Section 6 Report Review

Attachment to letter dated OCT 2 0 2003

Project: Implementation of Candidate Species Monitoring

Final or interim report? Final

Job #: WER09(72) **Grant #:** E-9

Reviewer's Station: Corpus Christi ES FO, Austin ES FO, Arlington ES FO

Lead station was contacted and concurs with the following comments:
___ Yes ___ No _X_ Not applicable (reviewer is from lead station)

Interim Report	Final Report
___ is acceptable as is	_X_ is acceptable as is
___ is acceptable as is, but the comments below need to be addressed in the next report	___ is acceptable, but needs minor revision (see comments below)
___ needs revision (see comments below)	___ needs major revision (see comments below)

Comments:

Texas Parks and Wildlife Department response to Section 6 Review Form attached to letter dated March 27, 2003
Project: Implementation of Candidate Species Monitoring
Job #: WER09(72)
Grant #: E-9
Prepared by: Lee Ann Linam
Date: August 29, 2003

FWS comments are in italics. TPWD response is in blue.

Please send us specific maps (including plots, if applicable) of confirmed locations for the following species:

Texas horned lizard – We are unable to comply with your request at this time. We have had data submitted from over 200 monitoring sites; however, maps from volunteers vary in scale and are not available for all sites. Our goal is to digitize locations based upon volunteer descriptions. When that task is accomplished, we will make a copy of the GIS file available to you. Until then, the county distribution map provided in the final report is the most detailed map available. (Contact person: Lee Ann Linam.)

Rydberg's scurfpea – Maps of the two sites monitored in Del Rio, Texas, are attached. (Contact person: Lee Ann Linam)

Big red sage – We provided a sketch of the site locations for the "subpopulations" in the final report; however, we now enclose a road map to show the location of the highway overpass in Boerne where the population is located. (Contact person: Lee Ann Linam.)

Horseshoe liptooth snail – Since over 700 randomly-located quadrats have now been sampled, it is not practical or possible to provide locations for all quadrats. We have however, provided maps of New Braunfels and Landa Park showing the boundaries of where sampling took place. (Contact person: Lee Ann Linam)

Navasota false foxglove (with all site numbers) – A map is enclosed. (Contact person: Dana Price)

Welder machaeranthera (with all site numbers) – Maps are enclosed. (Contact person: Dana Price)

branched gayfeather (with all site numbers) – Maps are enclosed. (Contact person: Dana Price)

Neches River rose mallow – A map is enclosed. (Contact person: Jackie Poole)

Please send us survey protocols/methods for plot selection and specific maps of confirmed locations for the following species:

Southern lady's slipper – These two sites were selected because they are sites located on state park property where monitoring is needed in order to assure no deleterious impact resulting from public access to the park. The site on Caddo State Park has been known fairly long and was historically reported by Nixon. The site on Atlanta State Park was first discovered by Singhurst in 1996. Although we tried to develop a volunteer-based monitoring project, this species proved problematic due to the unpredictability of its emergence. As a result, a monitoring procedure was never fully developed.

Since the conclusion of this Section 6 project, Jason Singhurst has initiated a much more thorough survey and monitoring effort for this species in East Texas, including these two localities. A description of his methods is attached. After his research project

provides more insight into this species, then it may be possible to design a more meaningful long-term monitoring approach. Maps of the two sites are attached. (Contact person: Jason Singhurst.)

fringed paintbrush – An error was made in the index page for this species. Although the correct scientific name is given, the common name should have been recorded as "tall paintbrush." A description of the survey protocols, etc., is provided, along with a map. (Contact person: Jackie Poole.)

Guadalupe Mountains fescue – A description of the survey protocols, etc., is provided, along with a map. (Contact person: Jackie Poole.)

Puzzle sunflower – A description of the survey protocols, etc., is provided, along with a map. (Contact person: Jackie Poole.)

Rafinesque's big-eared bat and southeastern myotis – The final report for this survey effort was submitted in 1998, and the principal investigator is no longer with TPWD; therefore, it is not possible to fully address all questions now submitted. We have compiled occurrence records for all localities where these species were collected during the study and made photocopies of corresponding maps. Please note, although Horner began this project in 1994, Section 6 funded only the 1997-98 monitoring of roosts. We have provided maps for all of the localities where Horner documented these species in 97-98 (these localities can be determined by examining the EOData and Comments section); however, we also have provided other occurrence records of these two species to you simply for your information. (Contact person: Lee Ann Linam for Peggy Horner.)

Western mastiff bat – The contract researcher has not yet provided a map for this project, although he indicates that one will be forthcoming. We will forward that to you when we receive it. (Contact person: Tom Lee, Abilene Christian University)

Karst monitoring materials – Texella is misspelled in the Texella reyesi guide. We would appreciate further involvement in the creation of the karst invertebrate field guide, and look forward to working with TPWD on developing monitoring protocols and priorities – We will note the spelling correction and continue to coordinate with you on this project. (Contact person: Mike Quinn)

Houston daisy and Texas windmill grass – There are letter codes under each of the year columns, including "Q" for "quantitative monitoring accomplished." Please explain what this exactly means, and provide us with the data collected. – When the letter "Q" occurs in the main table, it means that quantitative monitoring was conducted using the protocol described in the "Monitoring Plan for Houston Daisy." All data collected during quantitative monitoring was presented in the final report in the table titled "Intensive Houston daisy monitoring…" Any deviations in monitoring procedure, along with the notes from quantitative monitoring of Texas windmill grass, are described in the footnotes of that table. (Contact person: Lee Ann Linam)

Bracted twistflower – Please explain why there was in "incomplete survey conducted in 1998 at Barton Creek," and why the FM1283 ROW "site might have been overlooked" in 1999 and 2000. – In 1998 at Barton Creek our volunteers were simply unable to monitor all of Zippin's plots in the time available to them. In Medina county, rainfall was poor in 1999 and 2000, resulting in few Streptanthus apparent at any site. The FM 1283 ROW site was historically described as being located near a road cut 0.3 miles east of the junction of FM 1283 and CR 271; however, it was not until a good rainfall year was encountered in

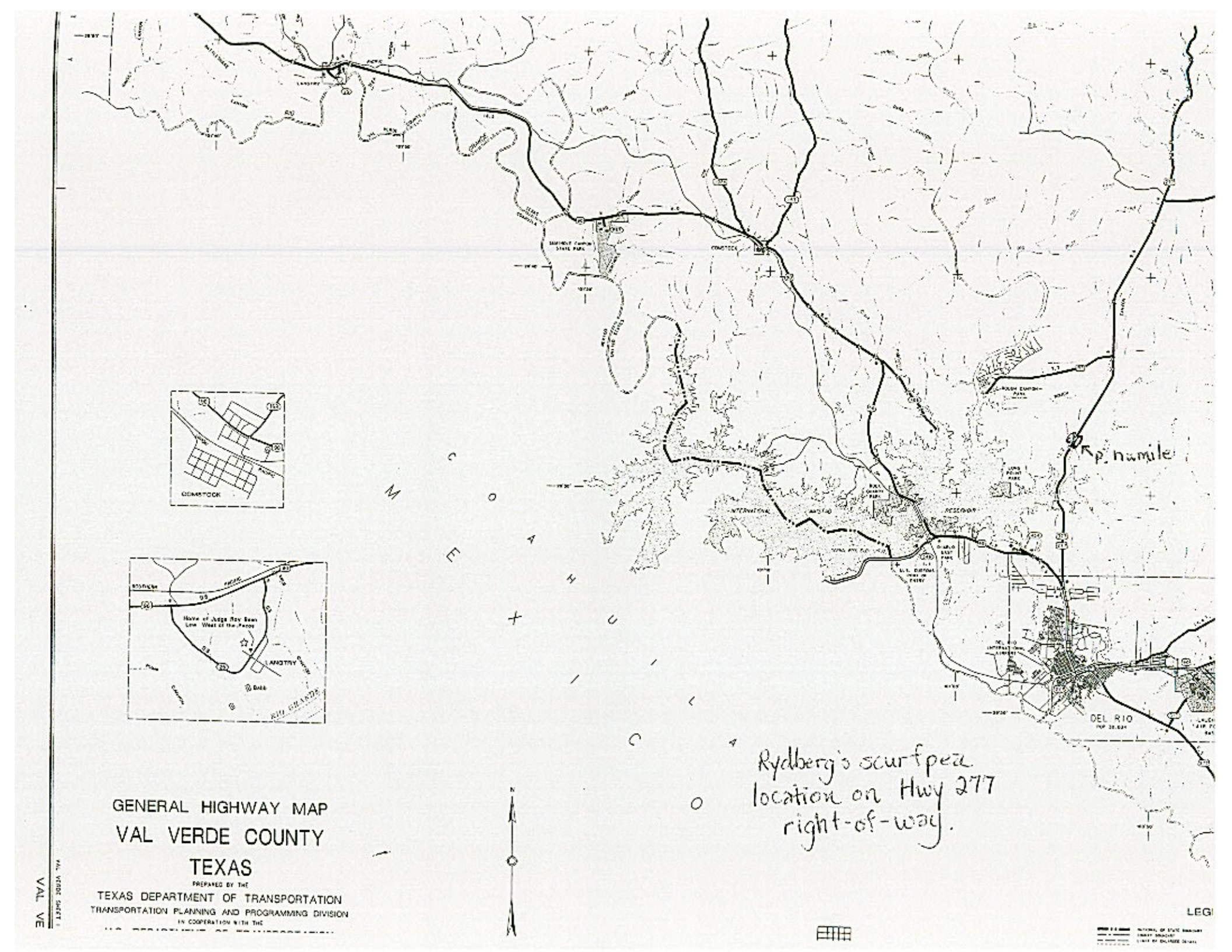
2001, that large numbers of Streptanthus were actually "discovered" growing on a road-cut approximately 0.6 miles east of the intersection. Because a few plants were found all along the ROW/fence boundary between the two roadcuts, that locality should actually be described as extending from the roadcut located 0.3 miles east of the intersection to just east of the roadcut located about 0.6 miles east of the intersection. I do believe that plants might have been located at the 0.6 mile roadcut in 1999 and 2000; however, their numbers were likely depressed, as were all other sites during those years. (Contact person: Lee Ann Linam.)

Maritime pocket gopher – It is not clear from the table of surveys at the Corpus Christi Naval Air Station if: 1) the area surveyed each visit was 35, 393 sq. ft., and 2) why protocol was not followed for countying "# Burrow systems marked – day 1" and "Total fresh mounds – day 1." Please provide answers/explanations. – Only a portion of the area was sampled during 1999; however, the entire field was sampled in 2000 and 2001. The area sampled has been determined, the data table has been updated (please note that incorrect units were supplied in the original table—these have been corrected as well), and an aerial photo is provided.

Regarding the protocols used, several experimental strategies were used during the several years of the study; however, day 2 burrow activity is a consistent parameter measured throughout the course of our monitoring. These species are difficult to monitor quantitatively (C. Rudolph, pers. comm.), and we were attempting to determine whether a one-day or two-day sampling scheme would be appropriate. We discovered that overnight burrow construction varies nightly. As a result, we recommend that the best population estimate could be obtained through counting burrow systems containing fresh mounds on day one. (Surveys should be conducted following a moist climate period.) A follow-up survey on day two could be used to gather further data on the variation in nightly mound construction activity. (Contact person: Lee Ann Linam)

Rafinesque's big-eared bat and southeastern myotis – A standardized form is mentioned with a list of information collected; however, the tables provided don't include all of this information. Please provide a complete table with all information recorded. – While we were able to locate copies of the data form mentioned (it is still used by our bat biologists), we were unable to recover all data sheets filled out by Peggy Horner. Some of the data recorded on these sheets may be available from the EORs included in this response. (Contact person: Lee Ann Linam for Peggy Horner.)

Reticulate collared lizard – A lot of great information was collected, unfortunately only bar graphs were provided in the report. Please provide tables with the data collected and maps of specific locations of the lizard. – Tables and maps provided by the principal investigator are attached. He indicated that raw data is not available in a tabular form. (Contact person – Jerry Husak, Oklahoma State University.)



GENERAL HIGHWAY MAP

VAL VERDE COUNTY

TEXAS

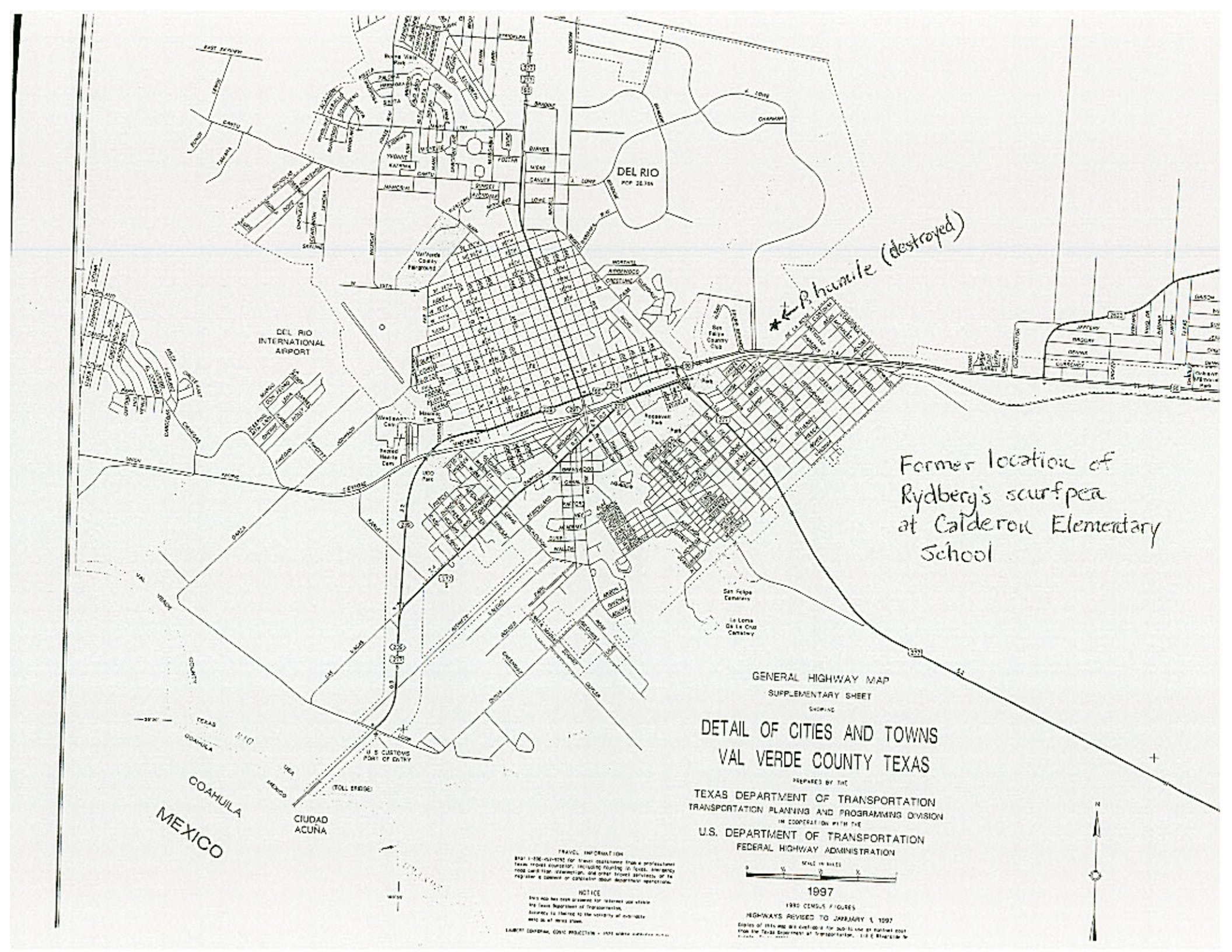
PREPARED BY THE

TEXAS DEPARTMENT OF TRANSPORTATION

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

IN COOPERATION WITH THE

VAL VERDE SHEET 1



Former location of Rydberg's scurfpea at Calderon Elementary School

← B humile (destroyed)

MAPQUEST

ORBITZ

Send To Printer Back to Map

Boerne TX
US

Notes: Location of highway right-of-way Salvia penstemonoides monitoring site

Book a Hotel:
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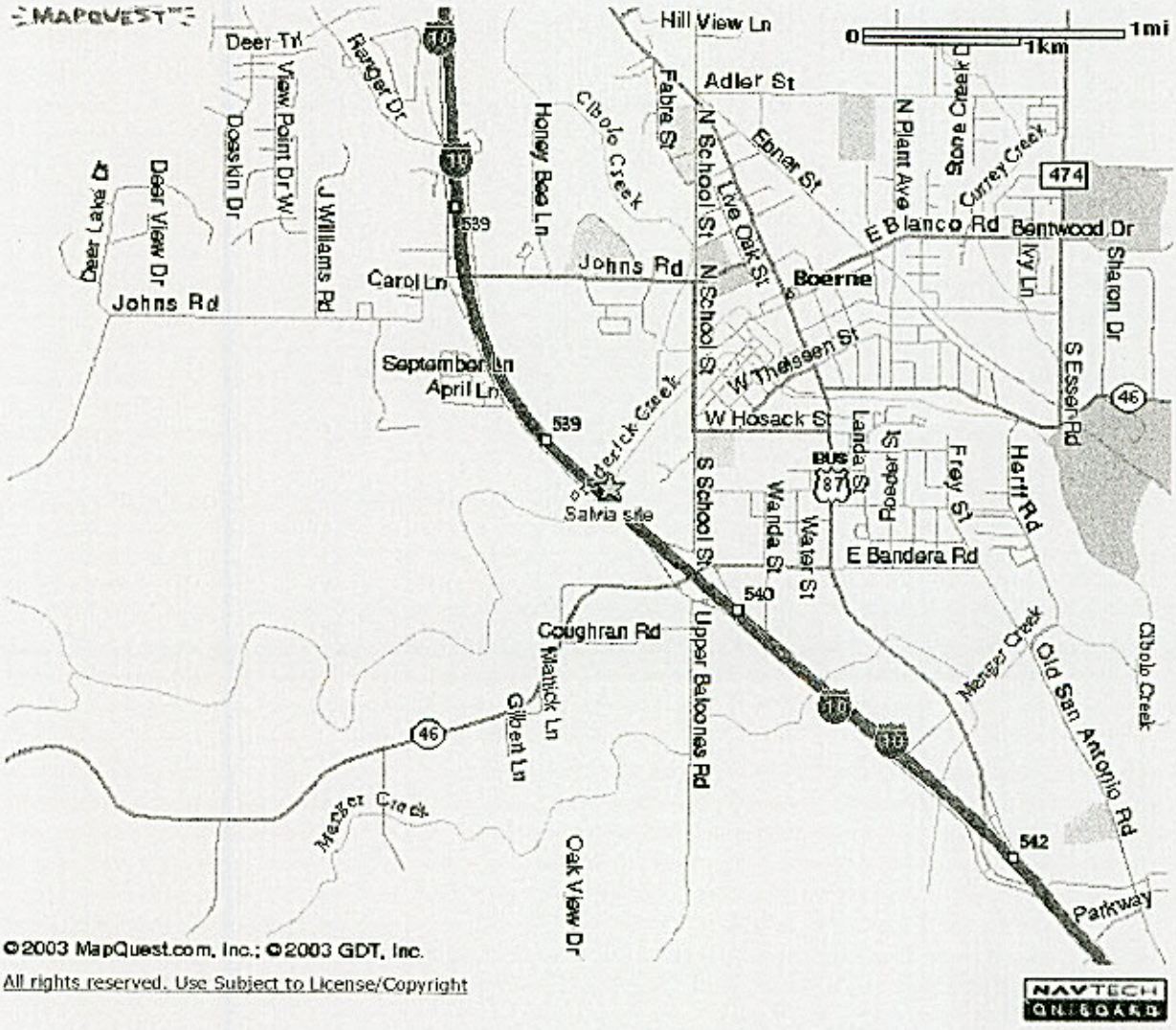
Orbitz Savers Nationwide!
Book Now!



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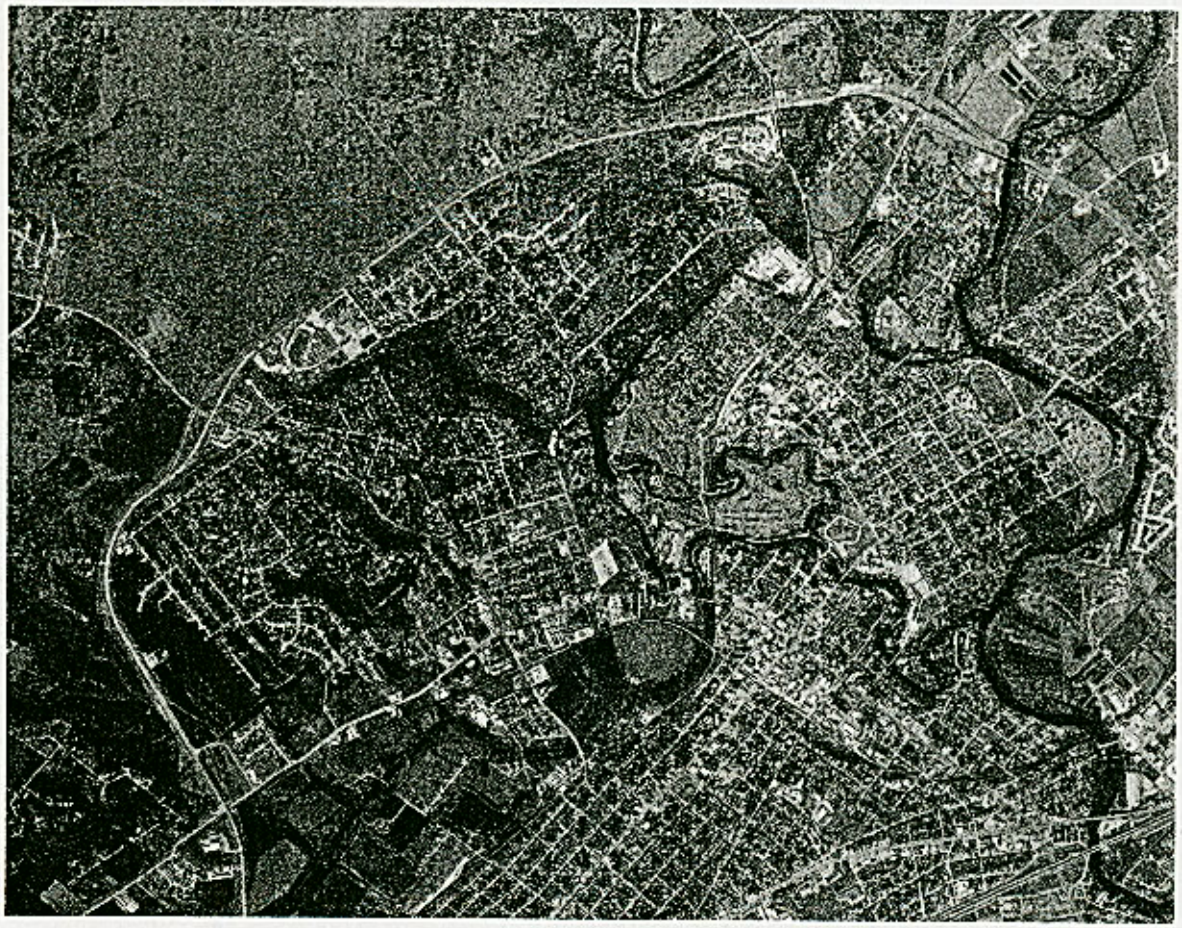
Location of study area within Landa Park, New Braunfels, Comal county, Texas.



2 0 2 4 Kilometers

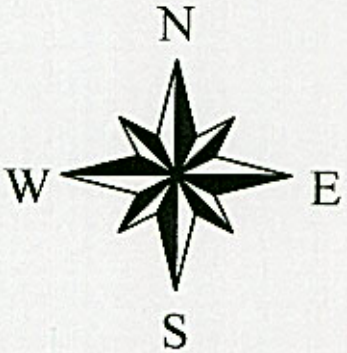
Sample area.shp

N
W E
S

Location of study site within Landa Park, New Braunfels, Comal county, Texas.



Study area.shp



Horseshoe liptooth snail sampling area at Landa Park, Comal county, Texas.



100 0 100 200 Meters

Sample area.shp

N
W E
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Agalinis navasotensis

Location: Grimes and Washington Counties

On 9/19/2001, WDP staff Dana Price and Jason Singhurst visited the two known localities with TAMU herbarium botanist Monique Reed and volunteer Lori Biederman. It was a good year for the plants. We observed about 500 plants at EOR #001 and 70 plants at #002.

After examining geologic and soil maps and digital imagery, we searched several nearby areas with outcrops. Oakville formation outcrops in Washington County were also examined. Some had other species of *Agalinis*, but no other populations of *A. navasotensis* were located.

On 10/02/2002, Dana Price visited the two EORs with Monique Reed and other TAMU faculty and students. This year the grasses (particularly little bluestem) were more dominant. *A. navasotensis* plants appeared healthy and vigorous, but only about 100 plants were observed at EOR #001 and about 20 plants at #002. Again this year, we unsuccessfully searched nearby localities that have similar soils and geology.

This species flowers in late September-October. As of September 5, 2003, we have not conducted any new surveys.

Psilactis heterocarpa

Location: Victoria, Refugio, San Patricio and Karnes Counties.

In 2000, Dana Price photographed this species for the rare plant book and in the process revisited the type locality (EOR #001) at Welder Wildlife Refuge as well as a few other EORs (#010, 018, and 024 were confirmed still extant). No quantiative monitoring was done.

In 2001, Greg Bowen, a reporter for the Victoria Advocate did a series of stories on this plant, the only globally-rare plant species known to occur in Victoria County. This spurred community interest in locating additional populations of the species. As a result, Dana Price conducted a workshop with community members to help them learn to identify the plant. Presentations were also given at the high school. This resulted on two new populations of *P. heterocarpa* being found on private land. One, in Karnes County, was discovered by amateur boatnist Pat Neill and Kenedy residents Erwin and Annie Kramer. This population was confirmed in November 2001 and contains hundreds of plants. A second new population on a ranch in Refugio County was reported by a high school student and her grandmother and was confirmed in October 2002. Hundreds or possibly thousands of plants are present on this ranch

In 2002, Lee Ann Linam and Dana Price revisited EOR #001 but in this wet year, found plants only in the drier area surrounding an oil-drilling pad. We gave a presentation on this species and other rare pants and animals of the coastal prairies for the Golden Crescent Nature Club in Victoria. Following this presentation, another population was reported on a private ranch in Goliad County, near the Refugio County line. This sighting has been confirmed by Don Kolle, a botanically-trained teacher in Victoria. Only two plants were seen on the site visit on November 14, 2002. However, the area where the landowner had first seen the plant had been trampled by cattle and affected by heavy rains, so the population may have been larger. On this date Dana Price and volunteer Pat Neill also revisited the Karnes County site and estimated at least 230 plants were present.

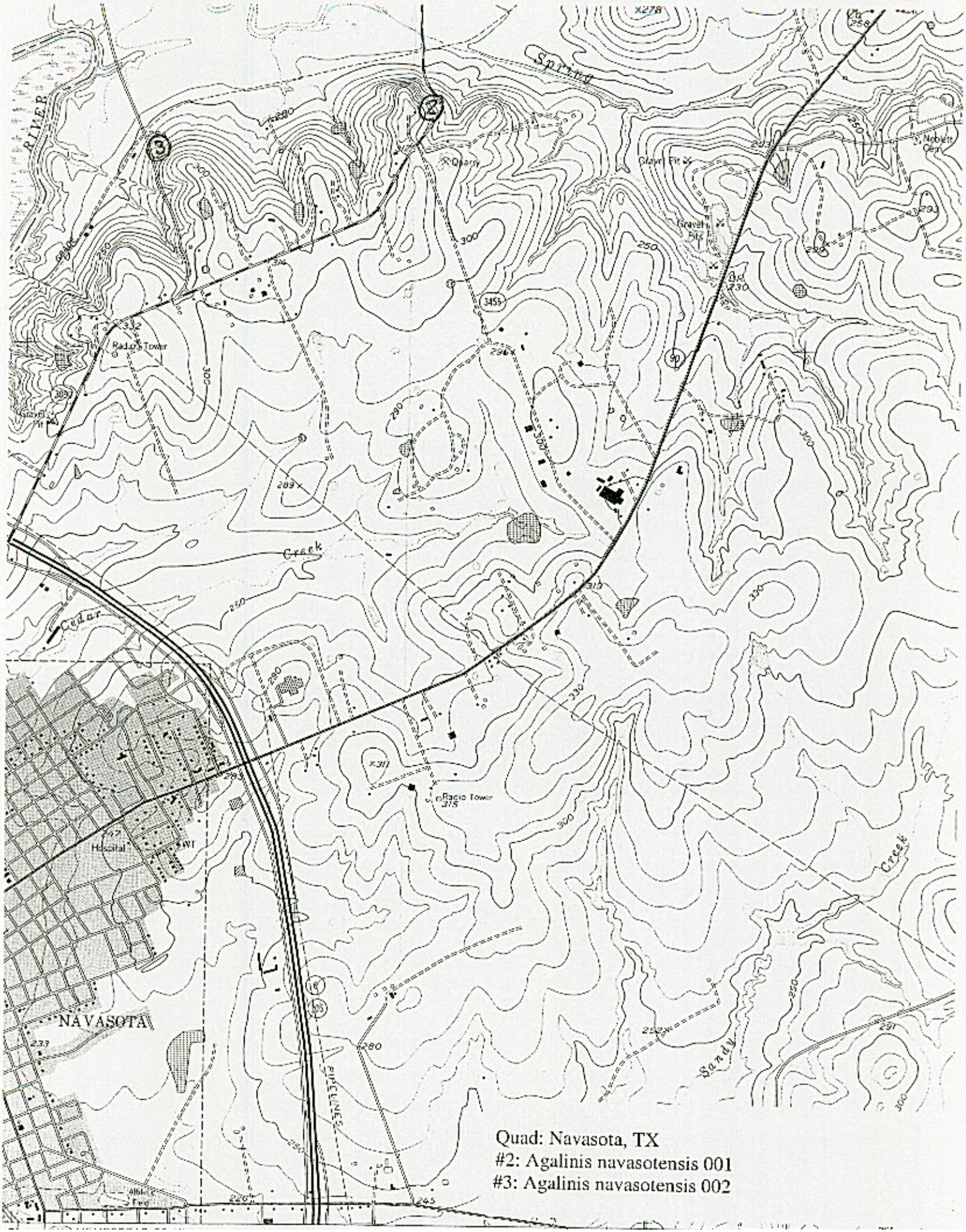
Liatris cymosa

Location: Brazos and Washington Counties

In 2001, a volunteer, Lori Biederman, trained in how to identify the species by meeting Dana Price at known sites (#016 and 024). She subsequently located 10 new populations of *L. cymosa* in and around College Station. Most of the sites were visited and confirmed by Dana Price in November 2001. Many of these are threatened by development. At one site where a new subdivision was being developed, Ms. Biederman obtained permission to remove seeds and corms. These plant materials were sent to the Lady Bird Johnson Wildflower Center to be included in their conservation collection.

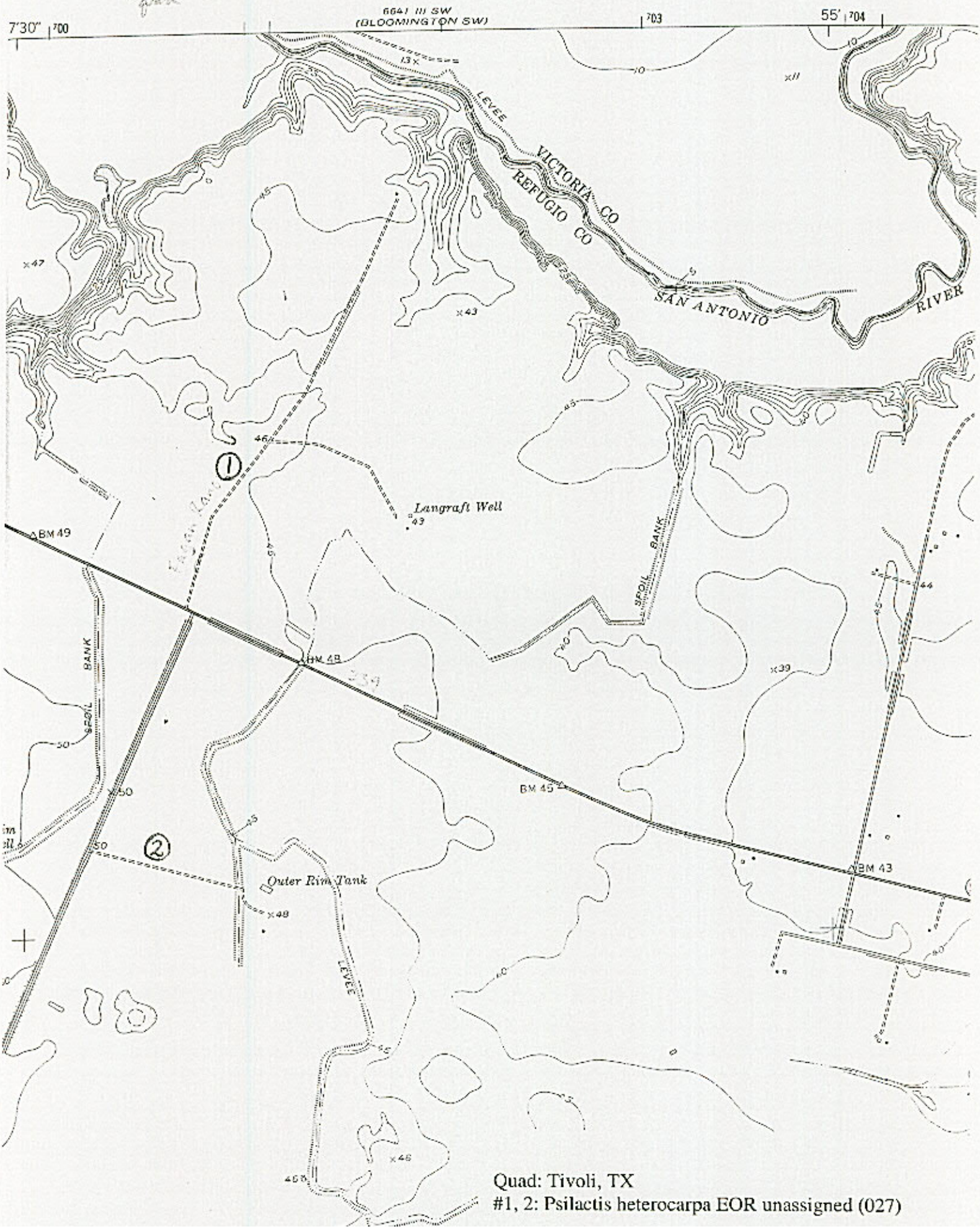
Ms. Biederman also revisited several previously known EORs. At the following locations, no plants were found: EOR#001, 002, 007, 013, 022, 025, and 026. Plants were present at the following sites: EOR#005 (40 plants; area is for sale), #011 (few plants), #012 (30-40 plants), #017 (14 plants in City arboretum), #019 (150 plants in City park).

In 2002, Lori Biederman (now a graduate student at TAMU) and Dana Price located three new populations of L. cymosa. One large population is on TAMU's range Science facility. Because the total number of EORs now is up to 40, the emphasis of work with this species will now shift to management at public-lands sites. No new surveys are planned for 2003.


Spring
RIVER
Quarry
Gravel Pit
Gravel Pits
Noblett Cem
Radio Tower
Creek
Cedar
Radio Tower
Hospital
NAVASOTA
Sandy
Creek
PIPELINES
Quad: Navasota, TX
#2: Agalinis navasotensis 001
#3: Agalinis navasotensis 002



Quad: Fannin, TX
#1: Psilactis heterocarpa EOR unassigned (028)



Quad: Tivoli, TX
#1, 2: Psilactis heterocarpa EOR unassigned (027)

Report on *Liatris cymosa* survey to College Station F02PRI06TXUS
Dana Price and Lori Biederman
28 August 2002

***Liatris cymosa* 038:** Texas A&M range area south of easterwood Airport. Followed main gravel road south of buildings, then minor dirt road between two drainages to open fields near tank and buildings. Area appears to be somewhat disturbed by construction of dam and powerline (part of area is under powerline R-O-W); burned in the past (some charred woody stems remain). Many clusters of *Liatris cymosa* in varying numbers, both north and south of the road crossing the dam. Total population contains at least 250 plants. Associates included sparse *Schizachyrium scoparium*, *Helenium amarum* and *Chamaecrista fasciculata*. *Liatris mucronata* present but not in flower yet. Lori collected a specimen to be deposited at TAES.

Lori's notes (per email 8/29/02):
Range Area. Near large tank rimmed with buildings. Between tanks. Disturbed site with sparse bluestem, partridge pea. Gravelly soil, not very diverse area. Also in Utility ROW south of this area and in an old field. Plants seem shorter and stockier than last year. Voucher? Yes
August 28, 2002 with Dana Price.

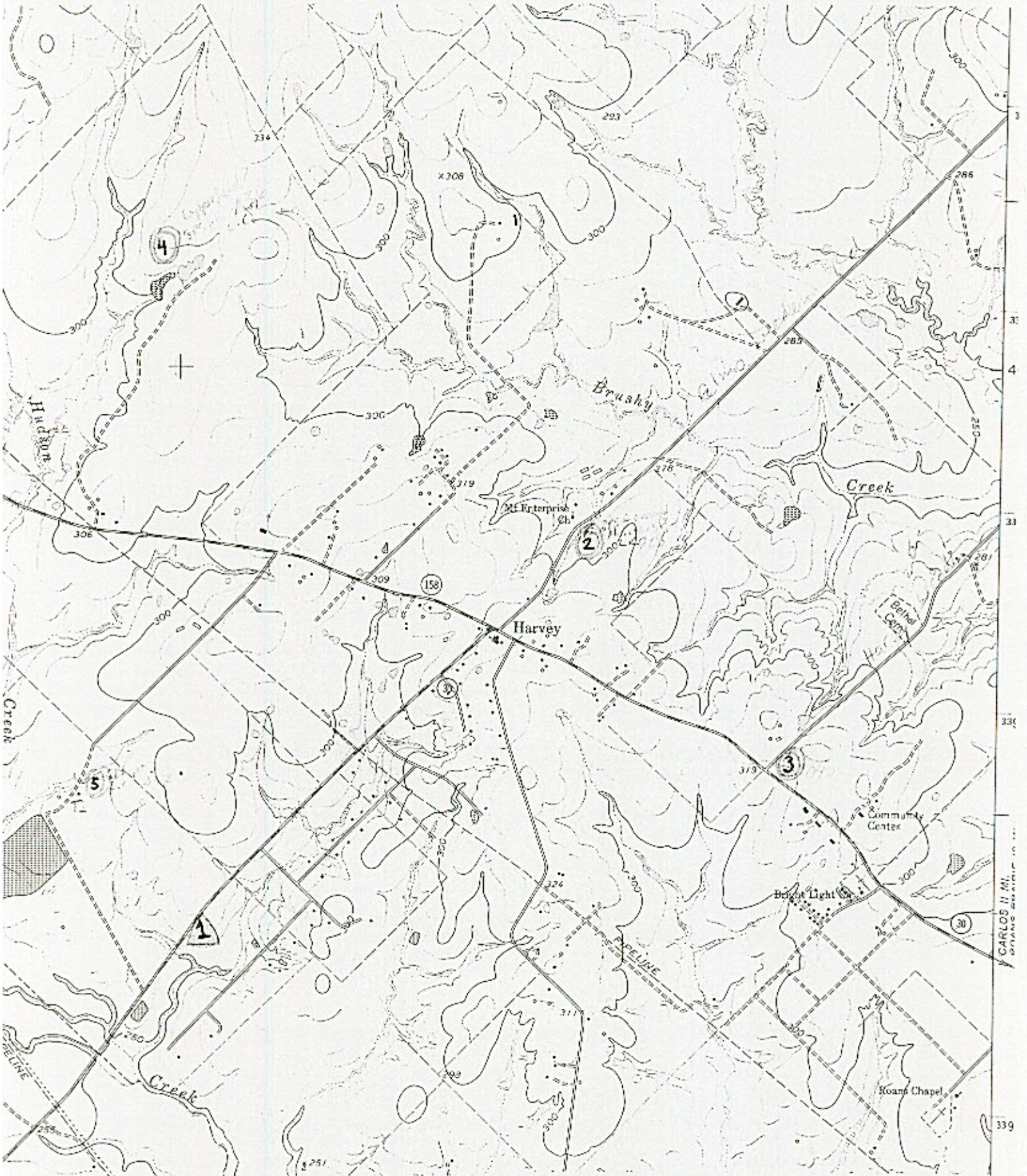
***Liatris cymosa* 039**: Dowling Rd. 0.8 mi W of FM 2818. Road curves here. About 50 plants in mowed area with native herbaceous vegetation, between Dowling Rd. and loop that gives access to several driveways. Partly under powerline R-O-W. Lori collected a specimen.

Lori's notes (per email 8/29/02):
Dowling Road. Aproximately 50 plants in a ROW island between Dowling road and utility corridor (north of Beeler). Plants are in the lower area in the center. Recently mowed. Voucher? Yes
August 28, 2002 with Dana Price.

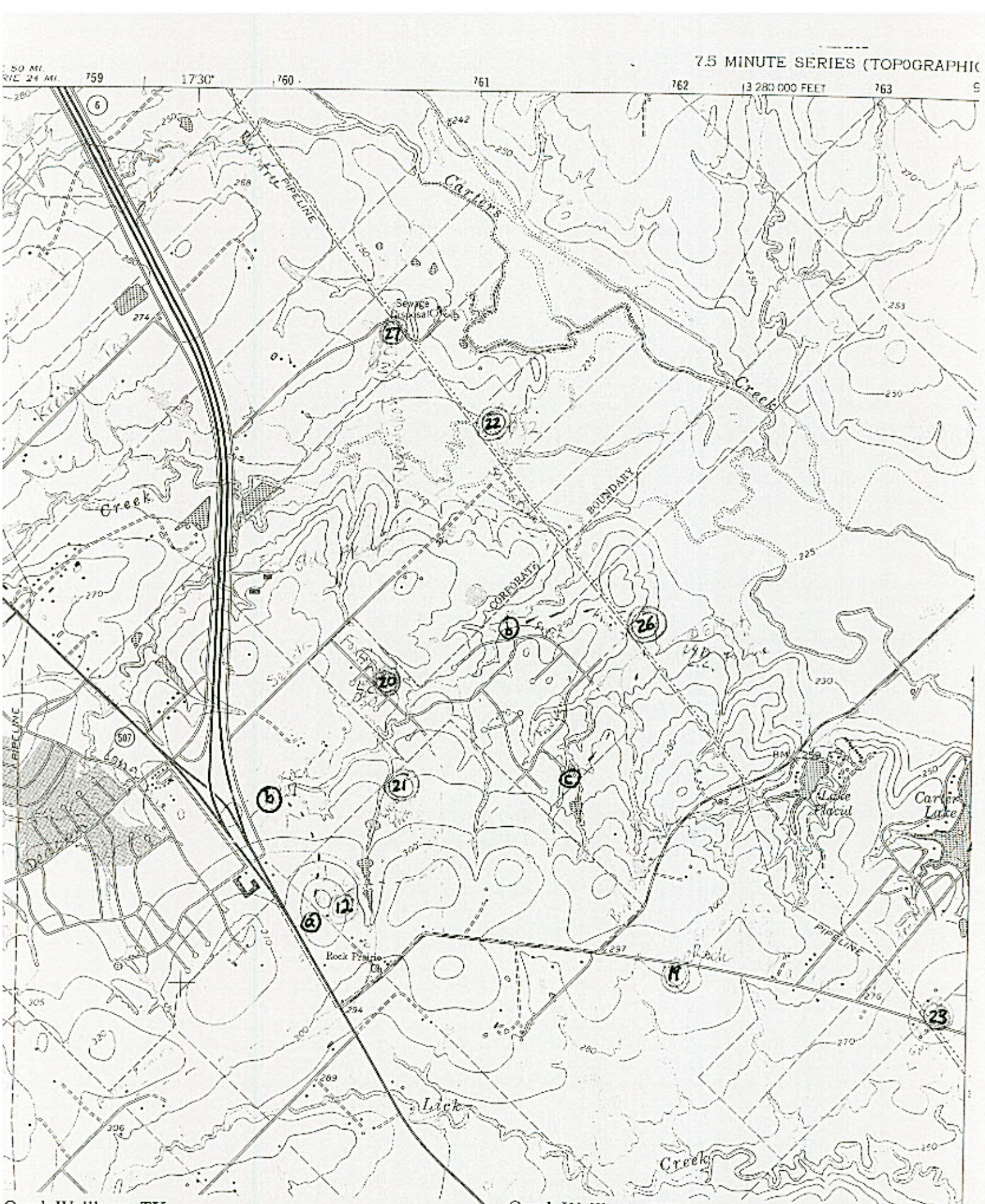
***Liatris cymosa* 040**: South side of Hardy Weedin Road, ca 50m east of SH 30. (Hardy Weedin is 0.9 mi S from the corner of SH 30 at Harvey, where the highway turns south) About 45 plants in unmowed strip along fenceline. Adjacent land is pasture with very few forbs, but a few *L. cymosa* plants are visible from the road.

Lori's notes:
Hardy Weedon Road. 40-50 plants on the southside of Hardy Weedon Road between barbed wire fence and mowed area. Sparse short grasses. There are a few plants in the adjacent field. Spared from mowing because of fence row?
Voucher? No
August 28, 2002 with Dana Price.

On this date the Andesron Arboretum was also visited and we observed a total of 12 plants (EOR#**017**) on edges of mowed area and paths.

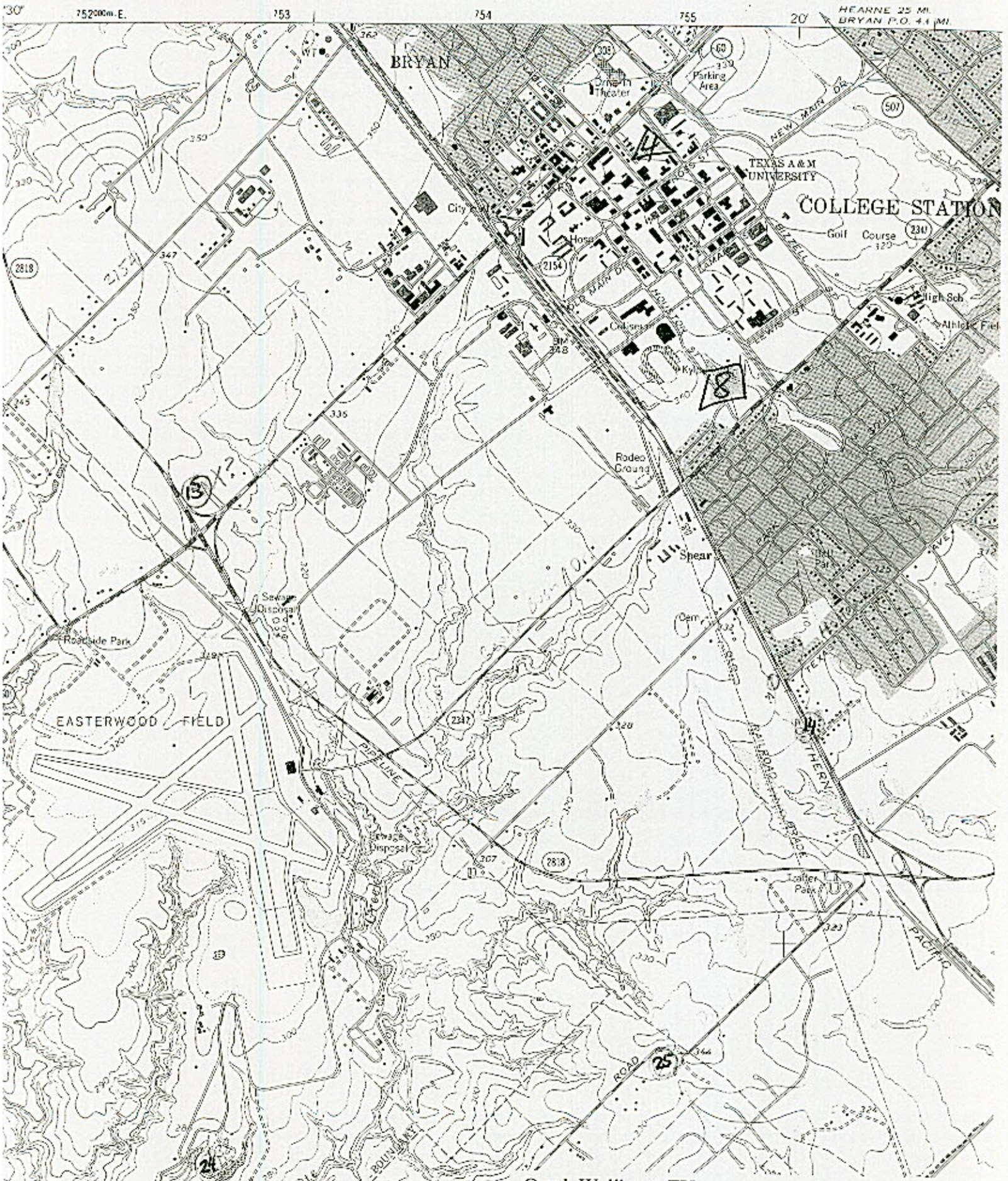


Quad: Bryan East, TX
#1: Liatris cymosa 013
#2: Liatris cymosa 028
#3: Liatris cymosa 040
#4: Liatris cymosa 037

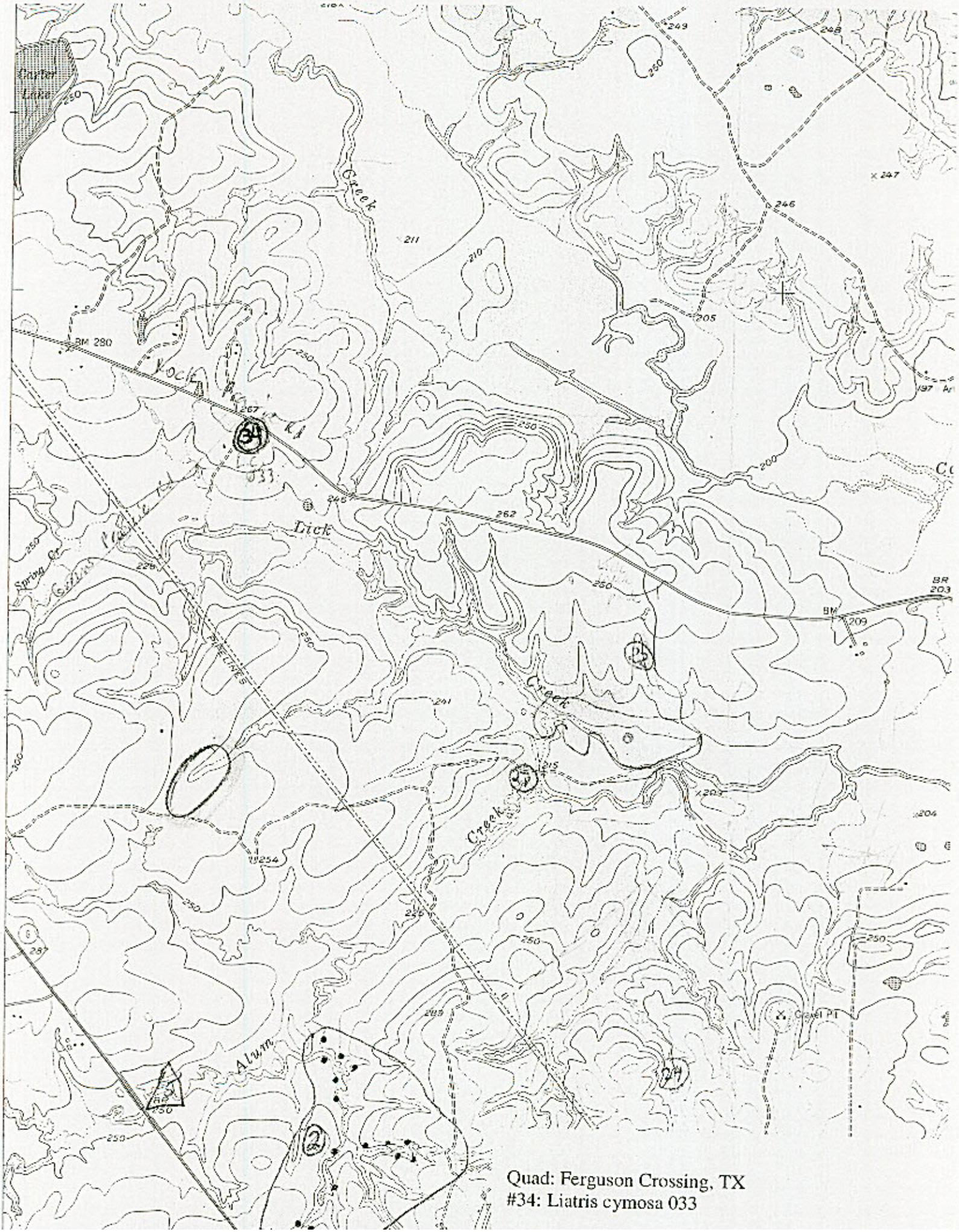


Quad: Wellborn, TX
#22: Liatris cymosa 032
#23: Liatris cymosa 034
#26: Liatris cymosa EOR unassigned

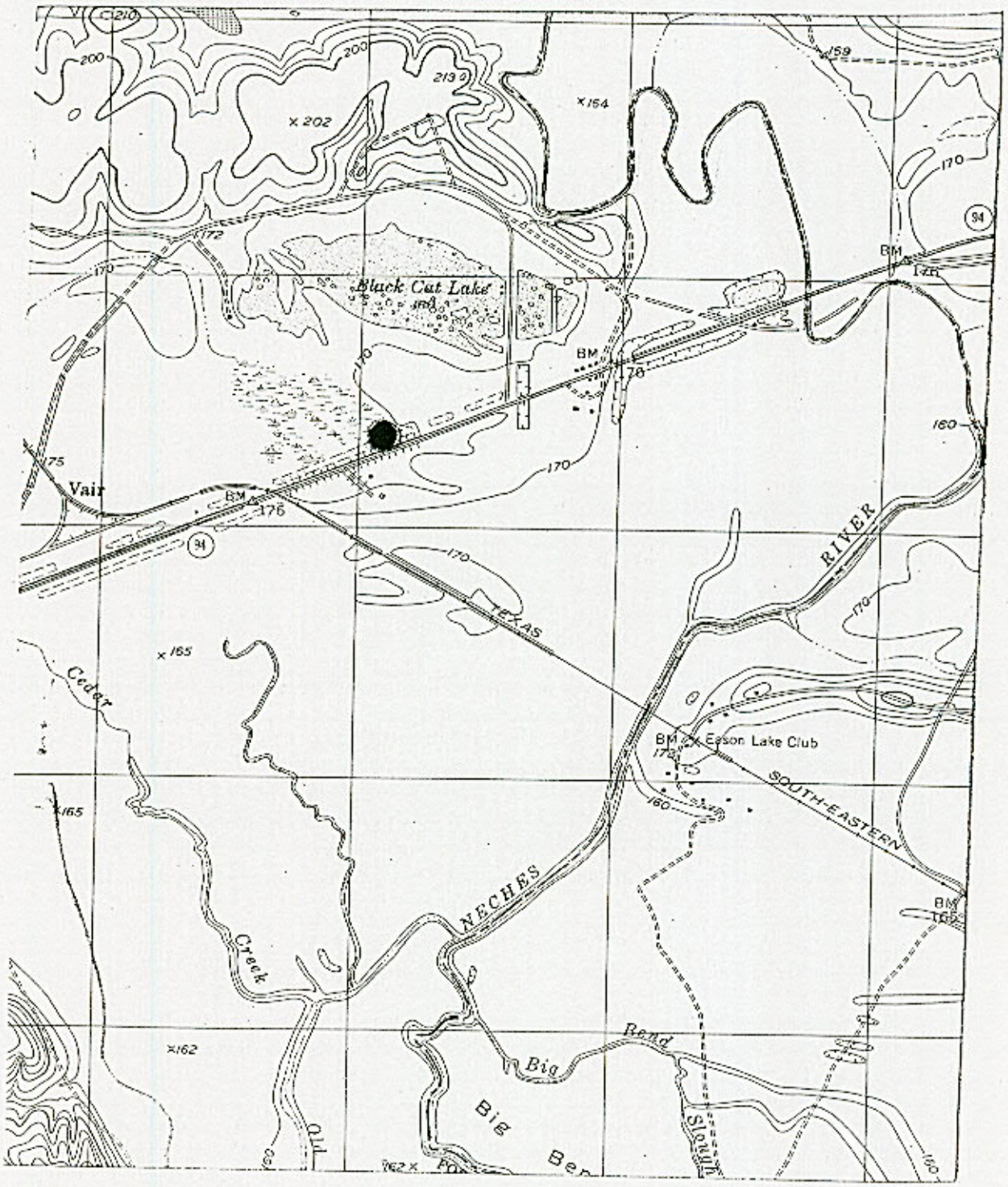
Quad: Wellborn, TX
#12: Liatris cymosa 031
#19: Liatris cymosa 029
#20: Liatris cymosa 030



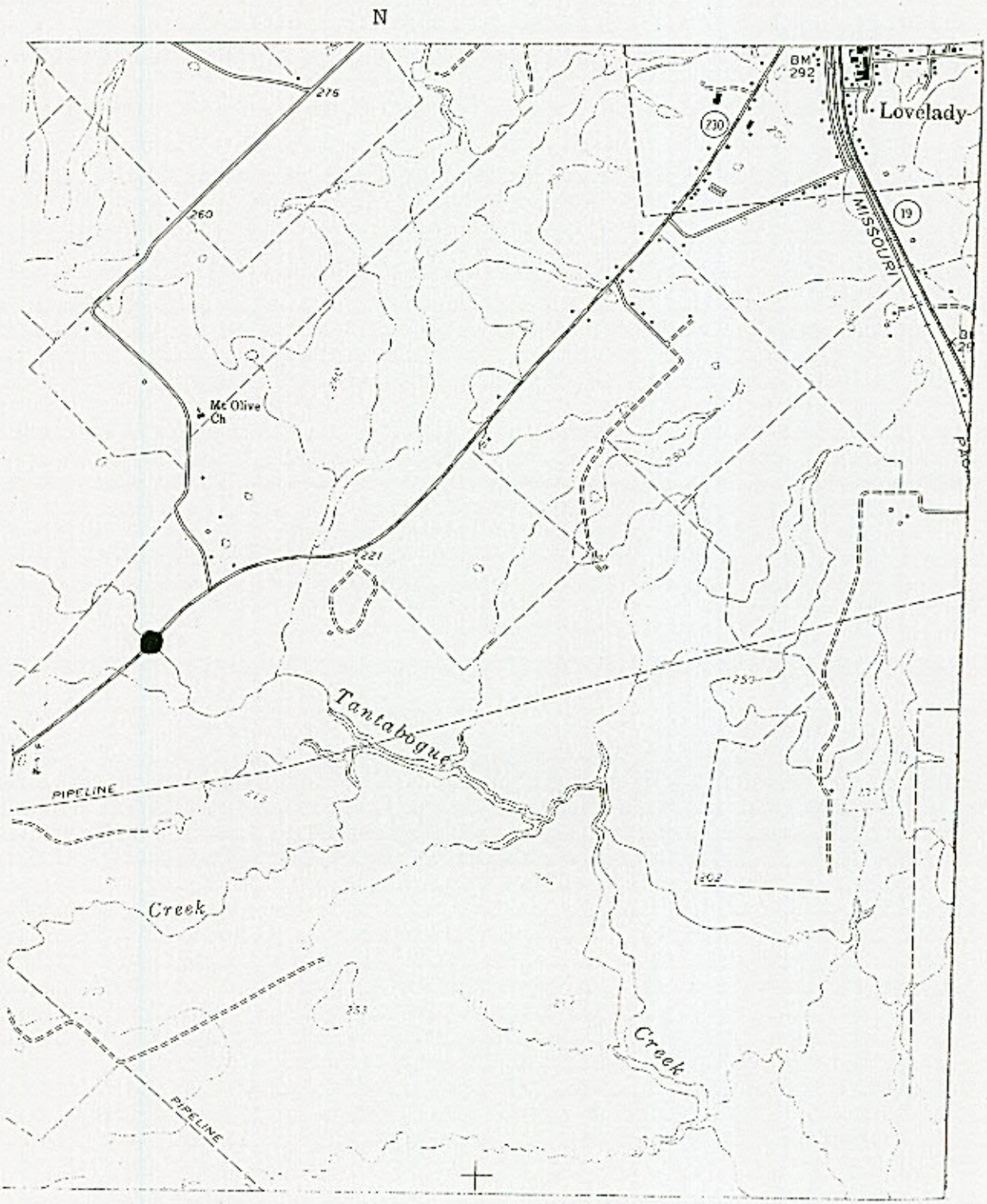
Quad: Wellborn, TX
#13: Liatris cymosa 021 (extirpated?)
#14: Liatris cymosa 026
#24: Liatris cymosa 038



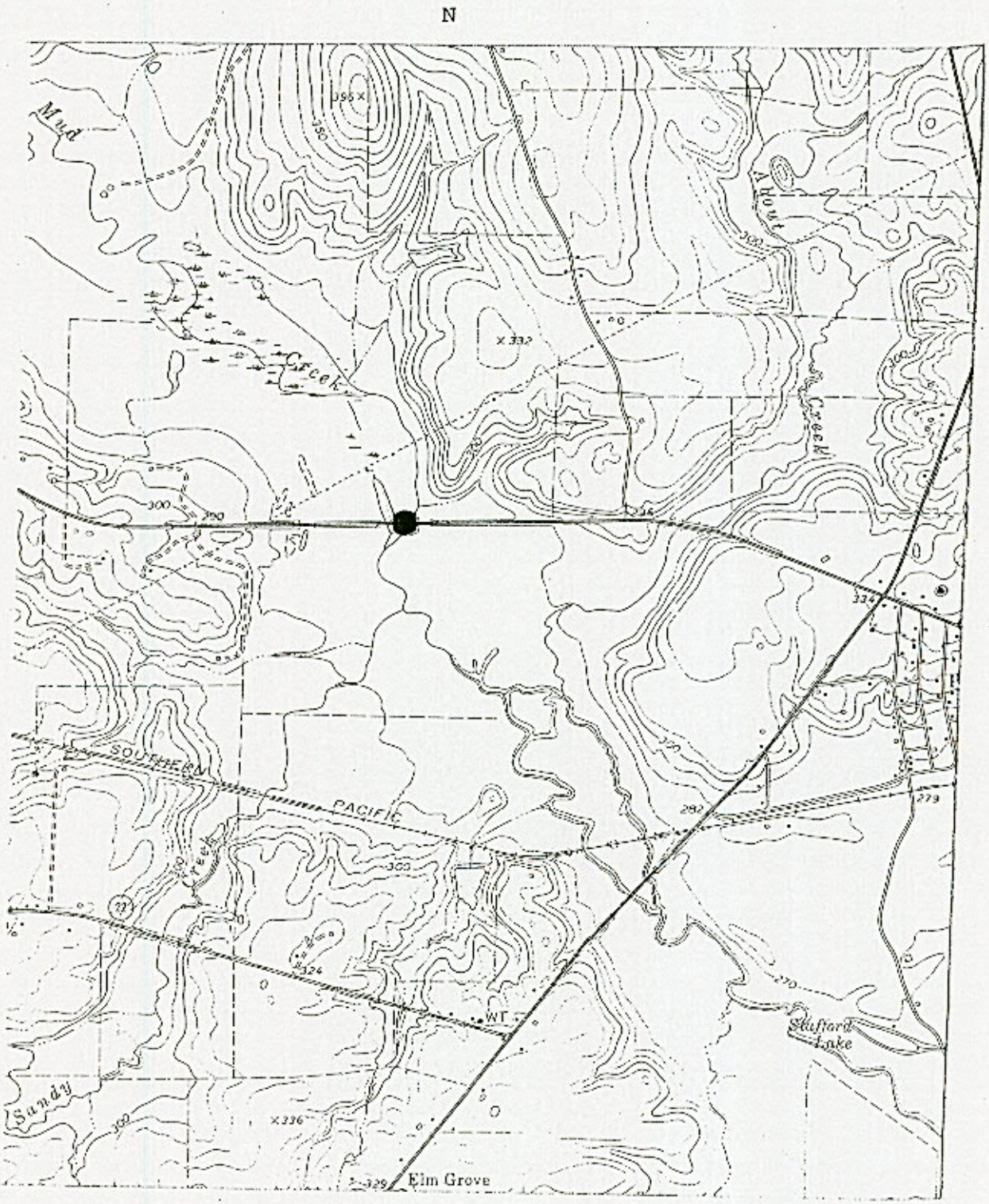
Quad: Ferguson Crossing, TX
#34: Liatris cymosa 033



Location of Neches River rose-mallow (Hibiscus dasycalyx) monitoring area in Trinity County, west of Neches River, Hwy 94

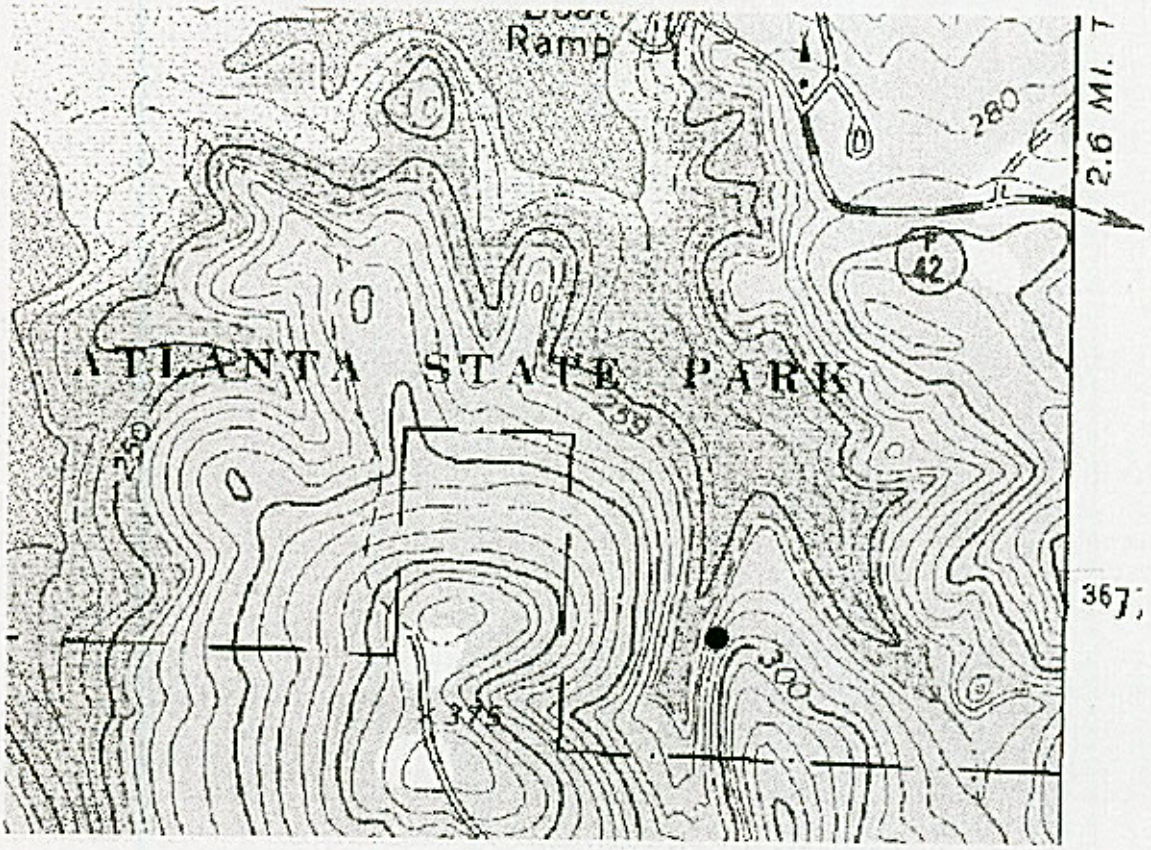


Location of Neches River rose-mallow (Hibiscus dasycalyx) monitoring area in Houston Co., SW of Lovelady, Hwy 230



Location of Neches River rose-mallow (Hibiscus dasycalyx) monitoring area in Cherokee Co., W of Ponta, Hwy 204

Cypripedium kentuckiense (Southern Lady's Slipper Orchid) at Atlanta State Park

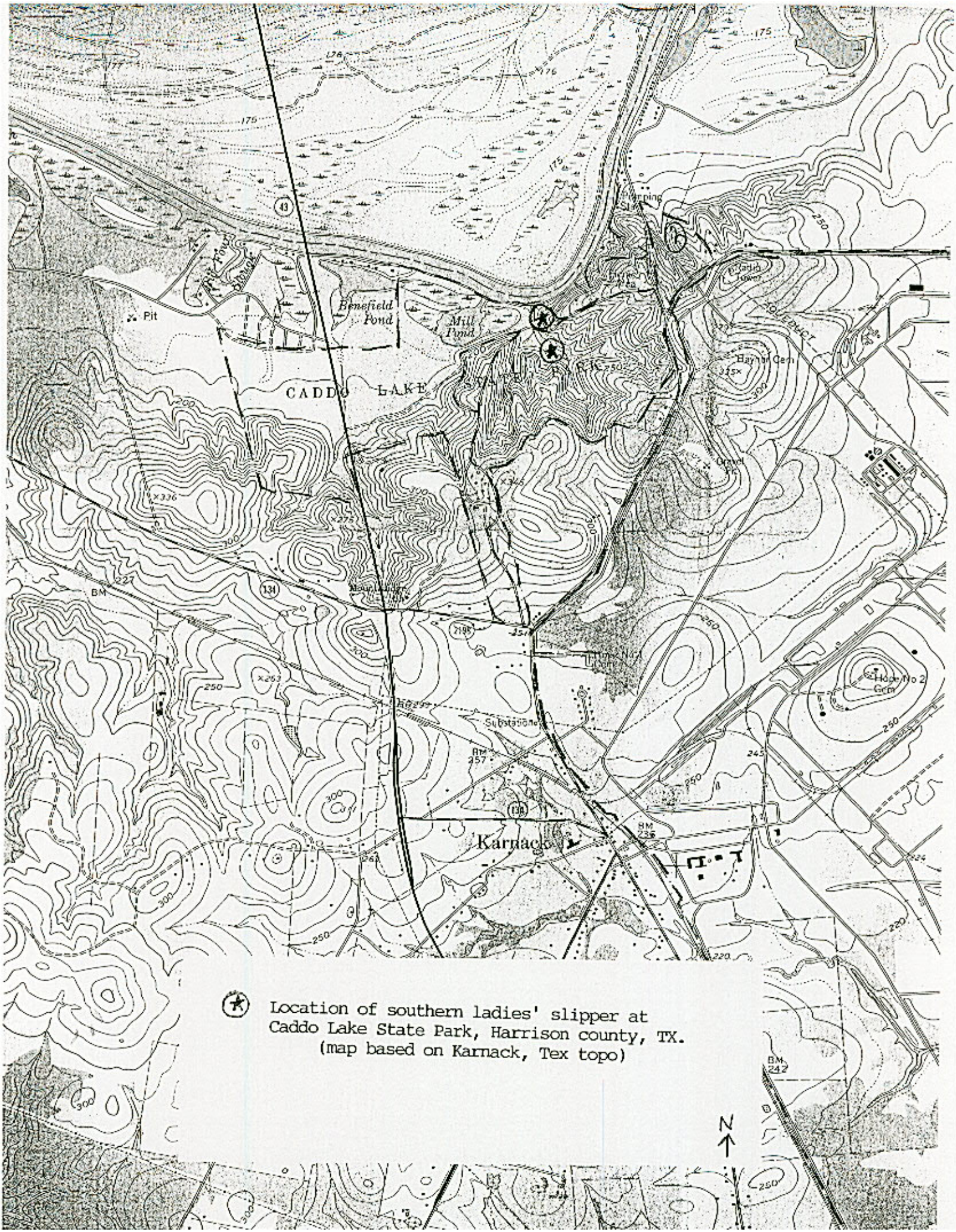


Douglassville Quadrangle (1:24,000)

Cass County, Texas

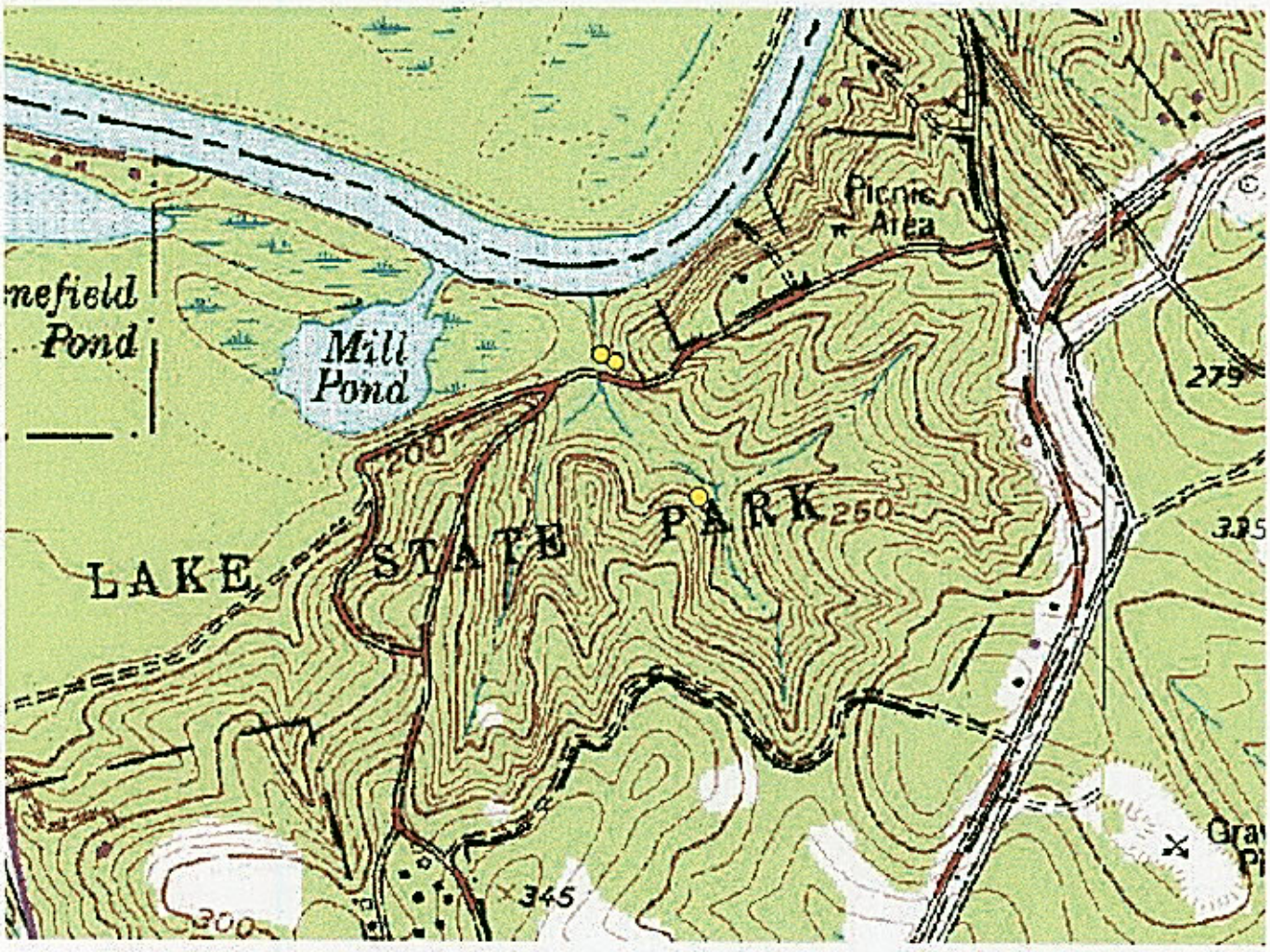
N

0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 Miles



Location of southern ladies' slipper at
Caddo Lake State Park, Harrison county, TX.
(map based on Karnack, Tex topo)

Cypripedium kentuckiense (Southern Lady's Slipper Orchid) at Caddo Lake State Park



Karnack Quadrangle (1:24,000)

Harrison County, Texas

N

0.3 0 0.3 0.6 Miles

Lee Ann Linam

From: Jason Singhurst [Jason.Singhurst@tpwd.state.tx.us]
Sent: Thursday, August 28, 2003 5:36 PM
To: 'lalinam@wimberley-tx.com'; Jackie Poole; Dana Price; Jason Singhurst; 'Tom Lee'
Cc: Craig Farquhar
Subject: RE: WER 09 Section 6 report revision

Lee Ann:

I pulled out the methods and deliverable from the Temple Inland and US Forest Service inventory work that I am conducting on Southern lady's slipper Orchid. They are the same protocols that I am using for Atlanta State Park and Caddo Lake State Park. FYI, these two state park sites are beyond the scope of the MOU I have between Tempe Inland and the USFS. I just through them in since they are on TPWD public lands. Is this the kind of information you need for your report?

Do you need a map of just the localities of Southern lady's slipper Orchid at Caddo Lake SP?

Regards

Jason Singhurst

Methods (Plants)

1. Survey 8 sites seasonally (spring, summer, and fall season visits) for 1 year.
2. Overlay digital ownership boundaries, forest roads, and soil layers on 1995 Digital Ortho-photography Quadrangles (DOQ) aerial photography with ERDAS Inc. Imagine 8.5 Software.
3. Photo-interpret DOQ's and delineate plant communities of concern and distinctive sites.
4. Conduct a floristic inventory of flora associated with each plant community of concern and distinctive site.
5. Collect plant vouchers of representative associated flora to be deposited at BAYLU Herbarium at Baylor University, Waco, Texas with a special collections place holder (collections can only be viewed via permission of TIFPC).
6. Photograph plant communities of concern, distinctive sites, and plant species of concern with a digital camera.

Deliverables

1. Inventory report containing site summary, floristic and avian species list, mapped areas of plant communities of concern and distinctive sites, and mapped location of plants of concern.

2. Inventory report, digital mapping layers (Arc/Info and shape file format) including point localities, plant community/association polygons, and associated tables, each archived on CD-Rom and submitted to TIFPC.

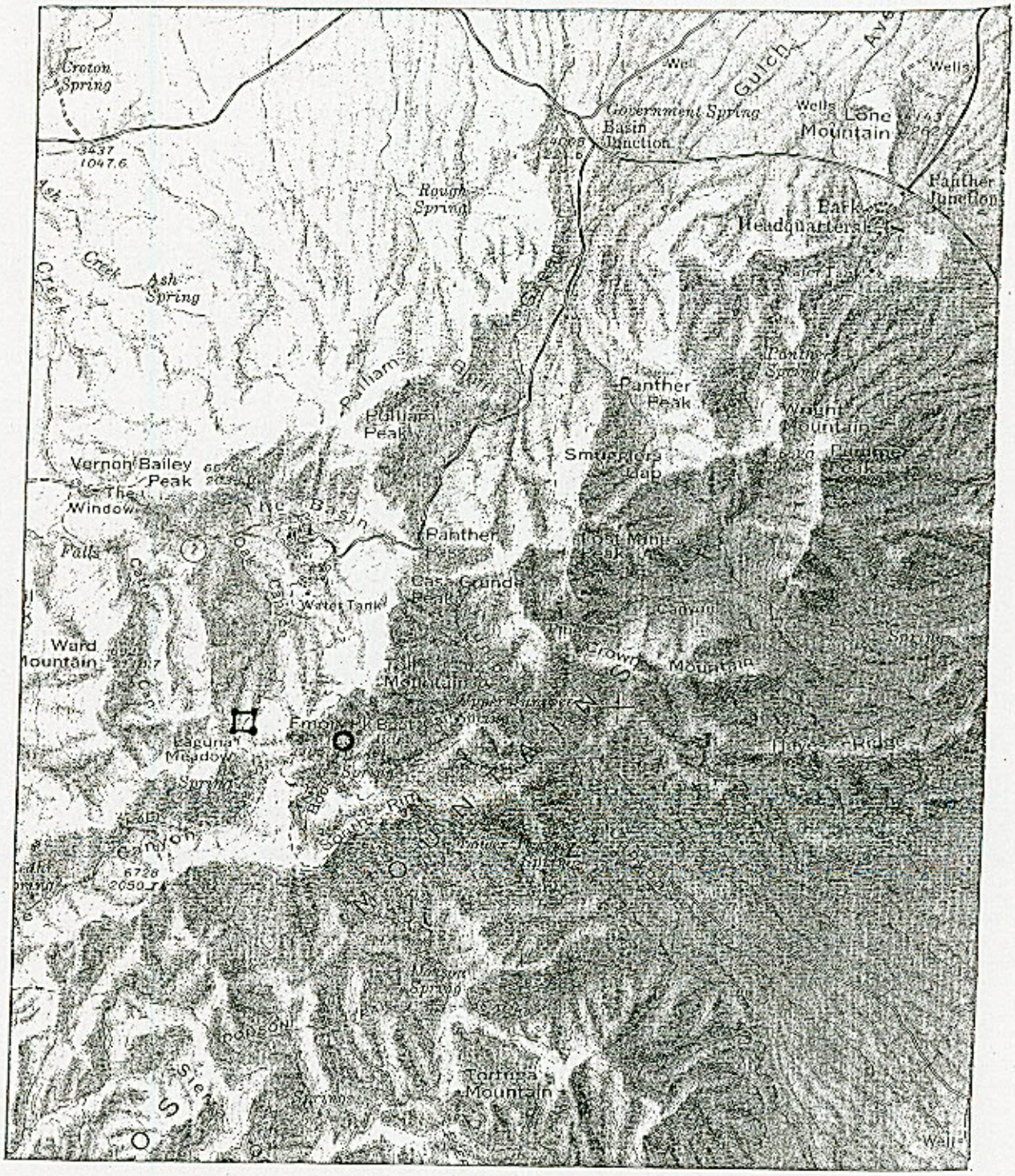
Survey protocols/methods for plot selection

Tall paintbrush (*Castilleja elongata*) – Two belt transects and one location by triangulation plot were established in the high Chisos Mountains of Big Bend National Park along the Laguna Meadows trail. The transects and the plot were placed in areas with high concentrations of tall paintbrush that were subjected to either fire succession or erosion. Belt transect one (a continuum of 25 1 m^2 plots) was located in a ten-year old fire scar to study the effect of succession on tall paintbrush. Cover, density, and frequency of all species in the plot were recorded, and plant height, number of stems, and reproductive condition of tall paintbrush were also measured. Belt transect two (a continuum of 13 1 m^2 plots) measured the same parameters as well as distance to and identity of nearest neighbor. Belt transect two was located perpendicular to the Laguna Meadows trail to evaluate the effect of the trail and of a newly constructed rock wall (that had buried two tall paintbrush plants). Tall paintbrush was located both above and below the trail and the rock wall. The location by triangulation plot pinpointed individuals of tall paintbrush both above and below the Laguna Meadows trail to determine the impact of the trail and subsequent erosion. Plant height, number of stems, reproductive condition, and distance to and identity of nearest neighbor were measured.

Guadalupe Mountains fescue (*Festuca ligulata*) – Six monitoring plots were established in the high Chisos Mountains in the vicinity of Boot Springs and Colima trails, the only known extant U.S. population of Guadalupe Mountains fescue. Plots were circular, 5 m in diameter, and were placed in concentrations of Guadalupe Mountains fescue. Each plot consisted of a rebar center stake and another rebar stake at 5 m due north. Guadalupe Mountains fescue individuals were identified by distance and bearing from the center stake. Presence/absence, number of inflorescences per plant, and number of spikelets per inflorescence were recorded.

Puzzle sunflower (*Helianthus paradoxus*) – In order to monitor the effect of Texas Department of Transportation (TxDOT) management on puzzle sunflower, a plot was established on highway right-of-way at the Diamond Y Creek crossing (ca. 8 miles north of Fort Stockton on Hwy 18). Originally the area was divided into 26 approximately equal 5 X 10 m subplots, on both sides of the highway and the creek. In 1992 a fiber optic cable severely disturbed the plot, and the stakes marking the sub-plots were lost. From 1992 on, four subplots were used (northwest, northeast, southwest, and southeast) following the crossing of the highway and the creek. Numbers of individuals of puzzle sunflower were counted within the subplots.

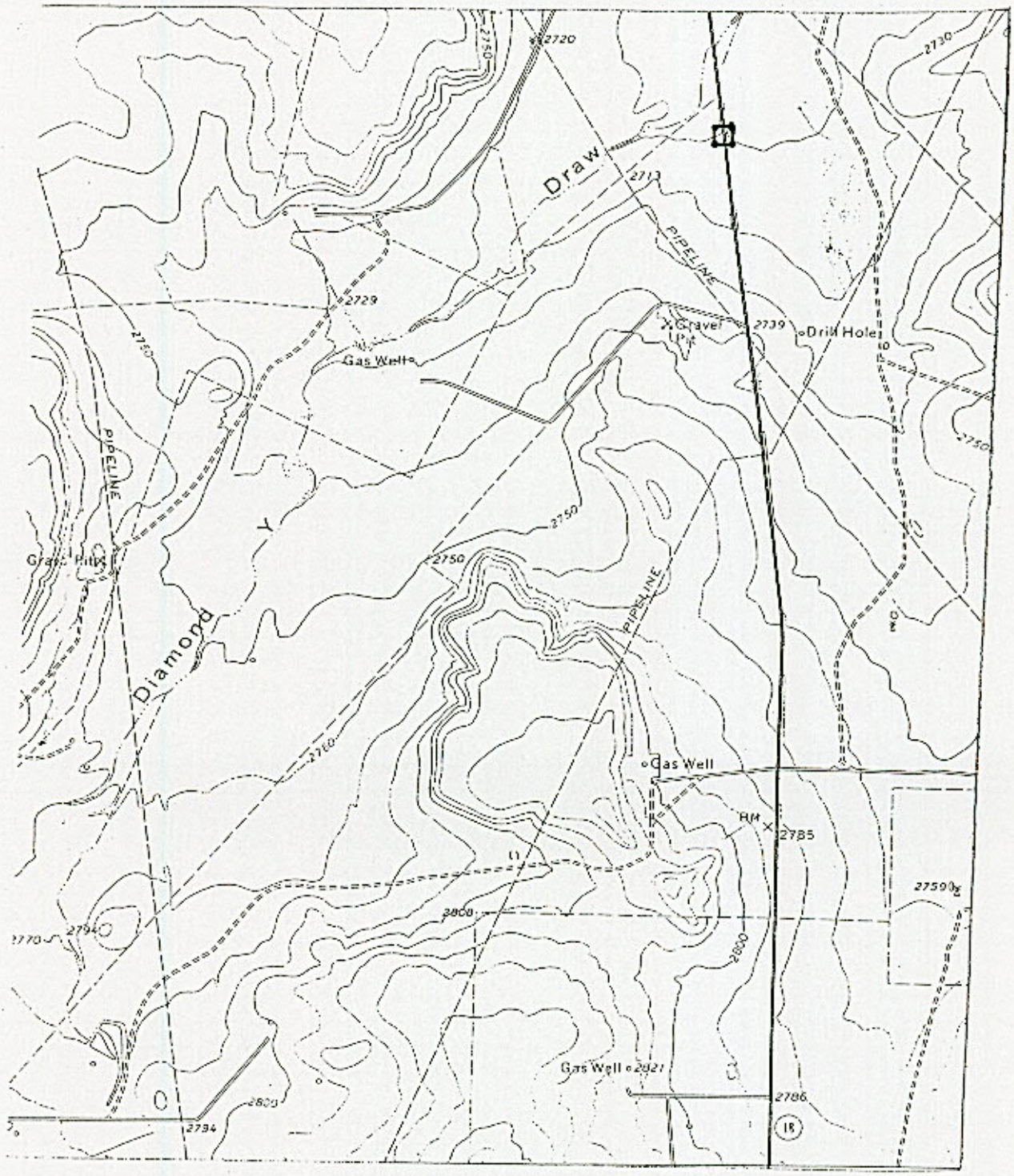
N



□ Location of fall paintbrush monitoring plots (upper Laguna Meadows trail, Big Bend National Park)

○ Location of Guadalupe Mountains fescue monitoring plots (Boot Springs and Colima trails, Big Bend National Park)

N



Location of puzzle sunflower monitoring plot

Pecos Co.: 10 miles north of Ft. Stockton

EOCODE: AMACC08020*005*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T

SNAME: CORYNORHINUS RAFINESQUII

SCOMNAME: RAFINESQUE'S BIG-EARED BAT

PLACENAME:

NATION: US SITECODE: S.USTXBP*19 SITENAME: BIG THICKET MEGASITE

PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXJFRS	Jefferson	VOTH	3009422	7	5,6

LAT: 301044N LONG: 0941059W S: 301041N N: 301047N E: 0941056W W: 0941102W

DIRECTIONS: AT HIGHWAY 96 NORTH FROM BEAUMONT JUST PAST CITY LIMITS AND JUST INSIDE BIG THICKET NATIONAL PRESERVE BOUNDARY; SOUTH OF PINE ISLAND BAYOU; VOTH MILL

NAT.REGION: WATERSHED:

04C UPLAND PRAIRIES & WOODS 12010005 SABINE RIVER (SABINE LAKE-TOLEDO BEND DAM)/COW BAYOU/CYPRESS/BOGGY CREEKS

SURVEYDATE: 1997-12-28 LASTOBS: 1998-08 FIRSTOBS: 1995-08-15 EORANK: ECRANKDATE:

EORANKCOM:

EODATA: IN 1995, ONE BIG-EARED BAT OBSERVED ROOSTING DURING THE DAY IN THE ABANDONED VOTH SAW MILL (ROOST #10); 12 OCTOBER 1996 ONE HIGH ON WALL; 0 IN FEBRUARY AND DECEMBER 1997; ONE IN MAY AND AUGUST 1998; 0 IN APRIL AND JUNE-AUGUST 1999

CONTACT:

EOTYPE:

GENDESC: ABANDONED SAW MILL CONSTRUCTED OUT OF CONCRETE WITH 20 FOOT CEILINGS

MINELEV: 10 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*40	BIG THICKET NATIONAL PRESERVE	FNPNP	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MGMTCOM:

PROTCOM: NPS IS CONSIDERING GATING THE ENTRANCE TO LIMIT ACCESS

OWNER: US:DOI/NPS OWNERINFO: Y

OWNERCOM:

COMMENTS: ACCESS TO AREA IS EASY; UNSUPERVISED GROUPS OF PEOPLE USE THE MILL AS TEMPORARY HOME AND/OR "PARTYING" AS EVIDENCED BY THE AMOUNT OF GRAFITTI, BROKEN BOTTLES, TRASH, AND CAMPFIRE RING; ROOST SUBJECT TO DISTURBANCE; ROOST #10 EAST TEXAS BAT SURVEYS

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:

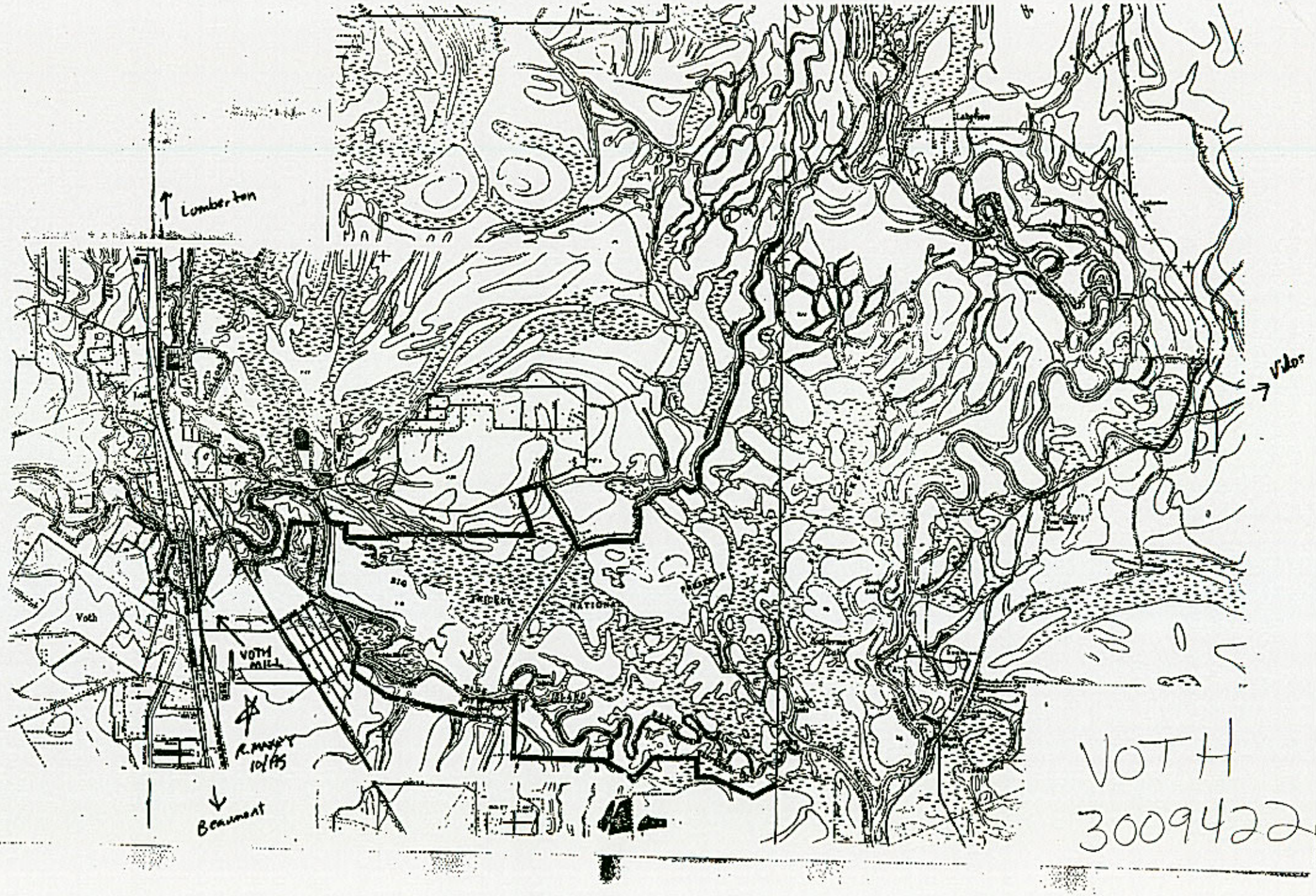
BESTSOURCE: MAXEY, RICKY. 1995. PERSONAL COMMUNICATION VIA PHONE AND FAX CONCERNING DISCOVERY OF PLECOTUS RAFINESQUII ROOST ON BIG THICKET NATIONAL PRESERVE PROPERTY.

ALL SOURCECODES:CITATIONS:

P95MAX01TXUS MAXEY, RICKY. 1995. PERSONAL COMMUNICATION VIA PHONE AND FAX CONCERNING DISCOVERY OF PLECOTUS RAFINESQUII ROOST ON BIG THICKET NATIONAL PRESERVE PROPERTY.

F96MIR01TXUS MIROWSKY, KATY. 1996. EAST TEXAS RARE BAT SURVEY: 1 JANUARY 1996-28 FEBRUARY 1997.

F97HOR01TXUS HORNER, M.A. 1997. EAST TEXAS RARE BAT SURVEY: 27-30 DECEMBER 1997.


Lumberton
Voth
VOTH mill
Beaumont
VOTH
3009422

EOCODE: AMACC09020*009*TX IDENT: Y SECTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T
SNAME: CORYNORHINUS RAFINESQUII
SCOMNAME: RAFINESQUE'S BIG-EARED BAT
PLACENAME:
NATION: US SITECODE: S.USTXPO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXHRDN	Hardin	SILSBEE	3009432	48	8,10
		VOTH	3009422	9	8,1

LAT: 301540N LONG: 0940942W S: 301443N N: 301544N E: 0940914W W: 0941054W
DIRECTIONS: 2.5 AIR MILES SOUTHEAST OF LUMBERTON, VILLAGE CREEK STATE PARK AND ADJACENT LANDS

NAT.REGION:
01B MIXED PINE-HARDWOOD FOREST
01A LONGLEAF PINE FOREST

WATERSHED:
12020006 VILLAGE/CYPRESS/BIG SANDY/BEECH/TURKEY/HICKORY CREEKS
12020007 PINE ISLAND/LITTLE PINE ISLAND BAYOUS/BATISTE/BOGGY/BLACK CREEKS

SURVEYDATE: 1997-12-28 LASTOBS: 1999-08 FIRSTOBS: 1995-10-26 EORANK: B EORANKDATE: 1995-10-26
EORANKCOM:

EODATA: TWO BIG-EARED BATS OBSERVED ROOSTING IN VILLAGE CREEK SP ROOST #4 IN HOLLOW BLACK GUM (NYSSA SYLVATICA) EAST OF CANEY SLOUGH/NORTH OF OLD LOGGING ROAD (WATER OAK TRAIL); FIRST OBSERVED SMALL CLUSTER OF BATS IN ROOST #12 YEAR-ROUND (ABANDONED CINDER BLOCK STRUCTURE NORTH OF VILLAGE CREEK); ON 96-09-20, ROOST 12 HAD ONE SOUTHEASTERN MYOTIS IN IT, ALONG WITH 22 BIG-EARED BATS; SINGLE BIG-EARED BAT IN ROOST #6 (BEECH TREE); ROOST #14 EQUAL SMALL CLUSTER IN WINTER (IN ABANDONED WOODEN STRUCTURE IN ATTIC); ROOST 4 AND 6 NOT MONITORED 97-12-28 DUE TO HIGH WATER; ROOST 12 HAD 11 AND ROOST 14 HAD 3 BATS 97-12-28; SEE SOURCES FOR LOCATION OF ROOSTS; FIRST DISCOVERY OF ROOSTS--ROOST #4 1995-10-26, ROOST #6 1996-09-10, ROOST #12 1996-07-16, ROOST #14 1997-02-03; ROOST #4 HAD ONE IN JUNE AND SEPTEMBER 1997 AND AUGUST 1998; ROOST #12 HAD 30 APRIL 1998, 10-25 IN MAY 1998, 20-25 IN AUGUST 1998, 18 IN MAY 1999, 22 IN JUNE 1999, 12 IN JULY 1999, 28 IN AUGUST 1999; ROOST #14 HAD 3 IN MARCH AND APRIL 1998, 7 IN AUGUST 1998, ONE IN APRIL 1999, 7 IN JUNE 1999, 15 IN JULY 1999, AND 9 IN AUGUST 1999

CONTACT:

EOTYPE:
GENDESC: MATURE BEECH-SOUTHERN MAGNOLIA AND WATER TUPELO-CYPRESS COMMUNITY SERIES WITH MANY POTENTIAL HOLLOW TREES AS ROOSTS; CANOPY MOSTLY CLOSED WITH UNDERSTORY MOSTLY OPEN; LARGE SLOW MOVING WATER BODY (VILLAGE CREEK) WITHIN QUARTER MILE OF ALL CAPTURES; ROOST IN BOTTOMLAND AREA IN STANDING WATER

MINELEV: 10 MAXELEV: 50 SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*177	VILLAGE CREEK STATE PARK	SPWPK	N

MORELAND: MORSPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: TX:TPWD OWNERINFO: Y
OWNERCOM:

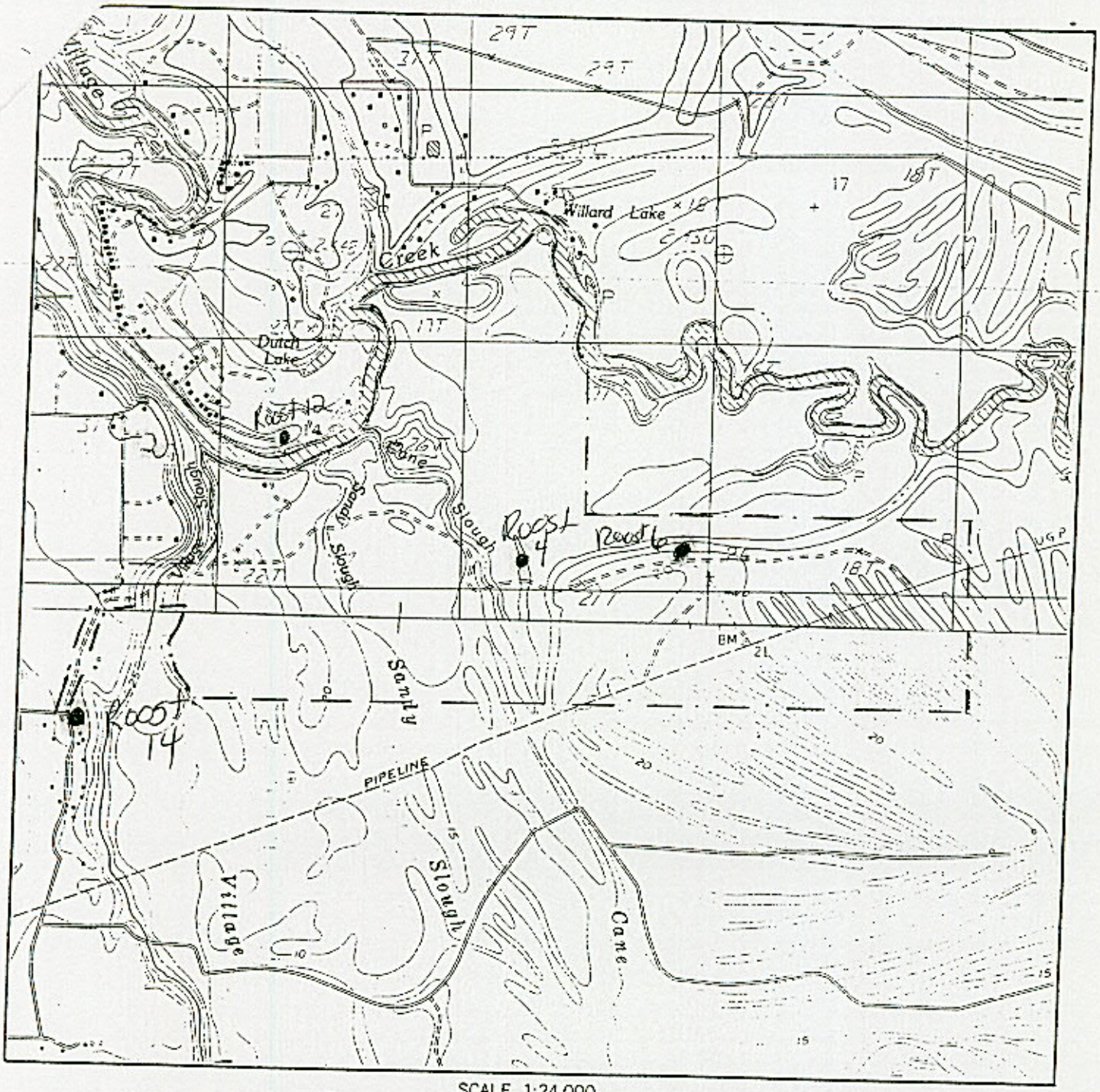
COMMENTS: ROOSTS #4, 6, 12, AND 14 EAST TEXAS BAT SURVEYS

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

DSBESTSOURCE:

1997 update on roost locations



Rafinesque's Big-eared Bat

Village Creek SP Roost 4, 6, 12, 14

EOCODE: AMACC01030*004*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT:
SNAME: MYOTIS AUSTRORIPARIUS
SCOMNAME: SOUTHEASTERN MYOTIS BAT
PLACENAME:
NATION: US SITECODE: S.USTXFO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXHRDN	Hardin	SILSBEE	3009432	34	8,10
		VOTH	3009422	8	8,1

LAT: 301540N LONG: 0940942W S: 301443N N: 301544N E: 0940914W W: 0941054W
DIRECTIONS: 2.5 AIR MILES SOUTHEAST OF LUMBERTON, VILLAGE CREEK STATE PARK AND ADJACENT LANDS

NAT.REGION:
01B MIXED PINE-HARDWOOD FOREST
01A LONGLEAF PINE FOREST

WATERSHED:
12020006 VILLAGE/CYPRESS/BIG SANDY/BEECH/TURKEY/HICKORY CREEKS
12020007 PINE ISLAND/LITTLE PINE ISLAND BAYOUS/BATISTE/BOGGY/BLACK CREEKS

SURVEYDATE: 1997-12-28 LASTOBS: 1999-07 FIRSTOBS: 1994-07-18 EORANK: D EORANKDATE: 1994-07-21
EORANKCOM:

EODATA: IN 1994, 14 CAPTURED IN MIST NETS OVER THREE NIGHTS IN THREE SEPARATE AREAS OF THE PARK; 11 FEMALES AND 3 MALES, MOSTLY ORANGE PHASE; MALES NOT REPRODUCTIVE; SOME FEMALES HAVE LACTATED IN PAST, SOME FEMALES NONREPRODUCTIVE; IN 1995, SEVERAL REPRODUCTIVELY ACTIVE FEMALES CAPTURED AND RADIO TRACKED TO MATERNITY ROOST, PLUS ONE SOUTHEASTERN MYOTIS (SUSPECTED BUT NOT CAPTURED TO VERIFY) OBSERVED ROOSTING IN VILLAGE CREEK STATE PARK ROOST TREE 2 (BLACK GUM), SOUTH OF VILLAGE CREEK SP ROOST 1; ON 96-09-20 ROOST 12 HAD ONE SOUTHEASTERN MYOTIS IN IT, ALONG WITH 22 BIG-EARED BATS--ROOST 12 IS A CINDER BLOCK ABANDONED BUILDING ACROSS VILLAGE CREEK (CIRCLE G RANCH); ROOST 2-6 COULD NOT BE CHECKED 97-12-28 DUE TO HIGH WATER, ROOST 12 WAS CHECKED, BUT NO SOUTHEASTERN MYOTIS; SEE SOURCES FOR LOCATIONS OF ROOSTS; MATERNITY ROOST (ROOST 2) DISCOVERED 95-05-26, ROOST 3 ON 95-10-04, ROOST 5 ON 96-01-30, AND ROOST 12 ON 96-07-16; ROOST 2 HAD <50 IN JUNE 1997, 10 IN JULY 1997, >50 APRIL AND AUGUST 1998, 0 MAY-JULY 1998, 80 MAY-JUNE 1999, 0 JULY-AUGUST AND DECEMBER 1999; ROOST 5 HAD ONE IN AUGUST 1998, ONE IN JULY 1999; ROOST 1 HAD ONE BAT OBSERVED IN JUNE AND JULY 1997; TOTAL OF 56 CAPTURED IN MIST NETS DURING 1994-1996

CONTACT:

EOTYPE:
GENDESC: MATURE BEECH-SOUTHERN MAGNOLIA AND WATER TUPELO-CYPRESS COMMUNITY SERIES WITH MANY POTENTIAL HOLLOW TREES AS ROOSTS; CANOPY MOSTLY CLOSED WITH UNDERSTORY MOSTLY OPEN; LARGE SLOW MOVING WATER BODY (VILLAGE CREEK) WITHIN QUARTER MILE OF ALL CAPTURES; ROOST IN BOTTOMLAND AREA IN STANDING WATER

MINELEV: 10 MAXELEV: 50 SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*177	VILLAGE CREEK STATE PARK	SPWPK	N

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: TX:TPWD OWNERINFO: Y
OWNERCOM:

COMMENTS: ROOST #'S 2, 3, 5 AND 12 EAST TEXAS BAT SURVEYS

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

DSBESTSOURCE:

NEW COUNTY RECORD (Y/N) Y Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOSTØ * 009 *TX FONUM: IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP* ..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: SC COUNTYCODE: TX NRDN COUNTYNAME: Nardin LOCALJURIS:

TX

TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT: 30 15 40	S: 30 14 4=
Silsbee	3009432	50		8,10		N: 30 15 44
Voth	3009422	10		8,1	LONG: 94 09 42	E: 94 09 14
						W: 94 10 51

DIRECTIONS: Multiple roosts within Village Creek SP & on adjacent private land

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: Ø1b Ø1a

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020006 12020007

	yr	mo	da		yr	mo	da		yr	mo	da
SURVEYDATE:				LASTOBS:	1999	08	?	FIRSTOBS:	1995	05	26

SRANK: (see code key) EORANKDATE:

SRANKCOM:

DATA: 26 May 1995 - Roost #2 discovered - maternity roost of Myotis austroriparius; June 1997 <50 and July 1997 10 M. austroriparius; 4 Oct 1995 Roost #3 discovered, possibly temporary or solitary ro (EOR.004)

LASTACTID: ... CONTACT.NAME: April, Aug 1998 >50 M. austro. May, June 1999 80 M. austro. CONTACT.NOTE:

HABTYPE:

HABDESC: Roosts #2 and 5 - Water tupelo; Roosts #3, 4 - black gum; Roost #6 - beach tree; Roost #12 cinder block structure; Roost #14 wooden structure

ELEV: 10 feet MAXELEV: 40 feet SIZE: acres

OWNCODE: MANAME: Village Creek SP MATYPE: CONTAINED: N (see code key)

PRIVLAND: MOREPROT: MOREMGMT: TNCINVOLVE:

PROTCOM:

MGMTCOM:

OWNER: OWNERINFO:

OWNERCOM:

COMMENTS: Roost #2-6, 12, 14 East Texas Bat Surveys ~~1994-1997~~

SPEC.TOPICS:

GEN.KEYWORDS:

ACCESS: BOUNDARIES: Y PHOTOS:

DATASOURCE: U98NOR01TXUS

SOURCECODES: ~~SPECIMENS:~~ (citation info. for specimens)

5NOR03TXUS F96MIR01 U96NOR01 U02ENN01TXUS

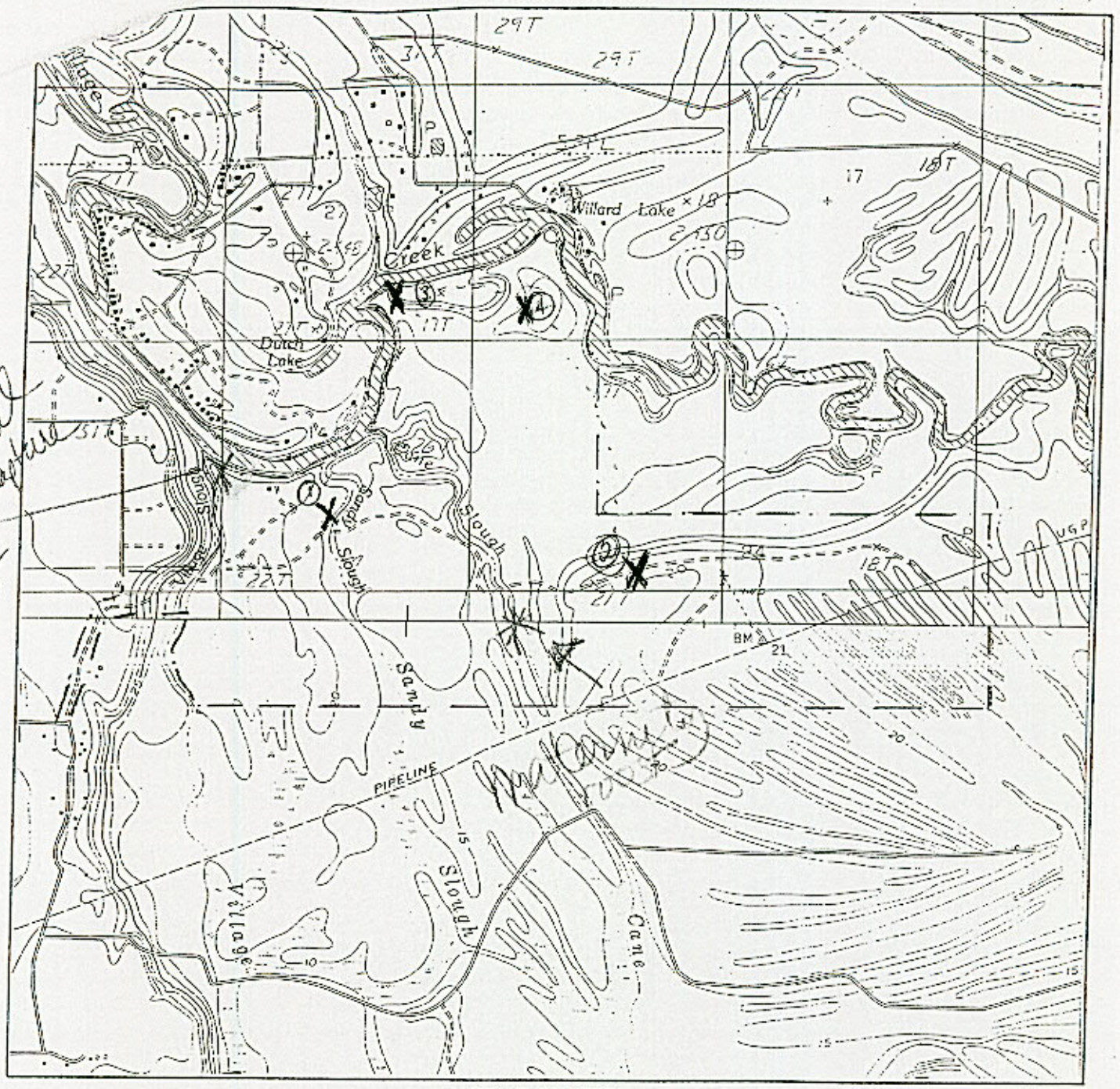
5NOR02 F94NOR03 U97MIR01 F97NOR01 U00KEE01TXUS

SCRIBR: Ø3-Ø6-12 SJB CDREV: Y MAPPER: Ø3-Ø6-12 SJB QC:

DATRESP: TXHP EDITIONDATE: Ø3-Ø6-12 EDAUTHOR: SJB

Maintenance History: INITIALS: CHANGE DATE:

VILLAGE CREEK S.P.



additional setting capture site in 1995

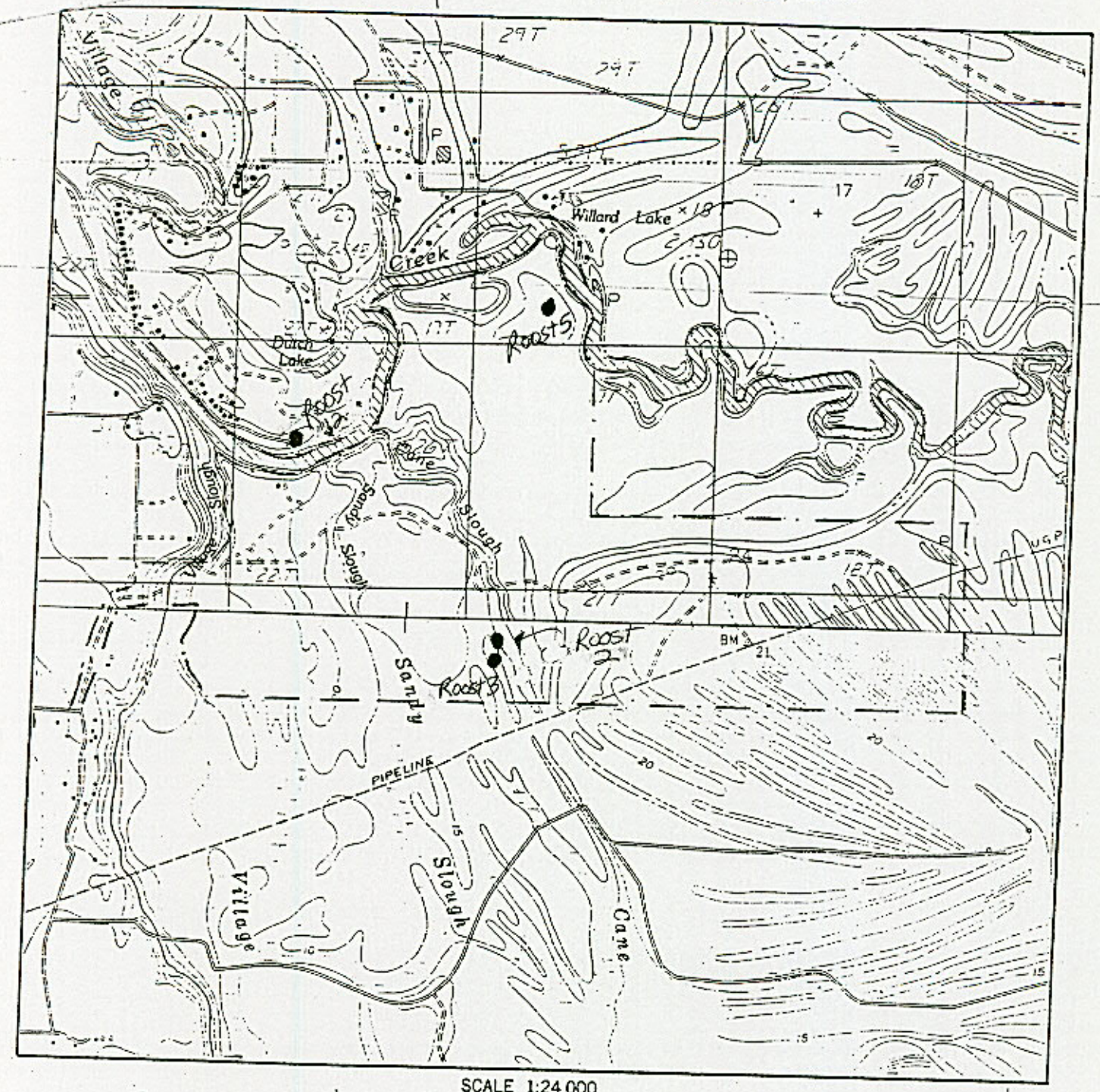
① Myotis austroriparius 18 July 1994 (3 captured)

② M. austroriparius 19 July 1994 (4 captured)

③ M. austroriparius 20 July 1994 (6 captured)

④ M. a. 20 July 1994 (1 captured)

1997 update on Roost Locations



Theastern Mystis

Village Creek SP.

Roost 1 (formerly VCSP 1)

Roost 3 (formerly VCSP2)

Roost 5 (formerly VCSP4)

Roost 12 (Circle G Roost ~~Murphy Roost~~)

EOCODE: AMACC08020*001*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T
SNAME: CORYNORHINUS RAFINESQUII
SCOMNAME: RAFINESQUE'S BIG-EARED BAT
PLACENAME:
NATION: US SITECODE: S.USTXFO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXLIBE	Liberty	DAVIS HILL	3009437	14	4,4

LAT: 301917N LONG: 0945002W S: 301914N N: 301920N E: 0945000W W: 0945005W
DIRECTIONS: 3.75 AIR MILES NORTHWEST OF STATE ROUTE 105 ABOVE TRINITY RIVER; 0.2 AIR MILE WEST OF LAKE BOWIE; DAVIS HILL STATE PARK

NAT.REGION: WATERSHED:
01B MIXED PINE-HARDWOOD FOREST 12030203 TRINITY RIVER (TRINITY BAY-BIG CREEK)/DAVIS/COW ISLAND/TURTLE BAYOUS/OLD RIVER

SURVEYDATE: 1994-07-21 LASTOBS: 1994-07-21 FIRSTOBS: 1994-07-21 EORANK: B EORANKDATE: 1994-07-21
EORANKCOM: INDIVIDUAL CAPTURED AND ASSUMED FORAGING, BUT ROOST SITE/BREEDING POPULATION UNKNOWN

EODATA: 1 ADULT MALE CAPTURED IN MIST NET

CONTACT:

EOTYPE:
GENDESC: PARK CONSISTS OF PINE/HARDWOODS AND BOTTOMLAND HARDWOODS, MARSHES, AND SWAMPS; THIS BAT CAUGHT IN NET PLACED AT INTERFACE WITH POWERLINE RIGHT-OF-WAY AND ATV TRAIL GOING INTO THE FOREST; DENSE UNDERSTORY; FULL MOON; NO OTHER BATS CAUGHT THIS EVENING

MINELEV: 100 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*268	DAVIS HILL STATE PARK	SPWPK	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: TX:TPWD OWNERINFO: Y
OWNERCOM:

COMMENTS:

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

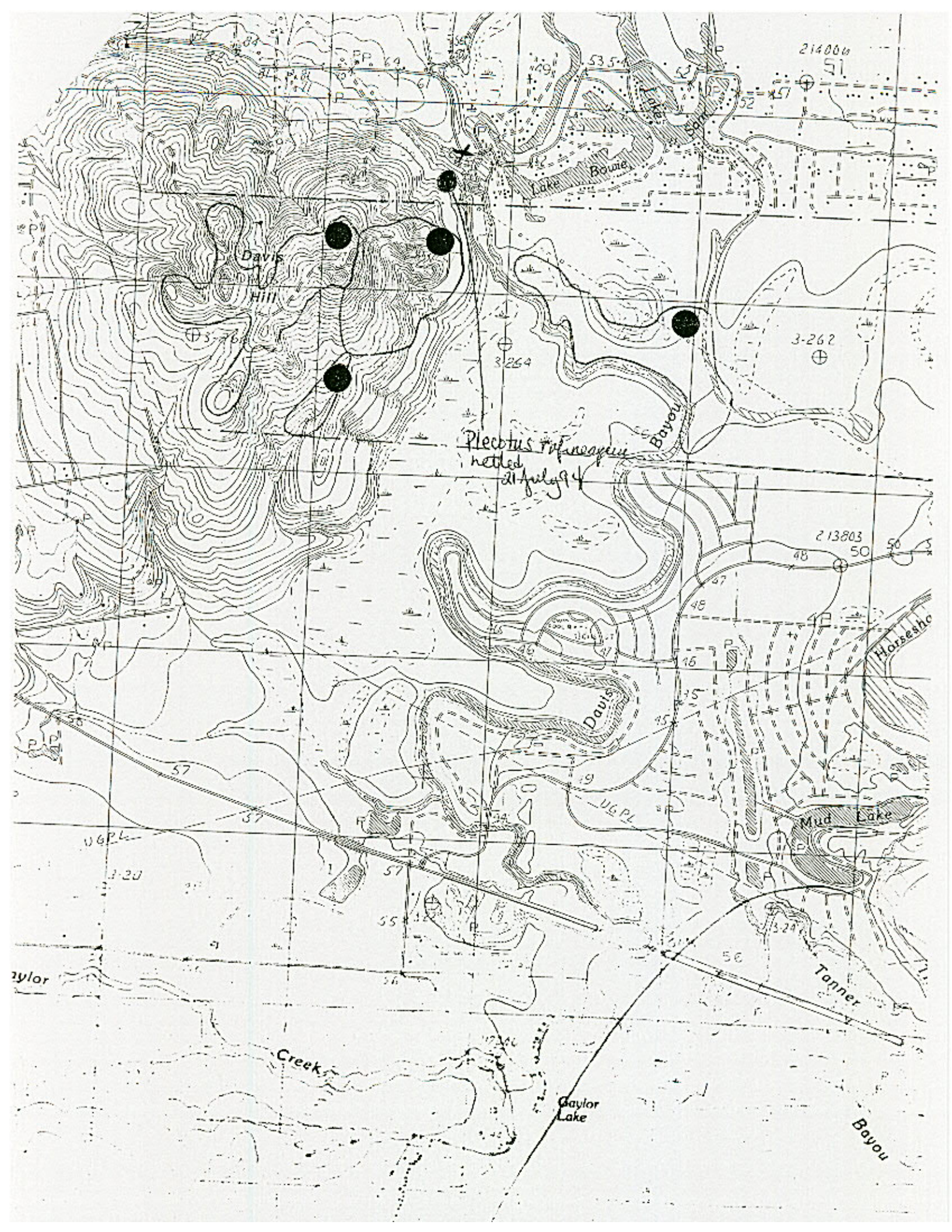
DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: HORNER, M.A. 1994. EAST TEXAS RARE BAT SURVEY: 18-22 JULY 1994 (VILLAGE CREEK AND DAVIS HILL STATE PARKS).

ALL SOURCECODES: CITATIONS:
F94HOR03TXUS HORNER, M.A. 1994. EAST TEXAS RARE BAT SURVEY: 18-22 JULY 1994 (VILLAGE CREEK AND DAVIS HILL STATE PARKS).

SPECIMENS:

EDITION: 94-07-26 EDAUTHOR: HORNER, PEGGY



Davis
Hill
Lake Bowie
Lake Sam
Bayou
Davis
Mud Lake
Horsesho
Tanner
Creek
Gaylor Lake
Bayou
UGPL
3-262
3-264
213803
Plecotus rafinesquii
netted
21 July 94

EOCODE: AMACC01030*008*TX IDENT: Y SECTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT:

SNAME: MYOTIS AUSTRORIPARIUS

SCOMNAME: SOUTHEASTERN MYOTIS BAT

PLACENAME:

NATION: US SITECODE: S.USTXHP*19 SITENAME: BIG THICKET MEGASITE

PRECISION: S SURVEYSITE: TURKEY CREEK UNIT/BIG THICKET NATIONAL PRESERVE
KIRBY NATURE TRAIL

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXHRDN	Hardin	KOUNTZE NORTH	3009443	26	2,2

LAT: 302818N LONG: 0942043W S: 302815N N: 302821N E: 0942040W W: 0942046W

DIRECTIONS: ROAD 420 TO BIG THICKET, TURKEY CREEK UNIT VISITOR CENTER; KIRBY NATURE TRAIL BEGINS BEHIND THE CENTER; CAPTURE SITE WAS "ISLAND" IN VILLAGE CREEK JUST BEFORE MERGING WITH TURKEY CREEK

NAT.REGION: WATERSHED:
01A LONGLEAF PINE FOREST 12020006 VILLAGE/CYPRESS/BIG SANDY/BEECH/TURKEY/HICKORY CREEKS

SURVEYDATE: 1995-05-31 LASTOBS: 1995-05-31 FIRSTOBS: 1995-05-31 ECRANK: EORANKDATE:

EORANKCOM:

EODATA: ONE ADULT MALE CAPTURED

CONTACT:

EOTYPE:

GENDESC: AREA APPEARED TO BE SUITABLE HABITAT DUE TO THE MATURE BOTTOMLAND COMMUNITY TYPE WITH WATER TUPELOS AND OTHER LARGE, PROBABLY HOLLOW TREES

MINELEV: 50 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*40	BIG THICKET NATIONAL PRESERVE	FNPNP	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MGMTCOM:

PROTCOM: UNDER PROTECTION OF NPS

OWNER: US:DOI/NPS OWNERINFO: Y

OWNERCOM:

COMMENTS:

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

DSBESTSOURCE:

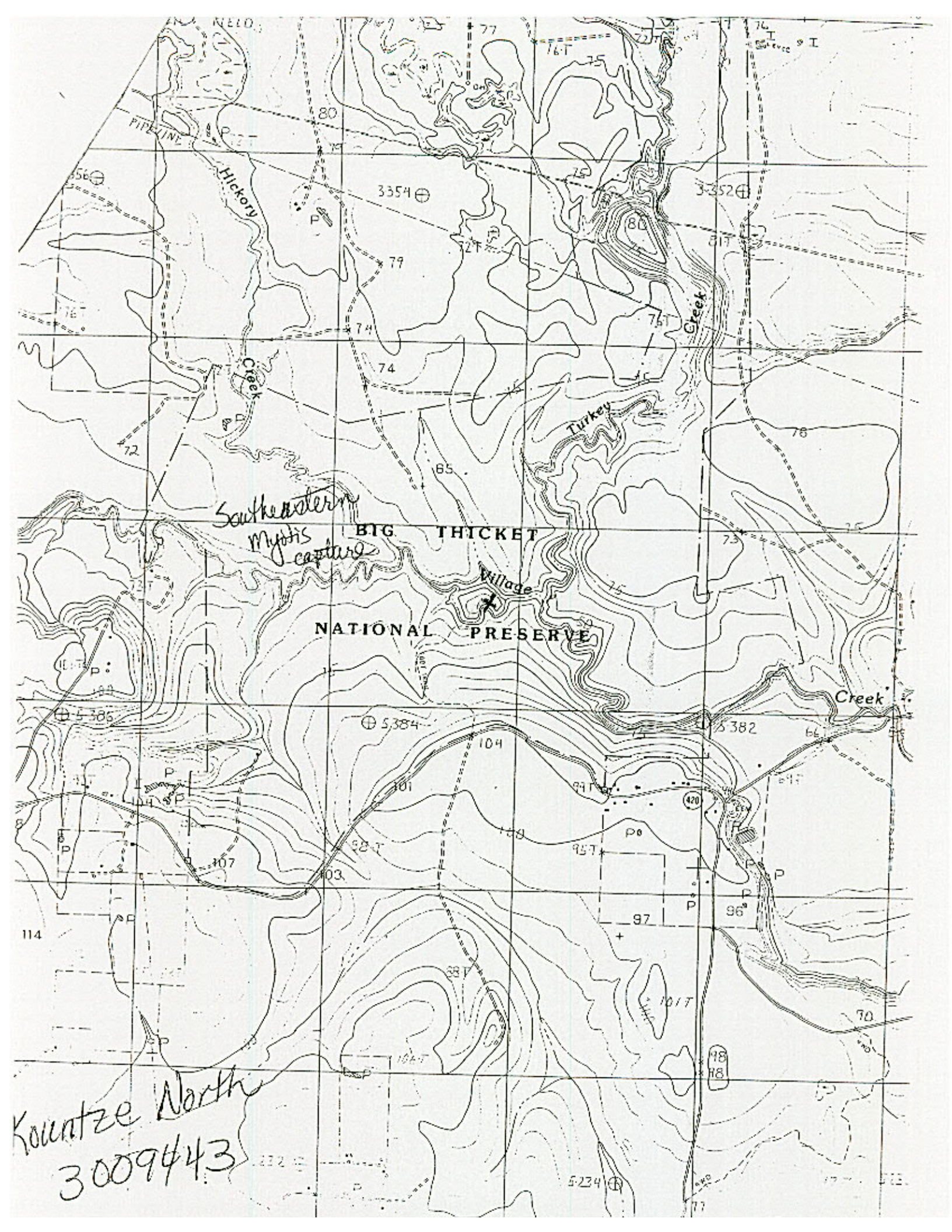
OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:

BESTSOURCE: HORNER, M.A. 1995. EAST TEXAS RARE BAT SURVEY: MAY 22-JUNE 2, 1995. (VILLAGE CREEK STATE PARK TO SEARCH FOR BAT ROOSTS AND CONDUCT BAT RADIO TELEMETRY WORKSHOP).

ALL SOURCECODES:CITATIONS:

F95HOR02TXUS HORNER, M.A. 1995. EAST TEXAS RARE BAT SURVEY: MAY 22-JUNE 2, 1995. (VILLAGE CREEK STATE PARK TO SEARCH FOR BAT ROOSTS AND CONDUCT BAT RADIO TELEMETRY WORKSHOP).

SPECIMENS:


Southeastern
Mystis
capture
BIG THICKET
NATIONAL PRESERVE
Village
Hickory
Creek
Turkey
Creek
Creek
PIPELINE
3354
3352
5386
5384
5382
420
Kountze North
3009443

NEW COUNTY RECORD (Y/N) Y Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOST0 * 015 *TX FONUM: _____ IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: TXSANJ TX COUNTYNAME: San Jacinto LOCALJURIS:

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT:	LONG:	S:	N:	E:	W:
Goodrich	3009458	4		8,10	303007	945427	303004	303010	945424	945430

DIRECTIONS: ca. 4.8 air mi E of Hwy 59 in Shepherd, S of Davison Bayou

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 016

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12030202

SURVEYDATE: yr mo da LASTOBS: yr 1999 mo 06 da FIRSTOBS: yr 1995 mo 07 da 1

ORANK: _____ (see code key) EORANKDATE: _____

ORANKCOM:

ODATA: July 1995, May 1996 - maternity roost for Corynorhinus rafinesquii (EOR.007 April, May, Aug 1998 1-75; June 1999 90

CONTACTID:... CONTACT.NAME: _____ CONTACT.NOTE:

OTYPE:

ENDESC: abandoned wooden house

INELEV: 71 feet MAXELEV: _____ feet SIZE: _____ acres

ACODE: ..... MANAME: _____ MATYPE: CONTAINED: _____ (see code key)

RELAND: _____ MOREPROT: _____ MOREMGMT: _____ TNCINVOLVE: _____

MTCOM:

OTCOM:

NER: Private OWNERINFO: Y

NERCOM:

MMENTS: Roost #11 East Texas Bat Surveys ~~[illegible]~~

OTL.TOPICS:

PIC.KEYWORDS:

TASENS: _____ BOUNDARIES: _____ PHOTOS: _____

STSOURCE: U96HOR0ITXUS

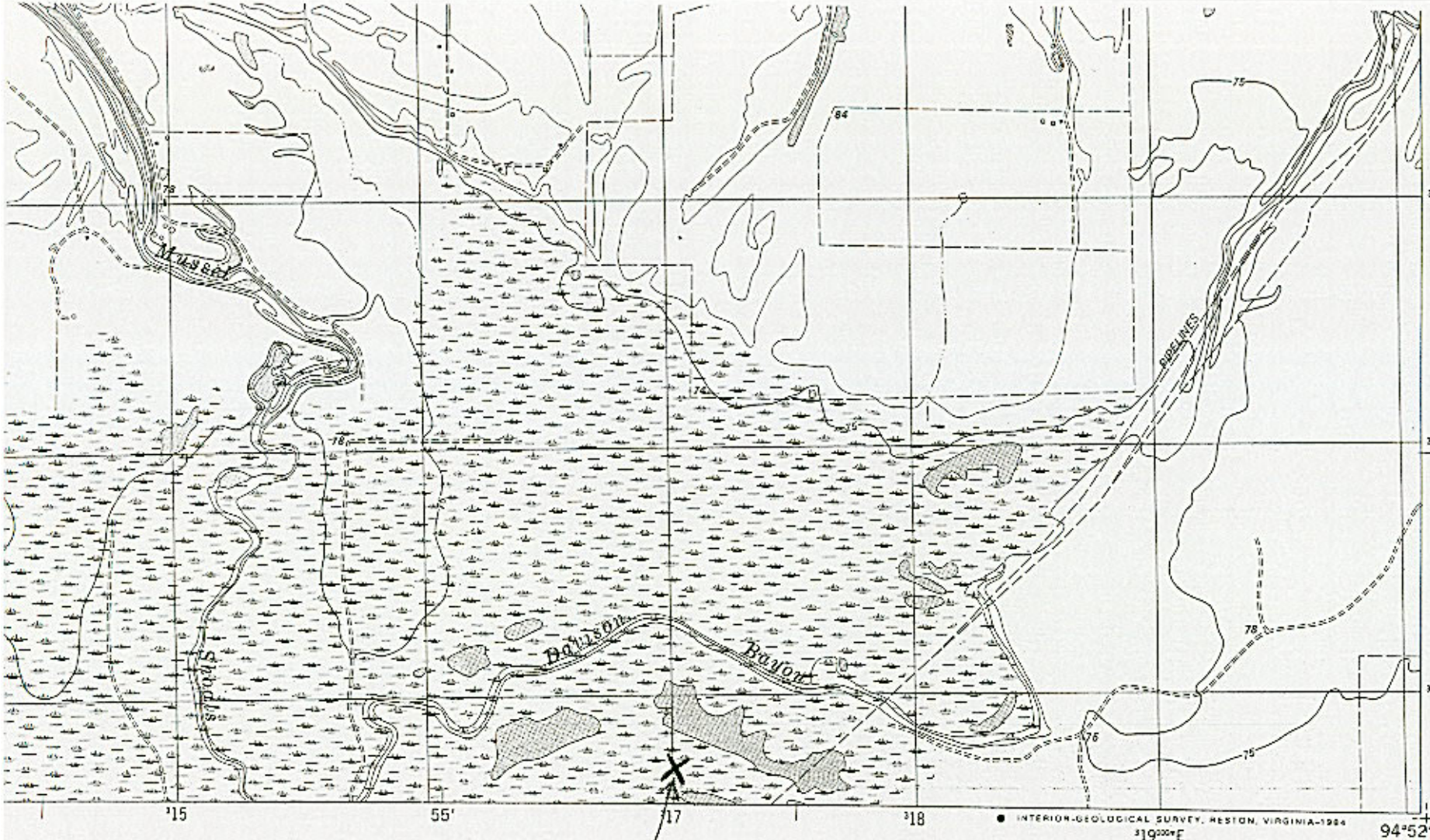
SOURCECODES: SPECIMENS: (citation info. for specimens)

96HOR0ITXUS U00KEE0ITXUS

98HOR0ITXUS U02LEN0ITXUS

ANSCRIBR: 03-06-25 CDREV: Y MAPPER: 05-06-25 QC:

TARESP: TXHP EDITIONDATE: 25 FRAUTHOR:



Abandoned house with Big-eared bat roost

1 MILE
1000 5000 6000 7000 FEET
1 KILOMETER

5 FEET
DATUM OF 1929

IRADO 80225, OR RESTON, VIRGINIA 22092
MBOLS IS AVAILABLE ON REQUEST

TEXAS
QUADRANGLE LOCATION

3094–322

ROAD CLASSIFICATION

Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road
Interstate Route
U. S. Route
State Route

(ROMAYOR) 7044 IV NE

3009458

GOODRICH, TEX.

SW/4 LIVINGSTON 15' QUADRANGLE

30094-E8-TF-024

1984

DMA 7045 III SW–SERIES V882

EOCODE: AMACC08020*008*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T
SNAME: CORYNORHINUS RAFINESQUII
SCOMNAME: RAFINESQUE'S BIG-EARED BAT
PLACENAME:
NATION: US SITECODE: S.USTXPO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: S SURVEYSITE: HEN HOUSE UNIT

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXJASP	Jasper	TOWN BLUFF	3009472	15	7,1

LAT: 305150N LONG: 0941038W S: 305147N N: 305153N E: 0941035W W: 0941041W
DIRECTIONS: ROOST SITE CA. 1.0 AIR MILE NORTH OF HIGHWAY 190 AND BOAT PIER AND RAMP IN MARTIN DIES, JR. STATE PARK

NAT.REGION: WATERSHED:
01A LONGLEAF PINE FOREST 12020003 NECHES RIVER (SABINE LAKE-SHAWNEE CREEK)/MILL/SANDY/CYPRESS/BILLIAMS CREEKS

SURVEYDATE: 1997-12-29 LASTOBS: 1997-05-01 FIRSTOBS: 1996-05-13 EORANK: ECRANKDATE:
ECRANKCOM:

EODATA: ROOST #1 FIRST DISCOVERED WITH SOUTHEASTERN MYOTIS IN MAY 1995; ON 5/13/96 CORYNORHINUS RAFINESQUII WERE THERE; 5/13/96 TO 10/13/96, ONLY ONE CORYNORHINUS (PLECOTUS) RAFINESQUII RECORDED IN ROOST; NO BATS RECORDED IN 1997, VARIOUS WATER LEVELS IN THE AREA; ROOST #15 DISCOVERED 1 MAY 1997, ONE INDIVIDUAL OBSERVED; ROOST #15 IS A LARGE HOLLOW WILLOW OAK OR WATER OAK NEXT TO CAMPSITE #126 (OR #112, SOURCES DIFFER); 0 IN FEBRUARY, MARCH, AND MAY 1998; 0 IN MAY 1999; ROOST TREE #1 FELL IN MAY 1998; ROOST TREE #15 FELL IN JUNE 1999

CONTACT:

EOTYPE:
GENDESC: MATURE BEECH-SOUTHERN MAGNOLIA COMMUNITY SERIES; MANY HOLLOW TREES AVAILABLE FOR ROOST SITES; GUM SLOUGH IS PERMANENT STANDING WATER WITH CYPRESS TREES ALONG EDGE; ROOST SITE IN BOTTOMLAND AREA WITHIN ONE FOOT OF STANDING WATER

MINELEV: 90 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*164	MARTIN DIES, JR. STATE PARK	SPWPK	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: TX:TPWD OWNERINFO: Y
OWNERCOM:

COMMENTS: ROOST #1 AND #15 IN EAST TEXAS BAT SURVEYS

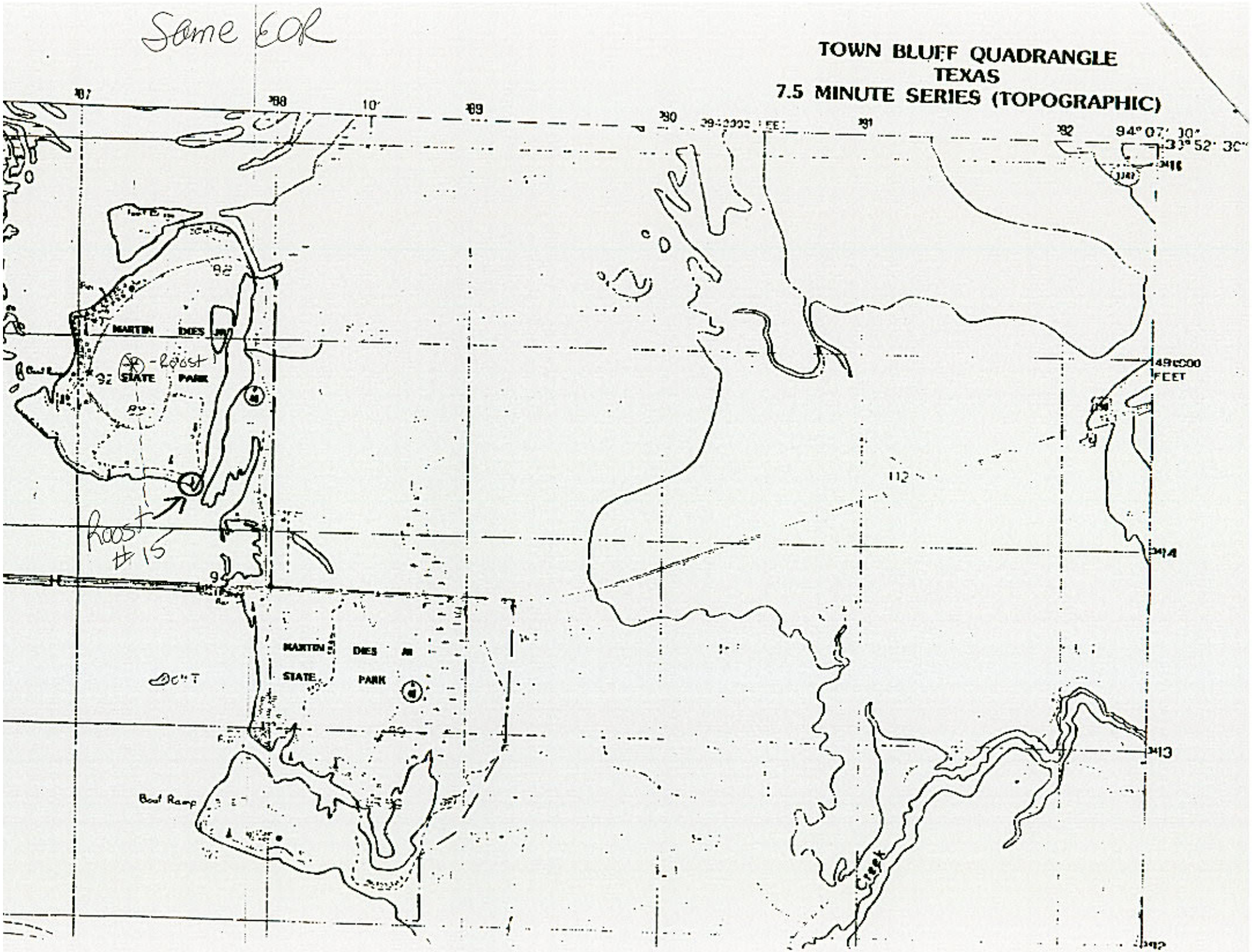
ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: MIROWSKY, K. AND M.A. HORNER. 1997. ROOSTING ECOLOGY OF TWO RARE VESPERTILIONID BATS, THE SOUTHEASTERN MYOTIS AND THE RAFINESQUE'S BIG-EARED BAT IN EAST TEXAS. 1996 ANNUAL REPORT TO TEXAS PARKS AND WILDLIFE DEPARTMENT.

ALL SOURCECODES:CITATIONS:
U97MIR01TXUS MIROWSKY, K. AND M.A. HORNER. 1997. ROOSTING ECOLOGY OF TWO RARE VESPERTILIONID BATS, THE SOUTHEASTERN MYOTIS AND THE RAFINESQUE'S BIG-EARED BAT IN EAST TEXAS. 1996 ANNUAL REPORT TO TEXAS PARKS AND WILDLIFE DEPARTMENT.


Some ROR
TOWN BLUFF QUADRANGLE
TEXAS
7.5 MINUTE SERIES (TOPOGRAPHIC)
94°07' 30"
33°52' 30"
MARTIN DIES JR
STATE PARK
Roost
Roost #15
MARTIN DIES JR
STATE PARK
Boat Ramp
112
Creek

EOCODE: AMACC01030*002*TX IDENT: Y SEQTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT:

SNAME: MYOTIS AUSTRORIPARIUS

SCOMNAME: SOUTHEASTERN MYOTIS BAT

PLACENAME:

NATION: US SITECODE: S.USTXFO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE

PRECISION: S SURVEYSITE: GUM SLOUGH
HEN HOUSE UNIT ISLAND NATURE TRAIL
MAGNOLIA RIDGE PARK

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXJASP	Jasper	TOWN BLUFF	3009472	14	7,1
		PACE HILL	3009482	12	1,10

LAT: 305150N LONG: 0941038W S: 305024N N: 305318N E: 0940944W W: 0941430W

DIRECTIONS: ROOST SITE CA. 1.0 AIR MILE NORTH OF HIGHWAY 190 AND BOAT PIER AND RAMP IN MARTIN DIES, JR. STATE PARK; CAPTURES CA. 1 AIR MILE SOUTHEAST OF HIGHWAY 190 AND BOAT PIER AND RAMP IN MARTIN DIES, JR. STATE PARK; CAPTURES ALSO AT MAGNOLIA RIDGE PARK, OWNED BY USCOE, WEST OF MARTIN DIES, JR. STATE PARK

NAT.REGION: WATERSHED:
01A LONGLEAF PINE FOREST 12020003 NECHES RIVER (SABINE LAKE-SHAWNEE CREEK)/MILL/SANDY/CYPRESS/BILLIAMS CREEKS

SURVEYDATE: 1997-12-29 LASTOBS: 1996-05-01 FIRSTOBS: 1994-05-19 EORANK: EORANKDATE:

EORANKCOM:

EODATA: IN 1994, 2 ADULT MALES, 1 ADULT FEMALE CAPTURED IN MIST NETS, NONE WERE REPRODUCTIVELY ACTIVE, FEMALE HAS SUCKLED IN PAST YEARS; IN 1994, IN NORTH SECTION OF STATE PARK 10 INDIVIDUALS CAPTURED, 2 OUTFITTED WITH RADIO TELEMETRY DEVICES; MATERNITY ROOST FOUND IN 1995 AND SEVERAL MORE INDIVIDUALS CAPTURED; IN 1995, 6 BATS CAPTURED AT MAGNOLIA RIDGE PARK; 1996, FROM APRIL TO MAY, 25-85 SOUTHEASTERN MYOTIS'S NOTED; NO BATS RECORDED IN 1997, VARIOUS WATER LEVELS IN THE AREA; ROOST TREE #1 FELL IN MAY 1998

CONTACT:

EOTYPE:

GENDESC: MATURE BEECH-SOUTHERN MAGNOLIA COMMUNITY SERIES; MANY HOLLOW TREES AVAILABLE FOR ROOST SITES; GUM SLOUGH IS PERMANENT STANDING WATER WITH CYPRESS TREES ALONG EDGE; ROOST SITE IN BOTTOMLAND AREA WITHIN ONE FOOT OF STANDING WATER

MINELEV: 80 MAXELEV: 100 SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*164	MARTIN DIES, JR. STATE PARK	SPWPK	N
M.USTXHP*1438	TOWN BLUFF DAM AND B.A. STEINHAGEN LAKE (USCOE)	FDAPK	N

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MGMTCOM:

PROTCOM:

OWNER: TX:TPWD AND US:DOA/COE OWNERINFO: Y

OWNERCOM:

COMMENTS: MIST NET LOCATIONS MARKED ON TOPO; CAPTURES WERE BEST ON TRAILS; ROOST #1 EAST TEXAS BAT SURVEYS

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: Y PHOTOS:

BESTSOURCE: HORNER, M.A. 1995. EAST TEXAS RARE BAT SURVEY: APRIL 27-MAY 6, 1995. (MARTIN DIES JR. STATE PARK TO SEARCH FOR BAT

NEW COUNTY RECORD (Y/N) Y Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOSTØ *008 *TX FONUM: IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: COUNTYNAME: LOCALJURIS:

TX JASP Jasper

TX

UADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT:	S:	N:	E:	W:
Town Bluff	3009472	21		7.1	305150	305147	305153	941035	941041
					LONG: 941038				

IRECTIONS: Martin Dies Jr. SP - Walnut Ridge Unit; ca 1 air mi N of of Hwy 190 and boat pier and ramp

otional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: Ø1a

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

TERSHED: 12020003

RVEYDATE: yr mo da LASTOBS: yr 1997 mo Ø5 da Ø1 FIRSTOBS: yr 1995 mo Ø5 da Ø1

RANK: (see code key) EORANKDATE: yr mo da

RANKCOM: Roost #1:

DATA: Ø1 May 1995 - Myotis austroriparius (EOR.002) maternity roost discovered; 13 May 1996 One Corynorhinus rafinesquii observed in roost; Ø Bats observed in Roost #1 Feb, April, May, Dec 199 Over

ITACTID:... CONTACT.NAME: (EOR.008) CONTACT.NOTE:

TYPE:

DESC: Roost #1 - black gum tree; Roost #15 Willow or Water Oak next to campsite #112 or #126 (sources differ)

ELEV: 90 feet MAXELEV: feet SIZE: acres

ODE: MANAME: Martin Dies Jr SP MATYPE: CONTAINED: Y (see code key)

ELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

TCOM:

TCOM:

ER: OWNERINFO:

ERCOM:

IENTS: Roost #1 + 15 East Texas Bat Surveys ~~1994-1997~~

L.TOPICS:

C.KEYWORDS:

SENS: BOUNDARIES: PHOTOS:

SOURCE: U98HORØ1TXUS

SOURCECODES: SPECIMENS: (citation info. for specimens)

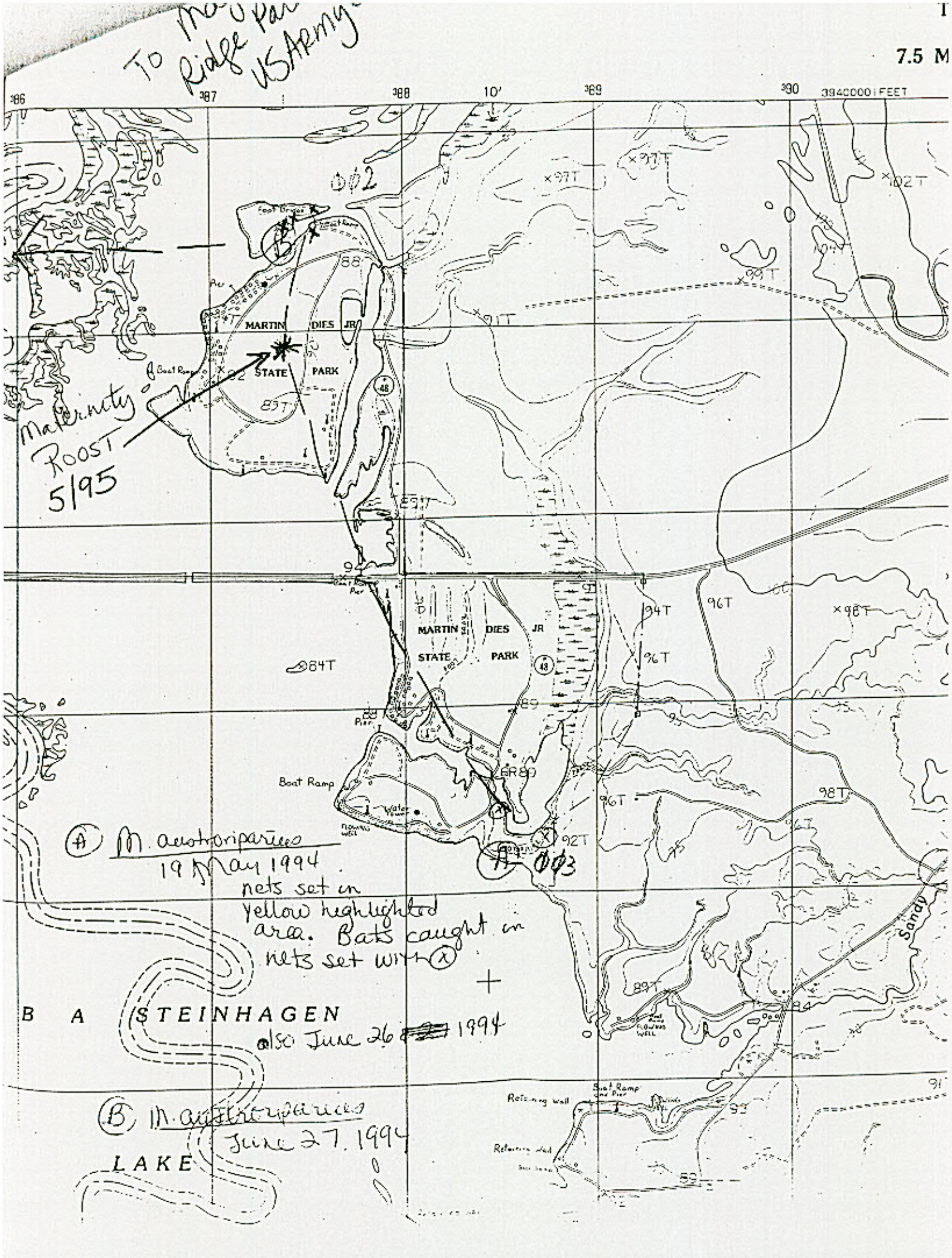
7MIRØ1TXUS UØ2LINØ1TXUS

5HORØ1TXUS UØØKEEØ1TXUS

SCRIBR: Ø3-Ø6-12 SJB CDREV: Y MAPPER: Ø3-Ø6-12 SJB QC:

RESP: TXHP EDITIONDATE: Ø3-Ø6-12 EDAUTHOR: SJB

enance History: INITIALS: CHANGE DATE:



To Ridge Park USArmy
7.5 M
3940000 FEET
MARTIN DIES JR STATE PARK
Boat Ramp
Maternity Roost 5/95
Ø02
Ø03
(A) M. austroriparius 19 May 1994 nets set in yellow highlighted area. Bats caught in nets set with (x)
also June 26 1994
(B) M. austroriparius June 27. 1994
B A STEINHAGEN
LAKE
Sandy
Retaining wall

EOCODE: AMACC08020*002*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T
SNAME: CORYNORHINUS RAFINESQUII
SCOMNAME: RAFINESQUE'S BIG-EARED BAT
PLACENAME:
NATION: US SITECODE: S.USTXFO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXJASP	Jasper	PACE HILL	3009482	7	10,4

LAT: 305655N LONG: 0940812W S: 305652N N: 305658N E: 0940809W W: 0940815W
DIRECTIONS: WESTERN PART OF JASPER STATE FISH HATCHERY AT BACK HOUSE (PAST POND #14); TRAIL BEHIND HOUSE INTO BOTTOMLANDS

NAT.REGION: WATERSHED:
01A LONGLEAF PINE FOREST 12020005 ANGELINA RIVER (NECHES RIVER-SAYOU LA NANA)/BAYOU LA NANA & ATTOYAC/INDIAN CREEK

SURVEYDATE: 1994-06-28 LASTOBS: 1994-06-28 FIRSTOBS: EORANK: A EORANKDATE: 1994-06-28
EORANKCOM: IDENTIFIED USING SEVERAL KEYS; OBVIOUS CHARACTERISTICS--BIG EARS

EODATA: CAPTURED AT 21:45 IN 18' MIST NET SET ACROSS TRAIL; MALE - TESTIS DESCENDED (AND OBVIOUS)

CONTACT:

EOTYPE:
GENDESC: MATURE BEECH-MAGNOLIA-PINE WITH OPEN UNDERSTORY; INDIAN CREEK CA. 100 YARDS AWAY, ANGELINA RIVER CA. 1 MILE AWAY, MARSHY AREAS LESS THAN 1 MILE NORTH OF HATCHERY BOUNDARY

MINELEV: 115 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*1235	JASPER STATE FISH HATCHERY	SPWFH	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: TX:TPWD OWNERINFO: Y
OWNERCOM:

COMMENTS:

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

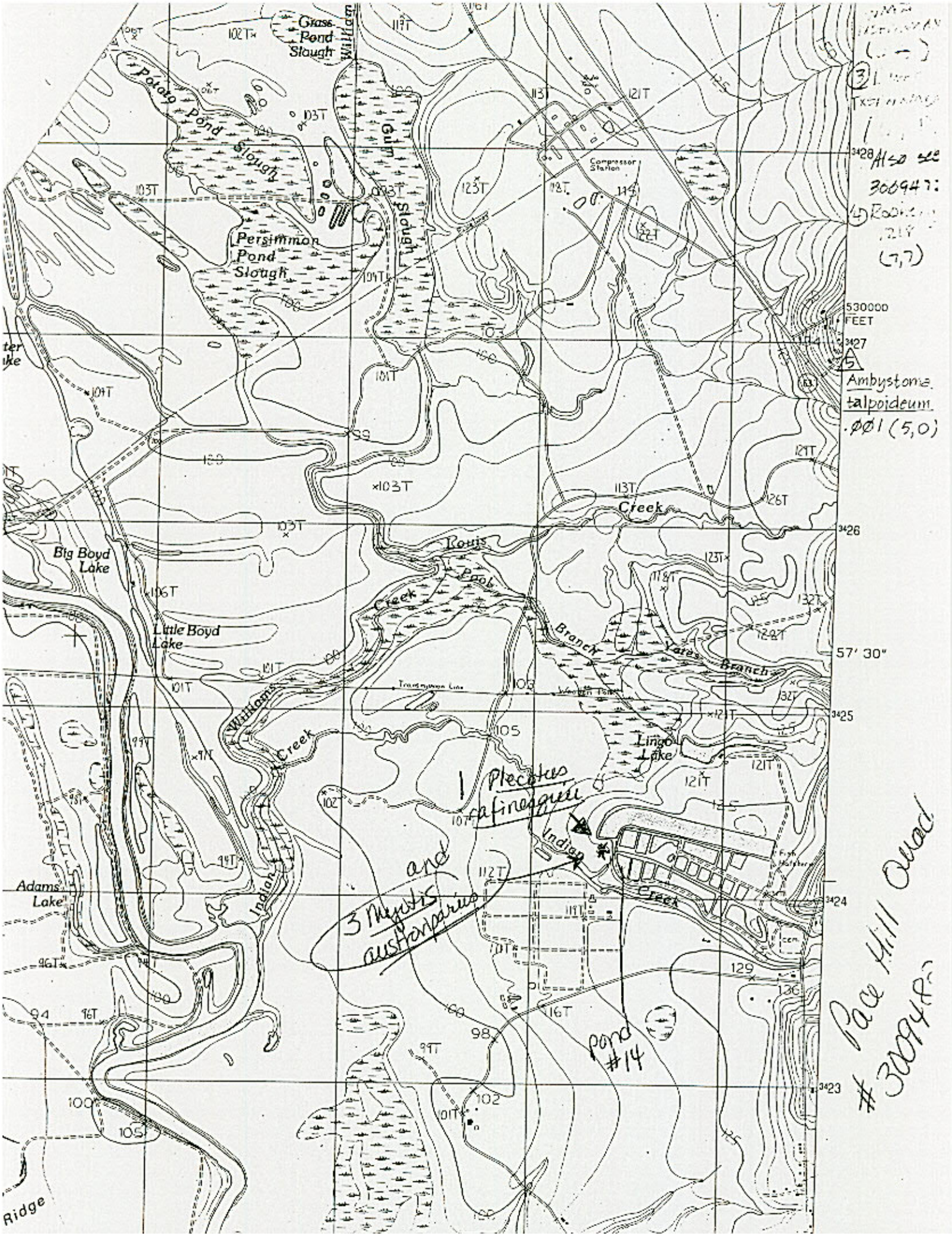
DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: HORNER, M.A. 1994. EAST TEXAS RARE BAT SURVEY: 26-30 JUNE 1994 (JASPER STATE FISH HATCHERY, BEECH CREEK UNIT OF BIG THICKET NATIONAL PRESERVE, MARTIN DIES JR. STATE PARK).

ALL SOURCECODES:CITATIONS:
F94HOR02TXUS HORNER, M.A. 1994. EAST TEXAS RARE BAT SURVEY: 26-30 JUNE 1994 (JASPER STATE FISH HATCHERY, BEECH CREEK UNIT OF BIG THICKET NATIONAL PRESERVE, MARTIN DIES JR. STATE PARK).

SPECIMENS:

EDITION: 94-07-06 EDAUTHOR: HORNER, PEGGY
TRANSCRIBR: 94-07-06 MAH MAPPER: 95-03-08 AEH CDREV: Y QC: Y LEADRESP: TXHP CHANGE.DATE: 95-08-25 INITIALS: DLS



Grass Pond Slough
Potato Pond Slough
Gum Slough
Persimmon Pond Slough
Compressor Station
Big Boyd Lake
Little Boyd Lake
Williams Creek
Louis Creek
Pool Branch
Yates Branch
Lingo Lake
Indian Creek
Adams Lake
Ridge
530000 FEET
57' 30"
Transmission Line
Weaver Point
Fish Hatchery
Ambystoma talpoideum .001 (5,0)
1 Plecotus rafinesquii
and 3 Myotis austroriparius
pond #14
Pace Hill Quad #300948
Also see 300947
(7,7)

EOCODE: AMACC01030*005*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT:
SNAME: MYOTIS AUSTRORIPARIUS
SCOMNAME: SOUTHEASTERN MYOTIS BAT
PLACENAME:
NATION: US SITECODE: S.USTXFO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXJASP	Jasper	FACE HILL	3009482	6	10,4

LAT: 305655N LONG: 0940812W S: 305652N N: 305658N E: 0940809W W: 0940815W
DIRECTIONS: WESTERN PART OF FISH HATCHERY BEHIND BACK HOUSE AND POND #14; TRAIL BEHIND HOUSE INTO BOTTOMLANDS, NORTH OF INDIAN CREEK, CA. 1 AIR MILE EAST OF ANGELINA RIVER; JASPER STATE FISH HATCHERY

NAT.REGION: WATERSHED:
01A LONGLEAF PINE FOREST 12020005 ANGELINA RIVER (NECHES RIVER-BAYOU LA NANA)/BAYOU LA NANA & ATTOYAC/INDIAN CREEK

SURVEYDATE: 1994-06-28 LASTOBS: 1994-06-28 FIRSTOBS: EORANK: A EORANKDATE: 1994-06-28
EORANKCOM: IDENTIFIED USING SEVERAL KEYS; DISTINGUISHING CHARACTERISTICS OF ORANGE, WOOLLY, PELAGE, SMALL SIZE, NO KEEL ON CALCAR, AND LONG TOE HAIRS EXTENDING BEYOND CLAWS

EODATA: CAPTURED 3 INDIVIDUALS USING MIST NETS; CAPTURED @ 22:30 (ADULT FEMALE, HAS SUCKLED), 23:34 (UNKNOWN SEX), 01:15 (ADULT FEMALE, HAS SUCKLED)

CONTACT:

EOTYPE:
GENDESC: BEECH-MAGNOLIA-PINE MATURE BOTTOMLAND FOREST WITH CLOSED CANOPY AND FAIRLY OPEN UNDERSTORY; INDIAN CREEK CA. 100 YARDS AWAY; ANGELINA RIVER CA. 1 MILE AWAY; MARSHY AREAS LESS THAN 1 MILE NORTH OF HATCHERY BOUNDARY

MINELEV: 115 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*1235	JASPER STATE FISH HATCHERY	SPWFH	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: TX:TPWD OWNERINFO: Y
OWNERCOM:

COMMENTS:

ADDTL.TOPICS: TOPIC.KEYWORDS:

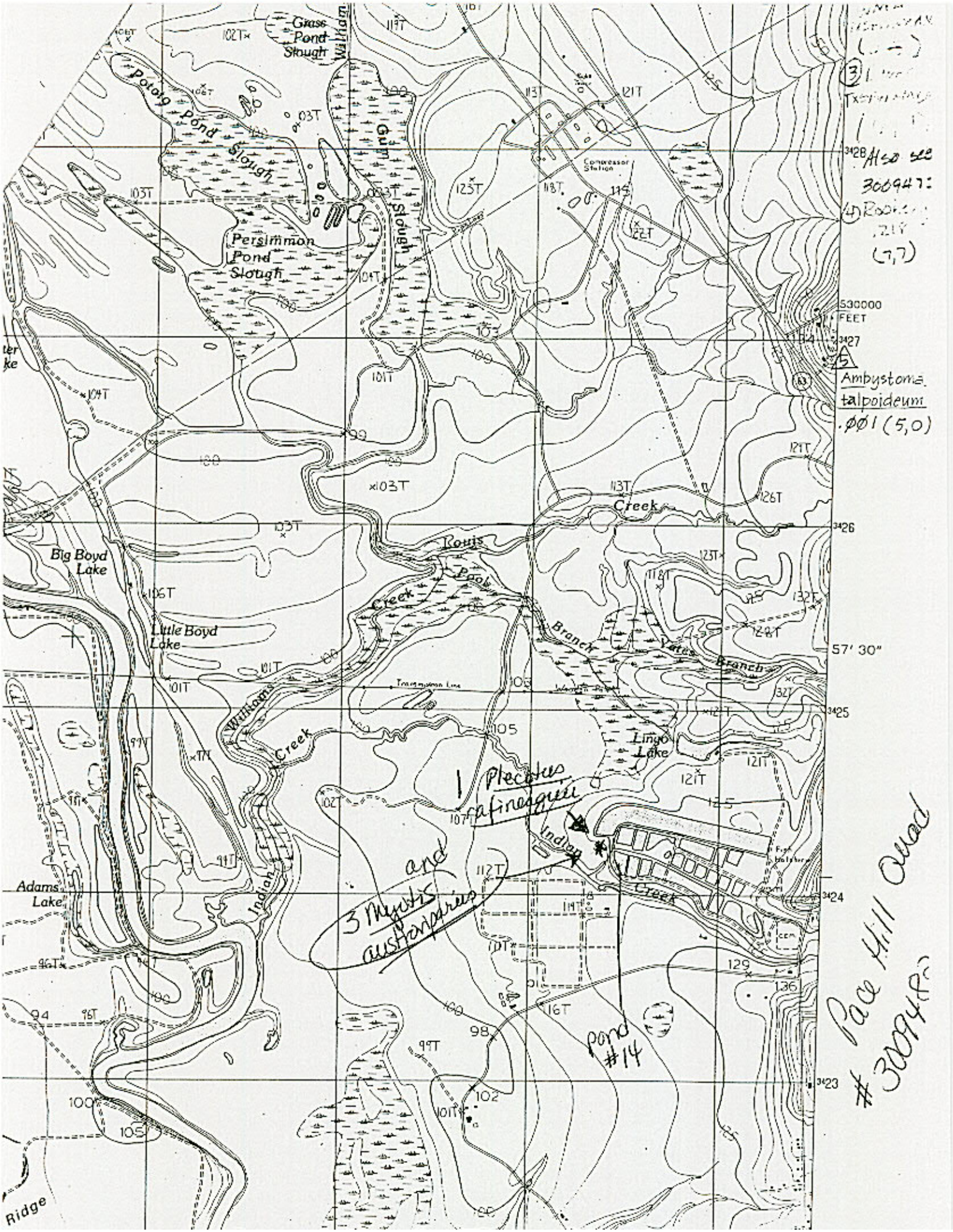
OSDIRECTIONS:

OSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: HORNER, M.A. 1994. EAST TEXAS RARE BAT SURVEY: 26-30 JUNE 1994 (JASPER STATE FISH HATCHERY, BEECH CREEK UNIT OF BIG THICKET NATIONAL PRESERVE, MARTIN DIES JR. STATE PARK).

ALL SOURCECODES:CITATIONS:
?94HOR02TXUS HORNER, M.A. 1994. EAST TEXAS RARE BAT SURVEY: 26-30 JUNE 1994 (JASPER STATE FISH HATCHERY, BEECH CREEK UNIT OF BIG THICKET NATIONAL PRESERVE, MARTIN DIES JR. STATE PARK).

SPECIMENS:


Grass Pond Slough
Potato Pond Slough
Gum Slough
Persimmon Pond Slough
Compressor Station
Big Boyd Lake
Little Boyd Lake
Louis Creek
Pool Creek
Branch
Yates Branch
Williams Creek
Lingo Lake
Indian Creek
Adams Lake
Ridge
530000 FEET
57' 30"
Also see 300947:
Ambystoma talpoideum .001 (5,0)
1 Plecotus rafinesquii
and 3 Myotis austroriparius
pond #14
Pace Hill Quad #300948

New County Record(Y/N) Y Element Occurrence Record

Elcode: EO#: State:
EOCODE: AMACC09020 *012 *TX FONUM: ____ IDENT: Y
SNAME: Corynorhinus rafinesquii
SCOMNAME:
ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....
NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)
SITENAME:
SURVEYSITE:
PRECISION: SC COUNTYCODE: TX NRRS COUNTYNAME: Harris LOCALJURIS:
TX ____ ____ ____
TX ____ ____ ____

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:
Moonshine Hill	3009512	6	____	8,4
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____

LAT: 30 05 22 S: 30 05 19
N: 30 05 25
LONG: 95 09 03 E: 95 09 00
W: 95 09 06

DIRECTIONS: Lake Houston SP; ca 0.2 mi SE of Isabell Lake; Just W of East Fork San Jacinto River

Optional Fields: (next four fields exist in EOR.OPT)
NAT.REGION: 015 ____ ____ ____ ____
PLACENAME:
DSDIRECTIONS:
DSBESTSOURCE:
WATERSHED: 12040103 ____ ____ ____

	yr	mo	da
SURVEYDATE:	____	____	____
LASTOBS:	1999	06	____
FIRSTOBS:	1996	05	22

EORANK: ____ (see code key) EORANKDATE: ____-____-____
EORANKCOM:
EODATA: 22 May 1996 one adult female, not lactating or pregnant; June-Dec 1997-0; June 1999 one
CONTACTID:... CONTACT.NAME: ____ CONTACT.NOTE: ____
EOTYPE:
GENDESC: abandoned concrete house in mixed pine & oak upland

MINELEV: 50 feet MAXELEV: ____ feet SIZE: ____ acres
MACODE: MANAME: MATYPE: CONTAINED:
M.USTXHP*.... Lake Houston SP ..... Y (see code key)
M.USTXHP*.... ____ ..... ____
MORELAND: ____ MOREPROT: ____ MOREMGMT: ____ TNCINVOLVE: ____
MGMTCOM:
PROTCOM:
OWNER: TPWD OWNERINFO: Y
OWNERCOM:
COMMENTS: Bat Roost #13 East Texas Bat Surveys
ADDTL.TOPICS:
TOPIC.KEYWORDS:
DATASENS: ____ BOUNDARIES: ____ PHOTOS: ____
BESTSOURCE: F96HOR@TXUS

SOURCECODE: SPECIMENS: (citation info. for specimens)
U02LIN01TXUS U00KEE01TXUS
U98HOR01TXUS
TRANSCRIBR: 03-06-26-SJB CDREV: Y MAPPER: 03-06-26 SJB QC: ____
DATARESP: TXHP EDITION: 03/06/26 EDAUTHOR: SJB
Maintenance History: INITIALS: ____ CHANGE.DATE: ____ (yr/mo/da)
MANUAL.FILE.NOTE:

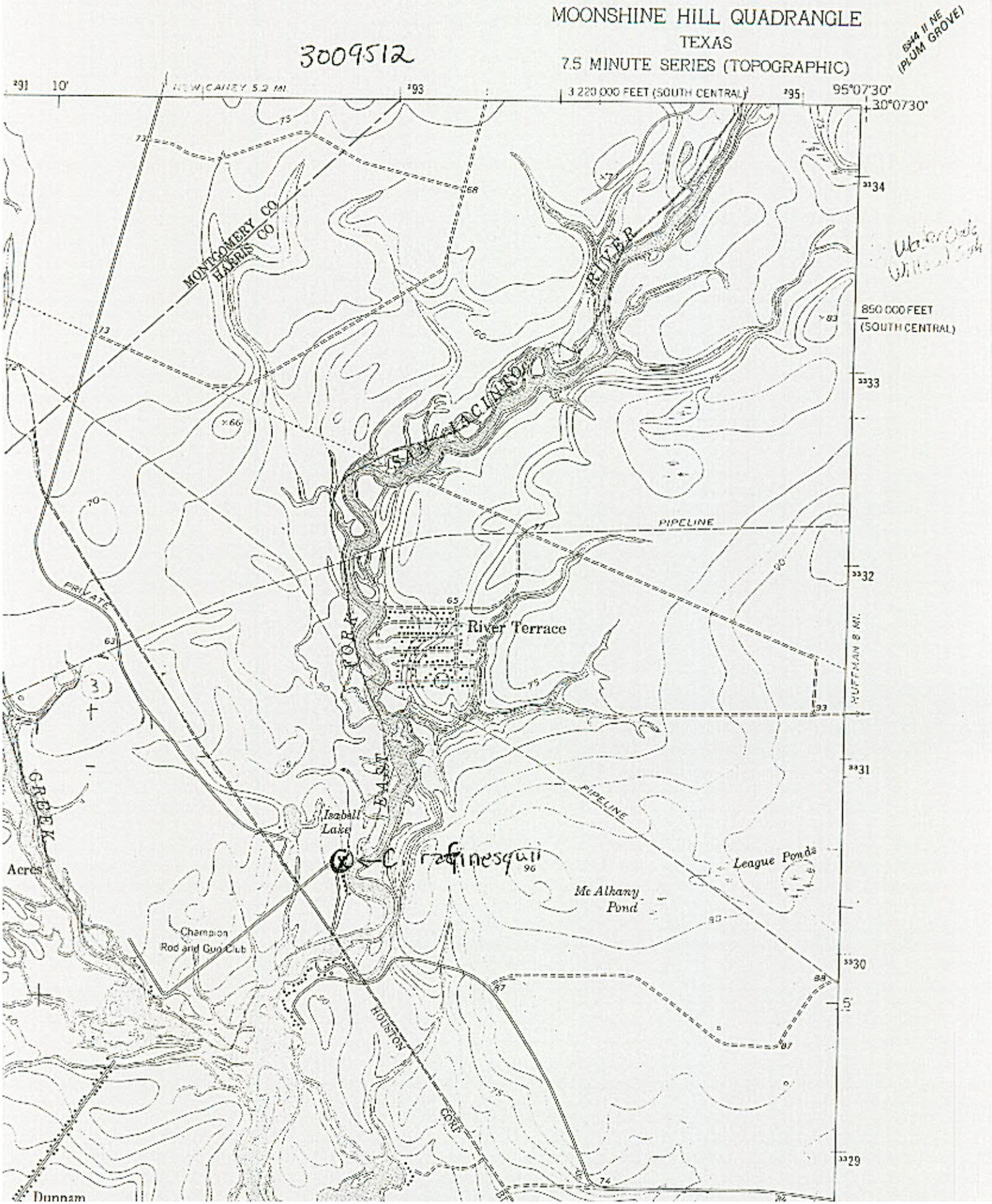
3009512

MOONSHINE HILL QUADRANGLE

TEXAS

7.5 MINUTE SERIES (TOPOGRAPHIC)

6944 II NE (PLUM GROVE)



NEW COUNTY RECORD (Y/N) Y Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOST0 *016 *TX FONUM: ____ IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: SC COUNTYCODE: TXWALK TX COUNTYNAME: Walker LOCALJURIS:

QUADNAME: Crabbs Prairie QUADCODE: 3009576 MARG NUM: 1 DOT NUM: TEN TEN: 2,3 LAT: 30 50 53 LONG: 95 44 00 S: 30 50 50 N: 30 50 56 E: 95 43 57 W: 95 44 03

DIRECTIONS: On I-45 7 mi N of I-45/FM1696 intersection N of Huntsville; Sulphur Branch bridge.

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 02a

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12030202

SURVEYDATE: yr mo da LASTOBS: yr 1998 mo 03 da 18 FIRSTOBS: yr 1995 mo 01 da 27

EORANK: ____ (see code key) EORANKDATE: ____

EORANKCOM:

EODATA: 27 January 1995 Myotis austroriparius winter roost; 18 March 1998 2-10 Pipistrellus sp March, May, June 1998 - 0 M. austroriparius; June - July 1999 - 0 bats

CONTACTID:... CONTACT.NAME: ____ CONTACT.NOTE: ____

EOTYPE:

ENDESC: cement culvert of I-45

MINELEV: 180 feet MAXELEV: ____ feet SIZE: ____ acres

MATYPE: CONTAINED: (see code key)

LCODE: ..... MANAME: ____

RELAND: ____ MOREPROT: ____ MOREMGMT: ____ TNCINVOLVE: ____

MTCOM:

OTCOM:

NER: TxDOT OWNERINFO: ____

NERCOM:

MMENTS: Roost #19 East Texas Bat Surveys

OTL.TOPICS:

PIC.KEYWORDS:

TASENS: ____ BOUNDARIES: ____ PHOTOS: ____

STSOURCE: F98HOR04TXUS

SOURCECODES: SPECIMENS: (citation info. for specimens)

)98HOR01TXUS U00KEE01TXUS

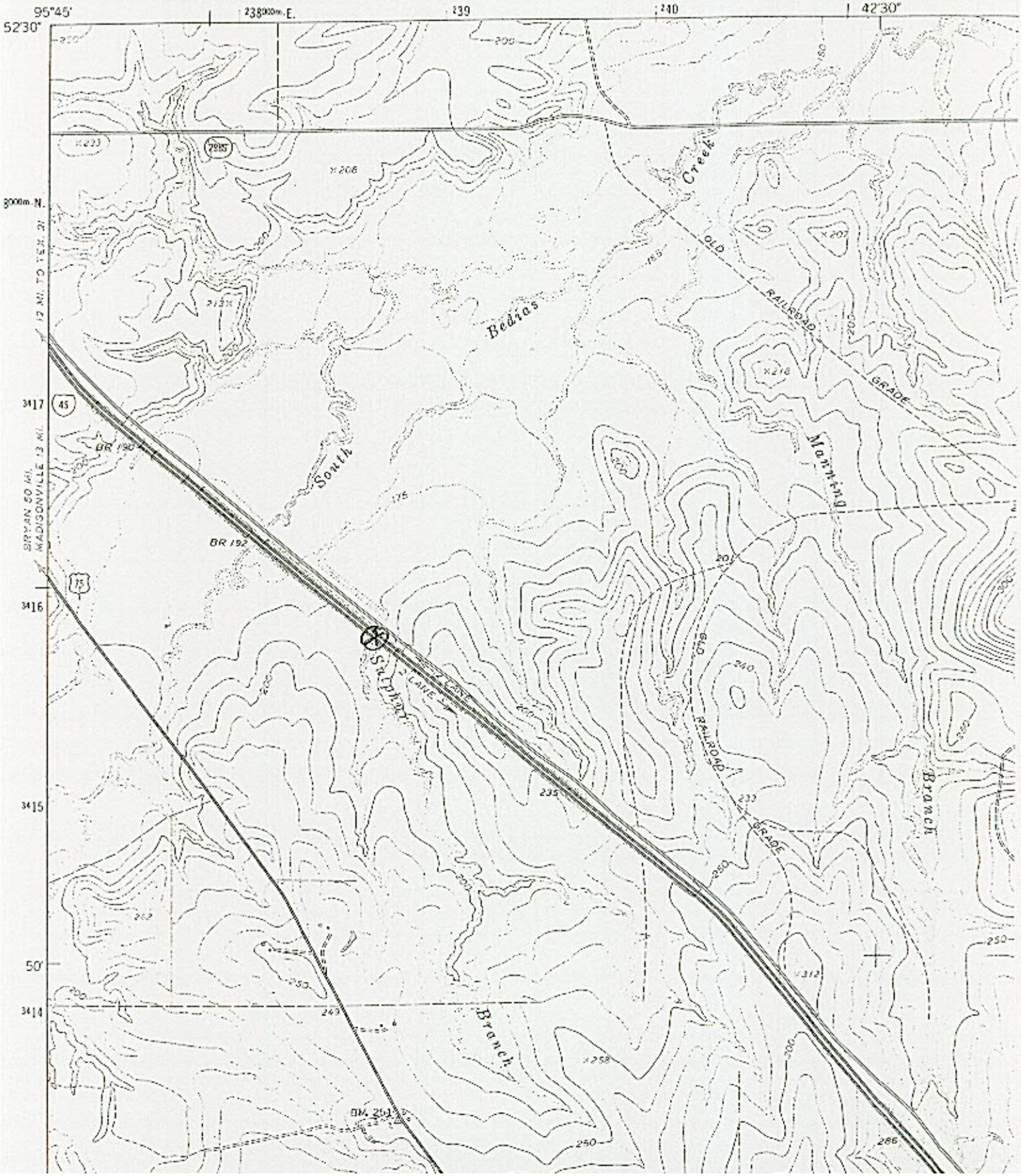
)02LIN01TXUS

ANSCRIBR: 03-06-26 SJB CDREV: Y MAPPER: 03-06-26 SJB QC: ____

TARESP: TXHP EDITIONDATE: 03-06-26 EDAUTHOR: SJB

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Crabbs Prairie
3009576



EOCODE: AMACC01030*007*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT:
SNAME: MYOTIS AUSTRORIPARIUS
SCOMNAME: SOUTHEASTERN MYOTIS BAT
PLACENAME:
NATION: US SITECODE: S.USTXPO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXPOLK	Polk	BLANCHARD	3009561	S	10,8

LAT: 303929N LONG: 0950017W S: 303925N N: 303932N E: 0950014W W: 0950020W
DIRECTIONS: FROM JUNCTION OF HIGHWAYS 350 AND 3126 GO SOUTH-SOUTHEAST 3.1 MILES ON 3126, BATS 1000 FEET WEST OF ROAD; LAKE LIVINGSTON STATE RECREATION AREA

NAT.REGION: WATERSHED:
018 MIXED PINE-HARDWOOD FOREST 12030202 TRINITY RIVER (BIG CREEK-HURRICANE BAYOU)/BIG/KICKAPOO/WHITE ROCK/KEECHI CREEKS

SURVEYDATE: 1995-06-09 LASTOBS: 1995-06-08 FIRSTOBS: 1995-06-09 EORANK: EORANKDATE:
EORANKCOM:

EODATA: ONE ADULT CAPTURED ON TRAIL TO POND BEHIND PARK HEADQUARTERS

CONTACT:

EOTYPE:
GENDESC: LOBLOLLY PINE, WATER OAK, WILLOW OAK, SWEETGUM; SMALL POND NEARBY WITH STANDING PUDDLES

MINELEV: 150 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*202	LAKE LIVINGSTON STATE RECREATION AREA	SPWRA	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: TX:TPWD OWNERINFO: Y
OWNERCOM:

COMMENTS:

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

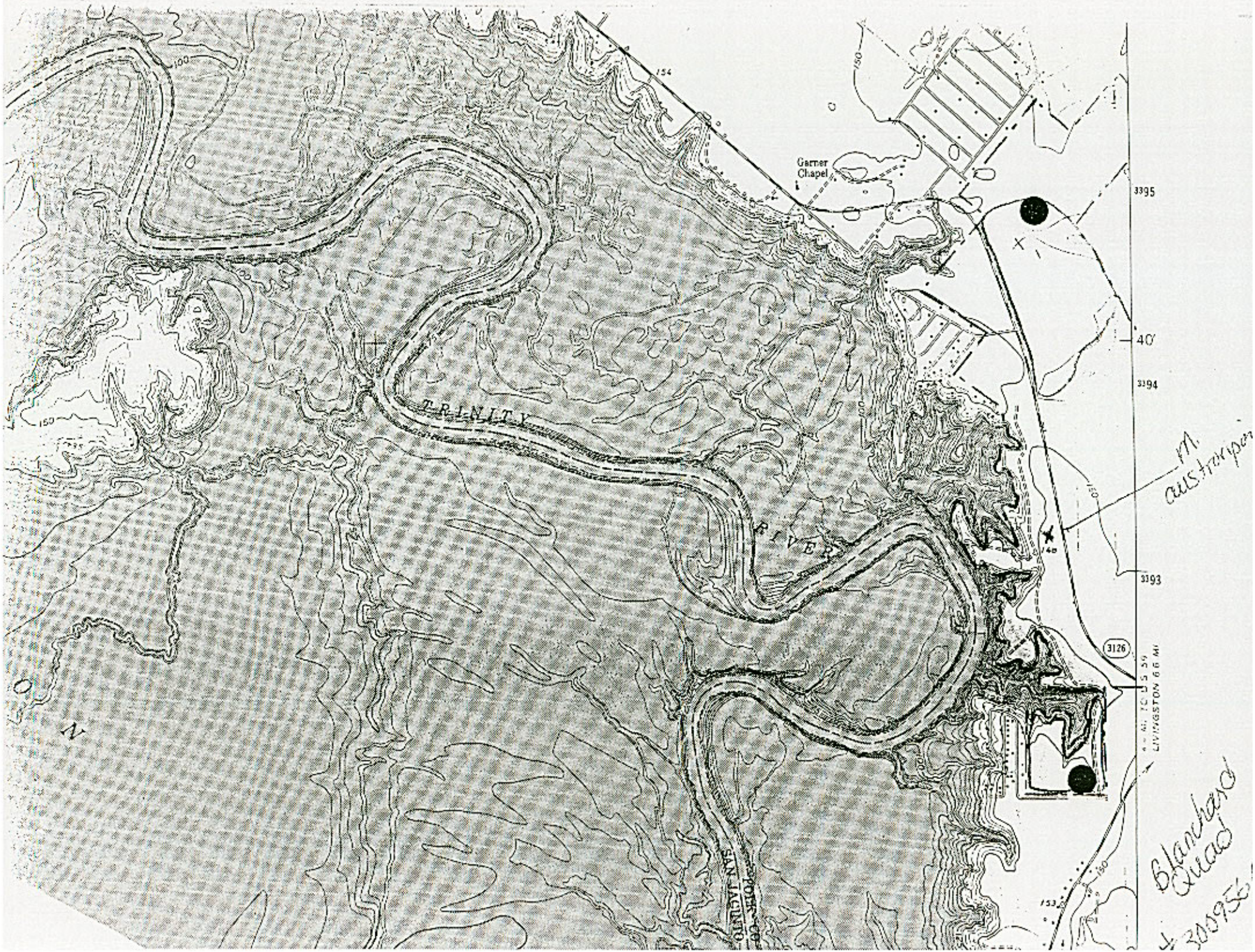
DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: MIROWSKY, K. 1995. EAST TEXAS RARE BAT SURVEY: 6 JUNE-17 AUGUST 1995. (SUMMER INTERNSHIP PROJECT).

ALL SOURCECODES:CITATIONS:
F95MIR01TXUS MIROWSKY, K. 1995. EAST TEXAS RARE BAT SURVEY: 6 JUNE-17 AUGUST 1995. (SUMMER INTERNSHIP PROJECT).

SPECIMENS:

EDITION: 95-10-03 EDAUTHOR: HORNER, PEGGY
TRANSCRIBR: 95-10-03 MAH MAPPER: 96-01-16 ABH CDREV: Y QC: Y LEADRESP: TXEP CHANGE.DATE: 96-07-24 INITIALS: DLS
AMACC01030*007*TX MYOTIS AUSTRORIPARIUS



Garner Chapel
TRINITY
RIVER
3395
40'
3394
3393
3126
LIVINGSTON 6.6 MI
m. austroripa
Blanchard Quad

EOCODE: AMACC01030*006*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USSSA: SPROT:
SNAME: MYOTIS AUSTRORIPARIUS
SCOMNAME: SOUTHEASTERN MYOTIS BAT
PLACENAME:
NATION: US SITECODE: S.USTXHP*95 SITENAME: SABINE NATIONAL FOREST
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXSHEL	Shelby	LOGANSPORT EAST	3109388	6	3,7

LAT: 315517N LONG: 0935740W S: 315514N N: 315520N E: 0935737W W: 0935743W
DIRECTIONS: SWEDE JOHNSON LAKE FLOODPLAIN; 1000 FEET SOUTH OF LOUISIANA/TEXAS STATE LINE; NORTH TOLEDO BEND WMA

NAT.REGION: WATERSHED:
01B MIXED PINE-HARDWOOD FOREST 12010004 SABINE RIVER (TOLEDO BEND DAM-GARRISON CREEK)/BIG SANDY/TENAHA/FLAT FORK CREEKS

SURVEYDATE: 1995-06-20 LASTOBS: 1995-06-19 FIRSTOBS: 1995-06-19 EORANK: EORANKDATE:
EORANKCOM:

EODATA: ONE ADULT MALE CAPTURED IN MIST NET

CONTACT:

EOTYPE:
GENDESC: BOTTOMLAND WITH MANY HARDWOODS, MARSHES, AND SLOUGHS INTERSPERSED WITH PINE AREAS

MINELEV: 25 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*8	SABINE NATIONAL FOREST	FFSNF	Y
M.USTXHP*241	NORTH TOLEDO BEND WILDLIFE MANAGEMENT AREA	SPWWM	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM: TPWD LEASES LAND FOR WMA FROM U.S. FOREST SERVICE

PROTCOM:

OWNER: US:DOA/USFS AND TX:TPWD OWNERINFO: Y
OWNERCOM:

COMMENTS:

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

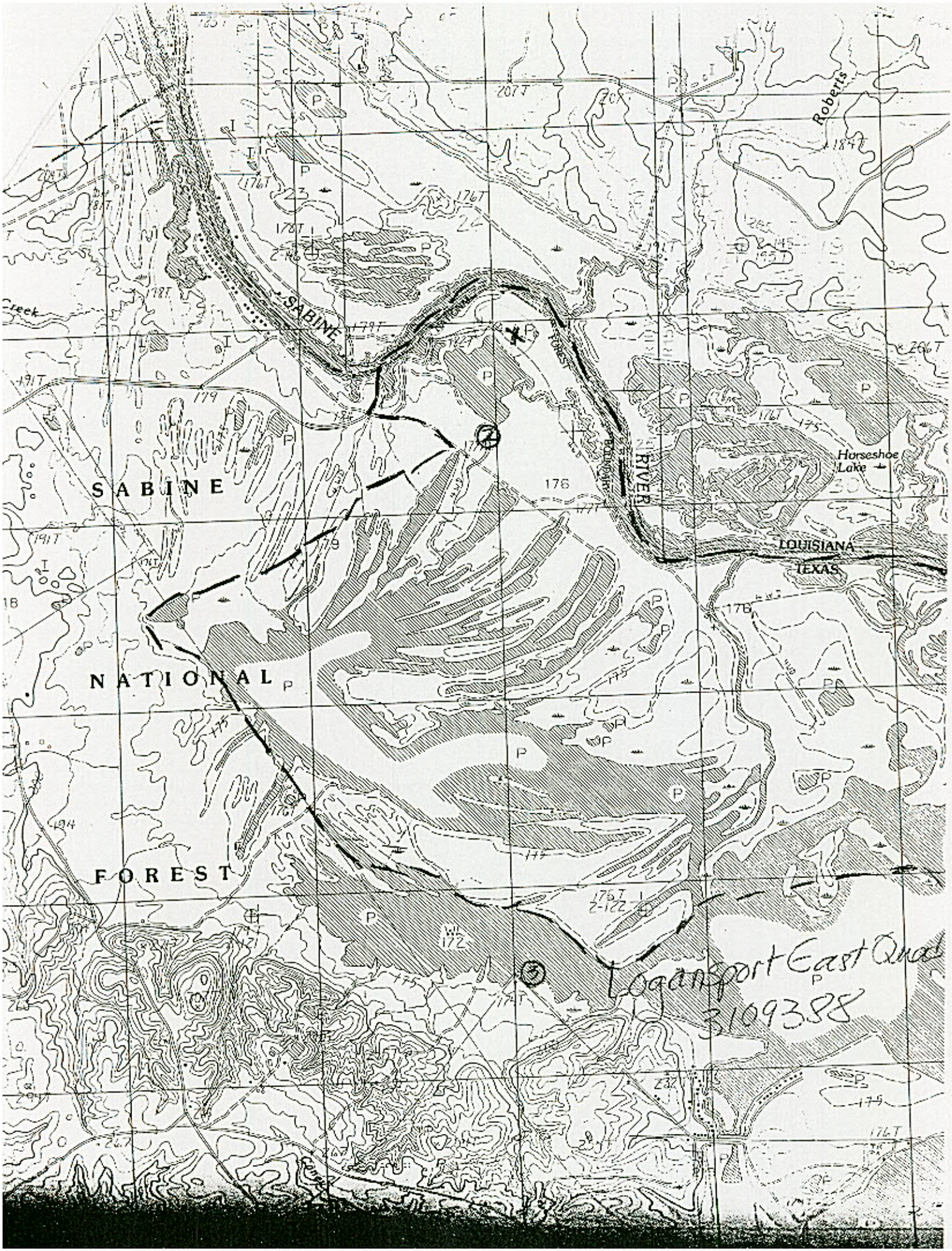
DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: MIROWSKY, K. 1995. EAST TEXAS RARE BAT SURVEY: 6 JUNE-17 AUGUST 1995. (SUMMER INTERNSHIP PROJECT).

ALL SOURCECODES:CITATIONS:
F95MIR01TXUS MIROWSKY, K. 1995. EAST TEXAS RARE BAT SURVEY: 6 JUNE-17 AUGUST 1995. (SUMMER INTERNSHIP PROJECT).

SPECIMENS:

EDITION: 95-10-03 EDAUTHOR: HORNER, PEGGY
TRANSCRIBR: 95-10-03 MAH MAPPER: 96-01-15 AEH CDREV: Y QC: Y LEADRESP: TXHP CHANGE.DATE: 01-06-27 INITIALS: DLS
AMACC01030*006*TX MYOTIS AUSTRORIPARIUS


SABINE
NATIONAL
FOREST
SABINE RIVER
LOUISIANA
TEXAS
Horseshoe Lake
Roberts
Logansport East Quad
3109388

NEW COUNTY RECORD (Y/N) N Element Occurrence Record

Elcode: EO# State:

EOCODE: AMACC08020 * 011 *TX FONUM: ____ IDENT: Y

SNAME: Corynorhinus rafinesquii

SCOMNAME:

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: TX JASP TX COUNTYNAME: Jasper LOCALJURIS:

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT: 31 01 30	S: 31 01 27
Ebenezer	3109412	64		6,8	LONG: 94 10 37	N: 31 01 33
						E: 94 10 34
						W: 94 10 40

DIRECTIONS: Cement culvert at Sandy Creek on R255 ca 1.6 mi SW of Ebeneze Angelina NF

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 01a

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020005

SURVEYDATE: yr - mo - da LASTOBS: yr 1998 - mo 08 - da FIRSTOBS: yr 1997 - mo 11 - da 01

EORANK: ____ (see code key) EORANKDATE: ____ - ____ - ____

EORANKCOM:

EODATA: 01 Nov 1997 6-8 roosting in culvert; March 1998 2; Aug 1998 8; May, June, N 1999 0

CONTACTID:... CONTACT.NAME: ____ CONTACT.NOTE: ____

EOTYPE:

ENDESC: double rectangular cement culvert

MINELEV: 120 feet MAXELEV: ____ feet SIZE: ____ acres

MATYPE: CONTAINED: Y (see code key)

ACODE:..... MANAME: Angelina NF

ORELAND: ____ MOREPROT: ____ MOREMGMT: ____ TNCINVOLVE: ____

GMTCOM:

ROTCOM:

WNER: ____ OWNERINFO: ____

WNERCOM:

OMMENTS: Roost #18 East TX Bat Surveys

DTL.TOPICS:

PIC.KEYWORDS:

TASENS: ____ BOUNDARIES: ____ PHOTOS: ____

STSOURCE: U98HOR01TXUS

SOURCECODES: U02LIN01TXUS U00KEE01TXUS

SPECIMENS: (citation info. for specimens)

ANSCRIBR: 03-06-25 SJB CDREV: Y MAPPER: 03-06-25 SJB QC: ____

TARESP: TXHP EDITIONDATE: 03-06-25 EDAUTHOR: SJB

NEW COUNTY RECORD (Y/N) N Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOSTO *014 *TX FONUM: IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: TX JASP COUNTYNAME: Jasper LOCALJURIS:

TX

TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:		
Ebenezer	3109412	65			LAT: 31 01 30	S: 31 01 27
						N: 31 01 33
					LONG: 94 10 37	E: 94 10 34
						W: 94 10 41

DIRECTIONS: Cement culvert at Sandy Creek on R255 ca 1.6 mi SW of Ebenezer; Angelina NF

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: D1a

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020005

	yr	mo	da		yr	mo	da		yr	mo	d
SURVEYDATE:		-	-	LASTOBS:	1998	- 08	-	FIRSTOBS:	1997	- 11	- 0

ORANK: (see code key) EORANKDATE: - -

ORANKCOM:

(EOR.011)

ODATA: 01 Nov 1997 6-8 Corynorhinus rafinesquii roosting in culvert; March, Aug 1998 8 C. raf.; 5 May 1998 1 Pipistrellus subflavus; March-June, Sept, Nov 1999 0 bats

ONTACTID: ... CONTACT.NAME: CONTACT.NOTE:

OTYPE:

ENDESC: double rectangular cement culvert

INELEV: 120 feet MAXELEV: feet SIZE: acres

.CODE:	MANAME:	MATYPE:	CONTAINED:
	Angelina NF		Y (see code key)

RELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MTCOM:

OTCOM:

NER: OWNERINFO:

NERCOM:

MMENTS: Roost #18 East Texas Bat Surveys 1997

OTL.TOPICS:

PIC.KEYWORDS:

CASENS: BOUNDARIES: PHOTOS:

STSOURCE: J98HORDITXUS

P97RUDDITXUS

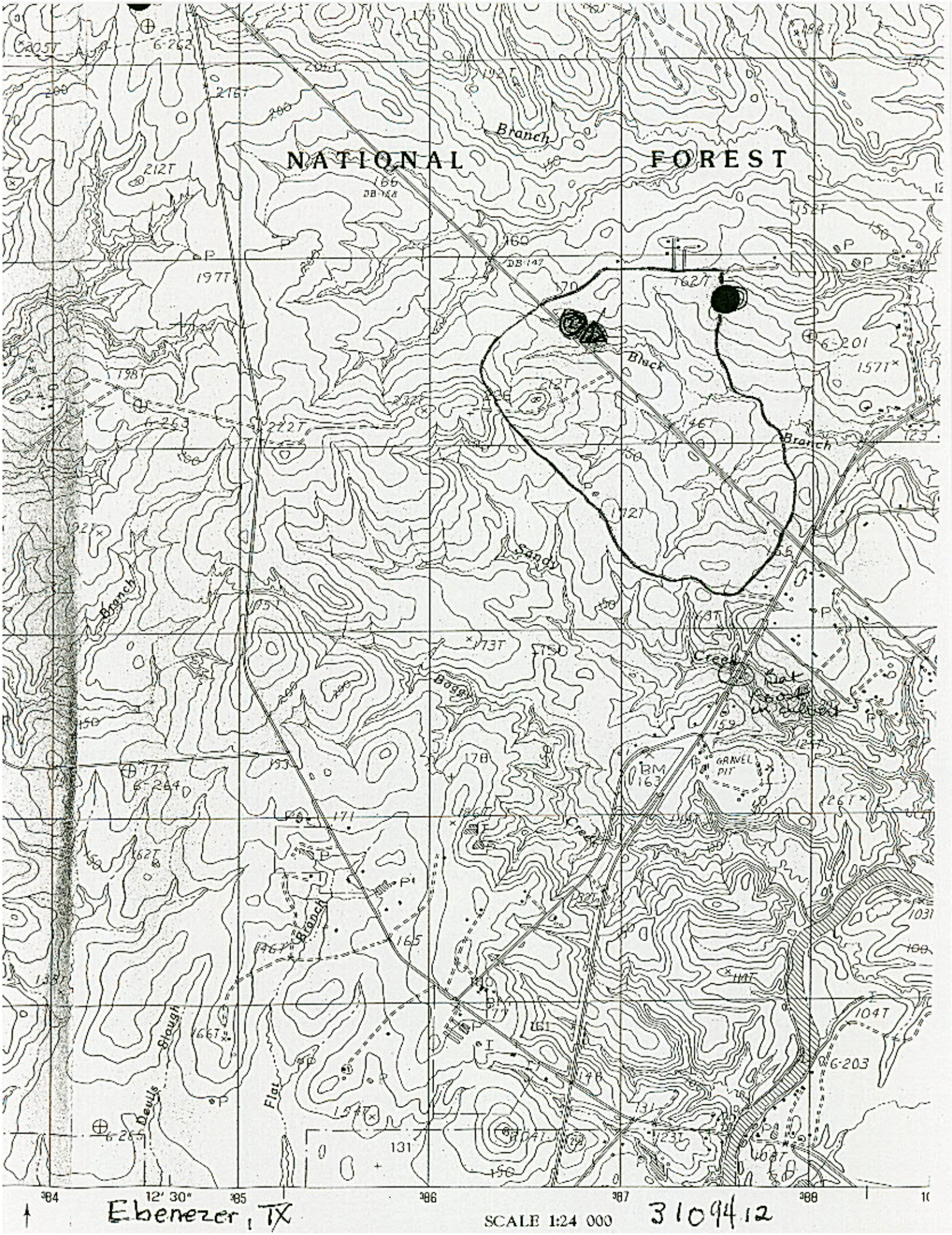
SOURCECODES: SPECIMENS: (citation info. for specimens)

J98HORDITXUS UDDKEEDITXUS

UDDLENDITXUS

NSCRIBR: 03-06-25 CDREV: Y MAPPER: 03-06-25 QC:

ARESP: TXHP EDITIONDATE: -95 EDAUTHOR:



Ebenezer, TX

SCALE 1:24 000

3109412

EOCODE: AMACC08020*003*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T
SNAME: CORYNORHINUS RAFINESQUII
SCOMNAME: RAFINESQUE'S BIG-EARED BAT
PLACENAME:
NATION: US SITECODE: S.USTXHP*97 SITENAME: ANGELINA NATIONAL FOREST
PRECISION: S SURVEYSITE: ALDRIDGE SAW MILL

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXJASP	Jasper	BOYKIN SPRING	3109413	128	8,8

LAT: 310202N LONG: 0941651W S: 310159N N: 310205N E: 0941648W W: 0941654W
DIRECTIONS: END OF BOYKIN SPRING ROAD, FOREST SERVICE ROAD 326; 1000 FEET EAST OF NECHES RIVER

NAT.REGION: WATERSHED:
01A LONGLEAF PINE FOREST 12020003 NECHES RIVER (SABINE LAKE-SHAWNEE CREEK)/MILL/SANDY/CYPRESS/BILLIAMS CREEKS

SURVEYDATE: 2003-02-11 LASTOBS: 2003-02-11 FIRSTOBS: 1995-06-27 EORANK: EORANKDATE:
EORANKCOM:

EODATA: 10 BATS CAPTURED IN THE ROOST (ROOST #9) ON 6/95; 1 ADULT MALE, 3 ADULT FEMALES POST LACTATING, 1 ADULT FEMALE NON-REPRODUCTIVE, 4 JUVENILE FEMALES, 1 JUVENILE MALE; JUVENILE MALE DIED AND WAS KEPT AS A SPECIMEN FOR EDUCATIONAL PURPOSES; 1 ADULT MALE CAPTURED AT ROOST 8/95, RADIO TRANSMITTER ATTACHED; CA. 10-15 OTHER RAFINESQUII BATS OBSERVED AT SAW MILL, BUT IN DIFFERENT BUILDING; 10 JUNE 1996, MIST NETTED ONE ADULT FEMALE AND ONE EACH JUVENILE MALE AND FEMALE, 0 ON 19 SEPTEMBER 1996, ONE ON 28 OCTOBER 1996; 0 IN JANUARY/FEBRUARY 1997, 4-20 IN APRIL 1997, 12-14 IN MAY 1997, 10-25 IN JUNE 1997, 0 IN DECEMBER 1997, YOUNG APPEARED TO BE PRESENT IN JUNE 1997; 0 IN MARCH 1998, 27 IN MAY 1998, 10-25 IN JUNE 1998, 18 IN AUGUST 1998; >25 IN MAY 1999, >35 IN JUNE 1999, >30 IN JULY 1999, 6 IN NOVEMBER 1999; ON 11 FEBRUARY 2003, OBSERVED 2 HIBERNATING BIG-EARED BATS

CONTACT:

EOTYPE:
GENDESC: ABANDONED SAW MILL (REGISTERED HISTORIC SITE) CONSTRUCTED OUT OF CONCRETE WITH 30 FOOT CEILINGS; TWO OF FOUR REMAINING BUILDINGS APPEAR SUITABLE FOR ROOSTS; 11 FEBRUARY 2003, HIBERNATING ALONG A STRESS CRACK IN THE SOUTHWEST CORNER OF THE THIRD CONCRETE BUILDING OF THE OLD ALDRIDGE SAW MILL

MINELEV: 120 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*6	ANGELINA NATIONAL FOREST	FFSNF	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: US:DOA/USFS OWNERINFO: Y
OWNERCOM:

COMMENTS: TRAIL RUNS NEXT TO MILL AND ACCESS TO AREA IS EASY; UNSUPERVISED GROUPS OF PEOPLE USE THE MILL AS A PLACE FOR "PARTYING" AS EVIDENCED BY THE AMOUNT OF GRAFITTI, BROKEN BOTTLES, AND TRASH; ROOST SUBJECT TO DISTURBANCE; NATIONAL FOREST IS CONSIDERING RESTORING THIS MILL FOR HISTORIC PURPOSES BUT, DUE TO PRESENCE OF THESE BATS, MAY POSTPONE OR TAKE BATS' PRESENCE INTO CONSIDERATION BEFORE RESTORATION BEGINS; 11 FEBRUARY 2003, OBSERVERS RICKY MAXEY AND MEG GOODMAN; ROOST #9 EAST TEXAS BAT SURVEYS

ADDTL.TOPICS: TOPIC.KEYWORDS:

OSDIRECTIONS:

OSBESTSOURCE:

NEW COUNTY RECORD (Y/N) N Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOSTØ * Ø13 *TX FONUM: ____ IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: TXJASP TX COUNTYNAME: Jasper ..... LOCALJURIS:

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT:	S:	N:	E:	W:
Boykin Spring	3109413	140		8,8	31Ø202	31Ø159	31Ø205	941648	941654
					LONG: 941651				

DIRECTIONS: Aldridge Saw Mill, Angelina NF; ca 1.8 air mi S of Boykin Spring Lake

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: Ø1a

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020003

SURVEYDATE: yr mo da ____-____-____ LASTOBS: yr mo da 2003-Ø2-11 FIRSTOBS: yr mo d 1995-Ø6-2

EORANK: ____ (see code key) EORANKDATE: ____-____-____

EORANKCOM: (EOR.ØØ3)

ODATA: Corynorhinus rafinesquii maternity roost; C. rafinesquii observed in June, Aug 199 April, May, June 1997; 11 Feb 2003 [10 June 1996 5 bats mist-netted 1 Big brown, 1 Seminole, + 3 C. rafin

CONTACTID:... CONTACT.NAME: on back [ ] CONTACT.NOTE: (over)-

OTYPE:

ENDESC: Abandoned saw mill (registered historic site) constructed out of concrete with 30 ceilings; 2003 - along a stress crack in the SW corner of the third concrete building of the s

ENELEV: 120 feet MAXELEV: ____ feet SIZE: ____ acres

CODE: ..... MANAME: Angelina NF MATYPE: ..... CONTAINED: Y (see code key)

RELAND: ____ MOREPROT: ____ MOREMGMT: ____ TNCINVOLVE: ____

MTCOM:

OTCOM:

NER: OWNERINFO: ____

NERCOM:

MMENTS: Roost # 9 East Texas Bat Surveys ~~[illegible]~~

OTL.TOPICS:

PIC.KEYWORDS:

TASENS: ____ BOUNDARIES: ____ PHOTOS: ____

STSOURCE: U98HOR01TXUS

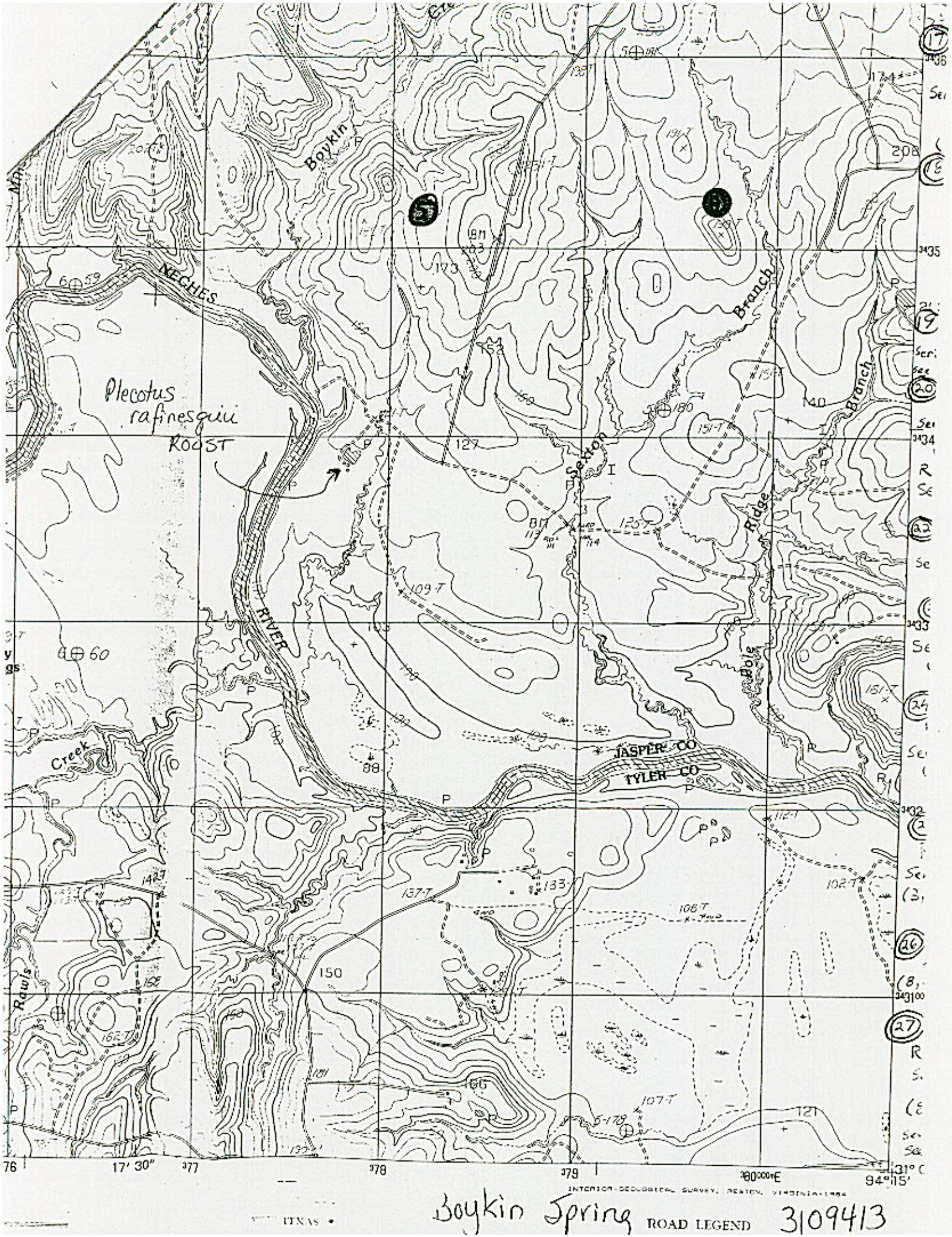
SOURCECODES: SPECIMENS: (citation info. for specimens)

FØ3GOOØ1TXUS F96MIRØ1TXUS

UØ2LINØ1TXUS UØØKFEØ1TXUS

NSCRIBR: Ø3-Ø6-24 [illegible] CDREV: Y MAPPER: Ø3-Ø6-24 [illegible] QC:

ARESP: TXHP EDITIONDATE: [illegible] EDAUTHOR:



Boykin Spring 3109413

EOCODE: AMACC08020*004*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T
SNAME: CORYNORHINUS RAFINESQUII
SCOMNAME: RAFINESQUE'S BIG-EARED BAT
PLACENAME:
NATION: US SITECODE: S.USTXHP*219 SITENAME: DAVY CROCKETT NATIONAL FOREST
PRECISION: S SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXTRIN	Trinity	DIBOLL	3109427	6	1,4

LAT: 311202N LONG: 0945225W S: 311159N N: 311205N E: 0945222W W: 0945228W
DIRECTIONS: FM 357 TO FOREST SERVICE ROAD 510A (TO HOLLY BLUFF CAMPGROUND) TO FOREST SERVICE ROAD 575; 5.6 AIR MILES WEST-NORTHWEST OF DIBOLL

NAT.REGION: WATERSHED:
01B MIXED PINE-HARDWOOD FOREST 12020002 NECHES RIVER (SHAWNEE CREEK-BOWLES CREEK)/SHAWNEE/CANEY/PINEY/CAMP CREEKS

SURVEYDATE: 1995-07-18 LASTOBS: 1995-07-18 FIRSTOBS: 1995-07-18 SORANK: EORANKDATE:
EORANKCOM:

EODATA: 1 ADULT FEMALE (POST-LACTATING) CAPTURED IN MIST NET

CONTACT:

EOTYPE:
GENDESC: HARDWOOD BOTTOMLAND-WILLOW OAK, WATER OAK-LOBLOLLY PINE WITH SOME SWEETGUM AND HICKORY; BAT CAPTURED IN MIDSLOPE PINE AREA WHERE NET WAS PLACED ACROSS ROAD

MINELEV: 200 MAXELEV: SIZE:

MACODE:	MANAME:	TYPE:	CONTAINED:
M.USTXHP*215	ALABAMA CREEK WILDLIFE MANAGEMENT AREA	SPWWM	Y
M.USTXHP*7	DAVY CROCKETT NATIONAL FOREST	FFSNF	Y

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: US:DOA/USFS AND TX:TPWD OWNERINFO: Y
OWNERCOM: TPWD LEASES LAND FOR WMA FROM NFS

COMMENTS:

ADDTL.TOPICS: TOPIC.KEYWORDS:

DSDIRECTIONS:

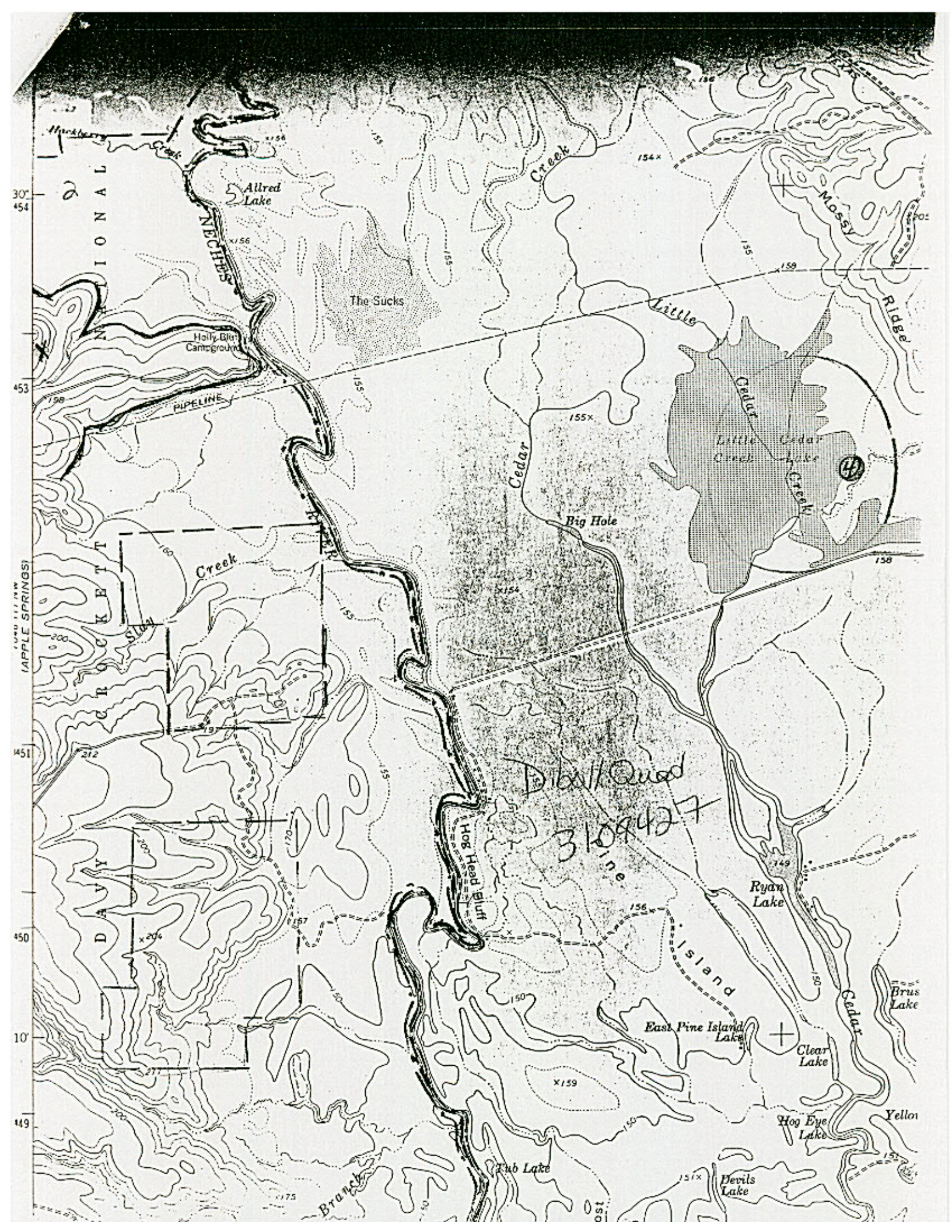
DSBESTSOURCE:

OWNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: MIROWSKY, K. 1995. EAST TEXAS RARE BAT SURVEY: 6 JUNE-17 AUGUST 1995. (SUMMER INTERNSHIP PROJECT).

ALL SOURCECODES:CITATIONS:
F95MIR01TXUS MIROWSKY, K. 1995. EAST TEXAS RARE BAT SURVEY: 6 JUNE-17 AUGUST 1995. (SUMMER INTERNSHIP PROJECT).

SPECIMENS:

EDITION: 95-10-03 EDAUTHOR: ROBNER, PEGGY
TRANSCRIBR: 95-10-03 MAH MAPPER: 96-01-16 AEH CDREV: Y QC: Y LEADRESP: TXHP CHANGE.DATE: 01-06-27 INITIALS: DLS



Allred Lake
NECHES
The Sucks
Holly Bluff Campground
PIPELINE
Creek
Little
Cedar
Little Cedar Creek
Cedar Lake
Creek
Big Hole
Mossy
Ridge
Slay
Creek
Hog Head Bluff
Pine
Island
Ryan Lake
East Pine Island Lake
Clear Lake
Cedar
Hog Eye Lake
Tub Lake
Devils Lake
Branch
(APPLE SPRINGS)
Dibolt Quad
3109427

EOCODE: AMACC01030*001*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT:
SNAME: MYOTIS AUSTRORIPARIUS
SCOMNAME: SOUTHEASTERN MYOTIS BAT
PLACENAME:
NATION: US SITECODE: S.USTXPO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE
PRECISION: M SURVEYSITE:

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXPANO	Panola	TIMPSON	3109484	1	2,2

LAT: 315913N LONG: 0942857W S: 315813N N: 320013N E: 0942757W W: 0942957W
DIRECTIONS: 8 MILES SOUTHWEST OF GARY, CA. 1 AIR MILE NORTH OF PANOLA/SHELBY COUNTYLINE

NAT.REGION: WATERSHED:
01B MIXED PINE-HARDWOOD FOREST 12010002 SABINE RIVER (GARRISON CREEK-ROCK CREEK)/DUCK/BIG SANDY CREEKS/MURVAUL BAYOU

SURVEYDATE: LASTOBS: 1969-12-10 FIRSTOBS: 1969-12-10 EORANK: EORANKDATE:
EORANKCOM:

EODATA: 1 MYOTIS AUSTRORIPARIUS AND 8 PIPISTRELLUS SUBFLAVUS WERE FOUND IN A SMALL SANDSTONE CAVE, WHICH HAD AN OPENING 1 METER IN DIAMETER BUT THE INSIDE DIMENSIONS OF WHICH INCREASED TO 1.5 BY 3.5 BY 4 METERS HIGH; INSIDE THE CAVE WAS A SMALL STAGNANT POOL, AND A SPRING-FED STREAM EMERGED BESIDE THE CAVE ENTRANCE; THIS IS THE FIRST LIVE SOUTHEASTERN MYOTIS FROM TEXAS

CONTACT:

EOTYPE:
GENDESC:

MINELEV: 420 MAXELEV: SIZE:
MACODE: MANAME: TYPE: CONTAINED:

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:
MGMTCOM:

PROTCOM:

OWNER: OWNERINFO:
OWNERCOM:

COMMENTS: THIS SPECIMEN EXTENDED THE KNOWN RANGE; IN 1967, A SINGLE SKULL WAS FOUND IN NEW BOSTON WHICH IS 100 MILES NORTH OF GARY; PRIOR TO THAT, THE CLOSEST SPECIMEN WAS PROVENCAL, LOUISIANA, APPROXIMATELY 75 MILES EAST OF GARY

ADDTL.TOPICS: TOPIC.KEYWORDS:

OSDIRECTIONS:

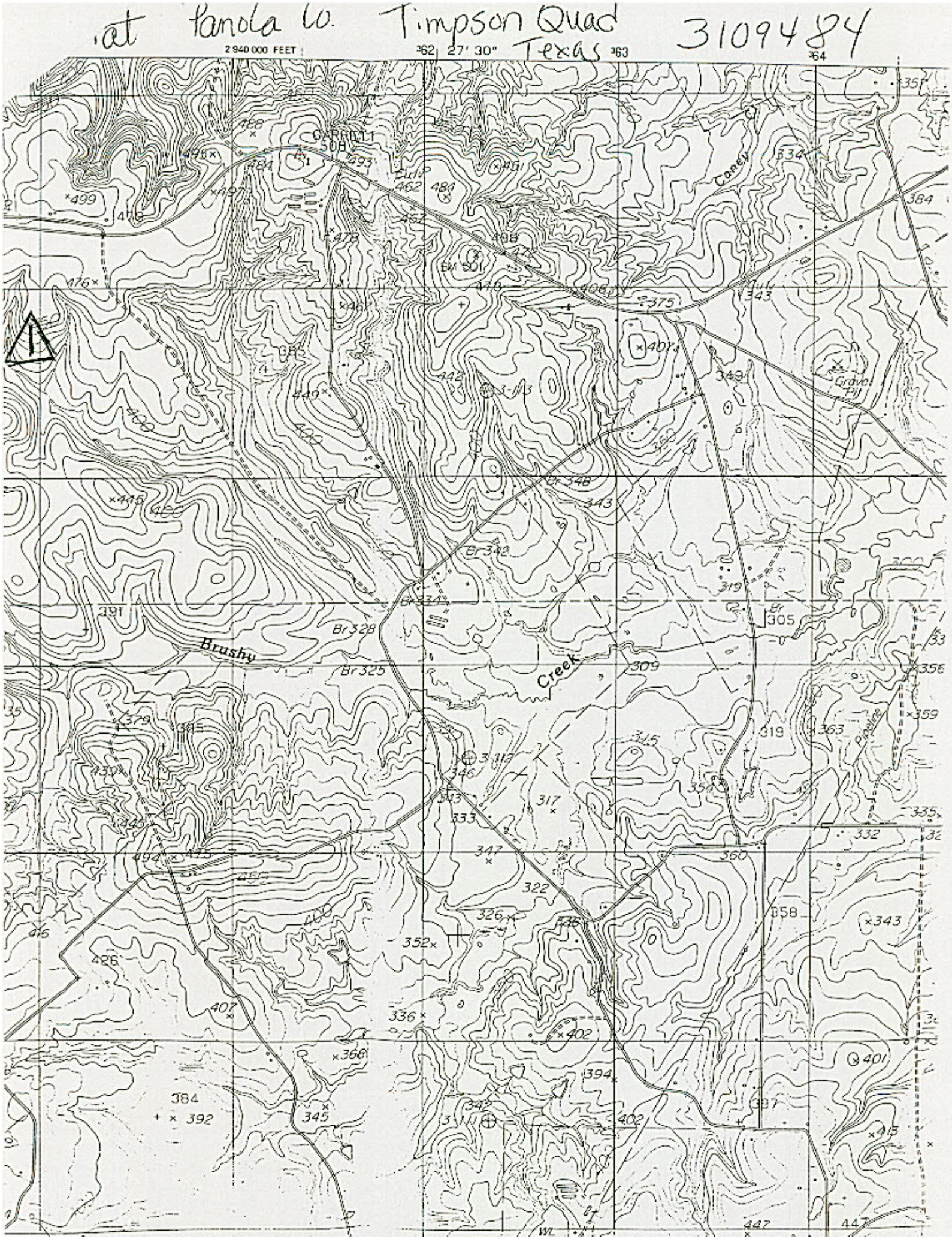
OSBESTSOURCE:

OWNER.SIGH: DATASENS: BOUNDARIES: PHOTOS:
BESTSOURCE: MICHAEL, E.D., R.L. WHISSENNAND, AND G. ANDERSON. 1970. A RECENT RECORD OF MYOTIS AUSTRORIPARIUS IN TEXAS. J. MAMM. 51(3):620.

ALL SOURCECODES:CITATIONS:
A70MIC01TXUS MICHAEL, E.D., R.L. WHISSENNAND, AND G. ANDERSON. 1970. A RECENT RECORD OF MYOTIS AUSTRORIPARIUS IN TEXAS. J. MAMM. 51(3):620.

SPECIMENS: MUSEUM UNKNOWN. 1969. E.D. MICHAEL, R.L. WHISSENNAND, AND G. ANDERSON, 1969-12-10. ONE SPECIMEN COLLECTED, LOCATION OF

at Panola Co. Timpson Quad 3109484



New Co. Record Y

Element Occurrence Record

Elcode: AMACC01030 EO#: 014 State: TX FONUM: IDENT: Y

SNAME: Myotis austroriparius

SCOMNAME:

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: M

	COUNTYCODE:	COUNTYNAME:	LOCALJURIS:
TX	NOUS	Houston	
TX			
TX			

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT:	S:	N:	E:	W:
Ratcliff	3109542	38		89	312308	312230	312408	950810	951010
					LONG: 950910				

DIRECTIONS: Ratcliff Lake Recreation Area, Davy Crockett NF

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 016

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020002

	yr	mo	da		yr	mo	da		yr	mo	da
SURVEYDATE:				LASTOBS:	1997	07	19	FIRSTOBS:	1997	07	19

EORANK: (see code key) EORANKDATE:

EORANKCOM:

EODATA: 19 July 1997 one male mist-netted from tree roost, March 1998 Φ

CONTACTID:... CONTACT.NAME: CONTACT.NOTE:

EOTYPE:

GENDESC: Sweet gum

MINELEV: 300 feet MAXELEV: feet SIZE: acres

MACODE:	MANAME:	MATYPE:	CONTAINED: (see code key)
M.USTXHP*....		.....	
M.USTXHP*....		.....	

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MGMTCOM:

PROTCOM:

OWNER: NPS OWNERINFO:

OWNERCOM: Ratcliff Lake Rec Area

COMMENTS: Bat Roost #17 East Texas Bat Surveys

ADDTL.TOPICS:

TOPIC.KEYWORDS:

DATASENS: BOUNDARIES: PHOTOS:

BESTSOURCE: 1998NORDITXUS

SOURCECODE: SPECIMENS: (citation info. for specimens)

NORINDITXUS

TRANSCRIBR: 03-06-26 SJP CDREV: Y MAPPER: 03-06-26 SJP QC:

DATARESP: TXHP EDITION: 03-06-26 EDAUTHOR: SJP

Maintenance History: INITIALS: CHANGE.DATE: (yr/mo/da)

MANUAL.FILE.NOTE:



M. austroriparius

ROAD CLASSIFICATION

HARD-SURFACE ALL WEATHER ROADS		DRY WEATHER ROADS
Heavy-duty	4 LANE 16 LANE	Improved dirt
Medium-duty	4 LANE 16 LANE	Unimproved dirt
Loose-surface, graded, or narrow hard-surface		

U. S. Route State Route

(CENTRALIA) 6946 I SE

RATCLIFF, TEX.

N3122.5—W9507.5/7.5

1950

AMS 6946 I NW—SERIES V882

2105-143

Non Co. Record 4

Element Occurrence Record

Elcode: EO# State:

EOCODE: DBATROOST0 *017 *TX FONUM: _____ IDENT: 4

SNAME: _____

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME: _____

SURVEYSITE: _____

PRECISION: SC COUNTYCODE: COUNTYNAME: LOCALJURIS:

TX LEON Leon

TX

TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:		
Buffalo	3109641	1		6,6	LAT: 31 25 18	S: 31 25 15
						N: 31 25 21
					LONG: 96 02 58	E: 96 02 55
						W: 96 03 01

DIRECTIONS: ~2.6 mi S of I-45/Hwy 79 x-sect in Buffalo, on I-45

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 02a

PLACENAME: _____

DSDIRECTIONS: _____

DSBESTSOURCE: _____

WATERSHED: 12030201

SURVEYDATE: yr - mo - da LASTOBS: 1999 - 07 - FIRSTOBS: 1995 - 01 - 27

EORANK: (see code key) EORANKDATE: yr - mo - da

EORANKCOM: _____

EODATA: 27 January 1995 Myotis austroriparius winter roost; 18 March 1998 21 Pipistrellus subflavus; 13 May and 27 June 1998 - one P. subflavus; June, July 1999 - one P. subflavus

CONTACTID: CONTACT.NAME: CONTACT.NOTE:

EOTYPE: _____

GENDESC: begins as one 4' box culvert and turns into two 4' box culverts under I-45

MINELEV: 340 feet MAXELEV: feet SIZE: acres

MACODE: MANAME: MATYPE: CONTAINED:

M.USTXHP*.... ..... (see code key)

M.USTXHP*.... .....

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MGMTCOM: _____

PROTCOM: _____

OWNER: TxDOT OWNERINFO:

OWNERCOM: _____

COMMENTS: Roost #20 East TX Bat Surveys

ADDTL.TOPICS: _____

TOPIC.KEYWORDS: _____

DATASENS: BOUNDARIES: PHOTOS:

BESTSOURCE: F98NORD4 TXUS

SOURCECODE: SPECIMENS: (citation info. for specimens)

J98NORD1TXUS UDDKEED1TXUS

J02LINDITXUS

TRANSCRIBR: 03-06-26 SLB CDREV: 4 MAPPER: 03-06-26 SLB QC:

DATARESP: TXHP EDITION: 03-Nov-26 EDAUTHOR: SLB

Maintenance History: INITIALS: CHANGE.DATE: (yr/mo/da)

MANUAL.FILE.NOTE: _____


Buffalo
Jr High Sch
Athletic Field
Gas Wells
Harrow Lake
Copper
Creek
Graham Cem
3109641

New Co. Record N

Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOSTØ * Ø18 *TX FONUM: _____ IDENT: Y

SNAME: _____

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME: _____

SURVEYSITE: _____

PRECISION: SC

	COUNTYCODE:	COUNTYNAME:	LOCALJURIS:
TX	LEON	Leon	
TX			
TX			

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:			
Buffalo	3109641	2		43	LAT: 31 2738	S: 31 2735	
						N: 31 2741	
					LONG: 96 05 03	E: 96 05 06	
						W: 96 05 00	

DIRECTIONS: On I-45 0.8mi N of I-45/Hwy 79 x-sect in Buffalo

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: Ø2a

PLACENAME: _____

DSDIRECTIONS: _____

DSBESTSOURCE: _____

WATERSHED: 12030201

	yr	mo	da		yr	mo	da		yr	mo	da
SURVEYDATE:				LASTOBS:	1998	06	27	FIRSTOBS:	1995	Ø1	27

EORANK: _____ (see code key) EORANKDATE: ____-____-____

EORANKCOM: _____

EODATA: 27 January 1995 - Myotis austroriparius winter roost; 21 March 1998 9 Pipistrellus subflav 13 May 1998 - one male P. subflavus; 27 June 1998 one P. subflavus; 1998 Ø M. austroriparius;

CONTACTID:... CONTACT.NAME: _____ CONTACT.NOTE: _____

EOTYPE: _____

GENDESC: 5' cement box culvert under I-45, 4' box culvert under accessroad

MINELEV: 340 feet MAXELEV: _____ feet SIZE: _____ acres

MACODE:	MANAME:	MATYPE:	CONTAINED: (see code key)
M.USTXHP*....		.....	
M.USTXHP*....		.....	

MORELAND: _____ MOREPROT: _____ MOREMGMT: _____ TNCINVOLVE: _____

MGMTCOM: _____

PROTCOM: _____

OWNER: TxDOT OWNERINFO: _____

OWNERCOM: _____

COMMENTS: Roost #21 East TX Bat Surveys

ADDTL.TOPICS: _____

TOPIC.KEYWORDS: _____

DATASENS: _____ BOUNDARIES: _____ PHOTOS: _____

BESTSOURCE: F98HOR04TXUS

SOURCECODE: SPECIMENS: (citation info. for specimens)

U98HORØ1TXUS UØØKEEØ1TXUS

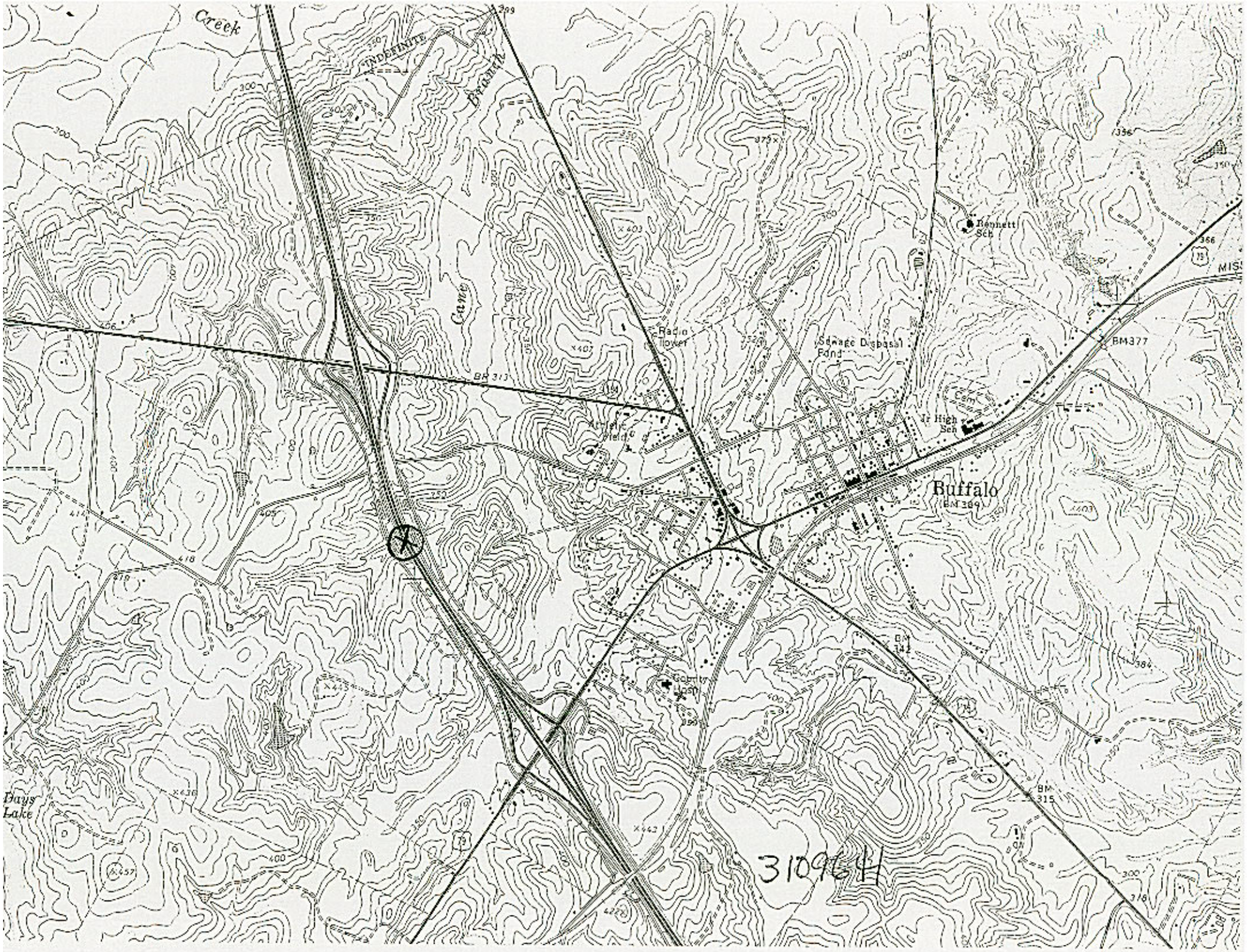
UØ2LTNØ1TXUS

TRANSCRIBR: Ø3-Ø6-26 [illegible] CDREV: Y MAPPER: Ø3-Ø6-26 [illegible] QC: _____

DATARESP: TXHP EDITION: Ø3-Ø6-26 EDAUTHOR: [illegible]

Maintenance History: INITIALS: _____ CHANGE.DATE: _____ (yr/mo/da)

MANUAL.FILE.NOTE: _____


Creek
INDEFINITE
Branch
Cane
Radio Tower
Sewage Disposal Pond
Bennett Sch
BM377
Jr High Sch
Buffalo
BM 389
BR 313
Athletic Field
Cem
County Hosp
BM 315
Days Lake
310964

New Co. Record Y

Element Occurrence Record

Elcode: EO#: State:

EOCODE: OBATROOSTO *019 *TX FONUM: _____ IDENT: Y

SNAME: _____

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME: _____

SURVEYSITE: _____

PRECISION: SC

COUNTYCODE:	COUNTYNAME:	LOCALJURIS:
TX FREE	Freestone	
TX		
TX		

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:
Lanely	3109651	4		29

LAT: 31 30 41 S: 31 30 36
N: 31 30 44
LONG: 96 06 13 E: 96 06 10
W: 96 06 16

DIRECTIONS: Culverts under I-45 and access road 4.7 mi N of I-45/Hwy 79 x-sect in Buffalo; Whitney Branch

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 02a

PLACENAME: _____

DSDIRECTIONS: _____

DSBESTSOURCE: _____

WATERSHED: 12030201

	yr	mo	da
SURVEYDATE:	____	____	____
LASTOBS:	1999	07	____
FIRSTOBS:	1995	01	27

EORANK: _____ (see code key) EORANKDATE: ____-____-____

EORANKCOM: _____

EODATA: 27 January 1995 - Myotis austroriparius winter roost; 21 March 1998 440 Pipistrellus subflavus, one male M. austroriparius; 13 May 1998 11 P. subflavus, 1 male M. austroriparius; 27 June 17 P. sub

CONTACTID:... CONTACT.NAME: _____ CONTACT.NOTE: _____

EOTYPE: _____

GENDESC: Three 6' box culverts under I-45 and five 4' box culverts under access road

MINELEV: 330 feet MAXELEV: 340 feet SIZE: _____ acres

MACODE:	MANAME:	MATYPE:	CONTAINED: (see code key)
M.USTXHP*....		.....	
M.USTXHP*....		.....	

MORELAND: _____ MOREPROT: _____ MOREMGMT: _____ TNCINVOLVE: _____

MGMTCOM: _____

PROTCOM: _____

OWNER: TxDOT OWNERINFO: _____

OWNERCOM: _____

COMMENTS: Roost #22 East Texas Bat surveys

ADDTL.TOPICS: _____

TOPIC.KEYWORDS: _____

DATASENS: _____ BOUNDARIES: Y PHOTOS: _____

BESTSOURCE: F98NOR01TXUS

SOURCECODE: SPECIMENS: (citation info. for specimens)

J98NOR01TXUS VOOKEE01TXUS

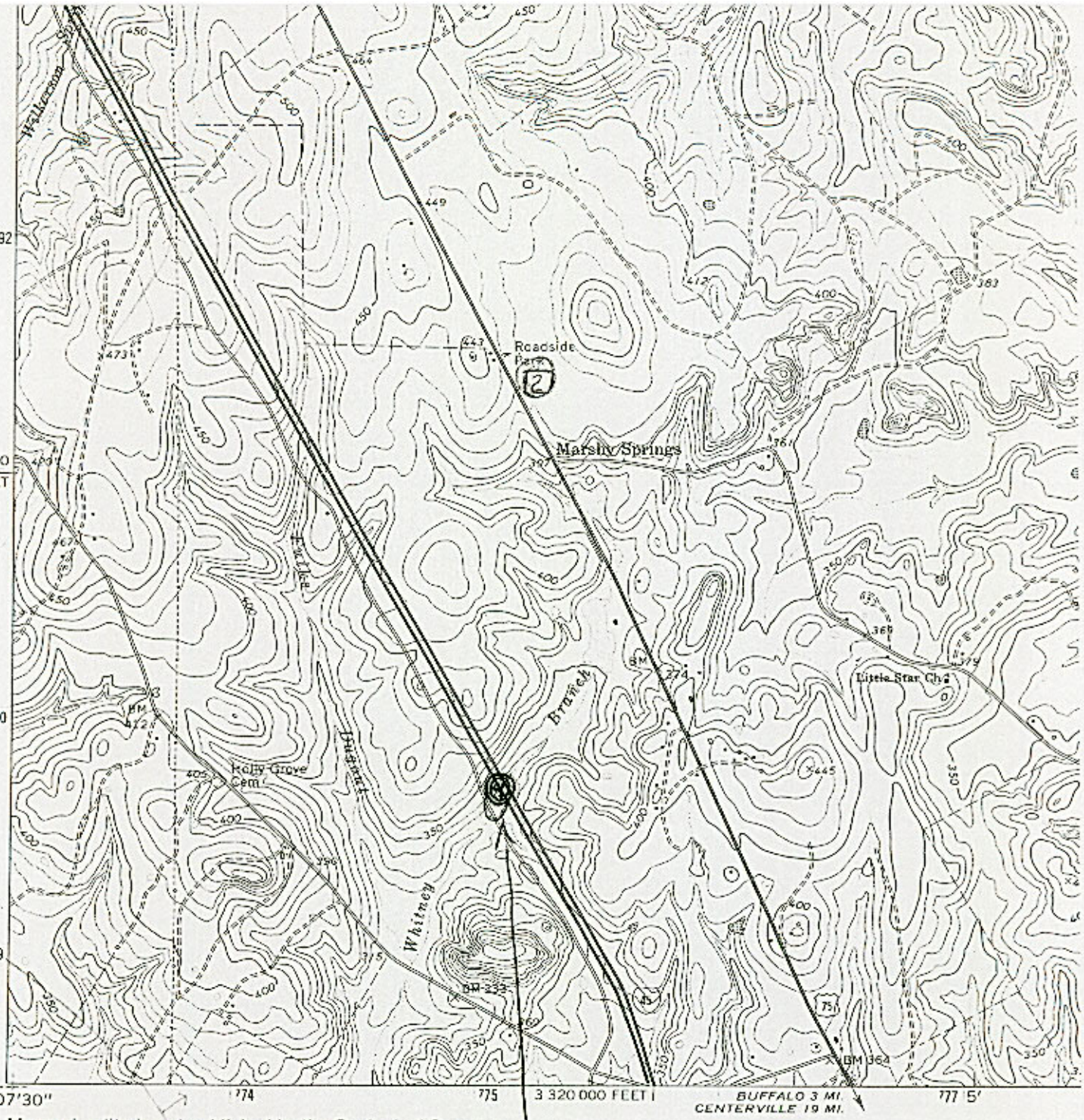
U02LIT01TXUS

TRANSCRIBR: 03-06-27 CDREV: Y MAPPER: 03-06-27 QC: _____

DATARESP: TXHP EDITION: 02-06-27 EDAUTHOR: _____

Maintenance History: INITIALS: _____ CHANGE.DATE: _____ (yr/mo/da)

MANUAL.FILE.NOTE: _____



Mapped, edited, and published by the Geological Survey

Control by USGS and NOS/NOAA

Topography by photogrammetric methods from aerial photographs taken 1964. Field checked 1965

Polyconic projection. 1927 North American Datum
10,000-foot grid based on Texas coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks, zone 14, shown in blue

Fine red dashed lines indicate selected fence lines

To place on the predicted North American Datum 1983 move the projection lines 15 meters south and 24 meters east as shown by dashed corner ticks

(DONIE) 6746 I NW

Roost



UTM GRID AND 1982 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Revisions shown in purple and woodland compiled from aerial photographs taken 1978 and other source data
This information not field checked. Map edited 1982

FOR

Lanely, TX 3109651

New Co. Record N

Element Occurrence Record

Elcode: EO#: State:

EOCODE: OBATROOST*020 *TX FONUM: _____ IDENT: Y

SNAME: _____

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME: _____

SURVEYSITE: _____

PRECISION: SC

COUNTYCODE:	COUNTYNAME:	LOCALJURIS:
TX FREE	Freestone	
TX		
TX		

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:		
Dew	3109652	2		95	LAT: 31 33 39	S: 31 33 36
						N: 31 33 42
					LONG: 96 08 03	E: 96 08 00
						W: 96 08 06

DIRECTIONS: On I-45 8.3 mi N of I-45/Hwy 79 x-sect in Buffalo

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 020 _____ _____ _____ _____

PLACENAME: _____

DSDIRECTIONS: _____

DSBESTSOURCE: _____

WATERSHED: 12030201 _____ _____ _____

	yr	mo	da		yr	mo	da		yr	mo	da
SURVEYDATE:	____	- __	- __	LASTOBS:	1998	-06	-27	FIRSTOBS:	1998	-06	-27

EORANK: _____ (see code key) EORANKDATE: ____ - __ - __

EORANKCOM: _____

EODATA: 27 June 1998 2 Pipistrellus subflavus

CONTACTID:... CONTACT.NAME: _____ CONTACT.NOTE: _____

EOTYPE: _____

GENDESC: _____

MINELEV: 400 feet MAXELEV: _____ feet SIZE: _____ acres

MACODE:	MANAME:	MATYPE:	CONTAINED: (see code key)
M.USTXHP*....		.....	
M.USTXHP*....		.....	

MORELAND: _____ MOREPROT: _____ MOREMGMT: _____ TNCINVOLVE: _____

MGMTCOM: _____

PROTCOM: _____

OWNER: TxDOT OWNERINFO: _____

OWNERCOM: _____

COMMENTS: Roost #27 (T-A) East TX Bat Surveys

ADDTL.TOPICS: _____

TOPIC.KEYWORDS: _____

DATASENS: _____ BOUNDARIES: _____ PHOTOS: _____

BESTSOURCE: F98NOR04TXUS

SOURCECODE: JDOKEE01TXUS SPECIMENS: (citation info. for specimens) _____

TRANSCRIBR: ws-06-27-SJB CDREV: Y MAPPER: 03-06-27 SJB QC: _____

DATARESP: TXHP EDITION: 03-06-27 EDAUTHOR: SJB

Maintenance History: INITIALS: _____ CHANGE.DATE: _____ (yr/mo/da)

MANUAL.FILE.NOTE: _____



Dew
(BM 464)
PIPELINE
PIPELINE
Blain
Dugout
Browns
Creek
BM 448
BM 446
BR 409
Cedar
Creek
Creek
Roost
Rest Area
Rest Area
LANELY 4 MI.
15 MI. TO U.S. 84
BUFFALO 9 MI.
(LANELY)
6747 II SE
BUFFALO 8 MI.
35'
3498
3497
3495
3494
Dew
3109652

New Co. Record Y

Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOST0 *021 *TX FONUM: ____ IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: U COUNTYCODE: COUNTYNAME: LOCALJURIS:

TX SANA San Augustine

TX

TX

QUADNAME: QUADCODE: MARG NUM: DOT NUM: TEN TEN: LAT: S: N: LONG: E: W:

UNMAPPABLE

DIRECTIONS: Central SanAugustine Co. - private land

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 01b 01a

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020005

SURVEYDATE: yr - mo - da LASTOBS: yr 1989 - mo 05 - da FIRSTOBS: yr 1989 - mo 05 - da

EORANK: ____ (see code key) EORANKDATE: ____ - ____ - ____

EORANKCOM:

EODATA: May 1989 - Corynorhinus rafinesquii maternity roost (EOR.013)

CONTACTID:... CONTACT.NAME: CONTACT.NOTE:

EOTYPE:

GENDESC: wooden structure

MINELEV: ____ feet MAXELEV: ____ feet SIZE: ____ acres

MACODE: MANAME: MATYPE: CONTAINED:

M.USTXHP*.... ..... ____ (see code

M.USTXHP*.... ..... key)

MORELAND: ____ MOREPROT: ____ MOREMGMT: ____ TNCINVOLVE: ____

MGMTCOM:

PROTCOM:

OWNER: Private OWNERINFO: ____

OWNERCOM:

COMMENTS: Roost #23 East TX Bat Surveys

ADDTL.TOPICS:

TOPIC.KEYWORDS:

DATASENS: ____ BOUNDARIES: ____ PHOTOS: ____

BESTSOURCE:

U98NOR01TXUS

SOURCECODE: SPECIMENS: (citation info. for specimens)

U02LIN01TXUS

TRANSCRIBR: 03-06-27 SAB CDREV: Y MAPPER: 03-06-27 SAB QC: ____

DATARESP: TXHP EDITION: 03-06-27 EDAUTHOR: SAB

Maintenance History: INITIALS: ____ CHANGE.DATE: ____ (yr/mo/da)

MANUAL.FILE.NOTE:

NEW COUNTY RECORD (Y/N) Y Element Occu

Elcode: EO# State:

EOCODE: AMACC01030 * 012 *TX

SNAME: Myotis austroriparius

SCOMNAME:

ELEMENT RANKS: GRANK: ..... NRANK

NATION: US SITECODE: S.USTXHP*.....

ITENAME:

URVEYSITE:

RECISION:

Meg will get exact location in July. SOR (20 June 2003)

IDENT: Y

... code in SBR)

COUNTYCODE: COUNTYNAME: LOCALJURIS:

TX SMIT Smith

TX

UADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT:	S:
Big Sandy	3209551	5			LONG:	N:
						E:
						W:

IRECTIONS: Private property - Sabine River, West of Gladewater

tional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 01b

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

TERSHED: 12010002

RVEYDATE: yr mo da LASTOBS: yr 1999 mo 07 da FIRSTOBS: yr 1996 mo 03 da 06

RANK: (see code key) EORANKDATE: - -

RANKCOM: 1996-03-06 - roost site discovered; 9 Oct 1996 100; 22 Oct 1996 17 Nov 1996 10 bats visible 8 males, 1 fe

DATA: year-round roost; Jan 1997 - 10-25 observed; Feb 1997 - 3; March 1997 10-25; May 1997 >25; June 1997 >25; September 1997 >25; Nov 1997 >25; Dec 1997 5-25

NTACTID:... CONTACT.NAME: CONTACT.NOTE: July 1999 90

TYPE:

NDESC: water tupelo

IELEV: feet MAXELEV: feet SI M

CODE: MANAME:

ELAND: MOREPROT: MOREMGMT:

TCOM:

TCOM:

ER: private OWNERINFO:

ERCOM: Byrd's property

MENTS: Roost #7 East Texas Bat Surveys 1994-1997

TL.TOPICS:

IC.KEYWORDS:

ASENS: BOUNDARIES: PHOTOS:

TSOURCE: F96MIR01TXUS

Where's Byrd property near Winona.

- old army bunkers w/ Pips (need to map as roosts)

- see F96MIR01TXUS

SOURCECODES: SPECIMENS: (citation info. for specimens)

U98HOR01TXUS U00KEE01TXUS

U02LIN01TXUS

NSCRIBR: 03-06-16 SOR CDREV: Y MAPPER: 03-06-16 SOR QC:

ARESP: TKHP EDITIONDATE: EDAUTHOR:

NEW COUNTY RECORD (Y/N) Y Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOST0 * 010 *TX FONUM: _____ IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: TX SMIT TX COUNTYNAME: Smith LOCALJURIS:

QUADNAME: Big Sandy QUADCODE: 3209551 MARG NUM: 6 DOT NUM: TEN TEN: LAT: LONG: S: N: E: W:

IRECTIONS: Private property - Sabine River, West of Gladewater

otional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 016

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

TERSHED: 12010002

RVEYDATE: yr mo da LASTOBS: yr 1999 mo 07 da FIRSTOBS: yr 1996 mo 03 da 0

RANK: (see code key) EORANKDATE: yr mo da

RANKCOM: for Myotis austroriparius

DATA: Year-round roost; 1996-03-06 roost site discovered; 9 Oct 1996 100 bats; 22 Oct 1996 misnetted 8 male 17 Nov 1996 1 female; Jan 1997 10-25 observed; 1997 3; March 1997 10-25; May, June, Sept, Nov 1997 >25 each month; Dec 1997 5-25

NTACTID:... CONTACT.NAME: CONTACT.NOTE: July 1999 90 M. austro.

TYPE:

NDESC: water tupelo

IELEV: feet MAXELEV: feet SIZE: acres

ODE: MANAME: MATYPE: CONTAINED: (see code key)

ELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

TCOM:

TCOM:

ER: private OWNERINFO:

ERCOM: Burds property

MENTS: Roost #7 East Texas Bat Surveys 1994-1997

TL.TOPICS:

IC.KEYWORDS:

ASENS: BOUNDARIES: PHOTOS:

SOURCE: [U98HOR01TXUS]

F96MIR01TX

SOURCECODES: SPECIMENS: (citation info. for specimens)

V02LIN01TXUS

U00KEE01TXUS

SCRIBR: 03-06-12 SQB CDREV: Y MAPPER: 03-06-12 SQB QC:

RESP: TXHP EDITIONDATE: 03-06-12 EDAUTHOR: SQB

NEW COUNTY RECORD(Y/N) Y Element Occurrence Record

Elcode: EO# State:

EOCODE: AMACC01030 * 013 *TX FONUM: ____ IDENT: Y

SNAME: Myotis austroriparius

SCOMNAME:

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP* ..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: TX WOOD COUNTYNAME: Wood LOCALJURIS: TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT: 32 35 04	S: 32 35 0
Hawkins	3209552			2,3		N: 3235.0
					LONG: 95 13 58	E: 95 13 55
						W: 95 14 01

DIRECTIONS: Little Sandy NWR (Little Sandy Hunting & Fishing Club), W of Hawkin

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 016

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

ATERSHED: 12010002

SURVEYDATE: yr ___ mo ___ da ___ LASTOBS: yr 1997 mo 12 da ___ FIRSTOBS: yr 1996 mo 03 da 01

ORANK: ____ (see code key) EORANKDATE: ____-___-___

ORANKCOM:

ODATA: 15 June 1996 - 19 mist netted, 28 Sept 1996 one male mistnetted, only a few bats could be heard See: Jan 1997 - 0; Feb-Jun 1997 >25 each month; Aug 1997 0; Oct-Nov 1997 >25; Dec 1997 5-2

ONTACTID: ... CONTACT.NAME: ____ CONTACT.NOTE: ____ (over)

OTYPE:

ENDESC: a black gum within an extensive old growth bottomland hardwood forest
Registered champion

NELEV: 294 feet MAXELEV: ____ feet SIZE: ____ acres

CODE: ..... MANAME: Little Sandy NWR MATYPE: ..... CONTAINED: ____ (see code key)

RELAND: ____ MOREPROT: ____ MOREMGMT: ____ TNCINVOLVE: ____

MTCOM:

OTCOM:

NER: DOI: USFWS OWNERINFO: Y

NERCOM:

MMENTS: Roost #8 East TX Bat Surveys

OTL.TOPICS:

PIC.KEYWORDS:

CASENS: ____ BOUNDARIES: ____ PHOTOS: ____

STSOURCE: U98HORDITXUS

SOURCECODES: SPECIMENS: (citation info. for specimens)

F96MTRDITXUS U00ZLINDITXUS

F94HORD4TXUS U00KEEDITXUS

NSCRIBR: 03-06-23 SDB CDREV: Y MAPPER: 03-06-23 SDB QC: ____

ARESP: TXHP EDITIONDATE: 03-06-23 EDAUTHOR: SDB

NEW COUNTY RECORD(Y/N) Y Element Occurrence Record

Elcode: EO# State:

EOCODE: QBATROOSTQ * Q11 * TX FONUM: IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP* ..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: TX WOOD COUNTYNAME: Wood LOCALJURIS:

TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT: 32 35 04	S: 32350
Hawkins	3209552	3		2,3		N: 32350
					LONG: 95 1358	E: 95 13 5
						W: 95 14 0

DIRECTIONS: Little Sandy NWR (Little Sandy Hunting & Fishing Club), W of Hawkins

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: Q16

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12010002

	yr	mo	da		yr	mo	da		yr	mo	d
SURVEYDATE:				LASTOBS:	1997	12		FIRSTOBS:	1994	08	1

GRANK: (see code key) EORANKDATE:

GRANKCOM:

(EOR

GDATA: 13 Aug 1994 - roost discovered, no rare species; 6 March 1996 - Myotis austroriparius discovered; 15 June 1996 - 19 M. austroriparius mist netted; 28 Sept 1996 - one male M. austroripa

(over)

CONTACTID: ... CONTACT.NAME: CONTACT.NOTE:

ETYPE:

ENDESC: Registered champion Black gum within an extensive old growth bottomland hardwood forest

ENELEV: 294 feet MAXELEV: feet SIZE: acres

CODE:	MANAME:	MATYPE:	CONTAINED: (see cod key)
	Little Sandy NWR		

PRELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MTCOM:

OTCOM:

OWNER: DOI: USFWS ? OWNERINFO: Y

OWNERCON:

COMMENTS: Roost # 8 East Texas Bat Surveys ~~1994-1997~~

ETL.TOPICS:

TOPIC.KEYWORDS:

PHASENS: BOUNDARIES: PHOTOS:

ETSOURCE: U98HORQ1TXUS

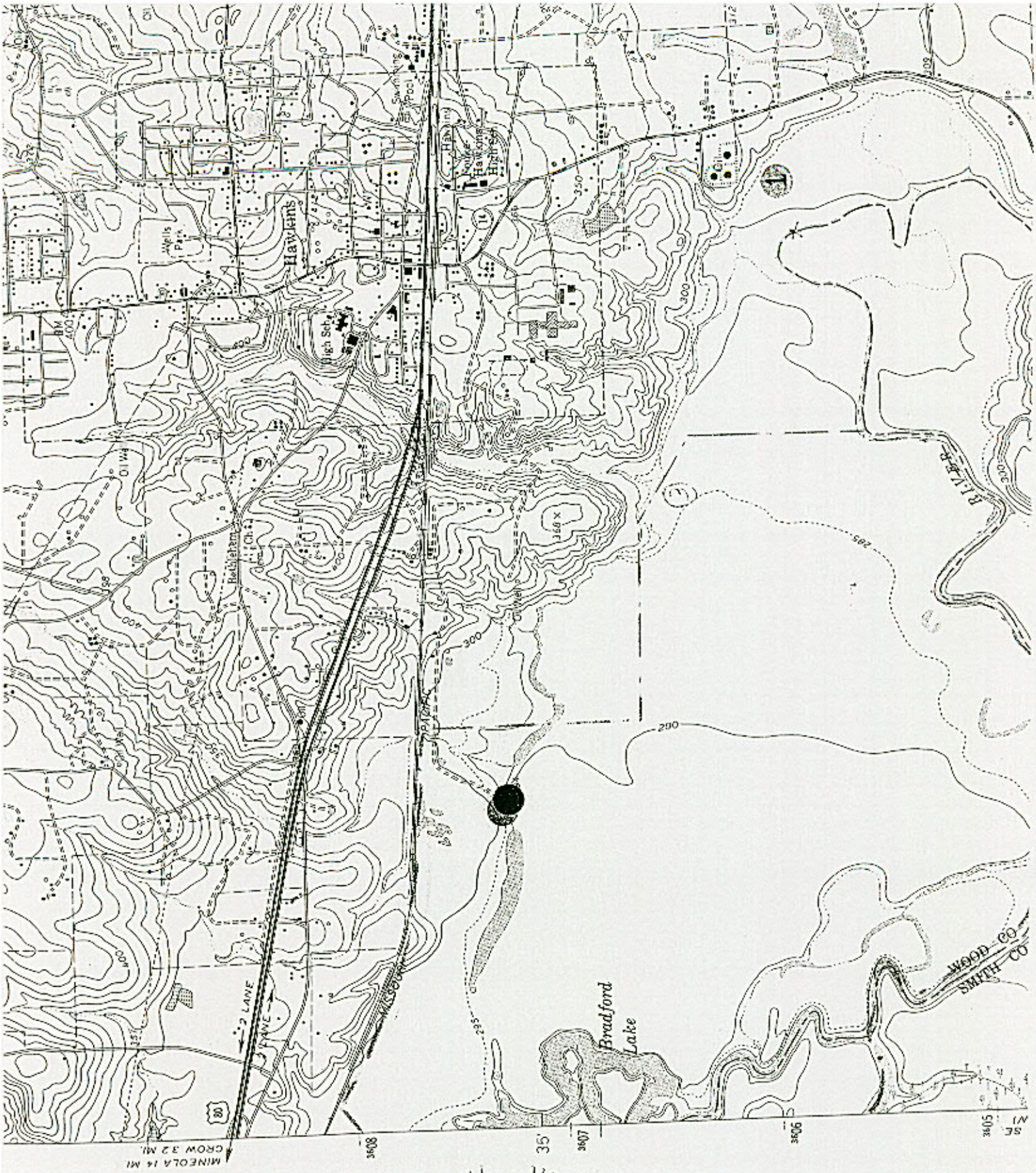
SOURCECODES: SPECIMENS: (citation info. for specimens)

U94NORQ4TXUS UQ2LINQ1TXUS

96MTRQ1TXUS

TRANSCRIBR: Q3-Q6-12 SKB CDREV: Y MAPPER: Q3-Q6-12 SKB QC:

AGRESP: TXHP EDITIONDATE: Q3-Q6-12 EDAUTHOR: SKB



Hawkins

3209552

NEW COUNTY RECORD (Y/N) N Element Occurrence Record

Elcode: EO# State:

EOCODE: OBATROOST0 *012 *TX FONUM: IDENT: Y

SNAME:

SCOMNAME: Bat Roost

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP* ..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: SM COUNTYCODE: TX WOOD COUNTYNAME: Wood LOCALJURIS:

TX TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT: 323520	S: 32344
Crow	3209553	8		13		N: 323550
					LONG: 951702	E: 951630
						W: 951725

DIRECTIONS: Little Sandy NWR (Little Sandy Hunting & Fishing Club - Trail 18), W of Hawkins

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 016

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

ATERSHED: 12010002

	yr	mo	da		yr	mo	da		yr	mo	da
URVEYDATE:				LASTOBS:	1997	10		FIRSTOBS:	1997	10	

RANK: _____ (see code key) EORANKDATE: ____-____-____

RANKCOM:

DATA: Oct 1997 identity of bats not verified, tree characteristics & number of bats in the roost indicate that it could be Myotis austroriparius; Roost has not been relocated

NTACTID: ... CONTACT.NAME: CONTACT.NOTE:

TYPE:

NDESC: Sweetgum

NELEV: 295 feet MAXELEV: _____ feet SIZE: _____ acres

CODE: ..... MANAME: Little Sandy NWR MATYPE: ..... CONTAINED: Y (see code key)

ELAND: _____ MOREPROT: _____ MOREMGMT: _____ TNCINVOLVE: _____

ITCOM:

TCOM:

ER: DOI; USFWS OWNERINFO: Y

ERCOM:

MENTS: Roost #16 East Texas Bat Surveys ~~1994-1997~~ 1997

TL.TOPICS:

IC.KEYWORDS:

ASENS: _____ BOUNDARIES: _____ PHOTOS: _____

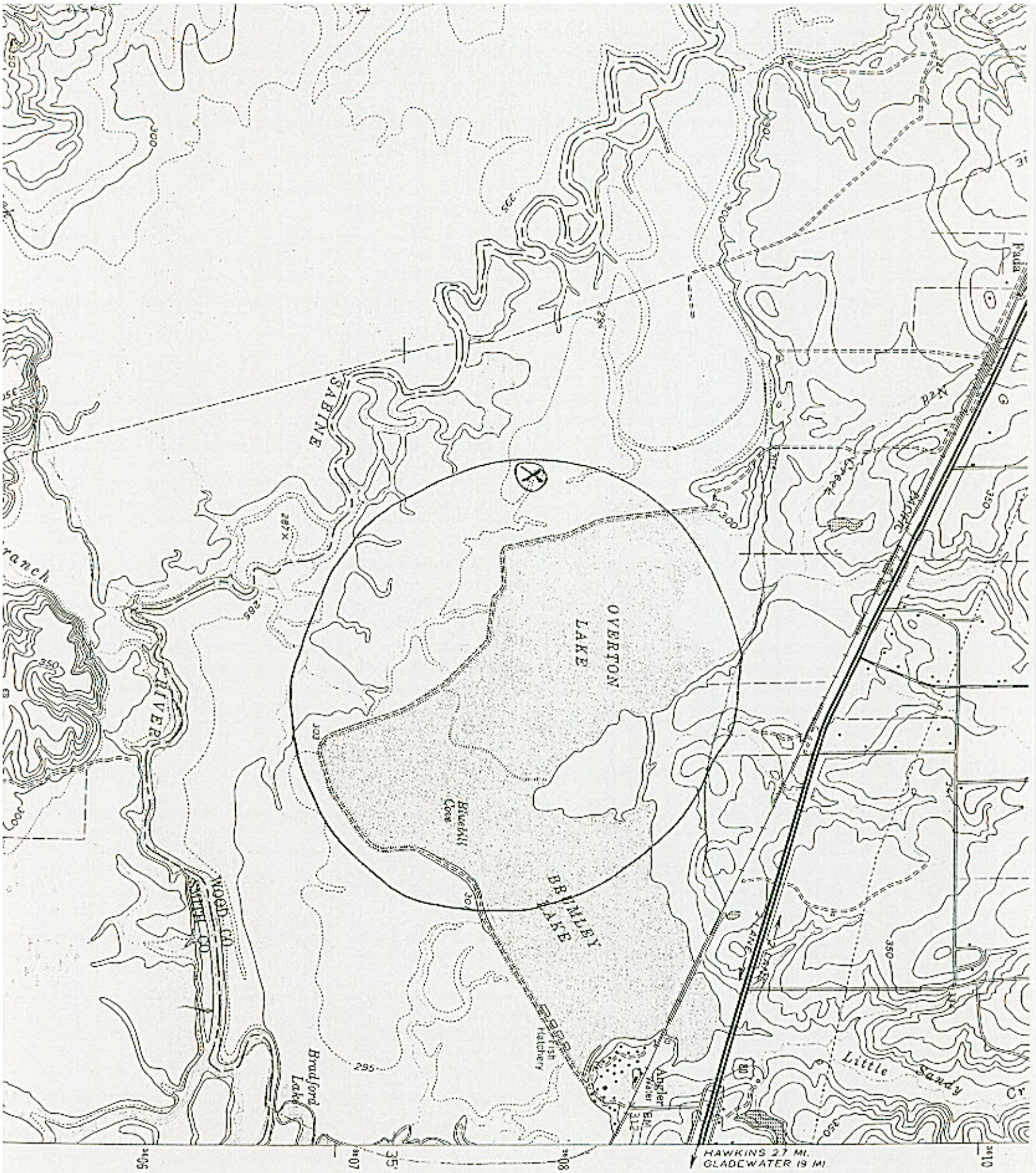
TSOURCE: U98HORD1TXUS

SOURCECODES: SPECIMENS: (citation info. for specimens)

D02LEND1TXUS

SCRIBR: 03-06-12 SJB CDREV: Y MAPPER: 03-06-12 SJB QC: _____

RESP: TXHP EDITIONDATE: 03-06-12 EDAUTHOR: SJB



Crow, Tex
3209553

Element Occurrence Record

Elcode: EO# State:

OCODE: AMACCD1030 * Ø11 *TX FONUM: _____ IDENT: Y

NAME: Myotis austroriparius

COMNAME: Southeastern myotis

LEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

ATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

ITENAME:

URVEYSITE:

RECISION: U

COUNTYCODE: TX COMA TX TX

COUNTYNAME: Comanche County

LOCALJURIS:

UADNAME: Unmappable

QUADCODE: MARG NUM: DOT NUM: TEN TEN:

LAT: S: N:

LONG: E: W:

IRECTIONS: Found in unknown mailbox in Comanche Co

otional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 2C

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

ATERSHED: 12070201

URVEYDATE: yr - mo - da

LASTOBS: yr 95 - mo 10 - da 23

FIRSTOBS: yr 95 - mo 10 - da 23

RANK: (see code key)

EORANKDATE: - -

RANKCOM:

DATA: Male adult Bat VR5 8673 specimen preserved at TTU as TTU 824

NTACTID:... CONTACT.NAME: CONTACT.NOTE:

TYPE:

NDESC: mailbox

NELEV: feet MAXELEV: feet SIZE: acres

CODE: MANAME: MATYPE: CONTAINED:

USTXHP*.... ..... (see code key)

USTXHP*.... .....

RELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MTCOM:

OTCOM:

NER: Texas Tech Univ Nat. Science Res. Lab OWNERINFO: TTU 82460

NERCOM:

MMENTS:

OTL.TOPICS:

PIC.KEYWORDS:

TASENS: BOUNDARIES: PHOTOS:

STSOURCE: Higginbotham Jeanne C. ones, 2001, The southeastern myotis Myotis austroriparius (Chiroptera: Vespertilionidae) from Comanche County Texas, Texas

SOURCECODE: Ø1 HIG Ø2 TX US

SPECIMENS: (citation info. for specimens) Collection Recent Mammals Natural Science Lab Museum of Texas Tech Univ TTU 82460

NSCRIBR: 02-03-07 JHY CDREV: Y MAPPER: 02-03-07 JHY QC:

ARESP: TXHP EDITION: 02 03 07 EDAUTHOR: JHY

ntenance History: INITIALS: CHANGE.DATE: (yr/mo/da)

UAL.FILE.NOTE:

Element Occurrence Record

Elcode: EO# State:

EOCODE: AMACC01030 * 009 *TX FONUM: IDENT: Y

SNAME: Myotis austroriparius

SCOMNAME: Southeastern myotis

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S

COUNTYCODE	COUNTYNAME	LOCALJURIS
TX JASP	Jasper	
TX		
TX		

QUADNAME	QUADCODE	MARG NUM	DOT NUM	TEN	
Town Bluff	3009472	(18)	6	TS	

LAT: 30 52 13 S: 30 52 10
N: 30 52 16
LONG: 94 10 39 E: 94 10 36
W: 94 10 42

DIRECTIONS: at B.A. Steinhagen Lake, ~~Town Bluff Dam~~ Unit of Martin Dies Junior State Park at northern edge of island, prior Walnut Ridge trail

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 1A

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020003

SURVEYDATE: yr mo da

LASTOBS: 99-05-01

FIRSTOBS: 99-05-01

EORANK: (see code key) EORANKDATE:

EORANKCOM:

EODATA: mistnetted 3 M. austroriparius females, all pregnant

CONTACTID:... CONTACT.NAME: CONTACT.NOTE:

EOTYPE:

GENDESC: lake with mixed hardwood forest and swamps over trail

MINELEV: feet MAXELEV: 85 feet SIZE: acres

MACODE: MANAME: Martin Dies Junior State Park MATYPE: CONTAINED: Y

M.USTXHP*.... ..... (see code key)

M.USTXHP*.... .....

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MGMTCOM:

PROTCOM:

OWNER: TPW OWNERINFO: Y

OWNERCOM:

COMMENTS:

ADDTL.TOPICS:

Element Occurrence Record

Elcode: ✓ EO# ✓ State:

EOCODE: __AMACC01030__ * 010 *TX FONUM: _____ IDENT: ✓ Y

SNAME: ____Myotis austroriparius ✓

SCOMNAME: __Southeastern myotis ✓

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME: _____

SURVEYSITE: _____

PRECISION: _S ✓ COUNTYCODE: COUNTYNAME: ✓ Nacogdoches LOCALJURIS:

TX NACO ✓

TX

TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:	LAT:	LONG:
Lake Nacogdoches South	✓3109457	6 ✓		9,~~8~~10	31 30 ~~27~~ 22	✓94 46 10

LAT: 31 30 ~~24~~ 19
N: 31 30 ~~30~~ 2
E: 94 46 07 ✓
W: 94 46 13 ✓

DIRECTIONS: _in Stephen F. Austin Experimental Forest: about 10 air miles SW of Nacogdoches ~~on HWY 7~~, ~1.5 miles south/east of HWY 7 @ 1.0-

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: ✓1B

PLACENAME: _____

DSDIRECTIONS: _____

DSBESTSOURCE: _____

WATERSHED: 12020004 ✓

SURVEYDATE: yr mo da ____-___-___ LASTOBS: ✓yr mo da _99__-07_-_11 FIRSTOBS: ✓yr mo da _99__-07_-_11

EORANK: _____ (see code key) EORANKDATE: ____-___-___

EORANKCOM: _____

EODATA: 1999 mistnetted one post-lactating female

CONTACTID:... CONTACT.NAME: _____ CONTACT.NOTE: _____

EOTYPE: _____

GENDESC: _ mixed hardwood forest _____

MINELEV: _____ feet MAXELEV: ✓210 feet SIZE: _____ acres

MACODE: MANAME: SFA Experimental Forest MATYPE: CONTAINED: ~~N~~ Y

M.USTXHP*.... Angel ... NF ..... Y (see code

M.USTXHP*.... _____ ..... _____ key)

MORELAND: _____ MOREPROT: _____ MOREMGMT: _____ TNCINVOLVE: _____

MGMTCOM: _____

PROTCOM: _____

OWNER: ____SFA State University; USFS OWNERINFO: Y ✓

OWNERCOM: _____

COMMENTS: _____

ADDTL.TOPICS: _____

Element Occurrence Record

Elcode: EO# State:

EOCODE: AMACC08020 * 010 *TX FONUM: IDENT: Y

SNAME: Corynorhinus rafinesquii

SCOMNAME: Rafinesque's big-eared bat

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: S COUNTYCODE: COUNTYNAME: Jasper LOCALJURIS:

TX JASP

TX

TX

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:		
Town Bluff	3009472	19	6.1	1.5	LAT: 30 52 13	S: 30 52 10
					LONG: 94 10 31	N: 30 52 16
						E: 94 10 28
						W: 94 10 34

DIRECTIONS: at B.A. Steinhagen Lake, ~~Town Bluff Dam~~ Unit of Martin Dies Junior State Park; on east-most tip of island Walnut Ridge northernmost

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: IA

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020003

SURVEYDATE: yr mo da

LASTOBS: 99-05-01

FIRSTOBS: 99-05-01

EORANK: (see code key) EORANKDATE:

EORANKCOM:

EODATA: 99: mistnetted one male over trail

CONTACTID:... CONTACT.NAME: CONTACT.NOTE:

EOTYPE:

GENDESC: lake with mixed hardwood forest and swamps

MINELEV: feet MAXELEV: 85 feet SIZE: acres

MACODE: MANAME: Martin Dies Junior State Park MATYPE: CONTAINED: Y

M.USTXHP*.... ..... (see code key)

M.USTXHP*.... .....

MORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

MGMTCOM:

PROTCOM:

OWNER: TPW OWNERINFO: Y

OWNERCOM:

COMMENTS:

ADDTL.TOPICS:

New Co. Record Y

Element Occurrence Record

Elcode: EO#: State:

EOCODE: AMACC08020 *013 *TX FONUM: _____ IDENT: Y

SNAME: Corynorhinus rafinesquii

SCOMNAME:

ELEMENT RANKS: GRANK: ..... NRANK: ..... SRANK: .....

NATION: US SITECODE: S.USTXHP*..... (computer generated code in SBR)

SITENAME:

SURVEYSITE:

PRECISION: U

COUNTYCODE:	COUNTYNAME:	LOCALJURIS:
TXSANA	San Augustine	
TX		
TX		

QUADNAME:	QUADCODE:	MARG NUM:	DOT NUM:	TEN TEN:
UNMAPPABLE				

LAT: _____ S: _____ N: _____

LONG: _____ E: _____ W: _____

DIRECTIONS: Private land Central San Augustine Co.

Optional Fields: (next four fields exist in EOR.OPT)

NAT.REGION: 016 019 _____ _____ _____

PLACENAME:

DSDIRECTIONS:

DSBESTSOURCE:

WATERSHED: 12020005 _____ _____ _____

SURVEYDATE: yr mo da _____ LASTOBS: yr 1989 mo 05 da _____ FIRSTOBS: yr 1989 mo 05 da _____

EORANK: _____ (see code key) EORANKDATE: _____

EORANKCOM:

EODATA: May 1989 Maternity roost

CONTACTID:... CONTACT.NAME: _____ CONTACT.NOTE: _____

EOTYPE:

GENDESC: wooden structure

MINELEV: _____ feet MAXELEV: _____ feet SIZE: _____ acres

MACODE:	MANAME:	MATYPE:	CONTAINED: (see code key)
M.USTXHP*....		.....	_____
M.USTXHP*....		.....	_____

MORELAND: _____ MOREPROT: _____ MOREMGMT: _____ TNCINVOLVE: _____

MGMTCOM:

PROTCOM:

OWNER: Private OWNERINFO: _____

OWNERCOM:

COMMENTS: Roost #23 East TX Bat Surveys

ADDTL.TOPICS:

TOPIC.KEYWORDS:

DATASENS: _____ BOUNDARIES: _____ PHOTOS: _____

BESTSOURCE: U98HORDITXUS

SOURCECODE: U02LINDITXUS SPECIMENS: (citation info. for specimens)

TRANSCRIBR: 03-06-27 SAB CDREV: Y MAPPER: 03-06-27 SAB QC: _____

DATARESP: TXHP EDITION: 03-06-27 EDAUTHOR: _____

Maintenance History: INITIALS: _____ CHANGE.DATE: _____ (yr/mo/da)

MANUAL.FILE.NOTE:

OCODE: AMACC08020*006*TX IDENT: Y SEOTRACK: Y GRANK: G3G4 SRANK: S3 USESA: SPROT: T

NAME: CORYNORHINUS RAFINESQUII

COMNAME: RAFINESQUE'S BIG-EARED BAT

LACENAME:

ATION: US SITECODE: S.USTXFO*768 SITENAME: PINEYWOODS CONSERVATION INITIATIVE

RECISION: S SURVEYSITE: HUNTSVILLE FISH HATCHERY

COUNTYCODE:	COUNTYNAME:	QUADNAME:	QUADCODE:	MARGNUM:	TEN-TEN:
TXWALK	Walker	PHELPS	3009564	32	2,1

LAT: 304433N LONG: 0952832W S: 304430N N: 304436N E: 0952829W W: 0952835W

IRECTIONS: ABANDONED HUNTSVILLE FISH HATCHERY; FROM JUNCTION OF HIGHWAY 190 AND STATE ROUTE 2296 GO NORTHWEST 3.4 AIR MILES TO REACH THE STATE FISH HATCHERY WHERE BAT WAS CAPTURED

AT.REGION:	WATERSHED:
02A OAK WOODLANDS	12030202 TRINITY RIVER (BIG CREEK-HURRICANE BAYOU)/BIG/KICKAPOO/WHITE ROCK/KEECHI CREEKS

URVEYDATE: LASTOBS: 1993-09-07 FIRSTOBS: 1993-09-07 EORANK: EORANKDATE:

ORANKCOM:

ODATA: ADULT MALE CAPTURED IN MIST NET; TESTES FULLY EXTENDED; INDIVIDUAL WAS RELEASED

ONTACT:

OTYPE:

ENDESC: NET PLACED ACROSS A 75 CM DIAMETER CULVERT AT THE TPWD INACTIVE STATE FISH HATCHERY; CULVERT WAS ONCE USED TO FEED WATER TO THE HATCHERY PONDS

INELEV: 230 MAXELEV: SIZE:

ACODE:	MANAME:	TYPE:	CONTAINED:
.USTXHP*113	HUNTSVILLE STATE FISH HATCHERY	SPWFH	Y
.USTXHP*9	SAM HOUSTON NATIONAL FOREST	FFSNF	Y

ORELAND: MOREPROT: MOREMGMT: TNCINVOLVE:

GMTCOM: THERE IS NO ACTIVE MANAGEMENT PLAN FOR PROTECTION OF THIS SPECIES ON THIS PROPERTY

ROTCOM: ALTHOUGH ON STATE PROPERTY, THE CULVERT MAY BE USED FOR OTHER PURPOSES IN THE FUTURE, CAUSING IT NOT TO BE A POTENTIAL ROOST AREA FOR THIS SPECIES; HOWEVER, THE HISTORICAL USE OF THE CULVERT WAS FOR CARRYING WATER, SO IT IS DOUBTFUL THIS CULVERT WAS OFTEN USED BY BIG-EARED BATS IN THE PAST; ONLY WHILE IT IS UNUSED IS IT POSSIBLY USED BY THE BATS, AND IT'S IMPORTANCE FOR THE PROTECTION OF THE SPECIES IS MINOR

WNER: TX:TPWD AND US:DOA/USFS OWNERINFO: Y

WNERCOM:

OMMENTS: THIS IS A NEW COUNTY OCCURRENCE RECORD

DDTL.TOPICS: TOPIC.KEYWORDS:

SDIRECTIONS:

SBESTSOURCE:

WNER.SIGN: DATASENS: BOUNDARIES: PHOTOS:

ESTSOURCE: THIES, MONTE. 1994. A NEW RECORD FOR PLECOTUS RAFINESQUII (CHIROPTERA: VESPERTILIONIDAE) FROM EAST TEXAS. TX J. SCI. 46(4):368-369.

LL SOURCECODES:CITATIONS:

94TH101TXUS THIES, MONTE. 1994. A NEW RECORD FOR PLECOTUS RAFINESQUII (CHIROPTERA: VESPERTILIONIDAE) FROM EAST TEXAS. TX J. SCI. 46(4):368-369.

BAT ROOST MONITORING

Roost Location: Village Creek SP - Caney Slough

Roost Number: #2 - Water Tupelo Tree

Date	Observer	Estimated Numbers (<10, 10-25, >25)	Weather Summary (Within last 24 hours)[1]	Comments[2]
1 May 2002	Meg Goodman John Young Ricky Nasey Jerry Rashall	2 BCBs 1 unknown	clear; 90°F, humid 10:00am	very cool ☺

[1] Weather should include rain, high/low temps, wind, humidity, etc.
[2] Tree roosts should include amount of water at base of tree. Enter data into the comments section

For questions and return completed form to:

Peggy Horner
Texas Parks and Wildlife
3000 IH-35 South, Ste 100
Austin, Texas 78704
(512) 912-7015

Maritime Pocket Gopher (*Geomys personatus maritimus*) Volunteer Monitoring Results
Corpus Christi Naval Air Station
Updated 8-30-03

	Apr. 17-18, 1999	Feb. 25-26, 2000	Feb. 23-24, 2001
Volunteers	Bernice Speer Doyle	Bernice Speer Elizabeth Maxim Doyle Cross	Bernice Speer Elizabeth Maxim Doyle Cross
Area sampled (sq. m.)	35,393	173,046	173,046
# Burrow systems marked - day 1	42	not counted	not counted
Total fresh mounds - day 1	172	not counted	not counted
New fresh mounds - day 2	40	139	102
# Burrow systems active - day 2	22	87	62
% burrows confirmed active	50%	na	na
Active burrows/hectare	3.11	5.03	3.58
Fresh mounds/day/burrow	1.8	1.6	1.6
Days since last rainfall		0	1

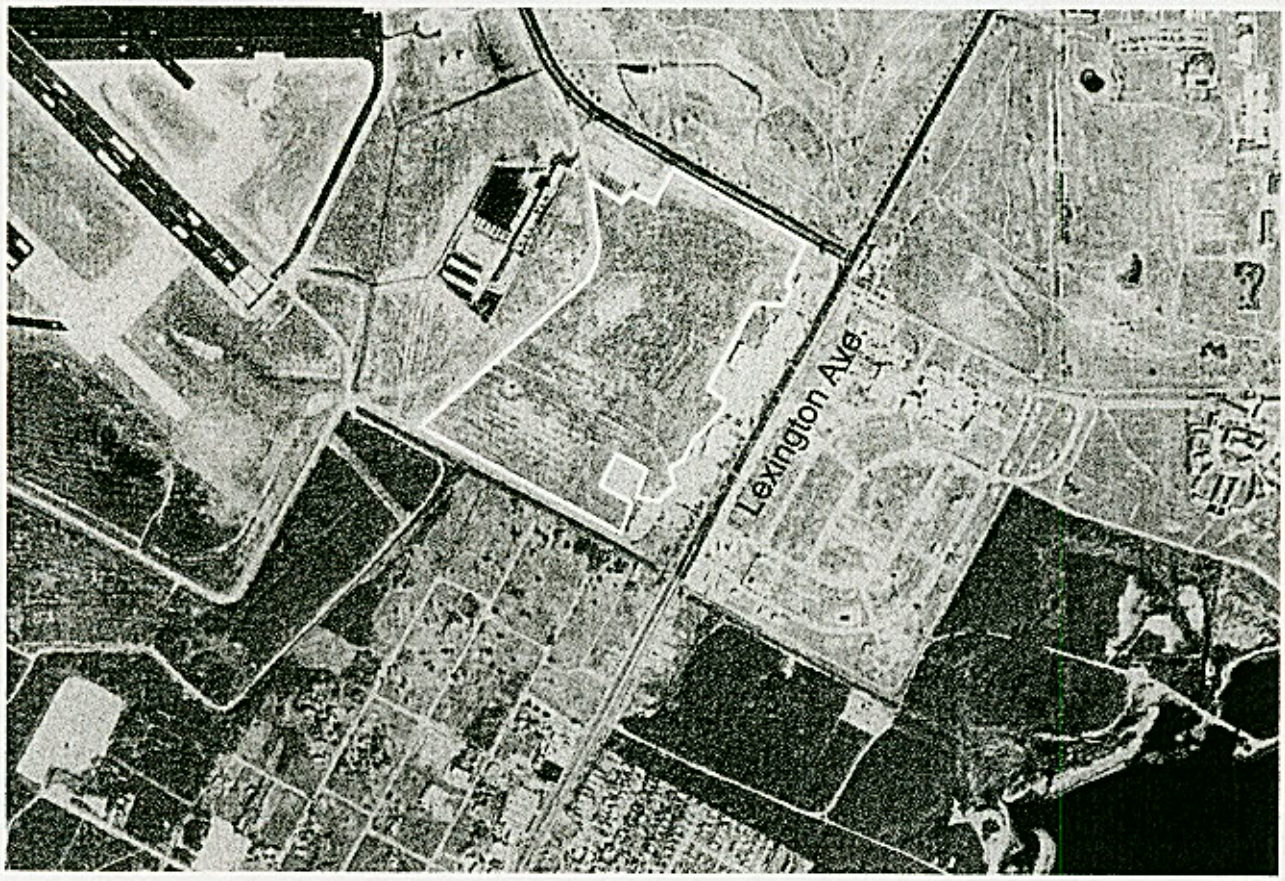
Sample methods - Gopher mounds are sampled in an undeveloped field located just off Lexington Road in the southeast portion of the base. Volunteers at this site mark fresh-appearing mounds on day 1 and then revisit the site on day 2. Fresh mounds on day 2 are counted and grouped into burrows based upon their distribution within a 10 meter radius of each other.

2001 - All fresh mounds on day 2 were counted. In contrast to 2000, during this year some burrow systems that seemed to clearly have fresh mounds on day 1 did not exhibit new mound-building activity on day 2. Other researchers have found that, dependent upon weather conditions, activity cycles, etc., gophers may not be consistent in their burrow excavation activities (C. Rudolph, pers. comm.). Therefore, an estimate of 62 gophers is clearly a minimum estimate.

2000 - All mounds at the site were counted (only a portion of the site was counted in 1999). A total of 87 gophers were estimated to occupy the site. Acreage of the sample area still needs to be determined.

1999 - B. Speer and D. Cross assisted TPWD in monitoring a subsection of this population in order to test monitoring techniques. All burrow systems and fresh mounds within about 1/3 of the study area were marked on day 1. On the second day, activity was confirmed in only 50% of the burrows. Gophers constructed an average of 1.8 mounds per burrow per day.

Maritime pocket gopher monitoring site - Corpus Christi Naval Air Station

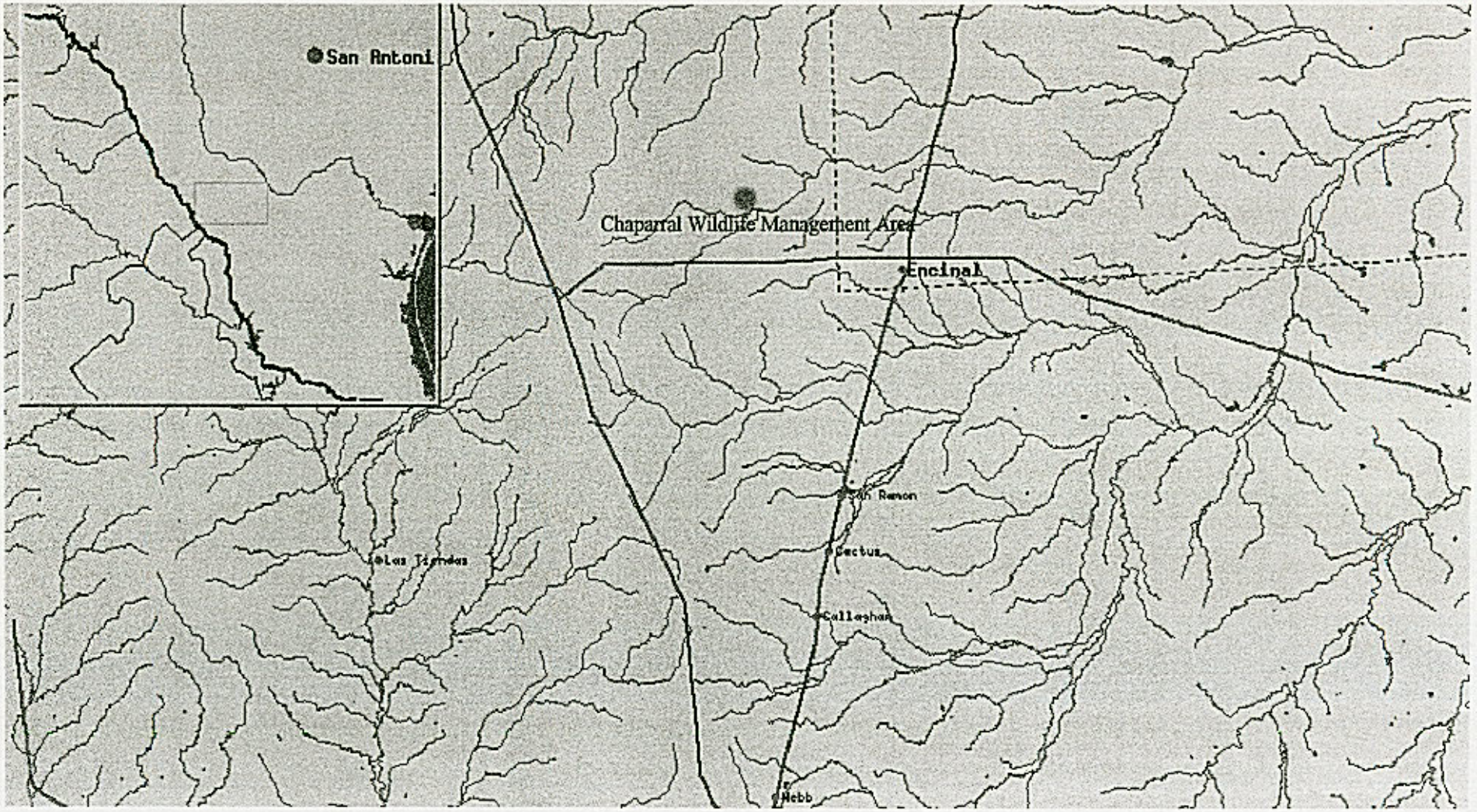


600 0 600 1200 Meters

Nas monitoring site.shp

N
W E
S

Crotophytus reticulatus study site – LaSalle county



Crotophytus reticulatus study sites – Starr county

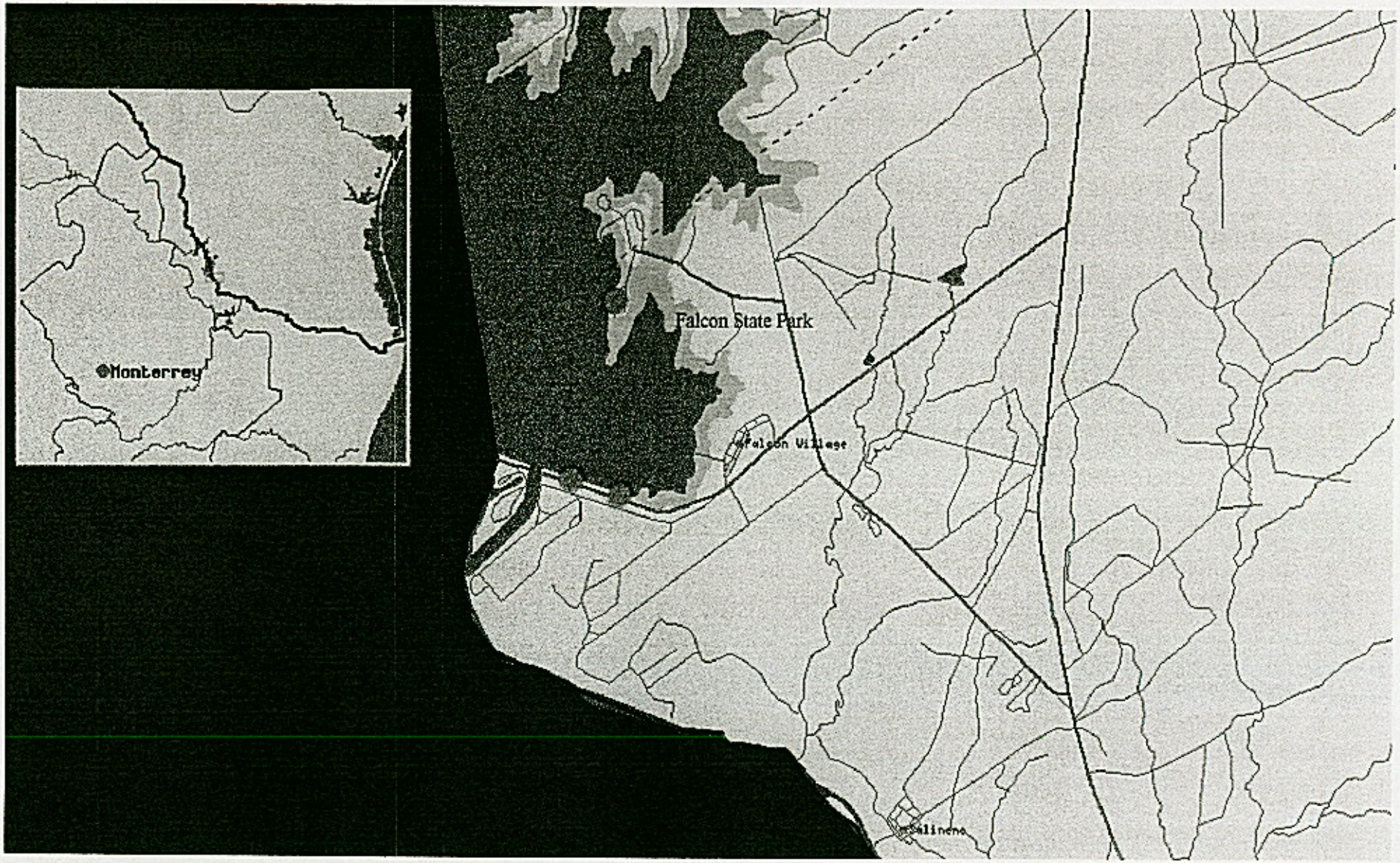


Table 1. Percentage of reticulate collared lizards observed at Falcon State Park in relation to substrate temperature (T_s) and air temperature (T_a).

T_s	T_a	Percent males active	Percent females active
30.2	27.4	0	0.67
35	30.1	0.22	0.13
37	31.6	0.33	0.27
40.6	32.1	0.22	0.20
42.8	35.4	0.11	0.20
45.6	35.2	0.11	0.13
49	38.2	0	0
49.6	38.2	0	0

Table 2. Percent microhabitat available and percent microhabitat used by reticulate collared lizards in Falcon State Park.

	Bare Ground	Grass	Gravel	Rock	Road	Tree
% available	26.9	21.3	2.1	48.2	0.67	0.71
Males	7.7	3.8	0	89.5	0	0
Females	5.3	5.3	0	89.4	0	0
Sexes combined	6.3	4.7	0	89	0	0

Section 6 Report Review

Attachment to letter dated MAR 2 7 2003

Project: Implementation of Candidate Species Monitoring

Final or interim report? Final

Job #: WER09(72) **Grant #:** E-9

Reviewer's Station: Corpus Christi ES FO, Austin ES FO, Arlington ES FO

Lead station was contacted and concurs with the following comments:
___ Yes ___ No _X_ Not applicable (reviewer is from lead station)

Interim Report	**Final Report**
___ is acceptable as is	___ is acceptable as is
___ is acceptable as is, but the comments below need to be addressed in the next report	_X_ is acceptable, but needs minor revision (see comments below)
___ needs revision (see comments below)	___ needs major revision (see comments below)

Comments:

We appreciate the incorporation of many of our comments from our March13, 2002 letter, including the monitoring and survey methods developed for several of the species and answers to many of our questions. We believe the following information is still necessary to complete the reports:

Please send us specific maps (including plots, if applicable) of confirmed locations for the following species:

Texas horned lizard
Rydberg's scurfpea
Big red sage
Horseshoe liptooth snail (with all quadrants)
Navasota false foxglove (with all site numbers)
Welder machaeranthera (with all site numbers)
branched gayfeather (with all site numbers)
Neches River rose mallow

Please send us survey protocols/methods for plot selection and specific maps of confirmed locations for the following species:

Southern lady's slipper
fringed paintbrush
Guadalupe Mountains fescue
puzzle sunflower
Rafinesque's big-eared bat
southeastern myotis
western mastiff bat

Following are other questions and/or comments we feel are necessary to address before finalizing this report.

Karst monitoring materials - Texella is misspelled in the *Texella reyesi* guide. We would appreciate further involvement in the creation of the karst invertebrate field guide, and look forward to working with TPWD on developing monitoring protocols and priorities.

Houston daisy and Texas windmill grass - There are letter codes under each of the year columns, including "Q" for "quantitative monitoring accomplished". Please explain what this exactly means, and provide us with the data collected.

Bracted twistflower - Please explain why there was an "incomplete survey conducted in 1998 at Barton Creek", and why the FM1283 ROW "site might have been overlooked" in 1999 and 2000.

Maritime pocket gopher - It is not clear from the table of surveys at the Corpus Christi Naval Air Station if: 1) the area surveyed each visit was 35,393 sq. ft., and 2) why protocol was not followed for counting "# Burrow systems marked - day 1" and "Total fresh mounds - day 1". Please provide answers/explanations.

Rafinesque's big-eared bat and southeastern myotis - A standardized form is mentioned with a list of information collected; however, the tables provided don't include all of this information. Please provide a complete table with all information recorded.

Reticulate collared lizard - A lot of great information was collected, unfortunately only bar graphs were provided in the report. Please provide tables with the data collected and maps of specific locations of the lizard.

FINAL REPORT

As Required by

THE ENDANGERED SPECIES PROGRAM

TEXAS

Grant No. E-9

Endangered and Threatened Species Conservation

Project WER09(72): Implementation of Candidate Species Monitoring

Prepared by: Lee Ann Johnson Linam



John Herron
Program Director, Wildlife Diversity

Robert Cook
Executive Director

November 1st, 2002

FINAL REPORT

STATE: Texas **GRANT NO:** E – 9

PROGRAM TITLE: Endangered and Threatened Species Conservation

PERIOD COVERED: September 1, 1996 – August 31, 2002

PROJECT NUMBER: WER09(72)

PROJECT TITLE: Implementation of Candidate Species Monitoring

PROJECT OBJECTIVE:

To implement a statewide network of citizens, organizations and conservation groups to assist with the ongoing monitoring of the candidate species of Texas.

PREPARED BY: Lee Ann Johnson Linam November 1st, 2002

APPROVED BY: Neil E. Carter 11/21/02

Neil E. Carter
Federal Aid Coordinator
Texas Parks & Wildlife Department

Date

IMPLEMENTATION OF CANDIDATE SPECIES MONITORING - Lee Ann Johnson Linam - Texas Parks and Wildlife Department, Wimberley, TX.

ABSTRACT -- There have been over 300 species of plants and animals listed as candidates or recognized as species of concern in Texas. The objective of this project, begun in 1996, was to implement a monitoring program for species of concern (including candidates) in Texas relying primarily upon citizen volunteers. The project developed a list of potential species to monitor and a draft of a monitoring manual. Two state-wide projects, Texas Horned Lizard Watch and Texas Mussel Watch, were developed and successfully implemented, and materials are under development for a third watch program, to perhaps be called Texas Cave Watch. Site-specific projects were developed that involved volunteers in monitoring at least 15 different species, while TPWD staff conducted monitoring, often involving volunteers, for an additional 10 species. During 2001-02 additional research was accomplished through four contracted survey projects. Candidate monitoring projects were grouped together with other citizen science projects under an identity called Texas Nature Trackers. The program has been successful in gathering valuable data on species of concern, conserving genetic material from some populations, and in increasing public awareness and involvement in conservation.

SIGNIFICANT DEVIATIONS -- This project met most of the goals approved by both parties in the Project Statement (Appendix I). While only a small portion of the species of concern in the state were addressed, a good framework was laid for continuing expansion of the project. In addition, monitoring accomplished by this project is complemented by other projects. The project failed to undertake an analysis of existing sources of bird data (such as Breeding Bird Surveys); however, many of these programs undertake their own data review and are complemented by efforts such as Partners in Flight. The project was able to use funds more efficiently than originally anticipated and thus to stretch project activity from four years to six. In addition, it was able to offer contracted funds for more intensive research on selected species in 2001-02.

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Project Overview

Appendix A – List of species of concern with monitoring potential.

Appendix B – Draft monitoring manual and monitoring methods chapter from Plan-It Texas manual.

Appendix C – Texas Horned Lizard Watch materials and results.

Appendix D – Texas Mussel Watch materials and results.

Appendix E – Karst monitoring materials.

1) Development of an approach to monitoring karst invertebrates in Texas
2) Thumbnail images of photos acquired for field guide project
3) Sample species accounts for field guide

Appendix F – Site-specific volunteer monitoring – monitoring packets and results

1) *Cypripedium kentuckiense* – southern lady's slipper
2) *Pediomelum humile* – Rydberg's scurfpea
3) *Rayjacksonia aurea* – Houston daisy
4) *Salvia penstemonoides* – big red sage
5) *Streptanthus bracteatus* – bracted twistflower
6) *Thalictrum texanum* – Houston meadow-rue
7) *Euchemotrema cheatumi* – palmetto pill snail
8) *Eurycea* salamanders
9) *Geomys personatus maritimus* – maritime pocket gopher
10) *Polygyra hippocrepis* – horseshoe liptooth snail

Appendix G – Results of monitoring by TPWD staff.

1) *Agalinis navasotensis* – Navasota false foxglove
2) *Psilactis heterocarpa* - Welder machaeranthera
3) *Liatris cymosa* – branched gayfeather
4) *Castilleja elongata* – fringed paintbrush
5) *Festuca ligulata* – Guadalupe Mountains fescue
6) *Helianthus paradoxus* – puzzle sunflower
7) *Hibiscus dasycalyx* – Neches River rose mallow
8) *Charadrius montanus* – mountain plover
9) *Corynorhinus rafinesquii* – Rafinesque's big-eared bat and *Myotis austroriparius* – southeastern myotis

Appendix H – Results from contracted research and monitoring projects.

1) *Charadrius alexandrinus* – snowy plover
2) *Crotaphytus reticulatus* – reticulate collared lizard
3) *Eumops perotis* – western mastiff bat
4) Independence Creek fishes

Appendix I – Project documents (proposal and project statement)

PROJECT OVERVIEW

The goal of developing a monitoring system for species of concern in Texas is an ambitious one, given the large number of species formerly classified as candidates (>300) and the size and diversity of the state. This project has taken a multi-pronged approach as outlined in the original project proposal—seeking to address relatively high priority species with known populations that could be monitored by site managers and local interested citizens. While the project has not been successful in monitoring all high priority species in the state, it has gathered meaningful data on approximately 30 species and created a framework and identity for extension of those monitoring activities in the future.

Initiation of the project required extensive review of the list of candidate species (now species of concern.) The species list was reviewed with Texas Parks and Wildlife Department Wildlife Diversity Branch staff, and monitoring potential was assessed. Results of that review are presented in a spreadsheet in Appendix A. A draft monitoring manual was prepared (Appendix B); however, it was soon realized that individual projects would require individualized monitoring approaches fine-tuned from the monitoring plans prepared by Candee (1996). Nevertheless, the draft monitoring manual was revised and has been utilized in offering training to private landowners through the Plan-It Texas project manual (Armentrout 1998). In addition, project staff provided outreach to over 200 private landowners through Plan-It Texas workshops.

Two candidate monitoring projects were developed to be statewide in scope—Texas Horned Lizard Watch and Texas Mussel Watch. Participants in Texas Horned Lizard Watch are provided with a monitoring packet and are encouraged to select their own monitoring sites. Monitoring materials and results from this successful five-year project are presented in Appendix C. Texas Mussel Watch seeks to address the monitoring of freshwater mussels in the state, many of which are considered to be imperiled (B. Howells, pers. comm.) Participants in Texas Mussel Watch must attend a workshop in order to participate in the monitoring program. Copies of workshop materials and a summary report are provided in Appendix D. A third workshop-based monitoring

project is envisioned. Discussions with FWS staff have identified monitoring of karst invertebrates as a high priority. During 2002 project funds were used to begin development of some of the monitoring materials that would be needed. A discussion of the project and samples of some of the materials are presented in Appendix E.

Much of the effort of the candidate monitoring project has been spent developing site-specific projects described in Appendix F. In these site-specific projects an attempt was made to pair up volunteers with a particular population of a species of concern that is in need of monitoring. Materials describing the species, the monitoring location, and the monitoring method (including datasheets) were developed by TPWD. TPWD biologists then met with the volunteers at the monitoring site for at least two monitoring periods to teach monitoring methods. When (and if) the volunteers become proficient on their own, they were encouraged to continue monitoring the site during the prescribed seasons and to send the data to TPWD. Developing such a volunteer systems requires much trial and error (and patience). Careful selection of volunteers is needed to match their capabilities with the requirements for the particular species. Some species are suitable for well-supervised high school students (the land-snail projects have worked well for students), while some projects require more expertise or patience. TPWD is currently cultivating relationships with Native Plant Society of Texas and Texas Master Naturalists chapters in order to encourage these skilled volunteers to become local site experts who can then offer educational experiences to local teachers and students if appropriate. Methods, discussion of particular site experiences and results, and copies of materials provided to volunteers can be found in Appendix F.

Some monitoring activities under this project have been accomplished by TPWD biologists. In several circumstances, TPWD staff have worked with site managers or volunteers to provide the potential for future monitoring to take place by those individuals. In particular, several species originally monitored by Jackie Poole are now monitored by on-site biologists, including *Castilleja elongate* and *Festuca ligulata* at Big Bend National Park and *Helianthus paradoxus* at The Nature

Conservancy's Diamond Y Preserve. In addition to the species described in Appendix G, Andy Price initiated work on the Chihuahuan mud turtle (*Kinosternon hirtipes*); however, monitoring could not be continued due to lack of access to private land.

During 2001-02 project funds were also available to seek outside research help in conducting surveys and monitoring for species of concern. (Prior to 2001-02, funds were used more conservatively in house in order to extend the project without additional funding.) TPWD solicited suggestions from FWS field offices regarding priority projects; however, the only species of concern nominated were the smalleye shiner (*Notropis buccula*) and the sharpnose shiner (*Notropis oxyrhynchus*). A proposal was solicited from researchers at Texas Tech University to address these species, but, despite an expressed interest, a proposal was not submitted. A second solicitation was offered to researchers at Southwest Texas State University; however, by that time summer flood conditions precluded effective sampling in the species' habitat. Reports from four projects that were successfully conducted are provided in Appendix H.

Several activities not funded by the project have served to enhance it. In 1999 TPWD citizen-based monitoring projects were placed under an umbrella identity called *Texas Nature Trackers*. Texas Nature Trackers has developed a brochure, webpage, and workshops to help attract potential volunteers to its various monitoring projects. Another Texas Nature Tracker project not funded by Section 6 , Texas Amphibian Watch, collects data primarily on frogs and toads. Though no Texas species are officially considered species of concern, a comprehensive monitoring program seems desirable in light of global trends. In addition, several activities not funded by this project have complemented it by addressing species of concern and candidate species. Ongoing or completed projects have addressed lesser prairie chicken (*Tympanuchus pallidicinctus*), snowy plover in West Texas (Conway et al. 1999), West Texas fishes, swift fox (*Vulpes velox*) (Kamler et al. 1999), Texas kangaroo rat (*Dipodomys elator*) (Kevin Mote, pers. comm.), Palo Duro mouse (*Peromyscus truei comanche*) (Robert Sullivan, pers. comm.), black-tailed prairie dog (*Cynomys ludovicianus*) (R. Sullivan, pers. comm.), Rio Grande mussels

(Howells 1999), Louisiana pine snake (*Pituophis melanoleucus ruthveni*) (Craig Rudolph, pers. comm.), timber rattlesnake (*Crotalus horridus*) (Ricky Maxey, pers. comm.), alligator snapping turtle (*Macroclemys temminchkii*) (R. Maxey, pers. comm.), diamondback terrapin (*Malaclemys terrpin littoralis*) (*Elliott and* Halbrook 1999), Texas tortoise (*Gopherus berlandieri*) (Kazmaier 1999), Texas horned lizard (*Phrynosoma cornutum*) (Heilgren et al. 1999), colonial waterbirds (Ortego 1999), rare plants on National Forests (Jason Singhurst, pers. comm.), South Texas rare plants (Dana Price, pers. comm.), and West Texas rare plants (McKinney 1999), among others. Baseline data gathered by some of these projects may provide a good framework for future monitoring activities under Texas Nature Trackers.

In conclusion, although admittedly unable to address all species of concern in the state during its time frame, this candidate monitoring project has gathered useful data for a substantial number of species. During recent Texas Rare Plant Conferences, data collected by Texas Nature Tracker volunteers were often the best sources of information regarding current status for several species. Volunteer records in Texas Horned Lizard Watch and Texas Mussel Watch are routinely used as a reference during environmental review. In addition the project has laid a good framework for monitoring species of concern in the state, and prospects for growth in the future look good. Contacts will continue with special interest groups, such as Native Plant Society chapters, Texas Master Naturalist chapters, and regional herpetological societies to find ready sources of qualified volunteers who can play the multiple roles of species monitoring, advocating for site conservation, and providing education to the local community.

Perhaps the activities of elementary school children and their teacher, Monea Fortunado, at Calderon Elementary in Del Rio provide us with the best reflection of the value of involving citizens in species monitoring. These children and their teacher adopted a recently-discovered population of the Rydberg's scurfpea (*Pediomelum humile*) on school property. They researched the species and its habitat and incorporated the population into an (unmarked) interpretive area on a nature trail they constructed. They monitored the species and recorded data regarding

chronology of blooming. They even experimented with supplemental watering during a drought period (we needed to work with them a little on experimental design). They alerted TPWD when school district plans threatened destruction of the population and made a plea to the school administration to avoid impacts to the scurfpea. Unfortunately, they had to play a salvage role when the project went forward as planned, clinging to the consolation that the seeds they collected might provide a remnant of their population at the LBJ National Wildflower Research Center. Perhaps in the end the efforts of Calderon Elementary School didn't conserve the population of Rydberg's scurfpea, but, one could imagine—just what if the superintendent of schools had been involved in a Texas Nature Trackers project in Mrs. Fortunado's class about 40 years ago....?

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APPENDIX A
List of species of concern with monitoring potential

Potential Monitoring Sites for Species of Concern in Texas

	Scientific Name	Common Name	Priority	Season	Month	Eco	Counties	Location	Notes
X	Acleisanthes crassifolia	Texas trumpets	med	spr-fall		EP	Val Verde	Hwy ROW	near Pediomelum
	Agave glomeruliflora	Chisos agave	low	spring	5	TP	Brewster	BBNP	BBNP trip
	Agrimonia incisa	incised groovebur	low	summer		ET	Ang., Jasp. Sabine	Angelina NF, others?	abundant, LSU-Shreveport working on it
X	Amsonia tharpii	Tharp's blue-star	high	spring	4,5	TP		Hwy ROW; UT	need info on chronology
	Aquilegia chrysantha var. hinckleyana	Hinckley's colujbine	high	spring	3,4	TP	Presidio	private	
	Aquilegia chrysantha var. hinckleyana	Hinckley's colujbine	high	spring	3,4	TP	Presidio	BBRSNA?	BBRSNA trip (remote)
	Aquilegia longissima	long spur columbine	low	sum-fall	6,7,8,9,10,11	TP	Brewster, etc.	BBNP	BBNP trip (remote)
	Arenaria livermorensis	Livermore sandwort	med	fall	8,9,10	TP	Jeff Davis	transition	
	Argythamnia aphoroides	Hill Country wild mercury	med	spring	4,5	EP	several	Hwy ROW	sites are difficult
X	Asclepias prostrata	prostrate milkweed	low	spring	3,4,5	ST	Starr, Zapata	Hwy ROW	Roma HS interested
	Aster laevis var. guadalupensis	Guad. Mtns. aster	low	summer		TP	Culberson	GMNP	GMNP trip (access & i.d. hard)
X	Aster scabricaulis	rough-stem aster	med	fall	10	ET	several	Hwy ROW	
	Batesimalva violacea	purple gay-mallow	med	fall	10,11	TP	Brewster	BBNP	BBNP trip
	Boerhavia mathisiana	Mathis spiderling	high	summer	5,6,7,8	ST	Live Oak, San Pat.	co.rd.ROW; private	need to check access
	Brongniartia minutifolia	little-leaf brongniartia	mid	summer	6,7,8	TP	Brewster	BBNP	BBNP trip (under study now)
	Caesalpinia brachycarpa	broadpod rushpea	med	spring	4,5,6	EP	Kinney, Sutton	Hwy ROW	status of sites is uncertain
	Castilleja ciliata	fringed paintbrush	med	sum-fall	6,7,8,9,10	TP	Jeff Davis	transition	
	Chaetopappa hersheyi	mat leastdaisy	low	spring	5	TP	Culberson	GMNP; Sierra Diablo WMA	GMNP trip
	Chamaesyce chaetocalyx var. triligulata	three-tongued spurge	med	sum-fall		TP	Brewster	BBNP	BBNP trip (hard to i.d.)
X	Chloris texensis	Texas windmill-grass	high	summer	6,7,8	CPM	upper coast		contact Wieland & Nemec
	Chrysothamnus neuseosus ssp. texensis	Guad. Mtns. rabbitbrush	med	fall	9,10	TP	Culberson	GMNP	GMNP trip
X	Colubrina stricta	Comal snakewood	high	spring	5	TP	El Paso	Hueco Tanks SP	good potential
	Coryphantha albicolumnaria	white column cactus	low	spring	3,4,5	TP	Brewster	BBRSNA; HwyROW	BBRSNA trip
	Coryphantha chaffey	Chaffey's cory cactus	med	spring		TP	Brewster	BBNP	BBNP trip
	Coryphantha duncanii	Duncan's cory cactus	med	spring		TP	Brewster	BBNP	BBNP trip
	Coryphanta hesteri	Herster's cory cactus	med	spr-sum		TP	Brewster	HwyROW	local already working on it
X	Crataegus warneri	Warner's hawthorn	med	spring		ET	northeast	Ft. Boggy SP, Daingerfield SP, Chef's Woods (TNC)	Tree; little-known; endemic; easy to i.d.
X	Croton alabamensis var. texensis	Texabama croton	med	spring		EP	Travis, Bell, Coryell	BC NWR; Ft. Hood	good potential
X	Cyperus onerosus	dune umbrella sedge	high	sum.-fall	6,7-11	RP	Andrews, etc.	Monahans	good volunteer source

Potential Monitoring Sites for Species of Concern in Texas

	Scientific Name	Common Name	Priority	Season	Month	Eco	Counties	Location	Notes
X	Cypripedium kentuckiense	southern lady's-slipper	high	summer	6,7,8	ET	Nacog., etc.	Caddo Lake SP; Atlanta SP	monitoring needed; collection a problem; use park staff?
X	Dalea reverchonii	Comanche Peak prairie-clover	med	spring		BP	Parker, Wise	Hwy ROW	
	Draba standleyi	Standley's draba	med-low			TP	Jeff Davis	transition	
X	Echeandia chandleri	lila de los llanos	med-low	fall	9,10,11	ST	Nueces-Cameron	LRGV NWR; HwyROW	
	Escobaria guadalupensis	Guad. Mtns. pincushion cactus	med			TP	Culberson	GMNP	GMNP trip
	Festuca ligulata	Guadalupe fescue	high	sum-fall	8,9	TP	Brewster	BBRSNA	BBRSNA trip
X	Gaillardia aestivalis var. winkleri	white firewheel	med	fall	8,9,10	ET	Hardin	TNC; HwyROW; BTNP (Turkey Ck); powerlines	fairly abundant; good for locals
	Galium coreilii	cliff bedstraw	low	spr-fall		TP	Brewster	BBNp	access difficult - on river
	Helianthus paradoxus	puzzle sunflower	high	sum-fall	8,9	TP	Pecos, Reeves	Diamond Y; HwyROW	currently monitored
	Hexalectris nitida	Glass Mountain coral-root	low	summer	8	EP	everywhere	private	call Bill Carr or David Wolfe
	Hexalectris revoluta	Chisos coral-root	low		????	TP	Brewst., Culb.	??	call Bill Carr or David Wolfe
	Hexalectris warnockii	Warnock's coral-root	low	summer	6,7,8	TP-EP	scattered	??	call Bill Carr or David Wolfe
	Hibiscus dasycalyx	Neches River rose-mallow	high	summer	8	ET	north central	HwyROW (4)	hard to I.d. (hybridization)
X	Justicia runyonii	Runyon's water-willow	low	fall	9,10,11	ST	Camer., Hidal.	Sabal Sanctuary; RdlP SP	
	Kallstroemia perennans	perennial caltrop	med	spr-fall		TP	Brewst., Pres.	BBRSNA	BBRSNA trip
	Lachnocaulon dignum	tiny bog buttons	med	sum-fall	8,9	ET	Jasp./Newt.	TNC (Little Rocky Preserve); Temple-Inland	
	Leavenworthia texana	Texas golden glade cress	high	spring	3	ET	San Aug., etc.	private	check with Kathy Nemec
	Lepidosprtum burgessii	gypsum scalebroom	med	summer	5,6,7,8	TP	Hudspeth	TNC	gypsum dunes
	Lesquerella thamnophila	Zapata bladderpod	high	spring	4	ST	Starr, Zap.	Las Palomas WMA	
X	Machaeranthera aurea	Houston machaeranthera	high	fall	10,11	CPM	Galv., Harris	?	contact Houston arboretum
X	Manfreda longiflora	St. Joseph's staff	med.	fall	9	ST	Hidalgo	?	contact Ideker
	Matelia texensis	Texas milkvine	high	summer	6,7,8	TP	Brewster	private	contact Mike Powell?
X	Nolina arenicola	sand sacahuista	med	spr-sum		TP	Culb., Hudspeth	I-10 HwyROW	good potential
	Opuntia arenaria	sandprickly-pear	high	spr-sum	5,6	TP	El Paso	?	Worthington may be working on it
	Opuntia aureispina	golden-spine prickly-pear	med	spring		TP	Brewster	BBNP	BBNP trip
	Opuntia imbricata var. argentea	silver cholla	med	summer	6,7	TP	Brewster	BBNP	BBNP trip
	Ostrya chisosensis	Big Bend hop-hornbeam	med	spr-sum	5,6	TP	Brewster	BBNP	BBNP trip
	Oxypolis ternata	threeleaf cowbane	med	sum-fall	8,9	ET	Hardin	historic in BTNP	not seen since 1980

Potential Monitoring Sites for Species of Concern in Texas

	Scientific Name	Common Name	Priority	Season	Month	Eco	Counties	Location	Notes
	Paronychia wilkinsonii	Wilkinson's whitlow-wort	med	spring	4	TP	Brewster	HwyROW	Marathon HwyROW site
X	Pediomelum humile	Rydberg's scurfpea	high	spring	4,5	EP	Val Verde	HwyROW	teacher; Junie Sorola
	Penstemon alamosensis	Alamo beard tongue	med	spring	4,5	TP	El Paso	Franklin Mtns. SP	contact Worthington
	Perityle bisetosa var scalaris	stairstep two-bristle rock-daisy	low	fall		TP	Brewster	Black Gap, TNC	contact Bonnie McKinney
	Perityle huecoensis	Hueco rock-daisy	high	fall	9	TP	El Paso	Ft. Bliss	access?
X	Philadelphus ernestii	canyon mock-orange	med	spring	4	EP	Travis, Hays, etc.	P-Falls SP; Hamilton Pool	adult project - steep slopes
	Phyllanthus ericoides	heather leaf-flower	low	sum-fall		TP	Brewst., Terrell	private	on lower Rio Grande
X	Physostegia longisepala	long-sepaled false dragonhead	low	spring	5,6	ET	southeast	HwyROW (40+ sites)	contact David Dunlap; easy to i.d.
	Polemonium pauciflorum ssp hinckleyi	Hinckley's Jacob's ladder	high	summer	7,8	TP	Jeff Davis	transition	
	Prenanthes barbata	barbed rattlesnake-root	low	fall	9,10	ET	eastern	USFS	fairly abundant; distribution large (Beech-Magnolia+)
X	Psilactis heterocarpa	Welder machaeranthera	med-low	fall	10	CPM	Vict.-Kleb.	HwyROW	
	Quercus graciliformis	Chisos oak	low	summer		TP	Brewster	BBNP	BBNP trip; hard to i.d.
	Rudbeckia scabrifolia	bog coneflower	med-hi	summer	8	ET	eastern	USFS (40 sites)	acid-seep bogs; easy to monitor
X	Salvia penstemonoides	big red sage	high	sum-fall	8,7,8,9,10	EP	southern	HwyROW; Lost Maples SP	set up - Mary Kennedy
X	Silene subciliata	scarlet catchfly	low	fall	8,9,10	ET	southeast	Sandylands; Village Creek SP;BTNP; HwyROW...	good for locals
X	Streptanthus bracteatus	bracted twistflower	high	spring	5	EP	southeastern	Austin parks; Garner SP; Eisenhower Park (SA)	local teachers; Garner popn. needs relocation
	Streptanthus cutleri	Cutler's twistflower	med	win-spr	2,3	TP	Brewster	BBNP; Black Gap WMA	BBNP trip
	Streptanthus sparsiflorus	sparsely-flowered jewelflower	med	spr-sum		TP	Culberson	GMNP	GMNP trip
	Thalictrum arkansanum	Arkansas meadow-rue	high	spring	4,5	ET	northeast	TNC - Lennox Woods	TNC is monitoring
X	Thalictrum texanum	Houston meadow-rue	high	spring	4,5	PO	Brazos	Lick Creek; HwyROW	contact Hugh Wilson
	Thelocactus bicolor var. flavidispinus	straw spine glory of Texas	high	spring	3	TP	Brewster	HwyROW	Marathon HwyROW site
X	Tillandsia baileyi	Bailey's ballmoss	med	fall	10	ST	southeast	RdlP SP; HwyROW	
	Trillium pusillum var texanum	Texas trillium	high	spring	3,4	ET	central	USFS (Angelina); private	Smith Co. property owned by NPSOT member
	Viola guadalupensis	Guadalupe Mtns. violet	med	spring	3,4,5	TP	Culberson	GMNP	GMNP trip (high up)
	Xyris drummondii	Drummond's yellow-eyed grass	low	summer	6,7,8	ET	eastern	USFS?	hard to i.d.
	Xyris scabrifolia	rough-leaf yellow-eyed grass	low	summer	7,8,9	ET	eastern	USFS?	hard to i.d.
	Zanthoxylum parvum	Shinners' tickle-tongue	high	spring	4	TP	Brew., Jeff Davis	Scout Ranch; private	access?

Potential Monitoring Sites for Species of Concern in Texas

	Scientific Name	Common Name	Priority	Season	Month	Eco	Counties	Location	Notes
	INVERTEBRATES								
X	Ashmunella pasonis	Franklin Mtns. wood snail	high	fall	9,10,11	TP	El Paso	Franklin Mtns SP	after rains
X	Assiminea pecos	Pecos assiminea snail	med	any	any	TP	Pecos	Diamond Y	
X	Cochliopa texana	Phantom cave snail	high	any		TP	Reeves	Phantom Cave Spring	abundant - have volunteer check occasionally
X	Euchemotrema cheatumi	palmetto pill snail	high	fall-spr		BLP	Gonzales	Palmetto SP	after rains (Bowles did not find in 1995)
	Fontelicella davisi	Davis Co. springsnail	high	any		TP	Jeff Davis	private	access?
	Fonticella metcalfi	Presidio Co. spring snail	high	any		TP	Presidio	private	access?
X	Polygyra hippocrepsis	horseshoe liptooth	high	fall-spr	9,10,11	EP	Comal	Landa Park	best sampled after rain
X	Sonorella metcalfi	Franklin Mtn. talus snail	high	fall		TP	El Paso	Franklin Mtns.	after rain
	Tryonia adamantina	Diamond Y Spring snail	low	any		TP	Pecos	Diamond Y	secure
X	Tryonia brunei	Brune's tryonia	high	any		TP	Reeves	Phantom Cave Spring	combine with C. texana & T. cheatumi
X	Tryonia cheatumi	Phantom Cave Spring tryonia	high	any		TP	Reeves	Phantom Cave Spring	combine with C. texana & T. brunei
	Tryonia stocktonensis	Gonzales Spring snail	low	any		TP	Pecos	Diamond Y	contact TNC
	Adhemarius blanchardorum	Blanchard's sphinx moth	high	?		TP	Brewster	BBNP	BBNP trip (being worked on)
X	Anomala tibialis	Tibial scarab	high	spr-sum		CPM	sand dunes	state parks; Padre Island	need Ed Riley to I.d.
	Argia leonorae	Balmorhea damselfly	low	spr-fall			widespread	Balmorhea SP	abundant
	Cincindela sp.	tiger beetles	low	summer			So.-TX thru W TX		taxonomy of all is questionable
	Euproserpinus wiesti	Walst's sphinx moth	high	?		HP	Hartley Co.	?	use butterfly clubs
	Heterelmis comalensis	Comal Springs riffle beetle	low	any		EP	Comal	Landa Park	contact USFWS to coordinate
	Lordithon niger	black lordithon rove beetle	low	spr-fall		PO	Dallas	?	Steve Ash - UKan
	Poladyras minuta minuta	minute checkerspot butterfly	high	?			central & west TX	?	use butterfly clubs
	Protoptila arca	San Marcos saddle-case caddisfly	high	winter	1,2,12	EP	Hays	San Marcos River	being monitored by Bowles
X	Protoptila balmorhea	Balmorhea saddle-case caddisfly	high	spr-sum		TP	Reeves	Balmorhea SP	could be monitored by snorkelers
	Somatochlora margarita	Big Thicket emerald dragonfly	low	spr-sum	4,5,6,7,8	ET	southern	USFS	easy to visually I.d., but may need to collect
	Stallingsi maculosa	maculated manfreda skipper	high	sum-fall	4,7-9,11-12	ST	several	?	apparently declined

Potential Monitoring Sites for Species of Concern in Texas

	Scientific Name	Common Name	Priority	Season	Month	Eco	Counties	Location	Notes
X	Taeniopteryx starki	Leon River winter stonefly	high	winter	1,12	EP	Coryell, Hamilt.	Leon River	has not been located recently
	Gammarus hyalleloides	diminuitive amphipod	high	any		TP	Reeves	Phantom Cave	
	Gammarus pecos	Pecos amphipod	high	any		TP	Pecos	Diamond Y	
	HERPS								
	Bufo houstonensis	Houston toad	med	win-spr	1,2,3,4	PO	Bastrop, et al.	HWY ROW	repeat of roadside surveys needed
	Cemophora coccinea copei	No. scarlet snake	low	spr-fall	4...9	ET		Daingerfield SP	
	Cemophora coccinea lineri	Texas scarlet snake	low	any	1...12	CPM	coastal	Aransas NWR, NAS - Corpus Christi	secretive, but trappable; warm, humid nights; wet years
	Coleonyx reticulatus	reticulated gecko	low	spr-fall	4...9	TP		BBRSNA; BGWMA	snake collectors may see it
	Crotaphytus reticulatus	reticulate collared lizard	med-high	any	1...12	ST		Falcon SRA; Chap. WMA;	mark/recapture best; time-area search is weather sensitive
	Drymarchon corais	indigo snake	low	spr-fall	3,..10	ST		SP & WMAs	drift fences & box traps; road surveys
X	Eurycea neotenes	Texas salamander		any	any	EP		Guad. Riv.; Landa; HGH; Kerr; Lost Maples	time-constrained searches
X	Eurycea sp. 1	Jollyville Plateau salamander	high	any	any	EP	Travis	Travis Aud. Sanc.;	time-constrained
X	Gopherus berlandieri	Texas tortoise	med	any	1..12 (in so.)	ST		Chaparral WMA, others	mark-recapture best; road transects
	Graptemys caglei	Cagle's map turtle	high	any	3..10 best	mix	Gonzales, Dewitt	Palmetto Bend SP	Killebrew working on it
	Kinosternon hirtipes murrayi	Chihuahuan mud turtle	high	spr-fall	4...10	TP	Presidio	BBRSNA	Andy starting project
	Macroclemys temminckii	alligator snapping turtle	high	any?	?	ET		Engeling WMA; Martin Creek Lake SRA;	TAMU project; wanted poster
	Malaclemys terrapin littoralis	Texas diamondback terrapin	med.-high	spr-fall	3...10	CPM		Brazoria NWR; San Bernard NWR; Mat. Isl. WMA;	visual surveys or trapping--boats needed
	Nerodia clarkii	Gulf saltmarsh snake	high	spr-fall	3...10	CPM	coastal	Aransas NWR; Galv. Is. SP;	aquatic drift nets--tough
	Nerodia h. harteri	Brazos water snake	low	spr-fall	4...9	RP		Fort Griffin SHP; Lake Whitney;	minnow traps; rock-flipping
X	Notophthalmus meridionalis	black-spotted newt	high	any	1...12	ST		Lag.Atas NWR; Sabal Sanc.; Welder Found.;	seining; aestivate in dry weather
	Pituophis melanoleucus ruthveni	LA pine snake	high	spr-fall	4,5,6 best	ET		Angelina NF; Big Thicket;	continue Rudolph's work if feasible
	Rana areolata	crawfish frog	high	spr-sum	4...8	CPM		Candy Abshire WMA;	need tape of voice
	Rana grylio	pig frog	low	spr-sum	4...8	CPM	Jefferson, Chambers	Murphree WMA; Sea Rim SP	

Potential Monitoring Sites for Species of Concern in Texas

	Scientific Name	Common Name	Priority	Season	Month	Eco	Counties	Location	Notes
	Sceloporus graciosus arenicolous	dunes sagebrush lizard	med	spr-fall	3...10	RP		Monahans Sandhills SP	Andy starting project
	Trachemys gaigeae	Big Bend slider	low	any	1...12	TP		BBRSNA;	river recreationists?
	MAMMALS								
	Dipodomys elator	TX kangaroo rat	high	spr-fall	4-10	RP		Copper Breaks SP?	R. Martin now monitoring
X	Geomys personatus maritimus	maritime pocket gopher	med	spring?		CPM		Corpus Christi NAS;	mound counts
	Geomys p. streckeri	Carrizo Springs pocket gopher	med	spring?		ST		HWY ROW?	mound counts
	Geomys p. bakeri	Frio pocket gopher	low	spring?		EP		HWY ROW?	common
X	Peromyscus truei comanchi	Palo Duro mouse	med-high	spr-fall	quarterly	HP		Palo Duro Canyon SP; Caprock Canyons SP	Kevin now monitoring it; check park foundation
	Sigmodon ochrognathus	yellow-nosed cotton rat	low	spr-sum?		TP	Brewster	BBNP	BBNP trip
X	Spilogale putorius interrupta	plains spotted skunk	med	winter	2, 9-11?	BP, RP		APC NWR, Katy area	spotlighting?
	Sylvilagus floridanus robustus	Davis Mtns. cottontail	med	spr-fall		TP	Jeff Davis	Davis Mtns. SP?	walking transects
	Tamias canipes	gray-footed chipmunk	med	spr-fall		TP	Culberson	GMNP	GMNP trip - walking transects
	Thomomys bottae limpiae	Limpia southern pocket gopher	med	spring?		TP	Jeff Davis	Davis Mtns. SP?	mound counts?
	Vulpes velox velox	swift fox	high	spr,fall?	3,4,5,9,10	HP		Rita Blanca NG?; roadsides?	supplement Kevin's surveys
X - indicates those species that TPWD scientists felt had the most potential for meaningful monitoring by citizen volunteers.									

APPENDIX B

Draft monitoring manual

and

Monitoring methods chapter from

Armentrout, D., ed. 1999. A Landowner's Manual for Sustaining Private Ranches in Central Texas. Plan-It Texas, HRM of Texas, Inc.

INTRODUCTION

What is Biological Monitoring?

Ask that question of ten biologists and you'll get ten different answers! Basically, monitoring is an attempt to gather information in order to track changes over time or in response to different treatments. It can take place at many scales. At its simplest, monitoring might consist of keeping notes about the various species that are seen on a property. Such a system will not measure quantitative changes, but one may notice that some species are added or lost over time. A second level might entail mapping where different plants, animals, or vegetation communities (such as wetland, prairie, forest, or scrubland) occur on the land and then revisiting those maps occasionally to detect changes in patterns of distribution. A third level of monitoring intensity might consist of establishing points or transects that are censused each year for species of interest. If areas are measured for these samples and they are distributed randomly, then even more information can be obtained about absolute density of the species. Finally, the most intensive level of monitoring might conisist of marking individual animals or plants and tracking the movement and/or survival of those individuals over time. The purpose of this manual is primarily to offer landowners, land managers, and interested citizens guidance for using techniques to achieve a moderate level of monitoring using transects, point counts.

Why monitor?

The results of a monitoring effort can offer valuble information for many purposes. Perhaps most importantly, for the individual landowner or land manager, it can allow you to understand how species are responding to the management practices on your property. You can thus tailor your management strategies to meet your own personal goals for the landscape. In addition, it may offer real, practical information, such as where the big bucks are for the potential hunting leasee or where the rare birds are for the potential bed-and-breakfast client. Censusing animal and plant populations also qualifies as a wildlife management activity for landowners interested in pursuing a wildlife management exemption on property taxes. For a schoolteacher or youth worker, monitoring can help to teach quantitative skills, identification skills, and interrelationships between environments and species.

At a larger scale, monitoring carried out in many localities can offer the chance to understand the status and trends for various species. This information will enable the monitor to speak in a knowledgeable and defensible manner about trends in species' abundance and will allow informed decisions to be made about the need (or lack thereof) for specific conservation actions. Perhaps most importantly, monitoring may shed light on the status and management needs of species early enough so that many options are still available for their conservation. Monitoring provides information, and information, whether in the hands of landowners, school teachers, or biologists, makes for informed decisions.

The basics

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So how do you get started? The first step is to decide what you want to monitor. Is bird diversity important to you? Are game species your main focus? Do you want to ensure that your management actions do not deleteriously impact rare plant species? Do you want to know what types of butterflies use landscape plants or how stream invertebrates respond to water quality? You may want to intially use a post-card system or field notes to keep track of interesting sightings before you design a monitoring system for specific species.

Texas Parks and Wildlife Department can provide you with information on what rare species, game species, or nongame species of interest may be found on your property or study site as well. It is also important to understand the habitat of the species in which you are interested. While a deer survey may be conducted over the whole property, you will only need to monitor golden-cheeked warblers in mature cedar stands. Once you know what you want to monitor and where you need to monitor it, specific techniques may be applicable. Later sections of this manual offer techniques for different animals, plants, and vegetation communities, but the following guidelines apply to all monitoring efforts:

1. **Make it repeatable** - Monitoring efforts should be set up in such a way that they can be repeated from year-to-year, season-to-season, etc. Standardized survey routes or points marked on maps can help to accomplish this goal, as can keeping good notes about the techniques used.

2. **Make it standardized** - Data needs to be collected under the same conditions each time using the same units of measure. For example, annual censuses should be collected at the same time of year (adjusting for climatic differences if appropriate), same time of day, and under the same weather conditions. In addition, results should be expressed in a unit of measure that can be compared between years and localities, such as # deer/acres surveyed, # reptiles/miles of road surveyed, # plants/square meter, etc.

3. **Keep it objective** - Where possible use precise counts and numbers, rather than estimates, as estimates vary between observers and even between years. When estimates must be used, create standardized categories, such as vegetation cover = 0-25%, 26-50%, 51-75%, or 75-100%. In addition, avoiding guessing at species identity--call it an unknown if you can't tell whether it's a doe or young spike, a Cooper's or sharp-shinned hawk.

4. **Randomize, randomize, randomize** - Try to set up sample points in a random manner. This is especially important if you are trying to obtain overall density or abundance estimates for the entire property. You can randomize by creating a grid on a map of the property with a numbering system, and then use a computer or random numbers table to randomly select your sample points. If randomization is logistically infeasible, don't despair. You can still obtain good trend information if you have to use established roads or paths. Just select your stopping points randomly and realize that you may not be getting a true representation of the entire property.

5. **Sample sufficiently** - In order to detect real changes you must be sure to collect enough data points. One simple method of doing this is to plot a running average (or running mean). As you collect sample points, average their results and plot them on a graph. As

you collect more and more samples, you will see that your average will begin to flatten out around one number. When your line begins to flatten, then you know that you have approached a sufficient sample size. (If your goal is to detect species diversity, then you can plot total number of species detected and determine when you have begun to no longer pick up new species). You may want to set a predetermined cut-off point, such as no more samples needed when running mean does not change by more than 5 % or no new species are added in five consecutive sample points.

6. **Provide for controls** - If you are trying to detect the effects of a particular management practice (such as brush clearing, grazing, exclosure fences, etc.), then you will need to be sure to sample a "control" area (an area where you do not change the management practices). Since many variables such as rainfall, etc., explain year-to-year changes in populations, only by comparing controls to management areas can you assess the real effectiveness of your management action.

You will want to devise a data form for each monitoring effort. Some examples are provided in this manual, but in general each data form should include the following information:

-observer name
-date/time
-weather - including temperature, wind speed, cloud cover/precipitation, relative humidity (appropriate for some species), noise level (appropriate at some localities)
-sample methods used
-habitat - photos may be useful
-map
-actual biological data (be sure to include units)

Etiquette

Finally, a word about monitoring manners is in order. By definition, many of the species that may be of most monitoring interest may also be somewhat rare. Care should be taken to ensure that monitoring efforts and techniques do not in themselves cause harm to the species or its habitat. In addition, permits may be required for some activities, especially when using calls to count endangered birds or when handling any threatened or endangeredspecies. When in doubt more guidance can be obtained from permit offices at Texas Parks and Wildlife Department and the U.S. Fish and Wildlife Service.

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MONITORING BIRDS

Due to the extreme popularity of bird-watching (a recent survey showed that birding is the fastest-growing outdoor recreation activity) and recent concern that some once-common species may now be declining, birds are one of the most-monitored species around; however, only recently have some national efforts begun to standardize the way information is collected. These efforts offer a major resource base for the citizen wishing to establish a monitoring program for birds. In addition, the large number of birders in most areas offer a ready source of volunteers for landowners who may wish to utilize their services.

Although techniques will vary for different types of species (see below), some considerations hold for nearly all bird species. First, the basic equipment need for bird monitoring is a good pair of binoculars. Most birders prefer binoculars that emphasize quality of optics and light-gathering capability over power of magnification. (In the description of a pair of binoculars, e.g. 7x35, the first number indicates the magnification, while the second number is an indication of its aperture, or light-gathering ability.) Some bird-monitoring may be conducted from a great distance, such as watching waterfowl on a pond or shorebirds on a beach, and may also be benefitted with a spotting scope, which provides higher magnification. In some circumstances a tape-recorder may be useful to record calls for later identification or to play tapes to attract birds; however, the use of calls to attract birds should be used judiciously, as they can disrupt behavioral patterns of sensitive species as well as bias density estimates. Finally, a simple word about clothing--drab clothes work best when attempting bird observation.

Timing is an important consideration in monitoring birds. Different birds may be permanent residents, winter residents, summer residents, or migrants, so monitoring efforts should either be timed to document the species of interest or conducted in all seasons to assess the complete bird population. In addition, annual climatic events, such as drought or cold fronts may affect bird activity, so monitoring efforts may need to be expanded in some years to reflect this variation. Secondly, time of day is a consideration. Many birds are most easily monitored in early morning or late afternoon when they forage or vocalize most consicuously. Other species, such as owls and nighthawks, may most optimally monitored at night. Finally, waterbirds, shorebirds, and wading birds may be affected by water levels. In coastal areas it may be best to count tidal flats on a falling tide when prey species are most abundant.

Bird Monitoring Techniques

Transects are a technique in which a person walks along a line listening and looking for birds. The transects can be a set width or variable width. In a set-width transect all birds seen or heard in a given width (e.g. 50 m. on either side of the line) are counted. The set width transect makes it easy to determine density (# birds/acre), but means that some birds encountered are excluded from the count. In a variable-width transect all birds seen or heard are counted. Variable-width transects are better for simply monitoring trends, (e.g. # birds/m. of transect walked), as detectability must be determined for each bird species if the results are to be converted to a density of birds/acre. Variable-width transects may be useful when efforts are focusing on one or two species for which detectability can be determined, especially when that species is rare and you

want to count all birds detected. Walking transects in general are best suited for woodland or forest songbirds. Usually 4-10 transects of 200-300 meters in length are sufficient to sample birds in a forest or woodland habitat. Driving transects may be useful in locations where birds are skittish about foot-traffic, but don't shy from vehicles at a distance, such as monitoring shorebirds on a beach with automobile traffic. (Remember to restrict driving to previously-established routes to minimize impacts to habitat). Transects may be modified and conducted from boats when the habitat and species are appropriate.

Point-centered counts consist of a series of sample points along a predetermined route. This technique is often used along roads, where the observer can drive between stops. At each stop the observer listens and watches for a set amount of time (usually 3-5 minutes), recording all birds seen or heard. Again, the observations can be limited to a fixed radius if density estimates are important. If all observations are recorded, then a measure of relative abundance (# birds/stop) can be obtained, but absolute density will be more difficult. Point-centered counts are useful in monitoring songbirds in patchy habitat, such as brushland and savannah, where a large number of widely-spaced sample points are desirable. Point-centered counts can also be used from boats for waterbirds and in monitoring owls at night. Instructions for conducting point-centered counts are found in Appendix E.

Spot-mapping is an intensive method that consists of thorough searches of a habitat patch on several days, where every occurrence of the species of interest is mapped. By looking at distribution of sightings, you can often estimate the total number of individuals present. It is useful for small acreages, when you are focusing on one or a few species, and is relevant only for breeding birds. It is time-intensive, but can offer useful management information regarding habitat patches. It is most useful for rare songbirds.

Use of playback recordings can help locate secretive species, such as owls or rails. In this technique a recording of the species of interest or of a screech owl is played at several widely-scattered stops. Because this technique causes birds to move toward the observer it cannot yield absolute density--it <u>can</u> help create a complete species list and reveal relative frequency of occurrence at different locations. Use of playback recordings should be used very judiciously, as it increases the energetic needs of species respounding to it. In addition, birds can become habituated to recorded calls and stop responding.

Monitoring nests and roosts - Some species have very conspicuous nests (eagles and some hawks), form large nesting colonies (herons, gulls and terns, and swallows) or roost in large groups (turkeys and vultures). For these species, it may be most effective to simply monitor those sites once they have been identified. For eagles and other raptors, information regarding production of young can sometimes be gathered by observing the nest. An additional insight into food habits may be gained by looking for pellets or prey remains beneath the nest site. For colonial nesters, it is simply desirable to obtain an annual population estimate at the colony site. At roosts you may wish to monitor abundance several times throughout the year by conducting counts in the evening when the birds fly back into the roosts. Observations at all these sites should take place from a distance, and great care should be taken that none of these monitoring

efforts disturb the birds during these sensitive periods.

Resources for Monitoring Birds

A good field guide is a must for monitoring bird populations. There are several series of field guides, including Peterson, Audubon, Golden, and the National Geographic Society. Another valuable aid in the field is Erlich et al. (1988) *Birder's Handbook: A Field Guide to the Natural History of North American Birds*, which is full of biological and ecological information in schematic form. Since many birds are identified by calls, one of the audio field guides produced by Peterson or Texas A&M University Press might also be useful. The Endangered Resources Branch of Texas Parks and Wildlife Department can provide illustrations and monitoring suggestions for rare species.

As mentioned earlier, several programs are now underway to systematically monitor birds throughout the country. For more information on how to participate in Christmas bird counts, breeding bird counts, migration counts, or set up bird-banding stations, contact the Partners-in-Flight program at Texas Parks and Wildlife Department or the National Audubon Society. And don't forget: There are lots of birders in your community who may be overjoyed to lend a hand in a bird-monitoring project. Contact local birding clubs or local chapters of the Audubon Society,

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MONITORING MAMMALS

While systematic programs to monitor the abundance of mammals do not exist on a broad scale, there are indications that monitoring needs of mammals may be just as great as those for birds. The 20th century has witnessed fluctuations in many game mammal and large carnivore populations--all with little quantitative information about what was happening to our "charismatic megafauna." On a smaller, but perhaps more insidious scale, many questions have been asked, but little is known, about the effect of the spread of red-imported fire ants on small mammal populations. Much insight could be gained at both the local and statewide level from more monitoring of mammal species.

Mammals are a diverse bunch--all you have to do is take a look at the adjectives used to describe them. They are diurnal (active in in the day), nocturnal (active at night), and crepuscular (most active in the morning and evening). They are fossorial (burrowing in the ground), arboreal (found in trees), terrestrial, and aquatic. Some are even volant (able to fly). Their size is variable too, from least shrews weighing a few ounces to the occasional 200-pound black bear found in Texas. Consequently, techniques used to monitor mammal populations are diverse as well, and few generalizations hold.

Mammal Monitoring Techniques

Transects are based on the same model used for birds. Like bird monitoring efforts, they can be fixed-width or variable width. Width of the transect will depend on the animal being sampled and the structure of the habitat. Walking transects are useful for censusing common and visible crepuscular or diurnal mammals like deer and squirrels or for obtaining an index of activity of small mammals like rabbits and rodents which may leave droppings, runway trails, or burrows that can be counted in a walking transect. They can also help determine herd composition for deer, since bucks, does, and fawns can be readily identified during the appropriate season. Several transects should be run--utilize the running mean method to determine how many.

Spotlight transects are commonly used to monitor deer, carnivores (including raccoons, skunks, foxes, coyotes, and the like), and other nocturnal mammals, such as opossums. Usually conducted from roads, they can be fixed-width or variable-width. If variable-width transects are established, then visibility can be estimated for the route to allow absolute density of the species to be determined. Moon phase should be considered during spotlight counts, as many species are more skittish during full moon. Spot-lighting is prohibited from public roadways.

Scent stations are also commonly used to determine relative abundance of carnivores. Usually most effective in the autumn, stations can be set up at .3 mile intervals along a transect and baited with a commercially scent available from trapper supply catalogues. The dirt around the post is sifted and raked and the scent applied in the evening. The station is then checked for tracks in the morning. An index of populations expressed as # posts visited is obtained.

Live-trapping is the most common method for obtaining detailed information on small mammal populations. The type of trap used will depend upon the target mammal, but the sampling technique is basically the same. The traps are layed out in a grid of at least 25 traps, with at least two grids randomly placed in each habitat type. Results will provide an index of abundance expressed as #/trap-hour, but, if coordinated with a scientific marking and recapture study, then can provide an absolute measure of species abundance. Some precautions are necessary when live-trapping mammals. Due to rabies concerns, live-trapping for raccoons, skunks, and canines is not recommended in any part of the state. Although rodents are not very susceptible to rabies, plague and hanta-virus may be health concerns in North and West Texas. Rodent trapping without professional assistance is not recommended in these parts of the state.

Specialized techniques are available for special mammal species. To monitor pocket gophers, flatten all gopher mounds in a pre-measured are, then monitor the mounds for new activity to obtain a population index. Other mammals provide readily-measured indices. Muskrat beds may be counted through transects or area counts to obtain an index of muskrat populations. Watch for evidence of freshly-cut vegetation on top of the mound to determine whether the bed is active. Similarly, transects conducted by boats in wetlands can be used to count nutria feeding pads and search for otter scat. (Nutria may also be effectively monitored through spotlight counts conducted from boats.)

Bats are another group of mammals with specialized monitoring techniques. Monitoring is most effectively conducted at the roost site, which may consist of a hollow tree, abandoned building, or cave, depending on the species. The recommended technique is a count of emerging bats conducted at roost sites during the evening. Bats may be counted inside the roost during the day using an infra-red light, but this technique should not be used if bats will be disturbed, as disturbance can cause loss of valuable stores of body fat, injury to young bats, or even abandonment of the roost. A less-invasive index of bat abundance is to monitor the amount of guano present at the base of the roost.

Resources for Monitoring Mammals

Several references are available regarding mammal identification and ecology. These include *The Mammals of Texas* (1994) published by Texas Parks and Wildlife Department and field guides published by the Peterson series, National Audubon Society, and Texas Monthly Press. Local universities and Texas Parks and Wildlife Department biologists may be able to offer assistance and suggestions for setting up monitoring efforts. The Endangered Resources Branch of Texas Parks and Wildlife Department can provide illustrations and monitoring suggestions for rare species. Bat Conservation International is a good source of information about monitoring and conservation of bat species.

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MONITORING REPTILES AND AMPHIBIANS

In the past decade, herpetologists (scientists who study reptiles and amphibians or "herps") have been confronted with two startling realizations: (1) Amphibian populations all over the world seem to be declining; and (2) No effective monitoring program is in place to understand what is going on with reptiles and amphibians. Since that time, several other events, from the increase in deformed frogs in the northern states to the disappearance of the popular Texas horned lizard (or horny toad) from the eastern third of Texas, indicate that reptiles and amphibians may have much to tell us about the health of the environment around us. Besides, herps are fun to monitor!

Like mammals, herps are a diverse group. From inch-long salamanders to 13-foot long alligators, they inhabit wetlands and desert, forests and plains, mud puddles and cliff faces. Consequently, monitoring techniques will be highly specific to the species of interest. One truth holds for all reptile and amphibian monitoring, however: Environmental conditions are very important when establishing monitoring for these cold-blooded animals. All are inactive in very cold weather, and most reptiles are inactive in cool weather. Amphibians, while somewhat more tolerant of cool weather, may be highly affected by moisture conditions, such as rainfall patterns and relative humidity. Monitoring efforts must consider these weather patterns in order to be most effective.

In order to understand the effect of environmental conditions on herp monitoring efforts, it may be important to conduct surveys under several conditions, noting the environmental variables present. Some variables to consider (when applicable) incude temperature (current and recent patterns), precipitation (current and recent patterns), relative humidity, barometric pressure, wind speed and direction, water levels, phH, conductivity, and moon phase. After a few "test" surveys have been conducted, then a prescription for survey conditions can be derived. Because of inherent variability in conditions and the nonrandom nature of some herp behavior, such as amphibian breeding choruses, surveys should also be conducted on several different days or nights.

Herp Monitoring Techniques

Transects are useful for some reptiles and amphibians. Diurnal transects can be used for lizards, snakes, and tortoises, when temperatures are above 70 F. Nocturnal transects can be used in the spring and summer to look and listen for frog species--preferable on moonless nights following rains when temperatures are above 60 F. Several transects, totalling at least 1 km. (1000 yds.) in length should be conducted. Since the transect will be minimal in width, results will be expressed as a trend of # animals seen/meter. Similar techniques can be applied along a stream or river to detect basking turtles as well. For more instructions regarding the walking transects, see Appendix D.

Spotlight transects conducted from vehicles are also useful for some species, especially snakes, frogs, and toads. Many of these species are drawn to warm asphalt or to the insects associated with roadside lights. Again, surveys should be conducted on a warm night. Since the effective

width of the transect is limited to the road itself, a spotlight may not actually be necessary (although it may be necessary to stop the vehicle to identify the species--Watch for traffic!) and results will be expressed as # seen/mile. Spotlight transects may also be conducted from boats for alligators.

Time-constrained searches may be one of the most effective techniques for amphibians and reptiles. It can be used for lizards in rocky habitats, horned lizards in habitats around red ant beds, terrestrial salamanders in moist woodland habitats, and spring salamanders in rocky aquatic habitats. In this method, you simply record the amount of time that you spend intesively searching an area and the number of animals found. Rocks, logs, and other objects may be moved to provide best results. Care should be taken to minimize permanent disruption of microhabitats through replacing all objects moved. In addition, for safety reasons, sticks or poles should be used to turn over the rocks and logs objects when poisonous snakes may be in the habitat. Absolute density cannot be estimated (unless you search all habitat available), but results expressed as # animals/hour can yield trend information from year-to-year or season to season.

Breeding pond counts are useful for frog and toad species that often congregate at these sites during the spring. An attempt can be made to count all individuals at the pond, or transects can be set up. Adults, eggs, and larvae (tadpoles) can be counted. Again, timing is very important, as these breeding choruses can dramatically peak one night and be almost non-existent the next. Visit on several nights and note the ideal environmental conditions (usually high humidity, moderate temperatures and dark moon). In addition, different species breed at different times of the year, so several visits should be made from late winter to early summer if the goal is to detect all species.

Live trapping is an intensive, but often effective, method of sampling herp populations, especially lizards and toads. It could be combined with efforts to sample mammal species, and, like those techniques, consists of laying out traps in a grid pattern. Precautions are again in order--some reptiles will bite, and traps must be checked frequently and covered when not in use. Results are expressed as # captured/trap-hour, although in an organized study animals can be marked to learn more about population size.

Specialized techniques are also applicable to some reptiles and amphibians. If the goal is to maximize effectiveness in determining species diversity, then habitats can be constructed to attract herp species, such as boards propped on rocks to provide cover for lizards and snakes and artificial ponds for frogs and toads. Aquatic species may be collected using seines or sampling dredges. Results with seines can be converted to density estimates. If more intesive studies are underway, then *lizards* and *turtles* can be marked from a distance using latex paint and a paint gun. Lizards can also be collected for identification by stunning them with a heavy rubber band (shot from your fingertip, of course!).

Resources for Monitoring Reptiles and Amphibians

Several references are available regarding herp identification and ecology. These include field guides published by Golden, Audubon, Peterson, and Texas Monthly Press. *Measureing and*

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Monitoring Biological Diversity--Standard Methods for Amphibians (1994), published by Smithsonian Institution Press, is a good resource regarding monitoring techniques. Audio field guides to frog and toad calls are also available and might prove very useful. Local universities may be able to offer assistance and suggestions for setting up monitoring efforts. The Endangered Resources Branch of Texas Parks and Wildlife Department can provide illustrations and monitoring suggestions for rare species.

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MONITORING FISH

Most people have probably sampled fish, but not with the goal of establishing a monitoring program! Despite a recognition by biologists that a systematic monitoring system is needed for sensitive fish populations (Garret and Price 1989), in fact, with the exception of closely monitored game fisheries and a few endangered fishes, few efforts have been initiated. This occurs despite the fact that we recognize that changes in fish habitat via water quality and quantity are some of the most pervasive environmental concerns today.

Monitoring fish does offer unique challenges. Special equipment is often needed. Identification usually must take place in the hand and then often is difficult. Rare fishes offer the dilemma of collection for monitoring reducing an already fragile population. For these reasons, it is suggested that the fish monitoring techniques offered below be implemented with the assistance of an aquatic biologist. On the other hand, to a great extent, fish are as well off as their habitat is. With a few special exceptions, indirect indices of water quality and flow may serve as an adequate barometer of the health of fish populations.

Fish Monitoring Techniques

Electroshocking is a technique for collection of fish that uses an electric current to stun fish. It can be applied from a boat or a backpack shocker. The stunned fish are then collected in a dip-net. Results are expressed as # fish/time shocked.

Rotenone is a commercially-available compound derived from a plant root that inhibits oxygen intake by aquatic animals, including fish and invertebrates. It has long been used by aboriginal populations to kill fish for food. It should not be used where populations of rare fish or invertebrates exist or in flowing systems where it cannot be contained. It is best used in a pond situation, where results can be expressed as # fish/area.

Seines, minnow traps, and gill nets are all equipment that can be used to collect fish. Seines are nets available in various lengths and mesh size that are pulled through the water by hand. They are useful for a large variety of fish where the water is shallow enough to wade. Results can be expressed as #/area sampled or #/seine haul. Minnow traps are useful for sampling small fishes, especially where the shoreline is steep-sided. They are set and left to be rechecked regularly. Results are expressed as #/trap-hours. Gill nets are suitable for larger species that can be removed from the net with little damage to the fishes' gills. They are also set and left to be rechecked. Results are expressed as #/hour.

Angling (believe it or not!) is also considered a valid technique for monitoring some fish populations. While angling data is most often used to assess the status of game fish populations, it may also be useful in monitoring the status of some sensitive species, such as the Guadalupe bass. Results are expressed as #/sampling time.

Habitat monitoring may be the most convenient method of monitoring aquatic species. Some features that might be monitored include flow, channel width and morphology (for streams),

substrate type, depth, vegetative cover, and changes in the watershed. Instructions for aquatic habitat monitoring are provided in Appendix I. Water quality is also critical to habitat quality. Recommended monitoring parameters include temperature, pH, dissolved oxygen, conductivity, turbidity, siltation, dissolved solids, and nutrients. Training and materials for water quality monitoring are available through participation in the Texas Watch program sponsored by the Texas Natural Resources Conservation Commission.

Resources for Monitoring Fish

There are a number of excellent keys available for identifying fish, including Pflieger (1975) *The Fishes of Missouri*; Robison and Buchanan (1984) *Fishes of Arkansas*; Hubbs, Edwards, and Garrett (1991) *An Annotated Checklist of the Freshwater Fishes of Texas with Keys to the Identification of Species*; and Page and Burr (1991) *Peterson Field Guide to Freshwater Fishes*. Excellent water quality monitoring materials are available from the Texas Natural Resource Conservation Commission and from some river authorities. Finally, local college and university staff and Texas Parks and Wildlife Department biologists may be able to offer some identification assistance, especially where sensitive species may occur.

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MONITORING INVERTEBRATES

Ironically, the animal group which most dominates the world in terms of sheer biomass and significance with respect to the maintenance of ecosystems, invertebrates, is also the least studied and monitored. Invertebrates are immensely important to the world in which we live--as pollinators, food sources, soil enrichers, scavengers and decomposers, and the subjects of much basic scientific and medical research. While some species have gained notoriety as pest species, others are important biological indicators--all reasons which lend merit to the idea that monitoring invertebrates could gain us some important biological insights.

Unfortunately, the fact that invertebrates are so little understood means that few resources exist to suggest how to develop an effective monitoring program. Invertebrates are everywhere and are diverse, and to monitor them all would prove logistically impossible. Instead, this manual will offer some suggestions regarding species that are particularly significant as indicators in the environment or which lend themselves particularly well to monitoring efforts.

Invertebrate Monitoring Suggestions

Butterflies, moths, and dragonflies - Butterflies, moths, and dragonflies all lend themselves quite well to monitoring, as they are relatively large, bright, and easy to identify even at a distance using binoculars. There are some organized efforts to involve citizens in monitoring butterfly species, such as the international Monarch Watch. In addition, there are several local, regional, or national groups devoted as hobbyists to the study and appreciation of butterflies. To start a monitoring program, begin to keep track of the number and type of species seen each day. For more rigorous monitoring, walking transects or time-constrained searches can be developed. For more information on the Monarch Watch program, including monitoring techniques and landscaping to attract butterflies, contact the Nongame Program at Texas Parks and Wildlife Department. Information on butterflies and moths is also available from the Xerxes Society.

Ants - There are many reasons to monitor ants, both good and bad. For example, you may want to monitor abundance of harvester ants (*Pogonomyrex* species) as an index of food availability for Texas horned lizards. On the other, you may want to monitor the abundance of fire ants in an attempt to recognize correlations with abundance of small mammals or reproductive success of ground-nesting birds. Ants which build visible mounds, such as harvester ants and fire ants, lend themselves particularly well to monitoring. Simply establish several random transects of set width, count the number of mounds occurring within the transect, and convert results to # mounds/area. Fire ant surveys will need to be conducted during warm weather after fairly recent rainfall, as mound visibility is more restricted during cold or dry conditions.

Beetles- Beetles are the single most diverse animal group in the world, but only two types of beetles have received much public attention. The *tiger beetles* are popular among some collectors, and information may be available from groups of tiger beetle enthusiasts regarding their monitoring and conservation. The other widely recognized group, the *dung beetles*, have no formal "fan" clubs, but have earned the respect of many land managers for their role in soil

aeration and fertilization. Because they are highly visible in their dung-collecting activities, an index of # beetles seen/hour could be developed as a means of monitoring the health of the soil cycle.

Other terrestrial insects - Insects in general are fascinating to most children, and some adults retain that fascination! Although a complete census of insect populations would require many techniques, including pitfall traps, light traps, and aquatic sampling, a partial invertebrate list for a property could be created simply using a sweep net. If some portion of the invertebrate population then proves of interest for monitoring (such as abundance of grasshoppers available for prairie bird species), a set of standardized sweep net transects could be established. Just remember: Like bird monitoring, timing is important with insects. Many invertebrates have complicated life cycles. The different stages may be found in widely divergent habitats or emerge at different times of year. It is important to understand the life cycle of the species of interest and then to adjust sampling efforts to fit annual climatic fluctuations so the sampling takes place during the period of peak numbers. Also like birds, some insects are more active at dawn or dusk, while others may peak during the day or night. Basic knowledge of the biology and behavior of the species is essential in scheduling optimum monitoring times.

Freshwater mussels - There are a plethora of good reasons for monitoring freshwater mussels... First, freshwater mussels are commercially important as a source of seed pearls for the cultured pearl industry. Secondly, studies conducted recently throughout the southeastern United States suggest that mussels everywhere have declined dramatically in number. Third, as filter-feeding invertebrates it is easy to imagine that the health of freshwater mussels may reveal to us something about the health of the water supplies we depend upon. Since several mussel populations are rare, it is important to not remove live mussels from the wild. Instead Texas Parks and Wildlife Department has joined with the Texas Watch program of the Texas Natural Resources Conservation Commission to create a "Mussel Watch" program that encourages participants to send in shells of mussels found in Texas rivers, streams, and reservoirs. To find out more about mussel identification and monitoring, contact the Mussel Watch program at one of these two agencies.

Aquatic insects - Like mussels, aquatic insects are also good indicators of water quality. Quantitative indices of water quality have been designed based upon the composition of the aquatic invertebrate community. For more information on how to use aquatic insects to monitor water quality, contact Texas Parks and Wildlife Department and the Texas Natural Resources Conservation Commission.

Protecting ecosystems - Finally, the sheer magnitude of the goal of invertebrate conservation begs that an ecosystem approach be adopted. In fact, an analysis of the distribution of invertebrate fauna believed to be rare in Texas reveals that many of these species are associated with unique or rare ecosystems. In general, spring systems prove to be often both biologically diverse and unique with respect to the species that occur there. In other instances, a rare plant may be associated with a rare invertebrate pollinator. Effective conservation must maintain the ecosystem that supports both the plant and the invertebrate.

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Resources for Monitoring Invertebrates

Several field guides, including the Golden and Peterson series, are available for insect identification. Texas Parks and Wildlife Department (TPWD) has recently published a guide to freshwater mussels in Texas as well. The Xerxes Society and TPWD can provide information about monitoring butterflies, while TPWD and the Texas Natural Resource Conservation Commission are good sources of information on aquatic invertebrates and water quality monitoring. Local butterfly clubs and universities may also be a good source of expertise. The Aquatic Studies Program of Texas Parks and Wildlife Department can provide guidance for monitoring rare invertebrate species, while TPWD's Heart of the Hills Research Center is a source of information on mussels.

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MONITORING PLANTS

While Texas has about 1100 vertebrates, it has over 5500 plants! It ranks second in the nation to California, and has about 400 plants found nowhere outside the state. Texas Parks and Wildlife Department has in place several very effective monitoring programs for plants on public lands and there are several organization of native plant enthusiasts. In addition, the primary stewards of rare plants in the state, private landowners, have many opportunities to keep an eye on the welfare of some of these unique and attractive Texas treasures.

Plants offer one major advantage in a monitoring program: They don't move! However, they can be tricky in other ways. First, you must know where to look. Plants, especially rare plants, are usually highly restricted by geology, topography, soil types, or land use. It is important to understand the habitat the species requires. Secondly, season is an important consideration in monitoring plants. Monitoring will, of course, be most easily accomplished during the growing season and ideally should be conducted during flowering so that reproductive effort can be measured and identification made easier. While most species flower in the spring and early summer, some flower in the late winter (some cacti) and some in the late summer and fall (most grasses and members of the sunflower family). Others are highly variable--flowering at different times each year, depending upon rainfall patterns. An additional complexity is that plants can look very different at different stages of their life. Leaf size and shape can be highly variable with rainfall and shading, and many seedlings look very different from the mature plant. Simply said--You may have to spend some time getting to know your plant before you can design an effective monitoring program for it.

Finally, watch your step! Keep in mind that plants' immobility make them much more vulnerable to the effects of your monitoring efforts. When setting up study sites, be sure that your activities do not actually harm the species you are studying through direct crushing or soil compaction or your monitoring counts will not only be meaningless, but deleterious as well.

Plant Monitoring Techniques

Complete counts are the simplest method of monitoring a very rare plant whose entire distribution on the property is known. For perennial species, if you want to track growth of an individual over time, then individuals can be marked using a nail and enscribed metal plate for woody species. Other species can be relocated if measurements to some fixed reference point are made.

Distribution maps can help monitor changes for a widely-distributed species whose abundance tends to fluctuate (such as annual wildflowers) or that may be expanding or retracting its distribution (such as Indiangrass or cedar). Simply plot the distribution of the species on a map each year. It will be difficult to detect annual changes, but over time some patterns of distribution and abundance may emerge.

Quadrats or line transects are the most efficient techniques for a species that is too abundant to count all individuals, but for which an accurate measure of abundance or trends is desired.

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MONITORING HABITAT

"Habitat is where it's at"--both where your species is located and where you can take action to benefit your species. An important part of translating monitoring results into conservation benefits is to understand the habitat needs of the species and the effects of changes in that habitat. A meaningful monitoring program should thus include habitat assessment as part of the species monitoring effort. In addition, many land managers are simply interested in techniques that will help them understand the condition of their vegetation communities, especially in response to management treatments. The techniques described below can help to provide a description of habitat for a monitored species or can be applied on a broader scale to monitor the condition of the landscape as a whole.

The design of habitat monitoring efforts will depend upon your goal and the type of vegetation to be sampled. Perhaps you want to see why black-capped vireos use one part of your property, but not another. You could distribute line transects in both occupied and unoccupied habitat to try to understand the differences in the vegetation community. Perhaps you know of one population of a rare plant and want to know where to look for others. You could use your sample quadrats to collect information on other plant species that share the same habitat, as well as information on soil type, in order to fine-tune your additional survey efforts. Perhaps you are concerned about the effects of brush encroachment on a prairie bird species. You could use a point-centered quarter method to monitor increases in brush to know when management actions are needed. Finally, you may simply wish to know what effect your grazing program is having on the composition of your grass species and the amount of bare ground. Long-term monitoring using transects can help you meet that goal as well.

Remember that vegetation communities are the result of a number of variables. When interpreting management implications you will have to take into consideration many features of the habitat, including soil type, geology, topography, hydrology, and previous land use, such as burning, mowing, grazing, etc.

Habitat Monitoring Techniques

Remote sensing is a method of producing vegetation maps using aerial photography, satellite imagery, or similar sources. This technique is good for producing a rough-scale overall vegetation map, but may or may not tell you much about specific variables that are linked to a species that you are monitoring. Photography is available from the Texas Natural Resource Information Service of the Texas Water Development Board or is often available at your local Natural Resource Conservation Service Office. You can use the photos to initially map different vegetation types, but then you must visit the sites on the ground in order to verify your classification.

Quadrats are square, rectagular, or round sample plots that are scattered randomly over the area of interest. All vegetation encountered in the quadrat is counted. This technique is more time-consuming than the two techniques described below, but it can produce the most information. It can be used in all types of vegetation, and size of the quadrat can be varied depending on the

TEXAS WILDLIFE WATCH

Finally, now that you have data, what do you do with it? Hopefully, your data will give you insight into significant biotic resources on your property or study site and what management actions you can take to conserve them. Help in analyzing the data you have collected may be available from Texas Parks and Wildlife Department biologists, other agencies, and local college or university staff. In addition, for some significant species, Texas Parks and Wildlife Department is interested in obtaining the results of citizen monitoring efforts should you wish to volunteer them.

TPWD values the information that may be available from the citizens of the state regarding the status and health of wildlife, especially plants and animals thought to be rare. Recent criticism of the Endangered Species Act has called for decisions to be based on sound science. At the same time, private landowners have expressed frustration that their efforts toward conservation have not been treated as significant when the status of species has been assessed. In an effort to make better use of the knowledge that Texans possess regarding their wildlife resources, the Endangered Resources Branch of Texas Parks and Wildlife Department has recently initiated a program called *Texas Wildlife Watch*.

Texas Wildlife Watch invites private landowners and citizens to share "what they know." * In addition to this manual, Texas Wildlife Watch can provide interested participants with photos, drawings, and descriptions of interest. In some cases, on-site technical assistance in setting up monitoring may also be available. In return, TPWD asks participants to provide an annual report regarding the species of interest. Several options for reporting are available if a participant is hesitant to provide site-specific information or would like to request anonymity.

This project is based on a premise that Texans want to conserve what's special and rare in Texas. It also believes that more information provides more options and creates better decisions, that disincentives that limit communication do not benefit anyone, that monitoring programs can yield information that empower landowners, and that trust is important. If you are interested in participating in Texas Wildlife Watch or in providing input regarding this program, contact the Endangered Resources Branch at 1-800-792-1112.

*In addition, Texas Wildlife Watch has several other opportunities for public involvement,

including monitoring projects on public lands, Texas Horned Lizard Watch, Mussel Watch, Monarch Watch, Hummingbird Round-up, and various bird counts. Contact the TPWD Nongame Program or Endangered Resources Branch at 1-800-792-1112 for more information.

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CHAPTER 6:
MONITORING RESULTS

Monitoring Rangeland Condition

Rangeland is a ranch's main resource for producing income and other benefits. The way you use your range affects all other ranch resources, the achievement of your goals and the sustainability of your ranch.

Periodically Monitor Your Range Condition

Range condition, often described as rangeland's "state of health," is an ecological measure of the *current* condition of the range as compared to its *potential*. The "state of health" of the range resource directly influences both short-term cash flow and sustained ranch productivity. Rangeland monitoring can be thought of as a "check-up" on the condition of rangelands to assess the productivity and stability of the resource base. Several criteria are used to determine range condition, including soil condition and stability, plant species diversity, distribution and vigor. Monitoring involves systematically recording observations of processes or activities to detect changes over time and ranges from a simple collection of photos taken annually to detailed lists of species and soil conditions. If you are unfamiliar with plant identification, you can begin with simple photographic records. As your interest, experience, and expertise grows, you can expand your monitoring.

Monitoring Techniques

There are three general kinds of habitat monitoring techniques: transect analyses, fixed point analyses and exclosure analyses. A transect is an analysis that identifies all plants and their condition *along a horizontal line* (it can be several meters long or much longer). Plants and their relative condition are identified and recorded, then the same line is checked again and again over months and years to determine any changes or trends in vegetation. Other factors, such as plant spacing, surface litter cover and indication of soil movement by erosion ("pedestaling" and rills) also may be recorded. A fixed point analysis involves checking the vegetation at a point, or from a fixed point in a certain direction. Again, identification of plants and their condition is observed and recorded. An exclosure analysis involves fencing an area to prevent livestock grazing so that comparisons can be made between the ungrazed habitat within the exclosure and the grazed habitat immediately outside the exclosure. Exclosure analyses over time give information, not only on the impact of all management decisions over time, but the difference in impacts due to livestock versus those for which livestock are not accountable.

Step transects. To run a step transect, determine the length of the line you will check. Mark the beginning and the end of the transect (with a stake and string, for example). Identify every plant that occurs under the string (you may want to expand the line to everything that occurs within six inches of the string) and record not only the plant but its condition. You will return to the same area and run the transect every several

years. The same data collected by step transects to determine range condition also indicate range trend once you have data from two or more points in time (usually three to five years apart).

Photo-points. A photographic record can provide an effective, objective measure of general range trend. The first step to using photo-points is to locate key range sites that you want to measure. Within each range site, select an area that looks typical of the site as a whole. The number of areas selected may be few or many, depending on the size of the ranch and number of different kinds of sites present.

Construct a plot frame (at least 3 feet x 3 feet) from rebar or PVC pipe. At each selected location, place the frame randomly (one technique is to toss your plot frame behind you over your head ...be careful if you've constructed it of rebar!). Then permanently mark the site where your plot frame landed by driving steel stakes at two opposite corners. Thus marked, the frame can be placed in the exact same location each year. Take a picture of the frame and the vegetation inside at each of your sites. Also make notes describing the vegetation within the frame. You may want to include another photograph of the general landscape around the frame.

One to several photo-points may be located in an area, but be realistic about how many plots you have the time to evaluate. Photos of each plot frame should be taken on an annual basis, preferably in the fall of the year. If other vegetative features of interest, such as cool season perennial growth, additional times would be added. Almost any type of camera or film can be used. Most of the time associated with this technique will be involved in traveling to and finding the photo-points. The growing availability and declining prices in accurate hand-held Global Positioning Systems (GPS) may be good accessory investments and act as significant time savers when a number of photo-points are distributed over large areas.

Comparisons between two or three photographs and their descriptions for the same frame over time provides an objective measurement of range trend. One day devoted to this monitoring method each year can be one of the most effective management tools for evaluating past grazing management decisions.

Exclosures. The use of exclosures to evaluate range trend involves excluding livestock and/or wildlife from grazing in specific areas. The differences between protected and grazed areas can then be used to make decisions concerning stocking rate and long-term range trend.

As with photo-points, the first step is to identify key range sites within the ranch. At least one exclosure should be located within each of these key sites. Exclosures can be constructed from simple materials. A few steel fence posts and wire can be used to fence off permanent areas, or mobile cages can be constructed using concrete reinforcement wire. Size of the exclosures can vary from a few square feet to thousands of square feet. The smaller the mesh of the wire, the more animals will be excluded from the site. Barbed wire will exclude only livestock. Woven wire may exclude other

grazers, including deer (if the fence is high enough) and rabbits (if the wire is woven small enough).

Periodic examination of the differences between the exclosures and grazed areas will give gross estimates of range utilization and trend. It may be helpful to take occasional photographs of the protected and grazed areas. Combined with detailed notes, these photos will document change over time.

The Point of Monitoring:

Monitoring is used in three conditions: (1) to record changes over time in the condition of the ecosystem functions, (2) to determine timing for moving livestock into a new area with respect to achieving desired production performance as affected by the condition of the forage, and (3) to determine when to remove the animals from the area before over-grazing can occur. The last two involve day-to-day and week-to-week management decisions that insure good health of animals and plants. Grazing is an important aspect of maintaining a grassland ecosystem, yet it also can be damaging if the perennial grasses are grazed repeatedly before recovery (over-grazing). Also, if the vegetation from one season to the next is not removed, over a period of time the overshading will also reduce the health of the perennial grasses. Finally, the grazing can be used to encourage or discourage certain kinds of vegetation, which the animals will selectively graze or avoid. Planned, timed grazing implies close monitoring of the growth rate to avoid regrowth before animals are moved away to avoid overgrazing, and adequate recovery before they are returned. And, finally, planning the time of grazing is influenced by wildlife or other operational considerations, such as avoiding conflicts with hunters or ground nesting birds. Since the holistic goal includes many factors, planning grazing is an important way to ensure that other "critters" are not adversely affected by the animals and human activity associated with caring for them.

The point of monitoring is to gain information to help make decisions that change the future (if change is needed). Once you get data from your monitoring efforts, you will likely want to set some new resource objectives and begin proactive management. For example, a resource objective might be to improve range condition from fair to good in five years in a particular pasture, or to increase the sustainable annual stocking rate from 35 acres per animal unit year to 25 acres per animal unit year. (Note that animal density may be very high for short periods of time, but widely spaced over the year, allowing the stocking rate to be much lower. In some intensely managed reclamation programs, cattle densities may be 100 animal units per acre, but for only a few hours!)

There are many other techniques to assist in proactive monitoring. Analysis of ranch rainfall records allows you to judge when future forage growth and forage shortages are likely and compare the current year with the normal year. Frequency of receiving different amounts of monthly rainfall help identify chances of returning to normal in a dry year.

The Grazing Manager computer software (available from NRCS field personnel) uses monthly monitoring of utilization and forage growth ratings to adapt the normal year

carrying capacity to the current situation. The Grazing Manager provides a quantitative decision-aid to balance forage demand with current year's production so that stocking rate can be managed more effectively.

As forage availability decreases, daily forage intake by cattle decreases exponentially thus affecting individual animal performance and increasing the need for supplemental feed. Monitoring animal body condition provides information after reduced forage supplies and nutrient intake affect animal performance. Routine fecal collection and analysis can provide "accurate" estimates of intake and supplementation requirements to achieve animal performance goals when coupled with the Nutritional Balance Analyzer software.

These four proactive monitoring methods allow timely adjustments to keep management on target and prevent major problems. With these approaches day to day decisions can be based on changes in current forage supply and future conditions can be predicted.

Monitoring long term changes is an important component of effective range forage management. You will do well to be proactive and not rely only on reactive monitoring criteria. Also monitor your operation frequently to allows timely adjustment in relation to current and forecast conditions. Traditional range monitoring documents long-term changes but provides little information on actual causes or specific management decisions that contributed to the observed change. *Stocking rate decisions are the most important range forage management factor affecting the ranch business and the range ecosystem.* Operational monitoring of your stocking rates allow you time to make adjustment to leave threshold residues ungrazed. That will keep your range ecosystems productive and sustain future income from livestock production.

For a good overview of rangeland monitoring, see also: Texas Agricultural Extension Services publication: *Range Condition: Key to Sustained Ranch Productivity* (Publication 5M-9-94). Also, for detailed coverage, see the book, *Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands.* It is published by the National Research Council, National Academy Press, Washington, DC and can be purchased by calling 1-800-624-6242. ISBN 0-309-04879-6.

Monitoring Wildlife Populations

There are several different reasons why you might want to monitor wildlife populations. You may want a *qualitative* survey, just to tell you *what species are there.* You may want *quantitative* information to give you an idea of *how many* individuals you have or whether your wildlife populations are increasing, declining or staying the same. If you have elected to claim a wildlife tax valuation for your land, you may need to monitor wildlife to prove that your management is sustaining populations of your target wildlife.

There are a number of ways to monitor wildlife populations. Some forms require expensive equipment and experience to avoid harming wildlife (or being harmed by it!).

Unless you are trained, it is best to leave these techniques to the pro's. However, a lay person can get some good information on wildlife trends by careful observation and record-keeping. Two good sources of specific information on monitoring various kinds of wildlife are Texas Parks and Wildlife Department (TPWD) and your local university's biology or wildlife department. Remember that wildlife vary greatly. One technique may work well for one species and not at all well for another. This chapter gives you a brief overview of techniques that you may develop by yourself without much training, and an overview of what is possible with the help of a wildlife management class, a paid consultant, or an available TPWD biologist.

First, a few words of caution. Handling wildlife should be considered somewhat hazardous...even with species you ordinarily wouldn't consider harmful. Many species of reptiles and amphibians carry *Salmonella* bacteria, which can make you sick if you ingest it. Be sure to wash your hands after handling any wildlife, and keep your hands out of your mouth, nose and eyes if you can.

Second, certain species of wildlife cannot be caught or handled without permits. If your monitoring plans require you to catch and handle wildlife, be sure you have the necessary permits or are working with species that do not require permits. You should not handle any wild birds without permits (but they are easy to monitor without handling). You should not handle any endangered species without state and federal permits. You should not capture any game species without the proper permits (from the state for resident game and from the state and federal government for migratory birds). Of course, if you are running a hunting operation on your property and game species are being harvested during the appropriate season, you can get all the information you want from those legally harvested individuals.

Now, on to various monitoring techniques. Qualitative studies are usually easier than quantitative surveys. Here are some kinds of qualitative studies you can do on your land:

Mammals

Track Surveys:

You can check muddy water sources, dirt roads and other dusty areas for tracks. You can easily identify most major groups of mammals by their tracks with just a little practice. There are several books available to help including *A Field Guide to Mammal Tracking in North America* by Halfpenny (Johnson Brooks Publisher, 1986), *A Field Guide to Animal Tracks* by Murie (Peterson Field Guide Series, Houghton Mifflin Co) and *Texas Tracks* (a two-page publication by Texas Parks and Wildlife). You can get creative and *attract* mammals to certain areas in order to get their tracks.

The night before you run a track survey, sweep the area you plan to check. Early morning is a good time to check for mammal tracks. Lots of mammals are active at night and their tracks show up well in early morning light when shadows are long. Where you place the bait may determine what kind of mammals visit the station: high in a bush may eliminate smaller rodents, inside a net wire enclosure will eliminate mammals too large to

get in. Rodents often come to a bait of peanut butter and uncooked oatmeal. Chew the oatmeal to moisten it, then mix it with peanut butter and smear on a stake or the branch of a plant. Wet cat food attracts raccoons, opossums, ring-tail cats, foxes, bobcats and coyotes. If you don't get tracks, that doesn't mean you don't have the wildlife...you may have shy or suspicious individuals or your bait may not be tempting!

Headlighting or Spotlighting:

Since mammals' eyes are very reflective, you can survey mammals at night from the back of a truck, on horseback, four-wheeler or on foot with a *very bright* light source and binoculars. Travel for a pre-determined distance, then stop and survey the area, sweeping in a full circle with your bright light. If you spot the reflection of eyes, keep the light source on the eyes while you attempt to identify the animal. It helps to have at least two people in a headlight survey: one to train the light and the other to use the binoculars. Don't forget to look up into trees. When you run a spotlight survey, try to get as much information as possible from each sighting. Try to determine where you are on your ranch and whether you are seeing adults or juveniles and what gender you are seeing (if it is possible for you to tell). Systematically returning to the same spots for subsequent surveys will eventually give you some information on trends. Be sure to survey at several different times of the year to get the most information; and repeat your surveys from year to year to get trend information.

A note of caution: it is illegal to hunt at night with a light. If you are running a mammal survey, be sure you *don't have a gun* with you. Under Texas law, merely having a gun with you while you use a spotlight can be considered a violation. It might be a good idea to inform your local game warden that you plan to do spotlight surveys of mammals so you won't get interrupted in the middle of your survey by a curious warden!

Traps:

You can also trap mammals, but that is the most expensive, time-consuming and potentially hazardous form of mammal survey. You can entice mammals into traps that don't injure the animal, such as Hav-a-hart traps with baits mentioned above. If you decide to trap mammals, be sure you know how to use the traps and how to release animals safely before you set your first traps out. Also, be sure you check your traps frequently to avoid stressing any captives. Animals in a trap may be very panicky, so watch your fingers and toes! Also, be aware that mammals carry a number of diseases (and they carry parasites that carry additional diseases). Rabies is an occasional visitor to Central Texas and it may be incubating in an animal that looks healthy. If you receive any mammal bites, it is a good idea to isolate the animal that bit you and report the bite to your physician and the Public Health Department. If you cannot be sure that you were bitten by a rabies-free mammal, you may have to take preventative rabies treatment. In any case, clean any mammal bite thoroughly and watch the wound for signs of infection. Seek medical attention at the first sign of infection.

Birds

There are a number of ways to monitor bird populations for qualitative information. In Texas, we have one group of year-round resident birds, a second group of birds that nest in Texas but winter further south, a third group of birds that nest somewhere further north and winter in Texas and a final group of birds that nest further north and winter further south, but use Texas for important migratory stops to rest and feed. So, survey in early Spring and Fall for the migrants (late January, February and early March, then again in September through mid-October). Survey in the Spring for Texas nesting species (from late February through April). When you are surveying birds, you should avoid wearing stark white clothing. For some reason, birds are more reluctant to come around surveyors in white or very light colors. Dark shirts and blouses work much better. You will find a serviceable pair of binoculars a must for bird surveys. Get binoculars that are at least seven power (they will say 7X, or 8X, etc. somewhere on the instrument). You don't have to spend a fortune for a decent pair of binoculars, but you don't want the cheapest ones either. The very inexpensive binoculars usually have glass that changes the color of things. Since color can be an important aspect of bird identification, you want to have fairly accurate color rendition. A good field guide is essential if you are just learning to identify birds. Peterson's Field Guides, the National Geographic Field Guide to Birds, the Golden Book series and the Audubon Field Guides are three examples. Each has its particular strengths and weaknesses. Find a guide that suits you and your level of expertise. You will probably find that you will eventually have them all!

Feeder and waterer surveys:

You can attract many species of birds to bird feeders. When birds become accustomed to feeding at feeders, they are usually easy for you to identify from a hiding place with binoculars and a bird identification book. It is relatively easy to attract seed-eaters to feeders. Use several feeders with different kinds of seed to attract the maximum number of species: sunflower seeds for one group, mixed wild bird seed for another, thistle for a third category. Hummingbirds come to special feeders of sugar-water, especially if the color red is near the food source. Also, sprinkle some seed on bare spots on the ground for the ground-feeding birds that ordinarily won't hop up on a feeder.

In the winter, suet will attract some of the insect eating birds. Other insect eaters are hard to lure to feeders. Water also attracts birds. To see them, it is better to attract them to water. Many birds will come to the sound of dripping water. You can temporarily place a water source in a tree (a plastic bottle with a hole in it works) and a pan under the water source, on the ground. You may want to establish the waterer for a few days before you do your survey, to get the birds accustomed to coming to the site for water.

Walking surveys:

Many species of birds will also come to the sound of other birds' scolding. If you make a *shhh-shhh-shhhh* sound or a *psh-psh-psh* sound, it may attract wrens, titmice, chickadees, kinglets and vireos. Practice sounding like the scolding birds you hear in

your area and soon you will be able to attract birds with your own imitation of a good scolding bird! Walk through your property, stopping to scold from time to time. Stand stock-still while you deliver your scolding. Sometimes, just cast your eyes about, looking for birds on treetops or utility wires or in the sky overhead. Don't forget to survey near bodies of water.

As you become adept at field identification of birds, you will find that you see birds from a great distance away and can identify many of them by their silhouette, position or their flight patterns.

Nesting bird surveys:

In the spring, many nesting species of birds will advertise their presence by singing territorial songs. These birds are defending a territory against other birds of their same species. They are advertising their intention to use the area for raising their young. The territorial songs of birds are different for each species. A trained ear can pick out which birds are present from the individual bird songs that are heard. After the birds have reared their young, they often stop singing, so you must do nesting surveys in the early spring. Some species stop singing by the end of February! You can learn to survey nesting birds by listening to tapes or records of bird songs and comparing the songs to those you hear on your property. There are a number of bird song tapes available in outdoor nature specialty stores and bookstores. You can also spend some time watching birds as they sing, to associate a particular song with a particular species. And you can learn bird songs by associating with experts who know the songs and are willing to teach you. Local Audubon societies and college biology departments usually have expertise and often are willing to exchange some bird song identification lessons for a pleasant afternoon in the country!

Mist Nets:

Some experts (bird banders) are licensed by the state and the federal government to survey birds by erecting fine nets in likely pathways where birds will fly. Birds that encounter the nets become entangled and are trapped. Trappers must check the nets very frequently (every fifteen minutes is not unreasonable) and must be adept at removing the birds without injuring them. Birds trapped in mist nets are outfitted with permanent metal identification bands clamped on their legs and a considerable amount of information is recorded for each bird. Recaptures of banded birds yields important information about migratory pathways, timing of migration, bird life expectancy, demographics, diseases, etc. Bird netting and banding is a skill that takes years of apprenticeship. You may want to invest the time and expense to become a bander, and if not, you may want to make your property available to a licensed bird bander in your area.

Frogs and Toads

Rainy Night Song Surveys:

Frogs and toads also sing (or "call") in the spring and summer. Males find water then advertise their presence to females, to attract them to the same pond for mating. The

songs of frogs and toads are specific to each species, just like bird songs. You can learn the frogs and toads in your area fairly quickly (there are far fewer species than birds).

Wetland surveys:

Frogs and toads are attracted to water, both for reproduction and for survival. You can attract frogs and toads to a survey area by maintaining small ponds and shallow watering areas (if you don't have natural ponds or riversides). Even a shallow feeding pan will lure in frogs and toads when the weather is hot and dry. Species can be identified with binoculars and a good field guide. The *Peterson Field Guide Series* is an excellent choice. If you're limber, you can catch frogs and toads at night with a bright light. It helps to have them in hand briefly for some of the more subtle points of field identification. None of our Central Texas frogs and toads bite, nor do they have strong poison, but they *do* produce some skin secretions that can be irritable, especially if you get the secretions in your eyes. Be sure to wash your hands after handling them.

Drift traps:

Frogs, toads and salamanders can be live-trapped by constructing drift traps. A drift trap consists of a barricade that runs along the ground forming a short "wall" with an occasional open bucket buried in the ground with its rim level to the ground. The barricade can be fairly short (six to eight inches tall is sufficient), and should fit firmly against the ground with no large holes. The frogs, toads and salamanders will walk until they encounter the drift wall, then they will turn one way or the other and travel alongside the wall until they fall into the bucket. Barricades can be made of plastic, fine net, hardware cloth or sheet metal. The buckets can be of any substance, but should be tall enough to prevent a frog or toad from jumping out. Some parts of the hill country are too rocky to construct an effective barricade fence and particularly too rocky to dig holes for the buckets. If you have soil, especially near a stock tank or natural pond, you may want to set up some drift nets nearby and see if you can successfully trap amphibians. Drift traps should be set up and run at night and inactivated (by covering the buckets) during the daytime. Traps should be checked frequently in periods of low humidity, because amphibians are so susceptible to desiccation if they can't find moist shelter.

Reptiles

Reptiles can be sighted sunning on rocks, trees and bare ground. Reptiles also depend on external conditions to provide heat. Because of heat radiation, you may find reptiles, especially snakes, warming themselves on dark-colored roads at night. Reptiles can also be caught in drift traps, but they are usually active in the daytime, so you would want to run your traps during the day. Reptiles often spend the heat of the day under rocks, branches or boards. Lifting such objects can reveal reptiles underneath. Be careful of poisonous snakes, and use a tool such as a short-handled hoe to lift rocks and boards, to keep poisonous reptiles at a safe distance from hands and fingers! If you survey your reptiles by turning over potential sheltering objects, remember to replace the objects as nearly as possible in the same place. That is because the slightly humid, shaded conditions under a rock create a micro-habitat for small invertebrates that are important components of the food chain for larger invertebrates and vertebrates. In the

Texas Hill Country, it takes between fifty and a hundred years to replace the micro-habitat that has been created under rocks. If you roll a rock over, it will take decades for a similarly rich habitat to develop again under that rock. Turtles can be surveyed with drift traps and by the use of binoculars trained on rocky ledges and logs at the water's edge.

APPENDIX C

Texas Horned Lizard Watch materials and results

TEXAS PARKS AND WILDLIFE

TEXAS Horned Lizard WATCH



Offering Texans who care about horny toads a way to get involved in conservation research

TEXAS PARKS & WILDLIFE

4200 Smith School Road
Austin, Texas 78744

PWD BK W7000-038 (12/01)

Monitoring Packet



Everyone loves horny toads, but for many Texans the fierce-looking yet amiable reptile is only a fond childhood memory. Once common throughout most of the state and parts of Arizona, New Mexico, Oklahoma, Kansas, Arkansas, and Louisiana, the horny toad (or Texas horned lizard) has disappeared from many parts of its former range. Now, through participation in the Texas Horned Lizard Watch, you can take part in an effort to better understand why our official state reptile is doing well in some locations and what factors may have contributed to its decline in other areas.

A survey conducted by the Horned Lizard Conservation Society in 1992 confirmed what many people's personal experience tell them: that in the last 30 years the horny toad has essentially disappeared from the eastern third of Texas. In addition, many respondents reported that the horned lizard was increasingly rare in Central Texas. Only in West Texas and South Texas do populations seem to be somewhat stable.

Many factors have been proposed as culprits in the disappearance of the horny toad, including collection for the pet trade, spread of the red imported fire ant, changes in land use, and environmental contaminants. Since 1967 horned lizards in Texas have been protected from the pet trade, but for the most part the decline of the Texas Horned Lizard has remained a mystery with little understanding of the management actions that could be taken to restore it.

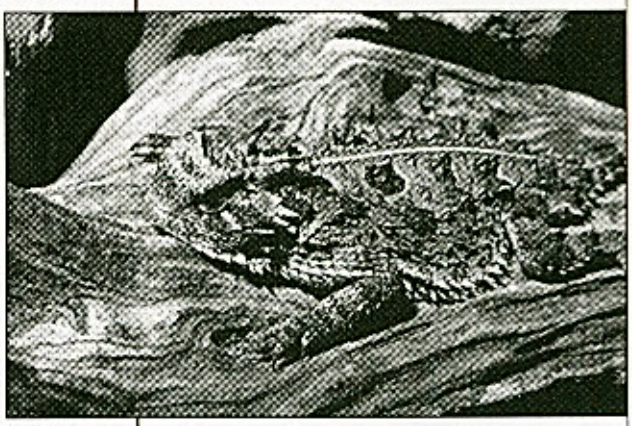
That lack of solutions is what prompted Texas Parks and Wildlife to seek the public's help in watching out for the horny toad. As a participant in Texas Horned Lizard Watch, you will be "on-the-ground" – collecting data and observations about the population of horned lizards on your property. The data you provide to Texas Parks and Wildlife may then shed light about patterns of decline or stability and thus finally offer some management alternatives for people wishing to maintain or restore a horned lizard population. In the process it gives Texans who care about horny toads a way to help.

About Texas Horned Lizards

Horned lizards are named for the long spines found at the rear of the skull. In the Texas Horned Lizard, the two central spines are much longer than any of the others–giving the appearance of two horns. The Texas Horned Lizard is a medium-sized lizard, about 5 to 8 inches in length, whose body tends to look flattened. General coloration is some shade of light brown or gray, with dark spots usually present on the back.

Two other species of horned lizard, the Round-tailed Horned Lizard and the Short-horned Lizard, occur in the western half of the state. On the Round-tailed Lizard, the tail is slender and rounded, but broadens abruptly near the base. Its four primary horns are of equal length and shorter than the Texas Horned Lizard. On the Short-horned Lizard, all the horns are greatly reduced in size. (See drawings for comparisons.)

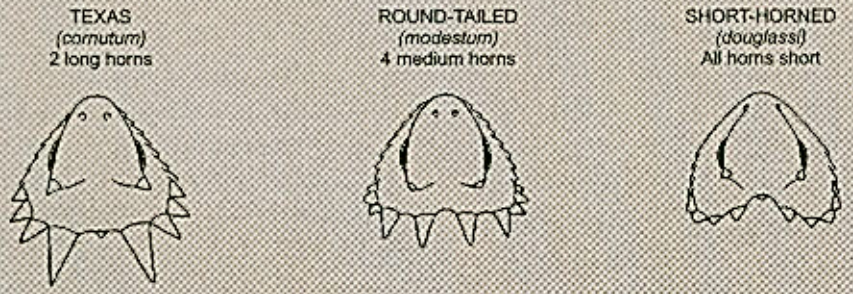
Texas Horned Lizards usually inhabit flat, open terrain, with sparse plant cover, although in the eastern portion of its distribution, vegetation cover may be somewhat thicker. They utilize mammal burrows, rock piles, or clumps of vegetation for cover and may scoop out a shallow depression in which to hide themselves. Horned lizards can often be found at the beds of harvester ants, their primary food source. Harvester ants, a large red species, create a large, flat open bed of sand or pebbles, with a central entrance and exit hole. The bed is usually devoid of vegetation due to the ants' feeding activities. In addition to harvester ants, horned lizards may also feed on other insects, spiders, and sowbugs.



Horned lizards require warm temperatures to stimulate their appetite. They will often be seen in a flattened body posture sunning themselves at ant beds or on rocks. They are not active at night or when temperatures fall below 75 degrees F. In general, they are seen only in late spring or summer and tend to hibernate underground from September or October to late April or early May.

Mating occurs soon after emergence from hibernation. The female digs a hole and lays about 30 eggs which are incubated by the warmth of the soil. Depending on ground temperatures, young horned lizards

HEADS OF HORNED LIZARDS *(Phrynosoma)*



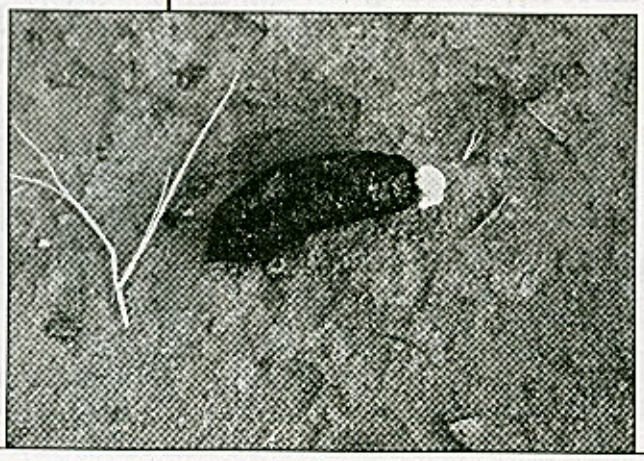
From: *A Field Guide to Reptiles and Amphibians of Eastern/Central North America*
(Peterson Field Guide Series – Houston Mifflin Co.)

About Texas Horned Lizards

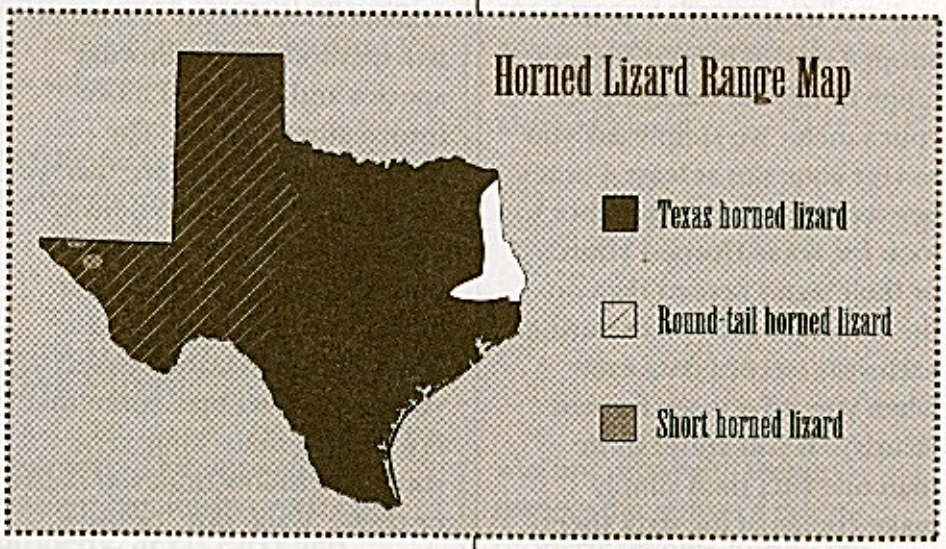
about 1 inch in length may begin to hatch about 5½ to 7 weeks later.

Horned lizards can live up to 10 years. Although snakes, mammals, and birds may prey upon them, the Texas Horned Lizard has developed some unique defenses. The horny appearance and coloration helps it to blend into sparse vegetation. In addition to the deterrence that the horns on the head may provide to predators, the horned lizard can inflate itself to a larger apparent size. Finally, the horned lizard is renowned for its ability under extreme stress to shoot a stream of blood from its eye (actually from ruptured blood vessels in the eyelid). It is believed that a chemical in the blood is especially distasteful to canid predators.

Sometimes Texas horned lizard sign such as scat (or dung) is much more visible than the species itself. Texas horned lizard scat is an oblong pellet that is straight or slightly curved. The whitish uric acid tip (the equivalent to urine) is very prominent. Harvester ant heads and other ant body parts are noticeable in the scat, especially when the scat is broken apart. The scat usually looks very large in relation to the lizard from which it came, ranging from ½ to 1½ inches in length and about ¼ inch in diameter. Most other lizard scat is relatively small compared to horned lizard scat. Scat of other lizards have the uric acid tip; however, the shape of the scat is much less symmetrical.



More information about the Texas Horned Lizard may be found in *Horned Lizards* by Jane Manaster (UT Press) and *Horned Lizards: Unique Reptiles of North America* by Wade Sherbrook (Southwest Parks and Monuments Association). Various field guides can offer other useful identification hints. More information about red imported fire ants, including their management, can be found at the following websites: *fireant.tamu.edu* and *uts.cc.utexas.edu/~gilbert/research/fireants/faq.html*





How to Monitor Horned Lizards

There are three ways you can participate in Texas Horned Lizard Watch. You may wish to participate in more than one survey type.

Please note that each survey type has its own unique data form.



Adopt -a- habitat

The first method is for you to adopt a site. A habitat site can range from your backyard to your ranch. We simply ask you to visit your site at least 3 times between May and September to look for Texas Horned Lizards or their sign. Record data on the enclosed data sheet during each visit (record data even when you do *not* see horned lizards). If you adopt more than one site, then simply make copies of the data sheet. If possible, please record your sites on a map for us We hope that you will record data at your site for many years so that we may understand trends in Texas Horned Lizard populations.



Transects

Transects are a more quantitative method for monitoring species and require a more formal survey effort. The benefits of transects are that we can convert results to density estimates and thus compare horned lizard populations at different sites. To conduct a Texas Horned Lizard transect you need to set up a route that is at least 3 miles long. The route can follow unpaved roads or trails. Walk, ride, or drive the route, recording all Texas horned lizards and ant beds that occur within 3 feet of your route on either side. (If driving, be sure to stop and check the identification of any horned lizards seen.) Mark your transect location on a map if possible. Transects should be conducted at least three times between May and September.



Horned Lizard Spotters

If you don't have access to a particular site that is likely to support Texas Horned Lizards, you can still contribute to our monitoring effort. Simply obtain a map of your town or county and record any Texas Horned Lizards or sign of them that you see throughout the year. TPW cannot accept sightings from private property without the landowner's written permission, but you may record sightings that occur on your own property, road rights-of-way, public parks, etc. Use a number to indicate the location of the sighting and write down the date the sighting was made. If you make an effort to sight Texas Horned Lizards for us, but do not see any lizards or horned lizard sign, then please return our form and indicate that no horned lizards were seen.



How to Monitor Horned Lizards

Additional Monitoring Notes...

Certain conditions apply to all three methods. You should try to make sure that your surveys are conducted under sunny or partly sunny dry weather conditions when temperatures are 80-95 degrees F and winds are slight or moderate. One good indicator of horned lizard activity is to check to see whether harvester ants are active. Ideally, your 3 survey efforts should be at least one month apart (although you may conduct additional surveys more frequently). If you do visit a site more frequently, then you may want to collect any horned lizard scat you encounter so that you don't recount it on subsequent visits.

Finally, be sure to mail in your survey forms, even if you do not see any Texas Horned Lizards. If you have any uncertainty about identification of the lizards or scat you see, don't hesitate to take a photo and send it to us. You may also send us scat that you collect if you are uncertain whether it was produced by a Texas Horned Lizard.

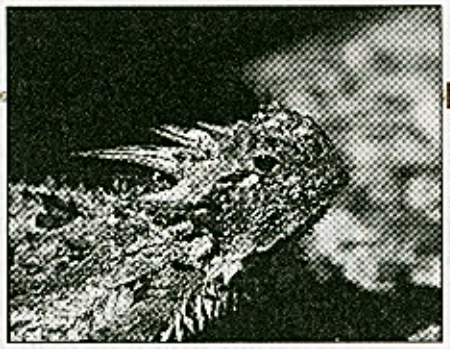
About the Landowner Access Request Form...

All Texas Horned Lizard Watch volunteers must send in a completed Landowner Access Request Form reflecting each property owner/manager's approval. This applies even if you are monitoring your own property. Texas Parks and Wildlife cannot use the data collected if written permission was not received. Please respect the rights of private property owners during the course of your volunteer efforts.

Please return all forms
(even if you did not see any Texas Horned Lizards)
by September 30

What Happens Next?

Texas Parks and Wildlife will compile the results of the surveys conducted by Texas Horned Lizard Watch volunteers and prepare an annual summary. This summary will be provided to all volunteers. It is anticipated that the results of your volunteer efforts will immediately assist TPW in understanding where Texas Horned Lizards still exist and how that relates to the abundance of harvester ants, imported red fire ants, etc. Over the long term, we will be able to assess how patterns of land use, fire ant expansion, urbanization, etc., relate to the abundance of horned lizards. We may thus be able to offer suggestions on land management or fire ant control that could ultimately benefit Texas Horned Lizards. For your part, participants will be provided with annual updates on the project, along with other interesting information on the Texas Horned Lizard. For participants that provide data over several years, TPW will also offer posters, books, or other forms of recognition or reward for long-term service.



Some Special Notes...

The Texas Horned Lizard is listed as threatened by Texas Parks and Wildlife, primarily to protect it from commercial exploitation. (It does not survive well as a pet.) Because of this designation, you should not collect or move Texas Horned Lizards that you encounter on your survey efforts. Secondly, legislation in Texas protects the rights of private property owners in regard to biological data that is collected on their property. Through your participation in this program, you are granting TPW the right to store and summarize data that you submit for your own property. That information will be subject to Open Records Act requests. If you wish to conduct surveys on another person's property, then you must obtain their written permission first. A permission form for the Texas Horned Lizard Watch is provided for your use. Please respect the rights of private property owners during the course of your volunteer efforts. Do not trespass or report any data without their permission.

TEXAS PARKS AND WILDLIFE



Texas Horned Lizard Watch

ADOPT-A-HABITAT DATA FORM

(Complete a separate data form for each site)



Adopt -a- habitat

Name:_____ Site #: To be assigned by TPW

Address:_____ County:_____

_____ Lat-Long or distance & direction from nearest town:

_____ _____

Phone:_____ *Please mark location on map if available*

Email:_____ Approximate area of site: _____acre(s)

Are harvester ants present? ☐Yes ☐No

Are red imported fire ants present? ☐Yes ☐No

Predominant habitat type:
(check any types that occur & circle dominant type)

- ☐ native grassland
- ☐ improved grasses
- ☐ mixed grass/shrubs
- ☐ predominantly shrubland
- ☐ woodland/forest
- ☐ desert scrub
- ☐ agriculture

Predominant land uses:
(check any types that occur & circle dominant type)

- ☐ residential
- ☐ ranching
- ☐ agriculture
- ☐ park land/preserve
- ☐ not in current use

Predominant soil type:
(check any types that occur & circle dominant type)

- ☐ sandy
- ☐ clay
- ☐ loam (intermediate between sand and clay)

SURVEY RESULTS

Date of Visit	Start Time	End Time	Temp (°F)	# of THL Seen	# of THL Scat (droppings) Seen	Comments/Notes (describe habitat where found)

After conducting at least three visits, send completed form(s) and map to:

Texas Horned Lizard Watch
Texas Parks and Wildlife
3000 IH-35 South, Suite 100
Austin, Texas 78704

Please submit all forms by **September 30**

To aid us in conserving paper and reducing printing costs, you may wish to photocopy this page.

TEXAS PARKS AND WILDLIFE



Texas Horned Lizard Watch

ADOPT-A-HABITAT DATA FORM

(Complete a separate data form for each site)



Adopt -a- habitat

SAMPLE

Name: Mark Herps

Address: P.O. Box 3810

Post, TX 76345

Phone: 123-456-7890

Email: horntoad@aol.com

Site #: To be assigned by TPW

County: Garza

Lat-Long or distance & direction from nearest town:

within Post city limits - residential lot

Please mark location on map if available

Approximate area of site: 1/2 acre(s)

Are harvester ants present? ☒ Yes ☐ No

Are red imported fire ants present? ☐ Yes ☒ No

Predominant habitat type:
(check any types that occur & circle dominant type)

- ☒ native grassland
- ☒ improved grasses
- ☐ mixed grass/shrubs
- ☐ predominantly shrubland
- ☐ woodland/forest
- ☐ desert scrub
- ☐ agriculture

Predominant land uses:
(check any types that occur & circle dominant type)

- ☒ residential
- ☐ ranching
- ☐ agriculture
- ☐ park land/preserve
- ☐ not in current use

Predominant soil type:
(check any types that occur & circle dominant type)

- ☐ sandy
- ☐ clay
- ☒ loam (intermediate between sand and clay)

SURVEY RESULTS

Date of Visit	Start Time	End Time	Temp (°F)	# of THL Seen	# of THL Scat (droppings) Seen	Comments/Notes (describe habitat where found)
5/10/2000	3:00 pm	3:15 pm	85	1 (2" long)		on red ant bed near fence (native grasses)
5/15/2000	10:00 am	10:15 am	80		1	on same ant bed
6/8/2000	4:15 pm	4:30 pm	90	2 (2" & 2.5" long)		1 on ant bed; 1 along fence (native grasses)
7/3/2000	6:00 pm	6:15 pm	92	1 (2.5")		on ant bed
7/29/2000	7:15 pm	7:30 pm	89	1 (2")		on ant bed
8/15/2000	11:00 am	11:15 am	93	4 young ones! (1" long)		along edge of garage (St. Augustine grass)
8/20/2000	5:30 pm	5:45 pm	95	2 (1" each)		in flower bed
9/12/2000	3:30 pm	3:45 pm	90	1 (2")		on ant bed

After conducting at least three visits, send completed form(s) and map to:

Texas Horned Lizard Watch
Texas Parks and Wildlife
3000 IH-35 South, Suite 100
Austin, Texas 78704

Please submit all forms by **September 30**

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TEXAS PARKS AND WILDLIFE



Texas Horned Lizard Watch

TRANSECT DATA FORM

(Complete a separate data form for each transect)



Transects

Name:_____

Address:_____

_____

_____

Phone:_____

Email:_____

Site #: To be assigned by TPW

County:_____

Lat-Long or distance & direction from nearest town:

_____

Please mark location on map if available

Length of transect: _____miles

Transect was: ☐ walked ☐ driven ☐ other

Predominant habitat type:
(check any types that occur & circle dominant type)

- ☐ native grassland
- ☐ improved grasses
- ☐ mixed grass/shrubs
- ☐ predominantly shrubland
- ☐ woodland/forest
- ☐ desert scrub
- ☐ agriculture

Predominant land uses:
(check the most significant types)

- ☐ residential
- ☐ ranching
- ☐ agriculture
- ☐ park land/preserve
- ☐ not in current use

Predominant soil type:
(check any types that occur & circle dominant type)

- ☐ sandy
- ☐ clay
- ☐ loam (intermediate between sand and clay)

SURVEY RESULTS

Date of Survey			
Start Time			
End Time			
Temperature (°F)			
Cloud Cover (cloudy, partly cloudy, partly sunny, clear)			
Wind Speed			
# of THL smaller than 1½ inches			
# of THL larger than 1½ inches			
# of THL scat (droppings) seen			
# of harvester ant beds			
# of red imported fire ant beds			
Other Notes (describe habitat & land use where THL found)			

After conducting at least three transects, send completed form(s) and map to:

Texas Horned Lizard Watch
Texas Parks and Wildlife
3000 IH-35 South, Suite 100
Austin, Texas 78704

Please submit all forms by **September 30**

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TEXAS PARKS AND WILDLIFE



Texas Horned Lizard Watch

TRANSECT DATA FORM

(Complete a separate data form for each transect)



Transects

SAMPLE

Name: Mark Herps

Address: P.O. Box 3810

Post, TX 76345

Phone: 123-456-7890

Email: horntoad@aol.com

Site #: To be assigned by TPW

County: Garza

Lat-Long or distance & direction from nearest town:

County road 5 mi. NE of Post

Please mark location on map if available

Length of transect: 3.5 miles

Transect was: ☒ walked ☐ driven ☐ other

Predominant habitat type:
(check any types that occur & circle dominant type)

- ☒ native grassland
- ☐ improved grasses
- ☐ mixed grass/shrubs
- ☐ predominantly shrubland
- ☐ woodland/forest
- ☐ desert scrub
- ☒ agriculture

Predominant land uses:
(check the most significant types)

- ☐ residential
- ☒ ranching
- ☒ agriculture
- ☐ park land/preserve
- ☐ not in current use

Predominant soil type:
(check any types that occur & circle dominant type)

- ☒ sandy
- ☐ clay
- ☒ loam (intermediate between sand and clay)

SURVEY RESULTS

Date of Survey	5/29/2000	6/20/2000	7/13/2000
Start Time	7:45 am	7:30 am	7:30 am
End Time	8:30 am	8:15 am	8:15 am
Temperature (°F)	82	85	87
Cloud Cover (cloudy, partly cloudy, partly sunny, clear)	clear	clear	clear
Wind Speed	<5 mph	10-12 mph	5 mph
# of THL smaller than 1½ inches	0	0	3
# of THL larger than 1½ inches	2	3	1
# of THL scat (droppings) seen	1	2	0
# of harvester ant beds	14	16	17
# of red imported fire ant beds	0	0	0
Other Notes (describe habitat & land use where THL found)	THL in first mile on red ant beds; near native grasses	all found on red ant beds in native grassland	3 little ones together on red ant bed in native grassland

After conducting at least three transects, send completed form(s) and map to:

Texas Horned Lizard Watch
Texas Parks and Wildlife
3000 IH-35 South, Suite 100
Austin, Texas 78704

Please submit all forms by **September 30**

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TEXAS PARKS AND WILDLIFE



Texas Horned Lizard Watch

HORNED LIZARD SPOTTER DATA FORM

(For recording horned lizards seen outside your adopted site or transect)

Horned Lizard Spotters

Name:_____

Address:_____

_____

_____

Phone:_____

Email:_____

County: _____

Did you see any Texas Horned Lizards in this county this year? ☐Yes ☐No

(If yes, then please record data below and on map)

Are harvester ants present in this county? ☐Yes ☐No

Are red imported fire ants present in this county? ☐Yes ☐No

SIGHTING LOG – Please record sighting numbers on a county map if available

Sighting Number	Date	# of THL (L) or scat (S)	Land Use	Habitat Type	Soil Type	Distance & direction from nearest town	Other Notes

KEY

Land use:
re = residential
ra = ranching
ag = agriculture
p = park land/preserve
na = not in current use
row = road right-of-way

Habitat type:
n = native grassland
i = improved grasses
m = mixed grass/shrubs
s = predominantly shrubland
w = woodland/forest
d = desert scrub
ag = agriculture

Soil type:
s = sandy
c = clay
l = loam (intermediate)

# of THL (L) or scat (S)
write **L** for lizards seen or
S for scat (droppings) seen

Send completed form(s) and map to:
Texas Horned Lizard Watch, Texas Parks and Wildlife, 3000 IH-35 South, Suite 100, Austin, Texas 78704

Please submit all forms by **September 30**

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TEXAS PARKS AND WILDLIFE



Texas Horned Lizard Watch

HORNED LIZARD SPOTTER DATA FORM

(For recording horned lizards seen outside your adopted site or transect)

Horned Lizard Spotters

Name: Mark Herps

Address: P.O. Box 3810

Post, TX 76345

Phone: 123-456-7890

Email: hornytoad@aol.com

County: Garza

Did you see any Texas Horned Lizards in this county this year? ☒ Yes ☐ No

(If yes, then please record data below and on map)

Are harvester ants present in this county? ☒ Yes ☐ No

Are red imported fire ants present in this county? ☐ Yes ☒ No

SAMPLE

SIGHTING LOG – Please record sighting numbers on a county map if available

Sighting Number	Date	# of THL (L) or scat (S)	Land Use	Habitat Type	Soil Type	Distance & direction from nearest town	Other Notes
1	5/3/2000	1 L	re	i	c	Main Street in Post	3" long
2	6/6/2000	1 S	ra	n	s	low water crossing in Justiceburg	on ant bed
3	7/11/2000	1 L	p	n, i	l	roadside park 10 mi. NW of Post	25" long
4	7/19/2000	1 S	na	m	c	vacant lot on 3rd St.	on ant bed

KEY

Land use:
- re = residential
- ra = ranching
- ag = agriculture
- p = park land/preserve
- na = not in current use
- row = road right-of-way

Habitat type:
- n = native grassland
- i = improved grasses
- m = mixed grass/shrubs
- s = predominantly shrubland
- w = woodland/forest
- d = desert scrub
- ag = agriculture

Soil type:
- s = sandy
- c = clay
- l = loam (intermediate)

# of THL (L) or scat (S)

write **L** for lizards seen or **S** for scat (droppings) seen

Send completed form(s) and map to:
Texas Horned Lizard Watch, Texas Parks and Wildlife, 3000 IH-35 South, Suite 100, Austin, Texas 78704

Please submit all forms by **September 30**

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TEXAS PARKS AND WILDLIFE



Texas Horned Lizard Watch

LANDOWNER ACCESS REQUEST FORM

To the landowner:

_____ (volunteer name) is participating as a volunteer in Texas Horned Lizard Watch. Texas Horned Lizard Watch is a monitoring program that uses citizen volunteers to gather data about the status and health of our state reptile. Texas Parks and Wildlife is very pleased to have the assistance of concerned Texans in watching over the health of the horny toad.

We have, however, instructed our volunteers that they cannot collect data on private land without the approval of the private landowner. Accordingly, we have prepared this form for your approval. The sections described below are the releases that we and our volunteers are required to obtain from you under Section 12.103 of the Texas Parks and Wildlife Code. If you are willing, then please sign one or both sections and provide a copy to our volunteer.

1. **Use of information**
   This documents my approval for TPW volunteers and employees to use (such as in analyses) site specific information from the property I own or manage. This may include placing that information onto a topographic map and entering the information into a Department database. Thus, the information could be viewed by the public.

   _____ _____
   (Landowner or authorized agent signature) *(Date)*

2. **Reporting information**
   This also documents my approval for TPW volunteers and employees to report (such as in publications or technical reports) the above approved information in a manner that permits identification of the location of the specific parcel of property that I own or manage.

   _____ _____
   (Landowner or authorized agent signature) *(Date)*

3. **Other conditions**
   If there are any conditions that apply to this approval, please specify and initial below.

   _____

   _____

   _____

Name and Address *(of landowner or authorized agent)*:

Name _____

Address _____

City, State, Zip _____

Phone numbers _____

_____

Optional:

Name of ranch or tract _____

County _____

Acreage _____

Location _____

To aid us in conserving paper and reducing printing costs, you may wish to photocopy this page.

Now Get Out There and Count Your Horny Toads!

If you have questions or need additional copies of monitoring materials...



Please contact:

Lee Ann Linam, Coordinator
Texas Horned Lizard Watch
Texas Parks and Wildlife
3000 IH-35 South, Ste. 100
Austin, TX 78704

(512) 847-9480
lalinam@wimberley-tx.com

or visit our Web site at:
www.tpwd.state.tx.us/hornytoads/

About the Special Nongame and Endangered Species Conservation Fund...

The "Special Fund" was created by the Texas Legislature in 1983 to underwrite the conservation and management work performed on Texas' nongame and endangered wildlife. This fund, sustained entirely by voluntary contributions and purchases of nongame art prints and stamps, has provided support for a variety of projects benefitting nongame and endangered species. For more information on this fund call the TPW Wildlife Diversity Program at 1-800-792-1112.

Thank you for supporting



Texas Horned Lizard Watch

NOTICE: Texas Parks and Wildlife receives federal financial assistance from the U.S. Fish and Wildlife Service. Under Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972, the U.S. Department of the Interior and its bureaus prohibit discrimination on the basis of race, color, national origin, age, disability or sex (in educational programs). If you believe that you have been discriminated against in any Texas Parks and Wildlife program, activity, or facility, or if you desire further information, please call or write: The U.S. Fish and Wildlife Service, Office for Diversity and Civil Rights Programs - External Programs, 4040 N. Fairfax Drive, Webb 300, Arlington, VA 22203, (703) 358-1724.

TEXAS HORNED LIZARD WATCH SUMMARY REPORT
1997-2001

Prepared by: Lee Ann Johnson Linam - Texas Parks & Wildlife Department

2001 Highlights

In 2001 Texas Horned Lizard Watch volunteers again expanded our understanding of the status of the state's favorite reptile. A total of 39 volunteers submitted data sheets, while an additional 14 informal reports were received. Data came in from 45 counties, including seven counties that were new to participation in Texas Horned Lizard Watch. Data was received for the first time from Coryell, Dallam, Goliad, Hartley, Henderson, Red River, and Reeves counties.

During 2001 participants could again choose to participate in Texas Horned Lizard monitoring at three different levels. Eight volunteers chose to participate at the most intense level, conducting transects that measured quantitative data on horned lizard and ant abundance. Densities on the four transects ranged from 0 horned lizards/acre to 1.38 horned lizards per acre.

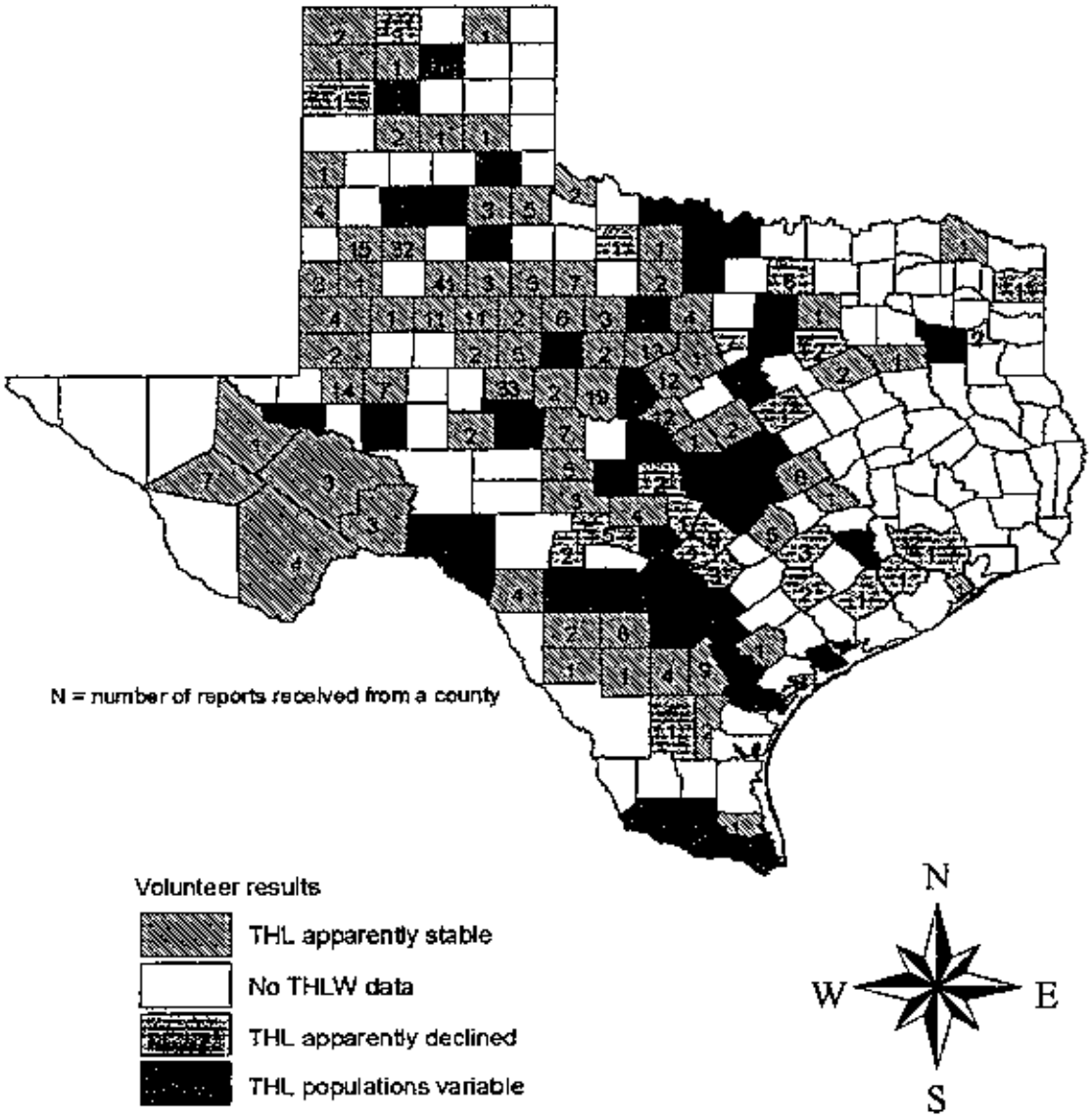
Other participants chose to adopt sites, such as a ranch, backyard, or local park, and provide more generic information about the presence or absence of horned lizards and habitat variables. A total of 26 adopted sites were monitored in 2001. About 85% of the sites and transects combined saw Texas Horned Lizards (THL) in 2001. Monitoring materials asked horned lizard watchers to be on the lookout for THL scat or droppings, and seven volunteers indicated that they used sightings of THL scat to confirm presence.

Twelve participants chose to participate as Horned Lizard Spotters in 14 counties--noting the locations of horned lizard sightings wherever they occurred in the county. Several monitors did exceptional jobs in collecting sightings from their own and nearby counties. Several volunteers indicated that they collected sightings from other members of the community to report to Texas Horned Lizard Watch, while others clearly made an effort to tally THL sightings wherever they traveled. Doris Steadman, Brandee Frishe, Judy Creager, and Beverly Kitzman made extensive contributions in 2001. Finally, data were also collected from reports to the Texas Parks and Wildlife website and from reports to the Biological Conservation database. These sources yielded more than 30 sightings.

Five-year summary

The 2001 season marked the fifth year that Texas volunteer scientists have helped Texas Parks and Wildlife gather data on our official state reptile. During the course of the monitoring project over 200 volunteers have submitted data--ranging from simple email reports to volunteers who have gathered sightings from all over their county. Six volunteers who have collected data from a site during all five years. Over 200 sites have been adopted for monitoring--providing a benchmark for comparisons in years to come. Data have been gathered from 137 counties, more than half the counties in Texas. THL have been reported from 116 of those counties.

Figure 1. Texas Horned Lizard Prevalence -based on 1997-01 Texas Horned Lizard Watch results



A map of THL prevalence based on five years of data from Texas Horned Lizard Watch (Figure 1) reveals a complex pattern of distribution. THL are apparently rare in the **Coastal Prairie** region of Texas, although they persist in sandy soils of some coastal counties, where volunteers have sighted them on barrier islands. Moving inland, THL are still regularly reported

from counties within the **Post Oak Savannah** ecoregion. These counties are characterized by sandy soils and less intensive agriculture. Few reports have been received from **East Texas** (perhaps due to historic and current scarcity of THL), with the exception of several counties within the post oak belt, such as Henderson, Smith, and Red River. These counties, again characterized by sandy soils, continue to report the present of THL. THL appear to have decreased in abundance in a belt that follows the counties of the IH-35 corridor north from San Antonio. Urbanization, intensive agriculture in **Blackland Prairie** soils, and prevalence of red imported fire ants (*Solenopsis invicta*) may be associated with declining trends in this region. Trends are truly mixed in the **Rolling Plains** and **Edwards Plateau** ecoregions, with some counties reporting THL present and other volunteers reporting that THL have not been seen in many years. Urbanization and fire ants may be exerting local effects on populations. Horned lizards are prevalent in much of the **South Texas Brush Country**, although some declines are reported along the northern edges of this ecoregion, roughly following US 90 and IH-37. Declines have also been reported for many years in the **Lower Rio Grande Valley**, presumably associated with urbanization and intensive agriculture, although THL are still commonly encountered in this region. Finally, West Texas remains the stronghold for the species. THL are still widely reported from the **High Plains** and the **Trans-Pecos**, although the species is reported to be less abundant in many urban areas.

Volunteer data indicate a relationship between the presence of THL and ant species. The five years of data indicate that distributions of Texas Horned Lizards and red imported fire ants (*Solenopsis invicta*) are not independent (Chi-square, $p<=0.001$), suggesting a negative correlation between the two species. The data also show an apparent relationship between the presence of Texas Horned Lizards and the presence of harvester ants (*Pogonomyrmex* sp.), their preferred food source ($p<=0.01$). In addition, data show that populations of the two ants are not independent of each other ($p<=0.01$). This confirms the findings of other researchers that have demonstrated that invasion by imported red fire ants negatively affect many native ant species, although the magnitude of this effect may decline over time (Morrison 2002).

Volunteers also provided data on habitat and land use. Overall, THL were reported most often from lands that were used for residential areas or for ranching (Figure 2), likely reflecting a tendency of volunteers to monitor residential areas. Data collected between 1998 and 2001 does not indicate that THL presence is related to land use; however, volunteers did not tend to sample some habitats (such as agriculture and parkland) frequently. During 2000 THL were found most often in native grassland, mixed grass and shrub communities, or in improved grasslands (Fig. 3); however, these differences were not statistically significant. THL were reported from sand, clay, and loam soils in 2000 and 2001 (Fig. 4). Chi-square analyses indicate that THL distribution may be linked to soil type ($p <= 0.025$), with a preference for sandy soils and less frequent occurrence on clay soils.

Fig. 2. Land use where Texas Horned Lizards were sighted, 1998-2001.

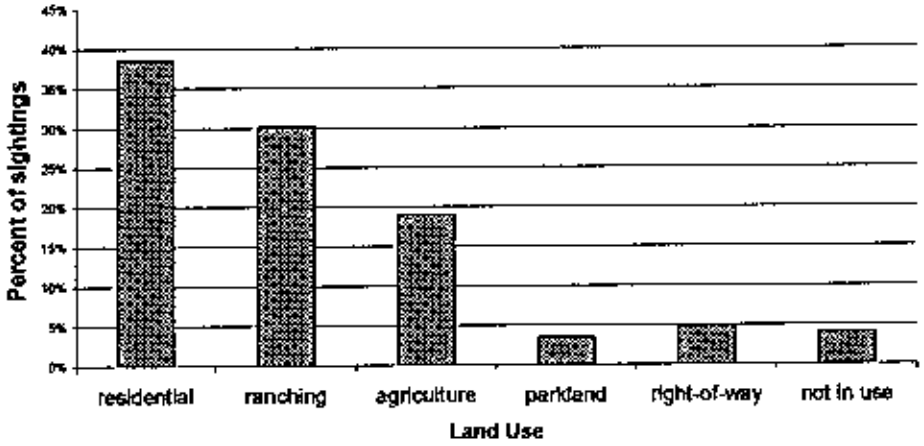


Figure 3. Habitat types where Texas Horned Lizards were found, 1998-2001.

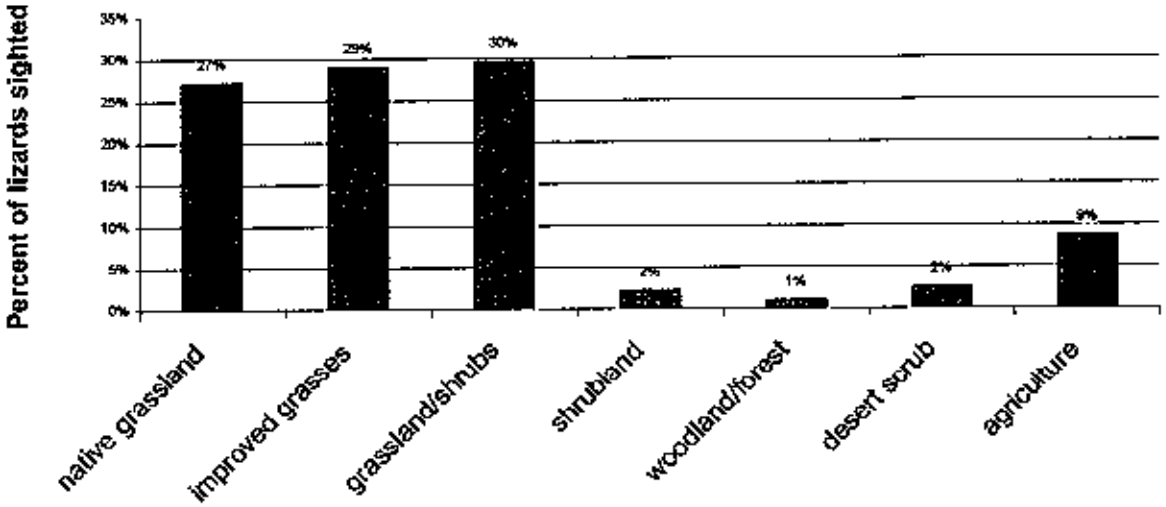
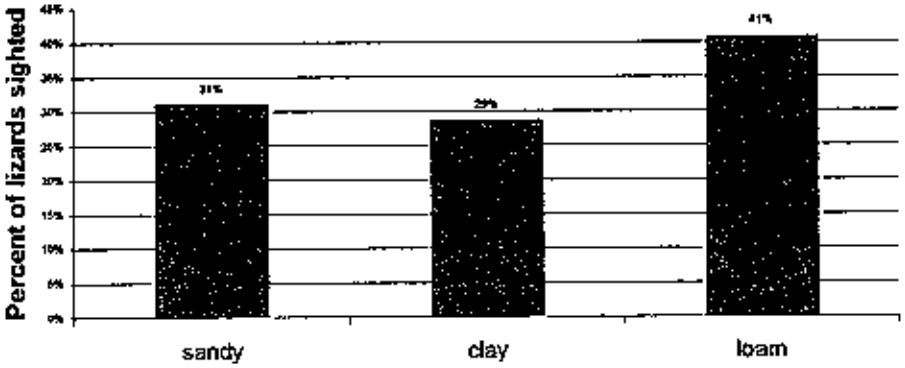


Figure 4. Soil types where Texas Horned Lizards were recorded in 2000-01.



Additional data may be interesting to volunteers wishing to compare their results to others. Many watchers reported approximate size information for THL seen (Fig. 5). Sizes ranged from less than one inch to over six inches. Most lizards were in the 4.0 – 4.9" size range. Lizards were sighted most frequently in July, June, and May, with the first sighting reported in March and the last sighting reported in October (Fig. 6). Young lizards (<1.5") were seen most often in July and August. Lizards were most often seen when temperatures were between 85 and 89 degrees F (Fig. 7), although sightings may reflect some bias against extremely high temperatures on the part of observers. Several lizards were spotted at greater than 100 F, and at least one volunteer sighted a lizard when temperatures were less than 70 F.

Fig. 5. Size classes of Texas Horned Lizards found, 2000-01.

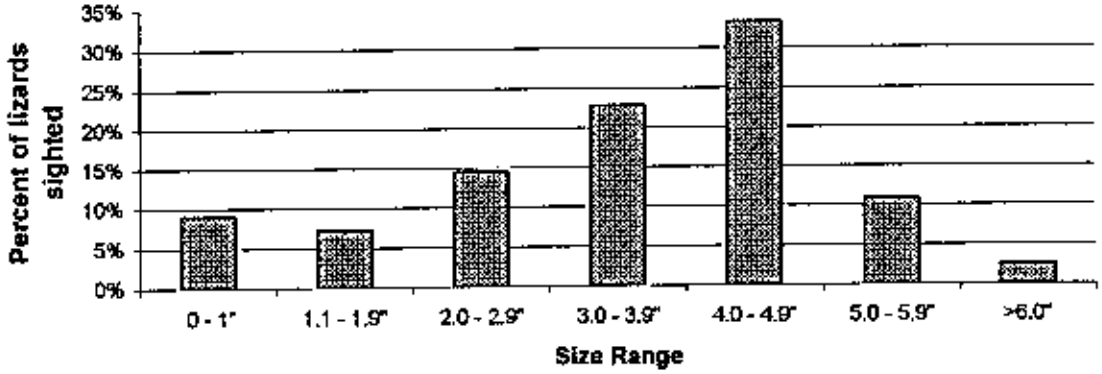


Fig. 6. Dates of Texas Horned Lizard sightings, 2000-01.

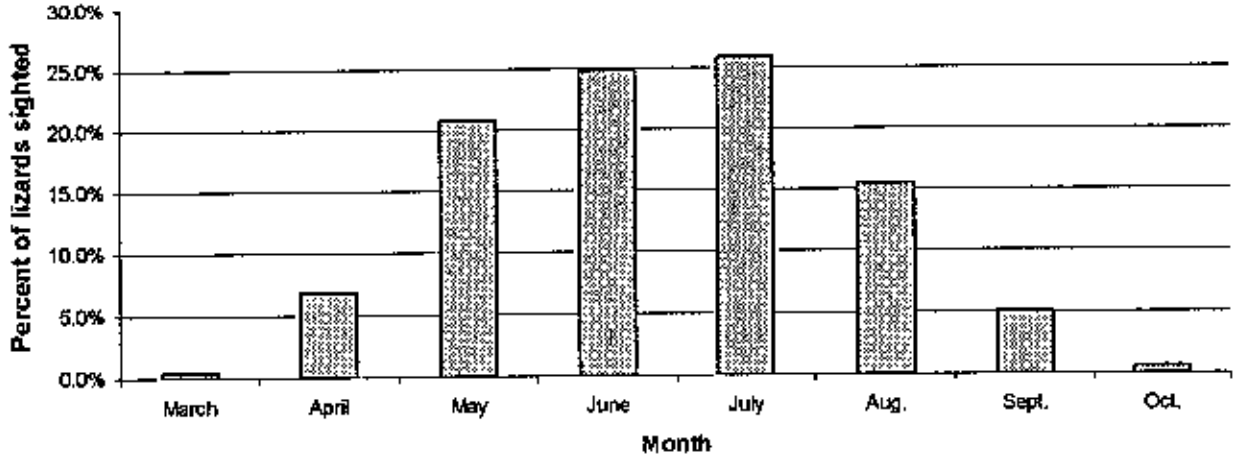
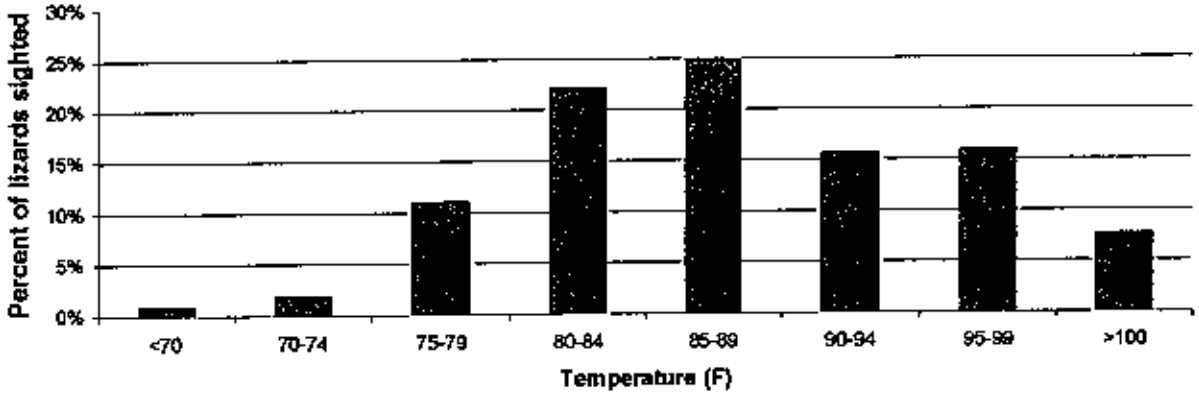


Fig. 7. Temperatures when Texas Horned Lizards were sighted, 2000-01.



Quantitative Results

While results of Texas Horned Lizard Watch have shed some light on distribution patterns and on the effects of habitat variables, survey results have not managed to reveal a trend in horned lizard populations over the five years of the survey. Only five sites have been monitored continuously since 1997, with little change noted at these sites (Table 1).

Table 1. Presence or absence of THL at sites monitored since 1997. Estimated densities, where available, are in parentheses. Results are also shown for one site monitored since 1998.

Location of site	1997	1998	1999	2000	2001
Coke county	Y (5.26)	Y (4.81)	Y (8.42)	Y (1.8)	Y (0.61)
Jeff Davis county	Y	Y	Y	Y	Y
Comanche county	Y	Y	Y	Y	N
Lubbock county	Y	Y	Y	Y	Y
Burnet county	N	N	N	N	N
Dickens county		Y (0.64)	Y (1.03)	Y (1.02)	Y (0.69)

Comparison of THL and ant densities between sites and years is problematic as well. During the first years of the watch application of quantitative survey techniques was not standardized--leading to large variances in results (Tables 2, 3, 4). In subsequent years most volunteers chose to not conduct the more standardized and quantitative transects, leading to small sample sizes. Therefore, although average densities are presented in the tables below, it should be noted that the greatest confidence should be placed in the earlier discussions based on presence/absence data and categorical variables.

Table 2. Texas Horned Lizard density/acre at Texas Horned Lizard Watch sites.

	n	Zero Values	Min.	Max.	Mean	St. Dev.
1997	86	43	0.33	436	15.68	56.61
1998	11	3	0.035	4.89	0.82	1.40
1999	17	6	0.17	8.42	1.26	2.02
2000	6	3	1.02	3.33	1.03	1.35
2001	7	2	0.08	1.38	0.50	0.49

Table 3. Harvester ant mound density/acre at Texas Horned Lizard Watch sites.

	n	Zero Values	Min.	Max.	Mean	St. Dev.
1997	83	16	0.222	871	36.77	101.19
1998	10	0	0.46	42.2	15.56	13.01
1999	14	0	0.46	72.56	13.22	17.95
2000	2	0	0.69	19.3	12.76	10.47
2001	5	0	1.38	75.00	22.25	30.44

Table 4. Imported red fire ant mound density/acre at Texas Horned Lizard Watch sites.

	n	Zero Values	Min.	Max.
1997	82	59	.403	145
1998	9	5	0.31	4.74
1999	14	11	0.92	725.6
2000	2	1	7.3	7.3
2001	4	2	1.38	2.76

Volunteer Participation

The number of volunteers participating in the watch program has varied since its inception, with a peak of 76 in 1999 (Figure 8). Publicity for the watch was highest in 1998 and 1999--probably resulting in the increased participation in those years. The vast majority of volunteers participate only one year (Figure 9). Success in seeing a horned lizard does not seem to influence whether or not volunteers continue to participate.

Figure 8. Volunteer participation in Texas Horned Lizard Watch, 1997-2001.

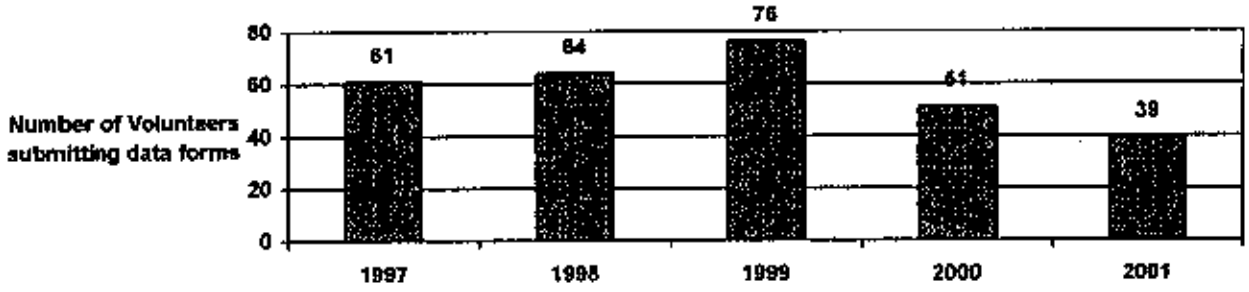
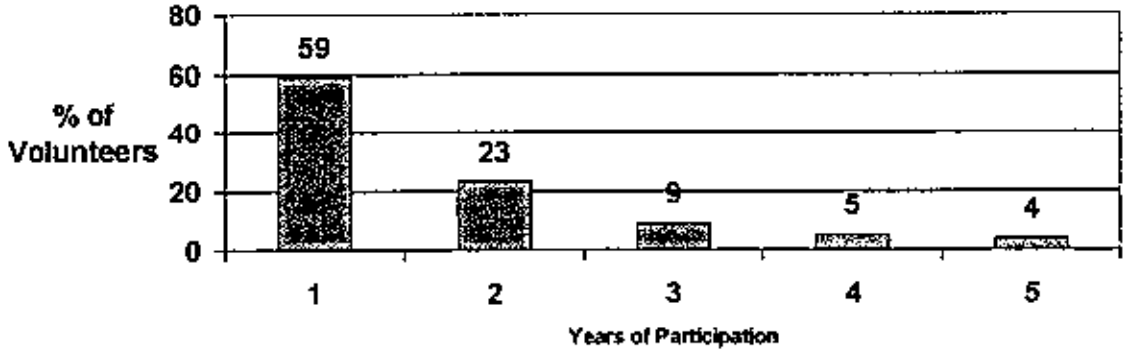


Figure 9. Number of years of participation by Texas Horned Lizard Watch adopt-a-habitat volunteers.



Conclusions and Recommendations

During its initial five years Texas Horned Lizard Watch has produced both public enthusiasm and insightful results. One notable accomplishment is an ongoing refinement of the current distribution map for the species. Project volunteers have produced encouraging results in the Post Oak Savannah ecoregion and in coastal counties where prior anecdotal reports had emphasized the species' scarcity. On the other hand, volunteers have also documented a decline of the species in some urban centers in West Texas. The project will continue to try to "fill in the gaps" regarding current distribution of the species.

Texas Horned Lizard Watch has also offered some insight into habitat relationships for the species based on simple presence/absence data. Most notably, volunteer results are the most conclusive data set in existence regarding relationships between red imported fire ants and horned lizards. Volunteer data have consistently shown a negative relationship between the two species. Data have also consistently shown a positive relationship between horned lizards and harvester ants and a negative relationship between harvester ants and red imported fire ants. Some years of data have implied a relationship between Texas horned lizards and land use or soil type. More conclusive results for these parameters are probably limited by the small number of data sheets from some land use types, as well as a tendency for volunteers with negative results to fail to send in data sheets.

The watch program has not fulfilled all initial expectations, however. It was hoped that the monitoring program might provide a quantitative measure of horned lizard abundance over time. Initial results showed that quantitative measures by so many different volunteers produced results that were highly variable and that many volunteers preferred a less strictly quantitative approach. Furthermore, ongoing research shows that sampling must be very intensive to detect changes in density of the species (Chip Ruthven, pers. comm.). These results led to a shift in emphasis to qualitative results regarding horned lizards and their habitat. In addition, most volunteers did not choose to continue monitoring year after year—leading to snapshot-type data, rather than trend data. These single observations perhaps could be updated by re-contacting the volunteers every five years to inquire about more recent observations.

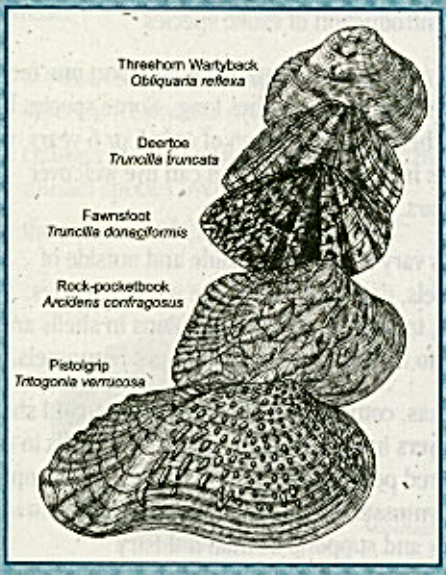
On the whole, Texas Horned Lizard Watch has been very successful in its attempt to engage citizens in meaningful, hands-on research. Participants are overwhelmingly enthusiastic, with many offering much more information and research than required by the data sheets. The personal recollections offered by watch participants were the inspiration for an essay contest in 2001-02 called "Hometown Horned Toads," that was designed to capture oral histories about people's experiences with horned lizards. Not only have results of Texas Horned Lizard Watch been poignant, however—they have also been significant. Results have been presented at scientific meetings, distribution data has been used in project planning, and habitat relationships have been used to offer management advice. The project will be continued and modified in future years to increase participation, refine habitat data, and assess trends through re-establishing contacts with initial participants.

APPENDIX D

Texas Mussel Watch materials and results

TEXAS PARKS AND WILDLIFE

Texas Mussel Watch



Freshwater Mussels in Texas

Freshwater mussels are one of the most imperiled groups of animals in the U.S. Texas hosts more than 50 species of native freshwater mussels. Because scientists have only recently become aware of the severe decline in mussel populations, some species may have become extinct before their decline was even documented. Although there are many mussel species considered rare in Texas, only one mussel species, the Ouachita rock-pocketbook mussel, which has been found only in two tributaries of the Red River, is listed as endangered.

Why the Decline in Freshwater Mussel Populations?

- Changes in flow rates of rivers and streams due to droughts, floods, or building of dams
- Increased deposition of soft silt due to excessive run-off
- Scouring of stream beds during storm events
- Increased amounts of aquatic vegetation
- Lack of suitable native fish hosts for larval stage
- Aquatic contaminants
- Introduction of exotic species

Adult mussels can range from less than one inch in length to nearly 12 inches long. Some species have thin shells and a life-span of only 5 or 6 years, while others have thick shells and can live well over 50 years.

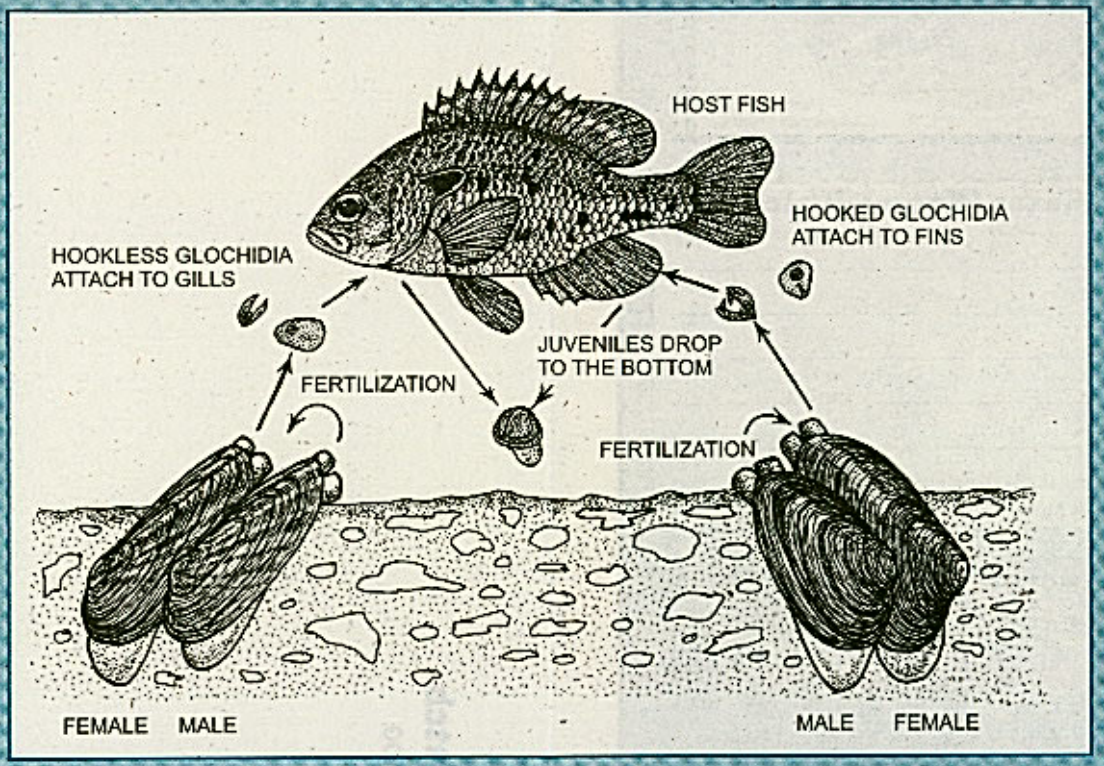
Shells vary both on the inside and outside of mussels, depending upon the mussel species. Color, texture, and shape variations in shells are used to help identify different types of mussels.

In Texas, commercial musselers sell mussel shells to buyers in Japan that use bits of the shells in the cultured pearl industry. One species, the Tampico pearlymussel, is famous for producing freshwater pearls and supports a small industry.

Mussel Biology

Freshwater mussels feed by filtering algae and small particles from the water. Most species have a larval stage that is parasitic on fish. Larvae are released by the female mussel and must locate a certain fish species or die. They usually attach to the host fish's gills or fins where they remain for a few weeks or months. Larval mussels rarely harm infected fish under natural conditions. If essential fish species are removed from the habitat, mussels will not be able to reproduce.

Texas Freshwater Mussel Reproductive Cycle



Losing our freshwater mussels would mean...

the loss of an important indicator of the health of aquatic ecosystems. Mussels are often the first species to vanish when environmental conditions change or decline. As filter feeders, mussels concentrate substances that are dissolved in the water. Mussel tissues can be examined to check for many toxic chemical pollutants of our rivers, lakes, and streams. Healthy mussel populations mean purer water for humans and countless aquatic plants and animals.

How do Volunteers Help?

Volunteers can play an important role in helping us understand freshwater mussels in Texas because resources for mussel research are limited and Texas is vast. Additionally, volunteers spread across the state can be on hand when local events cause sudden changes in water levels or water clarity, exposing mussels.

Texas Mussel Watch volunteer data can help us determine:

1) the distribution and relative abundance of different freshwater mussel species
2) changes in the distribution and abundance of mussel species over time
3) the presence of exotic mussels



Common Mapleleaf

Become a Texas Mussel Watch Volunteer!

Identifying mussel species in the field is fun and challenging. Most mussel monitoring can take place along the shores or in shallow water, especially when water levels are lower than normal during droughts or during the draw downs of reservoirs. Monitoring can take place incidentally as volunteers encounter mussels, but regular visits (once or twice a year) to a particular water body are encouraged.

Texas Mussel Watch Workshops

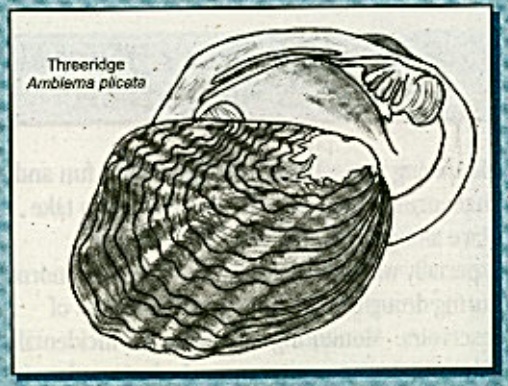
No special equipment is needed to monitor for mussels, but volunteers must attend a workshop to receive a monitoring manual and other materials to help mussel identification.

Monitoring workshops are scheduled in different parts of the state. For information about the workshop schedule, fill out and return the form to the right or contact:

Ann Miller
Texas Nature Trackers
Volunteer Coordinator
3000 IH 35 South, Suite 100
Austin, TX 78704
(512) 912-7025
ann.miller@tpwd.state.tx.us

For more on mussel monitoring, check this Web site:

www.tpwd.state.tx.us/mussels



Mussel illustrations by Robert G. Howells



Texas Mussel Watch

Name_____

e-mail_____

Address_____

City_____ Zip_____

Phone_____

☐ Please notify me about the schedule for Texas Mussel Watch workshops.

For more information about Texas Freshwater Mussels:

Freshwater Mussels of Texas, by Robert G. Howells, Raymond W. Neck, and Harold D. Murray; $29.95 per copy available by calling the Inland Fisheries Division of TPW, 1-800-792-1112.

For more information about other Texas Nature Tracker volunteer monitoring projects, visit the TPW Web site at: www.tpwd.state.tx.us/nature

TEXAS PARKS & WILDLIFE

4200 Smith School Road
Austin, Texas 78744

PWD BR W7000-589 (10/00)

Texas Mussel Watch
3000 South IH-35, Suite 100
Austin, Texas 78704

TEXAS PARKS & WILDLIFE

Texas Mussel Watch Summary Report

1997-2001

Prepared by Marsha May Reimer, Texas Parks and Wildlife Department

2001 Highlights

Locations within five Texas drainage basins in seven counties were examined for freshwater mussel species by four Texas Mussel Watch (TMW) volunteers, one group of students from Ronald Rushing's summer science camp, one student from Mary Kennedy's class and one TMW workshop by Texas Parks and Wildlife Department (TPWD), Texas Nature Tracker (TNT) biologist, Lee Ann Linam and outreach specialist, Marsha May Reimer. All TMW volunteers participated in at least one TNT TMW workshop, where they received training on identification and correct methods of handling freshwater mussels.

Live freshwater mussels were observed, identified, and released. Freshwater mussel shells and valves were collected and identified to species, when possible. When identification was questionable, samples were mailed to the TPW TNT biologist or outreach specialist for verification. The method for collecting data was by hand. Most data was collected using a random shoreline and/or shallow water search. Ronald Rushing's class ran three simultaneous transects that were approximately 15 feet apart, with the sample teams dropping a $0.25m^2$ quadrat every 7 paces the entire length of the 150'x50' gravel bar. Transect teams consisted of 3 junior high students each supervised by a science teacher.

Total volunteer time for the year was 109+ hours (Table 1.). Volunteers observed 6 live freshwater mussels, 45 shells, and 66 valves (ranging from recently dead to very-long dead[1]). A total of 12 species were found within 5 drainage basins. Comparing the five drainage basins examined in this study, the Brazos River drainage basin had the greatest number of species (Table 1.).

Table 1. Number of species collected in each drainage basin and total volunteer time (hrs) to collect those species in each drainage basin. (Total volunteer time for the Red River drainage basin is designated with a + because this information was not included on the volunteer's data sheet submitted to TPWD

Drainage Basin	Number of Species	Total Volunteer Time (hrs)
Brazos River	6	60
Colorado River	4	11
Guadalupe River	2	2
Red River	1	+
Trinity River	4	36
Total Volunteer Time:		109+ hrs

Smooth Pimpleback (Quadrula houstonensis), with a global rank of G2 (TPWD 2002), was collected from the Brazos River drainage basin by a TNT volunteer on 13 June 2002. G2 is defined as imperiled globally, very rare, 6 to 20 occurrences (endangered throughout range). The state rank for this species is S? (TPWD 2002), which means that it is not ranked or uncertain.

[1] See Shell Condition Terminology and Shell Counting Methods – page 4

2001 RESULTS

Species names from Howells *et al.* (1996). Counting methods and condition are defined on page 4.

Brazos River Drainage Basin

Trinity River (30°W 32" 501': 96°N 7"10'), Grimes County, Texas, 13 June 2002:

Transect search lead by Ronald Rushing and conducted by students and teachers from Navasota Junior High Summer Science Camp with 0.25 m^2 quadrat on gravel bar approximately 150'x 50', three lengthwise transects 15' apart. Students sampled every seven paces. Total of 60 volunteer hours produced the following specimens:

Navasota River gravel bar Species	*N* live	*N* shells	Condition	Percentage
Fragile Papershell (*Leptodea fragilis*)		0.5x2	long dead	3.5
Smooth Pimpleback (*Quadrula houstonensis*)	1	1+0.5x27	long dead	50.9
Southern Mapleleaf (*Quadrula apiculata*)		1+0.5x2	long dead	5.3
Threeridge (*Amblema plicata*)		2+0.5x10	long dead	21.0
Washboard (*Megalonaias nervosa*)		0.5x7	long dead	12.3
Yellow Sandshell (*Lampsilis teres*)		0.5x4	long dead	7.0

Colorado River Drainage Basin

Lake Travis, Burnet County, Texas, 28 October 2001:

Random shoreline and shallow-water search by hand, 10.0 hrs of total volunteer time, by participants of the Texas Master Naturalist Workshop produced the following specimens:

LCRA Property adjacent to Camp Balcones Springs, western end of Lake Travis, north shore, approximately 13 miles SE of Marble Falls, TX Species	*N* live	*N* shells	Condition	Percentage
Bleufer (*Potamilus purpuratus*)		0.5x1	long dead	16.7
Giant Floater (*Anodonta grandis*)	1			16.7
Pimpleback species (*Quadrula* sp.)		0.5x3	very-long dead	50.0
Threeridge (*Amblema plicata*)		0.5x1	long dead	16.7
Asian Clams present				

Cow Creek, Travis County, Texas, 16 September 2001:

Random shoreline search by hand, 1.0 hr of total volunteer time, by volunteer Joan Mukherjee, produced the following specimens: Asian Clams present

Guadalupe River Drainage Basin

San Marcos River, Caldwell County, Texas, 18 September 2001:

Random shoreline search by hand, 1.5 hrs of total volunteer time, by volunteer Betty Watkins, produced the following specimens:

San Marcos River, Caldwell-Guadalupe County Line, approximately 3 miles east of Martindale, TX Species	*N* live	*N* shells	Condition	Percentage
Washboard (*Megalonaias nervosa*)		0.5x5	long dead	100.0
Asian Clams present				

Red River Drainage Basin

Stock tank in Wichita County, TX, 19 November 2001:

Collected and identified by Dr. S. Alan Skinner while doing an archeological survey produced the following specimen:

Stock tank in Wichita County, near tributary to Wichita River, south of Iowa Park.				
Species	*N* live	*N* shells	Condition	Percentage
Tapered Pondhorn (*Uniomerus declivis*)	1			100.0

Trinity River Drainage Basin

Lake Livingston/Camp Olympia, Trinity County, TX, 25 September 2001:

Random shoreline and shallow water search by hand, 36.0 hrs of total volunteer time by TMW volunteer, produced the following specimens:

Lake Livingston/Camp Olympia				
Species	*N* live	*N* shells	Condition	Percentage
Flat Floater (*Anodonta suborbiculata*)		0.5x1	long dead	16.7
Giant Floater (*Anodonta grandis*)	3	0.5x1	long dead	66.6
Texas Lilliput (*Toxolasma texasensis*)		0.5x1	relatively-recently dead	16.7

Trinity River, Dallas County, TX, 19 November 2001:

Collected and identified by Dr. S. Alan Skinner while doing an archeological survey produced the following specimen:

Old East Fork of the Trinity River				
Species	*N* live	*N* shells	Condition	Percentage
Yellow Sandshell (*Lampsilis teres*)		0.5x1	recently dead	100.0

SHELL CONDITION TERMINOLOGY

It is not usually possible to determine exactly how long a freshwater mussel shell has been dead. Different conditions such as water and substrate pH, erosive or corrosive environments, and exposure to sun can impact specimen condition and rate of disintegration. None the less, some qualitative estimate of time-since-death can be very useful. The following terms are used in TPWD freshwater mussel surveys:

Very-recently dead: Soft tissue remains attached to the shell; shell in good condition, essentially as it would be in a living specimen; internal and external colors are not faded.

Recently dead: No soft tissue remains, but shell otherwise in good condition (looking like a living specimen that had been killed and cleaned); internally nacre is glossy and without evidence of algal staining, calcium deposition, or external erosive effects; internal and external colors are not faded.

Relatively-recently dead: Shell in good condition, but internally nacre is loosing its glossy nature; algal staining, calcium deposition, or external erosive effects (or some combination of these) is evident on the nacre; internal and external colors often faded somewhat.

Long dead: Shell shows early signs of internal and external erosion, staining, calcium deposition, or some combination of these; most or all of the internal coloration and glossy nature has faded (especially in species with colored nacre); shell epidermis with major sections absent, or , if present, clearly aged and flaking.

Very-long dead: Shell shows significant signs of erosion, staining, and calcium deposition more widely pronounced than above; coloration often faded white or nearly so; relatively little intact epidermis left; for specimens in erosive environments, internal features (*e.g.*, pseudocardinal teeth) and external features (*e.g.*, pustules) often weathered and smoothed, or otherwise exfoliated; shells often chalky, brittle, and crumbling.

Subfossil: Shells with little or no epidermis; nacre faded white and entire shell often white; sometimes with signs of erosion, staining, or calcium deposition; typically chalky and powdery to the touch; shells often brittle and crumbling.

SHELL COUNTING METHODS

0.5 x 1 = one valve (one half shell); counted as one specimen in some calculations.
1 = one living specimen with a complete shell (two matched valves);
1.0 = one complete shell consisting of two, matching valves.
0.5 x 2 = one valve from each of two individuals; counted as two specimens in some calculations.
3.0+ 0.5 x 2 = three complete shells (pairs of matched valves) and two additional unpaired valves from two additional individuals; counted as five specimens in some calculations.

On some occasions when a very large number of valves are counted it may not be possible or practical to count matching left and right valves. Count individual valves, and then note no attempt to match valve pairs was made.

Drainage Basin	Date	Collected by	Identified by	Monitoring Location	County	UPRR/TM	Collection Method	Random or Timed Search	Area or Transect Search	Water depth (m or ft)	Water temp. (degrees C or F)	Flow rate (m/sec or ft/sec)	Substrate type	Total Volunteer Time (hrs)	comments	common name	species	N alive	N alpha	N valve	Shell Condition	Corbicula spp. - present
Brazos	06/13/02	Daniel Huff / Ronald Rushing	Ronald Rushing	Navasota River	Grimes	30 degrees W 32°501' and 96 degrees N 7°10'	hand		0.25 m² quadrat				gravel	20	gravel bar approximately 150'x50', three lengthwise transects, 15' apart taken, students sampled every 7 paces with a 0.25 m2 quadrat	Washboard	*Megalonaias nervosa*			1	long dead	
																threeridge	*Amblema plicata*		1		long dead	
																pimpleback	*Quadrula pustulosa*			1	long dead	
																threeridge	*Amblema plicata*		1			
																smooth pimpleback	*Quadrula houstonensis*			1	long dead	
																Southern mapleleaf	*Quadrula apiculata*		1		long dead	
																smooth pimpleback	*Quadrula houstonensis*		1		long dead	
																Yellow Sandshell	*Lampsilis teres*			1	long dead	
																threeridge	*Amblema plicata*			2	long dead	
																Southern mapleleaf	*Quadrula apiculata*			1	long dead	
																Washboard	*Megalonaias nervosa*			2	long dead	
Brazos	06/13/02	John Hermann / Ronald Rushing	Ronald Rushing	Navasota River	Grimes	30 degrees W 32°501' and 96 degrees N 7°10'	hand		0.25 m² quadrat				gravel	20	gravel bar approximately 150'x50', three lengthwise transects, 15' apart taken, students sampled every 7 paces with a 0.25 m2 quadrat	Southern mapleleaf	*Quadrula apiculata*			1	long dead	
																threeridge	*Amblema plicata*			4	long dead	
																threeridge	*Amblema plicata*			1	long dead	
																smooth pimpleback	*Quadrula houstonensis*			2	long dead	
																smooth pimpleback	*Quadrula houstonensis*			3	long dead	
																smooth pimpleback	*Quadrula houstonensis*			2	long dead	
																Yellow Sandshell	*Lampsilis teres*			1	long dead	
																Washboard	*Megalonaias nervosa*			2	long dead	
																smooth pimpleback	*Quadrula houstonensis*			3	long dead	
																smooth pimpleback	*Quadrula houstonensis*			2	long dead	
Brazos	06/13/02	Brittany Markey / Ronald Rushing	Ronald Rushing	Navasota River	Grimes	30 degrees W 32°501' and 96 degrees N 7°10'	hand		0.25 m² quadrat				gravel	20	Very hot! And wet. Gravel bar approximately 150'x50', three lengthwise transects, 15' apart taken, students sampled every 7 paces with a 0.25 m2 quadrat	Washboard	*Megalonaias nervosa*			1	long dead	
																smooth pimpleback	*Quadrula houstonensis*			6	long dead	
																Yellow Sandshell	*Lampsilis teres*			1	long dead	
																Fragile Papershell	*Leptodea fragilis*			1	long dead	
																smooth pimpleback	*Quadrula houstonensis*	1			long dead	
																Washboard	*Megalonaias nervosa*			1	long dead	

Drainage Basin	Date	Collected by	Identified by	Monitoring Location	County	GPS/UTM	Collection Method	Random or Timed Search	Area of Transect Search	Water depth (m or ft)	Water temp (degrees C or F)	Flow rate (mass or Wave)	Substrate type	Total Volunteer Time (hrs)	Comments	common name	species	N alive	N shells	N valves	Shell Condition	Cordicula spp. Present
																Yellow Sandshell	*Lampsilis teres*			1	long dead	
																Fragile Papershell	*Leptodea fragilis*			1	long dead	
																smooth pimpleback	*Quadrula houstonensis*			7	long dead	
Colorado	08/16/01	Joan Mukherjee	Joan Mukherjee	Cow Creek	Travis		hand	random shoreline						1	I was surprised to find any. This beautiful creek is rapidly degrading. It is mostly on bedrock and now is filled with algae. Found on a rock in creek near a gravel bed.							yes
Colorado	10/20/01	Texas Master Naturalist Workshop, Marble Falls	Lee Ann Linam	LCRA Property adjacent to Camp Balcones Springs, western end of Lake Travis, north shore, approximately 13 miles SE of Marble Falls, TX	Sumol		hand	random shoreline and shallow-water						10	many mussels were unidentifiable	threeridge	*Amblema plicata*			1	long dead	yes
																bleufer	*Potamilus purpuratus*			1	relatively-long dead	yes
																pimpleback species	*Quadrula* sp.			3	very long dead	yes
																Giant Floater	*Anodonta grandis*	1				yes
Guadalupe	07/31/01	Mary Kenedy's student	Marsha Reimer	Frederic Creek, Boerne, TX	Kendall		hand	random shoreline						0.5	Student found shells while we were monitoring the Big Red Sage	paper pondshell	*Anodonta imbecilis*		1		relatively recently dead	
Guadalupe	09/18/01	Betty Watkins	Betty Watkins	San Marcos River - Caldwell - Guadalupe County Line - approximately 3 mi east of Martindale	Caldwell		hand	random shoreline		0-3ft	74 degrees F			1.5	Asian clams are present. However, they are fewer than last year and I have not seen any beds of live Asian clams this year. There were some observed last summer	Washboard	*Megalonaias nervosa*			5	long dead	yes
Red	11/19/01	Dr. S. Alan Skinner	Dr. S. Alan Skinner	Stock tank in Wichita County, near tributary to Wichita River, south of Iowa Park	Wichita										collected by Dr. S. Alan Skinner while doing an archeological survey. 1 mussel, 3" long, left valve 2" long	Tapered Pondhorn	*Uniomerus declivis*	1				
Trinity	09/25/01	Al Bartell	Al Bartell	Lake Livingston/Camp Olympia	Trinity		hand	random shoreline and shallow water		0.5 m		none	sand and mud	36	We usually find buckets of shells this time of year. This year very few (as you can see). I speculate that it is because we did not have a drought cycle this summer year (lake level has not changed).	Giant Floater	*Anodonta grandis*	1		1	long dead	not recorded
																Flat Floater	*Anodonta suborbicularis*			1	long dead	not recorded
																Texas Lilliput	*Toxolasma texasensis*			1	relatively-recently dead	not recorded
Trinity	11/19/01	Dr. S. Alan Skinner	Dr. S. Alan Skinner	Old East Fork of the Trinity River	Dallas										collected by Dr. S. Alan Skinner while doing an archeological survey. Right valve, 3 1/2" long	Yellow Sandshell	*Lampsilis teres*			1	recently dead	

Five-year Summary

Between 1997 and 2001, TMW volunteers recorded 31 different species of freshwater mussels (Table 2) from nine Texas drainage basins (Table 3). Five of those species have a global ranking of G1 and/or G2 (Table 2).

Table 2. Texas Freshwater Mussel species recorded by Texas Mussel Watch volunteers between 1997 and 2002.

Common Name	Species	Condition
Threeridge	*Amblema plicata*	live to very long dead
Giant Floater	*Anodonta grandis*	live to very-long dead
Paper Pondshell	*Anodonta imbecillis*	live to long dead
Flat Floater	*Anodonta suborbiculata*	recently dead to long dead
Tampico Pearlymussel	*Cyrtonaias tampicoensis*	live to very long dead
Wabash Pigtoe	*Fusconaia flava*	recently dead
Louisiana Fatmucket	*Lampsilis hydiana*	live to recently dead
Yellow Sandshell	*Lampsilis teres*	live to subfossil
White Heelsplitter	*Lasmigona complanata*	recently dead
Fragile Papershell	*Leptodea fragilis*	live to long dead
Pond Mussel	*Ligumia subrostrata*	live to very long dead
Washboard	*Megalonaias nervosa*	long to subfossil
Threehorn Wartyback	*Obliquaria reflexa*	live to long dead
Louisiana Pigtoe[1]	*Pleurobema riddellii*	relatively recently dead
Pink Papershell	*Potamilus ohiensis*	live to long dead
Bleufer	*Potamilus purpuratus*	live to subfossil
Southern Mapleleaf	*Quadrula apiculata*	live to subfossil
Golden Orb[2]	*Quadrula aurea*	recently to long dead
Smooth Pimpleback[3]	*Quadrula houstonensis*	live to long dead
Western Pimpleback[4]	*Quadrula mortoni*	live to long dead
Wartyback	*Quadrula nodulata*	very recently dead to recently dead
Pimpleback	*Quadrula pustulosa*	live
Lilliput	*Toxolasma parvus*	live to recently dead
Texas Lilliput	*Toxolasma texasensis*	live to long dead
Pistolgrip	*Tritogonia verrucosa*	live to long dead
Texas Fawnsfoot[5]	*Truncilla macrodon*	recently dead
Deertoe	*Truncilla truncata*	live to long dead
Tapered Pondhorn	*Uniomerus declivis*	live to long dead
Pondhorn	*Uniomerus tetralasmus*	live to long dead
Little Spectalcase	*Villosa lienosa*	recently dead

[1] Global Rank G1G2, State of Texas Rank S1 (TPWD 2002)
[2] Global Rank G1, State of Texas Rank S? (TPWD 2002)
[3] Global Rank G2, State of Texas Rank S? (TPWD 2002)
[4] Global Rank G2, State of Texas Rank S? (TPWD 2002) Note: Texas Parks and Wildlife Department, Texas Biological and Conservation Data System, Special Animal List, 11 Jul 2002, lists the scientific name for this species as *Quadrula pustulosa mortoni*, Howells *et al.* (1996) lists this species as *Quadrula mortoni*)
[5] Global Rank G2, State of Texas Rank S? (TPWD 2002)

Table 3. Freshwater mussels collected by Texas Mussel Watch volunteer from 9 Texas drainage basins.

Big Cypress Bayou	
Common Name	**Species**
Pond Mussel	*Ligumia subrostrata*
Texas Lilliput	*Toxolasma texasensis*

Brazos River	
Common Name	**Species**
Threeridge	*Amblema plicata*
Giant Floater	*Anodonta grandis*
Paper Pondshell	*Anodonta imbecillis*
Tampico Pearlymussel	*Cyrtonaias tampicoensis*
Yellow Sandshell	*Lampsilis teres*
Fragile Papershell	*Leptodea fragilis*
Pond Mussel	*Ligumia subrostrata*
Washboard	*Megalonaias nervosa*
Pink Papershell	*Potamilus ohiensis*
Bleufer	*Potamilus purpuratus*
Southern Mapleleaf	*Quadrula apiculata*
Smooth Pimpleback	*Quadrula houstonensis*
Pimpleback spp.	*Quadrula* spp.
Lilliput	*Toxolasma parvus*
Texas Lilliput	*Toxolasma texasensis*
Pistolgrip	*Tritogonia verrucosa*
Texas Fawnsfoot	*Truncilla macrodon*
Tapered Pondhorn	*Uniomerus declivis*
Pondhorn sp.	*Uniomerus* sp.
Pondhorn	*Uniomerus tetralasmus*

Colorado River	
Common Name	**Species**
Threeridge	*Amblema plicata*
Giant Floater	*Anodonta grandis*
Tampico Pearlymussel	*Cyrtonaias tampiconensis*
Yellow Sandshell	*Lampsilis teres*
Fragile Papershell	*Leptodea fragilis*
Washboard	*Megalonaias nervosa*
Bleufer	*Potamilus purpuratus*
Southern Mapleleaf	*Quadrula apiculata*
Pimpleback sp.	*Quadrula* sp.

Table 3 Continued.

Guadalupe River	
Common Name	**Species**
Threeridge	*Amblema plicata*
Giant Floater	*Anodonta grandis*
Paper Pondshell	*Anodonta imbecillis*
Tampico Pearlymussel	*Cyrtonaias tampicoensis*
Yellow Sandshell	*Lampsilis teres*
Washboard	*Megalonaias nervosa*
Southern Mapleleaf	*Quadrula apiculata*
Golden Orb	*Quadrula aurea*
pistolgrip	*Tritogonia verrucosa*

Little Wichita River	
Common Name	**Species**
Giant Floater	*Anodonta grandis*
Pink Papershell	*Potamilus ohiensis*
Southern Mapleleaf	*Quadrula apiculata*

Neches River	
River	**Species**
Threeridge	*Amblema plicata*
Yellow Sandshell	*Lampsilis teres*
Louisiana Pigtoe	*Pleurobema riddelli*
Western Pimpleback	*Quadrula mortoni*
Texas Lilliput	*Toxolasma texasensis*
Little Spectalcase	*Villosa lienosa*
Tapered Pondhorn	*Uniomerus declivis*

Red River	
Common Name	**Species**
Giant Floater	*Anodonta grandis*
Flat Floater	*Anodonta suborbiculata*
Wabash Pigtoe	*Fusconaia flava*
Pocketbook spp.	*Lampsilis* spp.
Yellow Sandshell	*Lampsilis teres*
White Heelsplitter	*Lasmigona complanata*
Fragile Papershell	*Leptodea fragilis*
Threehorn Wartyback	*Obliquaria reflexa*
Pink Papershell	*Potamilus ohiensis*
Bleufer	*Potamilus purpuratus*
Mapleleaf spp.	*Quadrula* spp.
Pistolgrip	*Tritogonia verrucosa*
Tapered Pondhorn	*Uniomerus declivis*
Pondhorn	*Uniomerus tetralasmus*

Table 3 Continued.

Sabine River	
Common Name	**Species**
Giant Floater	*Anodonta grandis*
Paper Pondshell	*Anodonta imbecillis*
Yellow Sandshell	*Lampsilis teres*
Pond Mussel	*Ligumia subrostrata*
Southern Mapleleaf	*Quadrula spiculata*
Pondhorn	*Uniomerus tetralasmus*

Trinity River	
Common Name	**Species**
Threeridge	*Amblema plicata*
Giant Floater	*Anodonta grandis*
Paper Pondshell	*Anodonta imbecillis*
Flat Floater	*Anodonta suborbiculata*
Tampico Pearlymussel	*Cyrtonaias tampicoensis*
Louisiana Fatmucket	*Lampsilis hydiana*
Yellow Sandshell	*Lampsilis teres*
Fragile Papershell	*Leptodea fragilis*
Threehorn Wartyback	*Obliquaria reflexa*
Pink Papershell	*Potamilus ohiensis*
Bleufer	*Potamilus purpuratus*
Southern Mapleleaf	*Quadrula apiculata*
Western Pimpleback	*Quadrula mortoni*
Wartyback	*Quadrula nodulata*
Pimpleback	*Quadrula pustulosa*
Pimpleback spp.	*Quadrula* spp.
Lilliput	*Toxolasma parvus*
Texas Lilliput	*Toxolasma texasensis*
Pistolgrip	*Tritogonia verrucosa*
Deertoe	*Truncilla truncata*
Pondhorn	*Uniomerus tetralasmus*

The Texas Parks and Wildlife Department's Texas Mussel Watch Project will continue to support volunteer monitoring of Texas freshwater mussels under the umbrella of the Texas Nature Tracker Program. Attached is a copy of the Texas Mussel Watch Monitoring Packet distributed during workshops.

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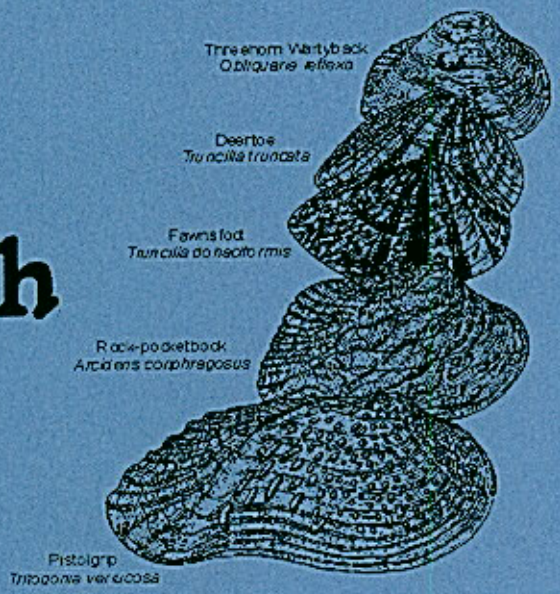
TEXAS PARKS AND WILDLIFE

Texas Mussel Watch



Special thanks to Robert G. Howells of TP&W's Heart-of-the-Hills Research Station for creating this mussel monitoring manual in cooperation with Texas Mussel Watch staff.

Freshwater Mussels of Texas Distribution Chart

This list is intended to serve as a starting point to familiarize yourself with mussel species that may occur in your area. Not all species indicated may still occur within the basin, and some species have very limited distributions within a system. In addition, some species in addition to those indicated may occur in your river system. Note species lists for adjacent systems to familiarize yourself with other possible species. Some river systems, such as the Llano, Pedernales, and San Saba, appear to have few or no living mussel populations.

Sample Group	SAMPLE GROUP DESCRIPTION	1. Canadian River	2. Wichita River	3. Red River	4. Sulfur River	5. Big Cypress Bayou	6. Sabine River	7. Angelina River	8. Neches River	9. Trinity River	10. San Jacinto River	11. Brazos River	12. Little Brazos River	13. Navasota River	14. Colorado River	15. Concho River	16. San Saba River	17. Llano River	18. Pedernales River	19. San Marcos River	20. Guadalupe River	21. San Antonio River	22. Frio River	23. Nueces River	24. Rio Grande	25. Devils River	26. Pecos River	27. Lavaca River
	A:Thick shell; heavy pseudocardinal teeth; shell sculpturing.																											
	B:Rectangular form; moderately heavy shell																											
	C:Beak above hinge line; moderately heavy shell; no shell sculpturing																											
	D:Shell moderately thick; beak above hinge line; sexually dimorphic; no shell sculpturing; hinge teeth																											
	E(Part 1): Thin shell; no hinge teeth E(Part 2): Thin shell; hinge teeth																											
	Family: Unionidae																											
A 1 - 22	TEXAS PIMPLEBACK (*Quadrula petrina*)[5]														X	X	?	?	?		X							
	SMOOTH PIMPLEBACK (*Quadrula houstonensis*)[5]								X	X	X	X	X	X														
	WESTERN PIMPLEBACK (*Quadrula mortoni*)[5]				X	X	X	X	X	X	X																	
	DEERTOE (*Truncilla truncata*)			X	O	X	X		X	X	X																	
	WABASH PIGTOE (*Fusconaia flava*)			X	X	X	O		X	X	X																	
	TEXAS PIGTOE (*Fusconaia askewi*)[2,3]				X	X	X	O	X	X	X	O																
	TRIANGLE PIGTOE (*Fusconaia lananensis*)[2]								X	O	X																	
	THREEHORN WARTYBACK (*Obliquaria reflexa*)			X	X	X	O	O	X	X	X																	
	MAPLELEAF (*Quadrula quadrula*)		X	X	X	X																						
	GULF MAPLELEAF (*Quadrula nobilis*)						X		X	X	O																	
	SOUTHERN MAPLELEAF (*Quadrula apiculata*)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	?	?	?	X	X	X	X				X
	GOLDEN ORB (*Quadrula aurea*)[5]											O			X					X	X	X	X	X				
	LOUISIANA PIGTOE (*Pleurobema riddellii*)[3]				X	X	X		X	X	X																	
B 1 - 5	THREERIDGE (*Amblema plicata*)			X	X	X	O	O	X	X	X	X	X	X	X	X	?	?		X	X	X		X				
	BANKCLIMBER (*Plectomerus dombeyanus*)				X	X	X	X	X	X	X																	
	ROCK-POCKETBOOK (*Arcidens confragosus*)[5]			X	X	X	X		X	X	X	X	X		X						X	X						X
	WASHBOARD (*Megalonaias nervosa*)				X	X	X	O	X	X	X	X	X	O	X						X	X	X		X			
	PISTOLGRIP (*Tritogonia verrucosa*)				X	X	X	O	X	X	X	X			X		?	?		O	X	X						
C 1 - 7	BLEUFER (*Potamilus purpuratus*)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	?	?	?	X			O	O			X
	TAMPICO PEARLYMUSSEL (*Cyrtonaias tampicoensis*)			*					*		X				X	X	?	?			X	X	X	X	X	X	X	
	ROUND PEARLSHELL (*Glebula rotundata*)					X		X	X	X	X										O							X
	SANDBANK POCKETBOOK (*Lampsilis satura*)[2]				X	X	X		X	X	X																	
D 1 - 9	YELLOW SANDSHELL (*Lampsilis teres*)		X	X	X	X	X	O	X	X	X	X	X	X	X	O	?	?		X	X	X		X	X		X	X
	POND MUSSEL (*Ligumia subrostrata*)				*	X	X		X	X	X	X	X		X							X		X				
	TAPERED PONDHORN (*Uniomerus declivis*)				X	X	O		X	X	X	X		X	X							X						O
	PONDHORN (*Uniomerus tetralasmus*)		X	X	O	X	X		X	X	X	X	X	X							X		X					
	TEXAS LILLIPUT (*Toxolasma texasensis*)			O	O	X	X		X	X	X	X	X	X	X	X				X	X	X		X	X	X		X
	LILLIPUT (*Toxolasma parvus*)			X	X	X	X		X	X	X	X			X		?				X		X	X	X			
	TEXAS FATMUCKET (*Lampsilis bracteata*)[5]														X	X	?	?	?		X	X						
	LOUISIANA FATMUCKET (*Lampsilis hydiana*)			O	X	X	X	X	X	X	X	X									X	X		X				
	FAWNSFOOT (*Truncilla donaciformis*)			X		O	O		X	X	X																	
	TEXAS FAWNSFOOT (*Truncilla macrodon*)[5]								X		X				X	X												
E (Part 1)	GIANT FLOATER (*Anodonta grandis*)	X	X	X	X	X	X		X	X	X	X		X	X	X	?	?	?		X	X		X	O			X
	PAPER PONDSHELL (*Anodonta imbecillis*)		X	X	X	X	X	O	X	X	X	X	O		X	X	?	?			X	X	X	X	X	X		X
	FLAT FLOATER (*Anodonta suborbiculata*)			*		*	*		*	*		*																
E (Part 2)	PINK PAPERSHELL (*Potamilus ohiensis*)		X	X	O	X				X	X	X																
	TEXAS HEELSPLITTER (*Potamilus amphichaenus*)[3]						X		X	X																		
	WHITE HEELSPLITTER (*Lasmigona complanata*)			X	X		*		*	*	*									*								
	FRAGILE PAPERSHELL (*Leptodea fragilis*)		X	X	X	X	X	X	X	X	X	X	X	O	X	X												

X = Recent Occurences (within last 30 years)
O = Historical Occurences (over 30 years old)

* = May be introduced population
? = Unknown if mussel populations still exist

Freshwater Mussels of Texas Distribution Chart

SAMPLE GROUP DESCRIPTION

A:Thick shell; heavy pseudocardinal teeth; shell sculpturing.
B:Rectangular form; moderately heavy shell
C:Beak above hinge line; moderately heavy shell; no shell sculpturing
D:Shell moderately thick; beak above hinge line; sexually dimorphic; no shell sculpturing; hinge teeth
E(Part 1): Thin shell; no hinge teeth E(Part 2): Thin shell; hinge teeth

Sample Group		1. Canadian River	2. Wichita River	3. Red River	4. Sulfur River	5. Big Cypress Bayou	6. Sabine River	7. Angelina River	8. Neches River	9. Trinity River	10. San Jacinto River	11. Brazos River	12. Little Brazos River	13. Navasota River	14. Colorado River	15. Concho River	16. San Saba River	17. Llano River	18. Pedernales River	19. San Marcos River	20. Guadalupe River	21. San Antonio River	22. Frio River	23. Nueces River	24. Rio Grande	25. Devils River	26. Pecos River	27. Lavaca River
Sample not available	OUACHITA ROCK-POCKETBOOK (*Arkansia wheeleri*)[1]			X																								
	SPIKE (*Elliptio dilatata*)																			O								
	PLAIN POCKETBOOK (*Lampsilis cardium*)			X		X																						
	SOUTHERN HICKORYNUT (*Obovaria jacksoniana*)[2]			X	X	X	X		X	X	X														X	X	X	
	TEXAS HORNSHELL (*Popenaias popei*)[3]																								X			
	SALINA MUCKET (*Potamilus salinasensis*)[2]																								O			
	RIO GRANDE MONKEYFACE (*Quadrula couchlana*)[4]																											
	WARTYBACK (*Quadrula nodulata*)			X		X	O		X																			
	PIMPLEBACK (*Quadrula pustulosa*)			X		X			X																			
	FALSE SPIKE (*Quincuncina mitchelli*)[1]											O			X		?	?			X				X		O	
	SQUAWFOOT (*Strophitus undulatus*)				X	X	X	O	X	O	O				X	O	?	?			X	X						
	MEXICAN FAWNSFOOT (*Truncilla cognata*)[2]																								X			
	LITTLE SPECTACLECASE (*Villosa lienosa*)				X	X	X	X	X	X	X																	
	Family: Corbiculidae																											
	ASIAN CLAM (Corbicula sp(p).)	Introduced species occurring in all major river systems in Texas (Howells et al.1996).																										
	CAROLINA MARSHCLAM (Polymesoda caroliniana)	Occurs typically in coastal areas (Howells et al. 1996).																										
	Family: Mactridae																											
	ATLANTIC RANGIA (Rangia cuneata	Occurs in coastal areas, historically listed in the Nueces River from Green and Mission lakes, in the																										
	Family: Dreissenidae																											
	ZEBRA MUSSEL (Dreissena polymorpha)	Introduced species first found in Lake St. Clair in 1988. Not present in Texas as of 1994 (Howells et al 1996).																										
	DARK FALSEMUSSEL (Mytilopsis leucophaeata)	Occurs in low-salinity brackish and fresh waters in or near coastal rivers (Howells et al.1996)																										
	Family: Sphaeriidae																											
	FINGERNAIL CLAMS	Generally not common, but widely occurring across the state (Howells et al.1996)																										

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[1] **Federal Endangered Species**
[2] **State Rank (S1) - Critically imperiled, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences**
[3] **State Rank (S2) - Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences**
[4] **State Rank (SH) - Of historical occurrence in state. May be rediscovered.**
[5] **State Rank (S?) - Not ranked to date**

X = Occurences (within last 30 years)
O = Historical Occurences (over 30 years old)

* = May ... reduced population
? = Unknown if mussel populations still exist

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TEXAS MUSSEL WATCH

VOLUNTEER MONITORING PROJECT

Texas Parks and Wildlife

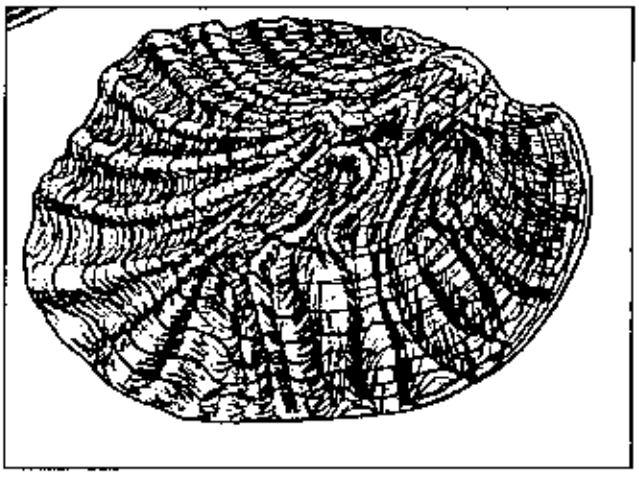
INTRODUCTION

Native freshwater mussels are important elements of aquatic ecosystems, subjects of valuable sport and commercial fisheries, and barometers of environmental quality. When environmental conditions degrade, they are among the first organisms to decline and vanish. Indeed, among the 300 or so species of freshwater mussels in North America, over half are already extinct, endangered, or threatened. Unlike most plants and animals, when freshwater mussels die, they leave behind shells that often record past events. Knowledge about which species were present once and which are present (if any) now, often provides volumes of information.

Despite their importance, prior to 1992, very little work had been done with freshwater mussels in Texas. Since January 1992, Texas Parks and Wildlife (TPW) has examined over 1,300 sites in all major drainage basins around the state to ascertain the status of our mussel populations. However, Texas is a big state and many areas have yet to be studied. Further, mussel population status can change rapidly over short periods of time requiring constant reexamination of known populations. Additionally, sites with reduced mussel abundance or which may contain very rare species may have mussels surviving in small areas of microhabitat that can be difficult to locate.

From the onset of field work with freshwater mussels, interested volunteers have periodically collected and sent specimens to Heart of the Hills Research Station for identification. We have now established a more-formal group of volunteers that can survey mussel populations throughout the state. These efforts will not only provide up-to-date mussel distribution and status data, but will also yield insight into water quality and other environmental conditions in Texas.

WASHBOARD JUVENILE (*Megalonaias nervosa*)



FRESHWATER MUSSELS: A UNIQUE GROUP OF ANIMALS

TERMINOLOGY

Naiad (or naiade): Refers to freshwater mussels of the family Unionidae (and Margaritiferidae in other states). This term is also applied to aquatic larvae of some insects. There are other bivalve shellfishes that live in fresh water as well, but which belong to other families including Asian clams, fingernail clams, and zebra mussels.

Mussels: This is a common term that can be applied to many families and species of bivalve shellfishes from freshwater, estuarine, and marine environments. It can be a catch-all term for any bivalve mollusk (Bivalvia or Pelecypoda). "Mussel" is also applied commonly to marine mussels like blue mussels (*Mytilus edulis*) that are harvested for human consumption and that produce adhesive threads (byssus or byssal threads) for attachment to solid objects (native freshwater mussels do not possess these adhesive threads as adults).

Clams: This too is a common term that can be applied to many families and species of bivalve shellfishes from freshwater, estuarine, and marine environments. It can also be a catch-all for any bivalve mollusk.

Unionids: This refers to members of the family Unionidae. Local musselers sometime corrupt this by calling all freshwater mussels "unios." However, the genus *Unio* is a group of European and northern Asian species; none occur in the U.S. This term refers specifically to freshwater mussels (Unionidae) and not to other freshwater-dwelling bivalves like Asian clams, fingernail clams, or zebra mussels.

Shellfish: This collective term includes both mollusks (*e.g.*, snails, squid, clams) and crustaceans (*e.g.*, crabs, lobsters, prawns). It does not specifically mean freshwater mussels.

FRESHWATER MUSSEL BIOLOGY

Habitat

Freshwater mussels dig into the bottoms of rivers, streams, ponds, lakes, and reservoirs. As adults, they do not produce adhesive byssal threads to attach to solid objects like marine mussels and zebra mussels (some juvenile unionids may develop such threads). Some require clean, flowing waters and some have evolved to live in static waters without current, but others are tolerant of a wide variety of environmental conditions. They prefer substrates of mud, sand, and gravel, but usually avoid deep-soft silt, deep-shifting sands, and scoured boulders and bedrock. Some thin-shelled species may be able to lie on very soft bottoms in which heavy-shelled mussels would sink and smother. Freshwater mussels often prefer harder, calcium-rich waters.

Feeding

All mussels filter-feed on algae, detritus, and small particles in the water, and may be able to absorb organic molecules in solution. Freshwater mussels are Mother Nature's biofilters. They filter and clean the aquatic environment, and also concentrate contaminants like pesticides, heavy metals, and bacteria. In turn, freshwater mussels are eaten by other animals ranging from freshwater drum to muskrats.

Reproduction

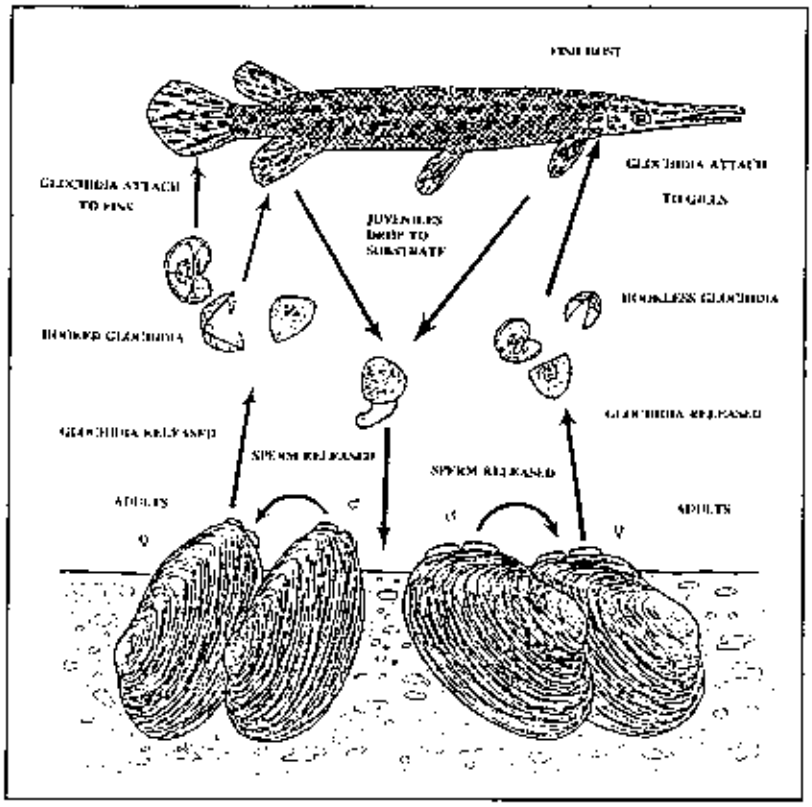
A unique aspect of mussel biology is their method of reproduction. All, but perhaps three of the 300 or so species in North America, have a larval stage that requires a fish host (or in one case a salamander). Larval mussels, called glochidia, are parasites on fish. In most mussels, sexes are separate. Males release sperm into the water that in turn enter the female through one of her siphon tubes. Eggs and larvae are held in pouches called marsupia on the female's gills. When sufficiently mature, the glochidia are released. Mussel glochidia are often host specific and can only survive on certain species of fish. Some require a single species of fish, but others may use a wide variety of host fish. Still, not just any fish will do. They also usually attach to either gills or fins (rarely elsewhere). Once released from the mother, the glochidia must find the appropriate species of fish in a short time and attach to the correct place on the fish or they will die. Successfully encysted glochidia remain on their host for a few weeks or months, then drop to the bottom and begin life in the substrate.

In nature, parasitic glochidia almost never harm their hosts. Indeed, fish can develop an immunity to reinfection by other glochidia. This immunity may also apply to other more harmful parasites like anchor worms. In short, healthy mussel populations can mean healthier fish populations.

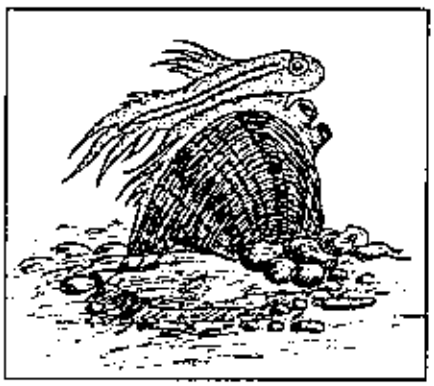
Freshwater mussels use a variety of methods to deliver glochidia to potential host fish. The simplest approach involves discharging glochidia singly or in small groups, and hoping they happen to encounter an appropriate fish. A more complex approach involves releasing glochidia in groups in mucus packets called "conglutinate masses." The conglutinates are designed to be eaten by fish (thereby delivering the glochidia to the fish's gills). They often resemble insect

larvae, worms, or even larval fishes. In yet another approach, females of some species develop soft-tissue flaps (mantle flaps) that resemble fish, worms, or insects. Females carrying developed glochida ready for release may wiggle these "lures" to bring potential host fish closer and increase the chances of her young finding a host. For example, Texas lilliput (*Toxolasma texasiensis*) females have two worm-like lures (caruncles) that they actively wiggle. Texas fatmucket (*Lampsilis bracteata*) and sandbank pocketbook (*Lampsilis santra*) have mantle flaps that resemble small fish. Some other mussels have net-like mucus structures around their glochidia to entangle potential hosts. One high-tech approach involves placing all glochidia in a "lure" and sending it downstream several feet on a thin mucus thread. These "super conglutinates" dart about in the current to attract host fish.

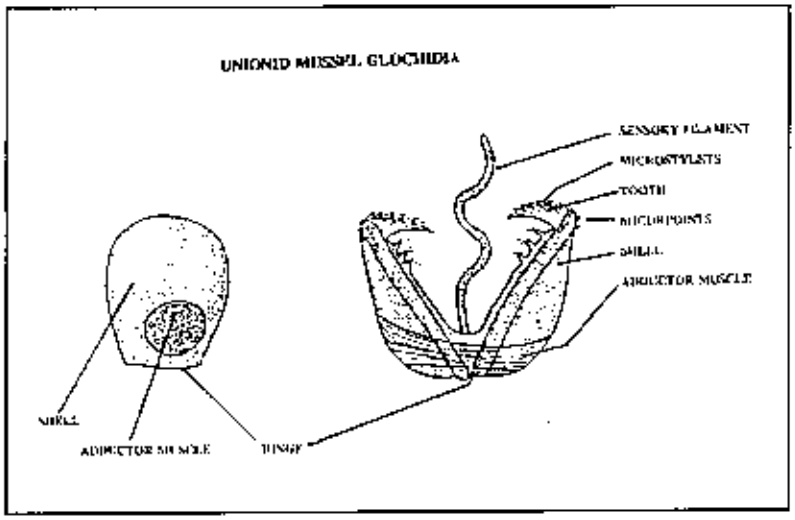
FRESHWATER MUSSEL LIFE CYCLE



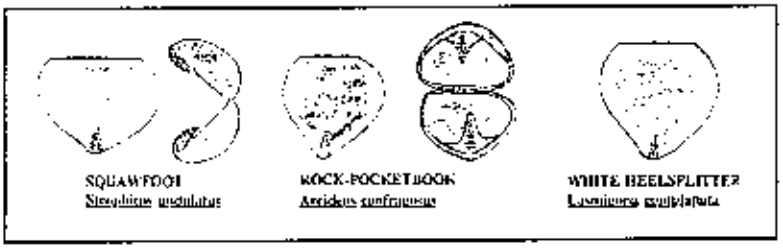
TEXAS FATMUCKET (*Lampsilis bracteata*)
FEMALE MANTLE FLAP

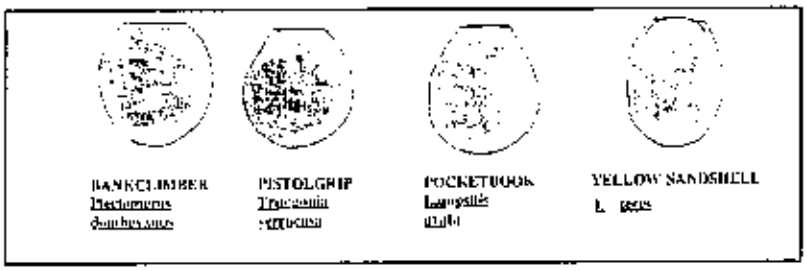


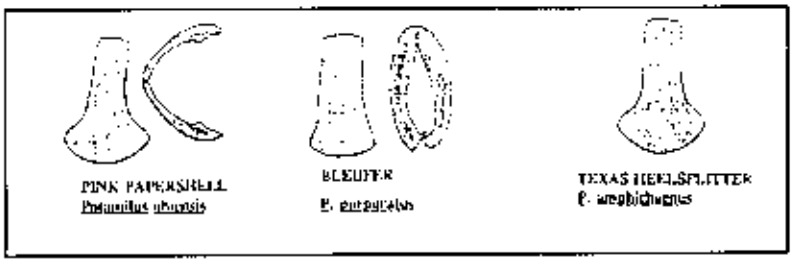
FRESHWATER MUSSEL GLOCHIDIA (ANATOMY)



FRESHWATER MUSSEL GLOCHIDIA (MAJOR FORMS)







REASONS FOR RECENT POPULATION DECLINES

Many factors are responsible for declines seen recently in many freshwater mussel populations. These losses are not restricted to Texas, but are taking place throughout the U.S. and around the world. Certainly pollution from many sources has eliminated mussels from some water bodies. Over harvest has occurred, including at some sites in Texas. However, most causes for declines are far more complex and often reflect wide-ranging overall environmental changes.

In many areas of northern, southern, western, and central Texas, extensive overgrazing that began shortly after the Civil War has dramatically reduced or changed natural vegetative cover. At the same time, wells drilled to pump aquifer waters to people, crops, and livestock have reduced spring and river flows in some areas. Extensive tracts of land have been cleared for homes, businesses, highways, and other human activities. Additionally, rainfall patterns have changed. Many areas now experience an average of more rainfall than 90 to 100 years ago. However, this precipitation comes less often as light or moderate showers and more frequently as severe storms separated by periods of drought. Combined, these factors result in more runoff and more frequent, more destructive scouring floods. Scouring floods during the past 20 to 30 years have removed both mussels themselves and the softer substrates they require. For example, prior to 1900 Kerr County in Central Texas had not recorded a flood over a 6-foot rise. But that year a major flood struck. By 1939, researchers were reporting that scouring floods were increasing in intensity and frequency. They identified the problem then as the most significant threat to the aquatic environment. This trend has continued. Many river systems no longer support the mussel populations they had as recently as the 1970s, including the Medina, upper Guadalupe, Pedernales, Blanco, San Marcos, Llano, and parts of the San Saba rivers. Some, like the Llano River that was internationally known in the 1800s for is mussels and pearls, no longer appear to support any established mussel fauna at all.

Many mussel populations in eastern Texas remained healthier longer than in other parts of the state. However, recent building developments, highway construction, and land clearing have altered natural vegetative cover that disturbed fragile, sandy soils and resulted in erosion problems. Often even minor modification or removal of terrestrial vegetation causes extensive sand deposition in local rivers and streams. Other areas may see accumulations of deep, soft silt. Substrates of both deep, shifting sand and deep, soft silt are unacceptable habitats for nearly all mussels. Some eastern Texas streams that held significant mussel populations less than 20 years ago have now been smothered in sand or silt and no longer support any unionids. Sand deposition has also been a problem in some Central Texas rivers like the Llano.

Introduced exotic bivalves have not usually been implicated in mussel losses here, but have been directly responsible for declines elsewhere and are now threatening Texas. Asian clams (*Corbicula* spp.) invaded Texas in the 1960s. Although it has been found here in densities exceeding 2,000/m^2, its potential negative impacts on native mussels are far from clear and some authorities doubt how harmful it actually is. Undesirable competition between Asian clams and unionids seems likely, however.

Another exotic bivalve, the zebra mussel, *Dreissena polymorpha* (Family Dreissenidae), invaded the Great Lakes from Europe in the 1980s. A second species, quagga mussel (*D. bugensis*) has

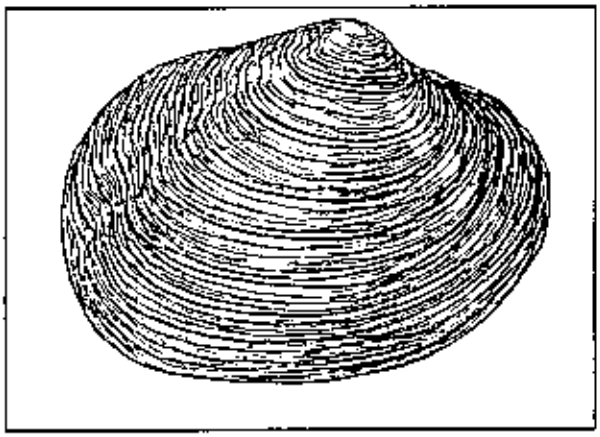
appeared there more recently as well. Zebra mussels escaped the Great Lakes, entered the upper Mississippi River and within a single year progressed downstream to New Orleans. Zebra mussels now occur in Oklahoma, Arkansas, and Louisiana. Unlike other freshwater bivalves in North America, zebra mussels have byssal threads and attach to solid objects as many marine mussels do. They may grow in water pipes, on buoys, and even covering native mussels (over 10,000 have been reported on a single native unionid) to the point of causing their deaths. Zebra mussels are not established in Texas...yet. However, in the fall of 1999, a large boat was transported from Lake Michigan to Lake Grapevine north of Fort Worth in Texas. The marina owner who received the boat noticed zebra mussels on it and called TPWD. The boat was cleaned and the zebra mussels were killed before it was launched. Nevertheless, zebra mussels were within a few feet of entering Texas' waters. Native freshwater mussels have largely been eliminated from western Lake Erie by zebra mussels. Will this be allowed to happen in Texas?

Excessive amounts of aquatic plants can also displace mussels. Overgrowth of native species caused by excess nutrient loads and rapidly growing exotic plants like hydrilla and water hyacinths, can all harm mussel populations.

Things that negatively impact the complex reproductive cycles of freshwater mussels are also responsible for declines. Dams that block fish from reaching mussel beds can eliminate successful reproduction. So, too, can fishery management practices that remove or replace critical host fishes. In other cases, mussels that use visual means to attract fish hosts could be harmed by increasing levels of turbidity. Other mussels require clean, washed, gravel substrates. Even limited amounts of silt deposition are unacceptable and can extirpate them from impacted areas. Other species cannot tolerate impoundment. As reservoirs have been built, some species have been advantaged, but others have declined.

With natural and man-made changes, threatening exotic species, and general lack of understanding and awareness of both mussels and the problems they face, the future unfortunately looks dim for many freshwater mussel species. Far too many Texas rivers now contain only old, subfossil shells to indicate what once was, but is no more.

GOLDEN ORB (*Quadrula aurea*)



IDENTIFICATION OF FRESHWATER MUSSELS

Unfortunately, freshwater mussels can be rather difficult to identify, especially for the novice. Historically, identification literature was limited, difficult to obtain, and even more difficult to understand. Specimen identity is further confounded by the extremely plastic variability many species display. In some cases, the same species can look quite different in different river systems, between still and flowing waters, or in big rivers or headwater streams. Some change dramatically with age. Other species may be sexually dimorphic, where males and females look very different from each other. Even experts still disagree on the classification of some forms.

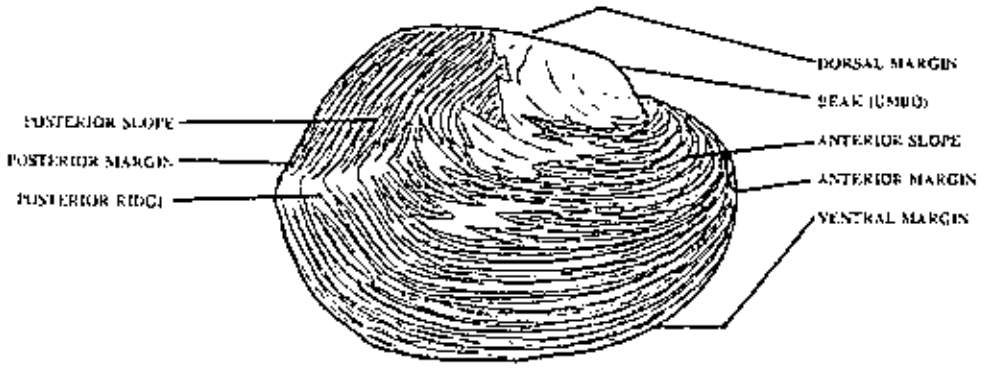
However, like many other disciplines, with the right information, mussel identification is not all that difficult. Some of the general traits to observe are:

1) **General Shape** – a) oval, triangular, etc. b) long or short c) compressed or inflated.
2) **External Features** – a) smooth or sculptured b) ridged, pimpled, etc. c) winged (alate) or not.
3) **Shell Thickness** – very thick to very thin.
4) **External Coloration** – a) color b) glossy to dull c) rayed or not (spoke-like marking).
5) **Internal Coloration** – a) color b) glossy to dull c) iridescent or not.
6) **Pseudocardinal Teeth** – a) present or absent b) number, size, shape, position, etc.
7) **Lateral Teeth** - – a) present or absent b) number, size, shape, position, etc.
8) **Other features:** Numerous other features can also be helpful; some of these include:
    a. **Beak shape and sculpturing**
    b. **Position of brood pouches on gills**
    c. **Siphon length**
    d. **Coloration of soft tissues**
    e. **Glochidial morphology**

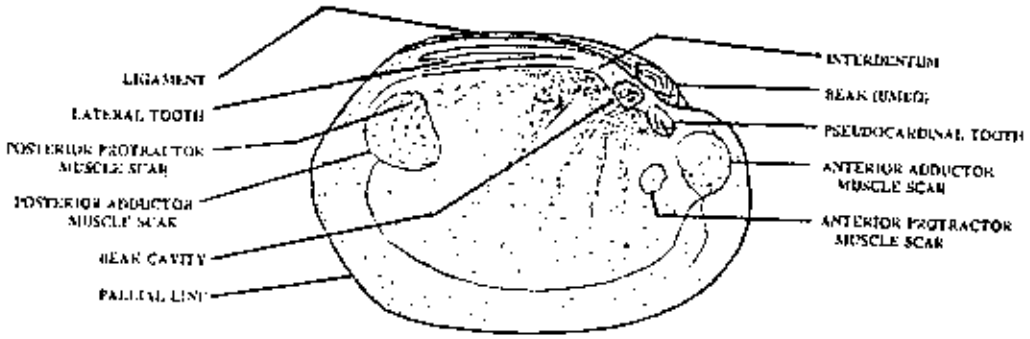
Examine the figures on the following pages. Note the names and terms for various shell and soft tissue parts. These are often critical in mussel identification. Finally, always remember freshwater mussels are an extremely variable group. There is often as much or more variation within a species as there is between species. Remember, freshwater mussels can look different in different environments.

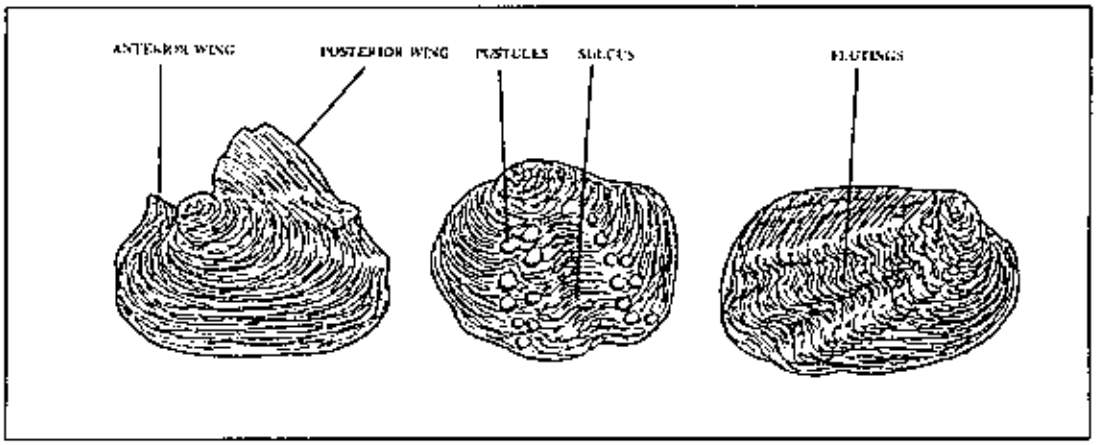
Although taxonomic keys are sometimes used to assist with mussel identification, the extremely variable nature of these animals makes keys either inaccurate or requires a long list of exceptions to nearly every couplet. For example, threeridge mussels (*Amblema plicata*) typically have 3-7 diagonal ridges across the shell. However, juveniles from the central Colorado River in Texas usually have no ridges at all. Others populations from the central Brazos and upper Trinity rivers may completely lack ridges even as adults. Conversely, specimens from the Neches River display numerous, large, strongly pronounced ridges, as do others from Big Cypress Bayou. Threeridges from the lower Nueces, central Guadalupe, and central Brazos rivers often show cross-hatch patterns (more-typically seen in other species like washboards, *Megalonaias nervosa*). Such variability has discouraged some workers, but consider it a challenge, not an obstacle.

EXTERNAL SHELL FEATURES

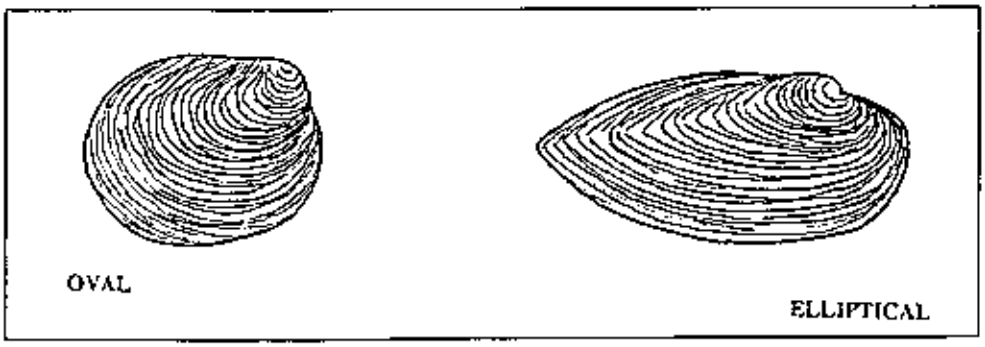


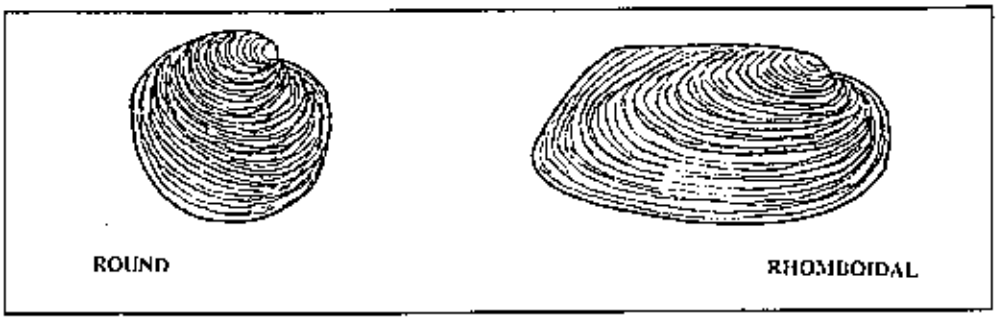
INTERNAL SHELL FEATURES

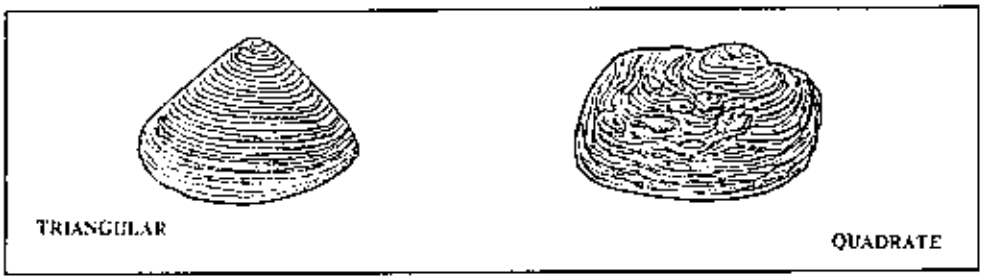


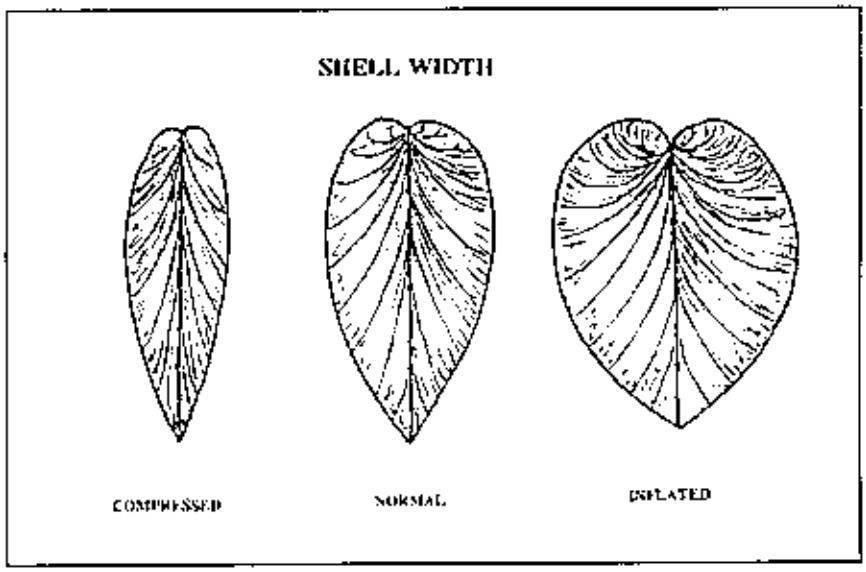


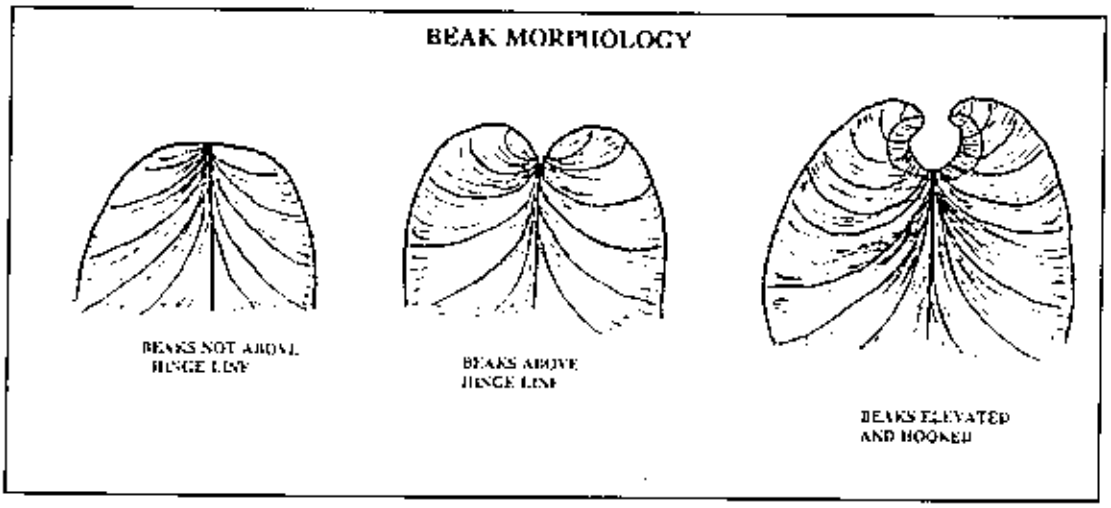
SHELL SHAPE


OVAL
ELLIPTICAL

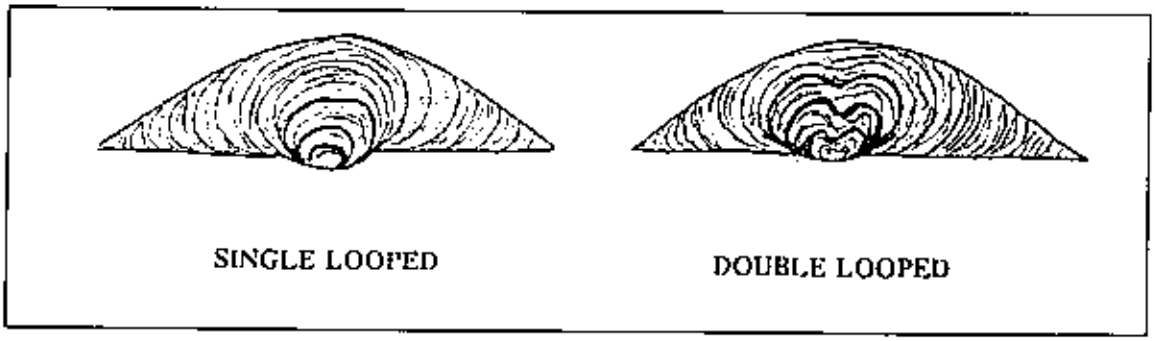

ROUND
RHOMBOIDAL

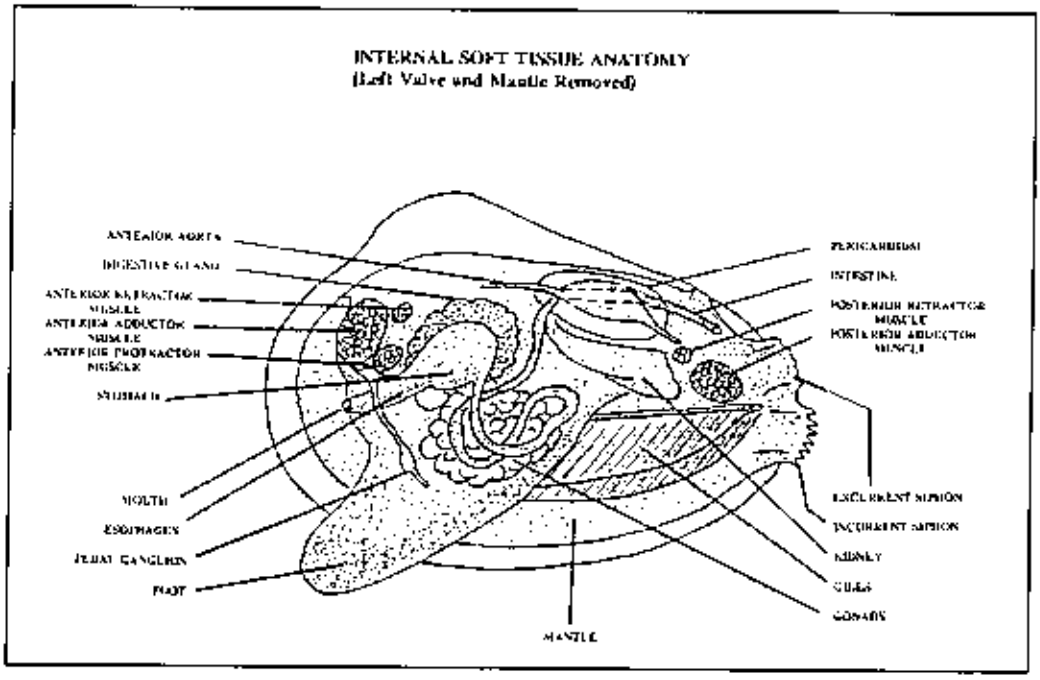

TRIANGULAR
QUADRATE


SHELL WIDTH
COMPRESSED
NORMAL
INFLATED



BEAK SCULPTURE





HARVEST OF FRESHWATER MUSSELS

HISTORICAL HARVEST

Freshwater mussels were harvested by Native Americans long before European contact and used for decorations, for tools, and for food. They also collected and used the freshwater pearls they found. Spanish explorers entering Texas quickly recognized the value of freshwater pearls. In 1654, Spanish soldiers came to the *Rio Conchos* (river of shells, now our Concho River) to find pearls. They reportedly enlisted local Indians in this effort. Although pearl harvest then was well below expectations, missions and the city of San Angelo developed from this effort. The humble mussel became a direct part of Texas history. Freshwater mussels were also harvested for pearls in Texas in the 1800s, but with little documentation. In 1909, Caddo Lake in northeastern Texas became the site of an internationally-known pearl rush following the discovery of two, large, gem-quality pearls. The fishery ended several years later when a dam constructed downstream caused lake levels to rise making harvest more difficult.

During the 1890s and well into the present century, freshwater mussels were extensively harvested in the Mississippi River Valley for their shells that were used to make buttons. This harvest was so intense and beds were being depleted so rapidly, the U.S. Fish Commission established a facility in Iowa to study mussels. A large volume of scientific data on freshwater mussels and the mussel fishery was produced from about 1895 until about 1930. Most of the shell fishery for buttons and associated government research extended only about as far southwest as Arkansas. Transportation costs prohibited wide-scale harvest in Texas. However, smaller, local button factories did develop in Texas, including operations in Mercedes and San Antonio, but were low-volume and short lived. Most Texas populations remained both unfished and unstudied. The shell-button industry largely faded away with the development of plastic in the mid-1900s.

CURRENT MUSSEL HARVEST IN TEXAS

Shells

Most harvest in Texas at present focuses on three primary types of mussels that are taken for their shells. These include washboard (*Megalonaias nervosa*), threeridge (*Amblema plicata*), mapleleafs (*Quadrula* spp.; primarily *Q. apiculata* in most of the state). These species are selected because they have thick, hard shells that have white nacres. These shells are, in turn, sold to shell buyers that export most to Japan and other countries for use in the cultured pearl trade. Native freshwater mussel shells are used to make cultured pearl implant nuclei (no one actually uses sand grains). Until recently, and still with only a few exceptions, a cultured pearl is about 99% North American freshwater mussel shell with only a thin veneer of pearly coating over it. Nothing else works quite as well as an implant nucleus. Freshwater mussels with thin or brittle shells, or those with colored nacres, are not used for this purpose. Musselers responding to a 1992 questionnaire reported harvesting between 600 and 1,200 tons from Texas in 1991. This trend declined over the past three or four years due to massive dieoffs among Japanese pearl-culture oysters; however, shell harvest dramatically increased in some other states in 1999

and 2000. Shellers usually focus on several species and larger sized specimens (though some may take animals below minimum legal limits in one state and transport them to other states for sale where minimum sizes are lower) and shell buyers usually avoid buying odd species or small shells. In some ways, this fishery tends to be somewhat self-regulating regarding species and size limits.

Pearls

Many people are surprised to find that freshwater mussels produce gem-quality pearls. Indeed, many produce high quality pearls. Texas pearls are reportedly among some of Europe's crown jewels. Although many mussels can produce gem-quality pearls, most do so only very rarely and other species never produce valuable pearls at all. Tampico pearlymussels (*Cyrtonaias tampicoensis*) are the source of the famous "Concho River pearls" that are often purple or pink in color. This species produces pearls somewhat more frequently than other unionids and is found only in Texas and northeastern Mexico. In San Angelo, San Antonio, and elsewhere in Texas, jewelers often specialize in jewelry made from local pearls. Because small mussels occasionally produce large pearls, some pearlers are less judicious about minimum-size regulations than many shell harvesters.

Pearl Culture

Cultured pearls can be produced in freshwater mussels exactly as they are in marine pearl oysters. One commercial, freshwater pearl-culture operation has been in business in Tennessee for some years and others do so in China and Japan. Several individuals in Texas have reported pearl-culture efforts locally, but at very limited levels. More-recently one university and other individuals have started to investigate developing this industry here. Producing cultured pearls from freshwater mussels requires both harvest of mussels with white nacre for implant nuclei and harvest of living specimens (of several species) to be implanted.

Meat (non-human uses)

Mussel meat is usually discarded by shell and pearl musselers. Some may use or sell this meat for trotline bait and anglers sometimes directly harvest mussels specifically for live bait. Although shellers usually avoid harvesting specimens that are too small to be sold, anglers using mussel meat for bait are much less concerned with species or size, and may take juveniles or rare species.

Meat (human consumption)

Although Native Americans did harvest and eat freshwater mussels, this practice preceded current pollution and environmental problems. Freshwater mussels concentrate organic pesticides, heavy metals, and bacteria. Subsequently, it is illegal in Texas to harvest freshwater mussels for human consumption today. State health department rules prohibit taking bivalve shellfish for human consumption from freshwater areas. Additionally, freshwater mussels are typically tough and lack flavor. Eating them could pose a potential health risk and is unlikely to be a culinary treat.

HARVEST REGULATIONS IN TEXAS

In Texas, harvest of any bivalve shellfish, or their shells, requires either a fishing license, commercial mussel license, or scientific collection permit. Even volunteers cannot take bivalve shells legally without being covered under one of these licenses or permits. Although mussel harvest regulations apply only to freshwater mussels, licensing requirements apply to all bivalve shellfish. Technically, taking a cockle or scallop shell along the Gulf Coast at Corpus Christi requires a license. Luckily such regulations are probably never enforced relative to sea shells.

Overview

In Texas, most commercial harvesters use an air pump, called a hookah pump, in a float or boat with air lines down to one or more divers on the bottom. A few use SCUBA. Other musselers wade or snorkel in shallow water. Visibility is usually minimal on muddy bottoms where mussels are most abundant. Some musselers wade or use an inner tube to feel for mussels with their feet (toe digging). Mussels are typically collected by hand (or feet) by feeling carefully along the bottom. All these methods are legal in Texas, but actual collection must be by hand.

Dredges that are pulled along the bottom or suction-type dredges have been used in Texas to harvest mussels. Although the state legislature still allows TPWD to issue dredge permits, currently none are being issued. Another devise called a brail or crowfoot has been commonly used elsewhere, but apparently has been infrequent in Texas (and is now illegal).

Licensing Laws from the Texas Legislature (Parks and Wildlife Code: Chapter 78)

The present state law concerning licensing freshwater mussel harvest was enacted by the Texas Legislature in 1993. Prior to that time, Texas had only a single mussel harvest license for sport and commercial harvest and no specific license for shell buyers. The current state code includes:

- Licensing code applies to all freshwater and marine bivalve harvest, except those covered under other chapters (*e.g.*, marine oysters). An interesting quirk of this law is that it covers both living animals and shells alike. Technically, a grandmother collecting cockle or scallop shells along the beach would be required to have either a mussel and clam fisherman's license; fishing license, scientific collecting permit, or be old enough to be exempted.

- Commercial mussel and clam fisherman's licenses:
  - Covers harvest of over 25 pounds of whole animals or over 12 pounds of shells/day.
  - Resident license $30.00.
  - Non-resident license $800.00
  - License period extends from 1 September through 31 August.

- Commercial shell buyer's licenses:
  - Covers those who purchase whole bivalves or shells
  - Resident license $100.00
  - Non-resident license $1,500.00

- Harvest for personal use under a fishing license:

  Up to 25 pounds of whole animals or 12 pounds of shell may be harvested each day under a fishing license. Although this aspect of the code is useful to anglers that take small numbers for use as live bait, it confounds our ability to closely monitor aspects of the mussel fishery. Pearl harvesters, for example, may collect several specimens, open them, then discard all but the pearls without ever being in possession of the bag limit. Some commercial shellers have actually fielded large families with each member claiming 25 pounds at a time. In both cases, substantial undocumented harvest may occur.

- Shell export fee:

  The Texas Legislature authorized Texas Parks and Wildlife to charge $0.03 per pound (or other value set by the Commission) on mussel shell exported from the state. Any monies raised by this export fee were to be directed into research, mitigation, and management activities related to mussels and clams. However, to date, the Department has chosen not to levy this export fee.

Current TPWD Mussel Regulations

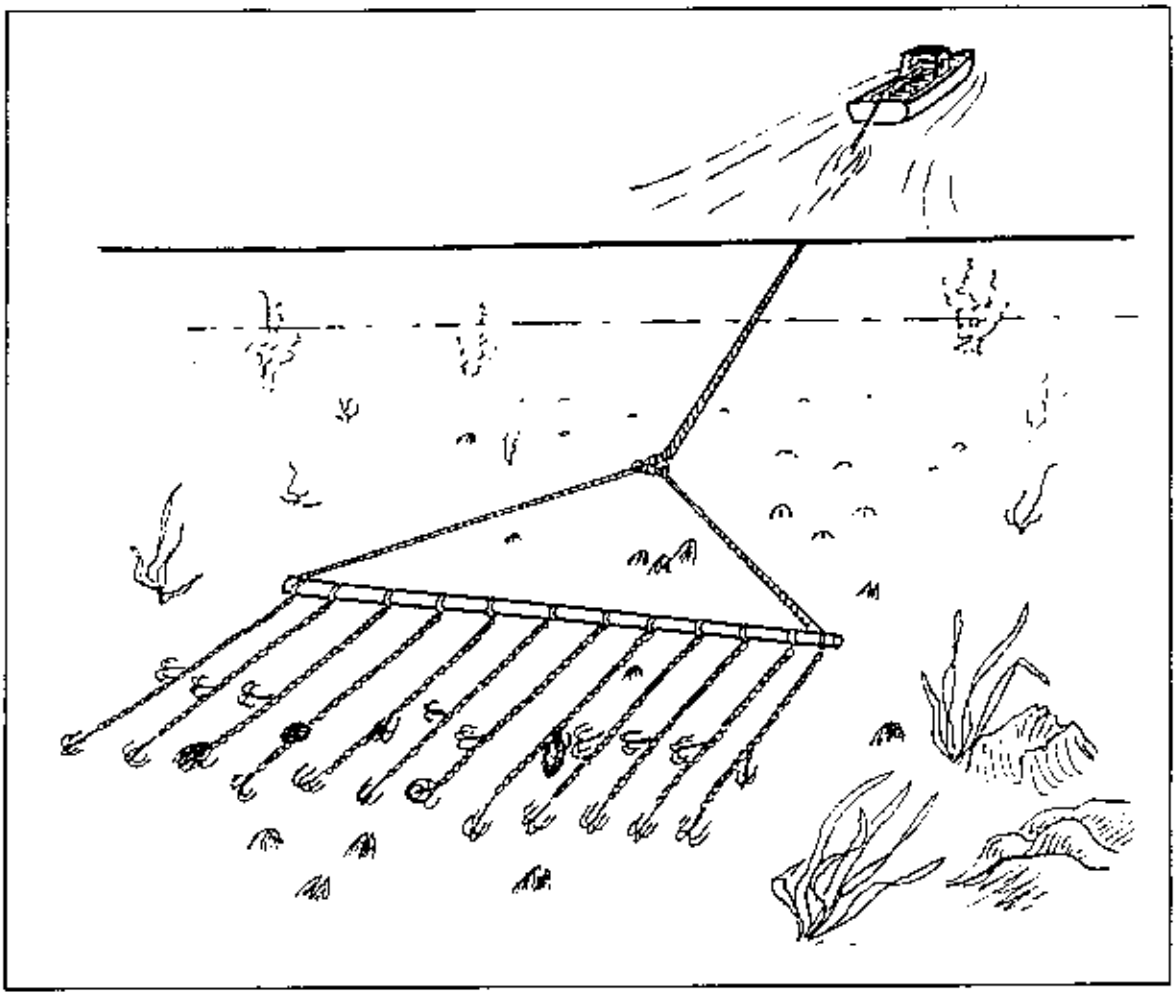
The Department's first mussel harvest regulations were written in early 1992 and went into effect in September 1992. They have been modified several times since. These regulations (unlike licensing laws from the Legislature) apply specifically to freshwater mussels (Family: Unionidae) only. Primary points include:

- No harvest for human consumption (clearly stated).
- Harvest by hand only. No restrictions on diving gear.
- No harvest after dark (30 minutes before sunrise and 30 minutes after sunset).
- Bag limits:
  - None Monday through Friday.
  - No more than 75 pounds/day on Saturday and Sunday.
  - No more than 75 pounds/day in possession within 500 yards of public waters on Saturday or Sunday.
- Minimum harvest size (based on passing the mussel through a ring with a specified inside diameter):
  - Washboards 4.00 inches
  - Threeridges and roundlakes 2.75 inches
  - Mapleleafs and pimplebacks 2.75 inches
  - Tampico pearlymussels 2.75 inches
  - Bleufer 2.75 inches
  - All other species 2.50 inches

- No-harvest mussel sanctuaries established at 25 locations statewide.

CAUTION !!!!! Harvest regulations can change at any time. Always check to determine the most-recent regulations in place before harvesting freshwater mussels.

BRAIL AND CROWFOOT HOOKS BEING TOWED BEHIND A BOAT



THREATENED AND ENDANGERED MUSSELS

Sadly, many freshwater mussels in Texas, like those elsewhere, are already very rare. Several may well be extinct. Nevertheless, only one species, the Ouachita rock-pocketbook (*Arkansia wheeleri*), is listed by the U.S. Fish and Wildlife Service or TPW as "endangered." It has only been found in two small streams in Lamar County between Paris and the Red River. Only two recently-dead shells have been found in Texas. No other taxa in Texas are listed for legal protection, other than under harvest regulations, regardless of their rarity.

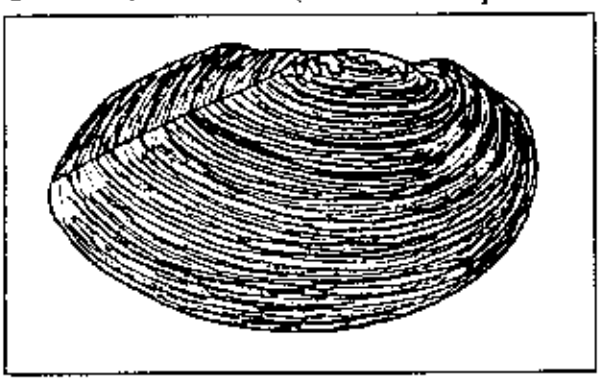
The endemic species in the Rio Grande are all problematic. Rio Grande monkeyface (*Quadrula couchiana*) has not been seen alive here since 1898. Mexican fawnsfoot (*Truncilla cognata*) has not been seen alive since 1972. Texas hornshell (*Popenaias popei*) and Salina mucket (*Potamilus salinasensis*) have only been represented in recent years by several recently-dead shells found downstream of Big Bend National Park (however, the former is still maintaining a living population in the Black River, New Mexico). Another species, false spike (*Quincuncina mitchelli*) has not been documented alive in the Rio Grande in decades and in Central Texas, has only been found as long-dead and subfossil shells since the late 1970s.

Among species endemic to Central Texas, Texas fatmucket (*Lampsilis bracteata*) and Texas pimpleback (*Quadrula petrina*), have only been found at four sites each in over 10 years. Golden orb (*Q. aurea*) has only recently been found at a fifth site on the San Marcos River. Further, several of these locations became completely dry during drought conditions in 1998 and 1999. Two other endemic species, smooth pimpleback (*Q. houstonensis*) and Texas fawnsfoot (*T. macrodon*), appear to have been reduced to a few small populations in the Brazos and Colorado drainages.

In eastern Texas, Texas heelsplitter (*Potamilus amphichaenus*) has only been known from about 250 specimens since it was described in 1898. However, it still maintains limited populations in the Sabine, Neches, and Trinity rivers (the only places where it occurs). Sandbank pocketbook (*L. satura*) seems restricted in Texas to a few stragglers in the Sabine River and one site on the Neches River, but is apparently more common in Arkansas and Louisiana. In Texas, Louisiana pigtoe (*Pleurobema riddellii*) has only been found alive twice in the past 10 years and southern hickorynut (*Obovaria jacksoniana*) has not been seen alive at all over the same time period.

Other species like plain pocketbook (*L. cardium*) and squawfoot or creeper (*Strophitus undulates*), both on the southwestern limit of their ranges in Texas, have also remained elusive in recent years.

TEXAS HEELSPLITTER (*Potamilus amphichaenus*)



TEXAS MUSSEL WATCH: VOLUNTEER MONITORING

Basic Assumptions and Cautions

Unfortunately, unlike some other states, Texas does not have a volunteer permit system available to identify individuals who are assisting the Department with its work. Again, collection or harvest of freshwater mussels requires a 1) fishing license, 2) commercial clam and mussel license, or 3) scientific collecting permit. Currently, Mussel Watch volunteers are listed as assistants under the scientific collection permit of Ann Miller and each is provided a letter explaining his/her involvement with the program. Volunteers should be aware that collection of even a dead mussel shell without a permit could be defined as a violation of state law or departmental regulations. Note also that any individual could purchase a Texas fishing license and legally harvest freshwater mussels with minimum size limits applying to such harvest. Sampling under a scientific permit includes all sizes of mussels. Check with TPW staff before attempting any collection efforts.

General Volunteer Collection Methods

Sampling Locations:

1) Exposed sand and gravel bars.
2) River and lake bottoms during low-water periods (droughts, drawdowns, etc.).
3) Shallow-water areas.

Sampling locations fall into two basic groups: (1) locations that have been surveyed for freshwater mussels at an earlier date and are being reexamined and (2) sites that have never been examined.

Sampling Methods:

1) Casual collection of specimens (no measure of time, area, or effort).
2) Number per unit of time (*e.g.*, 20 per man-hour).
3) Number per unit of area (*e.g.*, 20 per 100 square meters).
4) Number per unit of distance (*e.g.*, 20 in 100 meters of shoreline).
5) Number per 6.1-m transect.

   In this case, a rope 6.1-m (20 ft) long is stretched between two poles. This is placed randomly on the substrate. Volunteers move along the rope and collect all mussels and shells found within about 0.67 m (2 ft) on each side of the rope. This can be repeated any number of times.
6) Number per 0.25-m^2 quadrat.

   This requires making a square 0.5 m on each side. Among the least-costly material is PVC pipe (4 right angles and 4, 0.5-m lengths of pipe of any smaller diameter). Assemble and drill holes in the pipe to allow water to enter and leave, or add gravel or other material to weight the pipe before assembly. This device is then randomly placed on the bottom and all specimens inside are collected.

Methods 1-4 will probably be used most frequently. It is often not cost-effective to use the 6.1-m transect or 0.25-m^2 quadrat method at very low densities. In both cases, mussel densities must be relatively high (several specimens per m^2) or many samples (often 50-100, or more) must be taken to obtain statistically valid data.

Without authorization, volunteers should never use SCUBA or hookah diving, snorkeling, or other sampling gears like dredges and brails to obtain Mussel Watch data. In special cases, these methods may be permissible, but only after review of the personnel involved and sites to be sampled.

Data Collected:

1) Species.
2) Number (or number/time, number/area, number/effort).
3) Specimen condition (living, recently dead, etc.; see other descriptions herein).
4) Other bivalve species (Asian clams, fingernail clams, etc.).
5) Other data (data sheets have blanks for site-specific data as available). For example, data sheets have a space for water temperature. This is often useful data to have. If it is known, record it, but do not pass up an opportunity to collect data on mussels present because a thermometer was not available.

Remember, even finding nothing in an area not previously examined, or at a site studied in the past, is important. Record it. Not finding any mussels can be significant data. Also remember, even an otherwise important specimen can be nearly worthless without appropriate collection data (date, location, etc.).

Specimens Retained or Shipped to Texas Mussel Watch:

Ideally, volunteers would identify all specimens found, record these on a data sheet, and mail the data sheet to Ann Miller, Volunteer Coordinator (mailing address, phone, fax, and Email are given below). It may be difficult to accurately identify every specimen, especially at the onset of sampling efforts. Identification guides (and sometimes reference specimens) should help with classification. However, specimens whose identifications are uncertain should be mailed or taken to Texas Mussel Watch as needed. If questions about living animals arise, contact Ann Miller for advice on a case by case basis.

Specimens being mailed to Texas Mussel Watch should be rinsed or washed free of soft tissues or other organic material that may produce objectionable odors. Specimens should be sealed in plastic bags that are waterproof (note: most sandwich bags are not water tight). Material being shipped should be padded with newspaper, plastic bubble wrap, foam peanuts, or the like to prevent damage in shipping. Padded envelopes alone often provide insufficient protection. Every sample should be accurately labeled.

Gear and Equipment

1) Wading shoes, neoprene dive boots, other light footwear.
2) Knife.
3) Appropriate clothing (swim suit, cutoffs; hat; etc.).
4) Plastic or net bags for specimens.
5) Waterproof marker and labels.

Safety Considerations

1) Never take chances that could put you at risk of injury when surveying freshwater mussels.
2) Evaluate site status for safety concerns such as swift currents, soft or unstable bottoms, snags, deep water, etc.
3) Never enter water over your head without a knife (and preferably never at all). At times, it appears there are more trotlines per square foot of water body in Texas than anywhere else in the known universe. Finding legally-marked trotlines is only slightly more likely than finding a living dinosaur. Most are unmarked and can easily cause injury or death. Carry a knife and be careful.
4) Consider possible wildlife risks at sampling sites (alligators, water moccasins, etc.).
5) Consider risks from polluted waters.
6) Volunteer efforts should not include SCUBA or hookah diving or snorkeling without prior authorization and appropriate training.



TEXAS PARKS AND WILDLIFE

SURVEY DATA SHEET



Date:_____ _____Collected by:_____Identified by:_____

Address: _____City_____State TX Zip_____

Phone Number:_____E-mail _____

Monitoring Location:_____

County_____State TX Drainage Basin:_____

GPS/UTM: Lat:_____Long:_____

COLLECTION METHOD: ☐ Hand ☐ Snorkel* ☐ SCUBA*

Random or Timed Search _____Area or Transect Search_____

☐ random shoreline search ☐ Area_____(m or ft) ☐ 6.1-m (20 ft) transect

☐ random shallow water search ☐ 0.25-m^2 (2.7 ft^2) quadrat ☐ 40-m (131.2 ft) transect

☐ timed search (time_____) ☐ 10-m^2 (107.6 ft^2) quadrat

Total Volunteer Time (Hours Searching X Number of Volunteers):_____

Comments:_____

_____

Mussel Species	*N* Alive	*N* Shells (Whole)	*N* Valves (Halves)	Shell Condition (very-recently dead to subfossil)

[1]**Very-recently dead:** Soft tissue remains attached to the shell; shell in good condition essentially as it would be in a living specimen; internal and external colors are not faded.

[1]**Recently dead:** No soft tissue remains, but shell otherwise in good condition (looking like a living specimen that had been killed and cleaned); internally nacre is glossy and without evidence of algal staining, calcium deposition, or external erosive effects; internal and external colors are not faded.

[1]**Relatively-recently dead:** Shell in good condition, but internally nacre is loosing its glossy nature; algal staining, calcium deposition, or external erosive effects (or some combination of these) is evident on the nacre; internal and external colors often faded somewhat.

[1]**Long dead:** Shell shows early signs of internal and external erosion, staining, calcium deposition, or some combination of these; most or all of the internal coloration and glossy nature has faded (especially in species with colored nacre); shell epidermis with major sections absent, or , if present, clearly aged and flaking.

[1]**Very-long dead:** Shell shows significant signs of erosion, staining, and calcium deposition more widely pronounced than above; coloration often faded white or nearly so; relatively little intact epidermis left; for specimens in erosive environments, internal features (*e.g.*, pseudocardinal teeth) and external features (*e.g.*, pustules) often weathered and smoothed, or otherwise exfoliated; shells often chalky, brittle, and crumbling.

[1]**Subfossil:** Shells with little or no epidermis; nacre faded white and entire shell often white; sometimes with signs of erosion, staining, or calcium deposition; typically chalky and powdery to the touch; shells often brittle and crumbling.

Mail completed data sheet to: ***Marsha Reimer, Texas Mussel Watch, 3000 S IH 35, Suite 100, Austin, TX 78704 by August 31st***

* Volunteers should never use snorkeling or SCUBA to obtain TX Mussel Watch data without TPW authorization.

Field Observations

Water Depth (m or ft)_____

Water Temperature (C or F)_____

☐ **Flow Rate:**
[if known: (m/sec or ft/sec)_____]

1 – no flow
2 – low
3 – normal
4 – flood
5 – high

☐ **Water color:**

1 – no color
2 – light green
3 – dark green
4 – tan
5 – red
6 – green/brown
7 – black

☐ **Water clarity:**

1 – clear
2 – cloudy

☐ **Water surface:**

1 – clear
2 – scum
3 – foam
4 – debris
5 – sheen

☐ **Substrate:**

1 – none (mostly bedrock)
2 – mostly silt
3 – mostly sand
4 – mostly gravel
5 – mostly cobble
6 – mostly boulder
7 – other:_____

Wentworth scale of substrate size
A. Boulder - greater than 25.6 cm
B. Cobble - 6.4 - 25.6 cm
C. Gravel - 0.2 - 6.4 cm
D. Sand - 0.006 - 0.2 cm
E. Silt - less than 0.006 cm

What land uses are directly adjacent to the site: Check all that apply:

☐ Undisturbed natural area
☐ Suburban residences
☐ Urban residences
☐ Rural residences
☐ Recreation area (describe)
_____

☐ Cropland (list types)
_____

☐ Rangeland (pasture) for cattle
☐ Rangeland (pasture) for other livestock (list types)
_____
_____

☐ Industry/Manufacturing (describe)
_____

☐ Other
_____

Notes:_____
_____
_____
_____
_____

TEXAS PARKS AND WILDLIFE

SURVEY DATA SHEET

Date: 1/1/02 Collected by: Jane Doe Identified by: Mary Doe

Address: 100 Anywhere City Austin State TX Zip 78701

Phone Number: (512) 555-0000 E-mail Jane.doe@tx.com

Monitoring Location: Colorado River - 2 mi downstream of Congress Ave. Bridge

County Travis State TX Drainage Basin: Colorado

GPS/UTM: Lat: _____ Long: _____

COLLECTION METHOD: ☑ Hand ☐ Snorkel* ☐ SCUBA*

Random or Timed Search — Area or Transect Search

- ☑ random shoreline search
- ☑ random shallow water search
- ☐ timed search (time_____)
- ☐ Area_____(m or ft)
- ☐ 0.25-m^2 (2.7 ft^2) quadrat
- ☐ 10-m^2 (107.6 ft^2) quadrat
- ☐ 6.1-m (20 ft) transect
- ☐ 40-m (131.2 ft) transect

Total Volunteer Time (Hours Searching X Number of Volunteers): 1.5 hours

Comments: Found many Asian clam shells.

Mussel Species	*N* Alive	*N* Shells (Whole)	*N* Valves (Halves)	Shell Condition (very-recently dead to subfossil)
Threeridge		1	2	long dead to very-long dead
Washboard			3	very-long dead - subfossil

[1]**Very-recently dead:** Soft tissue remains attached to the shell; shell in good condition essentially as it would be in a living specimen; internal and external colors are not faded.

[1]**Recently dead:** No soft tissue remains, but shell otherwise in good condition (looking like a living specimen that had been killed and cleaned); internally nacre is glossy and without evidence of algal staining, calcium deposition, or external erosive effects; internal and external colors are not faded.

[1]**Relatively-recently dead:** Shell in good condition, but internally nacre is loosing its glossy nature; algal staining, calcium deposition, or external erosive effects (or some combination of these) is evident on the nacre; internal and external colors often faded somewhat.

[1]**Long dead:** Shell shows early signs of internal and external erosion, staining, calcium deposition, or some combination of these; most or all of the internal coloration and glossy nature has faded (especially in species with colored nacre); shell epidermis with major sections absent, or , if present, clearly aged and flaking.

[1]**Very-long dead:** Shell shows significant signs of erosion, staining, and calcium deposition more widely pronounced than above; coloration often faded white or nearly so; relatively little intact epidermis left; for specimens in erosive environments, internal features (*e.g.*, pseudocardinal teeth) and external features (*e.g.*, pustules) often weathered and smoothed, or otherwise exfoliated; shells often chalky, brittle, and crumbling.

[1]**Subfossil:** Shells with little or no epidermis; nacre faded white and entire shell often white; sometimes with signs of erosion, staining, or calcium deposition; typically chalky and powdery to the touch; shells often brittle and crumbling.

Mail completed data sheet to: Marsha Reimer, Texas Mussel Watch, 3000 S IH 35, Suite 100, Austin, TX 78704 by August 31

* Volunteers should never use snorkeling or SCUBA to obtain TX Mussel Watch data without TPW authorization.

Field Observations

Water Depth (m or ft) 0.5 m

Water Temperature (C or F) 21 °C

[3] **Flow Rate:**
[if known: (m/sec or ft/sec)_____]

1 – no flow
2 – low
3 – normal
4 – flood
5 – high

[2] **Water color:**

1 – no color
2 – light green
3 – dark green
4 – tan
5 – red
6 – green/brown
7 – black

[1] **Water clarity:**

1 – clear
2 – cloudy

[5] **Water surface:**

1 – clear
2 – scum
3 – foam
4 – debris
5 – sheen

[5] **Substrate:**

1 – none (mostly bedrock)
2 – mostly silt
3 – mostly sand
4 – mostly gravel
5 – mostly cobble
6 – mostly boulder
7 – other:_____

Wentworth scale of substrate size
A. Boulder - greater than 25.6 cm
B. Cobble - 6.4 - 25.6 cm
C. Gravel - 0.2 - 6.4 cm
D. Sand - 0.006 - 0.2 cm
E. Silt - less than 0.006 cm

What land uses are directly adjacent to the site: Check all that apply:

- [x] Undisturbed natural area
- [ ] Suburban residences
- [ ] Urban residences
- [ ] Rural residences
- [x] Recreation area (describe) Deer Hike and Bike trail
- [ ] Cropland (list types) _____
- [ ] Rangeland (pasture) for cattle
- [ ] Rangeland (pasture) for other livestock (list types) _____
- [ ] Industry/Manufacturing (describe) _____
- [ ] Other _____

Notes: Noticed raccoon tracks near the shoreline

Shell Condition Terminology

It is not usually possible to determine exactly how long a freshwater mussel shell has been dead. Different conditions such as water and substrate pH, erosive or corrosive environments, and exposure to sun can impact specimen condition and rate of disintegration. None the less, some qualitative estimate of time-since-death can be very useful. The following terms are used in TPWD freshwater mussel surveys:

Very-recently dead: Soft tissue remains attached to the shell; shell in good condition essentially as it would be in a living specimen; internal and external colors are not faded.

Recently dead: No soft tissue remains, but shell otherwise in good condition (looking like a living specimen that had been killed and cleaned); internally nacre is glossy and without evidence of algal staining, calcium deposition, or external erosive effects; internal and external colors are not faded.

Relatively-recently dead: Shell in good condition, but internally nacre is loosing its glossy nature; algal staining, calcium deposition, or external erosive effects (or some combination of these) is evident on the nacre; internal and external colors often faded somewhat.

Long dead: Shell shows early signs of internal and external erosion, staining, calcium deposition, or some combination of these; most or all of the internal coloration and glossy nature has faded (especially in species with colored nacre); shell epidermis with major sections absent, or , if present, clearly aged and flaking.

Very-long dead: Shell shows significant signs of erosion, staining, and calcium deposition more widely pronounced than above; coloration often faded white or nearly so; relatively little intact epidermis left; for specimens in erosive environments, internal features (*e.g.*, pseudocardinal teeth) and external features (*e.g.*, pustules) often weathered and smoothed, or otherwise exfoliated; shells often chalky, brittle, and crumbling.

Subfossil: Shells with little or no epidermis; nacre faded white and entire shell often white; sometimes with signs of erosion, staining, or calcium deposition; typically chalky and powdery to the touch; shells often brittle and crumbling.

TEXAS PARKS AND WILDLIFE

Texas Mussel Watch



Private Lands Access Request Form

To the landowner:

_____(volunteer name) is participating as a volunteer in Texas Mussel Watch. Texas Mussel Watch is a monitoring program that uses citizen volunteers to gather data about the status of freshwater mussels in Texas. Although very few of these species are considered threatened and endangered, they can be valuable indicators of the health of our environment. Texas Parks and Wildlife is very pleased to have the assistance of concerned Texans in watching over the health of these native species.

We have, however, instructed our volunteers that they cannot collect data on private land without the approval of the private landowner. Accordingly, we have prepared this form for your approval. The sections described below are the releases that we and our volunteers are required to obtain from you under Section 12.103 of the Texas Parks and Wildlife Code. If you approve, then please sign one or both sections and provide a copy to our volunteer.

1. Use of information

This documents my approval for TPW volunteers and employees to use (such as analyses) site-specific information from the property I own or manage. This may include placing that information onto a topographic map and entering the information into a Department database. Thus, the information could be viewed by the public.

_____ _____ _____

(Landowner or authorized agent signature) *(Date)*

2. Reporting Information

This also documents my approval for TPW volunteers and employees to report (such as in publications or technical reports) the above approved information in a manner that permits identification of the location of the specific parcel of property that I own or manage.

_____ _____

(Landowner or authorized agent signature) *(Date)*

3. Other conditions

If there are any conditions that apply to this approval, please specify and initial below.

_____

_____

_____

Name and Address
(of landowner or authorized agent)

Name _____

Address _____

City _____

State, Zip _____

Phone number _____

Optional:

Name of ranch or tract _____

County _____

Acreage _____

Location _____

TPW CONTACTS

Marsha Reimer, TPW, Texas Nature Trackers, 3000 IH-35 South, Suite 100, Austin, Texas 78704, (512) 912-7011, marsha.reimer@tpwd.state.tx.us

Lee Ann Linam, TPW, Texas Nature Trackers, 3000 IH 35 South, Suite 100, Austin, TX 78704, lalinam@wimberely-tx.com

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References to Avoid:

Internet Sites – Although the Internet has created ready access to a vast amount of information, unlike scientific journals and books, it often lacks any form of peer review. Consequently, many web sites contain incorrect or misleading information. Always be very cautious of Internet materials.

One of the most unfortunate examples came from CNN.com under the title "Mussels: the nation's most endangered family" by Hillary Mayell (December 1998; also presented in Year of the Ocean Daily News, December 1998). It begins to discuss freshwater mussels, pearls, and shell harvest, but then moves to explain how mussels live on hard objects off the coasts of Europe, America, and Southeast Asia and how pea crabs live in their gills. It shows a photograph of a marine mytilid mussel with a caption about the U.S. exporting 50 million dollars worth of shells to Japan. The author then goes on to explain how sea lions and squid love to eat mussels. The sea lions knock mussels against a rock until the shell breaks. It is also noted that humans eat "them." While it is true there are unionid mussels in Europe, America, and northern Asia, none of them live on rocks off the coasts of those countries (where mytilids live) and it is doubtful if any

marine pea crabs ever lived in unionid gills any where in the world. It is also true the U.S. exports unionid shells to Japan, but it seems unlikely the Japanese have any interest in mytilid shells. The concept of sea lions using rocks to break mussel shells is also interesting. One wonders which of their flippers they use to hold the rock and whether the sea lions learned this from watching sea otters or figured it out for themselves. Finally, the concept of fast-swimming squid consuming mussels is also intriguing. It sounds as though squid have been watching the local octopus feeding.

Another web site discussing Alabama freshwater mussels is also misleading. For example, it
discusses mapleleaf (*Quadrula quadrula*) presence in the state. It fails to note, however, that this species is restricted to a small region in the northern portion of the state within the Tennessee River drainage. It fails to mention that nearly all of Alabama is inhabited by southern mapleleaf (*Q. apiculata*) and Gulf mapleleaf (*Q. nobilis*), and not by their related namesake.

Another source of potential identification problems involves using standard reference books on freshwater invertebrates that were written decades ago. Books like Ward and Whipple's Freshwater Biology and Pennak's Freshwater Invertebrates of the United States can sometimes be as problematic as they are helpful. A great deal has been done in the realms of reclassification and distributional surveys since these texts were written in 1918 and 1953, respectively. They were good in their days, but science knows far more now.

TEXAS PARKS AND WILDLIFE

Texas
Mussel Watch



Recent Articles about Freshwater Mussels

U.S. Fish & Wildlife Service

News Release

December 6, 2000

Biologist Documents Rare Mussel in Chattahoochee River for First Time in 150 Years

News Releases Home Page

Search the News Releases
U.S. Fish & Wildlife Service Home

Contacts

Kyla Hastie, 706/613-9493, Extension 36
Tom MacKenzie, 404/679-7291

Carson Stringfellow was hoping to find mussels when he and his daughter Brooke went "musseling" at Goat Rock Reservoir, a section of the Chattahoochee River below Georgia Power's Bartlett's Ferry Dam. For Stringfellow, an environmental consultant and part-time environmental studies instructor at Columbus State University who specializes in freshwater mussels, or malacology, identifying and documenting mussels is a hobby and a passion. But in early October Stringfellow made the discovery of a lifetime.

What he found was a purple bankclimber (Elliptoideus sloatianus), a federally threatened freshwater mussel which had not been recorded in the Chattachoochee River in about 150 years.

"When I first saw it I was looking straight down on the top, and I thought it was a washboard," said Stringfellow, referring to one of the six other mussel species that he has documented in this section of the river. "But when I reached down and picked it up, I immediately knew it wasn't. I thought, Oh my, that's a purple bankclimber!"

Stringfellow recorded the physical description of the mussel and took digital photographs from many different angles, which he sent immediately to Dr. Jim Williams, a mussel biologist with the U.S. Geological Survey in Gainesville, Florida.

"I knew it was a purple bankclimber, but I wanted a second opinion," said Stringfellow. "I didn't tell Jim what I thought it was. I just said, Look at these

photos and tell me what it is."

"I couldn't believe after all these years that a purple bankclimber could still be in the Chattahoochee," said Williams. "I immediately looked back through historical records, and found only two other records of a purple bankclimber in the Chattahoochee -- and the most recent one was from about 1850."

According to Williams, records at the Columbus Museum in Columbus, Georgia show that the purple bankclimber was a staple of the diet of Chattahoochee Valley Native Americans. "Excavation of Indian middens has revealed numerous purple bankclimber shells. So prior to European settlement, this mussel was abundant in the Chattahoochee. But by the 1850s, the purple bankclimber was almost non-existent in the Chattahoochee," said Williams.

The decline of the purple bankclimber mirrors the story of freshwater mussels throughout the United States. According to a 1998 report by The Nature Conservancy, 67 percent of freshwater mussels in the United States are at risk of becoming extinct or are already extinct. Mussel declines can be attributed to pollution and sedimentation in our waterways, introduction of non-native species, and altered flows and temperatures resulting from dam construction and operations. The problem is most grave in the southeastern United States where rivers and streams once supported extremely diverse ecological communities.

According to Bob Butler, a biologist with the U.S. Fish and Wildlife Service who is currently writing a recovery plan for the purple bankclimber and several other southeastern mussel species, it is too early to tell whether the discovery of this individual mussel is significant to the recovery of the species.

"A single individual does not mean there is a viable population," said Butler. "We need to conduct surveys to find out if there are more individuals, and if they are recruiting young individuals into the population. Mussels can live over 50 years, so this could just be an individual that has survived since before the dams were constructed in the 1900's."

Sandra Tucker, Georgia Field Office Supervisor for the Service, said the Service is planning to team up with Georgia Power Company to do surveys in Goat Rock Reservoir. "The water is too cold for divers to do a comprehensive survey right now," said Tucker, "but when the water warms up in the spring, we would like to get a team in the water to find out what is or isn't down there."

The U.S. Fish and Wildlife Service is the principal federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. The Service manages the 93-million-acre National Wildlife Refuge System comprised of more than 530 national wildlife refuges, thousands of small wetlands, and other special management areas. It also operates 66 national fish hatcheries and 78

Ecological Services field stations. The agency enforces Federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts. It also oversees the Federal Aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

NOTE: You can view our releases or subscribe to receive them -- via e-mail -- at the Service's Southeast Regional home page athttp://southeast.fws.gov. Our national home page is at: http://news.fws.gov/newsreleases/.

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Musseled out. (US fresh water mussels are endangered)

Kim A. O'Connell.

Abstract: About two-thirds of the mussels in US rivers and streams are at risk because of human activity, pollution and alien species. Agricultural runoff from farming, poor erosion control, and dredging operations have killed many mussels. Hundreds of alien zebra mussels often suffocate a single native.

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To the casual observer wading in a river or creek, mussels may be nothing more than rock-like objects. But these freshwater bivalves--considered indicator species--contain crucial information about river ecosystems. When mussels' numbers fall, a river's water quality could be in serious danger.

Currently two-thirds of all freshwater mussels in the United States are at risk, according to a report released last summer by The Nature Conservancy. The mollusks are the most rapidly declining animal group in the country, and some scientists believe that one in ten species may have become extinct during this century alone. The federal endangered species list includes about two dozen species of mussels, with such colorful names as the Appalachian monkeyface pearlymussel, the orangefoot pimpleback pearlymussel, and the purple cat's paw pearlymussel.



Alien zebra mussels grow in a suffocating clump on a native mollusk.

Many freshwater mussels reside in the waterways of the Midwest and the Southeast, including St. Croix National Scenic Riverway in Wisconsin, Ozark National Scenic Riverways in Missouri, and Big South Fork National River and Recreation Area in Tennessee and Kentucky. The decline of freshwater mussels largely can be attributed to human actions. Agricultural runoff as well as improper erosion-control practices and dredge-and-fill activities are major killers of mussels. Known as filter feeders, these shellfish require unsifted, free-flowing water to survive.

Dams pose another threat by altering the flow of a river and preventing the migration of fish. Immature freshwater mussels must attach to a host fish species to complete their lifecycle. Without the host fish--which also helps to disperse the mussels--the young mollusks will die.

Mussels also are suffering as a result of the inadvertent introduction of an aggressive, non-native cousin--the zebra mussel. No larger than a quarter, the Eurasian zebra mussel, believed to have arrived in this country by transatlantic ship sometime before 1988, has spread throughout the Great Lakes and the Mississippi River basin. If this expansion continues unchecked, native mussels of the Mississippi River, which contains more endemic species of mussels than any other river system, could be reduced by 50 percent within a decade.

could be reduced by 50 percent within a decade.

Staff at St. Croix National Scenic Riverway--which flows between Wisconsin and Minnesota to meet the Mississippi--first spotted zebra mussels there in 1994, affixed to a boat traveling through. So far, thanks to an interagency action plan that went into effect in 1992, the alien has not taken hold at St. Croix. The preventive action plan is designed to halt or slow the spread of the mollusks and involves monitoring and restricting boater access, as well as education. St. Croix is host to 40 native mussel species (including the federally listed Higgins' eye pearlymussel and A winged mapleleaf mussel).

Concerned about the increasing number of zebra mussels found on boats traveling into the park, each month staff dive to check boats, marinas, and native mussel beds to be sure zebra mussels are not becoming entrenched.

Besides the hulls of boats, zebra mussels affix themselves to all sorts of objects, including shells, intake valves to power plants, and rocks. Once established, the exotics adhere to the shells of native mussels--sometimes hundreds of zebra mussels to a single native suffocating their hosts.

"The park was in a position of having to react quickly, given how rapidly zebra mussels were spreading," says Sue Jennings, resource management specialist for St. Croix. "Our plan has been very successful--I think that the task force has done an excellent job of joining together to formulate a plan...to slow the spread of zebra mussels into the St. Croix."

KIM A. O'CONNELL is outgoing news editor of National Parks.

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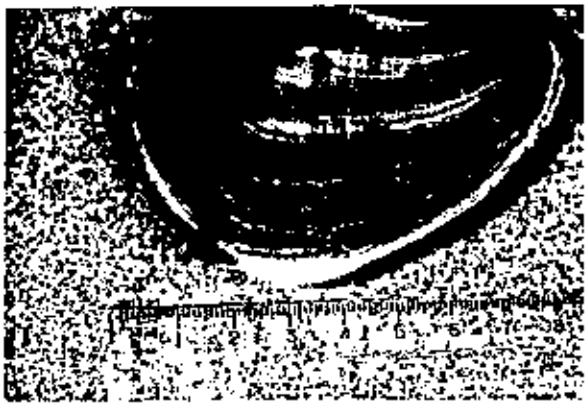
America's Mussels: Silent Sentinels

America's Mussels: Silent Sentinels | Are mussels living rocks or important natural resources? | Why are mussels so imperiled? | Why do we care? | Is there hope? | How can you help?

America's Mussels, most of us call them clams, are a group of critters that are so inconspicuous that they are often mistaken for rocks. They lie on the bottom of our lakes, rivers, and creeks. They barely move and they eat by filtering water for microscopic food particles. Even their reproductive life seems boring. The male disperses sperm and the water current carries it to the female where fertilization occurs. But throughout much of North America, and particularly in the Midwest, these rock-like creatures are sending an urgent message.

This female Higgin's eye pearlymussel packages her larvae into an enticing lure that will attract a specific fish. When the target fish approaches, she will expell her larvae at the fish. The larvae attach to the fish's gills or fins, and hitch a ride for a few weeks while they continue their transformation into a juvenile mussel.



North America has the highest diversity of freshwater mussels in the world. And within North America, historically the Midwest had some of the highest numbers of mussels species. Currently, however, in the Midwest (Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana and Ohio) more than half of the 78 known species are classified as Federally endangered, threatened or State species of special concern. No other group of animals in the Midwest is so gravely imperiled. To put this in perspective, The Nature Conservancy reports that about 70 percent of mussels in North America are extinct or imperiled, compared to 16.5 percent of mammalian species and 14.6 percent of bird species.

Are mussels so imperiled simply because they're delicate creatures that are on their way out anyway? NO. Although mussels look sedentary, they can move. Many species have adapted to the constantly changing situations in streams and rivers. They can also close their shells to avoid short term exposure to toxins or other unfavorable environmental conditions. Thus mussels are tough creatures that can withstand harsh conditions if those conditions are temporary. The fact that so many species of mussels are imperiled in the Midwest shows that there have been significant, long-term changes to our lakes and waterways. And those changes have been so dramatic that these aquatic species are having trouble surviving. Back to the top.

Are Mussels Living Rocks or Important Natural Resources?

In the past, mussels were used by native Americans in the construction of tools and utensils. Mussels were also an important food source. After European settlement, mussels were harvested for their shells to make pearl buttons. By the early 1900's, this multi-million dollar business was in full swing along the Mississippi River. Because there were no controls on this industry, mussels were over-harvested and the number of many species dwindled. This, along with the use of plastic replacements, put an end to the pearl button industry.

In the 1960's, the Japanese cultured pearl industry began to expand. If tiny pieces of sand or mussel shell are inserted into oysters they surround the disturbance with a silicate, creating a pearl. Thousands of tons of live mussels are harvested from North American rivers each year and shipped to Japan where pieces of the shells are used as "seed pearls.". The demand and high prices from this industry has resulted in increasing the occurrences of illegal mussel harvesting.

Mussels play an important role in the aquatic ecosystem. Many different kinds of wildlife eat mussels, including raccoon, otters, herons, and egrets. Mussels filter water for food and thus are a purification system. They are usually present in groups called beds. Beds of mussels may range in size from smaller than a square foot to many acres; these mussels beds can be a hard "cobble" on the lake, river, or stream bottom which supports other species of fish, aquatic insects and worms.

Although their lives appear boring, their reproductive strategies are quite fascinating. After the male has dispersed sperm that is carried by currents to the female where fertilization occurs, the fertilized eggs are transformed into a larval state inside the female. She then packages the larvae into an enticing lure that will attract a specific fish. When the target fish approaches, she will expell her larvae at the fish. The larvae attach to the fish's gills or fins, and hitch a ride for a few weeks while they continue their transformation into a juvenile mussel. When the transformation is complete, they drop off of the unharmed fish, and begin their life as a young adult mussel. Not only is this method of reproduction interesting to biologists and students of nature, the fact that mussels require specific species of fish to reproduce means that mussels are also good indicators of the health of their host fish populations. Back to the top.

Why Are Mussels So Imperiled?



Photo by G. Thomas Watters, Photographer

The ring pink mussel(*Obovaria retusa*) has been extirpated from the Midwest.

Visualize the Mississippi River (or the Ohio River or any one of the many rivers and streams traversing our countryside) as it must have appeared to the first European explorers. The riverbanks were forested, there were many sandbars, logjams were found periodically, and the water was completely free of man-made pollutants. Fish were probably plentiful, and if you sampled the sand and rocks on the bottom, you would have found an abundance of insects, worms, and other aquatic invertebrates. Then visualize the Mississippi or another waterway as it looks today. With these visualizations in mind, it's not too difficult to believe that many of the animals living in those waterways would have a hard time surviving today. But let's look at the changes that have been made to our rivers and streams and how those changes have affected mussels. Back to the top.

Dams

Numerous dams have been built on many of our rivers. Whether for hydropower, recreation, or navigation, dams are a physical barrier, which is a major threat to mussels. Part of the life cycle of young mussels includes attaching to the gills of a specific type of fish. These young mussels, which are actually larvae, are carried by the fish to different reaches of the river. Eventually the larval mussel drops off the gills, lands on the bottom, and if it's a suitable area, the mussel continues to grow. This is how mussels populate lakes and rivers. Because dams are a barrier to fish, dams also prevent mussels in the upstream portion from moving to the downstream portion, and vice versa.

A dramatic example of the impact of dams on distribution of mussels is provided by the ebony shell (Fusconaia ebena) and elephant ear (*Elliptio crassidens*) mussels. The primary fish host for these mussels is the skipjack herring. The skipjack was present in the Mississippi River watershed from the Twin Cities south to the Gulf of Mexico. It was actually a migratory species in the upper Mississippi River watershed where it was known to spawn in Lake Pepin and probably used other areas in the watershed as well. But after a hydropower dam was erected on the Mississippi River at Keokuk, Iowa in 1913, the skipjack herring could no longer migrate north of the dam. Thus, this species of fish was extirpated from the upper Mississippi River north of the dam at Keokuk. Along with the extirpation of the skipjack, all (or most) reproduction of the ebony shell and elephant ear mussels, upstream of the dam, ceased. Individual live specimens of these species are still found today in the upper Mississippi watershed. That is because these mussels are so long-lived and were so abundant before the dam. However, reproduction of these species no longer occurs north of the dam at Keokuk.

In addition to acting as barriers to fish movement, dams impact mussels by changing the flowing water environment of rivers. The reservoir area upstream of a dam is a lakelike environment in a segment of river. In most cases, riverine kinds of mussels cannot survive in lakes. So all the mussel beds in the upstream reservoir area of the dam are eliminated. Depending on the type of dam, releases from the dam may not mimic natural conditions, instead unnaturally high releases of water alternate with unnaturally low releases of water. The low water conditions are particularly hostile to mussels (and most other kinds of wildlife in the river). Back to the top.

Sedimentation and Pollution

Agricultural production causes eroding soil to run off into rivers and lakes. Bridges are also sites of high erosion and sedimentation. Large amounts of sediment entering streams and rivers can bury gravel and rocky bottoms and smother mussels. Many kinds of mussels cannot live on muddy or unconsolidated sandy bottoms, they need the river bottoms to be rock, gravel, or firm sands. The sediment in runoff often carries pesticides with it, which further poltutes the water. Other contaminants such as PCBs, mercury and lead are deposited in waterways from industrial plant discharges. A wide variety of other toxic substances are released from industrial sites.

With navigation on many rivers and industrial complexes located on riverbanks, there is always a threat of an oil or toxic chemical spill. Also, many public and private septic systems empty into our waterways. In the 1970s, NO live mussels were found in the lower fifteen miles of the Minnesota and the Mississippi Rivers, from the Twin Cities to Lake Pepin. It was referred to as a mussel desert. Poor water quality was the reason that these areas could not support mussels. Since that time, sampling indicates that water quality is improving. In fact, a recent mussel survey north of Lake Pepin documented the presence of good numbers of individuals and numbers of species of mussels. Back to the top.

Exotic Species

Exotic species are an ever-increasing threat to our native plants and animals. For native mussels, infestation of zebra mussels has had near catastrophic effects. Zebra mussels were inadvertently released into Lake Erie from a ship carrying ballast water from the Caspian Sea. They increase in numbers faster than non-native mussels and attach to almost any hard surface, including native

mussels. They reproduce so fast and in such abundance that the native mussels' movement, feeding, and reproductive behaviors are stifled. One mussel was found to have over 10,000 zebra mussels on it. Back to the top.

Why Do We Care?

- Monitors of aquatic health: the presence of diverse and reproducing populations of mussels indicate a healthy aquatic system which means good fishing, good water quality for waterfowl and other wildlife species, as well as insurance that our water is safe. Conversely, when mussel populations are at risk, it indicates problems for other fish and wildlife species, and people too.
- Ecological value: mussels are natural filters, feeding on algae, plankton, and silts, they help purify the aquatic system. Mussels are also an important food source for many species of wildlife including otters, raccoon, muskrat, herons, egrets, and some fish.
- Economic value: freshwater mussels have been and continue to be a major economic resource; first in the button industry and now in the cultured pearl industry. Mussels from North American form the nucleus of the cultured pearl industry in Asia.
- Education and aesthetic value: the study of mussels, their natural history, and habitat requirements provides interesting and important lessons on the interconnectedness of the aquatic system and how species adapt to their ecosystem.
- Cultural value: Mussels played an important role in the cultural history of prehistoric and recent native peoples of the Ohio and Mississippi River basins. They were used as food and the shells were used for ornamentation, tools, and as a commodity for trade. Indian shell middens (the piles of shells that native Americans have left behind) extend for miles along sites of old villages and encampments along the Mississippi and Ohio Rivers.
- Biodiversity: Mussels have, and hopefully will continue, to play an important role in our aquatic ecosystems. Considering that less than 20 mussel species are found in most other countries of the world, our North American rivers and streams are truly "rich" with close to 300 species!! Mussels do not get cancer. Researchers want to know why and mussels may have additional values in the future that we cannot now predict. The loss of any of these species will definitely have consequences on how the aquatic ecosystem functions.

Is There Hope?

Passage and implementation of the Endangered Species Act and the Clean Water Act has contributed to the recovery of some species. The Endangered Species Act provides protection of existing mussel communities containing threatened and endangered species and has promoted efforts to recover endangered mussels. Enforcement of the Clean Water Act has resulted in improved water quality which has allowed recolonization of mussels and fish in some areas. Back to the top.

How Can You Help?

In order to protect mussels, thereby protecting ourselves, the following things can be done.

- Conserve energy in an effort to limit the construction of new hydroelectric power plants.
- Limit or cease pesticide use to conserve soil and prevent runoff into nearby lakes and streams. Integrated Pest Management (IPM) strategies can replace pesticide use--find out more about it. Help control soil erosion by planting trees and plants to avoid runoff of soil into freshwater areas.
- Remove aquatic weeds from boat trailers and motors before using again to prevent the spread of things such as zebra mussels. DO NOT throw weeds back into the water.
- Help support watershed management programs by calling your local resource management agency.

- Support and follow zebra mussel quarantine, inspection, and decontamination programs.

Mussels of the St. Croix River | Mussels of the Ohio River | The Zebra Mussel Threat

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Bringing Mussels Back in the Southeast

by Richard G. Biggins and Robert S. Butler



Mussel shells collected from a muskrat midden on the Conasauga River in Tennessee
Photo by Richard Biggins/USFWS



Ten rifflesheil in Indian Creek, a Clinch River tributary in southwestern Virginia
Photo by Richard Biggins/USFWS

The world's greatest diversity of freshwater mussels occurs in the continental United States. Early American naturalists marveled at this fauna's beauty and diversity. T.A. Conrad wrote in a paper presented to the Academy of Natural Sciences of Philadelphia in 1834, "The great variety and beauty of the fresh water shells of this country are truly surprising. Whilst the streams of Europe contain very few species, not remarkable for elegance of color or variety, the rivers of Ohio, Kentucky, Tennessee, Alabama, etc., contain at least one hundred species of almost every imaginable shape."

Native Americans made extensive use of this abundant natural resource. Mussels in unimaginable numbers once paved the shallow shoals of many rivers and provided an easily accessible food supply. Many of the shells were fashioned into spoons, plates, hoes, and an array of other tools, and some of the colorful and ornate shells were transformed into adornments. In spite of extensive use, this mussel fauna remained relatively unchanged for centuries prior to European settlement.

However, during the last 100 years, the habitat of this rich fauna (nearly 300 species) has been inundated by impoundments, smothered in silt, dredged for navigation, and polluted with toxins. The U.S. Fish and Wildlife Service currently recognizes about 12 percent of our mussel fauna as extinct and 23 percent as threatened or endangered. No other widespread North American animal group has experienced this level of collapse. For example, The Nature Conservancy (TNC) considers 68 percent of our nation's mussel species at risk, compared to only 17 percent for mammals and 15 percent for birds. The American Fisheries Society estimates that 72 percent of our mussels need protection. The precipitous decline of freshwater mussels in the 20th century is unparalleled in our nation's history, and many more extinctions are likely without a coordinated conservation effort.

Freshwater mussels serve important ecological roles. They are a food source for many aquatic and terrestrial animals. They improve water quality by filtering contaminants, particulates, and excess nutrients from our rivers. Sensitive to toxic chemicals, they serve as an early warning of water quality problems before other biological resources are noticeably affected.

The economic value of some of the more common species is also significant. Native mussel shells are used in the cultured pearl and jewelry industries. In 1993, the mussel shell industry in the United States exported roughly 6,500 tons of shells. The annual value



A mussel shoal on the Conasauga River, Tennessee
Photo by Richard Biggins/USFWS

to the mussel shell industry has been estimated at $40 to $50 million, and the shell harvest provides employment to about 10,000 residents, primarily in the Mississippi River basin.

Although biologists have been documenting mussel declines since the early part of this century, only in the last 25 years have environmental laws been available to significantly reduce threats to these animals. Numerous federal, state, tribal, and local agencies; conservation groups; and concerned citizens now recognize the severity of the problem and the vulnerability of freshwater mussels. Many historical and current threats to this fauna are not economically or socially feasible to remedy. However, much can and is being done to help secure a future for this valuable national resource.

Since the early 1980s, the Service's Southeast Regional office, which encompasses an area containing more than 90 percent of the nation's mussel taxa and more than 95 percent of all federally listed mussels (70 species), has actively supported mussel research and conservation initiatives. As a result, the Service's Asheville (North Carolina) Field Office, with its many partners (Alabama Division of Game and Fish, Kentucky Department of Fish and Wildlife Resources, North Carolina Wildlife Resources Commission, Tennessee Wildlife Resources Agency, Virginia Department of Game and Inland Fisheries, U.S. Geological Survey [USGS], U.S. Forest Service [USFS], National Park Service, Natural Resources Conservation Service, Resource Conservation and Development Councils, State Soil and Water Conservation Districts, Tennessee Valley Authority [TVA], Tennessee Aquarium/Southeast Aquatic Research Institute [SARI], and TNC) is poised to implement a major mussel recovery program in the Southern Appalachians and lower Tennessee-Cumberland River ecosystems.

Recent advances in mussel research make it possible to maintain and propagate some endangered mussel species in captivity, and research is underway to develop propagation technology for other listed mussels. Captive propagated mussels can be used to augment existing populations and to reestablish populations into restored historical habitats.

Juveniles of the endangered tan riffleshell *(Epioblasma walkeri)* have been reared in captivity and for the past 3 years have been released into the Hiwassee River, a Tennessee River tributary in east Tennessee. This project, funded by the Service and the Tennessee Wildlife Resources Agency, is truly a cooperative venture. Gravid female riffleshells were provided by the Virginia Department of Game and Inland Fisheries. The young were produced at Virginia Polytechnic Institute and State University by the Biological Resources Division of USGS. The USFS, USGS, and TVA assisted with identification of the release sites in the Cherokee National Forest, and local school children assisted in the actual release of the juveniles. The Hiwassee River contains an extemely small and



Artificially propagated mussels ready for release into the wild
Photo by Richard Neves/U.S.G.S.

currently nonreproducing population of tan riffleshells.

Endangered mussel populations in two other upper Tennessee River tributaries have also been augmented. In 1999, the Tennessee portions of the Clinch and Powell Rivers above Norris Reservoir received over 100,000 juvenile of 6 endangered mussels, and more juveniles of these and other species are being released this year. In addition, SARI has released hundreds of juvenile fine lined pocketbook *(Lampsilis altilis)*, a threatened mussel, this year into the Conasauga River. Through this and future augmentations, we hope that the population levels increase to the point where the species can again sustain itself. Research is underway to identify other endangered mussel populations and river reaches that could benefit from augmentations.

In addition to augmenting existing populations, the Service and its partners are evaluating the feasibility of reintroducing mussels into currently unoccupied historical habitats. Thanks to the water quality improvement efforts of TVA, the Environmental Protection Agency, State water resource and natural resource agencies, industries, and municipalities, some reaches of the Tennessee River and its tributaries appear suitable for reintroducing their historic mussel fauna.

The Service and its partners have identified the lower French Broad River below Douglas Reservoir, Tennessee, as a potential mussel reintroduction site. This river reach historically supported approximately 60 mussel species. Thanks to TVA's reservoir release improvement program, the resident aquatic fauna has rebounded, and the habitat below the dam now appears suitable for mussel reintroduction. The area below Wilson Dam on the Tennessee River in north Alabama has also been identified for the reintroduction of 16 federally listed mussels. Historically, this river reach harbored the world's greatest mussel assemblage (more than 70 species).

The Asheville Field Office also has a cooperative riparian habitat restoration program that addresses the habitat needs of mussels and other imperiled aquatic organisms. This comprehensive effort, involving many of the same agencies and organizations mentioned above, restores and protects riverine habitat containing diverse aquatic communities. Many miles of important mussel streams have been degraded by poor land use practices, and efforts are underway to restore and protect the habitat quality through partnerships with willing private landowners.

Because this recovery action is a Service program funded under the Endangered Species Act, the effort focuses on endangered mussel restoration. However, the program has much wider economic, aesthetic, and ecological benefits. Habitat improved for mussels benefits sport fisheries and other wildlife. Improved habitat and cleaner streams have increased aesthetic and recreational value, and reestablishing biodiversity helps to restore the complex ecological function of aquatic communities. There are few quick fixes to the problems that have plagued our rivers and their aquatic life for many years, but through public and private partnerships on an ecosystem scale, we can restore aquatic ecosystems for the public's use and enjoyment.

Richard G. Biggins is the Fish and Mussel Coordinator and Robert S. Butler is the River Restoration Biologist in the Asheville Field Office.

Biologists using snorkeling equipment release adult mussels into a marked-off area in the Holston River in eastern Tennessee so that the success of the release can be monitored.
Photo by Richard Biggins/USFWS



Junior Edition

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To reproduce, mussels go fishing: the evolution of this freshwater pearl-maker reaches its apex in our Southeastern rivers. *Adele Conover.*

Abstract: Freshwater mussels disperse their larval packets by disguising them as fish. Once ingested by a predator, the larvae attach to its gills and stay there until they can survive on their own. The success of nearly 300 species of mussels in North America has spawned a lucrative industry for cultured pearls.

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All business, the silvery minnow flirts in the topaz waters of Brown Creek in northern Alabama. Several crayfish scull in the silt, hunting for food. A posse of snails on a rock grazes on the algae. A largemouth bass feints at the minnow. The crayfish scurry, the snails slink under the rock; only the minnow, seemingly unmindful, remains. The bass moves in for the kill, then finds itself with a mouthful of glochidiautiny mussels in the larval stage. The Trojan minnowua gelatinous packet of mussel larvae designed to emulate a bite-size fishuhad been tethered by a filmy three-foot tube to a mussel, an orange nacre mucket. The minuscule mollusks clamp onto the basses gill filaments. Now the fish has become an unwitting agent in their dispersal. The mussels will travel with the fish until they can make it on their own. After a few weeks, they will drop off and settle in a river or creek to live anywhere from 30 to 40 years, even, in some species, a century. Eventually they will produce their own faux fish packed full of larvae to tempt another bass. As the Rodney Dangerfields of the animal world, freshwater mussels are regarded by most humans (if they think of them at all) as inferior versions of their glamorous seafood cousinsumarine mussels, which are so relished with garlic and wine. Yet freshwater mussels have spawned major industriesuproducing pearls, or providing shells to button manufacturers and "seeds" for growing cultured pearls. Their tale also includes Native Americans and explorers, biologists and divers, town festivals and grandpaes shirt studs. The first inkling of the orange nacre mucketes elaborate ruse was discovered in a close relative, the southern sandshell, by U.S. Fish and Wildlife Service (USFWS) biologist Bob Butler as he sloshed in Limestone Creek, a tributary of the Pea River on the Florida-Alabama border, in June 1988. Butler knew that in many mussel species, after fertilization and brooding, a mother mussel spews countless glochidia in the water with the hope that somehow theyell latch on to the "right" species of fish. In most cases, the glo- chidia of a given mussel species can transform themselves into juveniles while attached to only a few species of fish. These are known as the host fish. To increase their chances, some mussel species have reshaped their mantle flapua piece of tissue that can be moved out of the shelluto masquerade as fish prey (p. 70). Sometimes the larvae are wrapped in a mucous "conglutinate" to look like foodua bloodworm, insect larvae, fish eggs or even a small fish. Scientists are fairly certain that the appearance of the conglutinate determines what species of fish will be attracted. Five years later, in the spring of 1993, while wading in Brown Creek in Bankhead National Forest in Alabama with biologists Paul Hartfield of the USFWS and Wendell Haag of the U.S. Forest Service (USFS), Butler spotted a glochidia package entangled in a fallen hemlock sapling. A few minutes later, the biologists recorded a mother "giving birth" as she reeled out an ersatz fish attached to a mucus-like strand (see illustration above). The fish was a glochidia package, complete with an eye spot. Freshwater mussels are complex creatures with a kidney,

stomach, intestine, intake and outlet siphons, gills, a foot, a mantle and a "brain": a handful of neurons connected by three ganglia. They can discern light and dark and temperature changes. "Your average four-ounce mussel can pump two quarts of water per hour," says Dick Neves, a USFWS biologist who also teaches at Virginia Tech. They inhale algae, diatoms, silt, and metals and other particulates. Anything inedible is neatly packaged in mucus and spit out. When a young mussel first drops off a fish gill, it uses its tiny foot to push food into its mouth until the siphons develop fully. As the mussel matures, its foot takes on a more conventional useuhelping it get around as well as bury itself in the stream bottom. As adults, mussels are usually found semi-buried in the creek bottom, shells agape, siphons hard at work straining the water. Nearly 300 freshwater mussel species are found in the United States (mostly in Southeastern rivers), more than anywhere else in the world. No less than 250 species of crayfish and 313 of snails dwell in Southeastern rivers. "You donet have to go to the Tropics to see biodiversity; ites right here in your backyard," says Bob Butler. All of this variability is the product of time, a range of habitats and a good location. Freshwater mussels were here when the Appalachians were still forming. While the Appalachians were weathering into the relative stumps that we see today, however, our freshwater mussels persevered, particularly in the Southeast, which escaped ice-age glaciation. Freshwater mussels were regarded with enthusiasm by mound-building Native Americans, judging from the middens they left behind. These early inhabitants prized freshwater mussels not only as food but for their pearls and shells, which served as tools, decorations and jewelry. Nor did the pearl mussel go unnoticed by Hernando de Soto. As related by De Sotoes scribe, at the River of the Holy Spirit (probably in Georgia) a woman who had been taken captive made her escape carrying with her a basket containing numbers of unbored pearls. The New Worldes introduction to freshwater pearl fever began in 1857 near Paterson, New Jersey. A shoemaker named David Howell gathered some mussels for his supper from a local stream called Notch Brook and discovered a 400-grain pearl, nearly an inch in diameter. One expert estimates that the pearl would have been worth $25,000 if it had not been cooked. In the pearl rush that followed, Notch Brook was just about stripped of mussels, and locals had prospered to the tune of $115,000. As word got around, people began to view their rivers anew. Early on, they picked and toed mussels in shallow water and, in deeper waters, raked them from the bottom. The waste in mussels was tremendous, but pearls were found in New York, Ohio, Texas, Arkansas, Florida, Connecticut, Mississippi and Wisconsin. In Wisconsin in 1889, nearly $300,000 worth of pearls was found. In 1902 two pearls found near Lansing, Iowa, were reportedly sold for $50,000 and $65,000. There were pearl rushes in other waters in the Ohio Valley drainageuthe Clinch, Eel, Little Miami, Mississenewa, Tennessee, West Fork of the White River and Wabash. Pearls from the Wabash River were said to have the finest luster and greatest value of any in the Midwest. A Vincennes, Indiana, jeweler of the time, Granville "Granny" Palmer, contended that people "really like a beautiful pearl, much more than a diamond." He went on to note, "If you found a good pearl, that was great, then everybody got drunk in that camp." Pearlers werenet the only threat, or even the biggest, to American freshwater mussels. In 1891, a German button maker named John Frederick Boepple, using freshwater mussel shell, established the first freshwater pearl button company in Muscatine, Iowa. By 1896, bolstered by protective tariffs, the manufacture of pearl buttons had become an industry. Shells big and small, young and old, were harvested as if there was no tomorrow. The mussel supply was presumed to be limitless, as was demand. "Pearl buttons [are] now worn by nearly every individual from the cradle to the shroud," U.S. Bureau of Fisheries biologist Robert E. Coker pointed out in 1919. In 1916, when button production peaked, American factories turned out 40 million gross with a value of $12.5 million. In the Mississippi River system alone, 9,746 mussel collectors were employed. The Bureau of Fisheries had begun to worry by 1910. The agency tried to culture freshwater mussels (without much success) and began surveys of watersheds where there might be more mussel beds. By the 1940s, and just in the nick of time from the musselse perspective, plastic buttons came on the scene, and the American shell button industry dwindled.

In mid-century the American freshwater mussel seeded a new industry: cultured pearls. The thickness, solidity and iridescence of American shell that made it prized by the button industry also made it valued by the Japanese as the best material for a cultured-pearl nucleus. Oysters protect themselves by encasing irritants with nacre (mostly calcium carbonate), forming pearls. Starting with a relatively large, round irritant (a piece of mussel shell), the oyster makes a pearl in a relatively short time. Today cultured pearls are a $3 billion industry (Smithsonian, January 1985). But there are signs that the use of American mussel as the major material for pearl nuclei may be waning. Pollution, exploitation, dams and the ad-vancing zebra mussel (Smithsonian, February 1994) have had their effects. The latter is overwhelming native species with sheer numbers as it spreads across the country. If the pearl industry does turn from American shell to another "seed" for cultured pearls, among the casualties will be the American shell industryuand people like shell exporter Lonnie Garner, CEO of the U.S. Shell Company in Hollywood, Alabama: "Ieve dove, picked, brailled [dragged the bottom using special hooks, to which the mussels attach themselves], made the crowfoot hooks, cut the wire to make the chain, built the winches, built the boats. . . . I grew up with it." As a businessman Garner thinks of the American freshwater mussel as a renewable resource. "A mussel population can be managed just like deer or waterfowl. We ought to look at a seven-inch washboard mussel just like ites a 400-pound deer." He has a bit of a love-hate relationship with the biologists. "They mean well but when I talk about management to them I feel like a Baptist preacher talking to a bunch of atheists." He says, "We got to stop this pollution and we got to change the effect the dams have had on mussels." In the name of navigation, flood control and eventually hydroelectric power, dams were erected on the Mississippi River and throughout Kentucky and Tennessee. "In the years spanning the 1930s to the late 1970s," notes biologist Jim Williams of the U.S. Geological Survey (USGS), "more than 125 large dams were constructed in the Southeast." According to USGS biologist Steve Ahlstedt, there are 100-year-old mussels, some the size of small hubcaps, stuck between dams with no way to reproduce because their host fish canet get to them anymore. For instance, the skipjack herring, a.k.a. the Tennessee tarpon, could once be found in every major watershed from Florida west to Texas and north to Pennsylvania and across to Wisconsin and Minnesota. Now, because of the dams, the skipjack herring canet abet ebonyshell mussels of the upper Mississippi watershed. The hickorynut mussel has also been marooned in the upper part of the Ohio River because the shovelnose sturgeon canet climb dams, either. At the moment the price of shell is down. "Nobody buyine," says Garner, sitting in one of his storage sheds piled high with bag after bag of mussel shelluwashboards, inky-looking ebonyshells, monkeyface and pimpleback. Garner blames his current stock overload on a virus that knocked out nearly 60 percent of the oysters in Japan. "Now weere feeline the ripple effect," he says. If the American shell industry goes down the tubes, he adds, "what would the rivers be without the people? Ied hate to see the day when the river people arenet out workine on it." "Lonnie Garneres not buying any shell," confirms mussel fisherman and dealer Leon Bivens, owner of Bivens Shells and Flags in Athens, Alabama. But Garneres stock overload doesnet mean that Garner rival DeLon Dobson, production manager of Tennessee Shell in Camden, Tennessee, isnet buying. Bivens is still out on the river, or rather Wheeler Lake, a 40-mile stretch of the Tennessee River between dams. "Weere river rats," says Bivense wife, Judy. The couple started out married life together when she was 13 and he was 17, picking and ginning cotton and catching fish commercially. But as Judy says, "With fish selling at 45 cents a pound and everything full of mercury and DDT," they were delighted when another shell exporter, James Peach, president of American Shell, came to them. "He bought us diving gear and he got half of what we got," says Leon. "Weeve dove in Tennessee, Texas, Georgia. . . . I donet know what else Ied do, Iem 54 years old and Ieve got a seventh-grade education. Only job I could get would be minimum wageuthat would give me about enough money to buy gas to get to the job and back." Leon is also the middleman in selling shell caught by his son, Steven, nephew Kevin and

son-in-law Bradley Carter, as well as any other mussel fisherman who brings a bag of mussels to the Bivensese spotless shopua garage furnished with a scale, diving gear and a couple of barrels for "cooking out" the mussels. (Dealers want shell rather than the mussel itself. The whole thing has to be cooked and the meat cleanly separated before the shell goes to market.) When Bivens has about 2.5 tons he drives the load to Camden, Tennessee, to sell to Tennessee Shell. The professional mussel fisherman is an independent sort, and mussel fishing rigs reflect their ownerse individuality. Out on Wheeler Lake, Leones 16-foot-long flat-bottomed boat whisks past five unoccupied boatsuthe only sign of life is a diveres flag and a telltale yellow air tube leading over the side and into the water from an air compressor (often a converted beer keg) on the boat. A diver can make $70 to $100 a day. Today Steven Bivens sits morosely in his boat, his ever-present "diving buddy" Fred, a largish black-and-tan dog, at his side. "Ieve been out here for four hours and only got one mussel. Thates about $3," he says. "They must be dug in." Diving for shell is risky business. As Jeff Garner, Ala-bama state malacologist, says, "It takes a tough man or woman to crawl around in the dark at the bottom of the lake to pick up shell." A diver in Texas drowned not long ago when his air hose became knotted in a swift current. Not far from here a diver nicknamed Sharkbait died of hypothermia when he dove without the right protective clothing. In diving for mussels, apart from fighting the current, the trick is to stay down long enough to find the mussels and then selectively pry them out. The Bivens troops all wear lead belts that can easily be dropped if they get into any kind of trouble. Other divers, who either cannot or will not buy regulation weights, improvise. One weighed himself down with a cast-off kitchen sink and another tied himself to a manhole cover. Neither resurfaced. Steven Bivens says, "You never know what youell run into under the river. . . . Might be a 70-pound flathead catfish four feet long thatell bump you if youere near their nest. Or youell get a bite from a gar or an alligator snapping turtle. But thates nothing. Ites the concrete blocks I watch out for. If I run into one, I just back off . . . never know who or what might be attached to the other end of it." Other underwater surprises are loaded guns, sunken boxcars, drowned trees and two-foot-long salamanders known as water dogs. The two barrels at the Bivensese are full of cooking musselsuwashboards, butterflies, pigtoes, monkeyface. As soon as theyere cooked out, Leon dumps them on the driveway with a big scoop. With the deftness of a surgeon Judy removes the meat from the shell, pinching for pearls as she goes. Every now and again a misshapen pearl pops up. "But mussline isnet like it used to be," says Judy. A similar sentiment is expressed by the biologists: "When we see a mussel we talk about it," says Mel Warren, research biologist at the Forest Service research lab in Oxford, Mississippi. This entire assemblage of invertebrates is threatened. Some 70 percent of American mussel species are in jeopardy, especially in the mussel-rich Southeast, where freshwater fauna are in such deep trouble that, at a recent meeting convened by the World Wildlife Fund, biologists declared most mussel habitat,

primarilySoutheastern U.S. waterways, critical global hot spots. "The Southeast is where the action is," says Jim Williams. Initiatives are under way to bring back freshwater mussels in North America. Mel Warren, Wendell Haag, Paul Hartfield, University of Alabama biologist Chuck Lydeard and his graduate student Kevin Roe are on their way to the headwaters of the Sipsey Fork in Bankhead National Forest in hopes of finding the orange nacre mucket and her pal the largemouth bass. Ites a cold April day. The royal fern is not up yet, but rugs of bluets, violets, trillium and coreopsis grace every sunny clearing. The white flowers of wild dogwood and laurel and the dark red flowers of pawpaw dot the understory, while beech, pine and big leaf magnolia preside. At the Sipsey Fork, a tributary of the Black Warrior River, a school of torpedo-shaped redhorse flashes past. The Bankhead is an island of wilderness in a sea of dammed rivers, cotton fields and sprawling development. Yet here is a remnant of the Southeastern mussel diversity that greeted De Soto. Although the Bankhead, like most every forest in the Southeast, has been repeatedly logged, the U.S. Forest Service has done a good job protecting the streams. Hartfield notes that elsewhere in the

region the creeks are unraveling. "Youell see this fine clear sand. Thates a bedloaduan artifact of bad agriculture farther upstream, or construction or cows muddying things up and adding to the erosion of the glueuthe silt and clay." The agency has even gone so far as to restrict horses by closing some horse trails and redirecting others away from streams. "Horses are hell on mussels," notes Hartfield. "They crush mussels in streams with their big hooves." The musselmen hit the stream. Chuck Lydeard and Kevin Roe will try to clip pieces of muscle tissue from the feet of mussels for DNA work. Wet-suited Mel Warren, surveying mussels, crawls slowly along the bottom. When he finds one and identifies it, he returns it to its "hole." The water is 50 degrees F, possibly warm enough for mussels to release their glochidia. Hartfield and Haag get ready to check the creek bottom with "water scopes"uglass-bottomed buckets. At first this seems a silent profession, but soon the names of mussels fill the air. Within 20 minutes, the musselmen have found triangular kidneyshell, southern pocketbook, rainbow, dark pigtoe. At Flannagan Creek they find what looks like a displaced Thai noodle. "Theyere here," says Hartfield. "Herees what we came foruevidence of a breeding orange nacre mucket." But the "fish" at the end of the Thai noodle looks pretty raggedy and ites not attached to Mom. Not far away, however, a pair of orange nacre muckets, female and male, are pumping water. At the Forest Service lab in Oxford, Mississippi, a dozen southern rainbows are living in individual aquariums. Some sit like headstones. Some toss about modified mantles that look like dreadlocks; others flutter mantles as subtle as eyelashes. Still others display what looks like a waving crowd of fevered alums at an Alabama-Auburn game. In one aquarium a bass regards a mussel. The mussel waves. Still the bass hangs back. Finally, the bass grabs a quick nip and ends up with a faceful of glochidia. Biologists especially want to know which fish species are host to which mussel species. In his laboratory Haag tranquilizes a fish and applies glochidia directly to the gills. A few days later he again tranquilizes the fish and checks under a microscope to see if the larvae are still there. (As the fish hosts for less than half of mussel species are known, establishing the pairing is a crucial step in mussel recovery efforts.) In another couple of weeks, Haag will vacuum the bass aquarium to see if tiny mussels have dropped off and are pattering about on their newly developed feet. The bass will be none the worse for wear. At the lab, captive propagation of the endangered tan riffleshell is working so well that the species is being reintroduced into the Hiwassee River. Ites easier to raise tigers than mussels, however. Mussels require a current of running water to feed, breathe, mate and spawn. As captives they can be protected from predators such as muskrats, raccoons and even crows, but they are still fair game for fungi and bacteria. Researcher Francis OeBeirn says, "They have to be scrubbed down individually to rid them of fungi and bacteria. . . . Mussels accomplish this toiletry themselves in the wild by digging themselves in the mud." OeBeirn and graduate student Michelle Steg are working with the unendangered wavy-rayed lampmussel before they turn to the tan riffleshell. These proxies completed their journey from glochidia to baby mussels by exposure to largemouth bass hosts, who traveled by truck from Arkansas. The babies, which look like a bunch of tomato seeds, will "soon be living a full life," says Steg. The only place in the world with a naturally reproducing population of tan riffleshells is the Clinch River in southwestern Virginia. USFWS mussel biologist Leroy Koch, who oversees the population, says, "Up until 1994, there were only a few individuals left in scattered areas. In 1995, a student stumbled on one in the town of Cedar Bluff." Some communities regard having an endangered species in their midst as equivalent to having nuclear waste dumped in their backyard, but Cedar Bluff, Virginia, regards its mussels with a certain pride. Town manager James K. McGlothlin says, "The riffleshell are here and ites a fact. And the citizens of Cedar Bluff are not going to be guilty of letting the last tan riffleshell go extinct." The rare mussel has become so much a part of the community that every fall the town holds a "mussel race." The race itself is based on the tan riffleshelles reproductive cycle. A "giant mussel," sculpted by local oral surgeon Glenn Harrison, releases "glochidia," numbered Ping-Pong balls bought by participants, from the town bridge. Downstream several wind socks in the shape of fish catch the "glochidia" as they float by; the winneres ball is the first to get caught. The proceeds last year went to build a playground. (In 1983, not far from here on the Clinch

River, the Nature Conservancy purchased an assemblage of islets called Pendleton Island to preserve a half-mile stretch of mussel bed populated by 45 mussel species.) The freshwater mussel would seem to be able to do everything except provide a cure for cancer. That could change. "You never see a tumor on a freshwater mussel," says biologist Neves. "Their resistance is legendary." The mussel may once again surprise us. But even if they donet hold a cure for cancer, a few freshwater musselsufor the moment, anywayuare still out there, winking seductively at obliging fish, filtering the water for the benefit of all. Biologist Adele Conover has never lost her infectious enthusiasm for the natural world. Lynda Richardson had never thought much about mussels until she was assigned to photograph them.

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U.S. Fish & Wildlife Service

Discover Freshwater Mussels: America's Hidden Treasure

They make no sound. They cannot see. Some may live for decades, but seldom move from a secure spot. Yet, freshwater mussels are causing a stir; becoming noticed and making us ponder their future as we make plans for our own.

For the Record

No other country in the world equals the United States in freshwater mussel variety. While all of Europe supports only 12 species, nearly 300 kinds live here, mostly within the vast watershed of the Mississippi River.

Unfortunately, these animals may be the most troubled natural resources in this country. It's estimated that 70% (Williams, et al. 1993) of our freshwater mussels are extinct, endangered, or in need of special protection. Many of their problems stem from how they live and changes that have occurred to their habitat during the past 200 years.

Life Down Under

Most freshwater mussels live burrowed in sand and gravel at the bottom of rivers and streams. Only a few are adapted to the quiet water and muddy depths of lakes, ponds, and reservoirs.

Unlike most animals, which must travel in search of food, their food drifts to them, mainly tiny plants and animals called plankton suspended in the water. By drawing water inside their shells through a siphon, their gills filter out food and take in oxygen.

Mussels usually don't move much, but a muscular "foot" helps them burrow and allows limited travel if disturbed by floods or drought.

The foot also helps anchor them against strong currents and may prevent a hungry muskrat from tugging them out for its dinner! A mussel's shell, however, provides its main protection from predators.

Their hard, calcium-based shells consist of two halves joined by a hinge. Unique names like "monkeyface," "threehorn wartyback," and "pink heelsplitter" refer to the wide range of shell size, color, shape, and texture found among mussel shells.

Something "Fishy"

Freshwater mussels need a lot of luck to successfully reproduce. Their unusual life cycle begins when eggs held inside the female are fertilized by sperm drawn inside her while siphoning water. For most species, if a male of her kind isn't nearby upstream, she can't reproduce. For a few, this is not a problem because they seem able to fertilize themselves.

The adaptations these species have developed to attract host fish are absolutely amazing considering mussels don't even have eyes to see what they are mimicking! When freshwater mussels "go fishing"

varies by species and takes place throughout the year. However, there are several species displaying during the summer months. The wavy-rayed lampmussel is currently displaying tissue that looks like various insects and fish The rainbow mussel is displaying small black projections that look like worms. For more information about these and other species displaying this summer contact the biologists listed at the end of the article. Also, check out the Unio Gallery website link for pictures of these fascinating freshwater mussel lures.

Once fertilized, the eggs develop into a larval stage inside the female before they are released into the water to begin a parasitic stage. With little time to waste, these youngsters, called glochidia, must attach themselves to a host fish or perish. For some mussels, the host is limited to only a few fish species. This generally harmless parasitic stage lasts a matter of weeks before the larvae transform into young mussels and are ready to drop off the fish and begin a life in the stream bottom.

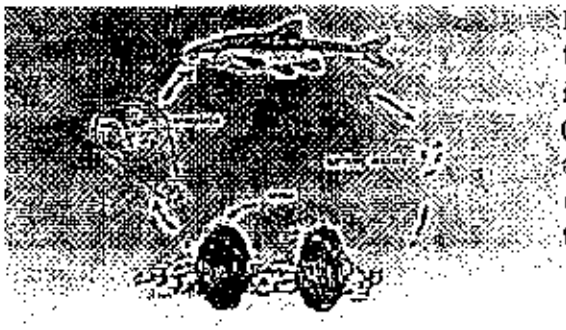

Figure 1: Follow clockwise beginning with the adult mussels at the bottom of the illustration. The mussels releases glochidia (larval mussels) which attach to the appropriate fish host species where they develop into juvenile mussels and drop into the river bottom to grow into adult mussels.

To increase the chances of their young making contact with a fish host, some females "go fishing." By displaying specially adapted tissues that look like fish prey, they try to lure fish to swim near them. Sensing a fish nearby, the female releases her young into the water, ready to clamp onto the fish.



Figure 2 This mussel is displaying a lure that looks like a small darter (small nongame fish). Photo from the Unio Gallery by Chris Barhnart..

Mussel Aches

Our native freshwater mussels face greater problems today than they did just a few years ago. Some problems aren't new. Although water quality has improved in some areas, pollution, especially non-point source pollution, causes the greatest threat to native mussels. Also sedimentation continues to take a serious toll. Habitat losses through channelization, clearing of riparian and streambank vegetation, dredging, and dam construction still persist. Mussels are impacted by loss of fish hosts from fish kills or dams that prevent fish migration. Poachers can impact mussles by violating harvest regulations set by conservation agencies. However, in some parts of the country, it's a non-native mussel causing the most concern.

Zebra Mussel Invasion

In 1988, the fist zebra mussels were spotted in Lake St. Claire near Lake Erie in Ohio. Assumed to have been stowaways in the ballast water of a trans-Atlantic ship, this native of eastern Europe is now widespread throughout waterways in the eastern half of the United States. Besides other problems, zebra mussels have nearly eliminated native mussels in some locations.



Figure 3 Zebra mussels covering native mussels.

Unlike native mussels, the much smaller zebra mussel (less than 2" in length) does not use a host animal in its life cycle, and reproduces at a tremendous rate. They can attach themselves to hard surfaces with thread-like structures called byssal threads. In zebra mussel-infested waters, it is not unusual for native mussels to be completely covered by zebra mussels. Competition for food and oxygen weakens and eventually starves native mussels.

They Lose, We Lose

Freshwater mussels have played a long and varied role in people's lives. Native Americans used them for food, tools, and jewelry. From about 1890 until the invention of plastics around 1950, mussel shells supported this country's button industry. More recently, the world's cultured pearl industry relies on implant beads made from the superior shells of North American mussels. In states where mussel collecting is legal, harvesting provides jobs and income to residents along rivers.

Mussels have other values more difficult to measure. In the rivers and lakes where they live, their filtering ability makes them natural water purifiers. They play an important role in the aquatic food chain as a food source for wildlife including muskrats and otters.

They also can tell us something about the health of the environment on which we both depend. Mussels respond to changes in water quality. Gradual mussel die-offs or sudden mussel kills are reliable indicators of water pollution problems and other environmental health concerns. Stable, diverse mussel populations generally indicate clean water and a healthy aquatic environment.

If we lose our freshwater mussels, we lose more than a biological legacy unmatched in the world. We lose a part of our cultural heritage, we lose an economic resource, and we lose an environmental health maintenance and warning system. Fortunately, there are efforts being made to avoid these losses and things everyone can do to help save our freshwater mussels.

Biologists from the U.S. Fish and Wildlife Service (Service) and the U.S. Geological Survey along with other Federal, State, and private agencies are working together to find solutions to problems facing our mussels. These partners have developed a National Strategy for the Conservation of Freshwater Mussels, which will serve as a blueprint for native mussel restoration. They have also formed the Freshwater Mollusk Conservation Society that will help guide research, restoration, and recovery efforts for freshwater mussels.

Mussels and their habitats are being surveyed, monitored and restored. The Service's endangered species program is working to conserve these species and their habitat. Some mussels facing extinction in the wild have been removed and brought to the Service's National Fish Hatcheries and State facilities for safe-keeping. Hatcheries are developing techniques for propagating rare mussels for release. We are beginning to reestablish mussel populations into restored streams and rivers. The Service's Fishery Resources offices help by providing technical assistance on habitat restoration and enhancement for mussels. States manage and monitor harvest activities to ensure that populations are not depleted by use. Aquarium and zoo personnel are also assisting with conserving endangered freshwater mussels through efforts such as research and education programs. The National Wildlife Federation has a long history of working to enhance national water quality and protect endangered species through advocacy, education, and on-the-ground programs. These efforts--including the "Keep the Wild Alive" campaign, which celebrates endangered species protection efforts worldwide--are helping to improve conditions for imperiled freshwater mussels. But there's more that needs to be done and you can help.

There are ways that you can help to provide a secure future for mussels. For instance, avoid contributing to water pollution. Follow application directions and don't use fertilizers and pesticides excessively. Leave stream sides vegetated even if it means giving up part of the view. Keep cattle and other livestock out of streams. Report suspected pollution problems to authorities. Get involved with land use planning in your community. In the

The Kiamichi - one of the most pristine and ecologically intact river basins in the region - has a watershed that drains 1, 830 square miles and is to a vast majority privately owned. Through a unique partnership that spans Federal and State agencies, local conservation and landowner organizations, and a conservation- minded corporation, the community-based Kiamichi River Initiative is a model to emulate.

Historically, local landowners have done a good job protecting the river using management practices like riparian borders. The narrow watershed is heavily forested, and until recently land use was primarily limited to forestry and cattle grazing. Water uses have been limited to fishing, swimming and occasional canoeing.

The free flowing river originates in the Ouachita National Forest at the Arkansas border and ends at its confluence with the Red River - the Oklahoma/Texas border. Most of the Kiamichi River basin is in narrow valleys that range from 3-12 miles in width and feature steep and rocky slopes. Pine-hardwood forest is the typical vegetation, with shortleaf pine dominating drier south-facing slopes and oaks, hickories and other hardwoods dominating north-facing slopes and bottomlands.

The river is home to the Federally listed (Endangered) Ouachita rock pocketbook (Arkansia wheeleri), one of the rarest mussels in North America. This species is the world's only remaining representative of it's genus and is evolutionarily distinct and a high priority for conservation. This mussel is sensitive to long-term changes in water conditions such as temperature, nutrient levels, current, substrate, pesticides and oxygen levels.

The only known healthy population of Ouachita rock pocketbooks exists in the clean waters of the Kiamichi River, home to another 28 mussel species, including seven imperiled or vulnerable ones and more than half the mussels known to live in Oklahoma waters. The species rich Kiamichi River also harbors more than 100 native fish species.

Spearheaded by the Nature Conservancy's Oklahoma chapter, the Kiamichi River Initiative is based in the small southeastern Oklahoma community of Clayton and seeks to build community support for the long-term health of the Kiamichi River watershed and the communities within its borders. The Nature Conservancy recognized early on that partnerships were essential to successful program planning and decision-making and established a core team of integral Federal and state agencies and other key groups during the first months of the project.

Representatives of the U.S. Forest Service, U.S. Fish and Wildlife Service, the Oklahoma Biological Survey, Ouachita Mountains Resource Conservation and Development district, Public Service Company of Oklahoma (PSO) a major electrical utility provider in the state, and The Nature Conservancy began working together. Meeting regularly, the partners provide input that helps assess the productivity and

long run, freshwater mussels will benefit from improvements in water quality. And so will you!

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Additional Web Sites:

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efficiency of efforts to maintain the ecological integrity of the river.

Central and Southwest Services, PSO's parent company, brought needed financial capital to the partnership. The corporation contributed $80,000 to help support operational costs associated with establishing and maintaining a local office in the watershed.

The Kiamichi River manager is working with local schools in the watershed. Classes will be learning about important watershed concepts and participating in hands-on water quality monitoring. To better realize the aquatic education objective, new partners from the Natural Resources Conservation Service, Oklahoma State University Extension Service and the Latimer County Conservation District have enthusiastically 'stepped to the plate.' The Nature Conservancy has assembled two 'River Resource Boxes' for area teachers. These educational trunks have stream ecology kits, field guides, books, and river activity manuals. Teachers and students can use the ecology kits to conduct aquatic sampling experiments and monitor water quality.

Goals for the year 2000 include a more detailed assessment of the critical reaches of the river and the development of several private land riparian restoration projects. Cooperative projects will provide benefits to individual landowners while improving aquatic conditions on the river. Furthermore, key demonstration projects will help The Nature Conservancy show other watershed landowners the benefits of similar projects on their property.

The success of the Kiamichi Initiative is entirely dependent on building local support. Initiative designers recognize that local communities must be empowered to chart a sustainable future for the Kiamichi watershed. Therefore, the development of a coalition of local citizens, landowners, community groups, corporations, Native American tribes, schools, and local, state and federal agencies is necessary.

Trust in the community is slowly gaining - one individual at a time - through honest up front discussions and dialogue. Much of the ground - work for the Kiamichi Initiative involves simply listening to the desires and concerns of area landowners and residents. With continued cooperation from all partners, the ultimate goal of developing and implementing a Kiamichi River Conservation Plan will be realized. At this time, no one really knows exactly what such a document will look like. However, most participants believe that such a plan will reflect the region's desire to maintain the natural integrity of the watershed while sustaining a high quality of life for local citizens and rural landowners.

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A REVIEW OF INTERACTIONS BETWEEN HUMANS AND FRESHWATER MUSSELS IN TEXAS

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A REVIEW OF INTERACTIONS BETWEEN HUMANS AND FRESHWATER MUSSELS IN TEXAS

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ABSTRACT. Human exploitation of freshwater mussels has occurred since prehistoric times. Prehistoric utilization was minor, but mussels were used as food, ornaments and tools. Historic utilization has involved food, button manufacture, pearls and "seed" for cultured pearls. Human impact has also occurred because of water projects and water pollution. Legal regulations, outlook for the future and environmental significance of freshwater clams are discussed.

The freshwater clams of the family Unionidae in Texas remain an imperfectly-known fauna. Following early compilations by Singley (1892, 1893), the only comprehensive treatment has been Strecker (1931). However, a plethora of nomenclatorial uncertainties and modern development of the biological species concept have combined to limit the usefulness of Strecker's monograph.

Delineation of species limits in unionids is difficult due to a complex interaction between natural genetic variation and external environmental factors which result in phenotypically plastic taxa. Consequently, a survey of the unionids of Texas and contiguous drainages is presently underway. Preliminary studies have revealed a moderately diverse fauna of approximately fifty species with centers of diversity in eastern and central Texas. The fauna consists of species derived from Mexican rivers and the Mississippi drainage in addition to several autochthonous forms (for details on the zoogeographic patterns of unionids in Texas, see Neck, 1982 in this volume).

Significant populational impacts have occurred even before the native fauna has been characterized. The purpose of this communication is to review the effect of human activities upon the freshwater naiads of Texas. Reference will be made in particular to Texas populations, but pertinent examples will be drawn from elsewhere.

DIRECT HUMAN IMPACT. Direct human impact includes those human activities which directly influence freshwater clams. Such activities are generally limited to utilization of naiads for food, tools or ornaments.

Prehistoric Utilization. Utilization of unionids by prehistoric culture groups (Baker, 1929; Matteson, 1953; Morrison, 1942) is well documented in the eastern United States, including Texas. Primary exploitation undoubtedly involved human consumption, but certain characteristics of freshwater clams limit their utility as

a foodstuff. A low level of nutrients in clam tissue and low dry-weight per individual clam generally preclude the dependence of even a moderate-sized settlement on naiads as a major food source (Parmalee and Klippel, 1974). Most species are commonly found concentrated in mussel beds which may be highly localized and scattered. Yet, the existence of large deposits of clam shells in archeological sites (Meighan et al., 1958) indicates a general (i.e. widespread) utilization of clams as a periodic food source (Forrester, 1964; Murray, 1982).

A small fraction of clam shells from archeological sites exhibit one or more modifications as either ornaments or tools (Jackson, 1938). Shells believed to be ornaments often have one or more simple holes which appear to have been carefully drilled (Lord, 1978; Neck, in press). Such shells probably function as necklaces, breastplates or other ornamentations.

Modified clam shells from archeological sites often may be interpreted as tools because the modification appears to be non-ornamental. Utilization of the putative tool may be difficult to determine unless ethnographic data are available. Clams appear to have been modified to form digging instruments, food implements or containers (Jelks, 1962; Sayles, 1935).

Historic Utilization. Historic direct utilization of freshwater clams appears to have been mainly as food and ornamentation with only local use as tools. Freshwater clams have never been widely accepted as a foodstuff in the United States. Conversations with persons who have sampled various species report the meat to be "rather chewy" with little flavor variability between species (D. J. Bereza, pers. comm.). Chowder recipes are preferred by most people (Bigony, 1979). Essentially the entire animal is edible although certain organs associated with the alimentary tract are likely to have a strong taste. Often, only the larger muscle masses are consumed. Unconfirmed reports have indicated utilization by restaurants of freshwater clams as food items (under another, certainly more appetizing name).

As a foodstuff today, freshwater clams are probably more widely utilized as fish bait or pet food. Much of the clam meat which is accumulated by the cultured pearl industry (see below) is sold for pet food or fertilizer. The Asiatic clam, Corbicula flumines, has colonized most of North America during the last 40-50 years. The major method of inter-drainage dispersal is probably as potential fish bait; unutilized clams are often discarded.

Freshwater clam shells or products made from shells have been widely utilized in an ornamental manner during historical times (Smith, 1919). Primary utilization of shell material by Americans was as buttons. Thousands of pounds of shell were removed from American rivers during the latter half of the nineteenth century and the first half of the twentieth century. Indeed, essentially all of our early studies or ecology, growth and zoogeography of freshwater clams resulted from commerically -oriented studies by the U.S. Bureau of Fisheries. Utilization of buttons made from

mother-of-pearl of freshwater mussels in Texas was concentrated in the Lower Rio Grande Valley (Garrett, 1929). Exploitation often concentrated on several species with strong thick shells in each area. The only species utilized in the Valley was Cyrtonaias tampicoensis.

In kind with their marine relations, freshwater clams also produce pearls in response to irritants (see Kunz, 1897). A thriving pearl industry developed around Caddo Lake in the early twentieth century (Shira, 1913). An estimated $100,000 worth of pearls was removed from Caddo Lake in 1912, a year considered poor in comparison with previous years. Interestingly, the shell resource of the Caddo Lake area was not utilized by the button industry because of transportation costs and competitive high local wages ($3 per day in oil fields). Fine white pearls were obtained from Megalonaias gigantea and Tritogonia verrucosa while colored pearls were found in Plectomerus dombeyanus; pearl color is the same as the nacre color for a particular individual.

Freshwater pearls are of minor significance in our modern economy, but are occasionally publicized (e.g. Mannix, 1965). However, there is one stream in Texas which still produces significant amounts of pearls. Individuals of Cyrtonaias tampicoensis in the Concho River in the vicinity of San Angelo, Tom Green Co., produce high-quality pearls of a purplish color. A local jeweler purchases 500 to 1200 of these pearls each summer on an ad libitum basis from local residents, primarily adolescents. Most pearls vary from 3 to 8 mm in diameter; the largest known is 13 mm in diameter (Pinkard, 1979).

While freshwater clams no longer provide large amounts of pearls, these animals are still a part of the modern pearl industry. Thousands of pounds of freshwater clam shells are annually exported to Japan for use in the cultured pearl industry (Lopinot, 1967). Pearl culture began in 1912 when Kokichi Mikimoto developed successful methods in Japan. Various potential nuclei, i.e. irritants, were tested. The best nuclei were those made from freshwater clam shells. Primary locations of diverse, high-density populations of freshwater clams in the world are eastern North America (especially the Mississippi River sytem) and mainland China. For some years China has had essentially no trade with Japan because of political factors; therefore, the Japanese cultured pearl industry has depended entirely upon shell from the United States (Lopinot, 1967).

Fuller (1974:251) has listed the major impacts of collecting for the cultured pearl industry as follows: 1) reduction of brood stock to a level that reproduction may not equal mortality; 2) physical alteration of substrate of mussel bed areas; 3) stress-induced abortion of brooded young following disturbance at improper times for successful reproduction; 4) "waste deaths" of juveniles below legal and/or utilitarian limits; and 5) uprooting of adults which are often not able to rebury themselves correctly. Fuller (1974:251) considers the use of diving gear to be "the greatest threat to commercially valuable mussels today."

The total tonnage of clam shell removed from the waters of Texas is unknown, although the figures must be large. Reports of shell removed from various reservoirs in Texas by a single company are given in Table 1 (a total of 3,820,252 pounds during 1978-1981). Shell operations by other companies are occurring in other drainages and reservoirs. Preferred species in Texas are Amblema plicata, Quadrula apiculata and Proptera purpurata. During the drought of 1978 many Texas reservoirs were at record low levels, allowing easy access to numerous clams by "amateur" shell collectors who sold their booty to shell companies for 20 cents per pound. Enterprising persons hired several children to dive and collect clam shells. One such person accumulated over 1100 pounds on his most successful day of operation. The shell industry in Texas has reached the economic point such that one company is considering some form of clam cultivation in order to increase and ensure a quantity of shell for their customers. Such methods have been successful elsewhere (Jones, 1950).

Although the lag time between shell collection and purchase report by the shell company is unknown, certain patterns of harvesting are evident (Table 1). Most harvesting occurs during the warm season. Harvesting peaks are evident in drought years (1978 and 1980) with much less activity in wet years when the reservoirs are full (1979) or flooding (1981). Harvesting activities have been concentrated in Eagle Mountain Lake (Tarrant Co.) and Lake Lewisville (Denton Co.) in the Trinity River drainage. Minor amounts have been removed from Lake Brownwood (Brown Co.) and Cedar Creek Reservoir (Henderson and Kaufman Counties).

Table 1. Reported clam shell harvest from various Texas reservoirs by a single shell company (pounds).

	1978	1979	1980	1981
January	-0-	24,400	85,800	88,000
February	-0-	-0-	44,000	44,000
March	80,400	-0-	156,200	84,000
April	69,200	87,800	174,00	70,600
May	111,600	66,874	214,400	57,525
June	220,800	68,253	381,400	-0-
July	188,400	30,000	188,400	-0-
August	232,800	89,200	198,600	-0-
September	295,000	52,800	44,000	-0-
October	99,000	73,400	-0-	14,000
November	40,000	67,800	-0-	-0-
December	40,800	36,600	-0-	-0-
Total	1,378,200	597,127	1,486,800	358,125

To prepare a nucleus for a cultured pearl, the thickest portion of the clam shell is cut into strips and then cubes which are then ground and polished into a spherical shape. These pellets are then sold to pearl farmers who insert the pellet into an incision in the foot of three-year old Japanese pearl oysters. The oysters are then

placed in submerged wire cages for an average of three years. Pearls are then removed, graded, sorted and polished.

Freshwater clams are also utilized to a minor extent in art crafts. Some of the larger shell shops in coastal Texas sell freshwater clam shells as well as the more colorful and more popular marine mollusc shells. Some of the naiad shells found in shell shops in south Texas are imported from Mexico. Shell waste from the cultured pearl industry can be manufactured into craft products (Mathiak, 1974).

Mollusk shells in general and clam shells in particular have long been a symbol of life, apparently because they represent an organism even after its death (Saul, 1974). In small central Texas towns with a dominant central or eastern European cultural influence, gravesites are occasionally covered with clam shells placed directly on setting mortar. Usually the shell involved is a marine species (the giant Atlantic cockle, Dinocardium robustum seems to be most common). However, an occasional grave is covered with freshwater clams.

INDIRECT HUMAN IMPACT. Certain human activities do not involve exploitation of freshwater clams but nevertheless affect individuals and populations of certain species. Included are activities which involve habitat modification (impoundments, channelization, runoff pattern alterations, water pollution and aggregate removal) and faunal modification (fish stocking, interdrainage water transfers and clam transfers).

Habitat Modification. Probably the most significant human activity to influence freshwater clams involves the numerous impoundments which have been constructed on most major and many minor streams. Construction of an impoundment has two major effects on the clam population. There is an increase in the absolute area of suitable habitat. Clams originally restricted to favorable areas of a narrow stream are able to colonize large areas of shallow water. In many cases, the original stream bed becomes unsuitable for freshwater clams because of accumulation of soft silt, development of an anoxic zone and the increase in water depth.

The most obvious effect of impoundments upon these clams is a change in species diversity, because those species adapted to lotic waters are unable to reproduce under reservoir conditions. Loss of species in reservoirs has been attributed to changes in water temperature and chemistry which alter reproductive success and survival rates (Isom, 1971; Gvancara and Freeman, 1978).

Certain species, however, are able to flourish under such conditions and become extremely abundant, e.g. Amblema plicata and Quadrula apiculata. Murray (1972, 1979) has reported on the unionid fauna of Lake LBJ and Lake Corpus Christi. Important in the ability of A. plicata to survive in impoundments is the ability to survive in water with no dissolved oxygen for 10 weeks (Imlay, 1971).

Streams which naturally support only a few species of clams may exhibit an increase in species number following impoundment. Lake Texoma was created on the Red River in 1944; prior to that time only four mussels were known from that section of the river although sixteen species existed above the dam site in various tributaries (Isely, 1925; Valentine and Stansbery, 1971). Subsequent observations of the naiad fauna of Lake Texoma (Sublette, 1954; Riggs and Webb, 1956; Valentine and Stansbery, 1971; White and White, 1977) have revealed a fauna of 13 species in the reservoir. While some of the increase is undoubtedly due to an increase in survey area, species enrichment may result from a maturation of clam microhabitats through time (White and White, 1977).

The clam community may be transformed from a many-species community to a community dominated by one to several very common species. Original clam communities in the Elm Fork of the Trinity River contained 17 species (Strecker, 1931; Read and Oliver, 1953; Read, 1954). An unpublished survey of Lake Lewisville has revealed the presence of 13 species (Neck, in prep.); this total includes two native species which normally are found in ponded water. These two species, Anodonta grandis and Anodonta imbecillis, have apparently become more common since the construction of various impoundments. Both of these species are rare or absent in shell middens of archeological sites in areas where they are now common (Murray, 1982). Species no longer present include those more adapted to moving water than those which remain. Species reduction due to impoundment is much greater in areas which are characterized by high-gradient, clear rivers, e.g., streams of the Tennessee River. Several species have become nearly extinct due to impoundment of these streams (Bates, 1962; Isom, 1969; Stansbery, 1971). Decline of species diversity can often be verified by comparison of living faunas with prehistoric shell middens (White, 1977; Parmalee et al., 1980).

Several clam species adapted to lentic water have been able to colonize small lakes, i.e. stock tanks, in areas which previously had only intermittent streams with no native unionid fauna. Survey of 15 small ponds on a tract of land near Athens, Texas (Henderson/Van Zandt counties) revealed unionid populations in nine ponds (Neck, unpub.). Uniomerus tetralasmus, Carunculina parva, Ligumia subrostrata, and Anodonta imbecillis were present in 7, 6, 4 and 2 ponds, respectively. The only pond which contained all four species also had the lowest elevation and was more susceptible to flooding with input of fish with glochidia.

Other habitat modifications which conceivably have affected freshwater clam communities exist. Channelization of streams includes an initial construction impact which reduces or eliminates populations and habitat. Such channels are not inherently inferior habitats if the walls and floor are stable (Wilson and Clark, 1912).

However, the resultant rapid runoff (instead of a slower, less variable discharge) with alternating periods of desiccation precludes recolonization by most, if not all species. Widespread land clearing, urban development and groundwater withdrawal (Brune,

1975; Muller and Price, 1979) all tend to exacerbate the problem rapidly changing water levels and velocities. Increased rates of soil erosion have exacerbated the problem of silt accumulation (Ellis, 1936). Removal of aggregate, i.e. sand or gravel, may impact mussel beds by killing individuals and removing required substrate which may or may not be replaced by subsequent fluvial activities.

Water pollution caused by excessive amounts of municipal, agricultural and industrial wastes has a general effect of reducing diversity of most natural benthic communities. Clam communities are likewise affected (Fuller, 1974). The earliest report of pollution effects on freshwater clams was reported by Shira (1913:6) who reported that saltwater and waste from oil and gas wells in the Caddo Lake area destroyed "many fishes and mussels." A noticeable decline in unionid population levels has been reported in the resacas east ("downstream") of Brownsville, Cameron Co., in the 1950's (B. T. Warburton, pers. comm.). Although utilization of DDT increased during this time period, the casual factors appear to be non-point source urban pollutants. Healthy populations of unionids presently occur in the area west ("upstream") of Brownsville.

A study in the San Marcos River revealed that freshwater clams are adversely affected by sewage effluent (Horne and McIntosh, 1979). Critical water parameters did not differ above and below point of outfall but clams were less abundant below the point than above. Apparently, critical stress levels occur during periods of low water flow. Oxygen depletion below 20% saturation level (which may occur as a result of sewage enrichment) has been shown to be a major stressor of freshwater clams (Ellis, 1937; Ingram, 1957).

Faunal Modification. Faunal modification is an apparently minor impact resulting from uncommon circumstances. Fish stocking activities are an everyday occurrence in our society. While it is possible for fish with attached glochidia to be involved, indication of such clam transfer requires that the new locality be beyond the normal range of the clam (Johnson, 1970). Two episodes have been demonstrated in Texas (Metcalf and Smartt, 1972; Neck, 1982); undoubtedly, numerous others occur. Existence of clams in stock tanks on drainages with no native unionid fauna is almost always due to fish stocking activities. However, there is the occasional interested person who deliberately places freshwater clams in a new stock tank.

An Asiatic clam, Corbicula fluminea, has colonized essentially all waterways of North America (Britton, 1979) including Texas (Britton and Murphy, 1977) following its initial Texas report in El Paso (Metcalf, 1966). This clam has planktonic larvae with no dependence upon fish. These life history characteristics (Aldredige and McMahon, 1978) plus a tolerance for polluted waters (Habel, 1970) have resulted in population explosions which have paralleled recent declines in unionid populations. A cause-effect relationship has not been established and research on this topic is quite limited (Boozer and Mirkes, 1979). The concurrent decrease

of native pleuroceriid snails and increase in the European snail, Bithynia tentaculata, in New York has been shown to be due to modified competitive relationships intensified by lake eutrophication (Harman and Forney, 1970). No such relationship involving native unionids and Corbicula has yet been demonstrated.

In addition to possible impacts on native fauna, Corbicula is a major problem in fouling condenser tubes of water-cooled electric generators (McMahon, 1977). Utilization of Corbicula in integrated biological treatment of wastewater (Dinges, 1976) has been proposed but initial trials have been unsuccessful. Interestingly, the imminently successful Corbicula is the only known introduced freshwater clam in North America (Hanna, 1966; Dundee, 1974).

THE FUTURE. With continued economic development and population growth in Texas during the next few decades, human impact on clams will continue. Additional impoundments are planned; the only factor which cancels an impoundment project is high land values due to urban development. Such development brings its own impacts. Hopefully, pollution control and monitoring will progress to the point that freshwater clams may be able to recolonize areas which are presently unsuitable for survival. Plans for inter-basin transfer of water present the possibility of colonization by species not native to the recipient stream.

Acid rain (which includes both acidic precipitation and atmospheric deposition of acidic particles) has become a major environmental concern during the past decade (see Babich et al., 1980; Cowling and Linthurst, 1981; Harnbeck, 1981). Naturally "pure" rainwater has a pH of about 5.7 due to dissolution of atmospheric carbon dioxide. However, a modern industrial civilization based upon fossil fuels produces oxides of sulfur and nitrogen to such an extent that rain pH values are significantly reduced. General environmental effects of this phenomenon are still unclear but aquatic organisms in acidic streams with low buffering abilities are known to suffer reproductive depression or even significant increase in mortality rates. Freshwater clams may be affected either directly or indirectly due to decimation of teleost communities. In Texas, effects of acid rain are likely to be most obvious in the eastern portion of the state due to the location of lignite deposits and stagnating wind patterns (Arena, 1981). Unfortunately, this area is characterized by acidic streams which drain soils with low buffering abilities.

LEGAL REGULATIONS. Like most of the so-called "lower animals," freshwater clams are not subject to the vast array of statutory regulations which affect vertebrates. Collecting of freshwater clam shells is, however, regulated by the State (Parks and Wildlife Code, Chapter 8, Subchapter A). Originating during the time of exploitation of mussel shell by pearl and button industries, this regulation requires a license (fee is $10.00) of anyone who "...may take any mussels, clams, or naiads or their shells from the public water of the state...". Each person collecting clams is required to have a permit; no permit is required for any person or company who only buys the shell material. No statement of amount of shell

collected is required. Prior to 1978 only a very few permits were issued (Table 2). At that time a Tennessee shell company began to buy shell in Texas. Note that permit numbers were highest during the drought years of 1978 and 1980. The peak in 1980 may have been partially influenced by increased publicity (Bigony, 1979; Pinkard, 1979).

Table 2. Number of mussel shell permits issued by Texas Parks and Wildlife Department by fiscal year (FY63 = September 1962 to August 1963).

FY63	1	FY69	3	FY76	0
FY64	1	FY70	7	FY77	0
FY65	1	FY71	0	FY78	205
FY66	0	FY72	0	FY79	111
FY67	2	FY73	0	FY80	520
FY68	4	FY74	0	FY81	115
		FY75	0		

Utilization of river aggregate is regulated by the Texas Parks and Wildlife Department. Concern is centered around siltation of the downstream riverine environment and destruction of teleost breeding grounds. Such concern will also tend to protect clam beds which may be concentrated in such areas (in part because the host fish are concentrated in these habitats).

At present several freshwater clams are listed as Endangered or Threatened by the U.S. Fish and Wildlife Service. None of the currently listed species occurs in Texas (Chambers, 1982). A list of restricted and declining nonmarine molluscs of Texas (Neck, ms.) includes a number of clams. Several of these species should be considered for listing by the USFWS, e.g. Lampsilis satura, Proptera amphichaena and Popenaias popei. All three of these species are naturally restricted to limited areas of Texas. L. satura and P. amphichaena appear to be quite limited as they are known from eastern Texas and western Louisiana. P. popei is also known from northeastern Mexico. All three species have been affected to some degree by human activities. Lack of precise data on these species precludes an accurate judgment of the status of these species in Texas at this time.

WHY CARE ABOUT CLAMS? The logical counter-argument to concern about freshwater clam communities is to ask, "What good are they?" Certainly the economic value is not significant when compared to the Gross National Product, but the extra income earned by the clam collectors is certainly significant to their families. Additionally, those persons wishing to possess pearls may do so with less economic investment due to the development of the cultured pearl industry.

The real importance of freshwater clams (even if not accepted by the general populace) is the part they play in a functioning ecosystem. These clams are filter feeders, taking in both

suspended sediment and organic materials. The shells provide substrate for many aquatic insects which in turn are fed upon by numerous aquatic and terrestrial organisms (some of which are economically important to fishing and hunting interests). Clams provide food for fish and waterbirds in addition to such economically important furbearers as raccoon and muskrat. Utilization of various phyto- and zooplankton species as food (by the clams) may provide a significant regulatory dampening effect which benefits other aquatic life, including fish.

Research is now appearing in the literature indicating that clams can be a important bioassay of past and present benthic conditions. Amblema plicata has been used to monitor trace metal contamination due to mine tailings or industrial pollution (Manly and George, 1977; Adams et al., 1981; Gardner et al., 1981). Monitoring of pesticide levels in aquatic environments by utilizing freshwater mussels has been reported (Bedford et al., 1968).

Additionally, clams are of cultural enrichment value in that the term clam has taken on new meanings in our fluid language. The term "clams" is used as a slang equivalent to U.S dollars while a reticent or taciturn person is known as a "clam." In addition, the term "clammed-up" refers to a person who will not talk about a certain topic. A hinged dredging bucket is known as a "clamshell." Also, clams are used, albeit only occasionally, in our humor (which has important social functions). The most widely known utilization is in a widely syndicated comic strip — the walking clam (with anatomically incorrect legs) of "B.C."

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PRELIMINARY ANALYSIS OF THE ECOLOGICAL ZOOGEOGRAPHY OF THE FRESHWATER MUSSELS OF TEXAS

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ABSTRACT. The ecological factors which influence the geographical distribution of freshwater clams in Texas are reviewed in relation to a map of clam biogeographical subprovinces. The Interior Basin, i.e. Mississippi River system, is the major source of Texas species with limited input from piedmont and coastal areas of adjacent Mexico. Central Texas contains several endemic species. Peripheral species occur in southeastern Texas and the Rio Grande drainage.

Zoogeography involves the study of the past and present geographical distributions of various animal groups with an ultimate goal of understanding the processes which produced observed patterns. The present distributional patterns exhibited by any group are the result of past and present ecological conditions as well as historical factors which affect dispersal opportunities. The purpose of this communication is to analyze the present distribution of freshwater mussels (family Unionidae) in Texas. Only ecological factors will be discussed in the present analysis. Historical factors have certainly affected the distribution of freshwater clams, but analysis of these factors will be presented at a later time.

Knowledge of the life cycle of a group of organisms is essential to an understanding of observed distributional patterns. These mussels may be either monoecious or dioecious. In either case sperm are liberated into the water and are taken into the female clams via the incurrent siphon. Fertilization occurs within the mantle cavity; resultant zygotes are brooded on the gills. Upon attainment of sufficient maturity the larval form, known as the glochidium, is expelled into the water. In most species this form then attaches to a fish. Attachment may occur on the gills, fins or general body surface. At this point the glochidium is a parasitic organism, obtaining all nourishment from the bloodstream of its host. When this stage has matured, it drops off the fish and begins the benthic portion of its life cycle. The familiar clam stage of the life cycle filters plankton and organic matter from the water. Growth generally occurs for three or more years before initiation of reproduction. For a thorough review of unionid bionomics see Fuller (1974).

ECOLOGICAL FACTORS. A number of ecological factors are known to affect the distribution of freshwater mussels. These factors can be grouped into hydrological, substrate and biotic factors.

The quantity and quality of water affect the unionid fauna which can survive in a particular body of water. Water depth and current velocities are extremely important. Carunculina texasensis may be found in water less than 10 cm in depth while other species require a depth of 5 m or more. Few unionids are found in the deeper portions of rivers and lakes. C. texasensis and Uniomerus tetralasmus are both typical of still waters; the latter species can even survive lengthy dessication periods (Strecker, 1908; Van der Schalie, 1940). Leptodea laevissima, however, requires moving water and is difficult to maintain in quiet aquaria while Megalonaias gigantea requires 8 to 20 feet of water (pers. observ.).

Water chemistry has profound effects on unionid species (Fuller, 1974). A moderate to substantial amount of calcium is required for the shell of all species. Acidic waters tend to etch the older portions of clam shell, requiring repair when the hole penetrates the inner layer of the shell. Range of pH values normally tolerated is at least 5.6-8.3 (Morrison, 1932). Decreasing pH values requires adaptation to lower dissolved calcium levels but higher dissolved carbon dioxide and metals (Wurtz, 1962; Fuller, 1974:242-243). Recently, Imlay (1973) has hypothesized that potassium level is a significant limiting factor; waters with potassium levels over 7 ppm contain few clams.

Substrate can also be an important ecological factor. Existence of relative proportions of mud, sand or gravel at any particular locality is largely a function of water depth and current but is also affected by upstream geological formations. Variation exists among species of freshwater clams in their ability to properly re-orient themselves following transport during periodic floods with concomitant increase in water velocities (Imlay, 1972). Some species are essentially unable to locomote from the place of initial settling; other forms move about readily in soft sediments.

The major biotic factor which affects freshwater clam distribution is the fish fauna which functions as potential hosts for the glochidial stage of the life cycle. Certain species of clams appear to be able to infest a wide variety of fish species while other clams are restricted to several suitable hosts (Fuller, 1974). A few species omit the glochidial stage; these species can exist independent of the fish fauna (except as potential prey of fish).

DISPERSAL METHODS. Freshwater clams classically exhibit low vagility; however, a variety of dispersal methods exist for these animals. Downstream movement may occur during floods but survival of such dispersants is probably unlikely. Some upstream movement by individual clams occurs but is incredibly slow. More rapid

intra-stream movements occur during the glochidial stage when dispersing fish may carry glochidia (=potential young clams) to new areas of a stream or lake.

Interstream dispersal is much more limited. Again glochidial dispersal via fish is the most likely occurrence. Such movement may occur when freshwater fish are able to migrate via temporarily-freshened estuaries to an adjacent drainage (Sepkoski and Rex, 1974). Unionids are rather intolerant of high salinities (see Gvancara, 1970). Transport to an adjacent stream system may also occur via stream piracy. Examples of stream piracy will be covered in a future analysis of the historical aspects of the distribution of freshwater clams; for examples outside Texas see Ortmann (1913) and Johnson (1970, 1972).

Another possible method of interstream dispersal involves avian phoresy. Instances of small unionid clams being found in mud attached to the foot of waterfowl have been reported (e.g., Frierson, 1899), but dispersal in this manner must be rare; van der Schalie (1945) rejected this method as a significant dispersal method for unionids. Most examples of clams attached to bird feet involves the smaller fingernail clams of the family Sphaeriidae.

FAUNAL OVERVIEW - NORTH AMERICA. Eastern North America supports the most diverse freshwater mussel fauna known in the world (Burch, 1975). Some rivers in the Tennessee River drainage may contain nearly 60 species. Zoogeographic provinces based on freshwater clams have been delineated by various workers, e.g. Simpson (1895), Henderson (1931), van der Schalie and van der Schalie (1950), and Roback et al. (1980) (see fig. 1). Peripheral to the highly diverse Cumberlandian Province lies a number of subdivisions exhibiting less diverse fauna.

FAUNAL OVERVIEW - TEXAS. Previous workers (as mentioned above) have divided Texas into two major provinces. The Mississippian is peripherally located and contains those drainages which function as tributaries to the Mississippi River. Drainages included are the Canadian, Red, Sulfur and Cypress systems. All other Texas streams, from the Sabine to the Rio Grande, empty directly into the Gulf of Mexico and are included in the West Gulf Province. Such a division is meaningful on a large scale but closer examination of the Texas unionid fauna reveals a more complex pattern.

The Texas freshwater mussel fauna contains approximately 50 species. A survey and revision is currently underway; last compilation of Texas unionids was that of Strecker (1931). Lack of precise species number results from a lack of field surveys and from the maddening plasticity of clam shell morphology.

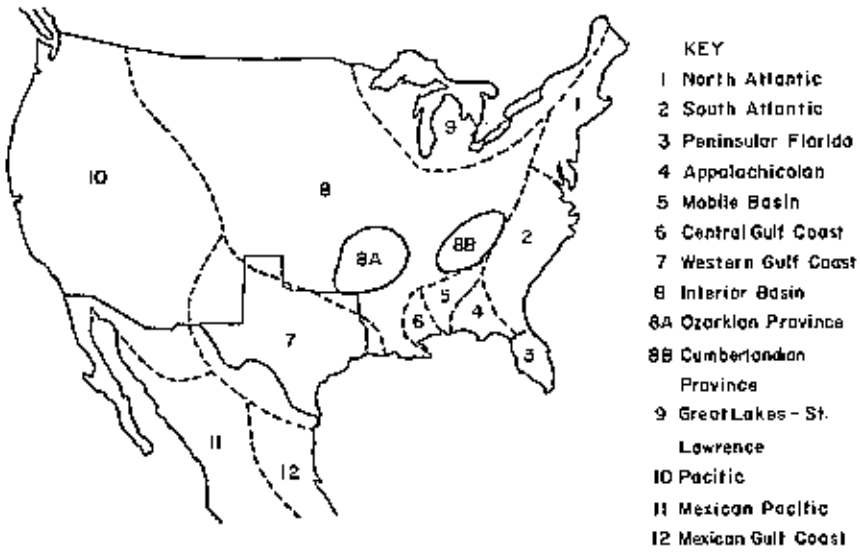

Figure 1. Faunal zones and provinces of freshwater clams of North America after Roback et al. (1980).

Variables such as water quality and current velocity may affect the appearance of the shell. Also adding to the nomenclatorial nightmare has been a classical unawareness of genetic variation within a taxon. The habit of christening all variants with a new epithet (to which is attached the name of the descriptor), has severely complicated the taxonomic situation. The fifty-odd valid species which occur in Texas are represented by over 200 specific epithets, most of which have been relegated to various states of synonymy. Analysis of the distribution of the freshwater clams of Texas has allowed the subdivision of the major provinces into several subprovinces (see Figure 2).

The Mississippian Province in Texas is referred to the Texoma Subprovince. It consists of the segment of the Canadian River which transects the Panhandle in addition to the Red River drainage; much of western Oklahoma and Kansas are included in this subprovince. Relatively few species occur in the western areas of this province; only one species is reported from the Texas segment of the Canadian River. Species diversity in the eastern portion of this area is moderately high.

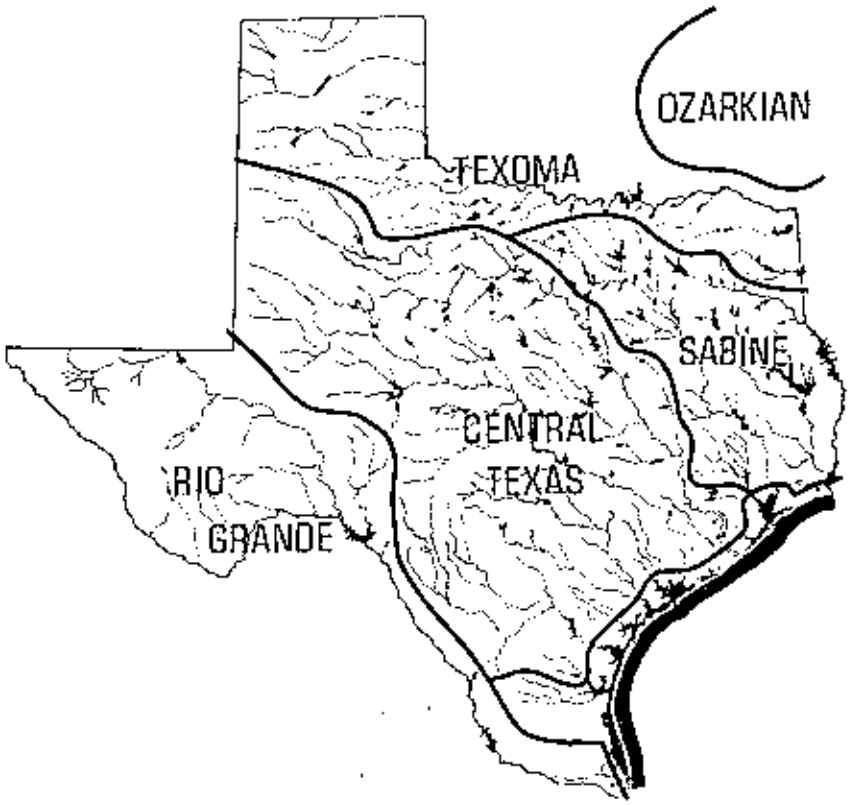

Figure 2. Biogeographical subprovinces of freshwater clams of Texas (no clams native in coastal area as indicated).

The Western Gulf Province includes the vast majority of Texas and has been delineated into three subprovinces. The Sabine Subprovince includes the eastern part of Texas (except for that encompassing the Texoma Subprovince) and adjacent southwestern Louisiana. Texas rivers in this area are the Sabine, Neches, Trinity and San Jacinto. Indicative of the subprovince are Lampsilis satura, Proptera amphichaena and the problematical species in the genera Fusconaia and Pleurobema.

The Central Texas Subprovince consists of the major streams in the area, i.e., Brazos, Colorado, Guadalupe, San Antonio and Nueces plus the shorter coastal plain streams, i.e. San Bernard,

Lavaca, Mission and Aransas rivers. Also included are the creeks feeding into the Baffin Bay system. Species present are wide-ranging Mississippian species, many of which occur southwestward into Mexico. One southern-derived species, Cyrtonaias tampicoensis, occurs throughout this region. This subprovince is characterized by four species which comprise the only endemic freshwater mussel community in Texas. These clams are Quadrula petrina, Quadrula aurea, Lampsilis bracteata and Sphenonaias mitchelli.

The Rio Grande Subprovince in Texas consists of the Rio Grande drainage; its southern extension into Mexico is not clear but does not include the Panuco-Tamesi system of southern Tamaulipas (see Pilsbry, 1909). This province is dominated by the southern-derived C. tampicoensis. Species occurring no further north than the Rio Grande include Popenaias popei, Quadrula couchiana, Disconaias fimbriata and Truncilla cognata. All of these species are rare in Texas and appear to be restricted to the upper portions of the drainage in Texas and Mexico. Few species occur in the New Mexico and Colorado portions of the Rio Grande (Metcalf and Stern, 1976; Brandauer and Wu, 1978).

ECOLOGICAL DETERMINANTS. Each of the subprovinces in Texas can be ecologically characterized in relation to the other subdivisions.

The extreme depauperateness of the freshwater clam fauna of the Texoma Subprovince is due to the extremely low runoff rates in an area characterized by braided, sandy-bedded streams. Tributary streams of the Red in Oklahoma support a number of species typical of the Ozarkian Subprovince. These species are unable to survive in the main streambed of the Red (see Valentine and Stansbery, 1971). That permanent water is the controlling factor is indicated by the increased species diversity of the freshwater clam fauna of Lake Texoma, an impoundment constructed on the Red in the mid-1940's (see White and White, 1977; Neck, 1982-this volume).

The Sabine Subprovince is typified by low-gradient streams over generally soft substrates in an area of relatively high precipitation. Water flows are more dependable than in areas to the west. The Sabine Subprovince follows the area of highest average annual runoff rates in Texas with the exception of the upper and middle portions of the Trinity River (Miller et al., 1963). Water chemistry is typified by acidic waters. The Trinity River is somewhat atypical in this grouping. The upper reaches of the Trinity drain Cretaceous limestones and chalk but these substrates form a small portion of the total area drained. The upper Trinity (above Dallas) does not contain the species typical of this subprovince; however, lack of additional species

indicative of the adjacent Central Texas Subprovince precludes grouping with that subdivision.

The inland portion of the Central Texas Subprovince is drained by high-gradient streams on well-indurated substrates, mostly Cretaceous limestones. Water flow is very erratic varying from severe droughts with almost no flow to catastrophic flooding (Baker, 1975). Water chemistry is typified by high levels of calcium carbonate yielding a moderately hard water. The coastal portion of the Central Texas Subprovince has drainages of low gradient on generally soft substrates. However, water chemistry is greatly influenced by the calcium carbonate-enriched water from upland areas of the Central Texas Subprovince.

The Rio Grande Subprovince is characterized by both high-gradient streambeds on generally hard substrate and low gradient deltaic distributaries on soft substrate. However, the Pecos River contains very alkaline water (gypsum and halite) in an area of unindurated substrates. The dominating portion of this subprovince lies in the area of confluences of the Rio Grande with the Pecos and Devils. The paucity of species native to the Rio Grande Subprovince is probably due to the restricted coastal plain to the south in Tamaulipas as much as the northward increase in seasonality, i.e. the loss of a tropical equable climate. An additional factor is the natural salinity of the Pecos which affects all of the Rio Grande below the confluence of the two streams.

FAUNAL ANALYSIS. The unionid fauna of Texas is seen to be a grouping of approximately 50 species with affinities to the Mississippi drainage to the east and but little influence from the Panuco-Tamesi system to the south. The major factor causing the depauperate nature of this fauna is an apparent mismatch of water supply and niche diversity. Eastern Texas has a supply of water and a nearness to the Mississippi as a faunal source, but the rivers are generally sluggish with acidic waters. The high-gradient streams of central and western Texas exhibit potential niche diversity but have irregular water flow.

Only one area of Texas appears to have been isolated for a sufficient time period to allow evolution of autochthonous forms. Q. petrina, Q. aurea and L. bractseta appear to have originated within the Central Texas Subprovince. However, the paucity of published information concerning clam faunas south of the Rio Grande drainage precludes determination of origin of several species occurring no farther north than this stream.

Very few species occur from the Red River to the Rio Grande; two forms that do are L. teres, A. imbecillis and M. gigantea. Taxa of two other genera, Carunculina and Uniomerus, occur

throughout the state, but species delineation and geographical distribution are still clouded for these forms.

CONTRAST WITH OTHER FAUNAE. Many maps have been drawn to illustrate the distributional patterns exhibited by different faunal groupings in Texas. A synthesis of biogeographic patterns as presented by Blair (1950) was based on terrestrial vertebrates but works very well on certain terrestrial invertebrate groups (Neck, unpub. data.) There are similarities as well as dissimilarities between Blair's map and the clam map presented here. Blair's Austroriparian Biotic Province is very similar to the Sabine Subprovince of this analysis. In a similar manner the more restricted Balconian Biotic Province of Blair is analogus to the Central Texas Subprovince, presented here. This similarity is the result of the dominance of water availability and limestone substrate, respectively, in the two above instances. In other cases, the obvious importance of current drainage patterns in determining clam distributional patterns overrides the terrestrial influences of geological substrate and meteorological parameters. In western Texas, the paucity of permanent water and, concurrently, freshwater mussels, also preclude an increased concordance between these biogeographic patterns.

A greater similarity would be expected between the unionid distributional pattern and another grouping of freshwater organisms, e.g. freshwater fishes. Hubbs (1957) presented an analysis of the freshwater fish distributional patterns in Texas. No map was presented, however; reference was made to an earlier analysis by Knapp (1953). This delineation of faunal relationships was largely drawn along stream divides (although the Navasota River is grouped with the rivers to the east rather then with the Brazos). One would expect a certain similarity with the clam pattern as presented here. However, the major portion of the lower coastal plain is divided quite differently.

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APPENDIX E

Karst monitoring materials

1) Development of an approach to monitoring karst invertebrates in Texas
2) Thumbnail images of photos acquired for field guide project
3) Sample species accounts for field guide

Development of an Approach to Monitoring Karst Invertebrates in Texas
Prepared by Lee Ann Linam, with major contributions from Jean Krejca

When candidate monitoring plans were developed for Texas in the mid-1990's, karst invertebrates consistently received high priority rankings for monitoring attention (Candee 1996). In addition, Texas Parks and Wildlife Department invertebrate specialist Mike Quinn identified karst invertebrates as the highest priority group in the state for monitoring and conservation attention. Follow-up discussions with Jean Krejca of the U.S. Fish and Wildlife Service, have helped to outline monitoring needs and approaches for karst invertebrates. The following discussion is based directly on input from Krejca.

"Several reasons exist for developing a monitoring program for karst invertebrates. Among these are conservation reasons. Karst invertebrates are unique and rare species, worthy of study simply because they are part of our planet's diversity of life. The habitat they live in, caves, are the conduits through which our groundwater flows. Clean caves and healthy cave ecosystems mean that our groundwater (=drinking water) is clean and healthy. Cave ecosystems are a decomposer community. This is one of the many ecosystem services on which humans depend, but are often overlooked. Biodiversity, the complex of life on earth upon which humans are dependent, is itself dependent on preserving a variety of special ecosystems that maintain that biodiversity. Habitat destruction from development threatens the existence of karst ecosystems. Wise development strategies (that do not harm the endangered species) can only be formed only when there is complete information available on the range and biology of the species. This field guide will help those that are trying to learn more about these species by providing them with identification help as well as general public awareness.

"There are scientific reasons as well why conservation and monitoring of karst invertebrates are high priorities. Karst invertebrates provide scientists with simple environments, or natural laboratories (lacking many sources of nutrient input, lacking temperature fluctuations) in which to study ecology. Karst inverts provide insight into geology, specifically the interconnectedness of the rock beneath our feet. Karst ecosystems provide information about hydrology and the quality and quantity of water that travels through submerged conduits. Finally, evolutionary trade-offs such as loss of eyes and pigment for gain of other sensory abilities can be

studied with these interesting species. Many times this gives us a snapshot into the mechanisms behind evolution of unique character traits.

"Finally, there are legal reasons to monitor the health of these species and ecosystems. There are 16 federally endangered species of karst invertebrates in the central Texas area. This means that surveys for these species are required by law, and development projects must take into consideration the well-being of these species." As the distribution and abundance of species of concern are better understood, then opportunities may exist for their conservation—perhaps reducing the need for further species listings or increasing the efficiency of ongoing conservation measures.

This Section 6 project has initiated development of a karst monitoring project following suggestions offered by Krejca. The first step in the monitoring project is development of a karst invertebrates field guide—designed in a modular format suitable for field conditions. One-time publication rights for approximately 80 photos have been purchased from well-known cave photographers. Thumbnail images of the photos are presented as Item 2. (Please note that these thumbnail images cannot be reproduced without the permission of the photographers.) Finally, TPWD Creative Services have created a sample set of species accounts for 10 different species. These are presented as Item 3. Note that these are presented as a sample draft for review. Revisisons in the final format are already anticipated, such as refinement of maps and inclusion of common names. TPWD will now seek additional funding for production of approximately 300 copies of the entire species set.

After the field guide is completed (completion goal is fall of 2003), TPWD will investigate opportunities to initiate a karst monitoring project. Monitoring protocols and priorities will be developed in close coordination with the U.S. Fish and Wildlife Service and other cave conservation interest groups. The ultimate goal, if determined to be feasible, is to train qualified cavers to monitor selected populations of selected species in selected localities.

Finally, a third extension of the project may be feasible, according to Krejca. A need exists to relocate and confirm the occurrence of some historic cave localities. It may be possible

for a second group of volunteers to be trained to undertake such a cave census. All activities will of course be undertaken only with permission of the property owners.

Literature cited:

Candee, M.E. 1996. Candidate Species Monitoring. Section 6 Grant E-1-6 Final Report.

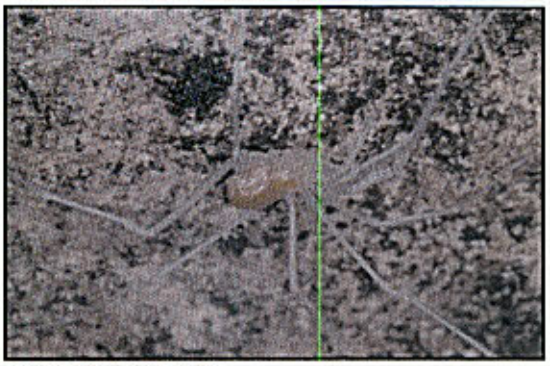
Acknowledgements:

Several images, taken by Jean Krejca, were donated by the U.S. Fish and Wildlife Service, Austin Office. These images are of: *Cicurina madla*, *Ceuthophilus secretus*, and *Ceuthophilus* new species B.

The image of *Cicurina varians* was taken with assistance of Peter Sprouse.



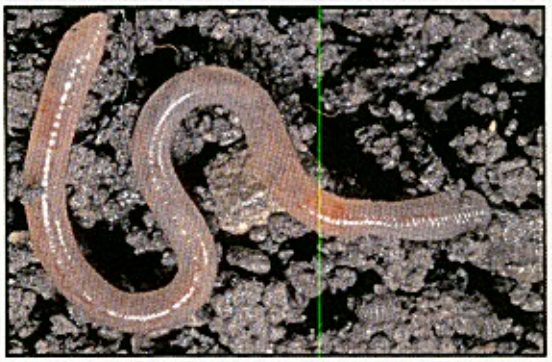
Armadillidium vulgare



Hoplobunus sp. (imm.)



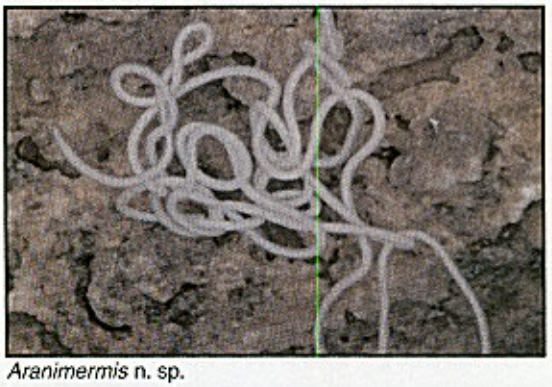
Stygobromus sp.



Order Hapotaxida



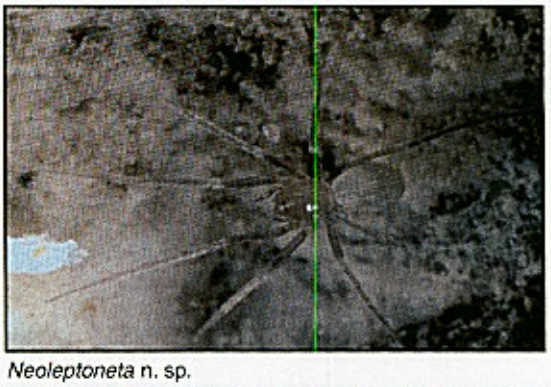
Acanthocyclops vernalis



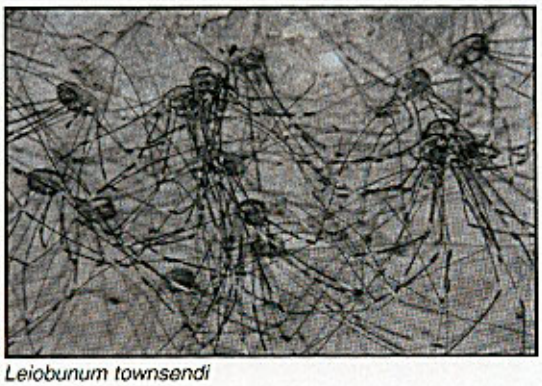
Aranimermis n. sp.



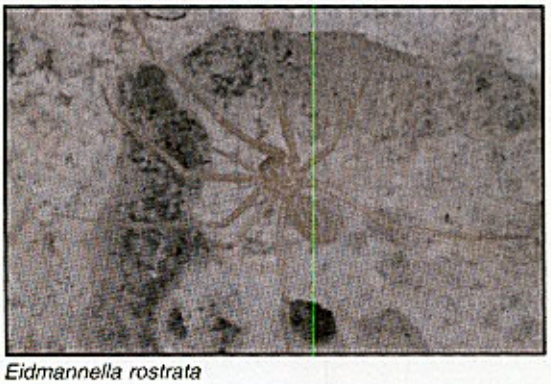
Ostracods



Neoleptoneta n. sp.



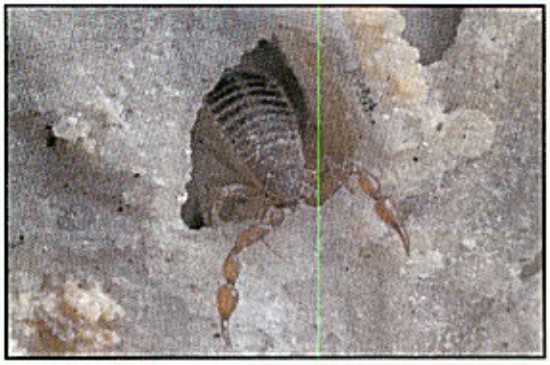
Leiobunum townsendi



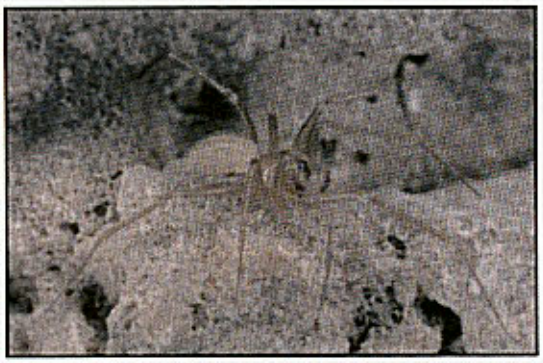
Eidmannella rostrata



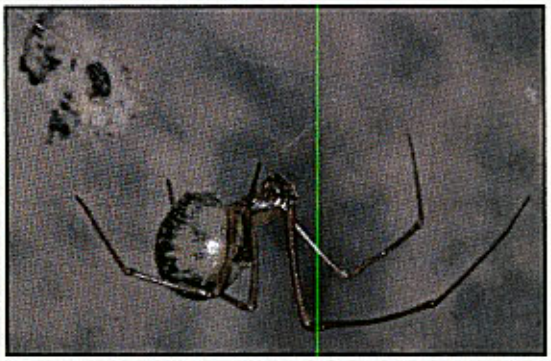
Eidmannella pallida



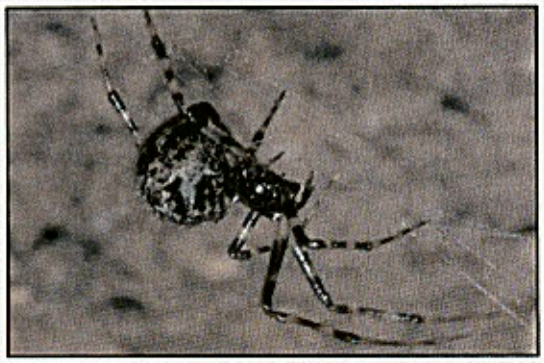
Tejachernes sp.



Meioneta llanoensis



Gaucelmus augustinus



Achaearanea sp.



Cicurina varians



Eperigone antraea



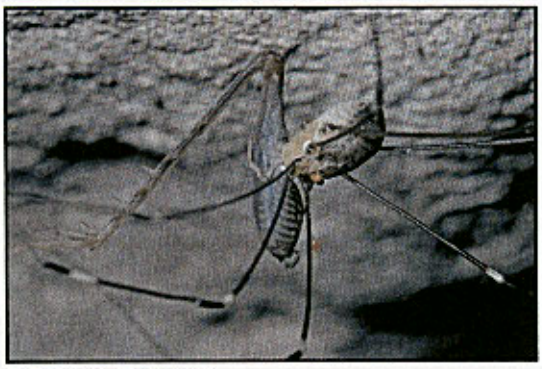
Leptoneta myopica



Tartarocreagris sp.



Ornithororos sp.



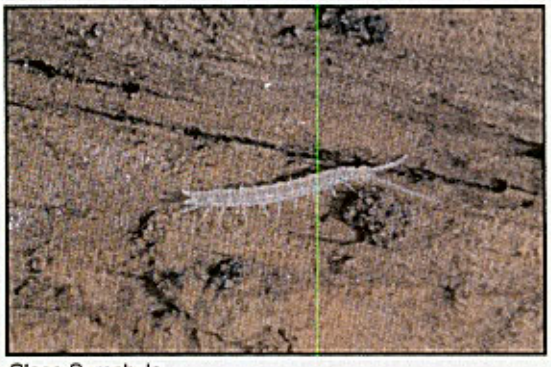
Leiobunum townsendi



Siphonophora sp.



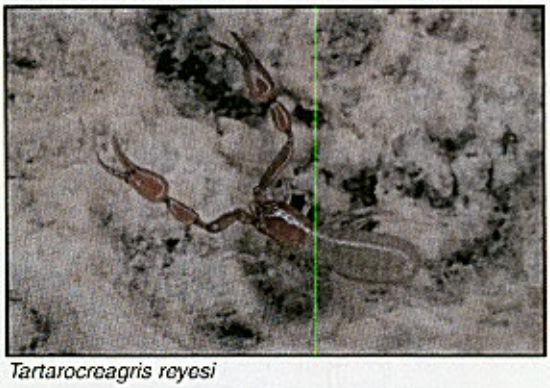
Sphalloplana zeschi



Class Symphyla



Sphalloplana zeschi



Tartarocreagris reyesi



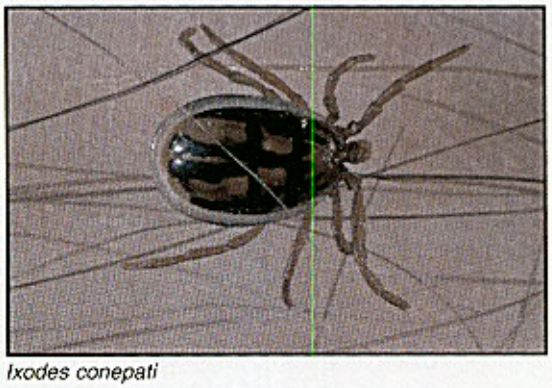
Vejovis reddelli



Tartarocreagris hoodensis



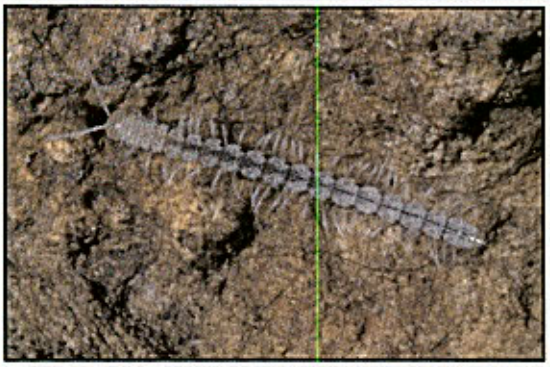
Order Geophilomorpha



Ixodes conepati



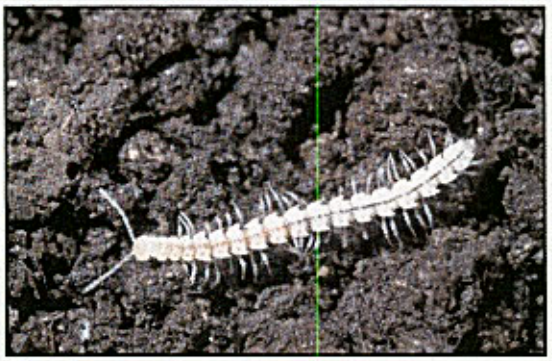
Solenopsis invicta



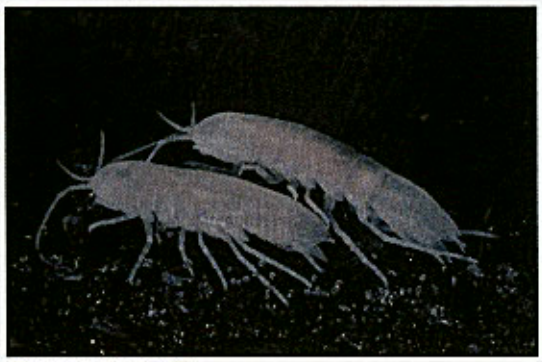
Speodesimus bicornurus



Philonthus sp.



Speodesmus sp.



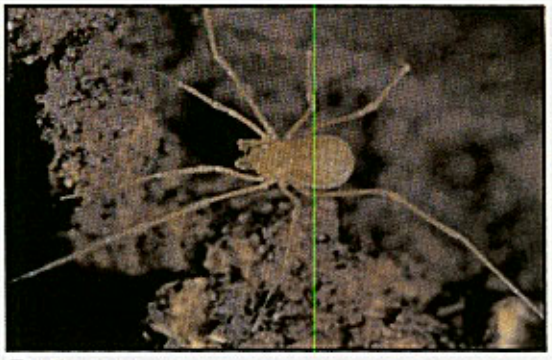
Cirolanides texensis



Hoplobunus sp.



Brackenridgia cavernamum



Texella n. sp.



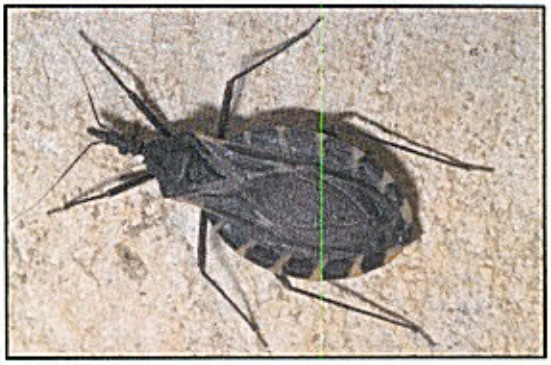
Caecidotea sp.



Texoreddellia texensis



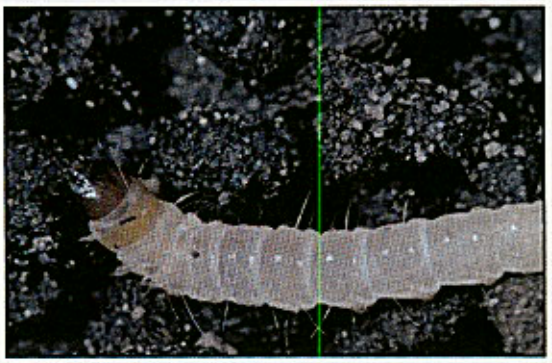
Rhadine exilis



Triatoma sp.



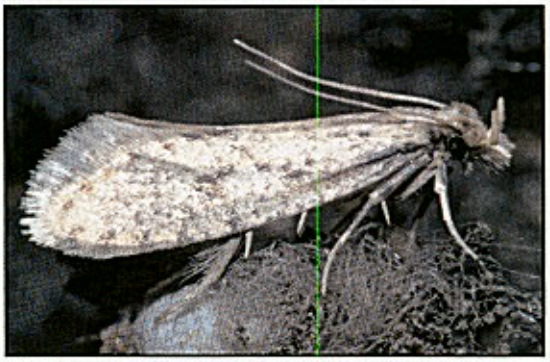
Diplura, Family Japygidae



Mydria sp.



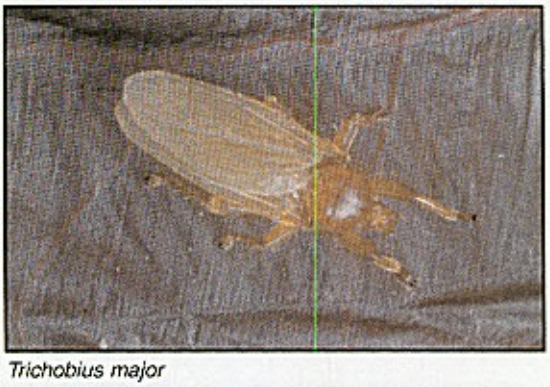
Thysanura, Family Machilidae



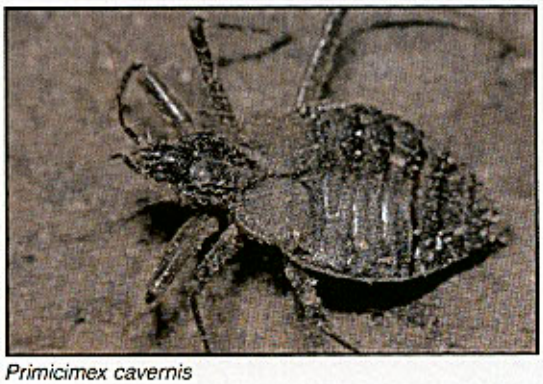
Mydria sp.



Pseudosinella violenta



Trichobius major



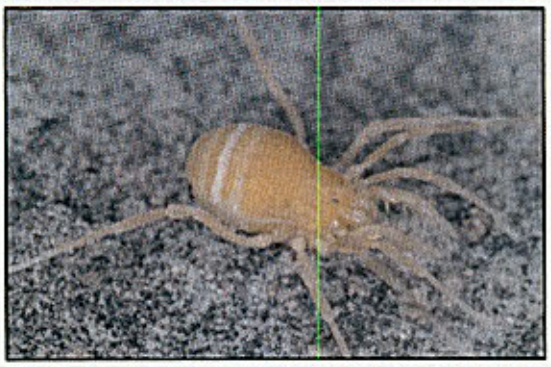
Primicimex cavernis



Dermestes cavernicola



Belonuchus sp.



Texella sp.



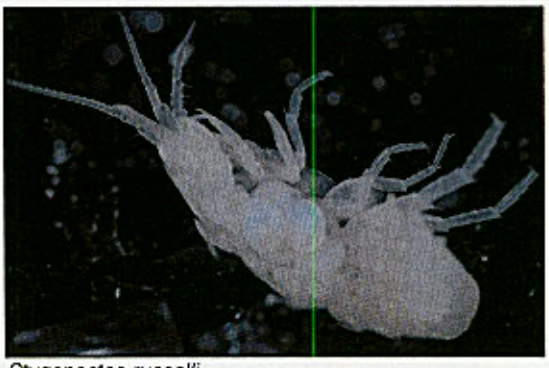
Rhadine howdeni



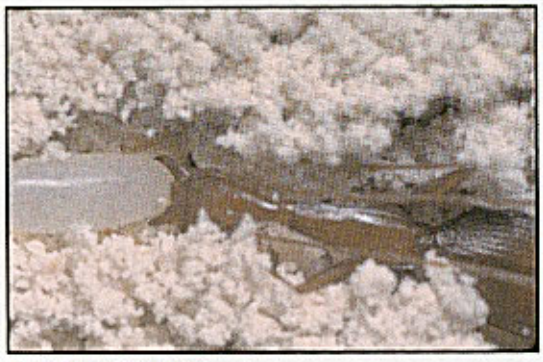
Tartarocreagris infernalis



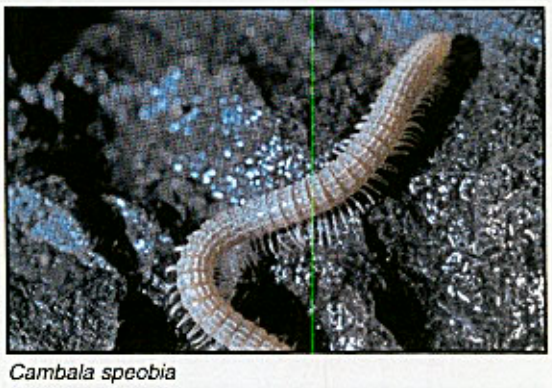
Niptus abstrusus



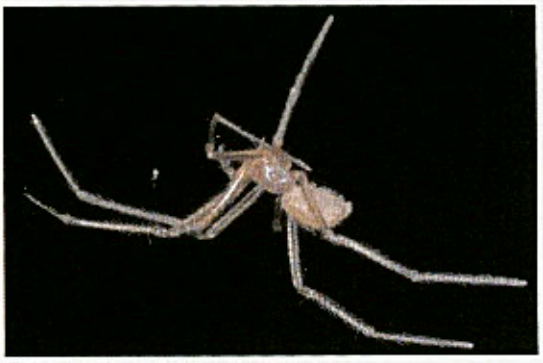
Stygonectes russelli



Rhadine subterranea



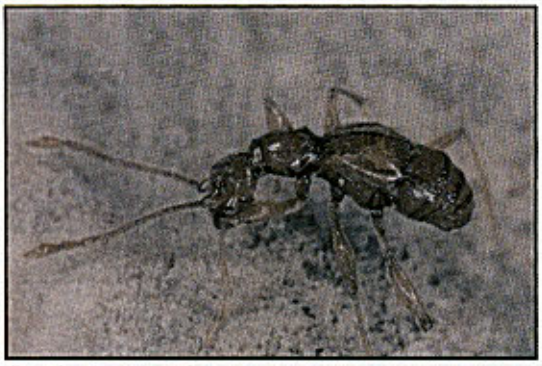
Cambala speobia



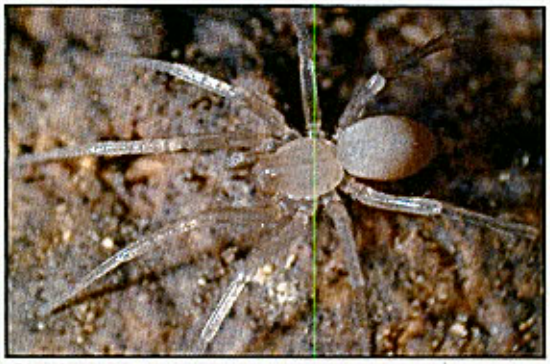
Eidmannella rostrata



Rhadine infernalis



Bastrisodes gravesi



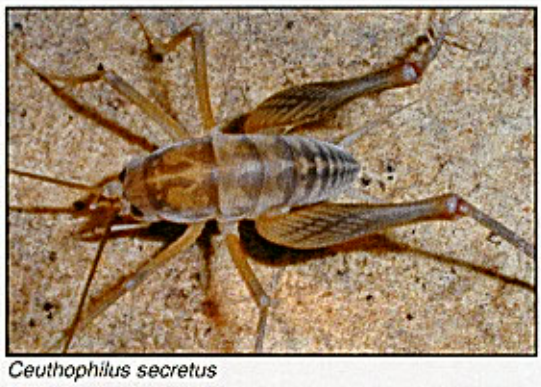
Cicurina madla



Ceuthophilus secretus



Cicurina varians



Ceuthophilus secretus



Ceuthophilus cunicularis



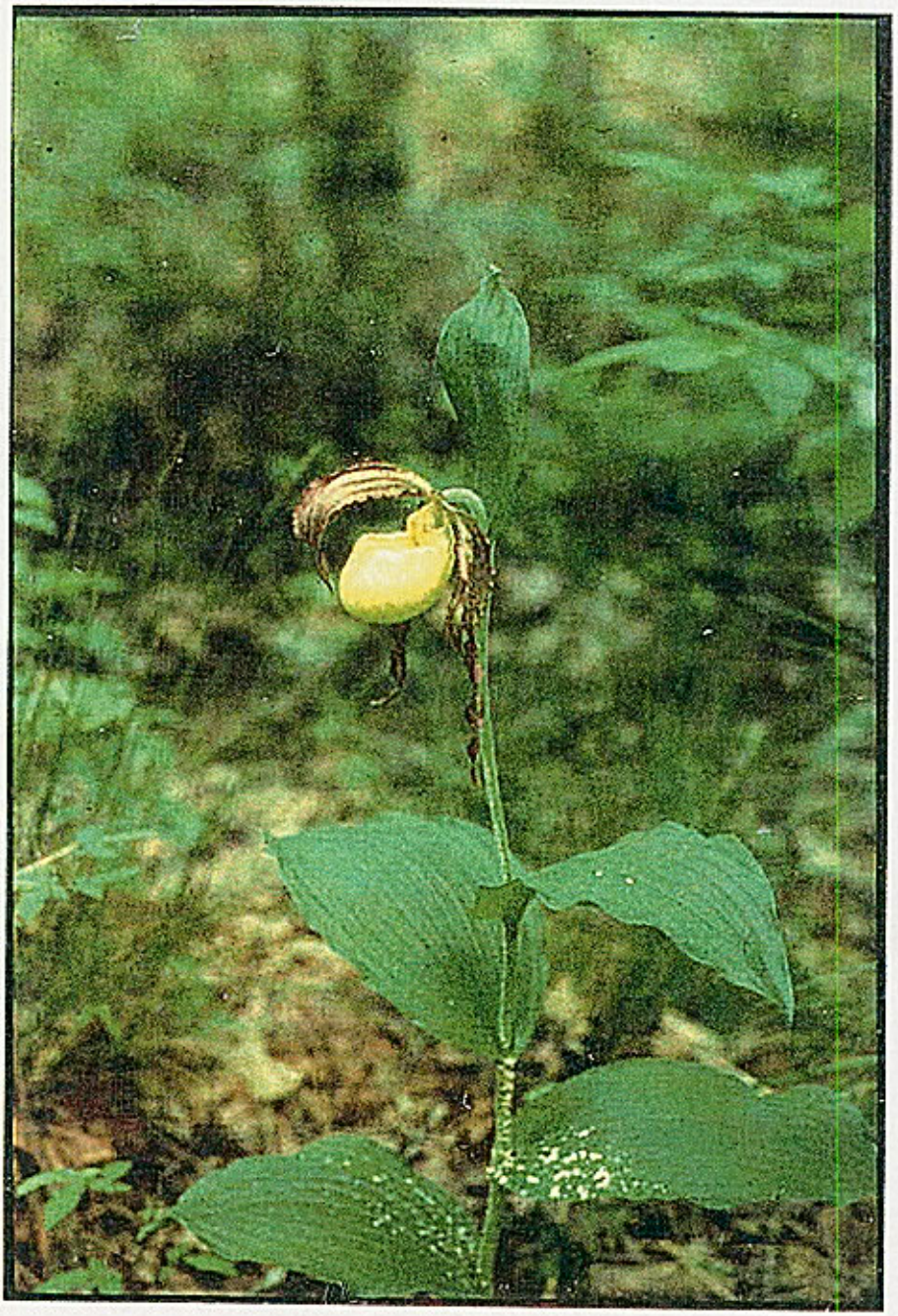
Ceuthophilus n. sp. B

Appendix F

Site-specific volunteer monitoring – monitoring packets and results

1) *Cypripedium kentuckiense* – southern lady's slipper
2) *Rediomelum humile* – Rydberg's scurfpea
3) *Rayjacksonia aurea* – Houston daisy
4) *Salvia penstemonoides* – big red sage
5) *Streptanthus bracteatus* – bracted twistflower
6) *Thalictrum texanum* – Houston meadow-rue
7) *Euchemotrema cheatumi* – palmetto pill snail
8) *Eurycea* salamanders
9) *Geomys personatus maritimus* – maritime pocket gopher
10) *Polygyra hippocrepsis* – horseshoe liptooth snail

Southern ladies' slipper
Cypripedium kentuckiense



Summary Report
Volunteer monitoring of southern lady's slipper (*Cypripedium kentuckiense*)

Status of project

Texas Nature Tracker monitoring began in 2000. Because the U.S. Forest Service had begun gathering data at National Forest sites, an attempt was made to gather volunteer data at two additional sites—Atlanta State Park (Cass county) and Caddo Lake State Park (Harrison county). Preliminary visits designed to familiarize potential volunteers with the species and to design a monitoring protocol were hampered by the unpredictability of emergence of the species. Population numbers are low, with no trends yet apparent. No formal monitoring protocol has been developed at this time; however, experience suggests that insight might be gained by finding a dedicated local volunteer (such as a NPSOT member or member of a state parks friends group) willing to frequently (2x/month from February – June) search for these populations in order to better understand the factors associated with emergence and reproduction. In addition, such a volunteer could work with the state parks to avoid impacts of activities on the populations. Finally, monitoring in these parks could complement ongoing work by Jason Singhurst in Sabine National Forest—revealing a more complete picture of the status of the species in the state.

Spring surveys for southern lady's slipper (*Cypripedium kentuckiense*) in East Texas.

Site	Date	# plants	# flowers	Monitor	Notes
Caddo State Park	13-Mar-00	2	0	Doug Hines	11 in 1992
	10-May-01	5	0	D. Hines	
Atlanta State Park	10-Mar-00	0	0	J. Singhurst	2 in 1996
	Spring '01	2		J. Singhurst	
Sampling methods - Multiple visits in March-April will be made to known sites on public lands. Number of plants and reproductive effort will be noted. The species is somewhat difficult to monitor due to the unpredictability of its emergence.					
2002 - Volunteers and TPW staff were unable to revisit populations at Caddo and Atlanta State Park. J. Singhurst did extensive surveys in the Sabine National Forest, however, where he focused on eight populations.					
2001 - At Caddo, three plants (one mature) were seen in the flat near the boat ramp parking lot, while two mature plants were seen in the paw-paw flat along the hiking trail. A third population has not been confirmed there since habitat changes in 1998. At Atlanta, two orchids were reconfirmed after apparently four years of non-emergence.					
2000 - An attempt was made to get monitoring off the ground for this species at two sites. Unfortunately winter drought and late cold snaps appeared to delay emergence at these two known sites. More intensive monitoring will be attempted in future years.					

DRAFT
8/23/92

ELEMENT STEWARDSHIP ABSTRACT
Cypripedium kentuckiense

ELEMENT CODE
PMORC0Q0F0

ELEMENT NAME
Cypripedium kentuckiense Reed. This species was recently described by Reed (1981) but there is considerable controversy about its taxonomic status (see Atwood 1984, 1985). Morphologically, this species has been well known for a long time to orchid specialists. Correll (1940, 1950), considered it the southeastern ecological entity of the *C. calceolus* complex. Most information published on *C. kentuckiense* is found under *C. pubescens* or *C. calceolus* var. *pubescens*. However, *C. kentuckiense* is now the name most widely accepted (Orzell 1990).

COMMON NAME
Yellow Lady's Slipper, Southern Lady's Slipper, Rafinesque's Lady's Slipper.

DESCRIPTION
General Description
A perennial herb that grows to approximately 3 feet tall with 2-9 long, ovate, many-nerved leaves. The flower (mostly 1 but occasionally 2), consists of a large cream-colored lip with a large opening. The lip has irregular teeth along the rim of the opening and the veins on the inner surface of the lip are dotted and lined with maroon. The petals and petaloid sepals are yellow-green and extensively striped with maroon or are entirely maroon (Medley 1985).

Technical Description
A terrestrial, perennial herb 3.5-9.7 dm tall with fibrous roots rising from short or elongate rhizomes. Leaves on the stem are broadly elliptic-lanceolate, plicate, prominently ribbed, to 2 dm long and 1 dm wide, sheathing the stem. The number of flowers per plant is 1 or 2. They are showy and subtended by foliaceous bracts. Sepals are spreading, free or with the lateral pair partially or wholly united. Petals are spreading, free, narrower than the sepals. Lip is sessile, dull-cream-colored to golden yellow, inflated saccate or pouch-shaped, horizontally placed, about 5 cm long. The column is declined with 2 laterally placed fertile stamens (each bearing a 2-celled anther), and a dorsally placed sterile petal-like staminode. The pollen is granular. The stigma is terminal and somewhat 3-lobed with a 1-celled ovary. The capsule is obovoid to ellipsoid (Correll, 1940, 1950, Correll and Johston 1979, Reed 1981).

Cytotaxonomic and Micro-anatomical Characteristics
The chromosome number for this species has not been reported. However, chromosome reports for closely related species have been published. Other members of *Cypripedium* have a chromosome number of 2N=20. This has been reported by several authors (Hindakova 1976, Averyanov 1977, Probatiova and Sokolovskaya 1984) and is probably similar for *C. kentuckiense*. Anatomical characteristics of the vegetative and flowering structures have been studied for other members of Cypripedium (Rosso 1966,

Withner et al. 1974). Currently, no additonal anatomical studies exist for this species.

Phenological Description

Flowers from mid April to early May throughout its range. Seeds mature from late May to June (Medley 1985). It has not been determined whether plants flower once and die or continue to produce flowers.

Summary of Distinguishing Characteristics

A morphologically distinct species in the field. It is the largest-flowered species of lady's slipper orchid known. On close examination, there are several characteristics that distinguish it from other lady's slipper orchids. There are irregular teeth that line the rim of the opening of the lip and there are bumps on the veins of the lower lip. There are maroon lines present on the veins inside the lip. The lip does not extend beyond the lip opening as seen in other slipper orchids. The dorsal sepal hangs over the lip like a canopy rather than erect as in *C. parviflorum* and *C. pubescens*. The pedicel of *C. kentuckiense* is longer than the pedicels of *C. parviflorum* and *C. pubescens*. Flowers 10-14 days later than both *C.pubescens and C. parviflorum (Atwood 1985).*

KEY TO SIMILAR SPECIES

1. Orifice length $\leq$ 1 cm.

    2. Lip small, 2-3 cm.

        ..... *C. parviflorum*

    2. Lip large, 3-5 cm.

        ..... *C. pubescens*

1. Orifice length > 1 cm

    ..... *C. kentuckiense*

HABITAT

Distribution

It occurs in three distinct but isolated areas of the southeastern U. S. (Orzell and Bridges 1987, Orzell 1990). It grows on sandy stream terraces of the Cumberland Plateau of Kentucky and Tennessee. Also found growing near seepages in the East Gulf Coastal Plain in Alabama and Mississippi. The third region includes the Boston Mountains, Oachita Mountains and the eastern portion of the West Gulf Coastal Plain in southern Arkansas, southeastern Oklahoma, Louisiana and eastern Texas. In this region, it is adjacent to wooded seepage areas on stream floodplains, and in mesic hardwood slopes and ravines (Medley 1985, Orzell and Bridges 1987, Orzell 1990). In Louisiana it occurs in lower mesic hardwood slopes near small streams of riparian floodplain forests, sometimes but not necessarily associated with seeps.

Populations of this species have been found in 8 counties of Kentucky, 1 county of Tennessee, 15 counties of Arkansas (highest number of site occurrences), 2 counties

of Alabama, 2 counties of Mississippi, 14 parishes of Louisiana, 7 counties of Texas and 4 counties of Oklahoma (Medley 1985, Orzell and Bridges 1987, Orzell 1990).

In Louisiana, found in 14 parishes (Bienville, Bossier, Catahoula, DeSoto, Evangeline, Grant, Jackson, LaSalle, Lincoln, Natchitoches, Oachita, Red River and Winn). There are 23 element occurrence records, most are thought to be exitrpated due to modern timber management practices and attempts to relocate occurrences have been unsuccessful (Element Occurrence Records, Louisiana Natural Heritage Program (LNHP), 1992).

In Texas, found in Cass, Harrison, Nacogdoches, Newton, Sabine, San Augustine, and Tyler Counties. Considered extirpated from Newton county since recent attempts to relocate it by the Texas Natural Heritage Program (TNHP) were unsuccessful (Orzell 1990, Poole 1992, Pers. Comm.). Records from Nacogdoches County have not been confirmed by TNHP (Poole 1992, Pers. Comm.). There are 8 element occurrence records, 4 in the National Forests of Texas (Sabine and Angelina National Forests). In the Sabine, 2 sites on the Tenaha Ranger District (RD) (Matlock Hills - Comp. 66 and Upper Colorow Creek - Comp. 67) and 1 on the Yellow Pine RD (Hurricane Bayou - Indian Mounds Wilderness). On the Angelina, found at Clear Branch (Angelina RD, Comp. 8) (Element Occurrence Records, TNHP, 1992).

Ranking

In Texas and Louisiana listed as S1 (imperiled in state; especially vulnerable to extirpation from state). It is listed globally as G3 (either very rare throughout its range or found locally in a restricted range or because of factors making it vulnerable to extinction throughout its range). It is currently under review to be listed as federally endangered or threatened (Category 2 - C2) by U.S. Fish and Wildlife Service.

Elevation

Populations have been reported to occur from 210-240 feet in East Texas to 1250 feet in Huntsville, Tennessee (Medley 1985). Found mostly on moderate to steep slopes or at base of slopes.

Climate

Found over a broad range of climatic conditions. In general two climatic patterns occur throughout its range. In Tennessee, Kentucky and parts of Arkansas, the average temperature ranges from 25-90 ^{o}F and precipitation falls heaviest in the spring (March-April) and is lower in summer months than in other times of the year. In contrast, Texas Louisiana, Mississippi and Alabama temperature ranges from 35-90 ^{o}F and two periods of heavy precipitation occur throughout the year. For these states, precipitation is heaviest during December-February and June-July. Precipitation is generally lower in April and October.

General Habitat

In Kentucky and Tennessee a species of mesic forest on stream floodplains that are annually inundated by high water in Kentucky and Tennessee. Further south (Alabama, Louisiana, Mississippi) and west (Arkansas, Oklahoma, Texas) habitat is more variable. May occur on mesic to dry mesic forests on floodplains, ravines, slopes, acid seep forests (Arkansas) and rarely in slash pine forests (Medley 1985).

In Texas, occurs in mesic hardwood ravine forests, either on lower mesic slopes or on stream terraces in relatively small stream valleys (Orzell 1990, Texas Natural Heritage Program). In the Sabine and Angelina National Forests *C. kentuckiense* occurs along the Yegua formation (Texas Natural Heritage Program).

General vegetation associated with sites varies throughout its range but the more common species include the following: Sweetgum (*Liquidambar styaciflua*), River Birch (*Betula nigra*), White Oak (*Quercus alba*), Blue Beech (*Carpinus caroliniana*), Flowering Dogwood (*Cornus florida*), Hickory species (*Carya* sp.), Blackgum (*Nyssa sylvatica*), Cow Oak (*Quercus michauxii*), American Beech (*Fagus grandifolia*), Tulip Tree (*Liriodendron tulipifera*), Umbrella Tree (*Magnolia tripetala*), Sycamore (*Platanus occidentalis*), Swamp Red Oak (*Quercus shumardii*), Red Maple (*Acer rubrum*), Ash species (*Fraxinus* sp.), Deciduous Holly (*Ilex decidua*), American Holly (*Ilex opaca*), Black Cherry (*Prunus serotina*), Blueberry species (*Vaccinium* sp.), Catbrier (*Smilax glauca*), Viburnum species (*Viburnum* sp.), Virginia Creeper (*Parthenocissus quinquefolia*), Poison Ivy (*Toxicodendron radicans*), Christmas Fern (*Polystichum acrostichoides*), May Apple (*Podophylum peltatum*), and Trillium species (*Trillium* sp.).

In East Texas, canopy species associated with sites includes American Beech (*Fagus grandifolia*), White Ash (*Fraxinus americana*), and Blackgum (*Nyssa sylvatica*). Understory species include, Flowering Dogwood (*Cornus florida*), Red Maple (*Acer rubrum*), Chalk Maple (*Acer leucoderme*), Bigleaf Snowbells (*Styax grandifolia*), and Ironwood (*Carpinus caroliniana*). Commonly associated herbs include, Slender Wood Sedge (*Carex digitalis*), Striated Sedge (*Carex striatula*), Partridge Berry (*Mitchella repens*), Christmas Fern (*Polystichum acrostichoides*), Cranefly Orchid (*Tipularia discolor*), Walter's Violet (*Viola walteri*), Eared Goldenrod (*Solidago auriculata*), Broad-beech Fern (*Thelypteris hexagonoptera*), and Slender Wake-robin (*Trillium gracile*).

BIOLOGY/ECOLOGY

A terrestrial perennial herb that occurs in mesic forests.

Sexual Reproduction

The success of sexual reproduction has not been determined for this species. It has been observed that in most populations flowering individuals are present but little evidence of seed production is found. Medley (1985), has noted that in several populations various bees and moths were found inside the lip. No observations however, were made of pollinator visits successfully removing pollinia from individuals. In other orchid species where little seed set has been observed, mature seeds have only arisen through asexual reproduction. This may also occur in this species but has not been demonstrated.

Hybridization

Hybridization between closely related species is unlikely. This species flowers later than other sympatric species (Atwood 1985). No reports of hybridization to date.

Asexual Reproduction

There is no evidence of asexual reproduction. Agamospermy has been found in other orchid species and may occur in this species as well (Atwood 1985).

Vegetative Growth

New plants can be grown from rhizome cuttings in cultivation (McInnis 1992, Pers. Comm.). The roots are probably associated with a mycorrhizal fungus as seen in other orchid species. The general group of fungi are of the Rhizoctonia group. Members of this group have been found in association with related species of *Cypripedium* (Harley and Smith 1983). Mycorrhizal fungi occur symbiotically with orchids and provide orchids with nutrients, vitamins and other resources they can not otherwise obtain.

It may be 8 or more years before plants reach flowering size.

Germination and Seedling Establishment

Seeds are tiny and more resistant to water than other orchid species (Stoutamire 1974). Studies of seed viability have shown that seeds stored in refrigeration for up to four years remain viable (Curtis 1936). The conditions for *Cypripedium* seed germination is best in temperatures between 10-20 ^{o}F and in darkness (Stoutamire 1974). Germination is usually poor and occurs over a long period of time (Veyret 1974).

Seed dispersal in *Cypripedium* is unusual in that seeds are not released immediately following maturity but released over a long period of time (several months) following maturity (Stoutamire 1974). Following the germination of seedlings a protocorm or primitive stem develops below ground. It is usually non-photosynthetic (Curtis 1943, Stoutamire 1974). In general a prolonged period of growth following protocorm development and first leaf development will occur (Curtis 1943, Stoutamire 1974).

Seedling establishment occurs over a long period. Seedlings develop a protocorm structure which gives rise to the first set of leaves. This may be completed over several years (Stoutamire 1974).

Allelopathy

Currently there are no reports of allelopathic effects caused by or to this species or any closely related species of *Cypridpedium*.

Pests and Disease

There is no specific information currently published on pests and diseases of this species. Orchids in general are relatively disease-free. However, if diseased, causal agents include; fungi, bacteria, viruses, mycoplasms, viroids, and parasitic plants (see review Hadley et al. 1987).

Ecological Value

Currently there is no documentation of this species as wildlife food or of other significant ecological value. Deer may browse the stems and flowers of this species but it is not considered a significant deer food because of its rarity (McInnis 1992, Pers. Comm.). Other orchid speices have been suggested as a food source for deer and rabbits (Mahler 1980). The roots of this species are highly desirable by herb collectors (Orzell 1990). Bees have been found associated with this species, but it is unknown if any nectar rewards are present for pollinators.

Indicator Value

In general the presence of this species at a given site indicates two things. First, it indicates a good quality site that is relatively undisturbed. Second, it indicates undisturbed hydrological patterns to the recharge areas and the drainage. This species is extremely sensitive to alteration of hydrology and soil disturbance. It would be an excellent indicator of good quality habitat and community sites.

Vulnerability

This section describes the vulnerability of the species rated as a total score of the following characteristics (0 = high vulnerability, 15=low):

Resproutability	1 (low resproutability)
Identification	3 (easy to identify)
Habitat Requirements	2 (limited requirements)
Reproductive Dispersal	1 (limited dispersal)
Distribution	0 (restricted distribution)
Total	7 (very vulnerable)

DETERMINATION OF EO QUALITY

In general, *Cypripedium kentuckiense* occurs in sandy soils along edges of seeps and small tributaries of mesic to dry-mesic forests that may be inundated annually (Medley 1985).

Of the 53 extant populations known in 1985, 14 were found within federal or state lands and 39 were privately owned (Medley 1985). Since 1985, additional sites have been found in Texas, Louisiana and Arkansas (Orzell and Bridges 1987, Orzell 1990, Texas Natural Heritage Program). The sites found in Texas were found on U. S. Forest Service (USFS) lands.

The quality of all known sites is considered good where a large population of flowering plants (perhaps 50 plants) are found. From the 1985 status report only 5 sites were found that could be considered good occurrences. These 5 sites were found in Arkansas (2 sites), Kentucky (2 sites) and Tennessee (1 site). In the 2 sites in Arkansas, 131 and 160 flowering plants Both sites are on USFS land. One site is the Meyer's creek seep located in Garland County and the other is Box Spring site in Montgomery County. The Meyer Creek site is considered a pristine habitat and has not been logged extensively. The Box Spring site has not been intensively logged recently (Medley 1985).

Of the 2 large Kentucky populations of *C. kentuckiense* found in 1985, Negro Creek (Knox County), contains the largest population known in Kentucky. Approximately 200 flowering plants and 100 vegetative plants were found at this site (Medley 1985). The Negro Creek site is privately owned. The second large Kentucky population of *C. kentuckiense* is the Rockcastle Wild River Site (Pulaski County). This site is on USFS land and has not been recently logged.

The largest population of *C. kentuckiense* known to occur throughout its range is found at the Slick Rock Ranch site in Scott County, Tennessee. At this site approximately 300-500 *C. kentuckiense* plants were found with between 60-70% of the population in flower (Medley 1985). This land is currently privately owned and has been recently sold to a lumber company and heavily impacted by timbering (Sommers 1992

pers. comm.).

The sites that contain extremely large populations (about 100 or more) flowering individuals of *C. kentuckiense* are considered excellent occurrences (Slick Rock Ranch Site). The plants at this site are very vigorous (Medley 1985). At the present time, the result of the recent logging activities have not been determined for the *C. kentuckiense* population at the Slick Rock Ranch Site.

A good occurrence for this species would consist of more than 100 flowering plants found along edges of seeps or tributaries in mesic forests that have not recently been intensively logged and have remained relatively undisturbed. Areas where small populations (0-20 individuals) exist are considered marginal occurrences. Poor occurrences include areas that contain very small populations (only 0-5 individuals).

THREATS

There are many different threats to the known extant populations of *Cypripedium kentuckiense*. The largest population, the Slick Rock Ranch site in Tennessee is threatened by logging and weed invasion (Japanese Honeysuckle, *Lonicera japonica),* (Medley 1985, Sommers 1992 pers. comm.). The Negro Creek population in Kentucky is potentially threatened by logging and clear cutting as it occurs in an area of Kentucky that is rapidly being cut-over (Medley 1985). Logging and intensive forestry practices threaten the other large populations of *C. kentuckiense* as well.

While logging is a potential threat to all of the extant populations of *C. kentuckiense*, another serious threat to this species is the extirpation and depletion of populations caused by orchid collectors. Over the last 20 years, almost 50 % of the populations have been eliminated due to orchid collectors (Medley 1985). In Kentucky, at least 2 populations have been extirpated. In the southwestern center of its range, (Arkansas, Louisiana and Mississippi), almost 60 % of the populations have been eliminated. Before 1985 in Louisiana, 11 populations of *C. kentuckiense* were known to exist but by 1985, only 2 populations were found. Orchid collecting is by far the greatest threat to all currently known populations. HIstorical occurrences.....

In addition to intensive logging practices (clear-cutting), and collection by orchid fanciers, populations of *C. kentuckiense* have to face a number of other threats. Lignite mining has caused the destruction of at least one population in Louisiana and is a potential threat to large populations in Arkansas, Louisiana, Mississippi and Texas. Cattle grazing may also destroy populations. Industrial development and oil exploration are also potential threats to this species.

LAND PROTECTION SPECIFICATIONS

Cypripedium kentuckiense is found at the edge of seeps in mesic forested floodplains. The amount of land protection needed for this species should include the boundaries of the population, a buffer zone around the population and any land associated with the drainage system which contributes to the creation of the small seeps and tributaries where this species occurs. *Cypripedium kentuckiense* will benefit more in large areas of land protection. Given the appropriate habitat, large populations of this species will develop. It is also important to protect large areas of land for this species so it will be able to recover from population depletions caused by collectors. If only a limited amount of land is protected immediately surrounding the population, the chance

of recovery is much smaller. Maintaining large areas that can contain large populations of numerous individuals (100 flowering or more) is needed to secure this species.

RECOVERY POTENTIAL

Recovery of *Cypripedium kentuckiense* requires the protection of large amounts of land surrounding extant populations known throughout its range. While it would be best to protect each and every site where *C. kentuckiense* occurs, the greatest effort must be made to protect privately owned land where large populations (100 or more flowering individuals) are found. Highest priority for land protection should include the largest populations known and the protection of populations in Arkansas where it is considered the distribution center. Once these habitats have been protected, a management plan is needed for each site and should include goals and objectives to increase populations of *C. kentuckiense*. The site should be secured for possible impacts surrounding the area. This can be accomplished by maintaining the integrity of the drainage systems leading into and out of the sites. In addition, access into sites should be controlled by fencing the perimeter of the sites.

Recovery of populations of *C. kentuckiense* on federal or state land requires recognition of extant populations by the agency, converting known sites into Special Management Areas or some other designation that will reduce impacts caused by timber removal. It will be important for the recovery of this species to have limited access to the sites by fencing or posting the area. Drainage systems leading into and out of the sites must not by altered by diversions, ditching, dredging etc.,. Any soil disturbances to the site should be minimized.

BIOLOGICAL MONITORING NEEDS

It is extremely important for *Cypripedium kentuckiense* to be monitored often and on a regular basis. Populations of this species can so easily be depleted by orchid collectors. By monitoring regularly, visits by collectors may be discouraged. In addition, immediate efforts can be made to further secure an area if it has recently been collected from.

BIOLOGICAL MONITORING PROCEDURES

A monitoring program for *Cypripedium kentuckiense* consists of relocating known extant populations and conducting periodic surveys of these populations. Periodic checks of the status of these populations must occur and especially during April-May when plants are flowering. Initially all individuals within a population or subsamples in large populations should be marked and populations should be mapped relative to the habitat its found in. Plant growth, recruitment, reproduction and general health should be determined for marked populations. Changes in location of the population over time may reflect changes in the habitat (e. g. changes in accretion patterns, drainage patterns, or encroachment of other species etc.,).

BIOLOGICAL MONITORING PROGRAMS

Currently only the Kentucky Heritage Program monitors individuals of *C. kentuckiense* by relocating marked individuals in populations (Evans 1992 pers. comm.). *Cypripedium kentuckiense* is included in the Special Plant List of all other state heritage programs where *C. kentuckiense* occurs.

For information regarding the tracking of *C. kentuckiense* in Kentucky contact:

Marc Evans
Kentucky Heritage Program
KY Nature Preserves Commission
407 Broadway
Frankfort, KY 40601
502-564-2886

RESEARCH NEEDS COMMENTS

More information is needed on the biology of *Cypripedium kentuckiense*. Specific information is needed on the success of sexual reproduction in this species. Many flowers are observed in the field but there is little evidence of the production of seed. Pollinators are virtually unknown for this species. Other research is needed to determine what the affect of grazing and light timber management has on the success of this species. It has been currently suggested that grazing has a negative impact on the population growth of this species (Medley 1985), but this has not been documented in the literature.

RESEARCH PROGRAMS COMMENTS

Currently only one person, Lucille MaCook, at the Missouri Botanical Gardens is studying the pollination biology of this species. For information contact:

Lucille MaCook
Missouri Botanical Gardens
P. O. Box 299
St. Louis, MO 63166
(314)577-5180

MANAGEMENT NEEDS COMMENTS

Once land protection of *Cypripedium kentuckiense* has been established encompassing extant populations and adequate drainage areas, initial management is needed for this species at the site to reduce any pre-existing disturbances. Following the initial management needs little other management is needed to maintain these sites.

MANAGEMENT PROCEDURES

Initially protected sites of *Cypripedium kentuckiense* must be managed to reduce pre-existing disturbances. Grazing must be reduced to light grazing. Any mowing of the area should be eliminated or reduced to times of the year when plants are physiologically inactive (fall-winter). To limit access, fencing must be established around the perimeter of the protected site and posted with signs stating no access. It would probably be beneficial to place warning signs of the consequences of collecting endangered plants in visible areas. All recreational activities on the site must be eliminated or at least reduced (vehicular traffic, off-road vehicle traffic, horse back riding etc.,). Limited recreational activities can be restricted to the buffer zone areas outside the immediate vicinity of *C. kentuckiense* populations.

Intensive timbering practices should be eliminated immediately following protection of *C. kentuckiense* populations. It is unknown what the affects of light timbering practices have on this species, therefore light timbering should be minimized. Other timbering practices such as the use of fire for conversion from hardwoods to pines should not be used on *C. kentuckiense* sites. No alterations of the drainage system must occur that would result in changes to the influx and output of water or changes in water quality, to a *C. kentuckiense* site. This species occurs in mesic habitats where the drainage system is extremely important to its success. Any alterations such as ditching, dredging, diversion of filling can have a strong impact on populations of *C. kentuckiense.* Any disturbances to the soil due to lignite mining or oil exploration should be terminated following protection. Any construction of roads, trails or levees directly through *C. kentuckiense* populations should be terminated and relocated around these populations.

SUMMARY OF STEWARDSHIP NEEDS

Cypripedium kentuckiense is an orchid species that occurs along edges of seeps and small tributaries of mesic forested floodplains of the southeastern U. S. It is a large showy orchid that is highly desirable to orchid collectors. The roots are extremely valuable to herb collectors. The primary threats to this species include the extirpation of sites by collectors and potential intensive timbering practices that have been occurring over time as timber demands increase. Recovery of this species will be accomplished by protecting the largest extant populations known to occur in Tennessee, Kentucky and Arkansas. Further protection is needed for sites in Arkansas where the occurrences are most abundant and are considered to be the distribution center for this species. Land protection will require buffer zones around each population to include drainage systems that contribute to the mesic condition this species needs. Management of protected land should include reduction of grazing, and intensive forest practices (clear-cutting and the use of fire for hardwood suppression). Restricted access should also be mandatory on protected lands by fencing and posting signs and regular monitoring of sites.

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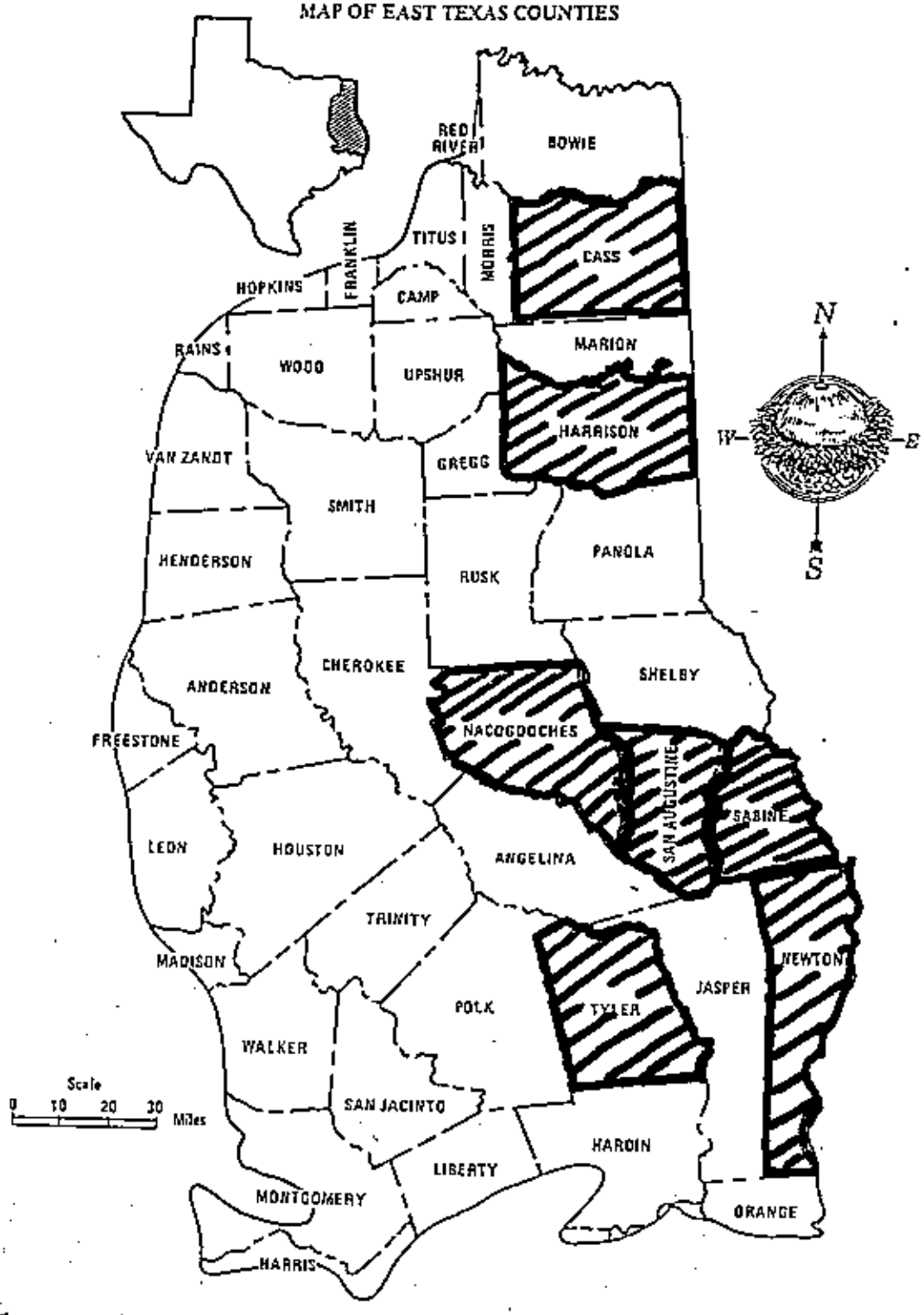
PREPARER

Susan L. Grace

UPDATE

23 August 1992

MAP OF EAST TEXAS COUNTIES




A. DiSalvo

Rydberg's scurfpea
Pediomelum humile



Summary Report
Volunteer monitoring of Rydberg's scurfpea (*Pediomelum humile*)

Status of project

Texas Nature Tracker monitoring began in 1998. Volunteer data was gathered at two sites in Val Verde county—the Hwy 277 right-of-way north of Del Rio and on Del Rio Independent School District property north of Calderon Elementary School.

Volunteer involvement

School classrooms have adopted the two sites. An elementary school gifted and talented teacher provided consistent, detailed monitoring of the species at the Calderon Elementary School site (although frequent contact by TPWD was required to obtain the data each year). A high school environmental science class provided inconsistent monitoring on the ROW site. Monitoring of this species is within the capabilities of teachers and students; however, our experience showed that teachers needed frequent encouragement (in the form of emails and occasional site visits) to follow through on monitoring and data submission.

Monitoring methods

Methods are described in the attached protocol. Complete population counts are fairly easy to accomplish; however, during dry conditions, the species may be more inconspicuous and spend little time above ground. In localities where individuals can be easily marked (such as the school district property) data may be obtained about longevity of individuals and reproductive effort. On the ROW, however, marking of individual plants is more problematic due to concerns about mowing. Location of a more protected population for detailed study would be desirable.

Results to date

The dataset is most complete for the Calderon population (see Table). No overall trend is apparent; however, the number of plants visible each year seems to be correlated with annual rainfall patterns (see Figure). The number of flowers present seems more closely related to the prior 6-month rainfall totals. (Note: Students may have failed to record flowering in 1998 when they were new to the project.) Unfortunately, the Calderon population was destroyed in 2001 during construction of a new campus on the site, despite appeals from the elementary school and TPWD to spare the scurfpea populations. The teacher was able to salvage four seeds from the 2001 production before the plants were destroyed. Closer monitoring of the ROW site and searches for additional populations suitable for monitoring will be attempted in the future.

MONITORING PLAN FOR:
RYDBERG'S SCURFPEA (*Pediomelum humile)*
Calderon Elementary School

Goals:
1. To monitor population size and to detect long-term trends
2. To assess annual reproductive effort
3. Other class goals?

Monitoring seasons:
Late March through late May/early June.

Site Locations:
Near nature trail on Del Rio ISD property north of Calderon Elementary School.

Equipment Needed:
*impressionable metal tags
*large nails & hammer
*permanent "Sharpie"-type fine point marker
*data forms, maps, pencil, & clipboard
Optional
*meter stick for measuring height or width
*insect collecting equipment (e.g. nets, vials, tweezers, ziploc bags, killing jars, aspirators)

Methods:

Volunteers should begin scouting the area for seedlings in late March (emergence may be tied to spring rainfall times). When a plant is found, the date and condition of the plant (seedling, non-reproductive adult, flowering, fruiting, post-reproductive, or dead/missing) should be noted. Each plant should be assigned a number and marked with a metal tag and piece of surveyors' flagging (the metal tag and surveyors' flagging can be driven into the ground with a nail).

Optional
After the initial census is made volunteers may wish to visit the site every 2-3 weeks to assess the condition of the plants. Data should be recorded during each visit (additional data sheets can be used if more than three visits are made to each plant). Plants should be followed throughout the season until they complete reproduction or until they die. After the season tags can be left in place, since these plants are perennial and will hopefully emerge at the same location the following year.

In preparing a report, volunteers can look at several parameters, including the timing of seedling emergence in relation to local rainfall patterns, the percentage of seedlings that develop into adult plants, the percentage of seedlings that eventually flower, the percentage of plants that eventually produce fruit, etc. After several years of data collection, the students can look at trends related to weather patterns, lifetime of individual plants, etc.

Several extensions of this project could be developed. Students could observe plants to identify pollinators and predators. Soil samples could be collected at sites with and without the scurfpea and analyzed at soil laboratories to assess whether soil factors may explain its rarity. Little is actually known about the factors affecting this species, and any observations gathered through the course of this project might offer more understanding for its conservation.

By May 15:
Send copy of all data sheets, maps, and reports to TPWD at:

Texas Nature Trackers
Endangered Resources Branch
3000 So. IH-35, Suite 100
Austin, Texas 78704
Fax: 512-912-7058
Email: lalinam@wimberley-tx.com

Special notes:
As with any project working with herbaceous plants, be careful not to disturb the habitat or injure the plants inside or outside the sample plots.

Questions:
Questions regarding this volunteer project can be directed to the following TPWD staff:

Lee Ann Linam
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: 512-847-9480
fax: 512-847-9480
e-mail: *lalinam@wimberley-tx.com*

Jackie Poole or Dana Price
3000 So. IH-35, Suite 100
Austin, TX 78744
phone: 512-912-7011
fax: 512-912-7058
e-mail: *dana.price@tpwd.state.tx.us*
jackie.poole@tpwd.state.tx.us

In addition, the following TPWD biologist is familiar with the biology of this plant:

Junie Sorola
106 Jodobo
Del Rio, TX 78840
phone: 830-774-7406
ssorola@delrio.com

Rydberg's Scurfpea Monitoring
Data Sheet

Site:_____

Name:	Phone 1:
Address:	Phone 2:
	Fax:
	e-mail:

Plant Number	Date	Number Flower Stalks	Number Seed Stalks	Plant Number	Date	Number Flower Stalks	Number Seed Stalks

Mail form to:
TPWD
3000 So. IH-35, Suite 100
Austin, TX 78704

MONITORING PLAN FOR:
RYDBERG'S SCURFPEA (*Pediomelum humile)*
Hwy 277 ROW - Val Verde county

Goals:

1. To monitor population size and to detect long-term trends
2. To assess annual reproductive effort
3. Other class goals?

Monitoring seasons:
Late March through late May/early June.

Site Locations:
Site 1 - Hwy 277 right-of-way about 7.9 miles north of the intersection of Hwy 277 and Hwy 90; located in sparse rocky habitat on a slope on the east side ROW
Site 2 – Hwy 277 ROW on the west side of the road across from site 1; there is a numbered marker on the fence that reads "385"
Site 3 – Hwy 277 ROW, east side, about 0.45 miles north of site 1 or 8.35 miles north of Hwy 277 and Hwy 90 intersection

Equipment Needed:
*data forms, maps, pencil, & clipboard
Optional
*meter stick for measuring height or width
*insect collecting equipment (e.g. nets, vials, tweezers, ziploc bags, killing jars, aspirators)

Methods:

Volunteers should begin scouting the area for seedlings in late March (emergence may be tied to spring rainfall times). Ideally, population counts should be conducted when a majority of the plants have reached the flowering stage. Flowering can occur from early April through late May. In very dry years plants may go dormant before reaching the flowering stage, so care should be taken to not miss survey opportunities. During the survey, the date and condition of the plant (seedling, non-reproductive adult, flowering, fruiting, post-reproductive, or dead/missing) should be noted.

Several extensions of this project could be developed. Students could observe plants to identify pollinators and predators. Soil samples could be collected at sites with and without the scurfpea and analyzed at soil laboratories to assess whether soil factors may explain its rarity. Little is actually known about the factors affecting this species, and any observations gathered through the course of this project might offer more understanding for its conservation.

By May 15:
Send copy of all data sheets, maps, and reports to TPWD at:

Texas Nature Trackers
Endangered Resources Branch
3000 So. IH-35, Suite 100
Austin, Texas 78704
Fax: 512-912-7058
Email: lalinam@wimberley-tx.com

Special notes:
As with any project working with herbaceous plants, be careful not to disturb the habitat or injure the plants inside or outside the sample plots.

Questions:
Questions regarding this volunteer project can be directed to the following TPWD staff:

Lee Ann Linam
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: 512-847-9480
fax: 512-847-9480
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jackie.poole@tpwd.state.tx.us

In addition, the following TPWD biologist is familiar with the biology of this plant:

Junie Sorola
106 Jodobo
Del Rio, TX 78840
phone: 830-774-7406
ssorola@delrio.com

Monitoring results for Rydberg's scurfpea (*Pediomelum humile*) near Del Rio, Texas

Site	Date	# plants	# plants with flowers
Calderon Elementary	April '98	87	0
	April '99	114	28
	April '00	63	0
	April '01	90	80
	April '02	0	
Hwy 277 ROW	March '98	13*	ns
	1999	ns	ns
	April '00	0	na
	April '01	93*	na
	April '02	ns	ns

*incomplete count ns = not surveyed

Sample methods - Students at Calderon Elementary closely monitor (at least weekly) two clumps of scurfpea in a natural area behind their school. They count total plants and number of plants that bloom. Students at Del Rio High School usually visit the right-of-way site several times each spring to look for and count scurfpea.

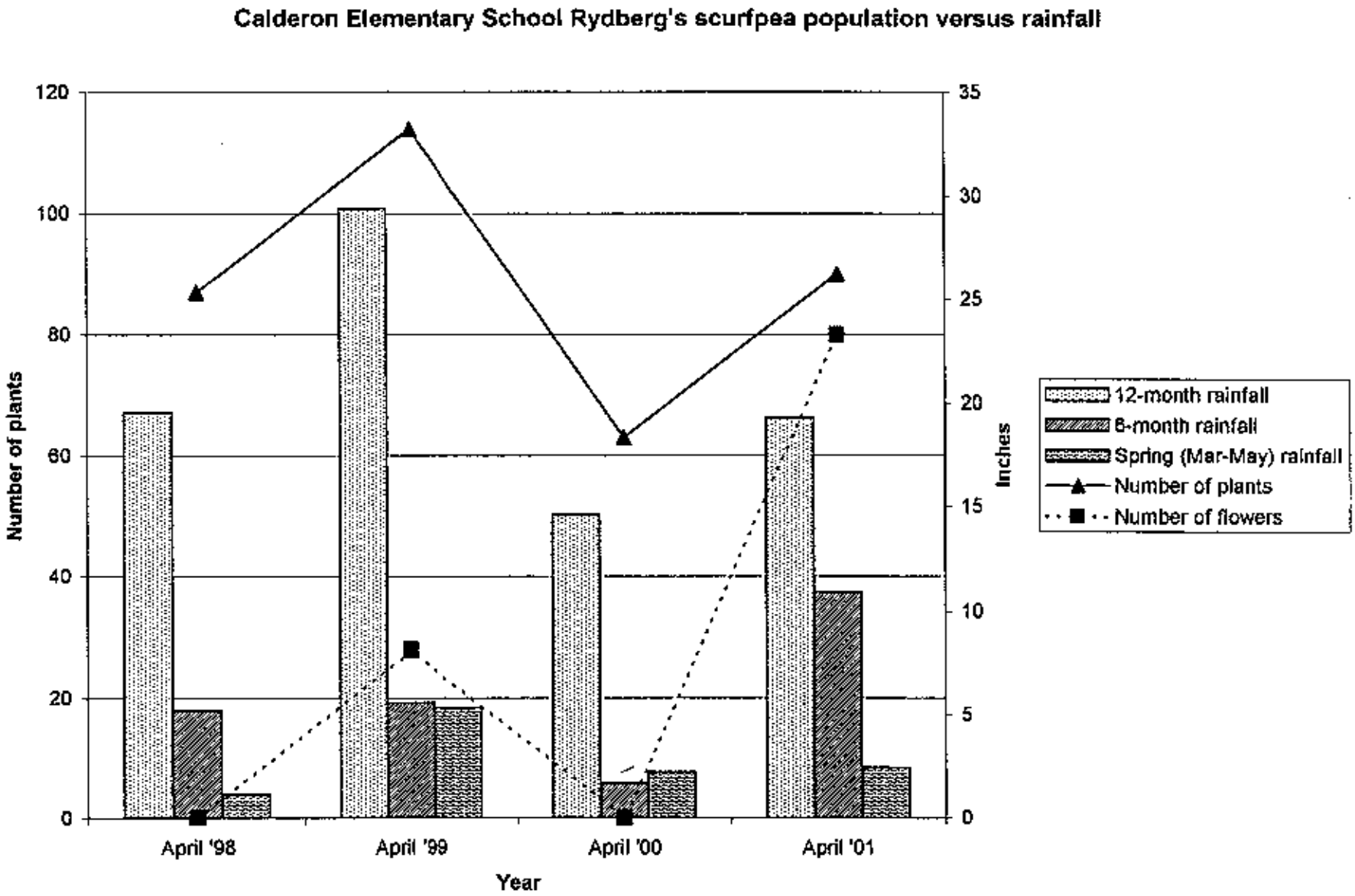
2002 - During 2001-02 the Del Rio Independent School District constructed a new campus at the Calderon Elementary site, resulting in the destruction of the population. M. Fortunado, a teacher at elementary school was able to salvage four seeds from the 2001 production. These seeds were placed at the LBJ National Wildflower Research Center. Volunteers were unable to monitor the Hwy 277 population in 2002.

2001 - Scurfpea numbers were up again at both locations due to good winter and spring rains. Approximately 90% of the plants monitored at Calderon Elementary bloomed. There is concern for this site, as the school district has plans to construct a new campus on the property. Contacts have been made with the school district to request consideration for the *Pediomelum* population. Scurfpea were located at three sites on Hwy 277. Although only an incomplete census was conducted, over 90 plants were found.

2000 - Scurfpea numbers declined at Calderon Elementary, presumably due to a severe winter and early spring drought. No flowering was detected. No plants were detected during several visits by teacher and students to the Hwy 277 site. This site might have received even less rainfall than the Calderon site.

1999 - Improved rainfall conditions during the winter of 1998-99 resulted in much higher plant numbers at the Calderon Elementary School site. Teacher M. Fortunado and her students were able to document flowering in 28 plants before dry conditions contributed to die-back. The Hwy 277 site was not monitored.

1998 - The population on US Hwy 277 has been intermittently monitored by G. Overfelt and the Del Rio High School Environmental Science Club since 1993. Although the volunteers were unable to visit the site during 1998, TPWD staff were able to confirm the presence of at least 13 individuals in a brief survey conducted on April 16. A second site, discovered by TPWD biologist Sylvestre Sorola and teachers at Calderon Elementary School in Del Rio, is located on undeveloped property owned by the school district and located directly behind the elementary school. Students at the school marked and closely monitored the population of *Pediomelum*, which reached a peak of 87 individuals in late-March, early-April. The population began to decline in April due to drought, and no flowering was noted. By the end of May all plants had died back.


Calderon Elementary School Rydberg's scurfpea population versus rainfall
120
100
80
60
40
20
0
Number of plants
35
30
25
20
15
10
5
0
Inches
April '98
April '99
April '00
April '01
Year
12-month rainfall
8-month rainfall
Spring (Mar-May) rainfall
Number of plants
Number of flowers

Houston daisy
Rayjacksonia aurea





Houston daisy monitoring techniques





Houston daisy habitat



Summary Report
Volunteer monitoring of Houston daisy (*Rayjacksonia=Machaeranthera aurea*)

Status of project

Texas Nature Tracker monitoring began in Harris county in 1997. Several historic roadside populations have been revisited to assess persistence of the population. Quantitative monitoring has been developed at seven sites, four of which are in Addicks reservoir. Data has also been gathered on Texas windmillgrass (*Chloris texensis)* where it occurs with Houston daisy.

Volunteer involvement

Two community college teachers, along with some student help, have conducted quantitative monitoring at the sites noted in Table 2; however, one teacher relocated. At this time only the North Harris County Community College (NHCCC) site has continuing volunteer involvement. Monitoring techniques are suitable for amateur naturalists; however, volunteers with particular interest and motivation are likely needed. In addition, sites in Addicks Reservoir should be monitored by a team of adults because of the size of the populations and because of safety concerns.

Monitoring methods

Methods are described in the attached protocol. Complete population counts are not realistic at most sites, since many individuals may occur and the growth form results in overlap between individuals. However, an index of complete canopy cover is workable for the species. In order to minimize variability in canopy cover estimates, a gridded quadrat was developed so that volunteers may count the number of 0.01 m^2 cells in which the species occurs. In addition, a measure of reproductive effort could be obtained by subsampling and counting flowers and fruits within randomly-selected cells.

Results to date

Many roadside populations of the species are very small, with uncertain future threats such as road or ditch improvement and the encroachment of non-native grasses. The largest populations persist in Addicks Reservoir, owned by the Army Corps of Engineers, followed by NHCCC. Results to date are not sufficient for detecting trends, although no declines are apparent. Long-term concerns exist at Addicks, where management of woody species may be needed in order to prevent encroachment into prairie openings which also support *Thurovia triflora, Liatris bracteata,* and *Hymenoxys texana.* Volunteers are working with maintenance staff at NHCCC to reduce mowing frequency at the Houston daisy site. Fortunately that population survived an unforeseen dumping of fill material on the site in 2001.

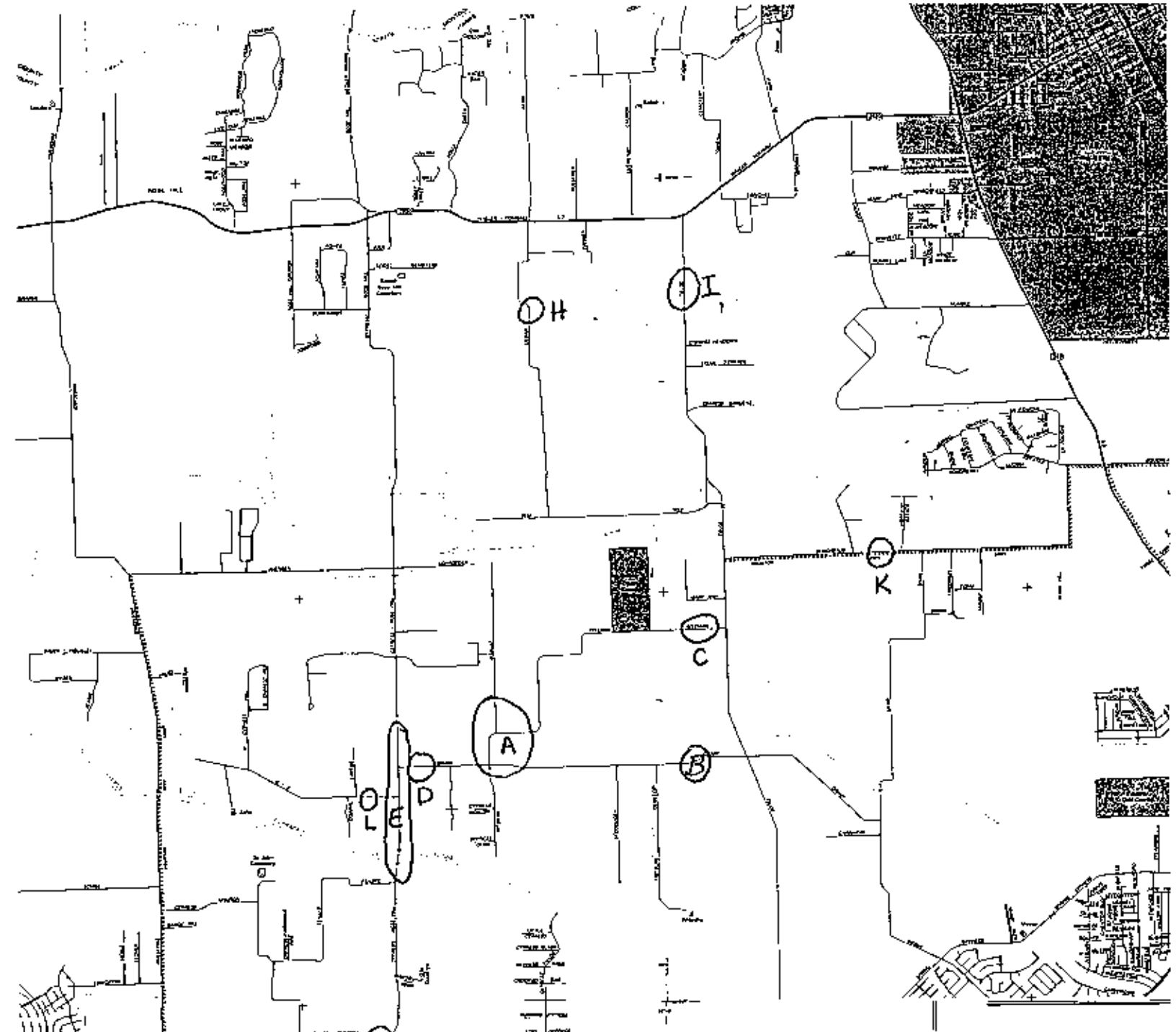


Figure 1. Houston daisy & Texas windmill grass locations near Cypress, TX.

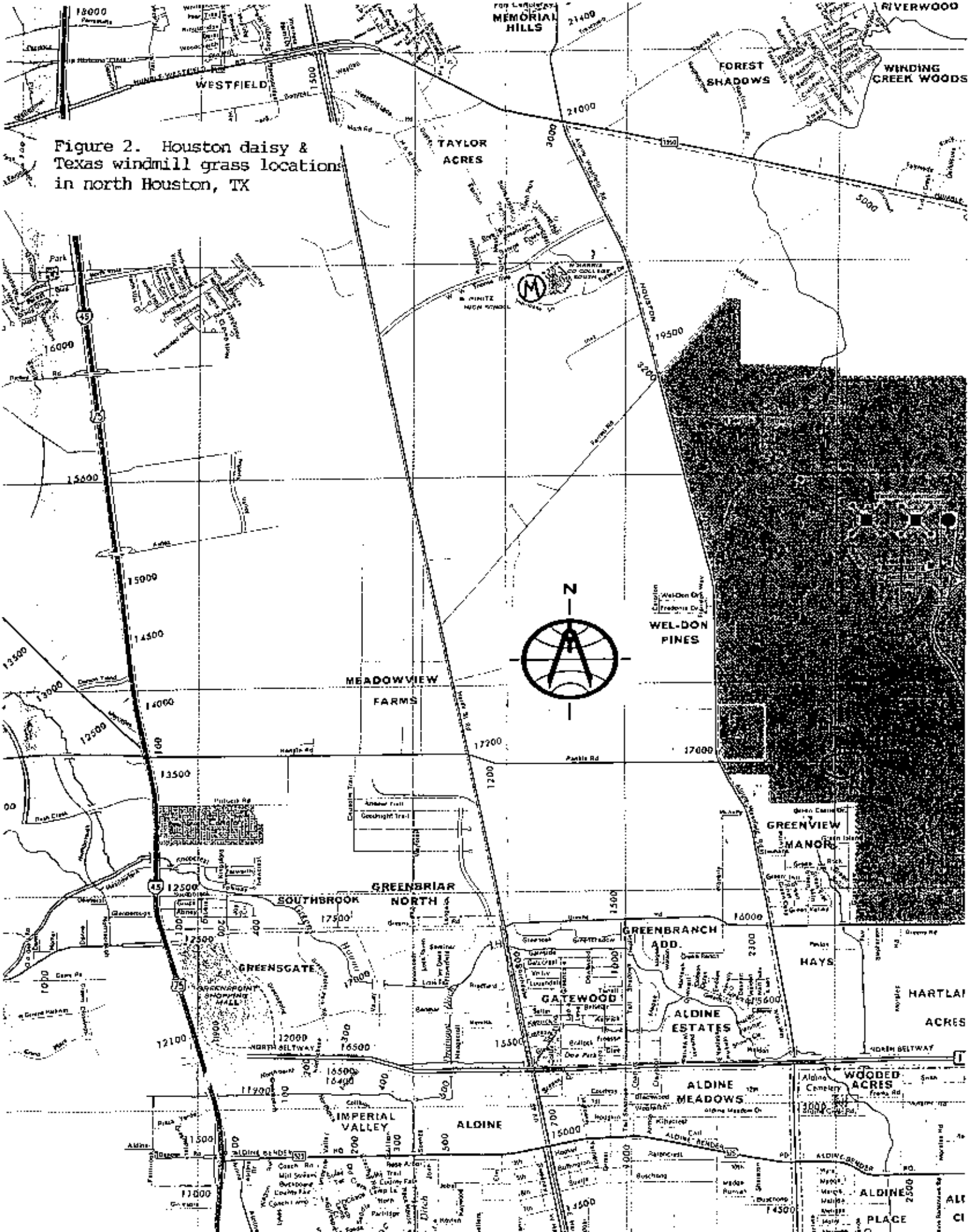


Figure 2. Houston daisy & Texas windmill grass locations in north Houston, TX

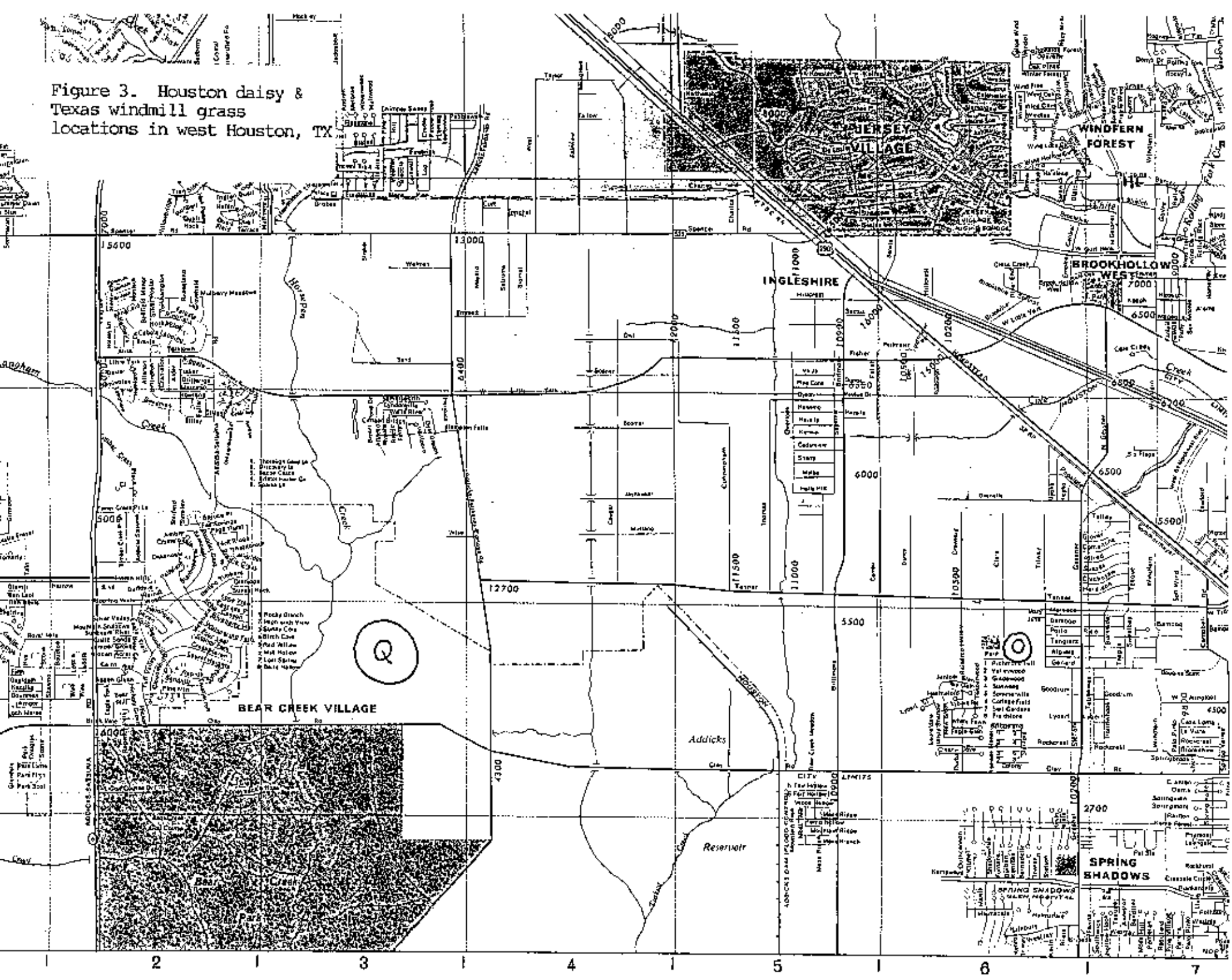
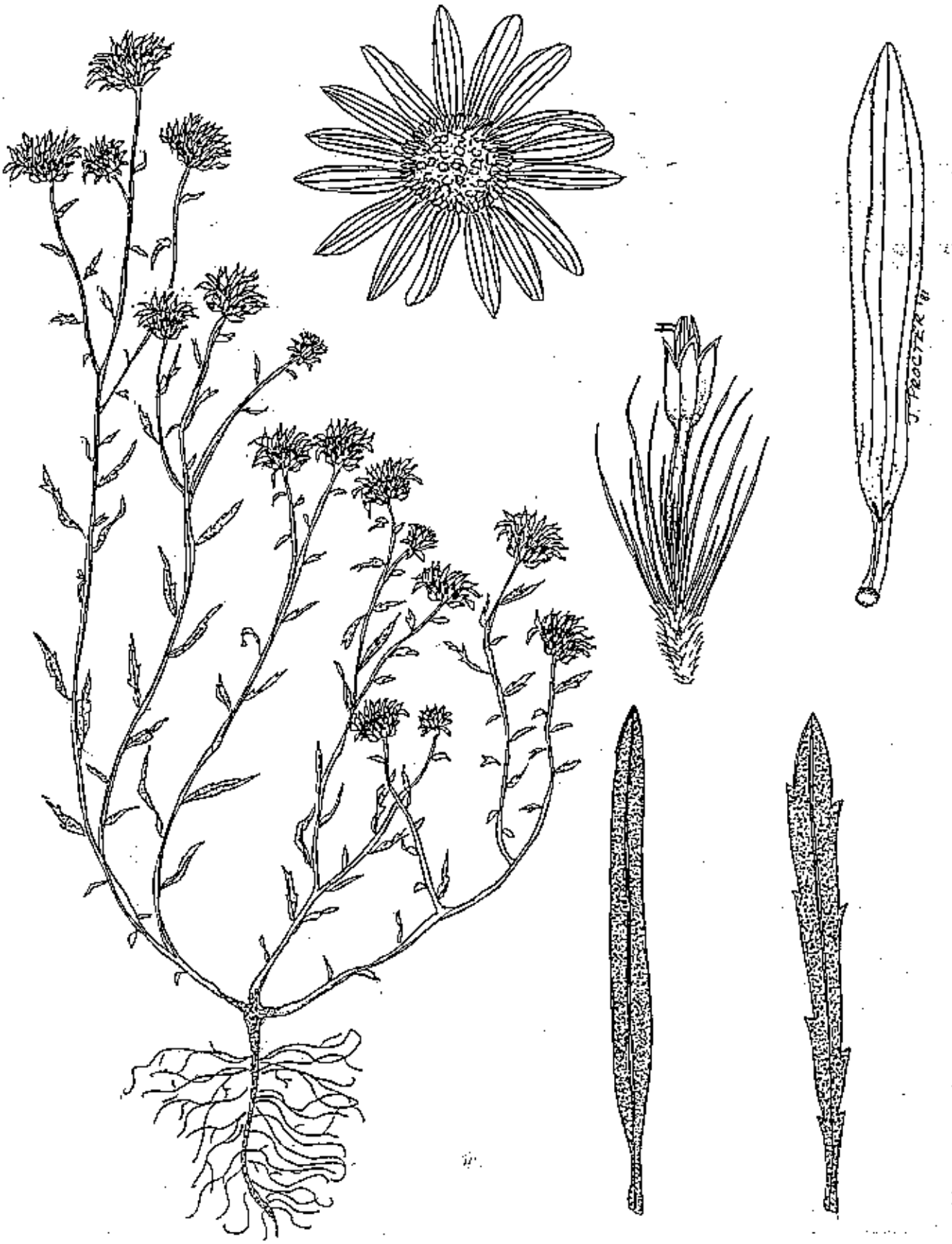


Figure 3. Houston daisy & Texas windmill grass locations in west Houston, TX



MONITORING PLAN FOR:
HOUSTON DAISY (*Machaeranthera aurea*)
Harris county

Background:

The Houston daisy is a small, low-growing member of the sunflower family with small (<1 cm. diameter) flowers. It is known from only 21 sites in Harris county (20 sites) and Galveston county (1 site). It is a plant of coastal prairie areas, most often located in bare ground near mima mounds and other barren soil types. It is often found with two other rare plants, Texas prairie dawn (*Hymenoxys texana*) and Texas windmill grass (*Chloris texensis*). Its highly restricted distribution in the prairie areas of Harris county makes it vulnerable to loss, primarily from urban expansion. The goal of this project is to annually assess the status of the plant at as many known locations as possible.

Monitoring season:
mid-October through mid-November (flowering season)

Site Locations:
The Houston daisy is known from four general areas in Harris county:

North Harris County Community College - one small population is found near the hiking path on property owned by the college.

Cypress area - Houston daisy has been located at several locations north and northeast of the community of Cypress. It occurs on public road rights-of-way, but its status on adjacent private lands is unknown.

Addicks Reservoir - Houston daisy has been found in some prairie openings in the U.S. Army Corps of Engineers Addicks Reservoir property (also a Texas National Guard training site) located to the north of Clay Road. It has also been reported from campus of Houston Community College located on Clara Road.

Pasadena area - Houston daisy is known from several "vacant lots" within the highly developed Pasadena area. It also occurs on a Houston Lighting and Power right-of-way in this area.

Equipment Needed:

*0.25 m^2, 0.5 m^2, or 1.0 m^2 quadrat, subdivided into 0.01 m^2 sections
*surveyors' flags
*measuring tape (in meters)
*data forms, maps, pencil, & clipboard

Optional
*camera
*insect collecting equipment (e.g. nets, vials, tweezers, ziploc bags, killing jars, aspirators)

Methods:

Level 1: Habitat Assessment - One goal of this monitoring effort would be to assess the rate of habitat loss for the species. To accomplish this task, monitors would simply drive to all known locations and determine whether the habitat remains in a grassland condition. Photo points could be established and photos taken each year.

Level 2: Population Monitoring - The goal at this level is to determine the amount of area occupied by the species and the number of individual plants present (if possible). Monitors should visit the site and use a 0.5 m^2 or a 1.0 m^2 quadrat divided into 0.01 m^2 segments to estimate the amount of area that the species occupies (its canopy coverage). Begin by laying down the PVC quadrat over a portion of ground that contains Houston daisy. Count the number of 0.01 m^2 segments in which the daisy occurs. Then pick up the quadrat and move it over to the next area that contains Houston daisy. It may be useful to use surveyors' flags to mark off the corners of the quadrats as you survey them.

Level 3: Reproductive Monitoring - This level of monitoring is optional, but it may help us to understand how the species responds to different weather patterns or to different management activities, such as mowing or grazing. The goal is to count the number of flowers present. If the population is large, then one could count the number of flowers within one segment of each quadrat placed (Use a random numbers table to select which segment each time). Results could then be expressed as a number of flowers/square meter. In addition to flower counts, monitors could also collect information on pollinators, a little-known area of the biology of this species.

After monitoring is completed:

1. Complete data sheet
2. Send copy of all data sheets and other materials to TPWD at:

   Texas Nature Trackers
   Endangered Resources Branch
   3000 So. IH-35, Suite 100
   Austin, Texas 78704

Special notes:
As with any project working with herbaceous plants, be careful not to disturb the habitat or injure the plants during your monitoring. Long plants and sleeves and closed-toed shoes are recommended at the Addicks Reservoir site, as thick brush is present. When monitoring along road rights-of-way, please note that the adjoining property is private property. Please do not trespass without written landowner permission.

Contacts:

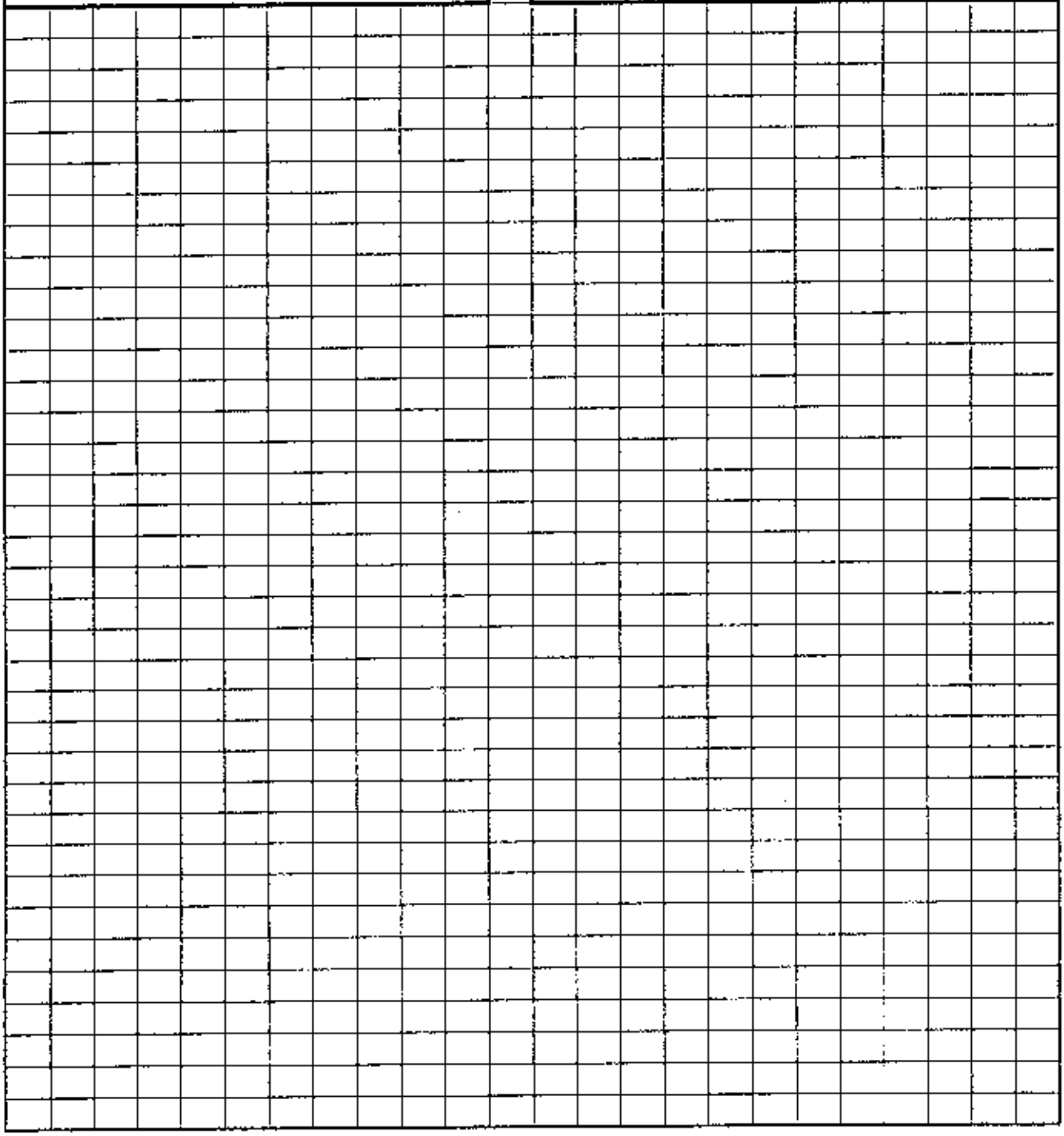
TPWD
Dana Price
3000 South IH-35, Suite 100
Austin, TX 78704
phone: (512) 912-7011
fax: (512) 912-7058
dana.price@tpwd.state.tx.us

TPWD
Lee Ann Linam
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: (512) 847-9480
fax: (512) 847-9480
lalinam@wimberley-tx.com

Addicks Reservoir
Gary Demarcay
(409) 766-3068

Houston daisy (Machaeranthera aurea)
and Texas windmill grass (Chloris texensis)
Data sheet

Name:	Date:
Address:	Monitoring location:
Phone:	Sampling site:
Email:	Species:
	Monitoring technique:



Total quadrats sampled: _____

Total occupied cells: _____

Percent of popn. sampled (est.): _____

November surveys for Houston daisy (*Machaeranthera aurea*) and Texas windmill grass (*Chloris texensis*) in Harris county.

Map Location	Site Description*	EOCode	Species	1997	1998	1999	2000	2001	2002
A	Cypress - Kitzmann Rd	PDAST64050*007	M. aurea	C	C	N	C	C	C
A1	Cypress - Bobcat Rd	PDAST64050*015	M. aurea	C	N	N	C	N	C
A	Cypress - Kitzmann Rd	PMPOA1E0J0*007	Chloris texensis	X	X	N	C	N	N
A2	Cypress - Grant Rd.	PMPOA1E0J0*008	Chloris texensis	X	X	N	X	N	N
B	Cypress - Grant Rd. E	PDAST64050*012	M. aurea	C	C	N	N	N	X
C	Cypress - Kitzmann x Telge Rd.		C. texensis	C	C	N	X	C	C
D	Cypress - Grant Rd. W	PDAST64050*003	M. aurea	C	C	N	C	N	C
D	Cypress - Grant Rd.	PMPOA1E0J0*016	C. texensis	X	C	N	X	N	N
E	Cypress - Cypress Rose Hill no. of Grant	PDAST64050*016, PDAST64050*002	M. aurea	X	N	N	X	N	X
G	Cypress - Huffmeister x Church Rd.	PDAST64050*014	M. aurea	C	C	N	Q	Q	Q
G	Cypress - Huffmeister x Church Rd.		C. texensis	X	C	N	Q	Q	Q
H	Cypress - Cedar Lane	PDAST64050*013	M. aurea	C	N	N	N	N	N
I	Tomball - Telge Rd.	PDAST64050*010	M. aurea	C	N	N	N	N	N
J	Tomball - Triechel Rd.	PDAST64050*009	M. aurea	X	N	N	N	N	N
K	Tomball - Boudreaux Rd	PDAST64050*008	M. aurea	?	N	N	N	N	N
L	Cypress - KZ Road	PDAST64050*006	M. aurea	C	N	N	N	N	X
M	North Harris Comm. College - W.W. Thorne	PDAST64050*004	Machaeranthera aurea	C	C	Q	Q	C	Q
N	North - Rankin Rd.	PMPOA1E0J0*021	C. texensis	N	N	X	N	N	N
O	Houston Comm. College - Northwest	PDAST64050*018	M. aurea	C	N	Q	N	N	N
O	Houston Comm. College - Northwest	PMPOA1E0J0*017	C. texensis	X	N	Q	N	N	N
Q	Addicks Reservoir	PDAST64050*022, PDAST64050*023	M. aurea	N	C	Q	Q	C	N

KEY: C= presence confirmed
X = surveyed, but not seen
N = site not surveyed
Q = quantitative monitoring accomplished

*All locations along roadways were surveyed in the right-of-way only. In 1997 several sites in the Pasadena area with records for both species were visited in a roadside survey. Although some of these "lots" remain undeveloped, no plants were visible from the ROW. Development of these lots is almost certain in the near future. Several other historic locations in the Cypress area were surveyed in 1997, but no populations were present on the ROW.

Intensive Houston daisy (*Mechaeranthera aurea*) monitoring - Harris county, Texas.

Site Description	Area surveyed sq. m.	Occupied quadrats	Occupied cells	Area surveyed sq. m.	Occupied quadrats	Occupied cells	Area surveyed sq. m.	Occupied quadrats	Occupied cells	Area surveyed sq. m.	Occupied quadrats	Occupied cells
	Nov-99			Oct-Nov, 00			Dec., 01			Nov., 02		
Addicks Reservoir - AHT057	17.75	40	309	33	43	124						
Addicks Reservoir - AHT039A				71.5	111	1259						
Addicks Reservoir - AHT039D				22	59	753						
Addicks Reservoir - AHT040				36	64	521						
Houston Community College - Northwest Campus	2.25	7	59									
Cypress - intersection of Cypress Church Rd. & Huffmeister Rd.				unk.	18	153	3	10	72	2.25	9	130
North Harris Comm. College - W.W. Thorne Rd.	unk.	85*	623*	483*	126*	919*				817	124	1236

*incomplete sampling

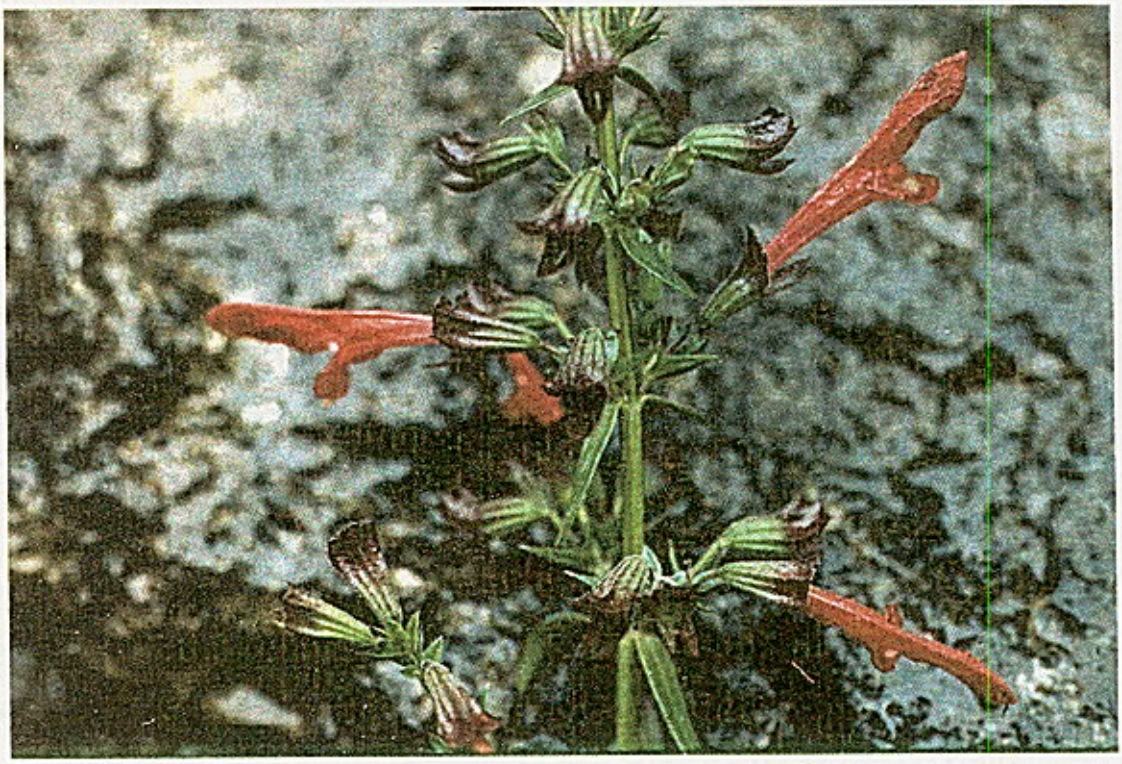
Sample methods - The complete population at each site is assessed using a 0.5 x 0.5 meter quadrat subdivided into 0.01 m^2 cells. An index of canopy cover is determined based upon the total number of 0.01 m^2 cells occupied by Houston daisy.

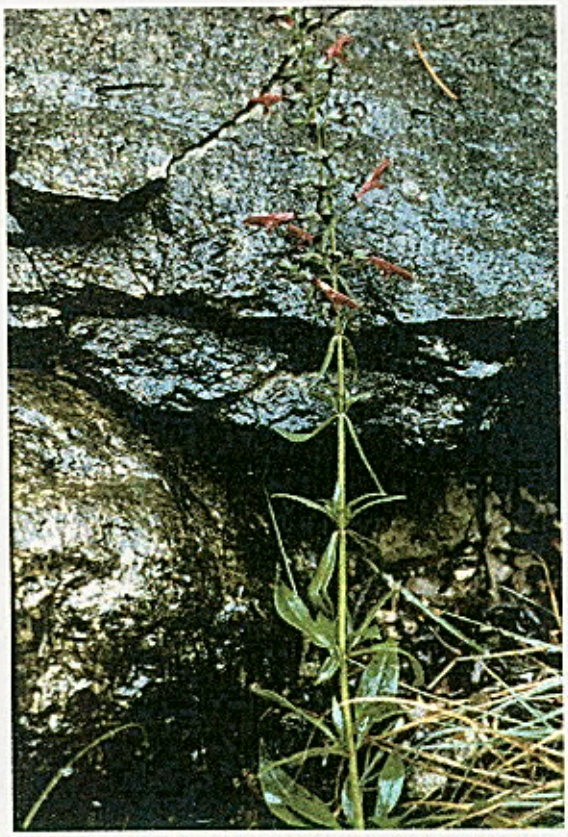
2002 - Survey efforts were hampered by extremely wet conditions. The Houston area received over 12 inches of rain during the last week of November, resulting in a lack of access to Addicks Reservoir. Houston daisy at well-drained sites seemed very vigorous; however, plants at Cypress and North Harris County Community College appeared stressed due to inundation. Monitoring at Cypress was accomplished by D. Price, L.A. Linam, B. Harris, and T. Ficker. Five patches of Chloris texensis, totalling 12.6 m^2, were also located at the site and on the ROW to the west. Monitoring at North Harris was conducted by D. Price, L.A. Linam, and J. Hartgrove-Freile. That population seemed to survive the deposition and removal of dirt in 2001.

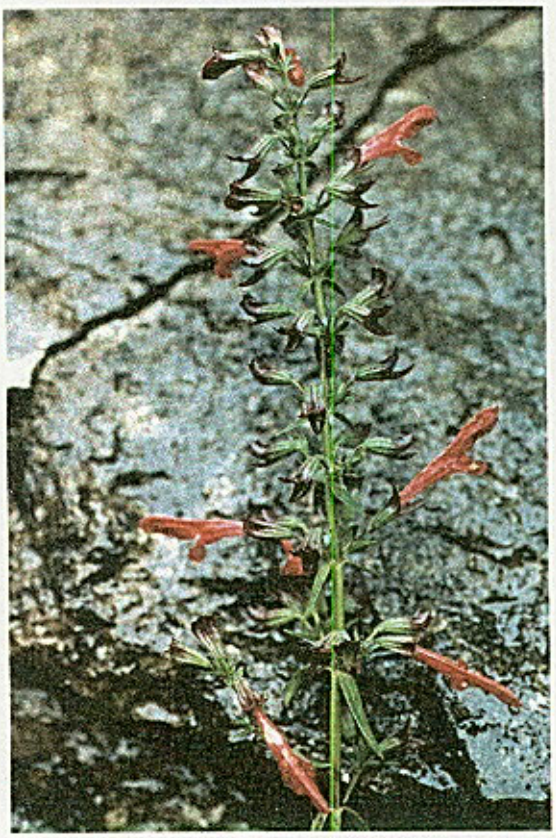
2001 - Few areas were surveyed in 2001 due to unavailability of volunteers. On 4-Dec.-01 L. Linam, K. McMillan, and J. Winans surveyed the Cypress location; however, some plants could have been overlooked due to the late stage of flowering. Texas windmillgrass was also estimated to occur on 60 m^2 on the ROW across the road to the west of the triangle. Volunteer J. Hartgrove-Freile reported that the population at North Harris Community College suffered a setback when a load of dirt was dumped into the low area it occupied. An effort was made to remove the dirt without harming the plants.

2000 - Late spring, summer, and autumn rainfall continued to be below average. Occupied cells at the Cypress location were estimated based on a percent cover estimate (D. Price & L. Linam, 11/02/00). Texas windmillgrass was also estimated to occur on 107 square meters at the Cypress site. Addicks site 57 sampled 10/21/00 by P. Julien; sites 39A, 39D, and 40 sampled 11/03/00 by P. Julien, D. Price, and L. Linam. NHCC sampled 11/02/00 by J. Hartgrove, D. Price, L. Linam, and students.

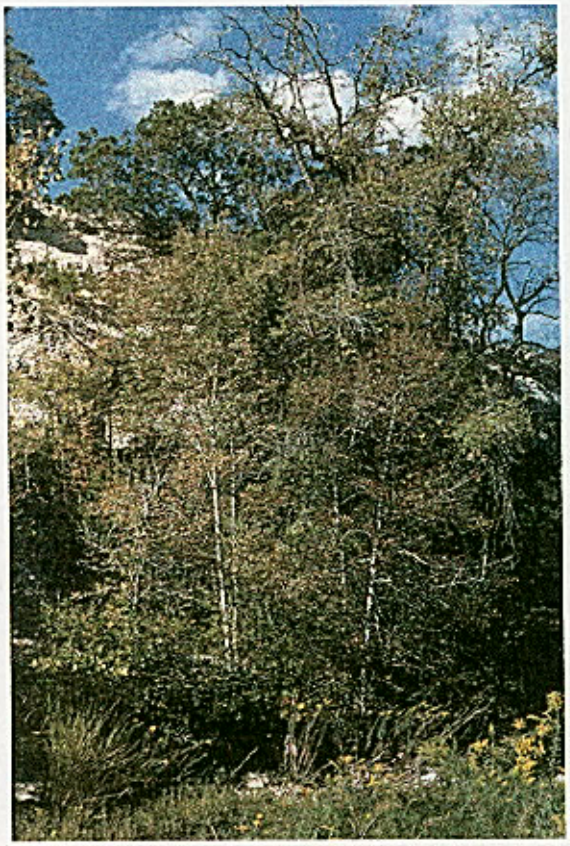
1999 - More than 150 inflorescences of Texas windmill grass (*Chloris texensis*) were also counted at the Houston Community College NW Campus site. Addicks reservoir sampled on 10 November by P. Julian. HCC NW sampled on 6 Nov. by P. Julian and L. Linam. NHCC sampled on 5 Nov. by J. Hartgrove, A. Miller, and L. Linam.

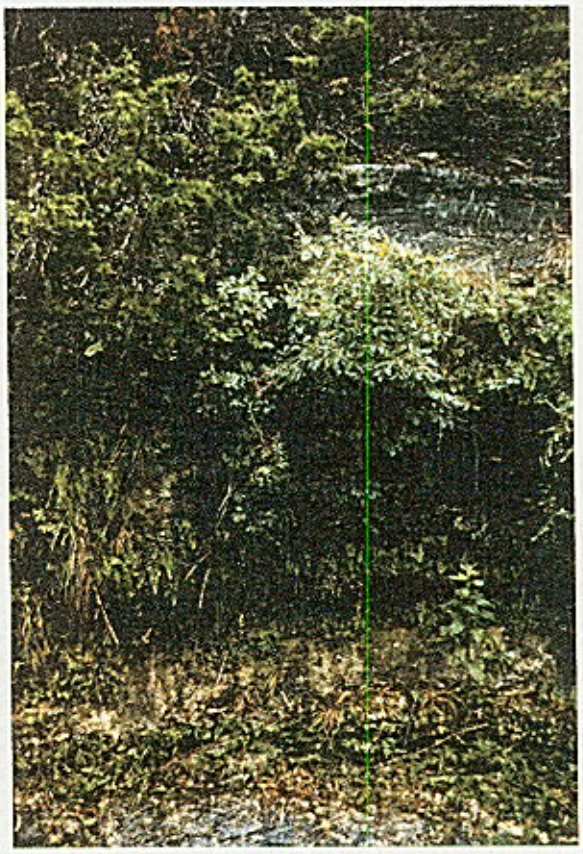






Salvia penstemonoides (Big red sage) photos by Jackie M. Poole





Salvia penstemonoides (Big red sage) habitat photos by Jackie M. Poole

Summary Report
Volunteer monitoring of big red sage (*Salvia penstemonoides*)

Status of project

Texas Nature Tracker volunteers began monitoring the Boerne IH-10 right-of-way site in 1997, continuing a monitoring project begun by J. Poole in 1991. Date has been collected each year since that time.

Volunteer involvement

This site has had the most consistent volunteer involvement of any TNT site. Mary Kennedy, a teacher at Texas Military Institute, has coordinated monitoring each year. She frequently involves other high school or university teachers, along with high school students. For several years her students have used data from the site to advance to regional and national science fairs.

Monitoring methods

Methods are described in the attached protocol. Complete population counts are conducted, along with measures of reproductive effort. Depending on total population count, reproductive effort may be assessed for every plant or for a subsample of plants.

Results to date

Consistently collected data since 1991 reveals that this population is clearly in decline. Overall plant numbers have declined approximately 75% since surveys began, and numbers of adult (stemmed) plants have declined approximately 90%. Some of the decline may be attributed to a flood in 1997 that killed all the plants in the largest subpopulation; however, other vigor measures offer cause for concern. During the past three years measures of vigor, such as the proportion of adult plants to rosettes, the average number of stems per plant, and the average number of reproductive bodies per

plant have declined. Furthermore, it appears that long-term population trends are independent of rainfall patterns, although stemmed plant numbers in the early 1990's seemed to follow rainfall trends (see Figure). Some more intensive monitoring may be needed, such as revisits to assess whether August rosettes eventually mature. In addition, attributes of microhabitats (such as insolation) for reproductive versus non-reproductive plants should be examined. Finally, seeds should be collected from this population. Perhaps plants could be germinated and reintroduced into the site of the former large subpopulation.

MONITORING PLAN FOR:
BIG RED SAGE (*Salvia penstemonoides)*
Boerne ROW Site

Goals:

1. To monitor population size and to detect long-term trends
2. To measure reproductive effort for a subsample of the population
3. Other class goals?

Monitoring season:
Late July – Early August

Site Location:
Kendall county, City of Boerne, Texas. IH-10 ROW in underpass along Frederick Creek. Frederick Creek crosses under IH-10 just northwest of the intersection of IH-10 and SH 46. Access is along unimproved eastbound access road located on south side of interstate.

Equipment Needed:
*data forms, pencil, & clipboard

Methods:

The population is divided into three segments. Site 1, the central site, was located underneath highway bridge. Dominant vegetation at the site is poison ivy. This site was lost in a flood in 1997 and has not been seen since that time. Site 2, the east site, is located east of the overpass. It is further from the creek and abuts up next to a rocky slope. Most of the site is shaded by small trees and shrubs. This site extends onto the adjacent private property to the north, but the plants on private land are not censused. Site 3, the west site, is located west of the overpass and near the creek. Most of the site is open, although there is a patch of persimmon among the salvia.

At each site an attempt is made to locate every big red sage. The plants are numbered according to the chronology of their discovery, but they are not physically marked. For each plant, record a plant number (PL #), the number of primary stems (# 1ST ST) emerging from the base of the plant, the number of secondary stems (# 2ND ST) branching from the primary stems, and the combined number of flowers or fruits present (# FL/FR). If the plant is just a rosette, then indicate "R" under the "#1ST ST" column. If many (>100) stemmed plants are present, then flowers and fruits may be subsampled, with counts made on every 5th stemmed plant encountered. If very many (>200) stemmed plants are present, then flowers and fruits should be counted on every 10th stemmed plant encountered. For stemmed plants where flowers and fruits are not counted, then "yes" or "no" should be recorded in the "# FL/FR" column to indicate their presence or absence. A note should be made to indicate which sampling scheme was used.

On the bottom of the page be sure to record any special notes about habitat conditions, weather conditions, or any other factors of interest.

After the visit

Send copy of all data sheets to TPWD at:

Texas Nature Trackers
TPW Wildlife Diversity Program
3000 So. IH-35, Suite 100
Austin, Texas 78704

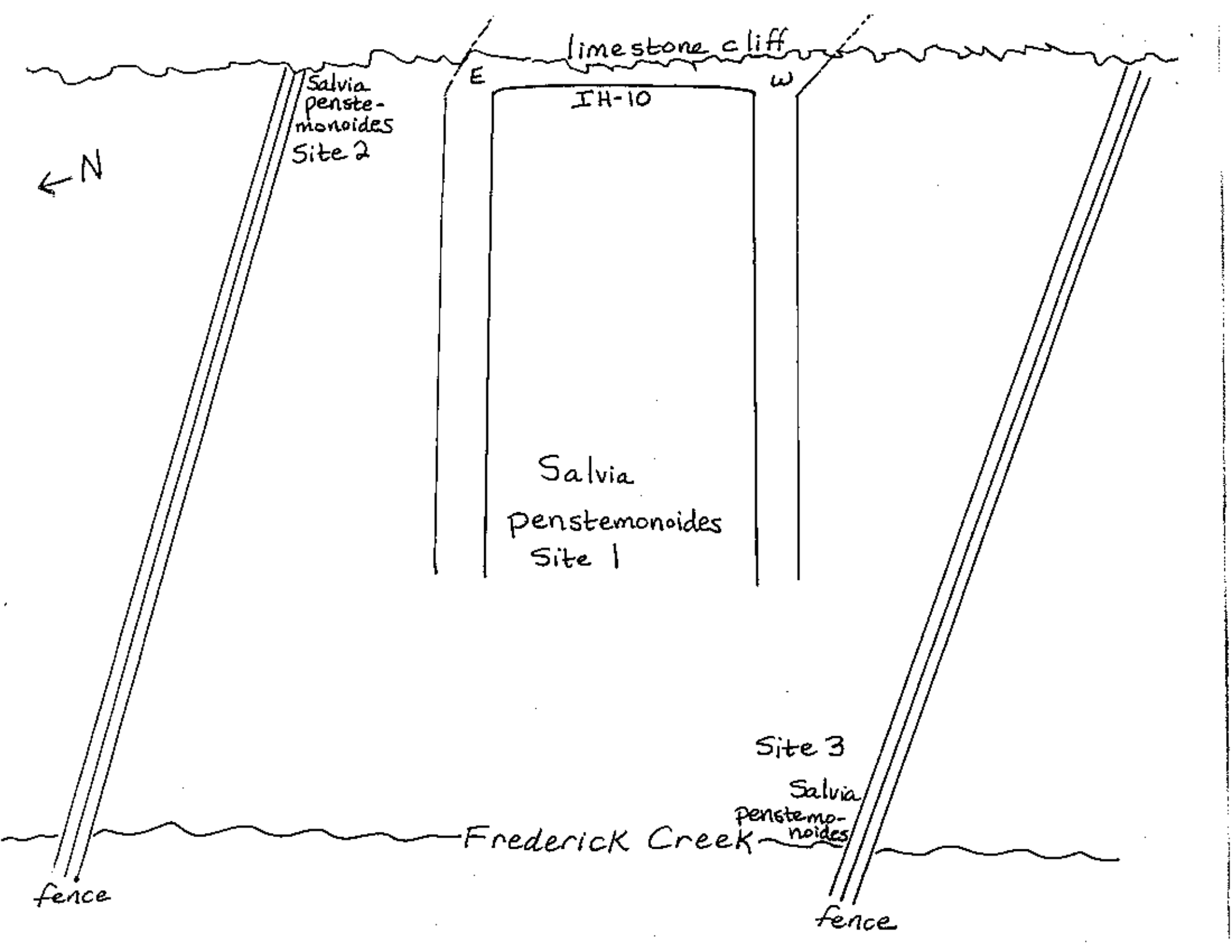
Special notes:
As with any project working with herbaceous plants, be careful not to disturb the habitat or injure the plants inside or outside the sample plots. Long plants and sleeves and closed-toed shoes are recommended, as poison ivy is abundant at this site.

Questions: Call Jackie Poole, Dana Price, or Marsha Reimer at 512-912-7011 or Lee Ann Linam at 512-847-9480.

BIG RED SAGE (SALVIA PENSTEMONOIDES) DATA SHEET
Highway ROW - Frederick Creek - Kendall County

Monitor name(s): _____ **Phone #:** _____ **Email:** _____ Address (required only if changed): 	**Monitoring Date:** **Site (circle one):** site 1 - central (under bridge) site 2 - east (near slope) site 3 - west (near stream)	**Reproductive sampling used (circle one):** -all stemmed plants -every 5th stemmed plant -every 10th stemmed plant **Other notes:**

PL #	# 1ST ST	# 2ND ST	# FL/FR	PL #	# 1ST ST	# 2ND ST	# FL/FR	PL #	# 1ST ST	# 2ND ST	# FL/FR


limestone cliff
E
W
IH-10
Salvia penste-monoides Site 2
N
Salvia penstemonoides Site 1
Site 3
Salvia penstemo-noides
Frederick Creek
fence
fence

Monitoring data for big red sage (Salvia penstemonoides) - Boerne IH-10 highway ROW site.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total # stemmed plants	105	258	125	112	130	67	45	44	42	7	24	12
Total # rosettes	359	318	51	115	85	59	54	98	133	165	78	113
Total primary stems	329	298	263	156	276	154	87	90	99	20	29	13
Average/plant	3.13	1.16	2.10	1.39	2.12	2.30	1.93	2.05	2.36	2.86	1.21	1.08
St. dev.	2.89	0.66	1.87	1.66	2.43	1.95	1.38	1.78	1.90	1.95	0.51	0.29
Total secondary stems	453	592	616	238	527	145	142	51	48	0	9	0
Average/plant	4.31	2.29	4.93	2.13	4.05	2.16	3.16	5.67	8.00	0.00	0.38	0.00
St. dev.	6.68	2.89	4.57	3.03	5.87	3.28	3.02	5.59	5.93	na	0.97	
Total flowers/fruits in subsample	3106	1913	2319	1120	2382	531	295	466	145	not	471	66
Average/plant	207.07	127.53	193.25	112.00	119.10	53.10	49.17	77.67	36.25	counted	19.63	5.50
St. dev.	293.00	126.94	161.30	125.50	127.02	61.73	42.75	95.03	30.66		27.03	8.61

Salvia data by microsite.

Year	Stemmed Plants			Rosettes	TOTAL
	Site 1	Site 2	Site 3		
1991	80	20	5	359	464
1992	218	24	16	318	576
1993	72	39	14	51	176
1994	79	20	13	115	227
1995	75	31	24	85	215
1996	38	7	22	59	126
1997	0	13	32	54	99
1998	0	30	14	98	142
1999	0	25	17	133	175
2000	0	3	4	165	172
2001	0	14	10	78	102
2002	0	0	12	113	125

Site 1 - central - between east- and west-bound lanes of IH-10
Site 2 - east - near rocky slope & private property line
Site 3 - west - near Frederick Creek

Sample methods - Volunteers from Texas Military Institute follow methods developed by Poole. All big red sage plants in three subpopulations are counted. Primary and secondary stems are counted. Flowers and fruits are counted on every plant or subsampled on every fifth or tenth stemmed plant, depending on population size.

2002 - Data were collected on July 31, 2002, by L.A. Linam, K. Palmer, M. Reimer, M. Kennedy, and volunteers from TMI. Overall numbers in 2002 were similar to 2001; however, growth seemed delayed in 2002, as many of the plants were only rosettes. In addition, all of the adult plants, although alive, were laying over on the ground, due to deposition of sandy silt during flood conditions in early July. Reproduction is likely be very low this year, as complete counts of reproductive bodies yielded only 66 buds, flowers, or fruit.

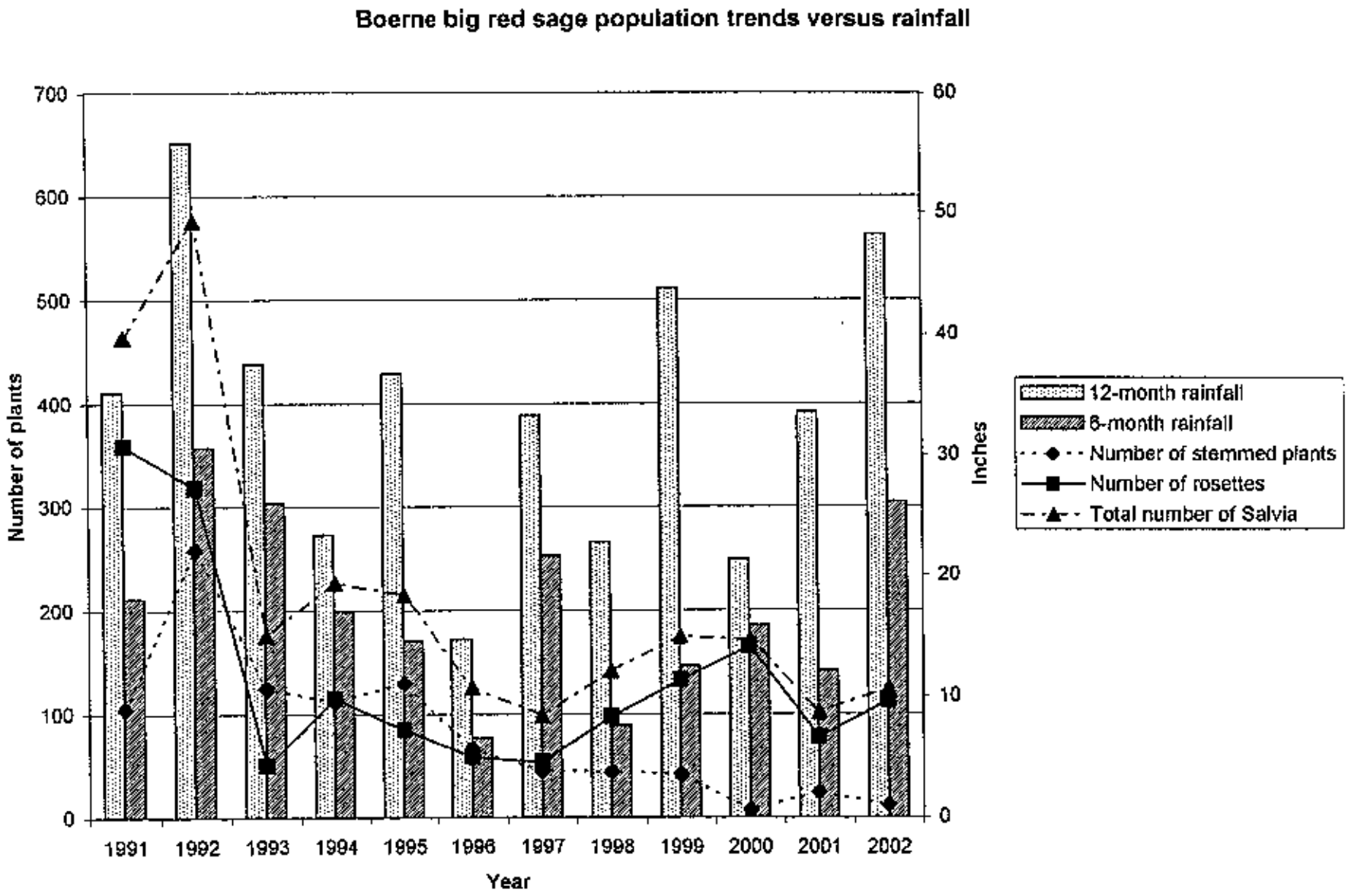
2001- Data were collected on August 3, 2001 by D. Price, M. Reimer, M. Kennedy, and volunteers from TMI. Although good winter/spring rainfall occurred during 2000-01, this population continues to remain depressed, primarily due to the extirpation of site 1 in 1997. Measures of vigor (multiple stems and flower counts) for the population are also very low, providing additional reasons for concern.

2000 - Data was collected on July 27, 2000. Most plants were in a rosette form, perhaps due to extreme drought in the Texas Hill country lasting until April 2000. This population has had severely limited reproduction for the past five years due to a combination of drought and loss of all perennial plants in site 1 during a flood in 1997. Its long-term viability should be closely monitored.

1999 - TPWD and TMI monitored the population in late July 1999. Numbers were very similar to 1998, with no recovery of the central population. Rosette numbers increased again in 1999.

1998 - Monitoring was conducted by TPWD and volunteers from Texas Military Institute. The population did not rebound in 1998 from the decline suffered in 1997 when a flood destroyed all the plants in one segment of the population. The area where large plants were found flattened by flood waters did not support any big red sage in 1998, suggesting that these perennials were dorwned or stressed beyond recover. The numbers of stemmed plants in remaining segments were similar to 1997, lathough there were many more rosettes in 1998--perhaps suggesting that these plants had emerged well after the wet winter of 1997-98, but had failed to develp due to a drought extending from March through August 1998.

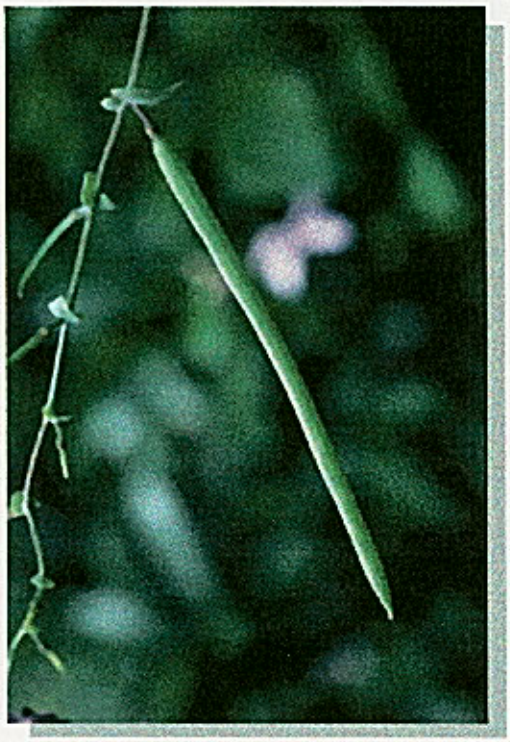
1997 - M. Kennedy of Texas Military Institute and colleagues assisted TPWD in gathering data on July 31, 1997. Numbers are at their lowest point since monitoring began, with no live plants seen in the largest of the three subpopulations. Closer examination revealed the presence of large decayed *Salvia* laying flat among the heavy grass of this section. Beorne experienced massive flooding during heavy rains in June 1997. Apparently Frederick Creek swept through this section, completely killing the already well-established plants.


Boerne big red sage population trends versus rainfall
Number of plants
Inches
Year
0
100
200
300
400
500
600
700
0
10
20
30
40
50
60
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
12-month rainfall
6-month rainfall
Number of stemmed plants
Number of rosettes
Total number of Salvia

Bracted Twist-Flower

Streptanthus bracteatus







Habitat: Central Texas on rocky, wooded slopes.

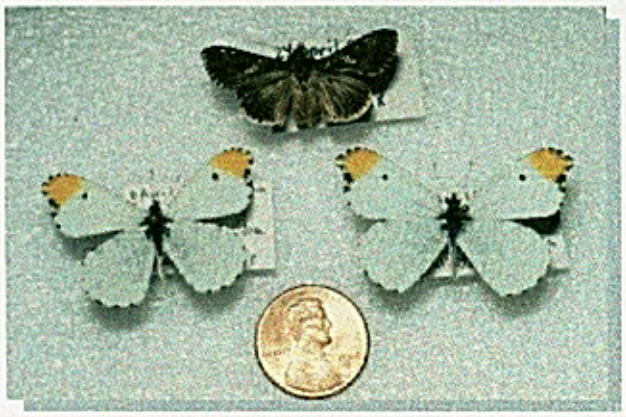
Description: Plants grow throughout the winter forming a basal rosette that resembles a dandelion plant except that the under side of the leaves have a purple tint. Leaves on the tall, erect stems are smooth and stemless. The flowering stem can grow 2 to 4 feet tall with violet-purple flower clusters form 4 to 10 inches in length. The name comes from the tiny leaf (bract) at the base of the stem of each flower. The seed is encased in a fruit about 6 inches long resembling a bean pod. When the fruit dries, it bursts open, flinging the seeds away from the plant to start the next generation.

Bloom period: April to May

Why rare: Habitat destruction, grazing by deer, and picking

Bracted Twist-Flower
Streptanthus bracteatus

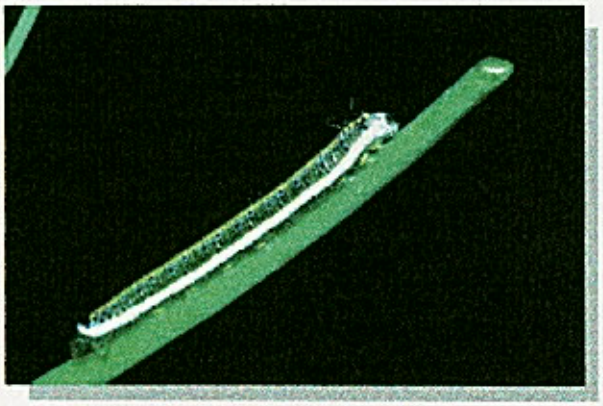
Sources of Herbivory



Top - Gray Looper Moth
Bottom - Falcate Orange-tip Butterfly



Gray Looper Moth Larvae



Falcate Orange-tip Butterfly Larvae



White-lined Sphinx Larvae



White-tailed Deer

Summary Report
Volunteer monitoring of bracted twistflower (*Streptanthus bracteatus*)

Status of project

Texas Nature Tracker volunteers began monitoring sites in Travis county in 1997, continuing a monitoring project begun by D. Zippin in 1993. The Bexar county site at Eisenhower Park was relocated in 1998, and efforts began to quantify Medina county roadside populations in 1999.

Volunteer involvement

Biology classes have been involved in monitoring Travis county sites; however, due to turnover of teachers and a low teacher to student ratio, TPWD staff have provided oversight each year. Additional oversight from a Texas Master Naturalist (TMN) volunteer, Mary-Ruth Holder has been valuable. Mary Kennedy has participated in monitoring the Bexar county site, and an Eagle Scout helped to build a deer exclosure to protect this population. Volunteer participation in Medina county has not been consistent, with no one volunteer yet becoming familiar with all sites. In order to relocate study plots and ensure correct identification of the species, volunteers with some expertise are needed for this project. An ideal situation might be for a NPSOT member or TMN to adopt the sites and then involve students as an educational activity.

Monitoring methods

Methods vary between sites. In Travis county, an effort has been made to continue to collect data in the sample plots established by Zippin (with the exception of Mount Bonnell where access to private land is no longer available). Within those plots all individuals are counted, and reproductive effort and herbivory are assessed. Notes are also made about bracted twistflower plants seen outside the study plots within the general

vicinity of the study sites. The long-term relevance of the Zippin study plots is uncertain, as seed fall in these annuals may lead to a shifting in plant localities over time. Over time efforts should be made to expand the size of the study area, to reflect both plants inside and outside the plots. In Eisenhower Park all plants are counted and reproduction and herbivory assessed. In Medina county, plants are simply counted at roadside locations.

Results to date

Travis county populations of bracted twistflower appear to be in decline. Even presuming that the Zippin plots may underestimate the overall subpopulation numbers, declines since 1993 appear severe and may approach 95%. Declining trends are so strong that the effects of rainfall are masked (see Figure). Clearly a better understanding and implementation of the management needs of this species is needed.

Trends are less apparent for the very small population in Bexar county. The population increased in response to increased rainfall in 2001. Long-term monitoring will continue to assess the effects of the deer exclosure.

Most roadside populations in Medina county were difficult to relocate until rainfall increased in 2001. Despite their reconfirmation, these populations remain vulnerable to road maintenance and development activity. Contact should be made with county road authorities. In addition, efforts should be made to locate and conserve larger populations located away from roadsides.

MONITORING PLAN FOR:
BRACTED TWISTFLOWER (*Streptanthus bracteatus*)

Goals:

1. To monitor population size and to detect long-term trends
2. To monitor the effects of deer and insects (="herbivory") on population size and reproduction
3. Other class goals?

Monitoring seasons:

1. Emergence of rosettes - January-March (optional sampling period)
2. Flowering season – late April/early May
3. Fruiting season - last week of June/first week of July (optional sampling period)

Site Locations (see attached maps):

1. Barton Creek Greenbelt - enter greenbelt at end of Scottish Woods Trail in Woods of Westlake subdivision and walk down to creek. Turn left and walk about ½ mile down trail. Plots are located on left-hand side of trail as you walk downstream. Contains 24 sample plots. Coordinate monitoring with City of Austin (Don Kolle).
2. Bee Creek - Located on City of Austin Water and Wastewater Department property. Call Anne Young (512-476-6686) to coordinate monitoring. Call Steve Hetzell or Jean Schulze (512-328-1206) at Ulrich treatment plant to check on need for permits. Sign in at treatment plant before going on site. Site is located northwest of junction of Redbud Trail with road to treatment plant. Park on left hand side of road and take loop trail to the site. Contains 15 sample plots.
3. Mount Bonnell
   -Zippin site (discontinued in 1998 due to lack of access to private land) - Park along roadside. Walk back down the road to the ornamental lamppost. Take the trail in. Turn left at main trail and right at next junction to find the site along right-hand side of trail at "Y." Contains 10 sample plots.
   -City site – Populations were reintroduced onto city park property north of stairway and along ridgetop.
4. Eisenhower Park (Bexar county) – Population is located on property boundary shared with Camp Bullis. Population was protected by deer-exclosure fencing in 2001. Coordinate monitoring with City of San Antonio (Eric Lautzenhauser).

Equipment Needed:

*small, flat plastic stakes (like ones used to identify small nursery plants)
*permanent "Sharpie"-type fine point marker
*measuring tape (in meters)
*data forms, maps, pencil, & clipboard
*small, transparent, flexible rulers
*hammer and tent stakes (if plots need to be remarked)

<u>Optional</u>

*meter stick for measuring height
*dial calipers

*insect collecting equipment (e.g. nets, vials, tweezers, ziploc bags, killing jars, aspirators)

Methods:

January-March

1. Find each plot stake; replace if missing.
2. Mark and map all individuals in the plots.
   - 2.1 use white plastic tags to number each plant
   - 2.2 place the tag in a consisent location (e.g. behind each stem)
   - 2.3 map each plant
3. Note all individuals seen outside the plots.

First week of May

1. If site was not visited in November, then perform steps 1-3 from the November methods.
2. Count all plants in plots.
3. Mark and map all new plants in plot.
4. Count missing plants in plot.
5. Optional: measure other variables (e.g. height, basal diameter, flower number, herbivory damage).
6. Map and estimate number of individuals outside the plots. (You may also set up additional plots for these individuals, but first optain permission from the City of Austin.)

Late June / early July

1. Count all plants in plots.
2. Count missing plants in plots.
3. Assess reproduction.
   - 3.1 count fruit number per plant
   - 3.2 measure the length of each frut

After each visit (or at end of project year)

1. Tally data on summary data sheet.
2. Send copy of all data sheets and maps to TPWD at:

   Texas Wildlife Watch
   Endangered Resources Branch
   3000 So. IH-35, Suite 100
   Austin, Texas 78704

Special notes:

As with any project working with herbaceous plants, be careful not to disturb the habitat or injure the plants inside or outside the sample plots. Long plants and sleeves and closed-toed shoes are recommended, as irritating plants may be present.

Questions: Call Dana Price or Marsha Reimer at 512-912-7011 or Lee Ann Linam at 512-847-9480

Bracted Twistflower Data Sheet

Site:_____

Name:	Phone 1:
Address:	Phone 2:
	Fax:
	e-mail:

		JAN/FEB/MAR	APRIL/MAY				JUNE /JULY				
		Date:	Date:				Date:				
Plot	Plant	Plant Status	Plant Status	*Height*	#	*herbivory?*	Plant Status	*Height*	#	fruit	*herbivory?*
#	#	(S,R, or A)	(R, A, or D)	*(m.)*	*flowers*	*(Y or N)*	(R, A, or D)	*(m.)*	fruit	length (mm)	*(Y or N)*

Key
S=seedling
R=rosette
A=adult with stem
D=dead or missing

Italicized sections are optional

Page _____

Mail form maps to:
TPWD
3000 So. IH-35, Suite 100
Austin, TX 78704



Figure 1. Bee Creek bracted twistflower location, Ulrich treatment facility, Austin, TX

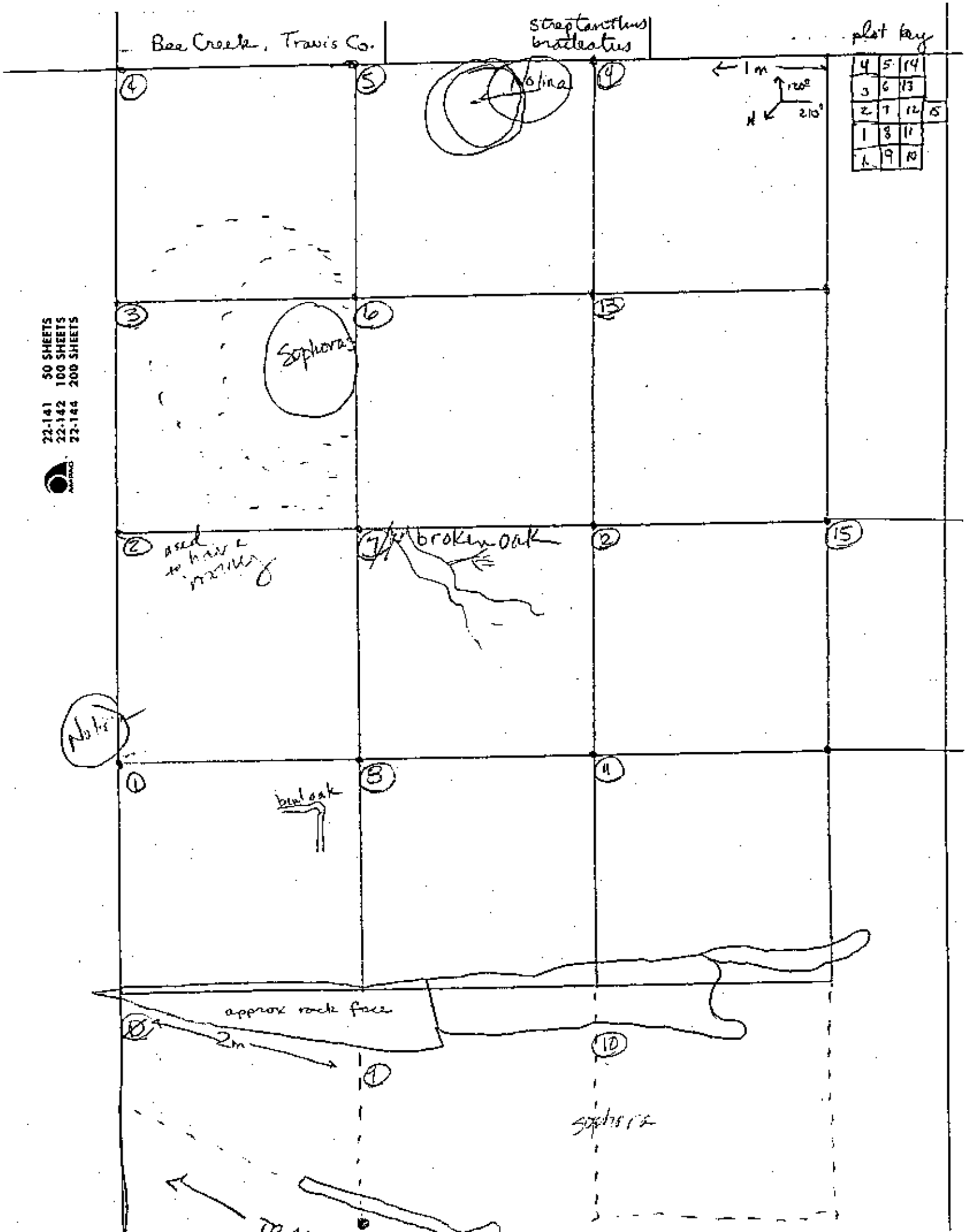
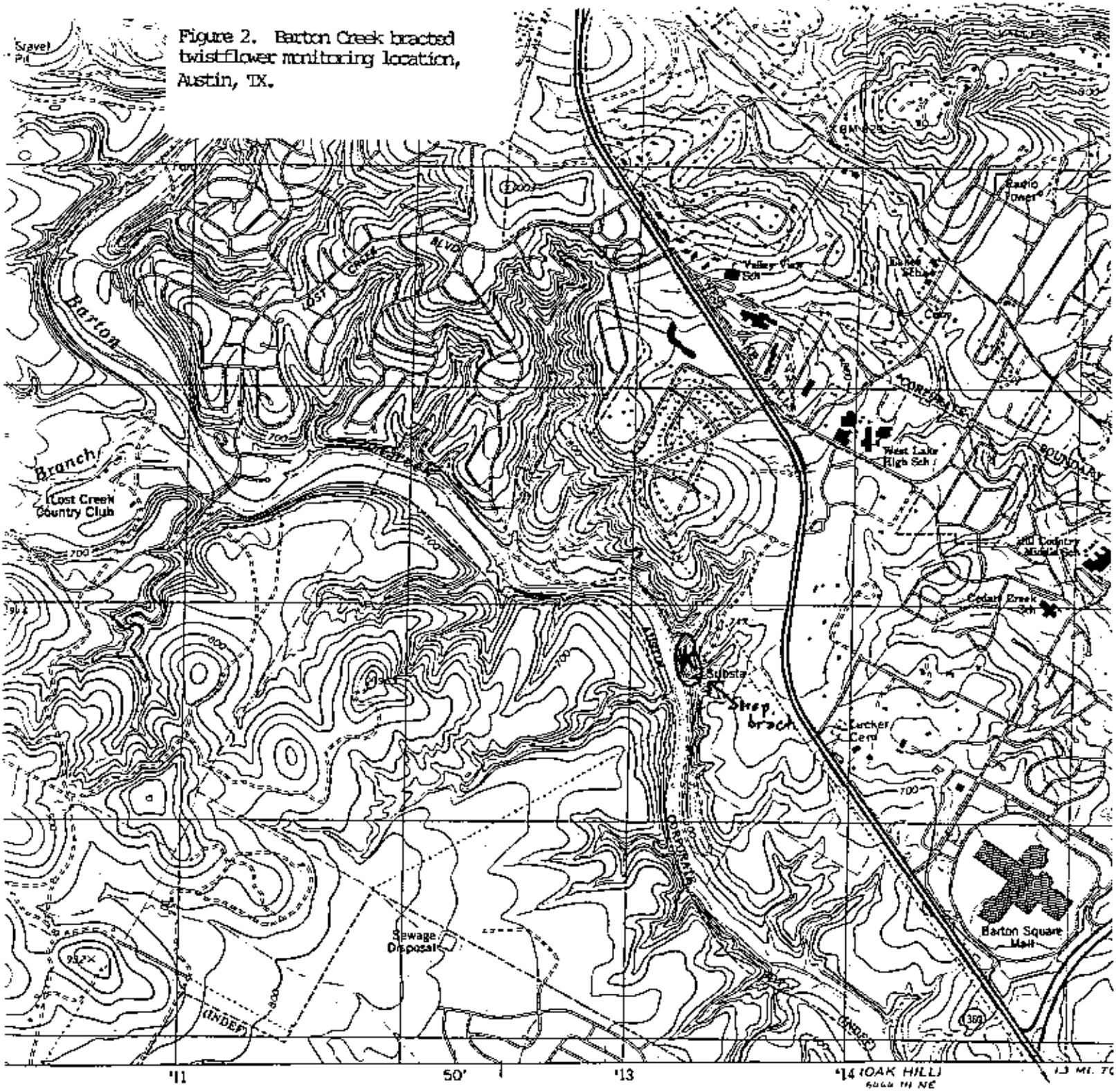

Bee Creek, Travis Co.
Streptanthus bracteatus
plot key
4 5 14
3 6 13
2 7 12 15
1 8 11
1 9 10
1 m
120°
210°
N
Nolina
Sophora
broken oak
used to have mainly
Nolina
bent oak
approx rock face
2m
sophora
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Figure 2. Barton Creek bracted twistflower monitoring location, Austin, TX.



SCALE 1:24000

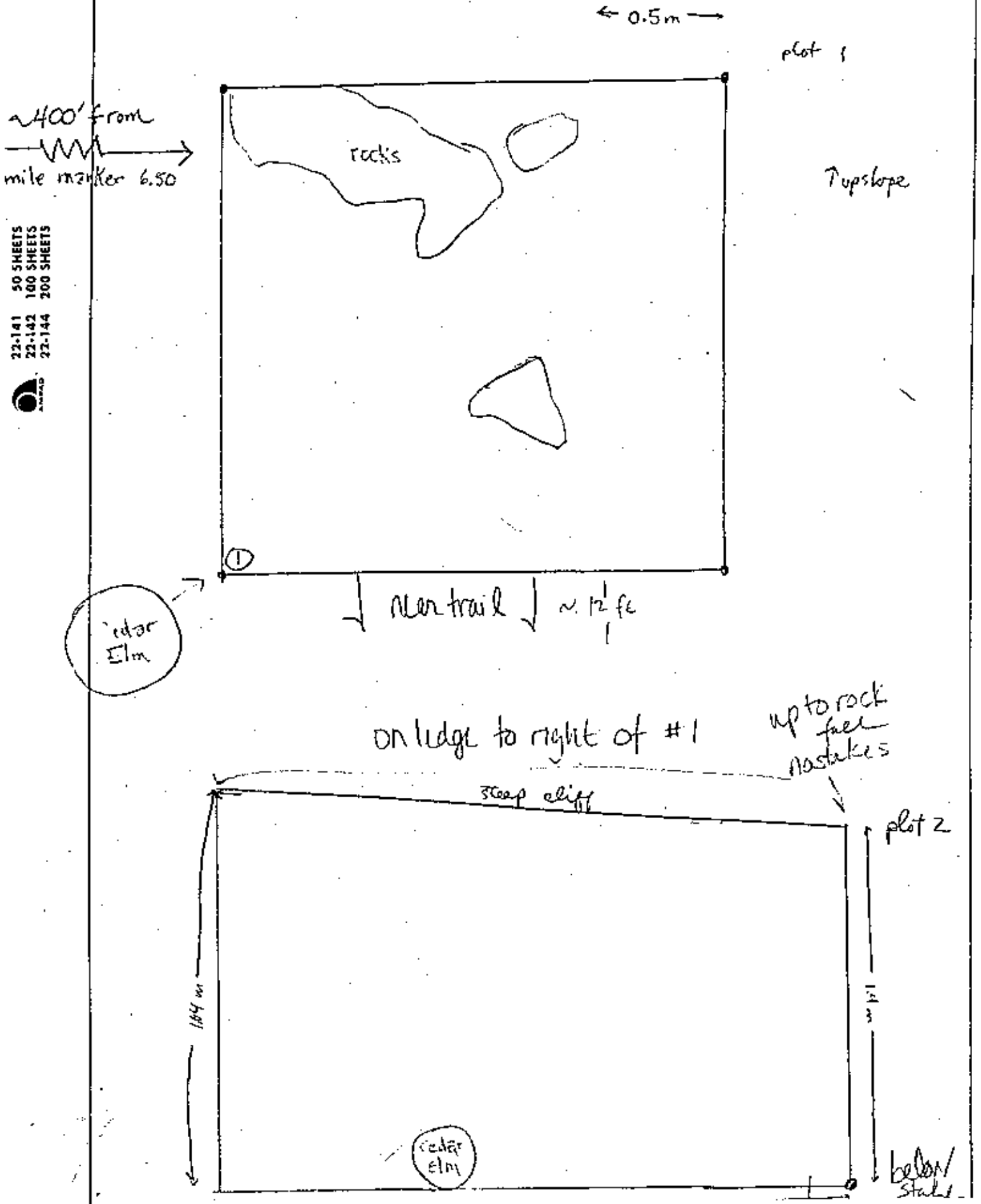
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

UTM GRID AND 1988 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
DIAGRAM IS APPROXIMATE

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDAI
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR REST
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE O

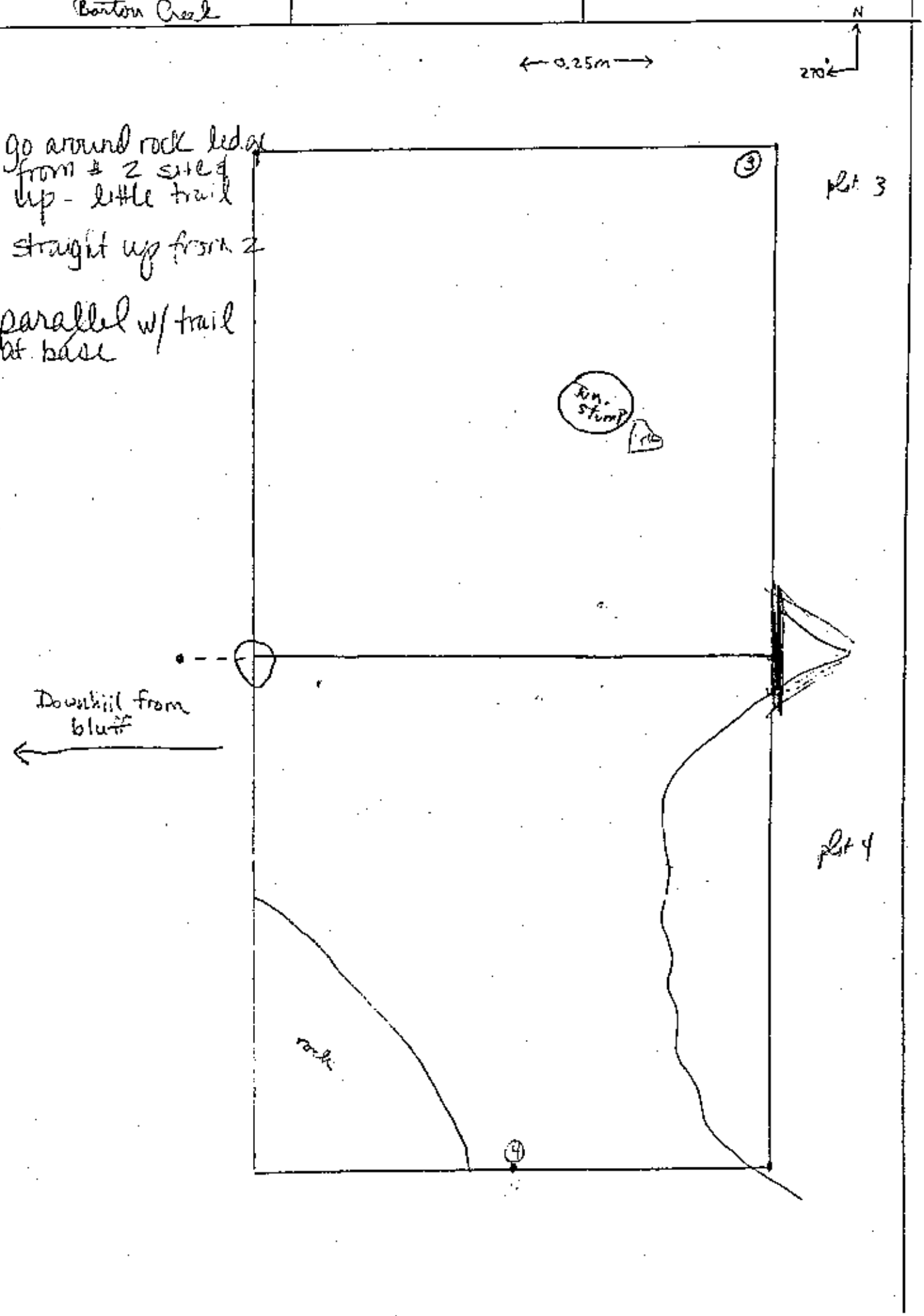
Barton Creek | Steptanthus | bracteatus

Numbers go downstream



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

Barton Creek



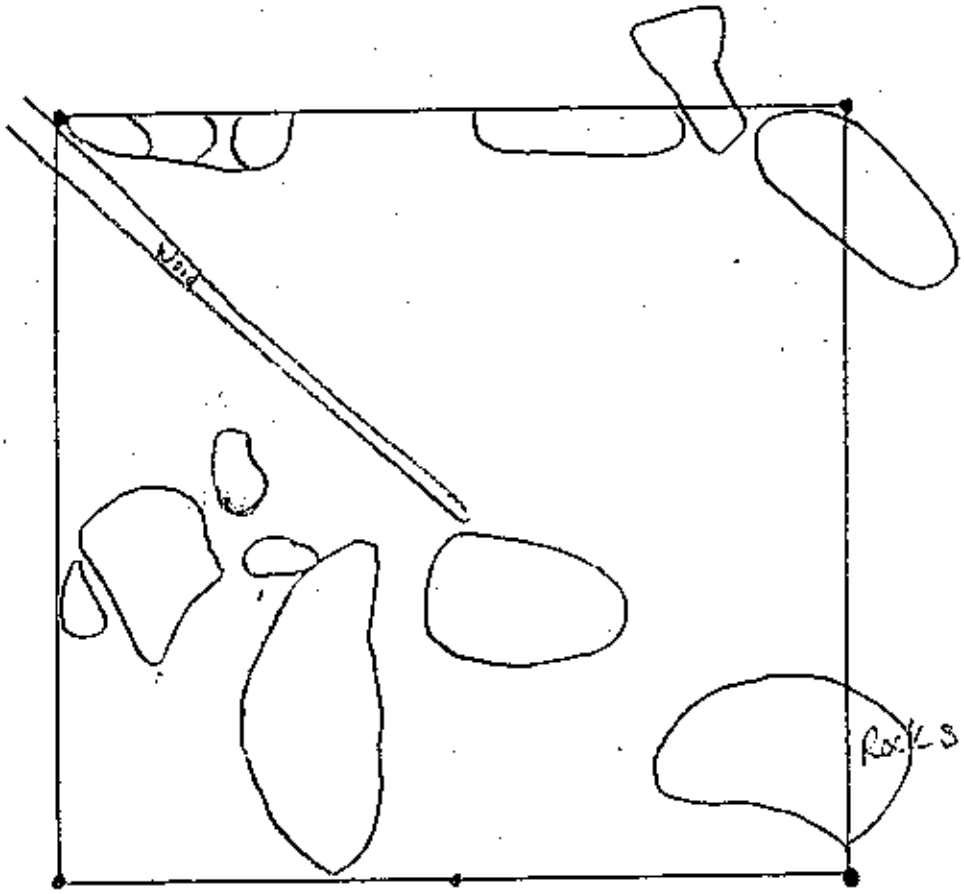
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Boston Creek

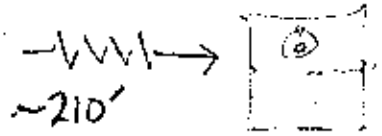


to right & upslope from 3/4

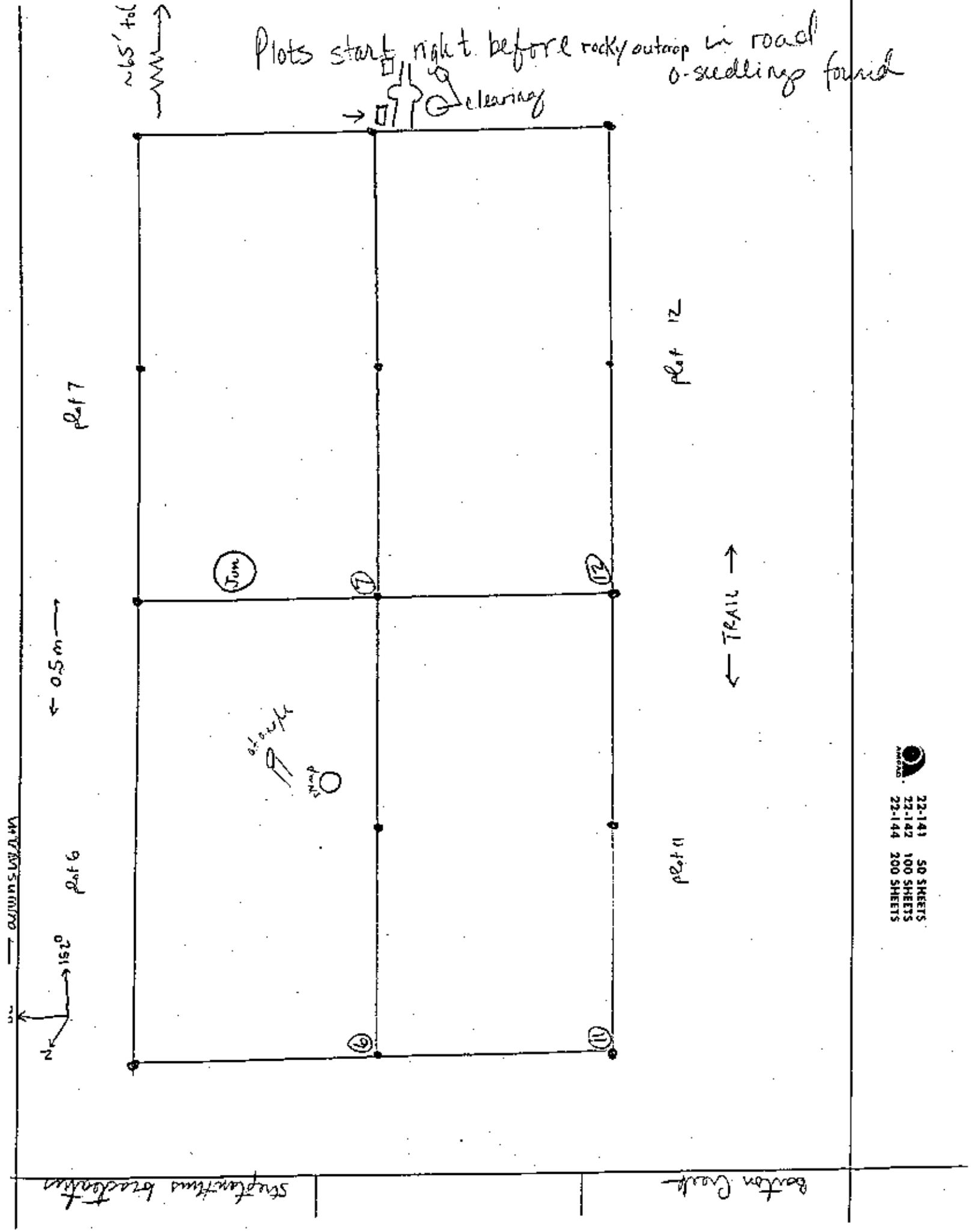
plot 5

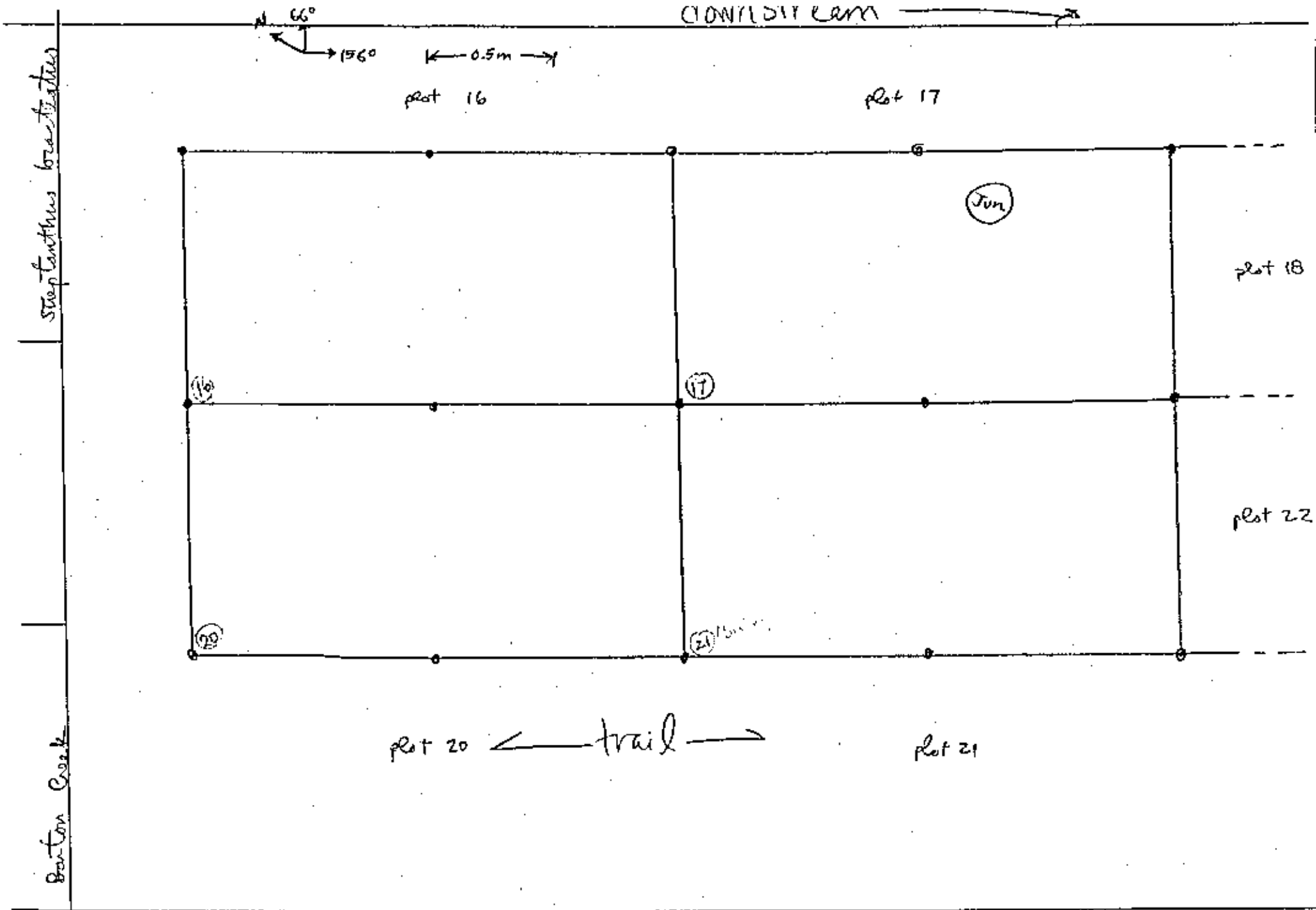


go back down to trail & walk downstream to 6

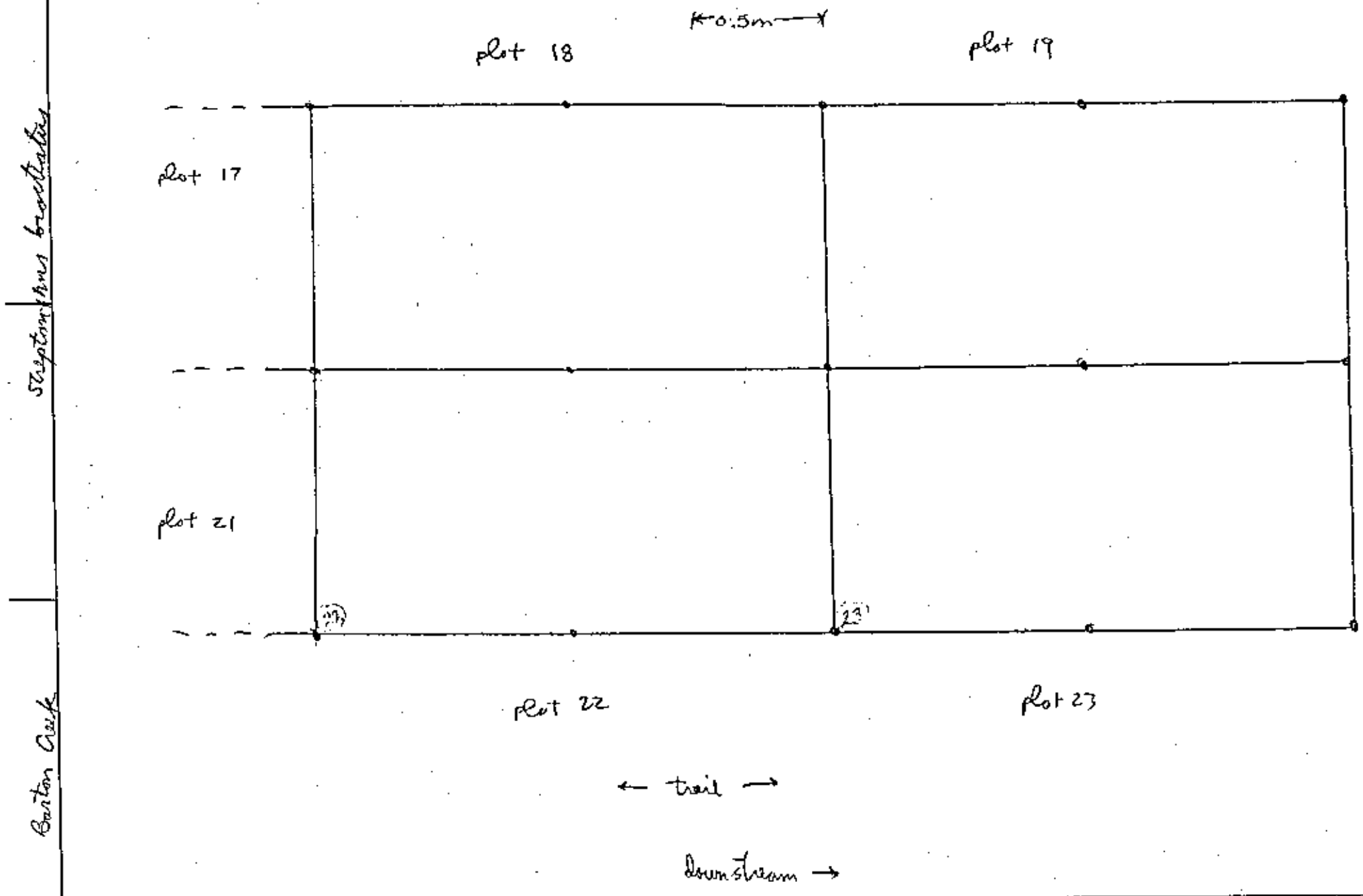


22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD


Plots start right before rocky outcrop in road
0-seedlings found
clearing
~65' to
plot 7
plot 12
plot 6
plot 11
Jun
7
12
6
11
0.5 m
TRAIL
swamp
152°
N
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



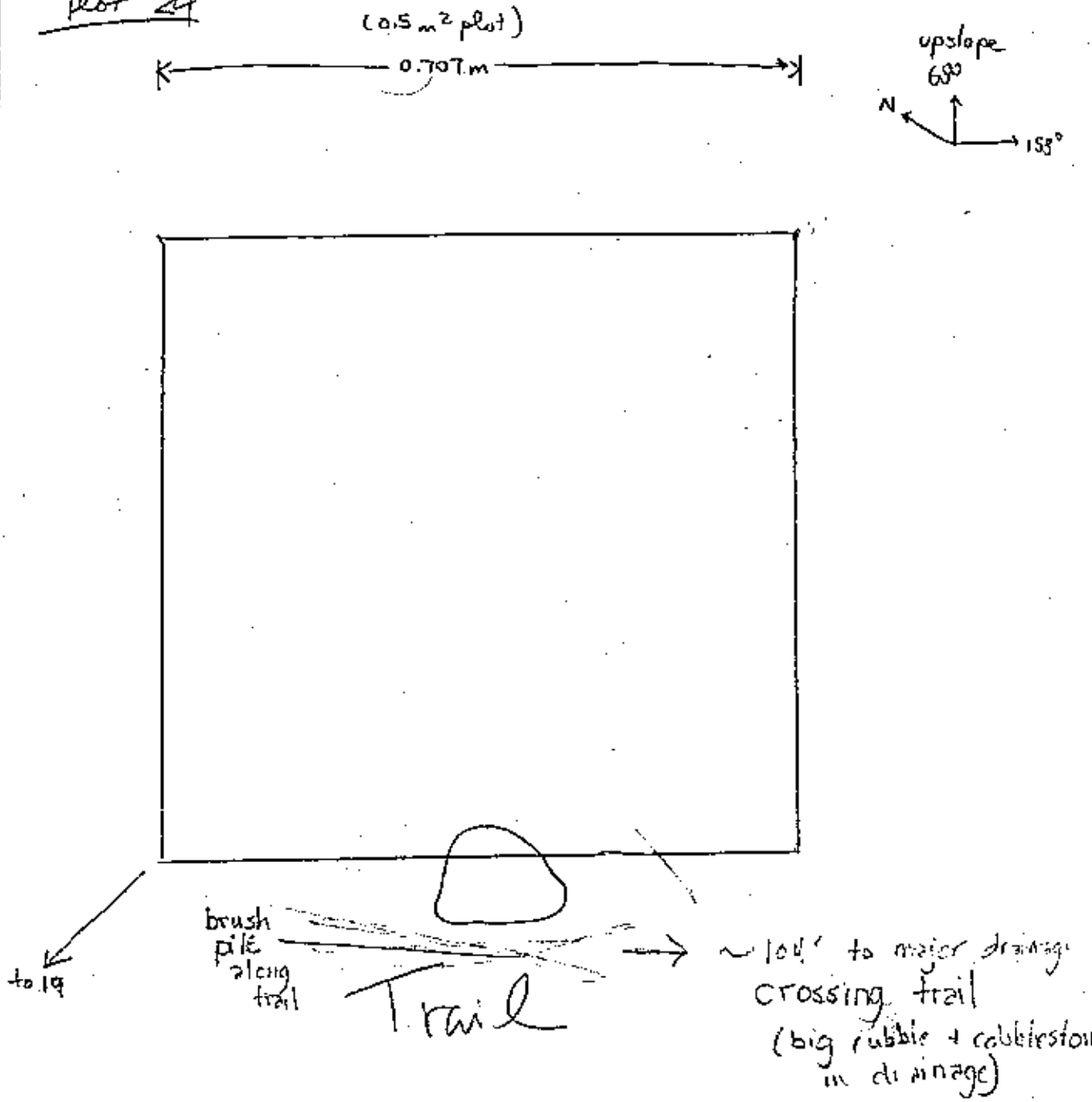
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



AMPAD
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

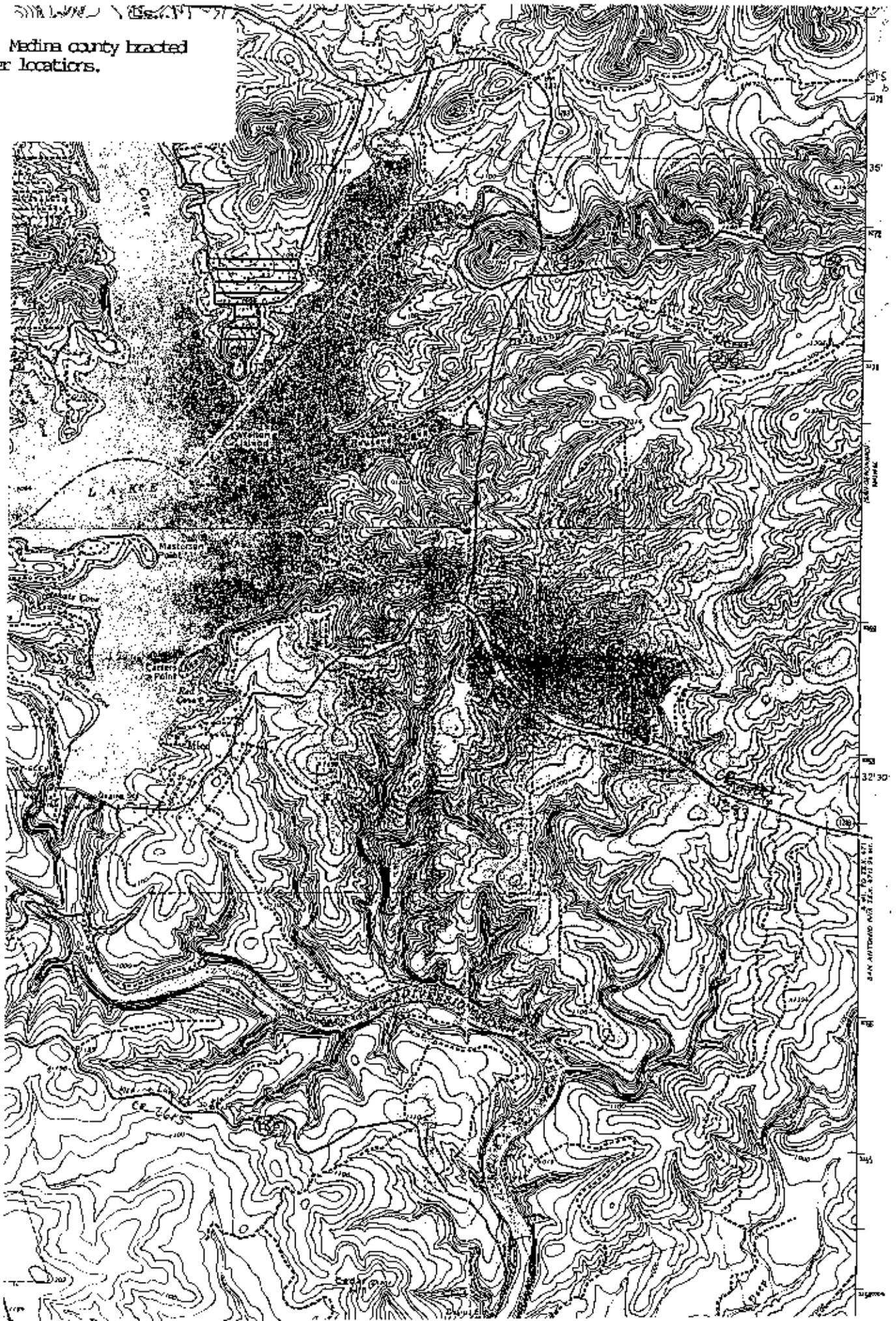
Barton Creek | | Streptanthus bracteatus

Plot 24



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Figure 3. Medina county bracted twistflower locations.



Number of bracted twistflower (*Strepthanthus bracteatus*) plants seen during spring surveys in the Texas Hill Country.

Site	1990	1991	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TRAVIS CO.									27-Apr	28-Apr	24-Apr	2-May
Barton Creek			411	373	386	62	76	47*	18	7	30	6
Bee Creek			72	32	165	3	18	37	16	1	8	2
Mt. Bonnell**			330	28	158	0	86	na	na	na	190	18
BEXAR CO.									23-Apr	4-May	1-May	1-Apr
Eisenhower Park					40			2	0	13	60	3
MEDINA CO.									23-Apr	4-May	1-May	15-May
FM 1283 ROW	many	0							0***	0***	424	10
CR2700		100+							0	0	4	1
CR 274 ROW		3							0	0	88	0
CR270-north fork		29							0	0	63	42
CR270-south fork		3							39	66	124	30
CR 2615 (EOR 18)											65	11

*Incomplete survey conducted in 1998 at Barton Creek.

**Access to historic site at Mount Bonnell denied by landowner's attorney in 1999, but reintroduced populations on City park monitored beginning in 2001.

***Site might have been overlooked

Sample methods - Travis county - Data at Barton Creek and Bee Creek are collected inside plots established by Zippin in 1993. All plants and reproductive bodies are counted. Herbivory is noted. At Mount Bonnell, data from 1993-1997 were taken in Zippin's plots. Beginning in 2001 data were taken on reintroduced populations on city property. Eisenhower Park - All plants and reproductive bodies are counted at one known population site. Nearby habitats are surveyed to search for additional populations.Medina county: Localities described in the Biological Conservation Database are visited and searched on foot. All bracted twistflower plants seen are counted. In additional roadsides are searched for flowering plants by cruising slowly.

2002 - Streptanthus numbers declined again in 2002, following a dry spring. At Barton Creek surveys outside the study plots revealed 22 plants in deer-proof exclosures and 9 other plants outside the exclosures and the plots. At Bee Creek apparent overall numbers continue to be dangerously low, with only 6 plants found in the plots. The introduced population at Mount Bonnell declined dramatically from high numbers in 2001. Populations counts were also down again in Bexar county. The impacts of the deer exclosure should continue to be monitored. Roadside populations in Medina county were present at most sites, but depressed from 2001 numbers.

Data at Barton Creek collected by L.A. Linam, M. Reimer, D. Price, M-R Holder, B. Glover, & Austin HS students. Data at Bee Creek collected by Linam, Reimer, Price, Holder, R. Furtado, & Westlake HS students. Data at Mount Bonnell collected by M-R Holder. Data at Eisenhower Park collected by Linam, D. Price, and J. Ellis. Data in Medina county collected by Linam, Price, P. McNeil, and P. Cox.

2001 - With the exception of an introduced population on the publicly-owned portion of Mount Bonnell, Streptanthus numbers on monitored plots in Travis county continue to be very depressed. At Barton Creek the species can be found outside the plots (at least 40 in 2001), especially in areas protected by deer-proof fencing. However, at Bee Creek apparent overall numbers continue to be dangerously low, with only 9 plants found in the plots and 4 plants found downslope. Browsing pressure may be a real issue for this population. Populations counts were up in Bexar county, although few of these plants set fruit apparently due to abundance of powdery mildew. This population has also recently been protected with a deer-proof fence as part of an Eagle Scout project. Favorable rainfall during the winter and early spring contributed to a rediscovery of Streptanthus at many historic sites in Medina county. While some populations were abundant this year, these roadside populations remain vulnerable to habitat change.

2001 Data at Barton Creek collected by L.A. Linam, A. Miller, M-R Holder, B. Glover, & Austin HS students. Data at Bee Creek collected by Linam, Miller, Holder, & Westlake HS students. Data at Mount Bonnell collected by M-R Holder on May 2-4, 2001. Data at Eisenhower Park collected by Linam, Miller, D. Price, and J. Ellis. Data in Medina county collected by Linam, Miller, and Price.

2000 - Populations in Travis county continue to be very depressed, likely due to the effects of two back-to-back winter droughts. Some decline in the numbers may be due to geographic shifts in these slope-side populations over time, as several bracted twistflower were seen outside the study plots on Barton Creek. Efforts will be made to count all Streptanthus in the vicinity in future years. Monitoring efforts are too young to predict trends in Bexar and Medina county, although the lack of twistflowers on historic sites in Medina county is worrisome. Local effects of habitat degradation, herbivory, and/or drought should point to concern for this species at all these monitoring sites.

Data at Barton Creek collected by L.A. Linam, A. Miller, M-R Holder, P. Maher, & Austin HS students. Data at Bee Creek collected by Linam, Miller, Holder, P. Pellerin, & Westlake HS students. Data at Eisenhower Park collected by Linam, Miller, M. Kennedy, & Eric Lautzenhauser. Data in Medina county collected by Linam, Miller, & M. Stiles.

1999 - Populations at all monitered sites fell in 1999 as rainfall was below average once again. An attempt was made to monitor several historic populations on roadsides in Medina county, but only one population was successfully relocated. Attempts should be made in subsequent years, however, due to the poor germination conditions in 1998-99.

Data at Barton Creek collected by L.A. Linam, A. Miller, P. Maher, & Austin HS students. Data at Bee Creek collected by Linam, Miller, Holder, P. Pellerin, & Westlake HS students. Data at Eisenhower Park collected by Linam, Miller, M. Kennedy, & Eric Lautzenhauser. Data in Medina county collected by Linam, Miller, & M. Stiles.

1998 - Surveys were not thorough at all sites during 1998, but some climatic effects seemed to be evident nevertheless. The winter of 1997-98 had abundant rainfall, but, beginning in late March, the Texas Hill Country experienced a severe drought that continued through late August. Both the Bee Creek and Barton Creek sites had a good abundance of rosettes in February. The Bee Creek site went on to have fairly good flower production, but when the Barton Creek site was visited in late May few flowering or fruiting twistflowers were found. The first year of volunteer monitoring at Eisenhower Park may have relected an even more dramatic effect from the drought, as only two small plants were found in April. By early May these two plants were nearly dead.

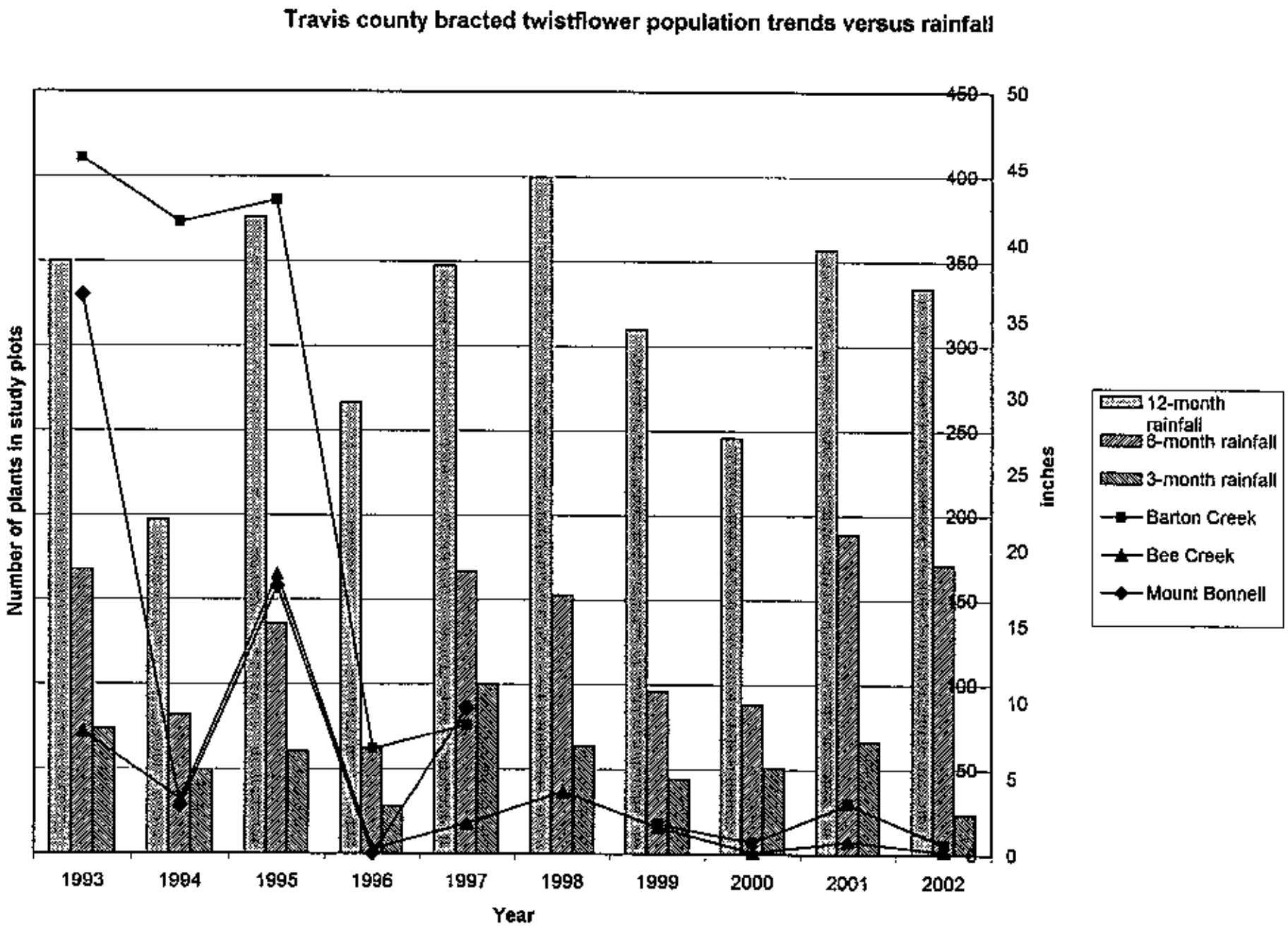
Data at Barton Creek collected by L.A. Linam, A. Miller, & Austin HS students. Data at Bee Creek collected by Linam, Miller, & Westlake HS students. Data at Eisenhower Park collected by Linam, Miller, M. Kennedy, & D. Bruns.

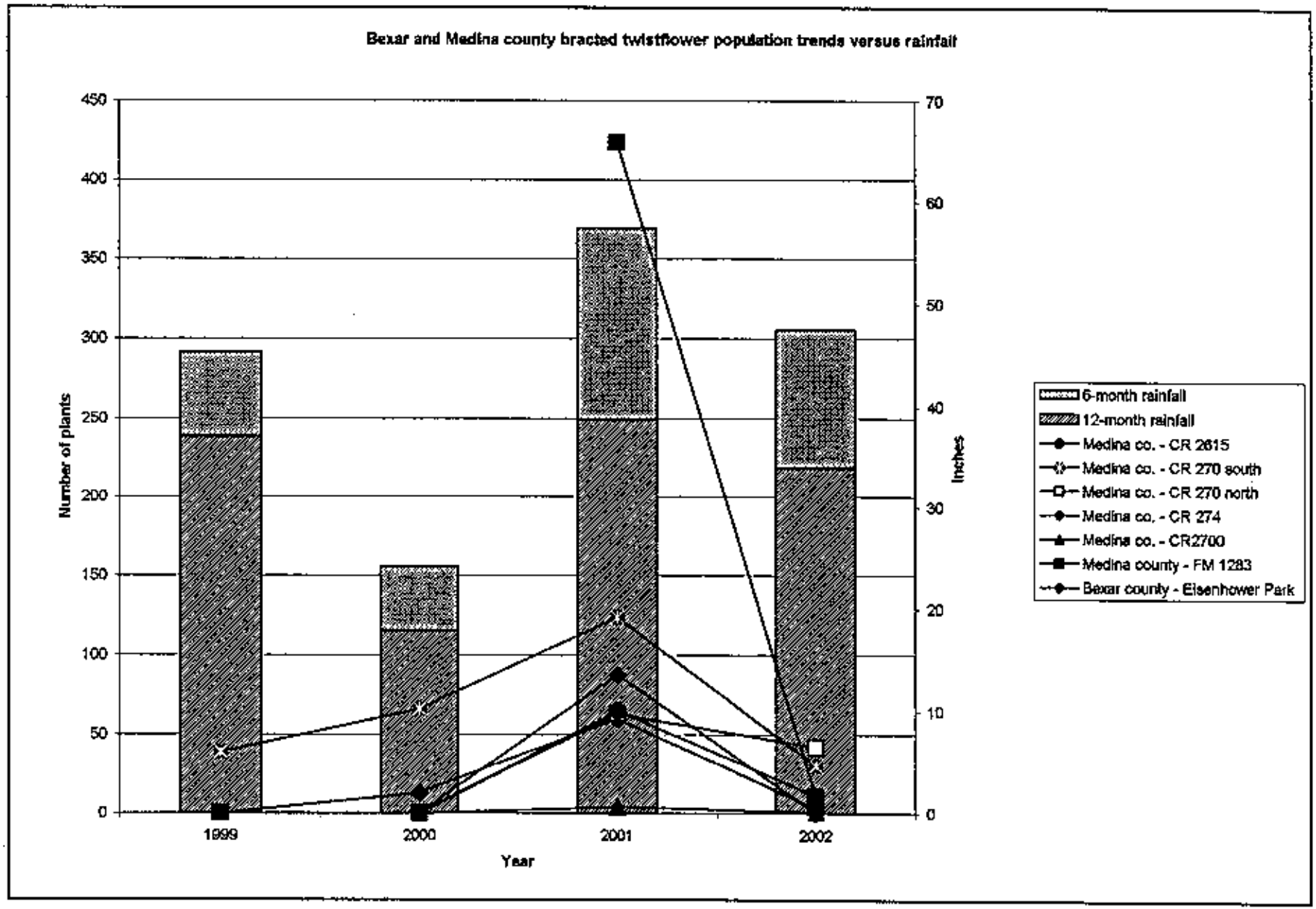
1997 - J. Lariviere and student volunteers from Wetlake High School assisted TPWD in monitoring the bracted twistflower at Barton Creek, Mount Bonnell, and Bee Cree during the first week of May, 1997. All three populations rebounded somewhat from the very poor year in 1997, but were still far below historical counts, perhaps due to poor seed porduction in 1996. Students also noted several other substantive populations at the Mount Bonnell site.

Summary statistics for intensive bracted twistflower monitoring, 2002.

Site name	Barton Creek*	Bee Creek	Eisenhower Park	Mount Bonnell Park	TOTALS
sample date	2-May-02	2-May-02	1-Apr-02		2002
total area in plots (sq.m.)	37.54	84	unknown	unknown	na
# plants seen	2	8	3	18	29
# plants/sq. m.	0.05	0.09	unknown	unknown	na
# plants with buds-flowers-fruit	1	5	not available	17	6
% of plants with b-f-f	50	83	na	94	21
total # buds-flowers-fruit	3	16	not available	91	19
avg. # b-f-f/flowering plant	3	3.20	na	5.35	3.17
# plants with herbivory	1	3	not available	1	4
% of plants with herbivory	50	50	na	6	14

*An additional 31 plants were seen outside the study plots at Barton Creek


Travis county bracted twistflower population trends versus rainfall
Number of plants in study plots
inches
Year
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
450
400
350
300
250
200
150
100
50
0
50
45
40
35
30
25
20
15
10
5
0
12-month rainfall
8-month rainfall
3-month rainfall
Barton Creek
Bee Creek
Mount Bonnell


Bexar and Medina county bracted twistflower population trends versus rainfall
Number of plants
Inches
Year
1999
2000
2001
2002
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
50
60
70
6-month rainfall
12-month rainfall
Medina co. - CR 2615
Medina co. - CR 270 south
Medina co. - CR 270 north
Medina co. - CR 274
Medina co. - CR2700
Medina county - FM 1283
Bexar county - Eisenhower Park

Houston meadow-rue
Thalictrum texanum





Summary Report
Volunteer monitoring of Houston meadow-rue (*Thalictrum texanum*)

Status of project

TPWD staff (L. Linam) began exploring the possibility of monitoring this species in 1999, when a visit to two sites in Brazos and Grimes counties was made with W.R. Carr (see attached report). At both locations the species is a common groundcover where it occurs. While some educational materials were prepared for a monitoring package, volunteers failed to participate during scheduled visits in 2000 and no monitoring protocol has yet been written. A draft datasheet has been developed, designed to test a line-intercept approach to monitoring. Such an approach might be suitable for an ecology class at Texas A&M University. In addition, Carr suggested that monitoring of woody encroachment through the use of aerial photography may prove useful.

Thalictrum texanum (Texas [=Houston] meadow-rue)

Buttercup family (Ranunculaceae)

TX only - Brazos, Harris (H), Waller counties

DESCRIPTION: Small, inconspicuous perennial, 30 cm (1 foot) or less tall. Roots tuberous. Leaves alternate, pinnately compound, long-petioled. Leaflets thin, about 1 cm long as well as wide, usually tri-lobed at tip. Flowers unisexual, staminate flowers with anthers equal to or longer than filaments. Fruit is an achene with 6-8 nerves. Flowering March-July (?).

HABITAT: Appears to be moist post-oak woodland, in partially shaded, damp, sandy soils. Habitat may be generally similar to that of *Spiranthes parksii*.

REDISCOVERY OF *HYMENOXYS TEXANA* AND NOTES ON TWO OTHER TEXAS ENDEMICS—Three endemic species were described prior to 1900 from low prairies near Houston, Texas. The specimens were collected by Charles Wright in the 1840's, Elihu Hall in 1872, and Houston's own resident botanist, F. W. Thurow, in 1889-90 and 1897 (actually resided in Hockley during that period).

Charles Wright taught at Rutersville College (near La Grange, Texas) in 1845 and 1846. The college and town of Rutersville no longer exist. Evidently, Wright traveled and collected along the road from near La Grange to Houston. He had previously visited Columbus, Texas in 1844 where he had relatives. According to Geiser (1937), Wright returned to Cambridge and spent the winter of 1848–49 helping Asa Gray sort out Wright's Texas collections. In 1849, Gray described one of Wright's collections as *Aplopappus aureus* Gray (Pl. Fendl., Mem. Amer. Acad. N.S. 4: 76, *Wright s.n.*, GH), the species now known as *Machaeranthera aurea* (Gray) Shinners, (Field & Lab. 18: 41. 1950).

F. W. Thurow lived in Hockley and collected plants in the 1880's and 1890's. He came from the Black Forest area in Germany when he was 12 years old and lived in Hockley for 43 years. His last 8 years were spent in Houston (Vines & Thurow, 1964). He collected *Machaeranthera aurea* in 1897 near Hockley (Fig. 1). He also collected *Hymenoxys texana* (Coulter & Rose) Cockerell in 1889-1890, a new species that was described by Coulter & Rose in 1891 (as *Actinella texana*; Bot. Gaz. 16: 27; *Thurow s.n.*, *Palmer 742*; Fig 2). Of it, Correll & Johnston (1970) state "Rare in sandy soils near Hockley and Houston, Harris Co., probably extinct (no known collections after 1900), Mar–Sep; endemic."

In 1872, Elihu Hall collected 861 specimens of plants in east Texas (Geiser, 1937). In his publication "Plantae Texanae" in 1873, he listed *Thalictrum debile* Buckl. var. *texana* Gray without a description (Fig. 3). Since this name is apparently a nomen nudum, the author citation refers to Gray's treatment in the Synoptical Flora of North America (Robinson, Editor, Volume 1, pt. 1, fasc. 1, p. 18. 1895) where Hall's publication, specimen (as occurring in moist prairies about Houston), and name as a variety are cited. Small (1903) elevated the taxon to the rank of species.

Transect no:_____ Date:_____ Monitors:_____

Feet from ditch	Thalictrum hit?	Canopy @ 3-6'?	Canopy @ >6'?		Feet from ditch	Thalictrum hit?	Canopy @ 3-6'?	Canopy @ >6'?
1					51			
2					52			
3					53			
4					54			
5					55			
6					56			
7					57			
8					58			
9					59			
10					60			
11					61			
12					62			
13					63			
14					64			
15					65			
16					66			
17					67			
18					68			
19					69			
20					70			
21					71			
22					72			
23					73			
24					74			
25					75			
26					76			
27					77			
28					78			
29					79			
30					80			
31					81			
32					82			
33					83			
34					84			
35					85			
36					86			
37					87			
38					88			
39					89			
40					90			
41					91			
42					92			
43					93			
44					94			
45					95			
46					96			
47					97			
48					98			
49					99			
50					100			

3009652

Notes on a Visit to the Lick Creek Park, Brazos County, Texas, 13 April 1999

William R. Carr
The Nature Conservancy of Texas

One 13 April 1999 I visited Lick Creek Park in the company of Lee Ann Linam of the Texas Parks and Wildlife Department. The goal of this visit was to re-locate two populations of Houston meadow-rue (*Thalictrum arkansanum*) reported from the park by Dr. Hugh Wilson and others from the Biology Department at Texas A & M University in College Station. Ms. Linam was investigating the possibility of establishing some kind of monitoring project at either or both sites.

Houston meadow-rue populations

One of the populations (suboccurrence A) had previously been examined by Dr. Jim Manhart and myself back on 17 March 1992 (Carr, 1992). We re-located this population using the 1992 map without too much difficulty, although brush in the clearing described had grown up considerably during the seven intervening years. This population is still small and is now threatened by shading from shrubs and saplings.

The second population (suboccurrence B) is of more recent discovery and was examined (by me) for the first time today. It is considerably larger and more viable, consisting of several hundred plants in grassy areas along the margins of a post oak woodland. This habitat is similar to that of the Houston meadow-rue occurrence at the property of Gail Allen in Grimes County. The Allen occurrence is A-ranked, and in my opinion it demonstrates at least one kind of "optimal" habitat. Since suboccurrence B at Lick Creek Park is in similar habitat, one might guess that it is the more defensible long-term. To find suboccurrence B, locate a drainage ditch in an open field in the southwestern quarter of the park. This ditch is oriented southwest-northeast; a compass bearing parallel to its length was 54-55°. The Houston meadow-rue population (suboccurrence B) lies on the southeast (i.e., ditch-side) margin of a strip of post oak woodland roughly parallel to and immediately northwest of this ditch.

Note that one specimen was collected (Carr & Linam 18084, TEX-LL). The roots on this specimen were a dirty yellow color when fresh, i.e., not black as described in Correll & Johnston (1970), and the stems were decumbent rather than erect. In both of these characters these plants (and those at the Allen site) are essentially indistinguishable from the specimens of *Thalictrum arkansanum* observed at Lennox Woods and adjacent John Hancock property earlier this year (see Carr 17991, Carr 17993, Carr 17995, Carr 17996, all at TEX-LL). Correll & Johnston (1970) also noted a difference of stigma lengths in the two taxa; since I do not have the proper equipment necessary to accurately measure units of 0.1 millimeter I have not attempted to examine this purportedly distinguishing character on any of the plants in the populations I've visited this year. It certainly seems to me that plants of both the Allen and Lick Creek Park populations key more readily to *Thalictrum arkansanum*, but I also wonder if anyone has seen anything that conforms precisely to the descriptions of *Thalictrum texanum*. For the time being

I've chosen to continue to discuss the two entities as distinct based on geographical separation if nothing else, with *Thalictrum arkansanum* being restricted to extreme northeast Texas and what everyone calls *Thalictrum texanum* being found in the Houston - to - College Station area of southeast Texas.

Additional notes on deciduous forest vegetation

While hiking to the two meadow-rue sites, I made some notes regarding a plant community that might not be represented in the current national vegetation classification. These notes could be added to those from the 1992 visit (Carr, 1992) and compared to those of other similar sites-- if and when access is gained-- in order to write up a description of some kind of water oak - cedar elm forest.

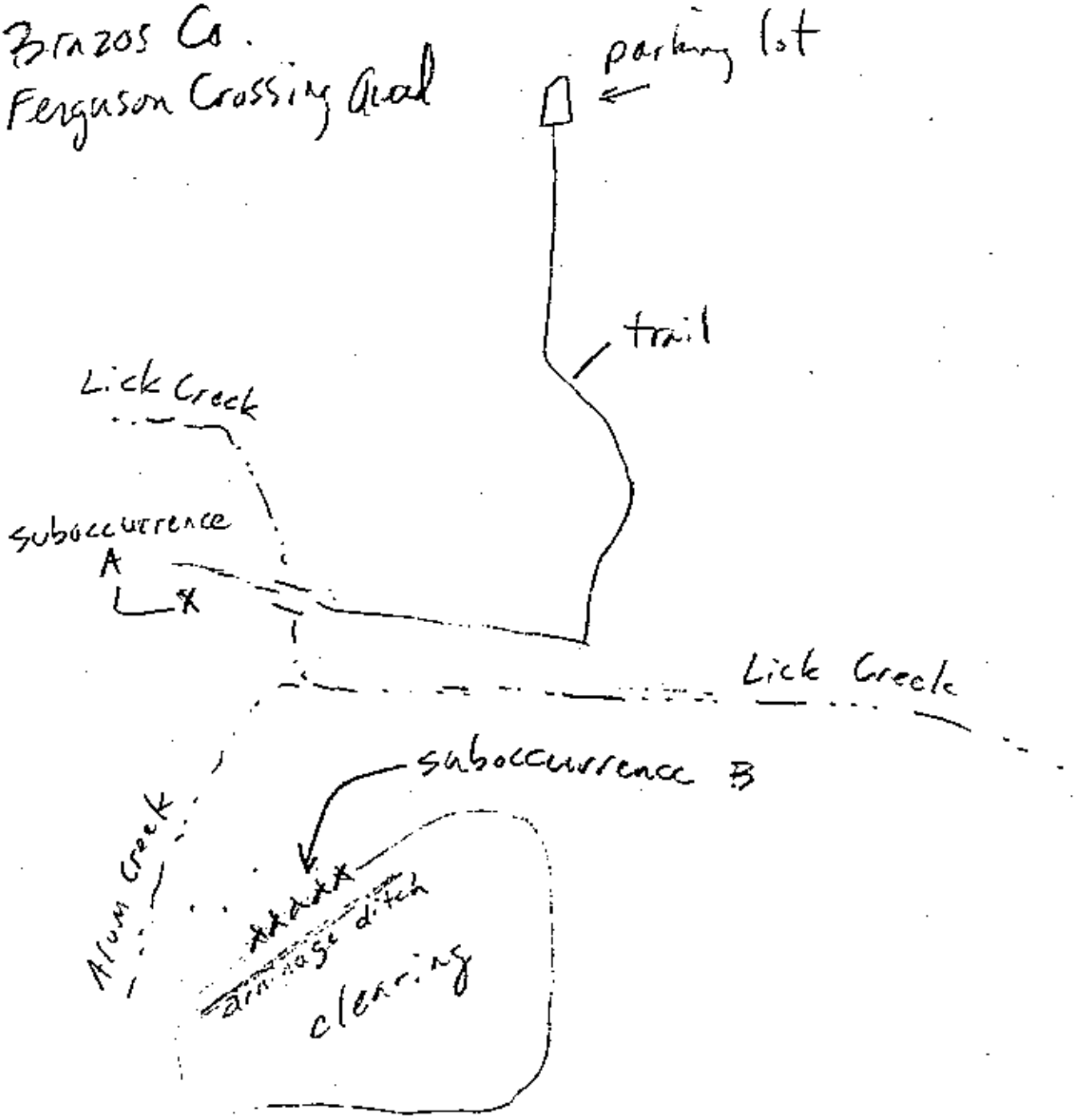
Vegetation of terraces along the major creeks within Lick Creek Park is a bottomland deciduous forest dominated by water oak (*Quercus nigra*) and cedar elm (*Ulmus crassifolia*). American elm (*Ulmus americana*) and a few post oak (*Quercus stellata*) are present but less common. Larger individuals of these tree species form a closed canopy at 60-70 feet. Most areas have a poorly developed subcanopy composed mostly of slightly smaller cedar elms. Oddly, sugar hackberry (*Celtis laevigata*) seems to be rare. The shrub layer is generally dense, dominated by yaupon (*Ilex vomitoria*), with American beautyberry (*Callicarpa americana*) a frequent associate. In some areas this shrub layer is fairly tall, often capping out at 10 feet or more. Vines such as greenbriar (*Smilax bona-nox*), trumpet creeper (*Campsis radicans*) and a grape (*Vitis* sp.) are occasional in this layer. The ground layer is fairly continuous and dominated, at least seasonally, by Cherokee sedge (*Carex cherokeensis*). Numerous other caric-sedges, (*Carex* spp.), grasses and forbs are present, but time did not allow a thorough investigation. Some frequently-encountered species include *Allium canadense* var. *canadense*, *Trepocarpus aethusae*, *Festuca obtusa*, *Stipa avenacea*, *Salvia lyrata*, *Myosotis macrosperma* and *Verbesina virginica*. See Carr (1992) for additional notes on this vegetation.

Literature Cited

Carr, W. R. 1992. Notes on Houston Meadow-Rue occurrence 011 at Lick Creek County Park, Brazos County, Texas, 17 March 1992 (F92CAR01). Unpublished report, Texas Natural Heritage Program, Texas Parks and Wildlife Department.

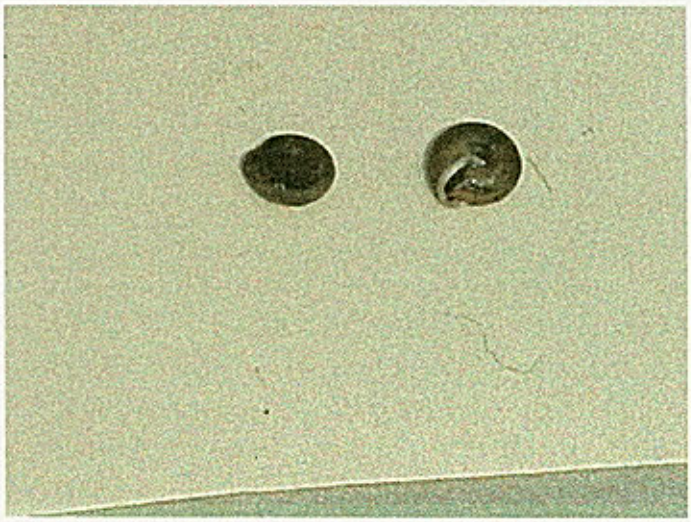
Correll, D. S. and M. C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner. 1881 pp.

Thalictrum texanum on
Lick Creek Park
Brazos Co.
Ferguson Crossing Quad



Palmetto pill snail (*Euchemotrema cheatumi*)







Volunteer survey efforts for Palmetto pill snail, Palmetto State Park, Luling, Texas





Microhabitat where snails were found.



This is prime habitat for the Palmetto Pill Snail. Note red pencil in picture is where Lee Ann located a Palmetto Pill Snail.

Now in the third year of monitoring for Palmetto Pill Snails at Palmetto State Park, the data is beginning to indicate that the primary habitat of the snails is within 5 feet of the water's edge.



Summary Report
Volunteer monitoring of palmetto pill snail (*Euchemotrema cheatumi*)

Status of project

Texas Nature Tracker volunteers began monitoring the single known population of the species at Palmetto State Park (Gonzales county) in 1999. Data has been gathered consistently on an annual basis since that time.

Volunteer involvement

Volunteer commitment to this site has been strong and involves a biology teacher at Luling High School (Melba Sexton), her 4-H club members, and several faculty members from Austin Community College. The techniques—using a 0.1 m^2 quadrat along modified transects—have proved workable for the students, who range in age from approximately 10-17. However, due to the small size of the distinguishing features of the species, it is desirable to have a biologist familiar with its identification confirm each sighting. Nevertheless, the presence of 10-20 volunteers greatly increases the sampling efficiency.

Monitoring methods

Methods are described in the attached protocol. The species is fairly rare, and strictly random sampling results in very low encounter rates. As a result, some modification of sampling techniques was made in 2002, in order to sample more intensively within five feet of the water's edge. In the future, it would be desirable to sample nearby wetlands in order to confirm the species' presence or absence at other wetlands within the park.

Results to date

The species is fairly rare, with only 23 live specimens having been encountered in 195 quadrats sampled. Modified sampling in 2002 did reveal that the species was more likely

to be encountered within 5' of the water's edge. In addition, wild onion and wild iris were often reported from successful quadrats—suggesting that there may be some association between this species and Liliaceae plants. More detailed habitat data from within quadrats will be collected in the future.

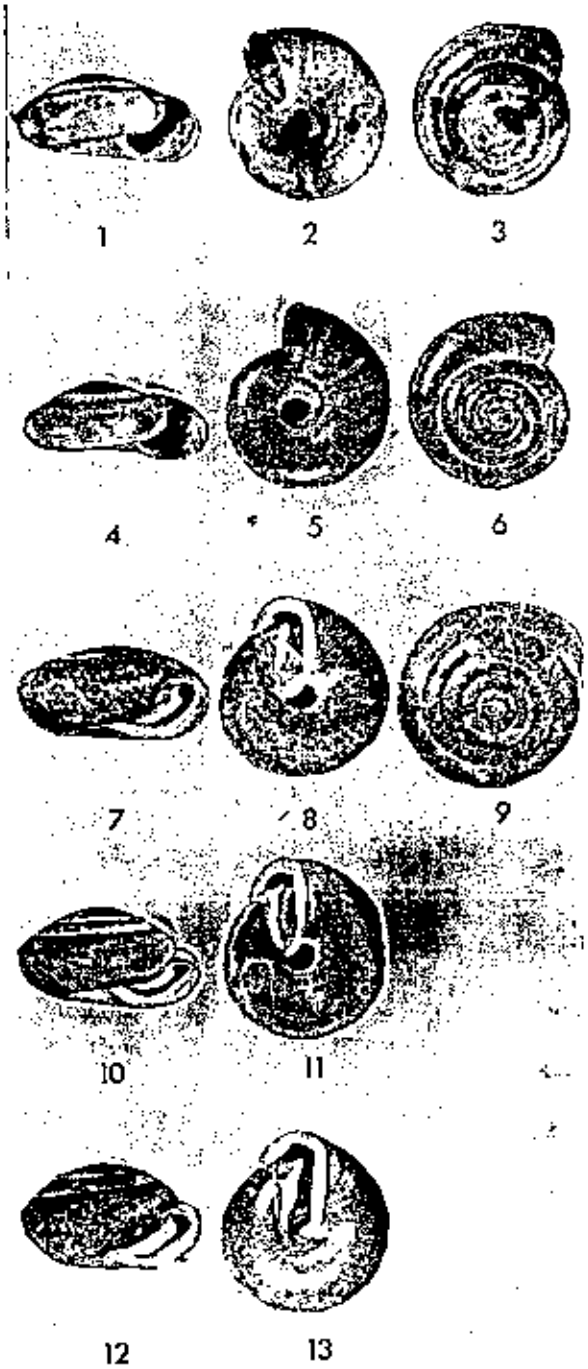


FIG. 1-3, Zonitoides arboreus (Say); x 4.3; FIG. 4-6, Zonitoides kirbyi n. sp.; x 3.8; FIG. 7-9, Stenotrema leai cheatumi n. subsp.; x 2.6; FIG. 10-11, Stenotrema leai leai (Binney); x 2.2; FIG. 12-13, Stenotrema leai aliciae (Pilsbry); x 2.9.

whorls, are more subdued. The umbilicus is contained approximately 3.2 times in the shell diameter. The whorls are well-rounded, the aperture is ovoidal and the peristome is thin. Measurements in mm. of holotype: diameter: 6.3; height: 3.4; aperture height: 2.04; aperture width: 1.53.

Holotype: No. 3286 Dallas Museum of Natural History; paratypes in Delaware Mus. Nat. Hist. No. 72862; paratypes will be deposited in the National Museum of Natural History, Carnegie Museum, Museum of Comparative Zoology, Academy Natural Sciences of Philadelphia, and the Museum of Zoology, University of Michigan. Type locality: Schulze Cave, Edwards Co., Texas, July 25, 1972.

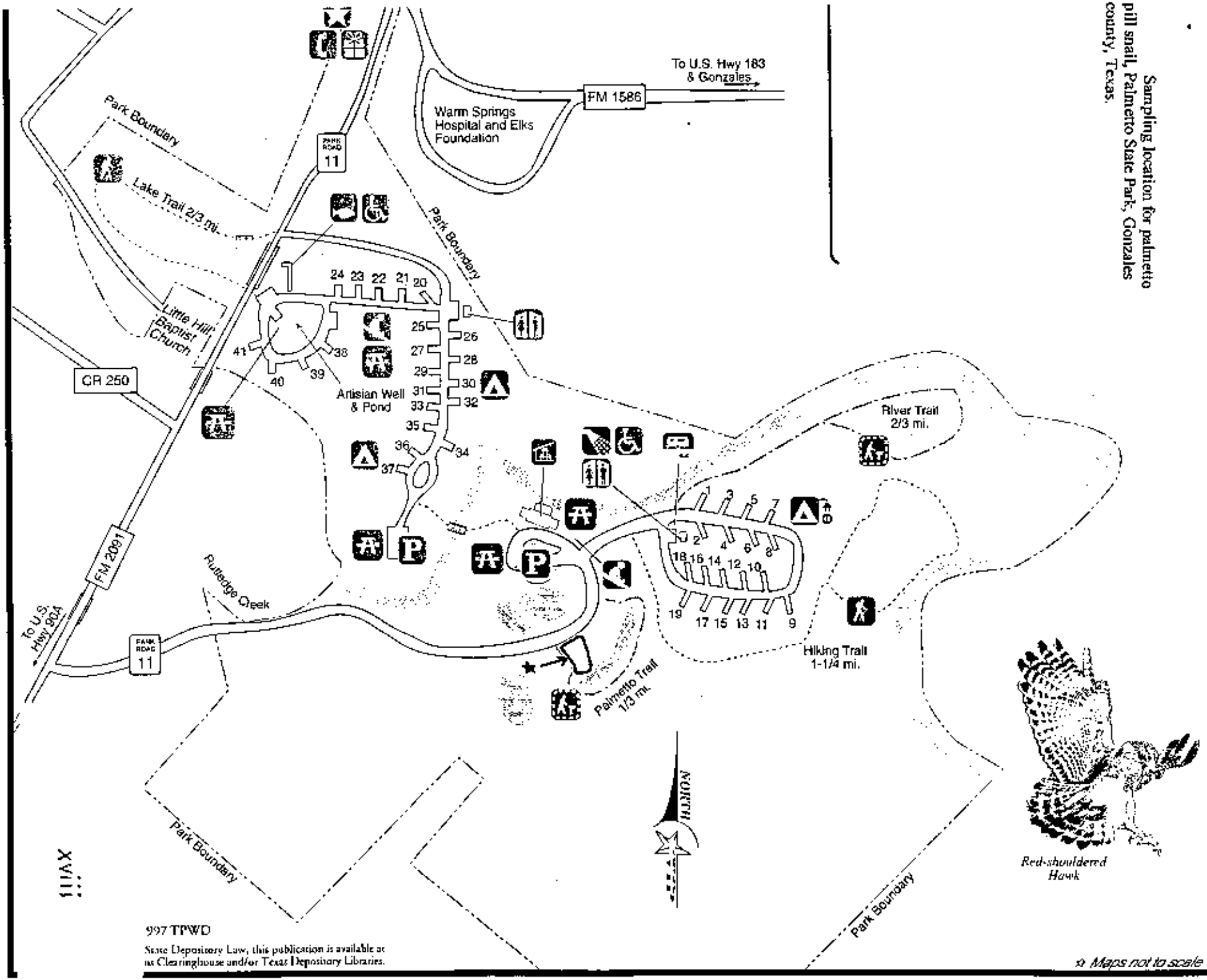
Discussion — *Zonitoides kirbyi* is most closely related in form to *Zonitoides arboreus* (Say) (figs. 1-3), but differs in several respects. *Z. kirbyi* is much larger and glossier with less distinct growth lines. It also has a much larger umbilicus which abruptly expands in the last whorl. The aperture is very ovately-lunate and not deeply rounded as in *Z. arboreus*. *Zonitoides arboreus* abounds in the area immediately surrounding the cave and only dead shells were found inside the cave. *Z. kirbyi* (live & dead shells) is found only in the cave. It appears that *Z. kirbyi* may be a form of *Z. arboreus* that has been microgeographically isolated long enough to become a separate species.

Stenotrema leai cheatumi *new subspecies*
Figs. 7-9

An undescribed polygyrid was collected by Dr. E. P. Cheatum and myself in Palmetto Park at Ottine, Gonzales County, Texas, on November 11, 1971. The locality is an ecologically isolated area that is low, swampy and thickly studded with shrubs and trees. Palmetto plants are extremely abundant. The surrounding environment is typical of the Texan Biotic Province as defined by Blair (1952) but being much drier. The undescribed snails were abundant on the moist ground under palmetto plants and under rotten logs.

Description — The shell is umbilicate, with a low, convexly conoid spire and 5.5 rather closely-set whorls. Except for the embryonic

Sampling location for palmetto pill snail, Palmetto State Park, Gonzales county, Texas.



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Maps not to scale

MONITORING PROJECT FOR THE PALMETTO PILL SNAIL
(Euchemotrema cheatumi)

Palmetto State Park

Background: The palmetto pill snail is a terrestrial snail known only from the moist palmetto woodlands of Palmetto State Park. It is a flattened snail approximately 1/4 to 3/8 inch in diameter. Although several similar snails exist in the park, it is distinguishable based upon a small ridge seen in the opening of the snail. Because only one population of this species is known, it is desirable to monitor its status and further define its distribution in the park. In addition, its population status may serve as an indicator of the status of wetland ecosystems in the park.

Location: The original collection site was at a pond maintained with a pump built in the 1930's by the CCC. Subsequent surveys show that the snail is consistently found in the moistest habitats near the pond edge. Primary surveys should be focused on the pond edge. In addition, surveys might be conducted at other wetlands throughout the woodlands of the park to determine whether it occurs elsewhere at this time.

Methods (1999-2001): These snails are found in moist areas under palmetto plants, under rotten logs, and presumably in other moist conditions within the leaf litter and plant growth. (It is a detritivore--feeding on decaying plant matter). Sample sites will be set up along the park's Palmetto Trail. At every 10 paces along the trail a random number between 1 and 10 will be selected (samples should be placed every 5 paces along the pump-fed wetland). The researcher will step into the woods this number of feet. Odd numbers will be sampled on the right-hand side of the trail, while even numbers will be sampled on the left-hand side of the trail. At the random location a sampling frame measuring 0.10 square meters will be set down. All snail shells within the frame will be counted. When a Palmetto pill snail shell is encountered, then it will be determined whether the snail is live or dead (live snails are a more brownish, translucent color). All live snails will be returned to the sample area after counting.

Methods: (2002): These snails are found in moist areas under palmetto plants, under rotten logs, and presumably in other moist conditions within the leaf litter and plant growth. (It is a detritivore--feeding on decaying plant matter). Sample sites will be set up around the hydraulic pump pond. Every five feet along the pond edge a transect location should be marked. Researchers should establish a transect perpendicular to the pond edge and use a random numbers table to select a sample location between 0 and 5 feet along the transect. At the random location a sampling frame measuring 0.10 square meters will be set down. All snail shells within the frame will be counted. When a Palmetto pill snail shell is encountered, then it will be determined whether the snail is live or dead (live snails are a more brownish, translucent color). All live snails will be returned to the sample area after counting.

In addition to the monitoring project on Palmetto Trail, surveys could be conducted in a similar manner near other wetlands to determine whether the Palmetto pill snail occurs in any of these areas.

Sampling Period: Monitoring is only needed one time per year; however, terrestrial snails are very sensitive to climate conditions. The counts should be conducted during wetter seasons of the year (late fall to early spring). January or early February may be desirable at this site to avoid problems with poison ivy. Extreme cold should probably also be avoided.

Equipment, etc.: TPWD will provide sampling frames and data sheets. Researchers should wear clothes and shoes that can get wet or damp. Because poison ivy is present in throughout the area, long pants, long sleeves, and clothes are recommended.

Contacts: Before initiating field work, contact should be made with the following person(s). TPWD is responsible for making the initial contact.

Project Coordinator:
Lee Ann Linam
TPWD Wildife Diversity Branch
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: 512-847-9480
fax: 512-847-9480
e-mail: *lalinam@wimberley-tx.com*

Palmetto State Park
Superintendent
Rt. 5, Box 201
Gonzales, Texas 78629
phone: 830-672-3266
fax: 830-672-2382

Data Sheet

Palmetto pill snail (Euchemotrema cheatumi) surveys in Palmetto State Park

Researcher names:_____ Date:_____ Temp:_____ Last rainfall date:_____

Location (ref. to pond)	Stop Number	Distance from water	Habitat Description	# Palmetto pill snails - live	# Palmetto pill snails - dead	Total Palmetto pill snails	# other snails	TOTAL SNAILS (live & dead)

TABLE 1.1
Random Numbers

070675	916842	966401	542766	892514	973957	143469
630428	722031	568266	641829	850008	319218	532349
993012	353005	283254	701168	128250	623839	160852
853288	883003	600302	943581	467369	087607	635091
089545	4k4864	938397	435776	556429	800254	029642
528574	096282	924248	560561	608270	494747	651399
368560	104761	855860	005399	440305	163575	715405
292942	013687	586571	047045	562309	872389	501739
932822	026152	326042	076212	982994	014049	734647
737644	647308	845733	340159	830107	460913	679605
137494	544706	571894	477885	104414	837553	655677
161702	822366	265393	945094	683360	171694	270341
003567	186188	564131	527002	147210	432210	359868
718999	538290	576971	230540	170998	234805	422531
768352	842437	459869	678261	597613	932247	910369
304096	577705	755321	234499	333282	805744	143096
079825	470950	458884	3k8292	678436	562199	215157
296914	241649	006622	691358	416434	571070	360663
930615	274605	420237	013190	917223	732138	408850
718366	821249	027368	370978	294322	391789	826979
479547	563323	535001	817266	092669	355960	035595
275029	221211	951621	282315	638196	393656	292350
788388	261245	312958	366130	572095	967311	133687
673868	520586	837094	248132	986489	824952	909139
200298	960639	973621	274557	070641	246149	609361
306980	542827	930550	792818	260624	237615	504706
052154	852758	325246	481179	180965	995285	503697
027764	807281	507855	016485	938118	025316	246609
370180	400693	827831	304910	924864	940013	698077
882266	457836	452749	853308	698510	348002	996156
535934	996423	334523	651680	982634	818301	489219
979073	169045	521949	112283	594822	214704	242282
160760	213669	141666	347999	828379	479250	279671
527643	453098	051855	242124	430860	776720	636403
174906	358273	333568	441821	788143	343371	938677
111183	761996	738390	283132	734932	513119	143441
002755	794838	364257	727445	699924	393653	853617
795431	751760	789823	577535	687767	654684	206255
535065	095899	824467	356553	188731	800936	883351
538911	561908	822471	338497	972356	241407	832722
617898	211850	636528	373906	993349	087115	885107
186376	287114	061995	636045	860021	527820	472253
161537	988531	508665	154734	885471	979596	730834
523209	009402	500986	951815	337487	897011	998905

Monitoring results for the palmetto pill snail (*Euchemotrema cheatumi*) in Palmetto State Park, Ottine, Texas

Date	Temp (F)	Last Rainfall	Site	Volunteers	Statistic	# palmetto pill snails - live	# palmetto pill snails - dead	Total palmetto pill snails	# other snails	TOTAL SNAILS (live & dead)	quadrats sampled
20-Feb-99			Hydraulic pump wetland	Luling 4-H, Speer, & Strong	Total # found	2	2	4	144	148	34
					Density/sq.m.	0.59	0.59	1.18	42.35	43.53	
5-Feb-00	45	2-Feb-00	Hydraulic pump wetland	Luling 4-H, Speer, & Strong	Total # found	3	2	5	254	264	32
					Density/sq.m.	0.94	0.63	1.56	79.38	82.50	
1-Feb-01	45	1-Feb-01	Hydraulic pump wetland	Luling 4-H, Speer, Maxim, & Strong	Total # found	5	4	9	336	354	57
					Density/sq.m.	0.88	0.70	1.58	58.95	62.11	
9-Feb-02	58	6-Feb-02	Hydraulic pump wetland	Luling 4-H, Maxim, & Strong	Total # found	13	21	34	241	275	72
					Density/sq.m.	1.81	2.92	4.72	33.47	38.19	

Sampling method - This species is sampled by groups of students who select random 0.1 m^2 quadrat locations along a route encircling the hydraulic pump-fed wetland on Palmetto trail. The students search through the litter for all gastropod shells encountered.

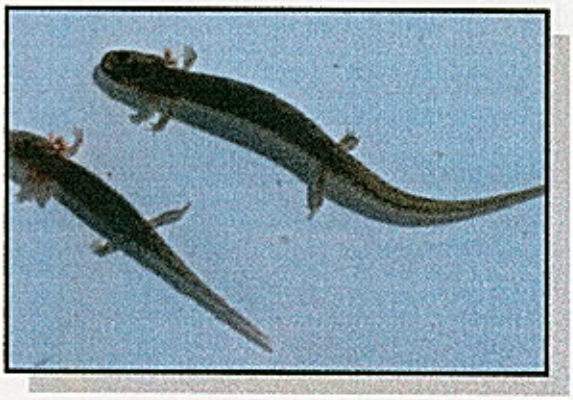
2002 - Methods were modified in 2002, so that all random sampling plots were located within 5' of water. As a result, higher densities of palmetto pill snail were encountered. Volunteers described locations where the pill snail were found as moist, with plant litter. Wild iris and wild onion occurred as several locations where they were found.

2001 - Results were fairly similar for the past several years, with volunteers finding that palmetto pill snails were rare in contrast to other gastropod species. All live palmetto pill snails encountered were within 3 feet of standing water. In addition, during a non-random search of detritus-laden soils near the water's edge, 12 palmetto pill snails (live and dead) were found within 10 minutes. The species seems closely tied to wetland areas. Sampling strategies will be revised during future years to sample optimum habitats more intensely, so that trends may be better assessed.

1999-2000 - Results were fairly similar for the two years, with volunteers finding that palmetto pill snails were rare in contrast to other gastropod species. Four of the five live palmetto pill snails encountered were found in litter between the roadside and the eastern edge of the pond. Palmetto pill snails encountered in 1999 were found 20+ feet from water, whereas pill snails found in 2000 were found five feet or less from water.

Salamanders of the Texas Hill Country

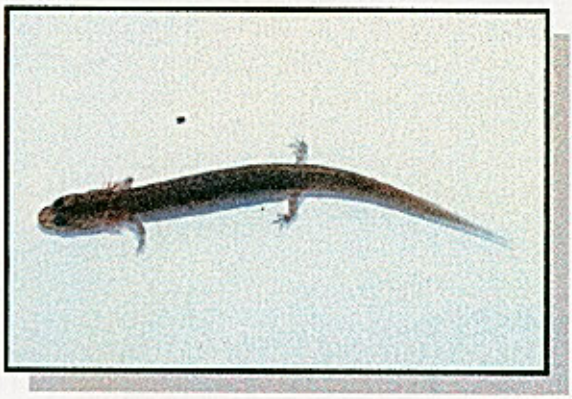
Eurycea



Smaller: Barton Creek Salamander *Eurycea sosorum*
Larger: Jollyville Plateau Salamander *Eurycea sp. 1*



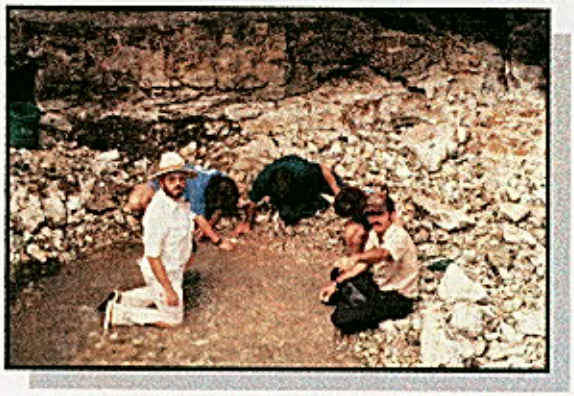
San Marcos Salamander
Eurycea nana



Sabinal Canyon Salamander
Eurycea neotenes



Fountain Darter
(Species that can be mistaken for salamanders when looking down through the water)



Salamander sampling under low-flow conditions at Comal Springs.

These species of salamanders inhabit the rocky or sandy bottoms of constant temperature, spring-fed pools and streams in Central Texas. The salamanders are generally 2 to 4 inches long and have external gills throughout their lives. Mosses and blue-green algae provide protection from predators and support the small aquatic snails, insects, and amphipods on which they feed. The primary threats to salamanders are the loss of aquatic habitat due to a reduction of spring flow and decreased water quality.

Summary Report
Volunteer monitoring of spring-dwelling salamanders (*Eurycea* sp.)

Status of project

Texas Nature Tracker volunteers have periodically monitored five species at six different sites. The Comal springs salamander (*Eurycea* sp.) was monitored in Landa Lake and in the spring runs of Comal Springs (Comal county) in 1997 and 1998, respectively; however, park staff were uncomfortable with continuing volunteer involvement. Surface populations of the Cascade Caverns salamander (*Eurycea latitans*) have been monitored at Honey Creek State Natural Area (Comal county) since 1997. Valdina Farms salamanders (*Eurycea troglodytes*) have been monitored in Stockman's Spring at Heart-of-the-Hills Research Station (Kerr county) very consistently since 1998. Jollyville Plateau salamanders (*Eurycea tonkawae*) have been monitored intermittently in Baker Spring at Travis Audubon Sanctuary (Travis county) since 1998. In 2002 monitoring of Fernbank Springs salamanders (*Eurycea pterophila*) was begun at two sites on private land in Hays county.

Volunteer involvement

Selection of appropriate volunteers has proven to be very important for these species. Habitats are sensitive, and in many habitats visibility can be difficult due to the presence of silt or the movement of water. In addition, identification can be confused with other organisms such as darters (*Etheostoma* sp.) or crayfish. At one locality, Stockman's Spring, a very knowledgeable and experienced high school teacher is using small classes of advanced biology students to successfully monitor for salamanders; however, in general, these projects are much better suited for a team of experienced amateur

naturalists who can become familiar with the species and the particular site. At this time volunteers are being sought for several of the sites.

Monitoring methods

Methods are described in the attached protocol. The time-constrained substrate search seems appropriate for this species in a variety of habitats; however, flow conditions can affect sampling effectiveness for these species and microhabitat characteristics can be important. Recording these features during sampling is important. Future sampling may experiment with the use of leaf bags to determine whether that is an effective sampling strategy in these habitats.

Results to date

Quantitative trends are difficult to assess for these species. Their quasi-subterranean habits and sensitivity to flow conditions can make sampling periods difficult to compare. For example, during several years of drought, volunteers and TPWD staff were unsuccessful in encountering *E. tonkawae*; however, following heavy rainfall in the summer of 2002, the species was very abundant. On the other hand, *E. pterophila* were easily encountered in June 2002 in Cypress Creek in Hays county, but none were found after flows had increased in September. *E. troglodytes* are abundant at Stockman's Spring, but only in shallow habitats dominated by cobblestone and watercress. *E. latitans* were fairly abundant at Honey Creek SNA until dramatic floods in October 1998 deposited huge amounts of rubble into spring runs. Encounter rates have dropped dramatically since that time; however the species may still occur in rock spaces within the substrate of the spring run. Volunteers can certainly contribute qualitative data about this species in the future, but the quality of their quantitative data will be determined by their ability to assess and respond to temporal habitat conditions.

From: Chippindale, P. T., A. H. Price, J. J. Wiens, and D. M. Hillis. 2000. Phylogenetic relationships and systematic revision of Central Texas Hemidactyliine Plethodontid salamanders. pp. 1-80.

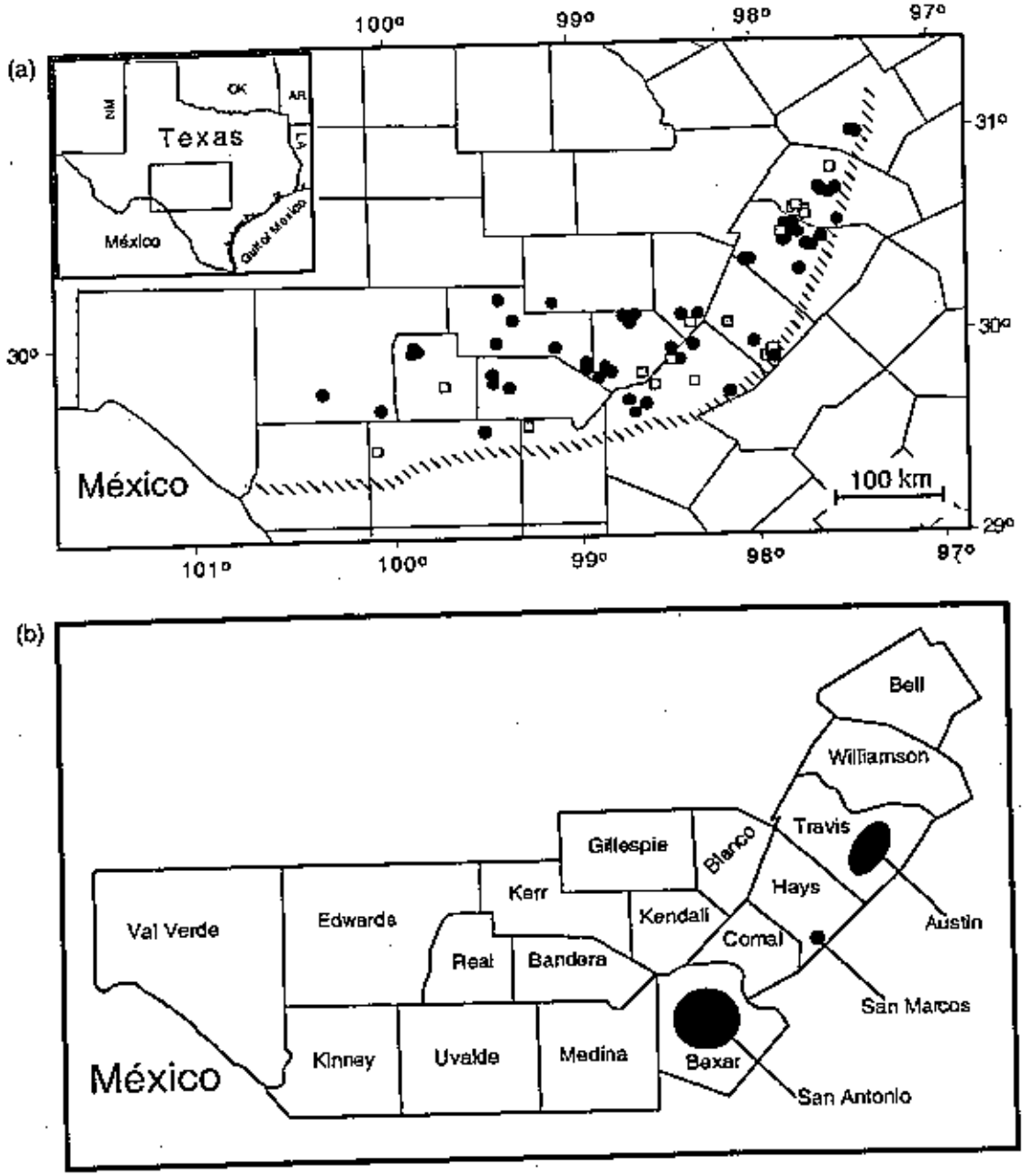


FIG. 1.—A. The Edwards Plateau region of central Texas, with collection localities for salamanders sampled in this study. Filled circles represent surface spring localities and stippled squares represent cave localities. The hatched line represents the southern and eastern margin of the Edwards Plateau (the Balcones Escarpment). Allozyme data were obtained for all localities shown, and cytochrome *b* sequence data were obtained for a subset of these localities described in the text. B. Counties in which cave and spring hemidactyliine plethodontid salamanders are known or suspected to occur; collecting localities are shown in Fig. 1A. Major cities are shown for reference and their outlines are greatly simplified.

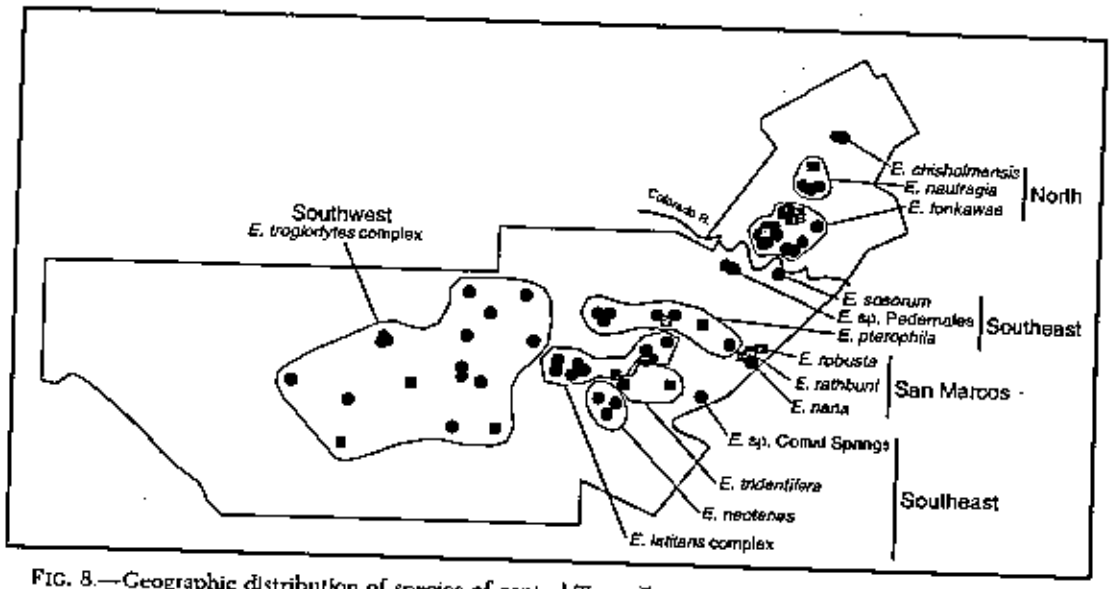


FIG. 8.—Geographic distribution of species of central Texas *Eurycea* recognized in this study. The region outlined corresponds to the counties in which these salamanders are known to occur, detailed in Fig. 1. Filled circles represent surface spring localities and stippled squares represent cave localities.

ument the remarkable diversity in the group, identify populations or groups of populations that appear to represent distinct species, and provide a framework within which future studies of this diversity can proceed.

In the following accounts, we have organized the species and informal groups that we recognize by geographic region. Appendix I provides precise locality information for all populations examined. The designation of a San Marcos region (inhabited by *Eurycea nana*, *E. rathbuni*, and *E. robusta*) is simply one of convenience, because the taxa from this area are highly divergent and the placement of *E. nana* is uncertain; no close relationship between *E. nana* and the other two species at San Marcos is implied. Museum acronyms follow Leviton et al. (1985). Distinguishing molecular character states are listed; for sequence characters, these refer to the position within cyt *b* relative to the first nucleotide in the alignment of the sequence we obtained (Appendix III).

SYSTEMATIC ACCOUNTS

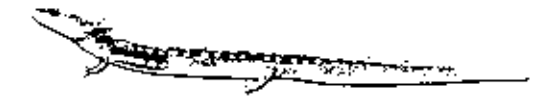
I. Southern Region

This assemblage includes all populations of *Eurycea* (including the two species formerly assigned to the genus *Typhlomolge*) from southwest of the Colorado River, ranging from western Travis County to eastern Val Verde County. We have examined specimens from 12 of the 14 counties in the southern region in which salamanders are known or thought to occur. The exceptions are Kinney Co., in which salamanders are likely to occur but no populations are known, and Val Verde Co. For the latter, repeated visits to the two known salamander localities at Del Rio (Fourmile Cave and San Felipe Springs; see Sweet, 1978*a*) failed to yield specimens. We expect that these salamanders would fall within the southwestern group that we recognize (see below) based on their location. Very late in the study, *Eurycea* were discovered by Riley Nelson and co-workers north of Del Rio in springs in the Devil's River drainage. Superficially, these appear similar to other surface populations from the southwest, but we have not yet examined them for molecular markers. The southern group is strongly supported as monophyletic in phylogenetic analyses of the molecular data that include mitochondrial sequence.

From: Conant, R. 1975. A Field Guide to Reptiles and Amphibians, 2nd ed. Houghton Mifflin Co. Boston. 429 pp.



SAN MARCOS



TEXAS

SAN MARCOS SALAMANDER *Eurycea nana* **Pl. 39**

Identification: 1½–2 in. (3.8–5.1 cm). Almost plain brown above, but with a row of yellowish flecks or spots down each side of back. Venter whitish or yellowish except where viscera and eggs (of females in season) show through translucent skin. *External gills present.*

A tiny neotenic species known only from the mats of algae carpeting the big spring pool that is the source of the San Marcos River, at San Marcos, Texas.

Similar species: (1) Texas Salamander is chiefly yellowish rather than brown. (2) Other neotenic salamanders of the general region are virtually white.

Range: San Marcos, Texas. Map 250

TEXAS SALAMANDER **Pl. 39; Fig. 88, p. 294**

Eurycea neotenes

Identification: 2–4⅛ in. (5–10.5 cm). Light brownish yellow in coloration, but mottled or flecked with darker pigment; a double row of light flecks on each side of body, at least in smaller specimens (lower row fades out in older ones). Belly and lower sides almost always white or cream, except where viscera or eggs may be seen through skin. Local populations vary in coloration, size, robustness, and head shape. Costal grooves 14 to 16. *External gills present.*

This neotenic salamander is a resident of springs, seeps, and small cavern streams along the Balcones Escarpment and on adjacent portions of the Edwards Plateau of south central Texas.

Similar species: (1) Several of the neotenic cave salamanders (*Typhlomolge, Eurycea tridentifera,* and *E. latitans*) are virtually plain white and they have flattened snouts. (2) See also San Marcos and Valdina Farms Salamanders.

Range: Edwards Plateau area from vicinity of Austin to Val Verde Co., Texas.

Subspecies: FERN BANK SALAMANDER, *Eurycea n. pterophila* (Plate 39). Known only from a small spring near Wimberley, Hays Co., Texas. EDWARDS PLATEAU SALAMANDER, *Eurycea n. neotenes.* Numerous localities from vicinities of Austin and San Antonio to Edwards and Val Verde Cos., Texas.

Note: Most of the small neotenic salamanders of the Edwards Plateau and Balcones Escarpment have restricted ranges. Many

THE TEXAS SALAMANDER

Robert G. Howells and Pamela J. Baker
Heart of the Hills Research Station

Central Texas is home to a number of very unusual and unique salamanders; none of which occur anywhere else. Some exist only at single locations and all but one or two are considered threatened or endangered species because of their limited distribution. Unfortunately, most live in subterranean or cave waters, or sink holes, where they cannot readily be observed. Indeed, among the five to seven recognized species, only two inhabit areas where they might be easily seen by the public.

The Texas salamander (Eurycea neotenes) is the most widely distributed species, with populations at multiple locations along the Balcones escarpment from Val Verde County to Bexar and Bell counties. It can be found in springs, seeps, and even caves in some 17 Hill Country counties. An additional subspecies, the Fern Bank salamander (E. n. pterophila) exists only at one site near Wimberly. The San Marcos salamander (E. nana) can only be found in Spring Lake at the headwaters of the San Marcos River.

A population of Texas salamanders was recently discovered at Stockman Spring near Mountain Home in northwestern Kerr County. This spring has supplied water to Texas Parks and Wildlife Department's Heart of the Hills Research Station since the 1920's when the facility was first constructed as a state fish hatchery. However, the spring was on private land until 1990 when it was formally purchased. Shortly thereafter, fences were erected to exclude cattle from the area, privately introduced fishes were removed from the spring pool, and generally efforts were made to return the area to its natural state. These

Most salamanders hatch from eggs laid in ponds or streams, have a brief aquatic larval stage, then absorb their gills, develop lungs and transform to air-breathing juveniles and adults which often live on land. However, Texas salamander and its relatives have a dramatically different life style. Because the central Texas environment is often hostile [at least to salamanders], these species remain small in size and retain larval characteristics, but eventually become sexually mature. They never absorb their gills, never develop lungs, and never breathe air or live on land (well almost never). Reaching sexual maturity without transformation to typical adult form is called neoteny (where body growth slows but gonads develop normally) or paedogensis (where gonads develop rapidly but body growth proceeds normally). Both survival strategies ultimately produce the same result...sexually mature "larvae" which can reproduce without risking potentially lethal arid environments on land.

Interestingly these are not the only salamanders in Texas to use this type of development. The tiger salamander (Ambystoma tigrinum) and other related mole salamanders, which are found throughout much of the United States and Mexico, may also have neotenic forms, especially in the Southwest and Mexico. Tiger salamander larvae hatch from eggs laid in small ponds, spend several months as aquatic larvae, then usually transform at about 3-4 inches (76-101 mm) in length and take up life on land. Adults are relatively large, 6-13.4 inches (152-400 mm) in total length and are often boldly patterned in dark black with yellowish blotches or bars. Some individuals or populations in more arid regions may become neotenic and reach total lengths over 12 inches (305 mm). Aztecs termed specimens found near Mexico City axolotles meaning water monsters, and this term remains in use today.

efforts should provided long-term security for a variety of spring-dependent animals.

Most of the Stockman Spring Texas salamanders are generally about 2.3 to 2.8 inches (60-70 mm) in total length. These specimens are somewhat darker than individuals in some other populations. They inhabit beds of watercress and water primrose just downstream of the main spring pool. Perhaps what is most interesting about this particular population is that it is located about twice as far from the Balcones fault area where most other populations are found. Previously reported populations exist at two locations near the southern Kerr County boarder, or farther, away.

Texas Salamanders in general are relatively small, only reaching a maximum size of about 4.1 inches (105 mm) in total length. They reportedly mature in their second year when males are about 1.7 inches (43 mm) and females are about 2.2 inches (56 mm) in total length. Individuals adapted for life in springs and seeps at the surface are yellowish to light or dark brown in color with small dots on their sides and pale tan or cream-colored bellies. They have a dark bar between each nostril and the eye; they eyes are well developed and functional. Other individuals may be adapted for cave life and may be virtually pigmentless and blind, or nearly so. Both forms have external gills.

Mortality rates have been found to be relatively high in some populations, with less than 1% surviving into their second year. Texas salamanders feed on small aquatic insects and amphipods, and probably on other small aquatic invertebrates.

It might also be interesting to note that Texas salamanders, while not protected as either threatened or endangered species, are better appreciated in the wild than as captives in aquaria. Although biologically fascinating, they are small, not brightly colored, require small living food items, and are intolerant of high water temperatures. The related San Marcos salamander, for example, normally lives at 70-71 F (21-21.5 C) and will die at 86 F (30 C) or more. Preferred and upper lethal temperatures are less well defined for Texas salamanders, but appear to be quite similar.

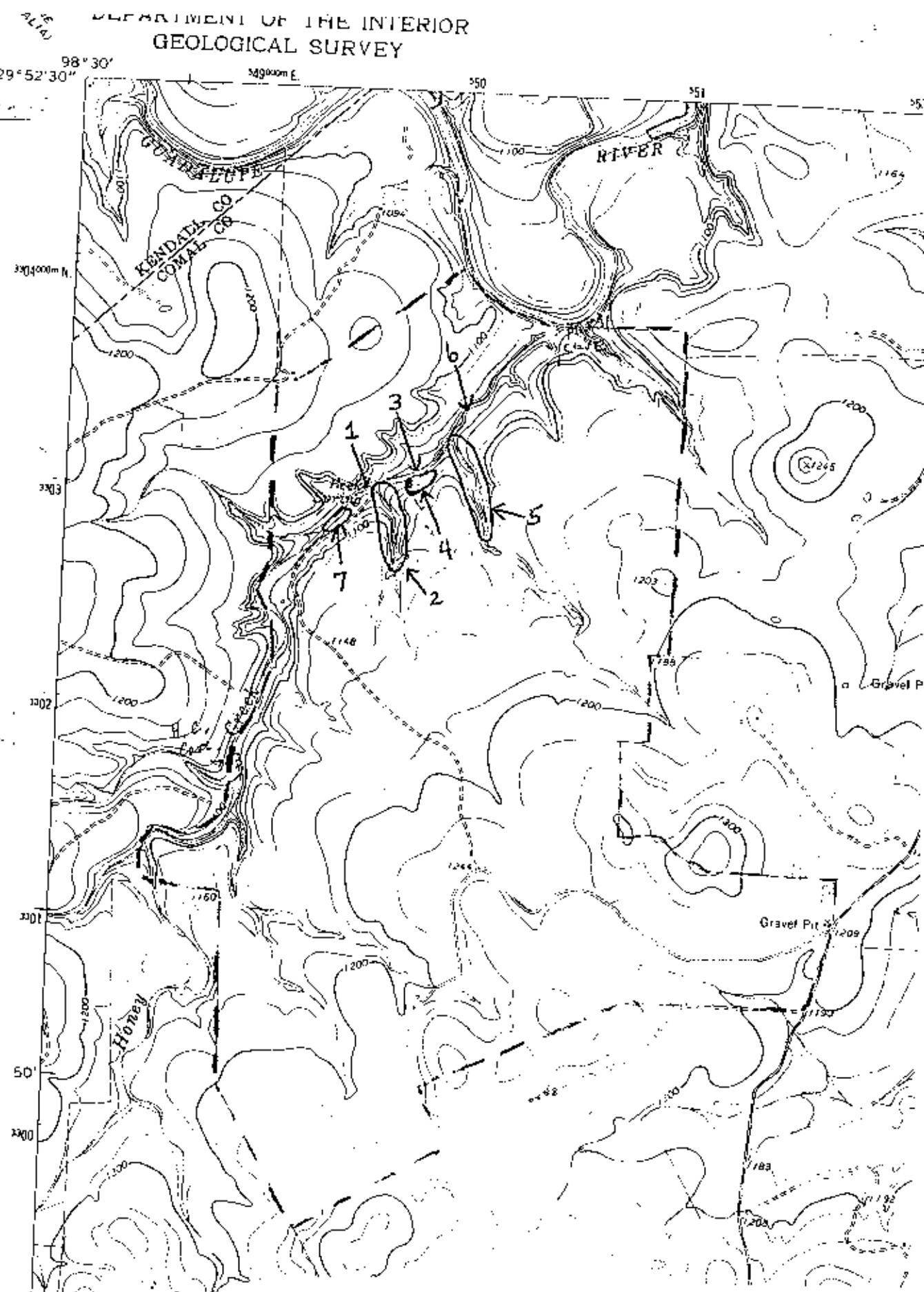


Figure 1. Eurycea sampling locations at Honey Creek State Natural Area.

MONITORING PROJECT FOR THE CASCADE CAVERNS SALAMANDER
(*Eurycea latitans*)
Honey Creek State Natural Area

Background: The Cascade Caverns complex includes small completely aquatic salamander ranging from surface to underground forms. The "species" is found in Hays, Comal, Kendall, and Kerr counties. Because it is dependent upon a fairly consistent flow of high quality spring water, it is desirable to monitor its status to detect any population changes as the conditions of springs may change. Currently, its complete distribution in the Honey Creek system is unknown, although it was originally described from Honey Creek Cave, and preliminary surveys have located it in several of the secondary spring flows.

Location: The survey will take place in the main stream bed of Honey Creek and in the secondary spring flows which enter the creek in the Natural Area.

Methods: The salamanders spend most of their time within spaces found among the rocks of the stream substrate. A time-constrained technique is used for this species in which a person turns over rocks and attempts to detect whether any salamanders are present. At the end of the sample period the amount of time spent searching and the number of salamanders detected are recorded. Results are expressed as # of minutes/salamander.

For this project we will walk down to the old road crossing on Honey Creek. From there teams may travel both upstream and downstream in the stream. Searches will be made of all secondary springs which flow into Honey Creek, as well as in random locations within the creek bed itself. Locations searched will be recorded and numbered on a topographic map. Results will be recorded on a data sheet. If possible, sample locations will also be recorded using a Geographic Positioning System.

Sampling Period: Because of the constant temperature of these spring systems, they may be sampled at any time. Because students/researchers will have to get wet, however, it will probably be better to sample during warm weather.

Equipment, etc.: A snorkeling mask and snorkel greatly aid visibility for this project. A limited supply will be provided by TPWD; however, students should be encouraged to bring any personal ones they might have. Waterproof watches are also needed (with the ability to measure seconds). Again, a limited number will be provided by TPWD. Waterproof data sheets will be provided by TPWD, along with rafts for transporting a small amount of gear. Otherwise, students should dress for aquatic work--with river shoes to protect their feet. Because it is about a ½ mile hike down to the creek, students may want to wear hiking boots and carry river gear in a back-pack.

Contacts: Before initiating field work, contact should be made with the following person(s). TPWD is responsible for making the initial contact.

Project Coordinator:
Lee Ann Linam
TPWD Endangered Resources Branch
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: 512-847-9480
e-mail: *lalinam@wimberley-tx.com*

Guadalupe River State Park
Mark Abolafia-Rosenzweig
3550 Park Road 31
Spring Branch, TX 78070
830-438-3062

MONITORING PROJECT FOR THE VALDINA FARMS SALAMANDER
(Eurycea troglodytes)
Heart of the Hills Research Station

Background: The Valdina Farms salamander complex includes a group of small completely aquatic salamander found in many spring ecosystems in the southwestern Edward's Plateau. Because it is dependent upon a fairly consistent flow of high quality spring water, it is desirable to monitor its status to detect any population changes as the conditions of springs may change. It is known to occur at Stockman's Spring--primarily in the shallow gravelly habitats vegetated with watercress on the far side of the spring.

Location: The survey will take place in Stockman's Spring on property owned by Heart of the Hills Research Station. Searches should be conducted among all the different habitats from the spring opening to the dam.

Methods: The salamanders spend most of their time within spaces found among the rocks of the stream substrate. A time-constrained technique is used for this species in which a person turns over rocks and attempts to detect whether any salamanders are present. At the end of the sample period the amount of time spent searching and the number of salamanders detected are recorded. Results are expressed as # of minutes/salamander.

A map of the spring should be drawn to show all the different habitats available--for example: each of the spring heads, deeper ponded areas, shallow riffle areas, shallow vegetated areas, etc. One or two volunteers at a time will be allowed to search in each different habitat type for a 10-minute segment. During the 10-minute segment the volunteers should be constantly searching, being careful not to cover the same area as any other searcher. Results will be recorded on a data sheet. If some areas remain unsearched after the first 10-minute segment, then volunteers may be shifted and another 10-minute segment begins.

Sampling Period: Because of the constant temperature of these spring systems, they may be sampled at any time. Because students/researchers will have to get wet, however, it will probably be better to sample during warm weather.

Equipment, etc.: A snorkeling mask and snorkel (for water deeper than 18") or a clear plastic view box/bucket (for shallower areas) greatly aid visibility for this project. A limited supply will be provided by TPWD; however, students should be encouraged to bring any personal ones they might have. Waterproof watches are also needed (with the ability to measure seconds). Again, a limited number will be provided by TPWD. Data sheets will be provided by TPWD. Otherwise, students should dress for aquatic work--with river shoes to protect their feet.

Special Notes: The spring habitats inhabited by these salamanders are very fragile and unique. Care should be taken to minimize disturbance by placing rocks back in place and avoiding walking through as many areas as possible (for example, it may be possible to sample some habitats while standing on the edge of the wetland instead of within it). No more than 8 volunteers widely spaced should be allowed in the entire sampling area at one time. Sampling should probably not be conducted more often than once every two-three months.

Contacts: Before initiating field work, contact should be made with the following person(s).

Project Coordinators:
Lee Ann Linam
TPWD Wildlife Diversity Program
200 Hoots Holler Rd.
Wimberley, TX 78676
phone/fax: 512-847-9480
lalinam@wimberley-tx.com

Heart of the Hills Research Station
Gary Garrett, Acting Manager
TPWD Inland Fisheries Division
HCO 7, Box 62
Ingram, TX 78025
830-866-3356

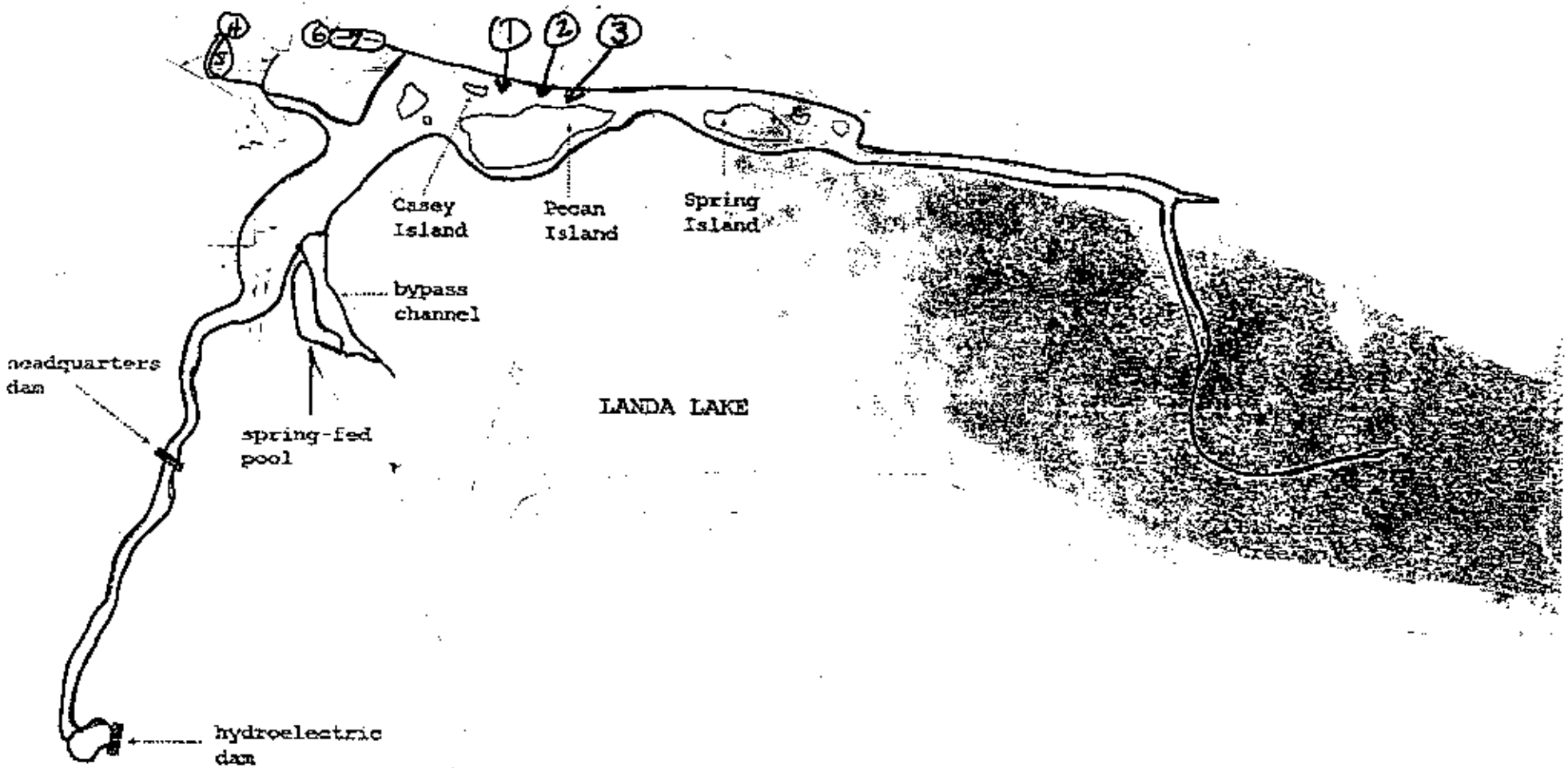


Figure 2. Sketch of Eurycea sampling locations at Stockman's Spring, Heart-of-the Hills, Kerr county, Texas.

Figure 3.

Comal Springs and Landa Lake, Landa Park, New Braunfels, Texas.

Salamander (Eurycea sp.) sampling locations.



MONITORING PROJECT FOR THE COMAL SPRINGS SALAMANDER (*Eurycea* sp.)
Comal River System

Background: The Comal springs salamander is a small completely aquatic salamander believed to occur only in the springs of the Comal River. Although it has long been known from the springs, the current status of its distribution throughout the Landa Lake systems is not completely known. Because Comal Springs are especially vulnerable to going dry as the water levels in the Edward's Aquifer drop, it is especially important to have a baseline understanding of the status of the species at this location. In addition, distribution information may be used to locate areas from which salamanders could be rescued to enter a captive breeding program if necessary.

Location: The survey will take place in Landa Lake and in spring runs 1 and 2 within Landa Park.

Methods: The salamanders spend most of their time within spaces found among the rocks of the stream substrate. A time-constrained technique is used for this species in which a person turns over rocks and attempts to detect whether any salamanders are present. At the end of the sample period the amount of time spent searching and the number of salamanders detected are recorded. Results are expressed as # of minutes/salamander.

Sampling in the lake will require diving under the water utilizing snorkeling gear. Depths will vary from 4-7 feet. For this project we will use paddle boats to access spring openings within Landa Lake in Landa Park (such openings may be detected by the air bubbles which rise from the spring openings). At least three lake sites within the park will be sampled.

Sampling in the spring run will involve wading in the water (6' to 1.5' feet deep) using a mask or other viewfinder to look underwater as rocks are turned. At least three sites in each spring run should be sampled. **Note:** Because of the fragility of the spring runs and the rare species found within them, sampling in the spring runs should take place only by a permitted researcher with the permission of the New Braunfels Parks & Recreation director.

Sampling Period: Because of the constant temperature of these spring systems, they may be sampled at any time. Because students/researchers will have to get wet, however, it will probably be better to sample during warm weather.

Equipment, etc.: Some snorkeling masks and snorkels are needed for this project. A limited supply will be provided by TPWD; however, students should be encouraged to bring any personal ones they might have. Waterproof watches are also needed (again a limited supply can be provided by TPWD). Waterproof data sheets will be provided by TPWD, along with rafts for transporting a small amount of gear. Otherwise, students should dress for aquatic work--with river shoes to protect their feet.

Contacts: Before beginning any field work, contact will have to be made with the following persons. (TPWD shall be responsible for making the initial contact.)

Landa Park:
Iris Nefendorf, Director
City of New Braunfels
Parks & Recreation Dept.
110 Golf Course Road
New Braunfels, TX 78130
830-608-2160

Project Coordinator:
Lee Ann Linam
TPWD Wildlife Diversity Program
200 Hoots Holler Rd
Wimberley, TX 78676
phone: 512-847-9480
fax: 512-847-9480
e-mail: *lalinam@wimberley-tx.com*

MONITORING PROJECT FOR THE JOLLYVILLE PLATEAU SALAMANDER
(Eurycea tonkawae)
Travis Audubon Sanctuary

Background: The Jollyville Plateau salamander is a small completely aquatic salamander found only in spring ecosystems within a small portion of northwest Travis county. Because it is so limited in distribution and its precise needs in terms of consistency of spring flow are not known, it is desirable to monitor its status to detect any population changes as the conditions of springs may change. Currently, most known populations of the salamander are being monitored; however, no monitoring program for the population at the Travis Audubon Sanctuary exists at this time.

Location: The salamander was originally found in Baker Spring and in a nearby spring called Audubon Salamander Spring. These sites should be monitored. In addition, several other promising canyons exist on the Sanctuary. These canyons should be surveyed to determine whether springs and salamanders are present.

Methods: The salamanders spend most of their time within spaces found among the rocks of the stream substrate. A time-constrained technique is used for this species in which a person turns over rocks and attempts to detect whether any salamanders are present. At the end of the sample period the amount of time spent searching and the number of salamanders detected are recorded. Results are expressed as # of minutes/salamander. Results will be recorded on a data sheet for each different site sampled. Sites will be plotted on a topographic map. Sample locations may also be recorded using a Geographic Positioning System.

Sampling Period: Because of the constant temperature of these spring systems, they may be sampled at any time. Because of the intermittent nature of some of these springs, it may be desirable to sample on a quarterly basis to represent some variation in spring flow. Sampling is not advised during November and December when deer hunts are taking place, and coordination of access is required during October when hunters are in the sanctuary preparing for the season.

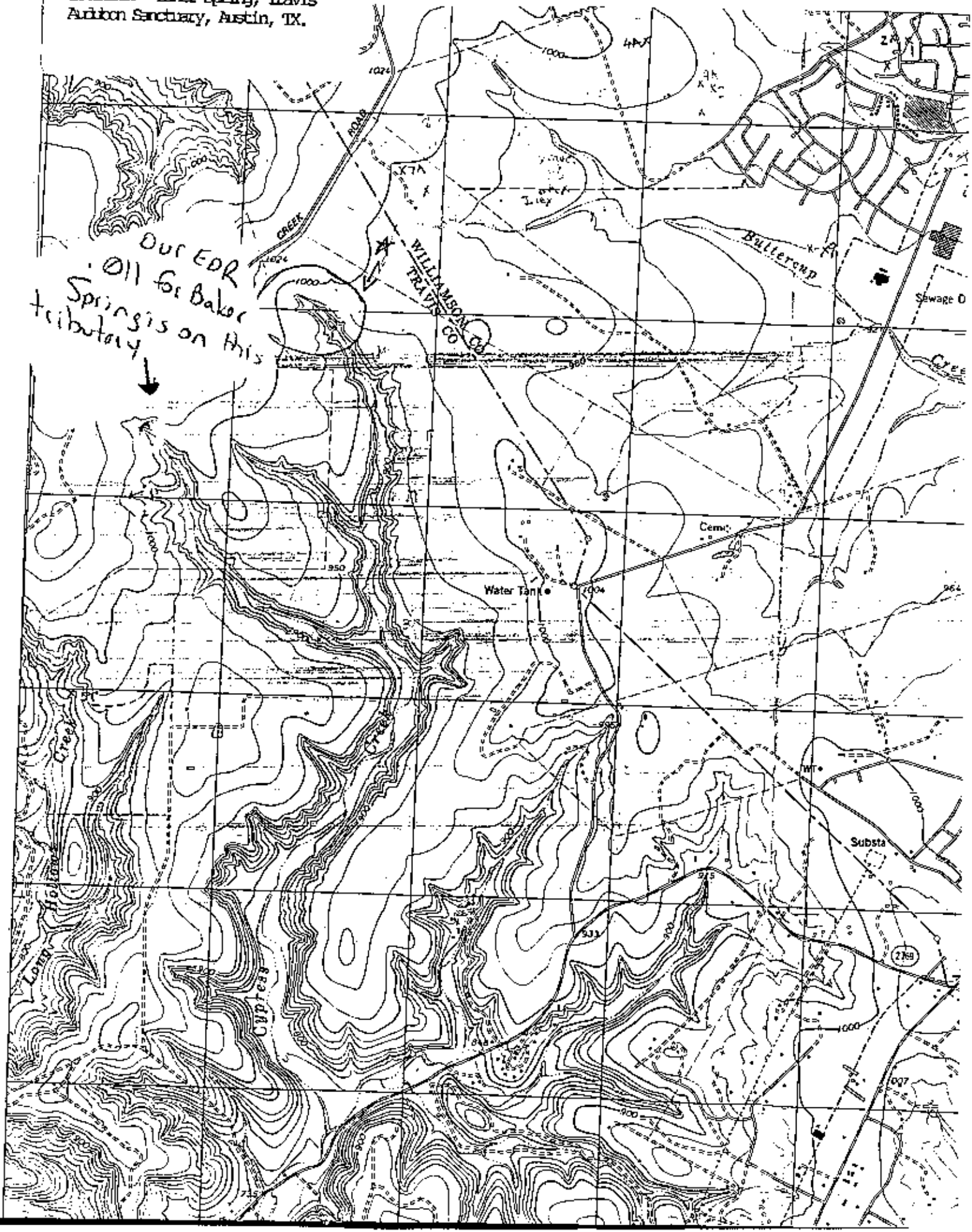
Equipment, etc.: Wading shoes should be worn. A clear plastic box may aid visibility in swifter or deeper water. Waterproof watches, with the ability to measure seconds, are desirable; although TPWD can provide a limited supply. TPWD will provide data sheets.

Contacts: Before initiating field work, contact should be made with the following person(s). TPWD is responsible for making the initial contact.

Project Coordinator:
Lee Ann Linam
TPWD Endangered Resources Branch
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: 512-847-9480
e-mail: *lalinam@wimberley-tx.com*

Travis Audubon Sanctuary
Bryan Hale
1404 Travis Heights
Austin, Texas 78704
phone: 512-474-5499 (hm)
512-912-4412 (wk)

Figure 4. Salamander sampling location - Baker Spring, Travis Audubon Sanctuary, Austin, TX.



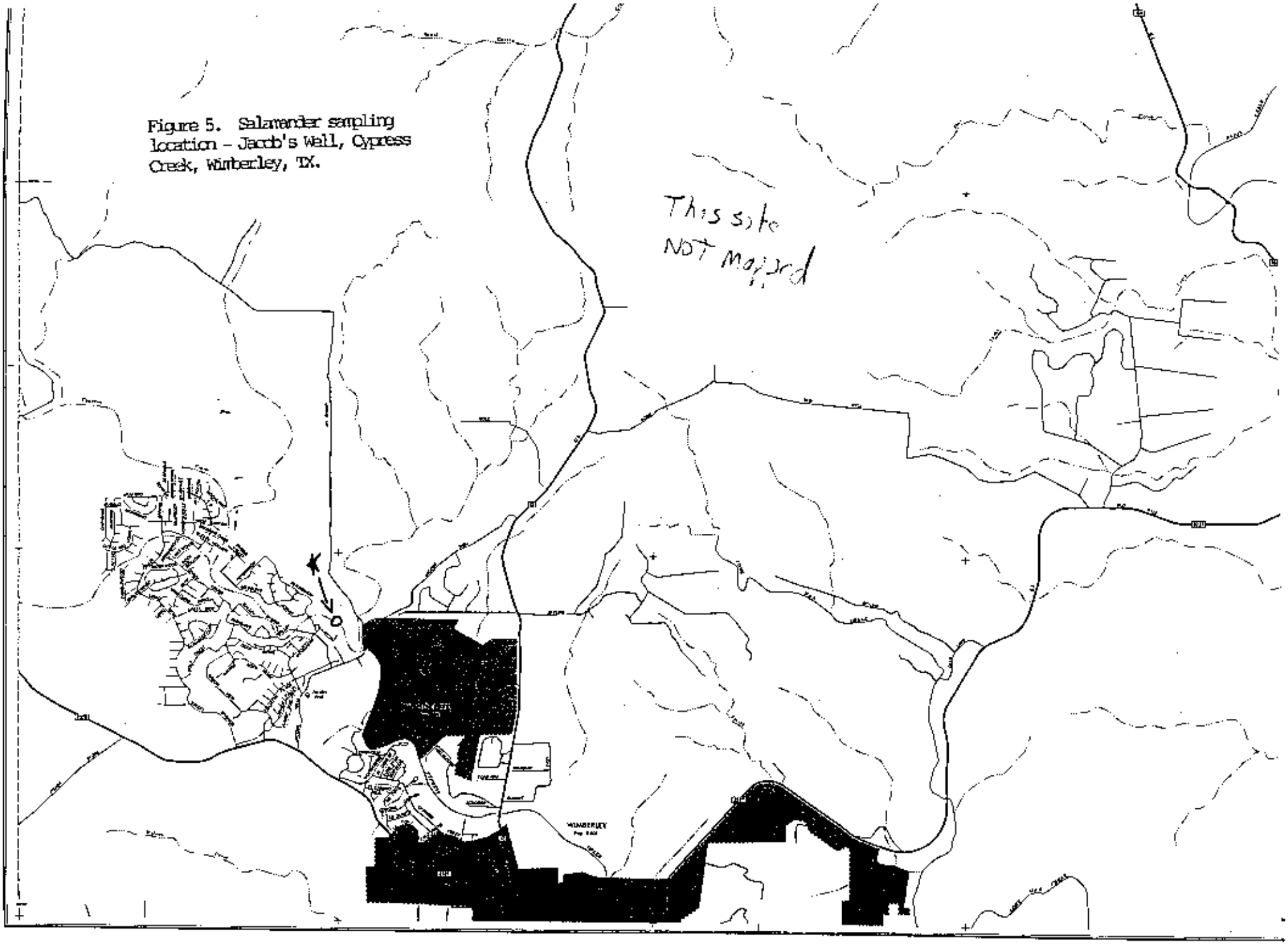


Figure 5. Salamander sampling location - Jacob's Well, Cypress Creek, Wimberley, TX.

MONITORING PROJECT FOR THE FERNBANK SPRINGS SALAMANDER
(Eurycea pterophila)
Fernbank Springs and Jacob's Well – Hays county

Background: The Fernbank Springs salamander is a small completely aquatic salamander found only in spring ecosystems within the Blanco River drainage. Because it is so limited in distribution and its precise needs in terms of consistency of spring flow and water quality are not known, it is desirable to monitor its status to detect any population changes as the conditions of springs may change.

Location: These two monitoring sites in Hays county are located on private property, but are owned by landowners very interested in conservation of the species. Jacob's Well is a large renowned spring feature that is the source of Cypress Creek. Fernbank Springs is another well-known large spring emergence located on the banks of the Blanco River north of San Marcos. Its flow feeds a pool at the spring mouth, a rapid shallow spring run that enters the river, and seepy wooded habitats along the river bank.

Methods: The salamanders spend most of their time within spaces found among the rocks of the stream and pool substrates. A time-constrained technique is used for this species in which a person turns over rocks and attempts to detect whether any salamanders are present. At the end of the sample period the amount of time spent searching and the number of salamanders detected are recorded. Results are expressed as # of minutes/salamander. Results will be recorded on a data sheet for each different site sampled; sample effort in different microhabitats should be recorded separately. Sites will be plotted on a topographic map. Sample locations may also be recorded using a Geographic Positioning System.

Sampling Period: Because of the constant temperature of these spring systems, they may be sampled at any time. Access should always be coordinated with the private landowner through Texas Parks and Wildlife Department.

Equipment, etc.: Wading shoes should be worn. A clear plastic box may aid visibility in swifter or deeper water. Waterproof watches, with the ability to measure seconds, are desirable; although TPWD can provide a limited supply. TPWD will provide data sheets.

Contacts: Before initiating field work, contact should be made with the TPWD, who will coordinate landowner contact.

Project Coordinator:
Lee Ann Linam
TPWD Endangered Resources Branch
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: 512-847-9480
e-mail: *lalinam@wimberley-tx.com*

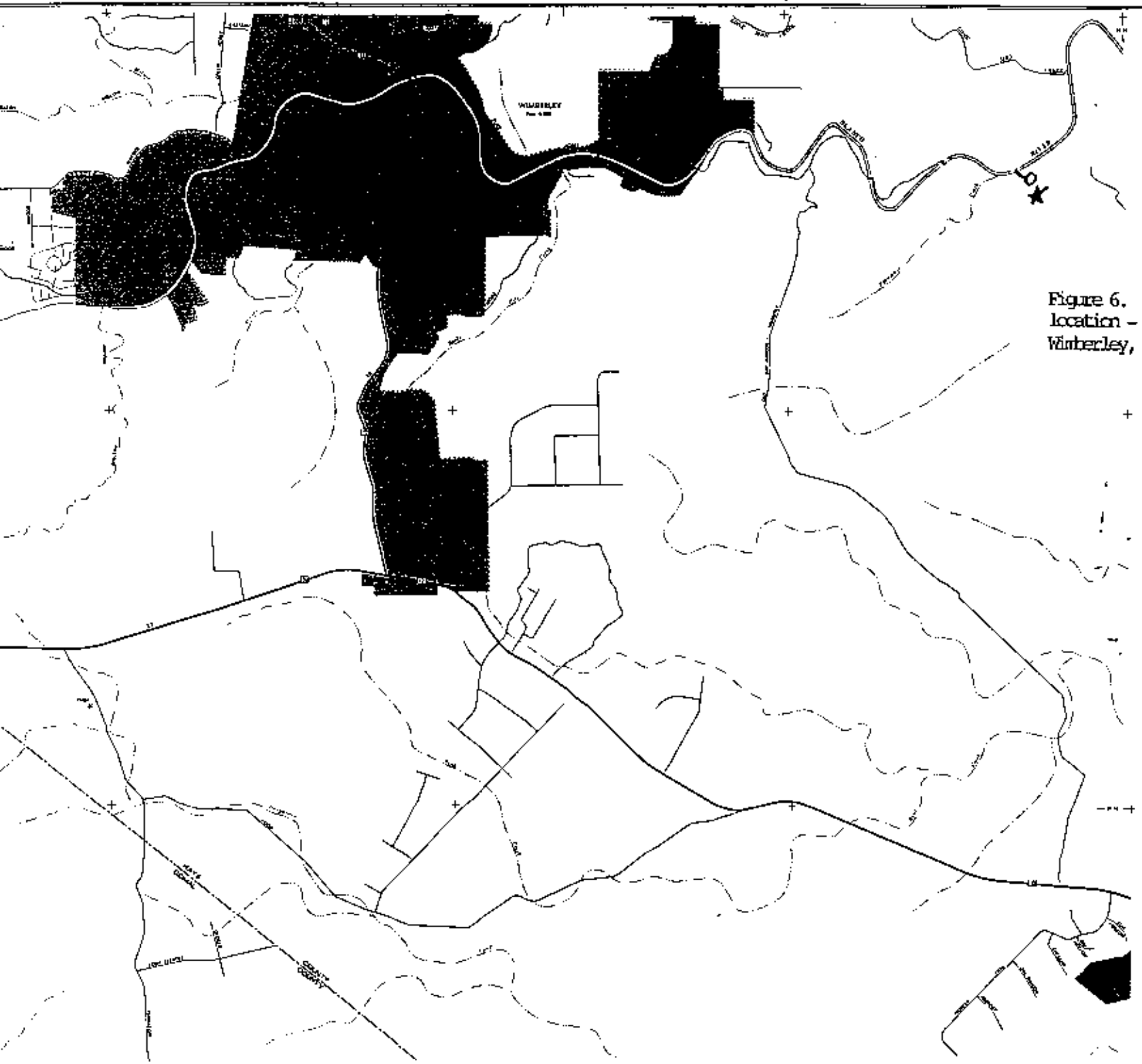


Figure 6. Salamander sampling location – Fernbank Springs, Wimberley, TX.

Results of Volunteer Monitoring Efforts for Eurycea Salamanders in the Texas Hill Country

Species	Location	Site	Spring 1997			Autumn 1997			Spring 1998			Autumn 1998			Spring 1999			Autumn 1999			Spring 2000			Fall 2001			Spring 2001			Fall 2001			Spring/Summer 2002			Fall 2002		
			T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R
Eurycea	Lands Lake	1	20	3	7																																
spiculus	Lands Lake	2	20	3	7																																
	Lands Lake	3	20	4	5																																
	TOTALS		60	10	6																																
	Lands Park	4										120	50	2																							
	Lands Park	5										70	10	7																							
	Lands Park	6										40	4	10																							
	Lands Park	7										170	3	57																							
	TOTALS											400	67	6																							
Eurycea	Honey Creek SNA	1				60	2	30	0			42	1	42				10	0	ns							13-May-01			8-Nov-01						22-Oct-02		
latitans	Honey Creek SNA	2				96	5	19	50	1	50	70	0	ns*				12	0	ns							0			10	0	ns						
	Honey Creek SNA	3				10	ns		10	0	ns	0						0		ns							30	0	ns	72	3	24				100	0	ns
	Honey Creek SNA	4				39	0	ns	40	0	ns	55	0	ns				0		ns							0			30	0	ns						
	Honey Creek SNA	5				80	5	16	105	5	21	60	2	30				0		ns							0			30	0	ns						
	Honey Creek SNA	6				0			60	0	ns	0						0		ns							35	0	ns	60	0	ns						
	Honey Creek SNA	7																0		ns							0			60	0	ns						
	TOTALS					290	12	24	265	6	44	227	3	76				18	1	18							18	2	9	40	0	ns						
																		40	1	40							84	2	42	302	3	101						
Eurycea	Hearn-of-the-Hills	A																						18-Oct-01			16-May-01			24-Oct-01			21-May-02			15-Oct-02		
troglodytes	(Stockman's Spring)	B										20	0	ns	20	0	ns	40	2	20	10	1	10	10	1	10	10	0	ns	20	0	ns	10	0	ns	20	0	ns
	" " " "	C										50	2*	ns*	0	ns	ns	0		ns	10	2	ns	0			0			0			0			0		
	" " " "	D										10	0	ns	20	0	ns	10	0	ns	10	0	ns	20	0	ns	0			20	1	20	20	0	ns	20	1	20
	" " " "	E										20	1	20	50	9	5.6	40	16	2.5	30	13	2.3	10	1	10	20	2	10	30	16	1.9	20	10	2	10	0	ns
	" " " "	F										10	0	ns	0	ns	ns	20	0	ns	10	0	ns	0			10	0	ns	10	0	ns	20	0	ns	20	3	6.7
	" " " "	G										10	0	ns	20	1	20	20	1	20	10	1	10	10	6	1.7	10	0	ns	0			10	3	3.3	10	0	ns
	" " " "	H										20	1	20	10	0	ns	10	0	ns	10	2	5	0			0			0			20	2	10	10	3	3.3
	" " " "	I										10	1	10	20	0	ns	18	0	ns	10	0	ns	0			10	1	10	0			0			0		
	" " " "	J										30	0	ns*	40	2	20	20	4	5	10	0	ns	20	0	ns	10	0	ns	20	0	ns	10	2	5	20	1	20
	TOTALS														40	6	6.7	0		ns	0		ns	0			0			0			0			0		
												190	3	60	190	12	16	170	23	7.7	110	19	5.8	70	8	8.75	90	3	27	100	17	5.88	110	17	6.47	110	6	13.8
Eurycea	Jacob's Well - Cypress																																				
pterophila	Creek; Hays county																																	13-Jun-02			4-Sep-02		
																																	30	5	6	25	0	ns
Eurycea	Fernbank Springs	pool																																19-Jul-02					
pterophila	(Hays county)	stream																																35	2	17.5			
		slope																																8	0	ns			
																																		40	0	ns			
																																		12-Jul-02					
Eurycea	Travis Audubon Sanc.																																						
tonkawae	Baker Spring & spring run	1							220	8	24	128	3	43						dry			dry			dry													
																																		52	26	2			

Sampling methods - A time-constrained methodology is used. Volunteers at these sites search for salamanders by carefully overturning rocks and litter. The amount of time spent searching and the number of salamanders encountered are recorded.

KEY: T=time in minutes spent searching; S=number salamanders found; R=encounter rate in minutes/salamander
*sighting uncertain, because habitat was unsuitable

Results of Volunteer Monitoring Efforts for Eurycea Salamanders in the Texas Hill Country

Species	Location	Site	Spring 1997 T	S	R	Autumn 1997 T	S	R	Spring 1998 T	S	R	Autumn 1998 T	S	R	Spring 1999 T	S	R	Autumn 1999 T	S	R	Spring 2000 T	S	R	Fall 2001 T	S	R	Spring 2001 T	S	R	Fall 2001 T	S	R	Spring/Summer 2002 T	S	R	Fall 2002 T	S	R
2001-02 - Increased rainfall in 2001 and 2002 resulted in better survey results during the past year. Mark Gustafson was able to reconfirm Cascade Cavern salamanders in the Back Spring tributary of Honey Creek for the first time in several years. Mary Beth Bauer and biology students from Ingram High School continued monitoring Valdina Farms salamanders at Baker Spring. Total encounter rates at that site vary, but encounter rates within good habitats (watercress and cobble) remain consistent over the several years of monitoring. Flow levels at Baker Spring in Travis county increased following heavy summer rains, and L. Linam found Jollyville Plateau salamanders to be very abundant in the stream for the first time in several years. L. Linam also sampled two spring sites on private lands in Hays county for Fernbank Springs salamanders. Salamanders were fairly abundant in the Cypress Creek outflow from Jacob's Well during June, but had declined in abundance by September--perhaps due to heavy summer flows. *E. pterophila* were also sampled at Fernbank Springs along the Blanco River. The spring structure at that site has been modified, and salamanders were difficult to encounter; however, the landowners are very interested in conservation of the species.																																						
2000-2001 - Once again, drought conditions throughout the year limited sampling opportunities. Honey Creek was sampled by two experienced observers (L. Linam and Dr. Mark Gustafson); however, only two salamanders were encountered, both in the creek channel. The spring run habitats of this site were greatly impacted in October 1998 when a flood event deposited massive amounts of rubble and boulders in the spring runs. Mary Beth Bauer and biology students from Ingram High School continued the monitoring at Baker Spring. Total encounter rates at that site vary, but encounter rates within good habitats (watercress and cobble) remain consistent over the several years of monitoring. No visits were made to the Travis Audubon Sanctuary due to low rainfall, but a visit was made to Fernbank Springs in Hays county at the invitation of the private landowner. Opportunities to monitor *Eurycea pterophila* may exist at that site.																																						
1999-2000 - Salamander monitoring during this year was limited by drought. Only a brief visit was made to Honey Creek State Natural Area with Friends of Honey Creek member Diane Lapierre. Springs were not flowing, but a salamander was found in the stream bed near a seep. Overall encounter rates increased during two visits to Stockman's Spring, but primarily due to shifts in sampling focus. Within habitats encounter rates did not show a significant shift. Most salamanders continue to be encountered in shallow water areas dominated by rocks and watercress. Mary Beth Bauer's advanced biology class continues the sampling at that site. Finally, during two visits to Baker Spring stream flow was non-existent and no salamanders were																																						
1997-98 - Students from New Braunfels High school participated in surveys for the Comal Springs salamander during September 1998. Salamanders were very abundant in the headwaters of spring run 1 and 3; however, a decision was made to forego sampling with students in the future due to concerns about habitat impacts. High school biology club students from Bracken Christian School began monitoring Cascade Caverns salamanders at Honey Creek State Natural Area in October 1997. Surveys in revealed the presence of salamanders, including larval stages, in several spring-fed tributaries of the creek, including several first-time records. A repeat visit in the fall of 1998 following a summer drought resulted in fewer salamanders encountered. Students from Ingram High School began monitoring Valdina Farms salamanders at Stockman's Spring, located on TPWD's Heart-of-the Hills Research Station, during September 1998. The salamanders seem mostly restricted to cobblestone areas with protective growth of watercress, filamentous algae, or other vegetation. Students from Live Oak Middle School began monitoring a population of Jollyville Plateau salamanders at Travis Audubon Sanctuary in April 1998. Habitat in the Baker Spring run was limited, but encounter rates were typical of other non-major spring habitats for these salamanders.																																						
1997 - Student volunteers from Churchill High School assisted TPWD in collecting data on distribution and abundance of the Comal Springs salamander population in Landa Lake during April 1997. The sampling efforts for the first time documented the presence of the species throughout many portions of Landa Lake at densities comparable to data collected by other researchers in the spring runs.																																						

KEY: T=time in minutes spent searching; S=number salamanders found; R=encounter rate in minutes/salamander
*sighting uncertain, because habitat was unsuitable

Eurycea Salamander Monitoring
Data Sheet

Site:_____

Name:				Phone 1:
Address:				Phone 2:
				Fax:
				e-mail:

Date	Search Area	Search #	Substrate - algae, silt, cobblestone, bedrock, etc.	Depth (inches)	Flow (s,m,f)	Search Time	#salamanders

Flour Bluff Pocket Gopher
(Maritime Pocket Gopher)

Geomys personatus maritimus



The Maritime Pocket Gopher, a member of the rodent family, is a genetically distinct subspecies of pocket gopher that occurs only in Nueces and Kleberg counties in loose, sandy soils. A single gopher will construct a burrow system that will include several (6-12) mounds. Maritime Pocket Gophers spend most of their life underground in this honeycomb of tunnels feeding on roots, bulbs, nuts, and seeds. The fur-lined, external pouches on each side of its head are used to carry food.

The monitoring project consists of counting fresh mounds. In the photo on the right, the mound on the left is old, while the mound on the right has been freshly dug. The dirt of fresh mounds will be darker in color and will have a granular texture.





A field of pocket gopher mounds.

Summary Report

Volunteer monitoring of Flour Bluff (maritime) pocket gopher (*Geomys personatus maritimus.*)

Status of project

Texas Nature Tracker volunteers have periodically monitored this species in Nueces county since 1998. Sampling has occurred three times at the TPWD Marine Development Center and three times at the Corpus Christi Naval Air Station.

Volunteer involvement

This project is appropriate for student involvement, and is aided by the presence of several teams of volunteers. Some judgment is required for assessment of the freshness of mound activity; however, high school students seemed to be capable of making those judgments. At this time, a volunteer, preferably a teacher with student help, is needed for one site.

Monitoring methods

Methods are described in the attached protocol. In general, monitoring of pocket gopher populations is problematic (C. Rudolph, pers. comm.). This project attempts to identify active burrows by the presence of fresh mounds located within a burrow pattern (i.e. within 10 m. of each other). In addition, an attempt is made to revisit the site on the following day in order to locate any new burrow activity. Based upon research by others, one active burrow system is considered to represent one gopher. In addition to the site-specific monitoring, it would be useful for local volunteers to map the occurrence of the species in the community by the presence of mounds.

Results to date

Results to date do not indicate that this species is declining. The study site habitat at the NAS is secure, as it is being set aside due to contamination of the soil during earlier uses.

In addition, NAS environmental staff are aware of the presence of the species and its status. The species is also abundant at the TPWD facility. Results there indicate that the management practices of mowing the levees produce preferred habitat for the species in contrast to unmowed areas. Monitoring of this species may not be needed on an annual basis; however, regular contact with site managers can ensure that beneficial management practices continue.

From: The Mammals of Texas by W.B. Davis & D.J. Schmidly. UT Press. 1994

Habits. The habits of *G. knoxjonesi* are similar to *G. bursarius*. Although genetic idence for hybridization with *G. bursarius* has been found, the apparent zone of ntact between the two species is extremely narrow and the resultant hybrid off ring are sterile or have a lower level of fertility, indicating that the two species rarely eract reproductively.

Remarks. Originally recognized as a new subspecies of *G. bursarius* in 1975, ldditional genetic analysis of this pocket gopher by Robert Baker and his students has bsequently shown that Jones' pocket gopher is essentially reproductively isolated om *G. bursarius* and therefore constitutes a separate species.

TEXAS POCKET GOPHER

Geomys personatus True

Description. A large, pale-drab or grayish-drab species with relatively long, scant ired tail, the distal half nearly naked; upper incisors with two grooves; underparts arbled white and dusky. External measurements average: (males) total length, 321 mm il, 110 mm; hind foot, 41 mm; (females) 303-103-39 mm. Weight, up to 400 g. Dental rmula as in *G. bursarius*.

Distribution. South Texas as far north as Val Verde County on the west and San tricio County on the east. See map on page 124.

Habits. This species occurs in deep, sandy soils. It is entirely absent from the silt ams of the flood plains of the Rio Grande and also from gravelly, stony, or clayey soils attered throughout its general range.

Numerous burrows of these gophers occur in the deep drift sands on Mustang nd Padre Islands where the sand is moist enough to permit packing. Sometimes the nnels are at the water table and the runways soppy with seepage, but most often ey are about halfway between the surface and the water table 50 cm below. Exca ated burrows average about 10 cm in horizontal diameter, 12.5 cm in vertical diam ter, and 25 cm beneath the surface. In places where the sand was drier, yet still moist nough to maintain a burrow, the tunnels are about 12 to 15 cm in diameter. In the oils near Robstown, Texas, the burrows ranged from 6 to 8 cm in diameter.



One partially excavated burrow system on Padre Island was more than 30 m long. There were numerous short side branches, but no food cache nor a chamber for fecal pellets, as is usual in burrows of *Geomys*, was found. Another burrow excavated on the mainland contained a food cache of Bermuda grass. The average mounds are large; a typical one might measure 45 by 60 cm in horizontal diameter and 12 cm in height. It could contain almost 6 kg of sand.

These gophers are ferocious isolationists; they resent molestation. When angry they emit a wheezy call at frequent intervals and gnash their teeth.

Their food consists largely of vegetation. Known items include roots of grasses (*Paspalum*, *Cynodon*, and *Cenchrus*) and the roots, stems, and leaves of a composite (*Helianthus*). Most of their foraging is done underground; the plants often are seized from below and pulled into the burrow. Their feces are capsule-shaped and about 19 mm in length and 7 mm in diameter. Individuals of this species, as well as other *Geomys*, have the interesting habit of ingesting their own fecal pellets. A fecal pellet is taken in the incisors directly from the anus, examined and manipulated with the aid of the forefeet, and then either discarded or thoroughly chewed and swallowed. Usually two to four pellets are produced at a time with only one or two being eaten, often none. There appears to be no pattern as to which pellet or pellets are eaten. Production of fecal pellets often occurs in the nest, in which case the rejected pellets are simply pushed out into the adjoining tunnel. Pocket gophers may also stop their travels through the burrow system to defecate, again either discarding or eating the pellets after examining each one carefully. Captive individuals have been seen to interrupt a meal of grass, potatoes, or other food to defecate and then consume one or more fecal pellets. This behavior is well-documented for many species of rabbits and rodents, and may serve to extract maximum sustenance from ingested plant foods.

Their breeding habits are not well known. Pregnant females have been captured in all months except April, June, August, and September, suggesting that breeding may occur year round. Young gophers about one-fourth grown were trapped in early April. Litter size ranges from one to five, averaging three. Probably no more than two litters are reared yearly.

In southern Texas, these gophers have little economic importance except in cultivated fields or where they become established along the highways. In the latter case, they may undermine the shoulders and initiate erosion.

LLANO POCKET GOPHER

Geomys texensis Merriam

Description. A cryptic species with *G. bursarius* and *G. knoxjonesi*. Morphologically, the Llano pocket gopher is slightly smaller than the plains pocket gopher but biochemical study is required to reliably separate the two. Dental formula as in *G. bursarius*.

Distribution. Occurs only in two isolated areas of the Texas Hill Country. Records are from McCulloch, San Saba, Mason, Llano, Gillespie, Uvalde, Zavala, and Medina counties. See map on page 124.

Habits. The natural history of *G. texensis* is undoubtedly similar to that of *G. bursarius*. The Llano pocket gopher is found in deep, brown loamy sands or gravelly sandy loams and is isolated from other species of *Geomys* by intervening shallow, stony to gravelly clayey soils.

Five specimens in the Texas Cooperative Wildlife Collection at Texas A&M University, collected in Llano County in mid-March, were reproductively active when captured. One contained three embryos, one had two embryos, one was "insemi-

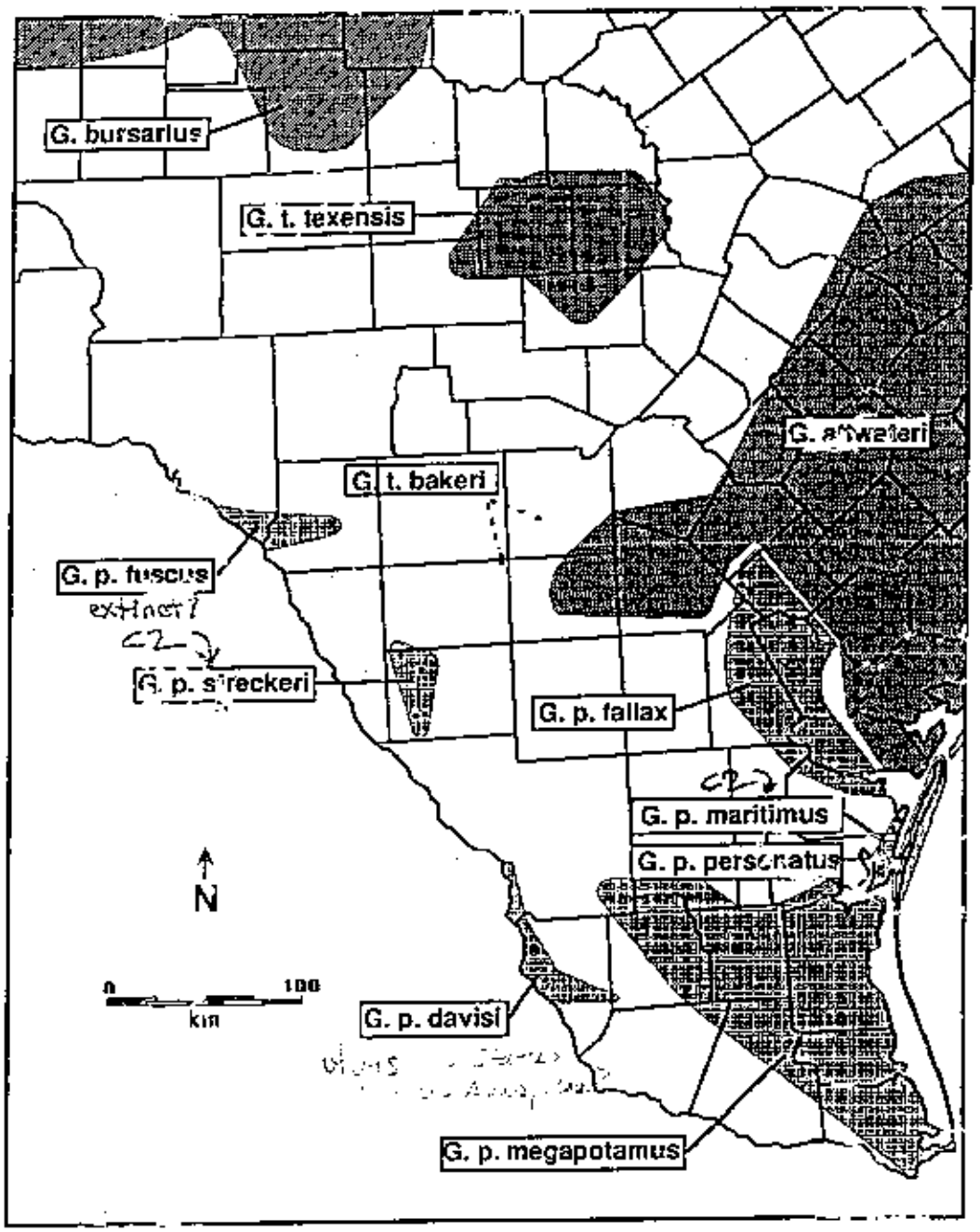


Figure 1.--Distribution of Geomys in South Texas.

MONITORING PLAN FOR:

FLOUR BLUFF POCKET GOPHER (MARITIME POCKET GOPHER)

Geomys personatus maritimus

Corpus Christi Naval Air Station

Background:

The Flour Bluff pocket gopher is a subspecies of a species of pocket gopher that occurs throughout most of south Texas. The Flour Bluff pocket gopher is genetically distinct from other subspecies and occurs only in Nueces and Kleberg counties in loose sandy soils. Because of the uniqueness of this species and continued population growth in Nueces county, it is desirable to monitor the status of large populations of the Flour Bluff pocket gopher and to understand changes in its distribution.

Goals:

1. To annually monitor population size at one site on the Naval Air Station.
2. To annually monitor distribution of pocket gophers on the Naval Air Station, Corpus Christi State University, and nearby areas.
3. Other class goals?

Monitoring seasons:

Any time of year, extremely hot or cold weather should be avoided. Detection of active burrows is easiest 3-6 days following rainfall.

Site Location:

Corpus Christi Naval Air Station (see attached map): a large open field (approximately 800' x 1200') at the end of Lexington road. A telephone line intersects the field in its southern portion. Gopher activity is heavy across this field.

Equipment Needed (will be provided by TPWD):

*surveyors' flags
*"Sharpie" permanent marker (one for each group of volunteers)
*data forms, maps, pencil, & clipboard (for each volunteer)

Methods:

If sufficient volunteers are available (at least 4-6), complete burrow counts may be conducted. The site can be divided based on landmarks such as roads, buildings, and telephone poles. Volunteers will walk through their area marking active burrow systems with a surveyor's flag. Active burrows can be identified by the presence of fresh dirt mounds. Fresh mounds are distinguished by darker, moister-looking dirt with a loose, granular texture, no smoothing, few animal tracks, and little debris on their surface. Each burrow system should be marked with only one flag. All mounds within 10 paces of each other should be considered to be in one burrow system, unless pattern of activity indicates distinctive burrows. Volunteers will systematically cover the entire study area. Once all burrows have been marked, then volunteers can pass back through the study area, removing flags and counting burrows.

If fewer volunteers are available, then transects can be walked. Volunteers should orient transects based on the telephone poles passing through the study area. As the volunteer walks toward the telephone pole, he will pause when he reaches a gopher mound. He will then assess whether an active burrow is within 10 paces of the mound. If so, he records an active burrow and then moves at least 10 paces further along the transect before looking for a new mound. The number of active burrows encountered and the number of transects walked is recorded.

Project Extensions:

1. Two-day study - Studies of pocket gophers have shown that a two-day study can help to more accurately estimate the relative population numbers. On day one have the volunteers place a flag at each active burrow. On day two revisit the site to assess whether any new burrow systems are evident based upon the night's activity.

2. Distribution mapping - It would be of interest to monitor the distribution of this subspecies over a larger area, especially since pocket gopher populations tend to shift over time and land-use changes may be occurring simultaneously. Volunteers could drive roads in the Naval Air Station and Corpus Christi State University--mapping all locations where gopher mounds are present. Please note that some areas of the Naval Air Station are off-limits to civilians and an attempt is made to minimize traffic in residential areas on the base. Please contact the Naval Air Station to obtain a map of acceptable survey areas before beginning work on the base.

After each visit (or at end of project year)

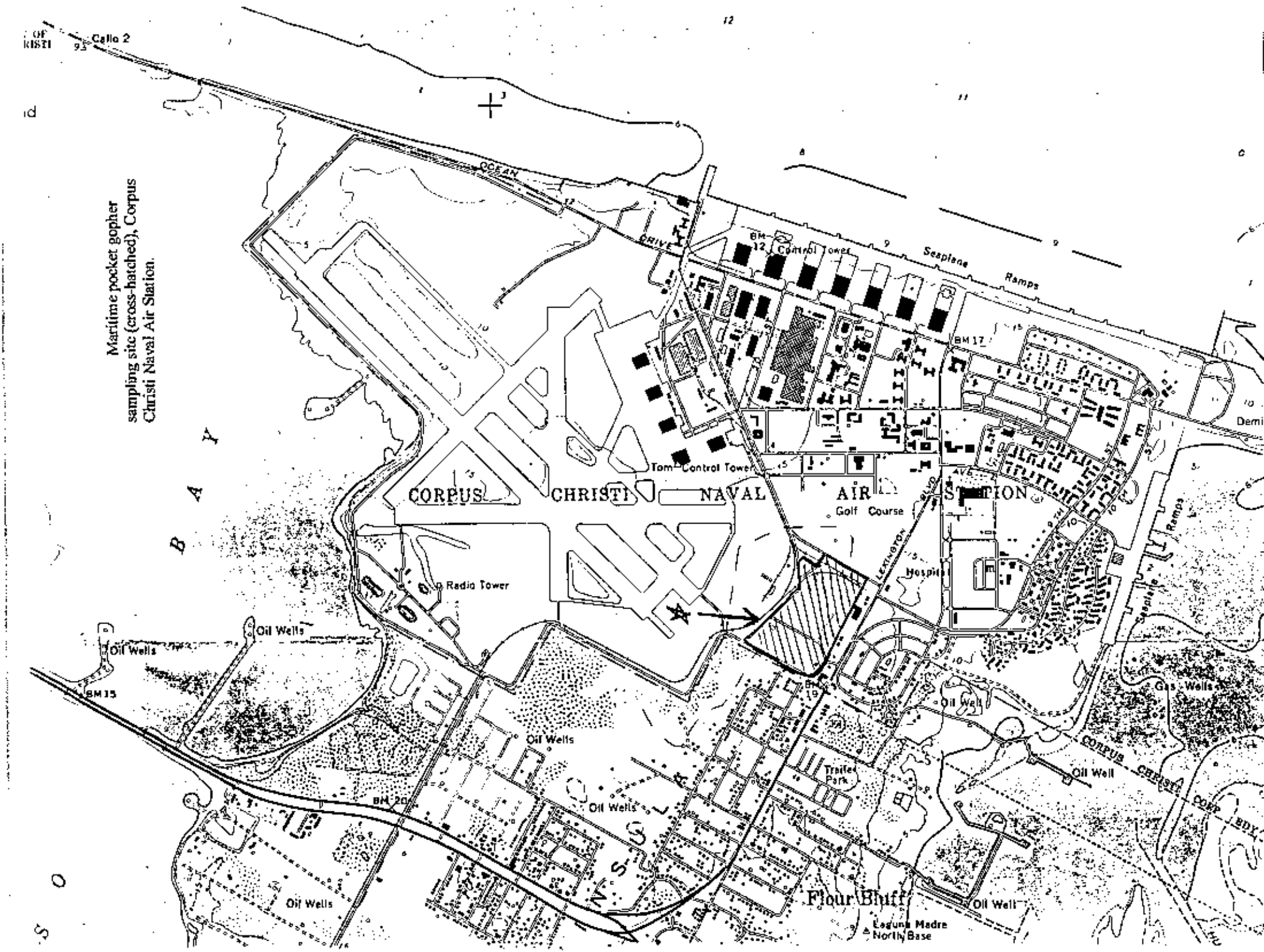
1. Tally data on summary data sheet.
2. Send copy of all data sheets and maps to TPWD at:

   Texas Wildlife Watch
   Endangered Resources Branch
   3000 So. IH-35, Suite 100
   Austin, Texas 78704

Special notes:

Some portions of the Naval Air Station are off-limits to civilian traffic. Please check with the Mike Hilger or Didi Byerly of the Environmental Division (byerly.d.r@nrst.navy.mil ; 361-961-3776) or other officials at the Naval Air Station before conducting conducting field work. Be certain to not leave any permanent markers behind after completing your study.

Questions: Call Lee Ann Linam at 512-847-9480.


Maritime pocket gopher sampling site (cross-hatched), Corpus Christi Naval Air Station.
Calle 2
OCEAN
DRIVE
BM 12
Control Tower
Seaplane Ramps
BM 17
Tom Control Tower
CORPUS CHRISTI NAVAL AIR STATION
Golf Course
Hospital
Ramps
Radio Tower
Oil Wells
BM 15
BM 19
Oil Well
Gas Wells
Trailer Park
BM 20
CORPUS CHRISTI
Flour Bluff
Laguna Madre
North Base
B A Y

Maritime Pocket Gopher (*Geomys personatus maritimus*) Volunteer Monitoring Results
Corpus Christi Naval Air Station

	Apr. 17-18, 1999	Feb. 25-26, 2000	Feb. 23-24, 2001
Volunteers	Bernice Speer Doyle	Bernice Speer Elizabeth Maxim Doyle Cross	Bernice Speer Elizabeth Maxim Doyle Cross
Area sampled (sq. ft.)	35,393		
# Burrow systems marked - day 1	42*	not counted	not counted
Total fresh mounds - day 1	172	not counted	not counted
New fresh mounds - day 2	40	139	102
# Burrow systems active - day 2	22*	87	62
% burrows confirmed active	50%	na	na
Active burrows/acre	27.1		
Fresh mounds/day/burrow	1.8	1.6	1.6
Days since last rainfall		0	1

*only about 1/3 of the study area was sampled.

Sample methods - Gopher mounds are sampled in an undeveloped field located just off Lexington Road in the southeast portion of the base. Volunteers at this site mark fresh-appearing mounds on day 1 and then revisit the site on day 2. Fresh mounds on day 2 are counted and grouped into burrows based upon their distribution within a 10 meter radius of each other.

2001 - All fresh mounds on day 2 were counted. In contrast to 2000, during this year some burrow systems that seemed to clearly have fresh mounds on day 1 did not exhibit new mound-building activity on day 2. Other researchers have found that, dependent upon weather conditions, activity cycles, etc., gophers may not be consistent in their burrow excavation activities (C. Rudolph, pers. comm.). Therefore, an estimate of 62 gophers is clearly a minimum estimate.

2000 - All mounds at the site were counted (only a portion of the site was counted in 1999). A total of 87 gophers were estimated to occupy the site. Acreage of the sample area still needs to be determined.

1999 - B. Speer and D. Cross assisted TPWD in monitoring a subsection of this population in order to test monitoring techniques. All burrow systems and fresh mounds within about 1/3 of the study area were marked on day 1. On the second day, activity was confirmed in only 50% of the burrows. Gophers constructed an average of 1.8 mounds per burrow per day.

MONITORING PLAN FOR:

FLOUR BLUFF POCKET GOPHER (MARITIME POCKET GOPHER)

Geomys personatus maritimus

TPWD/GCCA/CPL Marine Development Center

Background:

The Flour Bluff pocket gopher is a subspecies of a species of pocket gopher that occurs throughout most of south Texas. The Flour Bluff pocket gopher is genetically distinct from other subspecies and occurs only in Nueces and Kleberg counties in loose sandy soils. Because of the uniqueness of this species and continued population growth in Nueces county, it is desirable to monitor the status of large populations of the Flour Bluff pocket gopher and to understand changes in its distribution.

Goals:

1. To annually monitor population size on the roadsides and levees of the fish hatchery.
2. To annually monitor distribution of pocket gophers in the Flour Bluff area.
3. Other class goals?

Monitoring seasons:

Any time of year, extremely hot or cold weather should be avoided. Detection of active burrows is easiest 3-6 days following rainfall.

Site Location:

The Texas Parks and Wildlife Department / Gulf Coast Conservation Association / Central Power and Light Company Marine Development Center is located at the end of Waldron Road. Gophers utilize habitat along the road edges and along the levees of the fish production ponds. The entrance to the fish hatchery is gated; therefore, prior notification should be given to Robert Vega or Robert Adami (361-939-7784) that a sampling trip is scheduled.

Equipment Needed (will be provided by TPWD):

*surveyors' flags
*"Sharpie" permanent marker (one for each group of volunteers)
*data forms, maps, pencil, & clipboard (for each group of volunteers)

Methods:

Habitat area has already been determined for 14 areas (A – N) on the hatchery property (see map). Within the habitat areas active burrows will be counted each year. Active burrows can be identified by the presence of fresh dirt mounds. Fresh mounds are distinguished by darker, moister-looking dirt with a loose, granular texture, no smoothing, few animal tracks, and little debris on their surface. Each burrow system should be marked with only one flag. All mounds within 10 paces of each other should be considered to be in one burrow system, unless pattern of activity indicates distinctive burrows. Volunteers will systematically cover the entire study area, counting burrow systems and fresh mounds within the burrows. Once all burrows have been marked, then volunteers can pass back through the study area, removing flags.

Project Extensions:

1. Two-day study - Studies of pocket gophers have shown that a two-day study can help to more accurately estimate the relative population numbers. On day one have the volunteers place a flag at each active burrow. On day two revisit the site to assess whether any new burrow systems are evident based upon the night's activity.

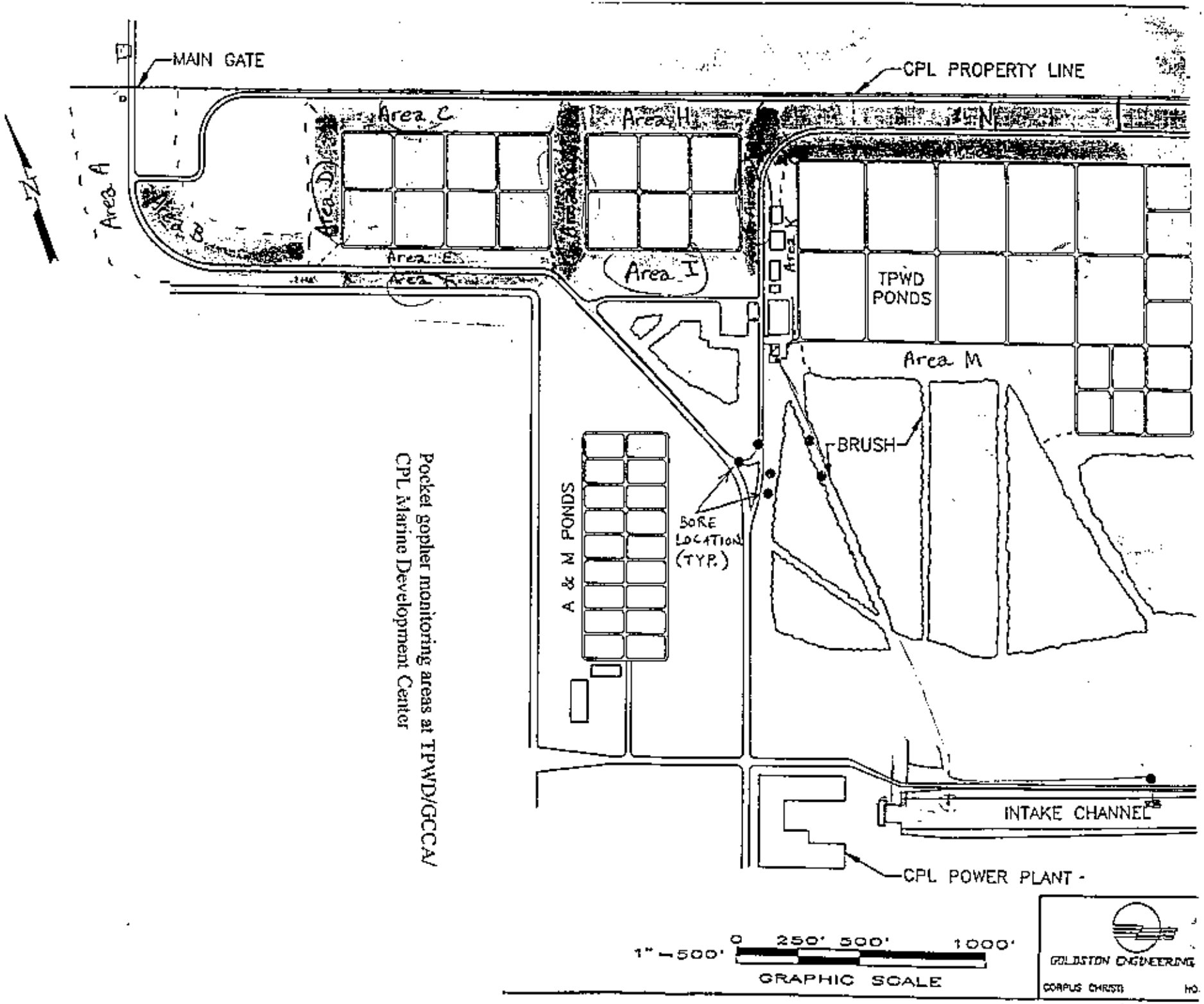
2. Distribution mapping - It would be of interest to monitor the distribution of this subspecies over a larger area, especially since pocket gopher populations tend to shift over time and land-use changes may be occurring simultaneously. Volunteers could drive or walk roads in the Flour Bluff area—mapping all locations where gopher mounds are present. Care should be taken to not trespass onto private property.

After each visit (or at end of project year)
Send copy of all data sheets and maps to TPWD at:

Texas Wildlife Watch
Endangered Resources Branch
3000 So. IH-35, Suite 100
Austin, Texas 78704

Special notes:
Be sure to coordinate visits with TPWD staff at the Marine Development Center. Be certain to not leave any permanent markers behind after completing your study.

Questions: Call Lee Ann Linam at 512-847-9480.



Pocket gopher monitoring areas at TPWD/GCCA/ CPL Marine Development Center

Maritime Pocket Gopher (*Geomys personatus maritimus*) Volunteer Monitoring Results
TPWD State Fish Hatchery - Flour Bluff, Texas

Site		TPW Marine Development Center										
Date		98-03-12				99-04-17		00-02-26				
Volunteer		Anissa Cates				Diane Hartung		Diane Hartung				
School		Kaffie Middle School				Miller HS		Miller HS				
Start time		9:30				10:00 a.m.		9:00 a.m.				
End time		12:20				12:00 noon		11:00 a.m.				
Temp (F)		55				75		70				
Last rain		98-03-07										
	Size	*Fresh*	*Old*	*Total*	*Fresh/*	*Fresh*	*Fresh/*	*Fresh*	*Fresh/*		*Clusters/*	*Mounds/*
Area	*(sq. ft.)*	*Mounds*	*Mounds*	*Mounds*	*Acre*	*Mounds*	*Acre*	*Mounds*	*Acre*	*Clusters*	*Acre*	*Cluster*
A	51,147	18	953	971	15.33	23	19.59	26	22.1	12	10.2	2.2
B	141,777	8	182	190	2.46	37	11.37	19	5.8	4	1.2	4.8
C	102,363	22	68	90	9.36	10	4.26	10	4.3	6	2.6	1.7
D	15,576	0	89	89	0.00	7	19.58	10	28	3	8.4	3.3
E	51,446	43	169	212	36.41	19	16.09	32	27.1	9	7.6	3.6
F	18,585	4	60	64	9.38	6	14.06	28	65.6	6	14.1	4.7
G	75,699	11	121	132	6.33	11	6.33	1	0.58	1	0.58	1
H	95,480	5	15	20	2.28	8	3.65	1	0.46	1	0.46	1
I	120,420	0	30	30	0.00	3	1.09	1	0.36	1	0.36	1
J	24,950	1	12	13	1.75	3	5.24	1	1.7	1	1.7	1
K												
L	154,019	16	441	457	4.53	38	10.75					
M	246,402					10	1.77					
N	135,546					16	5.14					
Totals	1,233,410	128	2,140	2,268	4.52	191	6.75	129	8.1	44	2.7	2.9

Sampling methods - This species is sampled by students counting all fresh gopher mounds found in sections of levee and roadside at the fish hatchery. In addition, in 2000 students began assigning all fresh mounds within 10 meters of each other to the same "cluster," representing potential active burrow systems.

2000 - An abbreviated survey of this site was made this year due to interruption by rain. Average number of fresh mounds/ acre was increased somewhat from 1999. In addition, an estimate of occupied burrows was attempted this year based on clusters of fresh mounds. Results indicated a total of 44 burrows or 2.7 burrows/acre. Once again active mounds were more common in mown than in unmown habitats.

1999 - Counts conducted by Miller High School students focused on fresh gopher mounds. Students were able to survey nearly all areas, resulting in an overall estimate of 6.75 fresh mounds/acre. Gophers were more common in mown areas than in areas with tall grasses.

1998 - Students from Kaffie Middle School used measuring tapes to determine the area in each sample area. They then counted both fresh and old gopher mounds. The number of fresh mounds/acre was determined as an index of population levels. Counts were compiled in 11 of the 14 segments, including all of the segments that seemed to support the highest gopher numbers, resulting in an index of 7.22 gophers/acre.

Data Sheet
Gopher Monitoring

Names:	Date:
Phone number:	Site:
Email:	Subsampling area:
Address:	Habitat description:
	Last rainfall date:

Burrow #	Day 1 # Fresh Mounds	Day 2 # Fresh Mounds

Total # Burrows	Total Fresh Mounds - Day 1	Total Fresh Mounds - Day 2

Horseshoe liptooth snail
Polygyra hippocrepsis



Dorsal view – live specimen



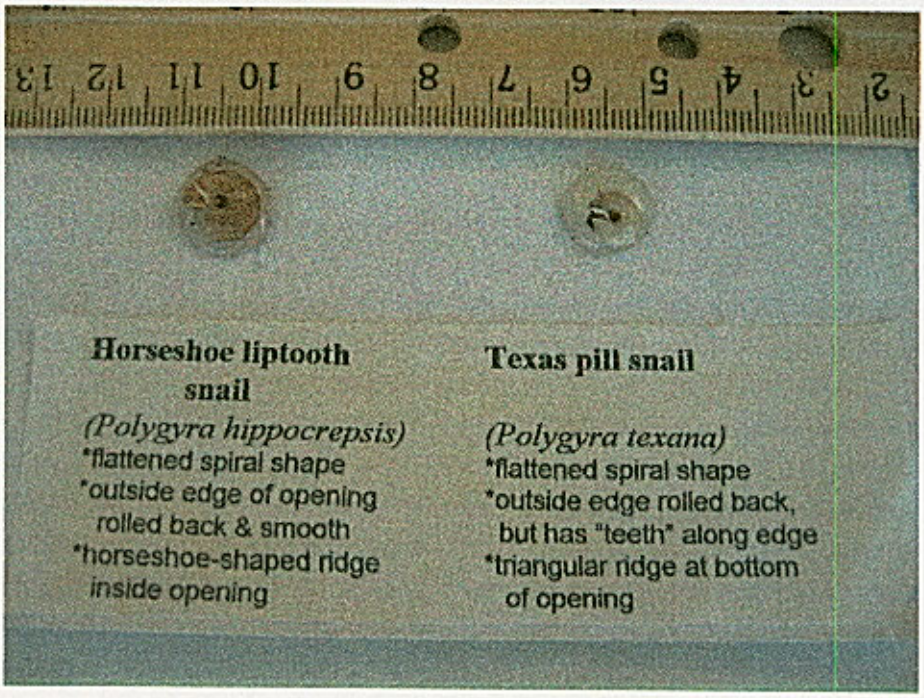
Ventral view – live specimen



Dorsal view – dead specimen



Ventral view – dead specimen



Comparison with common *Polygyra* species

Summary Report
Volunteer monitoring of horseshoe liptooth snail (*Polygyra hippocrepsis*)

Status of project

Texas Nature Tracker volunteers began monitoring the single known population of the species at Landa Park in New Braunfels (Comal county) in 1997. Data has been gathered consistently on an annual or semi-annual basis since that time.

Volunteer involvement

Volunteer efforts at this site have involved teachers and students from Churchhill High School and New Braunfels High School, with NBHS ultimately adopting the site for monitoring. The teacher, Denise Ortiz, has been proficient at identification and sampling methods; however school class size has usually been large, making continuing involvement by TPWD desirable, especially to confirm identification. Nevertheless, the presence of 20-60 volunteers greatly increases the sampling efficiency.

Monitoring methods

Methods are described in the attached protocol. Students are taught to use random sampling techniques within the known habitat of the species. The species is very rare, and these strictly random sampling methods result in very low encounter rates. In the future, we plan to utilize some classrooms to conduct more intensive, non-random searches in order to better assess whether some type of stratified sampling would be warranted. Such techniques could be used in nearby habitats as well to detect whether or not the species is present.

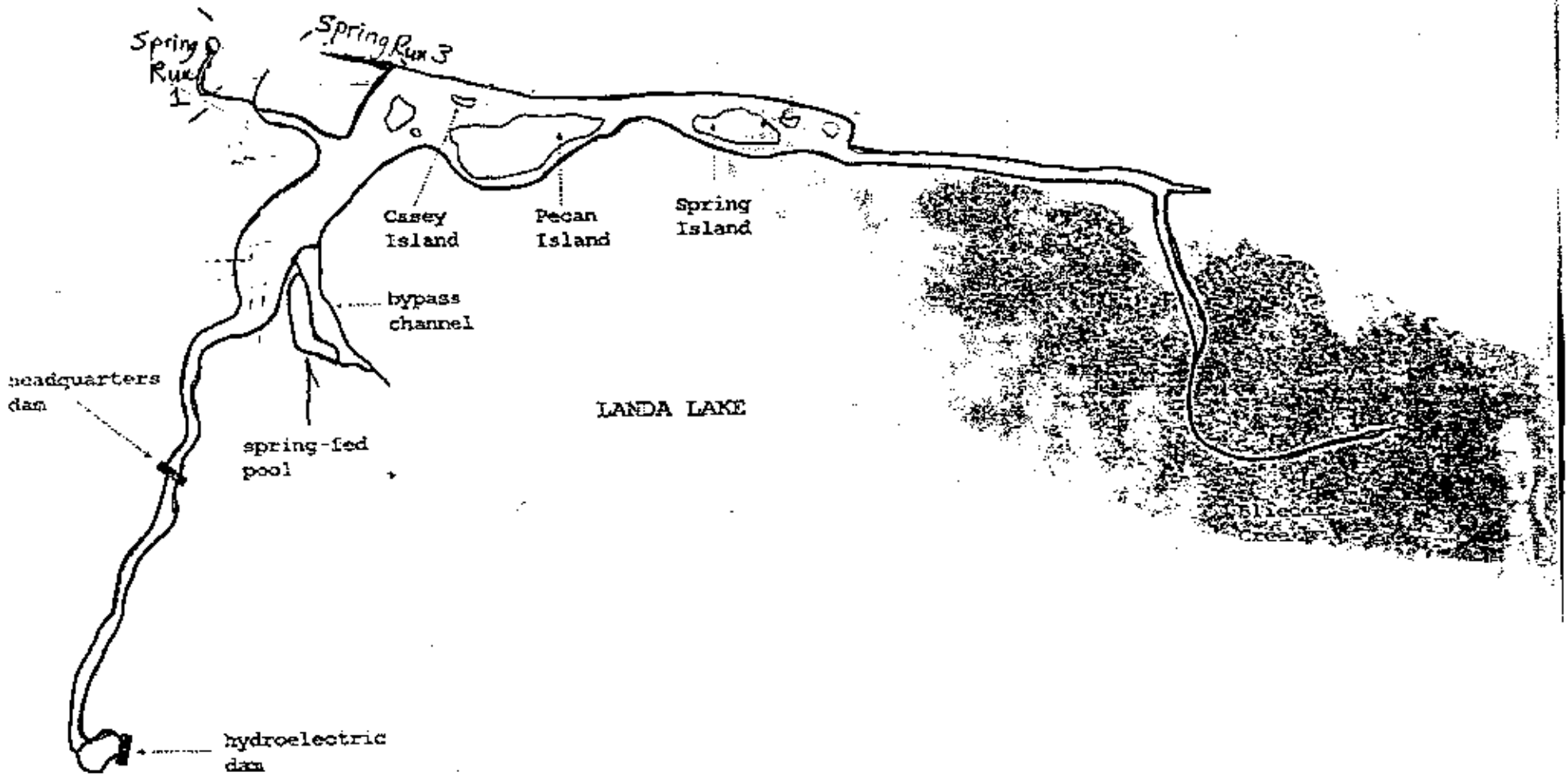
Results to date

This species is extremely rare, with only five live specimens having been encountered in 704 quadrats sampled. Live specimens were last found in 1999. Live specimens were

found in autumn, suggesting that at least some effort should be expended annually to sample during this season, but, with so few specimens encountered, few conclusions may be drawn. It is hoped that a more thorough non-random search might reveal some microhabitat features to target for the species, but it is also possible that this species is extremely rare and in danger of extinction.

Comal Springs and Landa Lake, Landa Park, New Braunfels, Texas.

Horseshoe liptooth snail (Polygyra hippocrepsis) sampling locations.



MONITORING PROJECT FOR THE HORSESHOE LIPTOOTH SNAIL (*Polygyra hippocrepsis*)
Landa Park - New Braunfels

Background: The horseshoe liptooth is a terrestrial snail known only from the wooded hillsides of Landa Park in New Braunfels. It is a flattened snail approximately 3/8 to ½ inch in diameter. Although another *Polygyra* snail occurs in the park, the horseshoe liptooth is distinguishable based upon a horseshoe-shaped ridge seen in the opening of the snail. Because only one population of this species is known, it is desirable to monitor its status and further define its distribution in the park.

Location: The snail has been found on the steep wooded hillsides along the spring runs in Landa Park and in the concrete culvert under Landa Park Road. In addition, it may occur in Panther Canyon.

Equipment needed:

- *one 25-100 m. measuring tape per team, plus at least two 100 m. measuring tapes for the baseline
- *one 0.1 m^2 rectangular quadrat per team
- * one data form, random numbers table, clipboard & pencil per team
- *magnifying lenses, small paintbrush (to clean snail), egg crate (for sorting snails)
- *sample snails for reference

Methods: These snails are found in moist areas within the leaf litter. (It is a detritivore--feeding on decaying plant matter). Sample sites will be set up along Spring Run 1 (on the west side of the road) and along Spring Run 3 (which runs eastward from the road to Landa Lake). Along these spring runs transects running from the base of the slope to the top of the slope will be established using random numbers. The length of the transect will be measured, and a random numbers table will be used to select locations for quadrats (five/transect on Spring Run 1 and three/transect on Spring Run 2). All snail shells within the frame will be counted and sorted to *Polygyra hippocrepsis*, *Polygyra texana*, and other. In addition, dead shells for *Polygyra hippocrepsis* will be counted (live snails can be separated from dead snails by seeing whether or not the shell floats in water). All live snails will be returned to the sample area after counting.

Sampling Period: Monitoring is only needed one time per year; however, terrestrial snails are very sensitive to climate conditions. The counts should be conducted during wetter seasons of the year (late fall to early spring). Extreme cold should probably also be avoided.

Notes: Researchers must sign in at the Parks and Recreation office before beginning work. Researchers should wear clothes and shoes that can get dirty or damp. Because poison ivy may be present in some areas, long pants, long sleeves, and clothes are recommended.

Contacts: Before initiating field work, contact should be made with the following person(s).

Project Coordinator:
Lee Ann Linam
TPWD Endangered Resources Branch
200 Hoots Holler Rd.
Wimberley, TX 78676
phone: 512-847-9480
fax: 512-847-1226
e-mail: *lalinam@wimberley-tx.com*

Landa Park
Iris Nefendorf, Director
New Braunfels Parks & Recreation Dept.
110 Golf Course Road
New Braunfels, Texas 78130
phone: 830-608-2160

ADDITIONAL NOTES FOR STUDENTS:

TO MAKE SNAIL MONITORING QUADRATS

1) Cut two pieces of PVC pipe 50 cm. long
2) Cut two pieces of PVC pipe 20 cm long
3) Use corners to join pieces together to make a rectangle--make sure pipe slides all the way into the corners.

SNAIL MONITORING INSTRUCTIONS

1. Use random numbers table to determine location of transects
   -between 001 and 115 meters along Spring Run #1 (pick 3 transects)
   -between 001 and 130 meters along Spring Run #3 (pick 5 transects)

2. At each transect site: Stretch your measuring tape uphill at your transect site to determine the length of your transect. Use a random numbers table to determine the location of quadrats on each transect, located between 01 and x (x is the length of your transect in meters). Select 5 quadrats/transect on Spring Run 1, 3 quadrats/transect on Spring Run 3.

3. At each quadrat location place the quadrat on the right hand side of the measuring tape, with the lower left-hand corner of the quadrat located at the randomly-selected number.

4. Count all snails in the quadrat by carefully picking through the leaf litter. Separate your counts into the following categories:
   -live horseshoe liptooth snails - remember that live snails appear brownish, and you can see that their is tissue inside when you hold it up to the light
   -dead horseshoe liptooth snails - dead snails may be whitish or simply dirty brown
   -Texas pill snails (*Polygyra texana*) - both live and dead
   -all other snails

Be sure to return all live horseshoe liptooth snails to their habitat when you are finished with the count.

5. Move on to the next quadrat and repeat.

RANDOM NUMBERS TABLE INSTRUCTIONS

Before looking at the table:

1. Decide how many digits of numbers you need (for samples between 1 and 10 you will need 1 column; for samples between 1 and 100, you will need 2 columns; for samples between 1 and 1000 you will need 3 columns;...)

2. Decide which columns you will read--for example: the first one on the left, the last three on the right, the two in the middle....)

3. Decide whether you will select numbers by going across, up the column, down the column, etc.

4. Finally, close your eyes and point to the table. That's your random starting point. If any numbers don't meet your criteria you skip to the next one. (For example, if you need a number between 1 and 130, but your three digit number is 204, then you skip it and keep going until you find a number between 001 and 130).

DIFFERENCES BETWEEN THE HORSESHOE LIPTOOTH AND TEXAS PILL SNAIL

horseshoe liptooth snail (*Polygyra hippocrepsis*)	**Texas pill snail** (*Polygyra texana*)
*note horseshoe-shaped ridge inside opening	*note "teeth" on upper margin of opening

Monitoring results for the horseshoe liptooth snail (*Polygyra hippocrepsis*) in Landa Park, New Braunfels, Texas.

Date	Temp (F)	Last Rainfall	Site	Volunteers	Statistic	# horseshoe liptooth - live	# horseshoe liptooth - dead	Total horseshoe liptooth	# Polygyra texana	# other snails	TOTAL SNAILS (live & dead)	quadrats sampled
28-Oct-97	70	26-Oct-97	Spring Run 1	Churchhill HS	Total number found	1	4	5	132	360	497	20
					Density (/sq. m.)	0.50	2.00	2.50	66	180	248.5	
22-Sep-98	80	12-Sep-98	Spring Run 1	New Braunfels HS	Total number found	0	1	1	185	316	502	59
					Density (/sq. m.)	0.00	0.17	0.17	31.4	53.6	85.1	
22-Sep-98	85	98/09/12	Spring Run 3	New Braunfels HS	Total number found	0	7	7	128	290	425	54
					Density (/sq. m.)	0.00	1.32	1.32	24.2	54.7	80.2	
17-Nov-98	75	14-Nov-98	Spring Run 1	NB HS	Total number found	0	5	5	129	308	442	49
					Density (/sq. m.)	0.00	1.02	1.02	26.3	62.9	90.2	
17-Nov-98	80	14-Nov-98	Spring Run 3	NBHS	Total number found	0	1	1	43	95	139	24
					Density (/sq. m.)	0.00	0.42	0.42	17.8	39.6	57.9	
15-Apr-99	70	13-Apr-99	Spring Run 1	NBHS	Total number found	0	2	2	237	440	679	43
					Density (/sq. m.)	0.00	0.47	0.47	55.1	102	158	
15-Apr-99	70	13-Apr-99	Spring Run 3	NBHS	Total number found	0	6	6	109	279	394	51
					Density (/sq. m.)	0.00	1.18	1.18	21.4	54.7	77.3	
30-Nov-99	67	27-Nov-99	Spring Run 1	NBHS	Total number found	2	3	5	237	435	672	40
					Density (/sq. m.)	0.5	0.75	12.5	59.3	109	168	
30-Nov-99	67	27-Nov-99	Spring Run 3	NBHS	Total number found	2	7	9	69	238	307	38
					Density (/sq. m.)	0.56	1.94	2.5	19.2	66.1	8.53	
30-Mar-00	70	28-Mar-00	Spring Run 1	NBHS	Total number found	0	1	1	157	279	436	69
					Density (/sq. m.)	0	0.145	0.145	22.8	40.4	63.2	
30-Mar-00	70	28-Mar-00	Spring Run 3	NBHS	Total number found	0	3	3	38	120	158	36
					Density (/sq. m.)	0.00	0.83	0.83	10.00	33.3	43.3	
11-May-01	78	6-May-01	Spring Run 1	NBHS	Total number found	0	4	4	113	124	241	46
					Density (/sq. m.)	0	0.87	0.87	24.6	27.0	52.4	
17-Apr-02	75	16-Apr-02	Spring Run 1	NBHS	Total number found	0	2	2	312	384	698	94
					Density (/sq. m.)	0.00	0.21	0.21	33.19	40.85	74.26	
16-Apr-02			Spring Run 3	NBHS	Total number found	0	2	2	63	189	254	83
					Density (/sq. m.)	0.00	0.24	0.24	7.59	22.77	30.60	

Sampling method - This species is sampled by groups of students who select random 0.1 m^2 quadrat locations along randomly selected transects in wooded habitats along Comal Spring runs in Landa Park. The students search through the litter for all gastropod shells encountered.

2002 - Involvement of several classrooms from New Braunfels High School (teacher Denise Ortiz) allowed the most intensive sampling to date; however, very few P. hippocrepsis shells were encountered. Students seemed to demonstrate a good search effort, as many other species were found. The extreme rarity of this species may require a more intensive search effort, with less focus on randomizing samples until a better habitat profile is developed.

2000-2001 - A more limited sampling effort was made this year due to constraints on volunteers' time. This sampling period represented the warmest sampling period undertaken, but no live horseshoe liptooth shells were encountered, so conclusions cannot be drawn.

1999-2000 - Excitement was generated in November 1999 when four live horseshoe liptooth snails were encountered by students and confirmed by TPW staff. The snails were found at three sites. All three sites were described as containing much leaf litter and detritus. One was at the base of a tree, while another was in the cove of a rock. The sampling date occurred 3 days after a rainfall event. This species continues to be quite rare, as the extensive sampling points over the last three years have sampled many similar microhabitats, resulting in few shells and even fewer live horseshoe liptooth snails encountered.

1998-99 - Several dead horseshoe liptooth snails were encountered, most near areas where litter had accumulated near rocks and trees and the base of slopes. New Braunfels experienced flooding rain in October 1998, perhaps resulting in a build-up of ground litter in certain locations.

1997-98 - Results indicate this to be a very rare species. The techniques, as well as distinguising features of *Polygyra hippocrepsis*, make this a very workable project for advanced science students, and the presence of volunteers greatly increases the number of samples that may be accomplished. With several teachers interested in the project, we hope to be able to sample across more seasons and rainfall patterns.

Data Sheet

Horseshoe Liptooth Snail (Polygyra hippocrepsis) Surveys in Landa Park

Researcher Names:_____ Date of Survey:_____ Date of Last Rainfall:_____ Temp:_____

Transect Location	Quadrat Location	NOTES	# horseshoe liptooth - live	# horseshoe liptooth - dead	Total horse-shoe liptooth	# Texas pill snails	# other snails	TOTAL SNAILS (live & dead)
1 (@ 1m.)	1 (@ 2m.)	mostly rocky	0	0	0	0	5	5
	2 (@ 14 m.)	big rock covers half of quadrat	0	0	0	14	7	21
	3 (@16 m.)	lots of leaves & deep soil	0	0	0	14	33	47
	4 (@21 m.)	lots of leaves at base of tree	0	0	0	20	34	54
	5 (@27 m.)	all rock	0	0	0	2	2	4

Texas Nature Trackers
FIELD INVESTIGATIONS USING RANDOM SAMPLING

Ann Miller, Texas Nature Trackers Volunteer Coordinator
Lee Ann Linam, Conservation Biologist

Introduction:
The following learning activities are intended to teach students field research skills that can be used to estimate populations. "Random Sampling In the Classroom" can be used as an introductory activity to teach concepts central to random sampling. For younger students, teachers may want to use the basic part of this activity through Procedure # 6.

Part 1: Random Sampling in the Classroom

Grade level: 4 - 12 **Subject:** Science/Math

Knowledge: estimating, ecosystems, populations, relationships between organisms and their environment

Skills: applying concepts, critical thinking, problem solving, using tools for scientific inquiry

Materials:
- 1 large box for each group. Each box should have a lid and a grid drawn on the bottom of the inside that divides the box into 6 sections (3 rows and 2 columns). A boot box or large pizza box works especially well. Line the bottom with a rough fabric to create friction so that the beans will not roll as easily.
- beans for each box (300)
- timer
- 1 die for each group

Background: In many situations, biologists are required to estimate the population of a particular species. Counting the number of individuals can be difficult or impossible for several reasons: 1) Sometimes there are too many of the species to count each individual. 2) The individuals may move and must be counted very quickly. 3) Individuals may be hard to find in the habitat. 4) The habitat is too large to be completely examined. In order to get an idea of the number of individuals present in a study area, biologists often must look for a method to estimate the population. Random sampling is a method used to make a population estimate and to reduce the chance of bias in deciding where to sample. This classroom activity teaches the concepts of estimation and random sampling. The field activity illustrates how to use random sampling in a real biological investigation.

Objectives: Students will:
1. devise methods for counting the number of beans in the box during a timed interval
2. define the terms: estimate, representative sample, and random sample
3. explain why biologists must work with estimates of the populations of species

have reduced the variance associated with your samples and that you have reached a sufficient sample size to estimate the population. You can also use the running mean strategy without a graph by making a decision that you will stop sampling when additional samples no longer change the estimate by greater than some predetermined amount (5%, for example).

8. Finally, compare the results of your estimates and the running mean exercise to the actual number of beans in the boxes.

Fig.1 Finding the running mean with samples of: 25, 30, 22, 44, 35, 27, 38, 40 (Round to .1)

$25+30=55 \quad \frac{55}{2}=27.5 \quad 25+30+22=77 \quad \frac{77}{3}=25.7 \quad 25+30+22+44=121$

$\frac{121}{4}=30.3 \quad 25+30+22+44+35=156 \quad \frac{156}{5}=31.2 \quad 25+30+22+44+35+27=183$

$\frac{183}{6}=30.5 \quad 183+38=221 \quad \frac{221}{7}=31.6 \quad 221+40=261 \quad \frac{261}{8}=32.6$

Graph the means (the bold numbers.)

The following questions can be used to extend thinking about random sampling.

1. Did we take enough samples to get an estimate that is close to the actual number of objects?
2. Can all of the boxes combined be compared to a large habitat that can not be easily seen or sampled by just a few biologists?
3. What are some of the pitfalls of random sampling?
4. What are some strategies scientists can use to reduce the error in estimating populations by random sampling?

Vocabulary:

1. estimate- a rough or approximate calculation
2. random sample - a subset of a larger group, each of whose elements has an equal possibility of occurring in the sample
3. representative sample - a subset of a larger group that is typical of the entire group (in this case, a sample that has an average number of items)
4. sample size – the number of data points collected to estimate a population characteristic
5. running mean – a moving average of a variable created as additional sample points are added to the mean; as additional sample points are added, variability decreases and accuracy increases

Part II - Random Sampling In the Field

After determining the location of a field site, use the following questions to help set up a successful random sampling field activity.

1. What are the boundaries of the area to be sampled?
2. What are the safety considerations for doing field work in the area to be sampled?
3. What question(s) could random sampling answer in this location?
4. What will be sampled?
5. What size should the quadrats be?

TABLE 1.1
Random Numbers

070675	915842	966401	542766	892514	973957	143469
630428	722031	568266	641829	850008	319216	532349
993012	353005	283254	701168	128250	623839	160852
853288	883003	600302	943581	467369	087607	635091
089545	4k4864	938397	435776	556429	800254	029642
528574	096282	924248	560561	608270	494747	651399
368560	104761	855860	005399	440305	163575	715405
292942	013687	586571	047045	562309	872389	501739
932822	026152	326042	076212	982994	014049	734647
737644	647308	845733	340159	830107	460913	679605
137494	544706	571894	477885	104414	837553	655677
161702	822366	265393	945094	683360	171694	270341
003567	186188	564131	527002	147210	432210	359868
718999	538290	576971	230540	170998	234805	422531
768352	842437	459869	678261	597613	932247	910369
304096	577705	755321	234499	333282	805744	143096
079825	470950	468884	3k8292	678436	562199	215157
296914	241649	006622	691356	416434	571070	360663
930615	274605	420237	013190	917223	732138	408850
718366	821249	027368	370978	294322	391789	826979
479547	563323	535001	817266	092669	355960	035595
275029	221211	951621	282315	636196	393656	292350
788388	261245	312958	366130	572095	967311	133687
673868	520586	837094	248132	986489	824952	909138
200296	960639	973621	274557	070641	246149	609361
306980	542827	930550	792818	260624	237615	504706
052154	852758	325246	481179	180965	995285	503697
027764	807281	507855	016485	938118	025316	246609
370180	400693	827831	304910	924864	940013	698077
882266	457836	452749	853308	698510	348002	996156
535934	996423	334523	651680	982634	818301	489219
979073	169045	521949	112283	594822	214704	242282
160760	213669	141666	347999	828379	479250	279671
527643	453098	051855	242124	430860	776720	636403
174906	358273	333568	441821	788143	343371	938677
111183	761996	738390	283132	734932	513119	143441
002755	794838	364257	727445	699924	393653	853617
795431	751760	789823	577535	687767	654684	206255
535065	095899	824467	356553	188731	800936	883351
538911	561908	822471	338497	972356	241407	832722
617898	211850	636528	373906	993349	087115	885107
186376	287114	061995	636045	860021	527820	472253
161537	988531	508665	154734	885471	979596	730834
523209	009402	500986	951815	337487	897011	998905

Appendix G

Results of monitoring by TPWD staff

1) *Agalinis navasotensis* – Navasota false foxglove
2) *Psilactis heterocarpa* – Welder macheeranthera
3) *Liatris cymosa* – branched gayfeather
4) *Castilleja elongata* – fringed paintbrush
5) *Festuca ligulata* – Guadalupe Mountains fescue
6) *Helianthus paradoxus* – puzzle sunflower
7) *Hibiscus dasycalyx* – Neches River rose mallow
8) *Charadrius montanus* – mountain plover
9) *Corynorhinus rafinesquii* – Rafinesque's big-eared bat and
   Myotis austroriparius – southeastern myotis

Rare Plant Surveys and Monitoring, 2001-02 – Dana Price, TPWD Botanist

Agalinis navasotensis – **Navasota false foxglove**

Location: Grimes and Washington Counties

On 9/19/2001, WDP staff Dana Price and Jason Singhurst visited the two known localities with TAMU herbarium botanist Monique Reed and volunteer Lori Biederman. It was a good year for the plants. We observed about 500 plants at EOR #001 and 70 plants at #002.

After examining geologic and soil maps and digital imagery, we searched several nearby areas with outcrops. Oakville formation outcrops in Washington County were also examined. Some had other species of *Agalinis*, but no other populations of *A. navasotensis* were located.

On 10/02/2002, Dana Price visited the two EORs with Monique Reed and other TAMU faculty and students. This year the grasses (particularly little bluestem) were more dominant. *A. navasotensis* plants appeared healthy and vigorous, but only about 100 plants were observed at EOR #001 and about 20 plants at #002.

Again this year, we unsuccessfully searched nearby localities that have similar soils and geology.

Psilactis heterocarpa – **Welder machaeranthera**

Location: Victoria, Refugio, San Patricio and Karnes Counties.

In 2000, Dana Price photographed this species for the rare plant book and in the process revisited the type locality (EOR #001) at Welder Wildlife Refuge as well as a few other EORs (#010, 018, and 024 were confirmed still extant). No quantiative monitoring was done.

In 2001, Greg Bowen, a reporter for the Victoria Advocate did a series of stories on this plant, the only globally-rare plant species known to occur in Victoria County. This spurred community interest in locating additional populations of the species. As a result, Dana Price conducted a workshop with community members to help them learn to identify the plant. Presentations were also given at the high school. This resulted on two new populations of *P. heterocarpa* being found on private land. One, in Karnes County, was discovered by amateur boatnist Pat Neill and Kenedy residents Erwin and Annie Kramer. This population was confirmed in November 2001 and contains hundreds of plants. A second new population on a ranch in Refugio County was reported by a high school student and her grandmother and was confirmed in October 2002. Hundreds or possibly thousands of plants are present on this ranch

In 2002, Lee Ann Linam and Dana Price revisited EOR #001 but in this wet year, found plants only in the drier area surrounding an oil-drilling pad. We gave a presentation on this species and other rare pants and animals of the coastal prairies for the Golden Crescent Nature Club in Victoria. Following this presentation, another population has been reported on a private ranch in Goliad County. This sighting has been confirmed by Don Kolle, a botanically-trained teacher in Victoria, but awaits a site visit.

Liatris cymosa – **branched gayfeather**

Location: Brazos and Washington Counties

In 2001, a volunteer, Lori Biederman, trained in how to identify the species by meeting Dana Price at known sites (#016 and 024). She subsequently located 10 new populations of *L. cymosa* in and around College Station. Most of the sites were visited and confirmed by Dana Price in November 2001. Many of these are threatened by development. At one site where a new subdivision was being developed, Ms. Biederman obtained permission to remove seeds and corms. These plant materials were sent to the Lady Bird Johnson Wildflower Center to be included in their conservation collection.

Ms. Biederman also revisited several previously known EORs. At the following locations, no plants were found: EOR#001, 002, 007, 013, 022, 025, and 026. Plants were present at the following sites: EOR#005 (40 plants; area is for sale), #011 (few plants), #012 (30-40 plants), #017 (14 plants in City arboretum), #019 (150 plants in City park).

In 2002, Lori Biederman (now a graduate student at TAMU) and Dana Price located three new populations of L. cymosa. One large population is on TAMU's range Science facility. Because the total number of EORs now is up to 40, the emphasis of work with this species will now shift to management at public-lands sites.

Monitoring Data for
Castilleja elongata
Big Bend National Park

The plot runs along the Laguna Meadows trail, from the first sharp turn beginning the descent from the black									
	"shale" to some large boulders about 100 meters down the trail. Numbers of individuals are								
	counted within 2 meters of the trail, both upslope and downslope.								
		1997	1996	1995	1994	1993	1991		
# plants upslope		1	11	34	64	63	57		
# plants downslope		0	3	1	2	5	17		

Monitoring data
for Festuca ligulata
Big Bend National Park

	2000 inflor. #	2000 spikelet #	2000 # plants	1998 inflor. #	1998 spikelet #	1998 # plants	1997 inflor. #	1997 spikelet #	1997 # plants	1996 inflor. #	1996 spikelet #	1996 # plants	1994 inflor. #	1994 spikelet #	1994 # plants	1993 inflor. #	1993 spikelet #	1993 # plants
PLOT 1	ca. 12 m at 20 degrees from rock shelter on slope below Boot Canyon trail, below Boot Springs camp sites																	
	2	54	3	28	374+	7	23	439	8	4	87	11	14	174	17	13	193	14
PLOT 2	5.85 m at 343 degrees from Plot 1 north stake																	
	0	0	1	17	325+	7	25	645	7	0	0	7	12	275	11	1	17	10
PLOT 3	14.5 m at 57 degrees from Plot 2 north stake																	
	0	0	1	0	0	2	5	70	2	0	0	6	7	98	6	4	78	6
PLOT 4	ca. 8.9 m at 87 degrees from large weeping juniper, below Colima Trail, base of boulder field																	
	0	0	1	6	75	6	114	1890	37	0	0	8	2	26	6	3	39	7
PLOT 5	ca. 27.5 m at 270 degrees from large weeping juniper below Colima Trail, base of boulder field																	
				115	1568	50	18	305	12	3	44	35	71	927	43	38	499	50
PLOT 5A:	ca. 27.5 m at 270 degrees from large weeping juniper below Colima Trail, base of boulder field; in 2000 this plot was resited at these coordinates, both original stakes were missing, the new stake is due west of a Nolina erumpens and a small pinyon																	
	0	0	54															
PLOT 6	ca. 24.4 m at 80 degrees from large weeping juniper, above Colima Trail, base of boulder field																	
	0	0	18	58	781	30	165	3127	51	1	15	47	44	547	41	1	17	38
TOTALS	2	54	78	224	2424	102	350	6576	117	8	146	114	150	2047	126	60	843	125

1993: Monitoring plots were set up and run on September 14, 1993 by Jackie Poole

1994: Monitoring was conducted on September 21, 1994 by Jackie Poole, Gena Janssen, ar

1995: Data sheets were lost,

1996: Monitoring was conducted on October 9, 1996 by Jackie Poole, Liz Slauson, and Wendy Hodgson,

1997: Monitoring was conducted on October 8, 1997 by Jackie Poole, Liz Slauson, and Kathy Rice.

1998: Monitoring conducted on October 14, 1998 by Jackie Poole and David Hernandez. Drought conditions prevailed.

1999: Monitoring was not conducted this year.

2000: Monitoring was conducted on October 3, 2000 by Jackie Poole (recorder) and Joe Sirotnak, Linda Hedges, Sally Roberts, and John Morlock. Few plants were in flower probably due to the severe drought. Reduced numbers of plants were probably also related to the drought. Both stakes for Plot 5 were missing. Using the distance and bearing from the reference feature the plot was relocated. Thus data previous to this date will not be comparable data taken later.

The plots are circular with a 5 m radius. Each plot is marked by a center stake and a stake at 5 m north. All Festuca ligulata plants within the plots are recorded.

broken = inflorescence stalk is broken, either partially allowing some spikelets to be counted (x(broken) or totally with no spikelets present (xbroken)

dispersing = seeds are dispersing but plumes are still present

inflor = inflorescence

mia = missing. Missing plants are looked for up to three years.

Helianthus paradoxus monitoring plot
Crossing of Hwy 18 and Diamond Y Creek

	1991	1992	1993	1994	1995	1996	1997
SW quad	331	161	158	2427	405	42	516
NW quad	132	62	105	323	171	18	42
NE quad	61	2	4	2	20	52	104
SE quad	21	0	41	11	67	62	142
outside				625	80	0	34
TOTAL	545	225	308	3388	743	174	836

Hibiscus dasycalyx
Monitoring on
Highway Right-of-way

SITE 1 - East of roadside park, west of Neches River, on Highway 94, Trinity County

	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993
# plants	20	15	17	49	13	15	18	41	38	27
#stems	nd	nd	nd	200	25	36	71	140	171	79
# fl/fr	nd	440	nd	354+	40	141	79	132	60	429

SITE 2 - 2.4 miles southwest of Lovelady on Highway 230, Houston County

	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993
# plants	12	4	8	14	13	6	2	1	4	4
#stems	nd	nd	nd	~50	39	13	7	5	73	43
# fl/fr	nd	0	nd	~194	9	34	14	3	224	449

SITE 3 - Mud Creek, Cherokee County

	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993
# plants	0 (+8)	5	1	2	1 (?)	1 (+~75)	1	1	1	1
#stems	nd	nd	nd	9	8	7	5	4	8	5
# fl/fr	nd	~130	nd	~205	25	186	83	100	322	183

1998 was a year of extreme drought in east Texas. Although the plants were up, they were stunted and not producing many flowers. At the Mud Creek site, the recently rediscovered plants under the bridge were inaccessible due to high water, even though it was a dry year. These plants are shown in parenthesis.

1999 shows the recovery from the drought. Also Hibiscus dasycalyx has begun colonizing the area at Site 1 which TxDOT has left unmowed. Four hybrids were seen at site 1, including some H. dasycalyx X H. moscheutos. Data collected by Kathy Nemec, Ricky Maxey, Jackie Poole, and Stephen F. Austin State University staff. Data recorded by Jackie Poole on August 4 and 5 1999.

2000 was another drought year. While some sites were just beginning to form buds and flower (Mud Creek), other sites were already in fruit (Lovelady). Due to a lack of time, numbers of stems, flowers, and fruits were not counted. Data collected by Ricky Maxey and Jackie Poole. Data recorded by Jackie Poole on 2 August 2000.

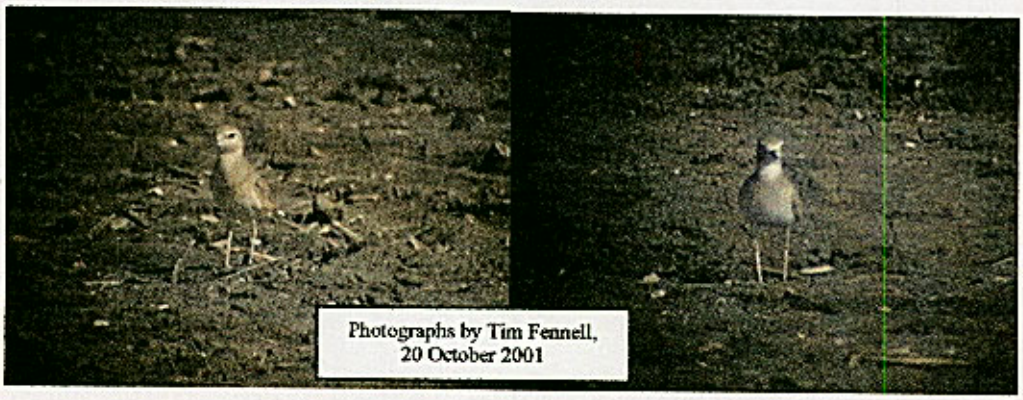
2001 was not exactly a drought year, but precipitation occurred sporadically. Insect herbivory was a major problem at the Lovelady site with ~90% of the leaves showing insect damage. The Highway 94 site has active hybridization occurring between H. dasycalyx, H. laevis, and H. moschuetus. There were 5 hybrids seen along with 10 individuals of H. moschuetus and 4 individuals of H. laevis. The Mud Creek plants appeared to be going into a second flowering phase with as many buds as fruits, but few flowers. Hybridization also occurs at this site. Due to lack of time, numbers of stems were not recorded. Data collected by Ricky Maxey, Kathy Nemec, and Jackie Poole. Data recorded by Jackie Poole on 14 August 2001.

Hibiscus dasycalyx
Monitoring on
Highway Right-of-way

2002 appeared to have had times of rain and drought, and precipitation varied between the sites. At Site 1 the powerline company had mowed their right-of-way which allowed us to survey more of the area. The increase in numbers may be an artifact of increased survey area. Plants appeared fairly healthy at this site with little drought stress. 15 individuals of H. laevis and 4 individuals of H. moschuetus were also seen, as well as three hybrid-appearing plants (H. dasycalyx X H. laevis). At Site 2, the plants on the right-of-way appeared severely drought-stressed, and the pond on adjacent private land was dry. The plants had numerous dead stems, and the few living stems had few, very small leaves. The number of plants increased at this site as it was very easy to pick out individual clumps as most other vegetation was dry and/or dead. Plants across the road in the pasture looked good however. Site 3 had been herbicided by the powerline company. Although it looked as though the vegetation was only affected at the stem tops, the one H. dasycalyx east of the bridge could not be found. Five plants were found west of this, east of the creek. The area east of the creek had been recently mowed, and the five plants were along the forest or creek edge. The west side of the creek had not been mowed, and vegetation had grown thick and tall, hiding H. dasycalyx. We found three plants here, and Karen Clary was going to ask TxDOT to mow the site as soon as possible. All plants were in fruit, with seeds ready to disperse. The hybrid swarm around the westernmost bridge had also suffered some from herbicides and mowing, but no easily discernible individuals of H. dasycalyx were seen there. Karen GPSed all sites. Data collected by Jackie Poole, Karen Clary, and Ricky Maxey; recorded by Jackie on September 30, 2002.

Mountain Plover (*Charadrius montanus*) Report

Prepared by Marsha May Reimer – Texas Parks and Wildlife Department



Photographs by Tim Fennell, 20 October 2001

Endemic to the North American Great Plains, the Mountain Plover (*Charadrius montanus*) is associated with shortgrass and mixed-grass prairies (Fennell 2002). The Breeding Bird Survey website displays the summer distribution of range of the Mountain Plover in 1996 (see attached map) at:

(http://www.mbr-pwrc.usgs.gov/bbs/htm96/map617/ra2810.html)

To find out more about the distribution of Mountain Plovers in Texas, I sent out an E-Mail on the TEXBIRDS list serve at TEXBIRDS@LIST.AUDUBON.ORG on 3 October 2001 requesting information on any sightings of these birds along with a few field observations. This list serve is visited by many talented birders throughout the entire state of Texas. This report includes the information that I received.

Knopf (1996) describes a breeding population in the Davis Mountains, TX that may not migrate. I received an E-Mail from Petra Hockey on 4 October 2001, stating that there was no record of Mountain Plovers in the Davis Mountains during the summer of 2001 (see attached E-Mail).

Fennell (2002) states that the largest wintering Texas population of this species occurs in eastern Williamson and Bell Counties near Granger, Texas (see attached map). Tim Fennel's first sightings of Mountain Plovers at Granger, TX began with one observation on 4 February 1995 with no location details and one observation on 28 November 1997. Tim has been monitoring Mountain Plovers in the Grainger area faithfully since 19 January 1998 (see attached data sheets submitted to the Texas Parks and Wildlife Department). This report also includes data of wintering Mountain Plovers collected between 13 October 2001 and 16 March 2002 and submitted by Tim Fennell to the Texas Parks and Wildlife Department on 1 July 2002. The maximum daily number of Mountain Plovers observed between 13 October 2001 and 16 March 2002 ranged from 116 birds on 4 November 2001 to 3 birds on 16 March 2002 (Figure 2 and Table 1).

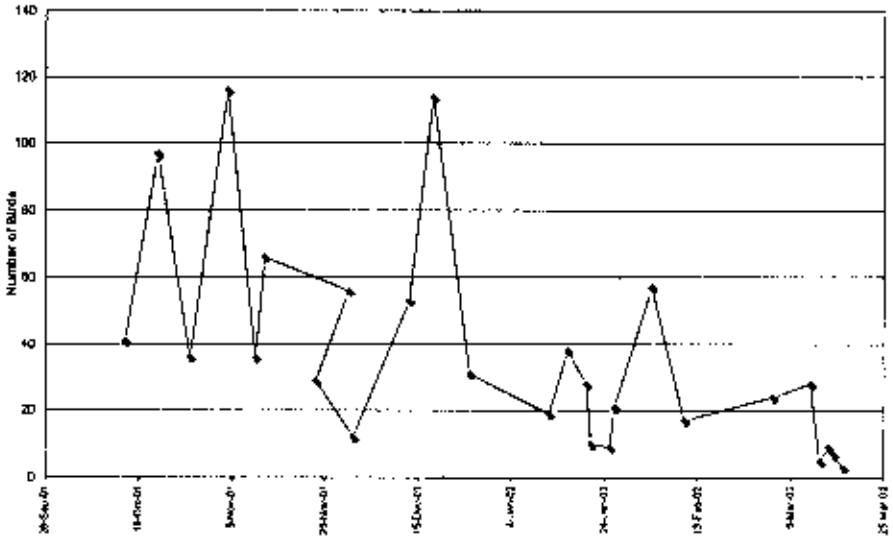


Figure 2. Grainger, TX Wintering Mountain Plovers (*Charadrius montanus*)
13 October 2001 - 16 March 2002

Table 1. Maximum number of Mountain Plovers observed for each day (See Granger Mountain Plover: October 13, 2001 – March 16, 2002 by Tim Fennell)

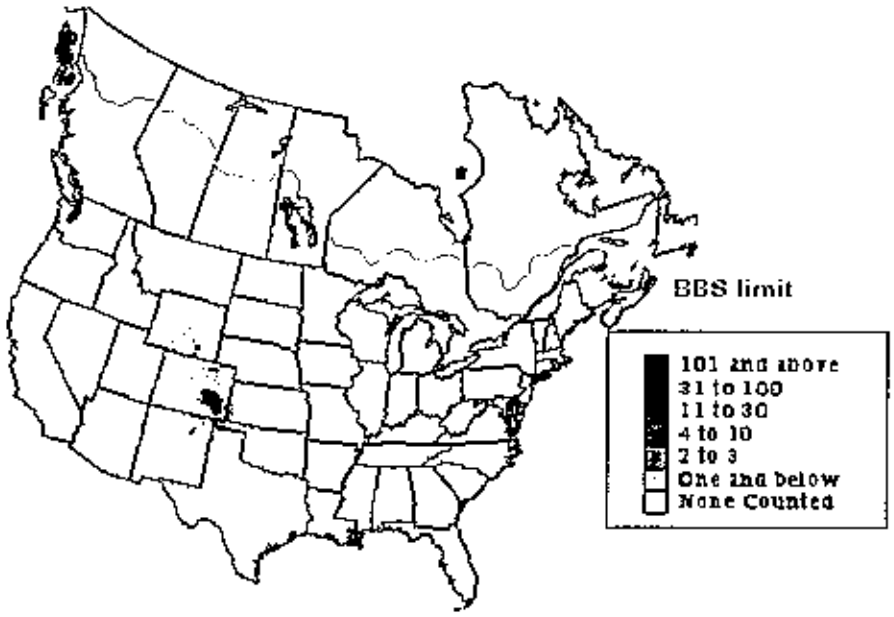
Date	Maximum Number of Birds Observed
13-Oct-01	41
20-Oct-01	97
27-Oct-01	36
4-Nov-01	116
10-Nov-01	36
12-Nov-01	66
30-Nov-01	56
23-Nov-01	29
1-Dec-01	12
13-Dec-01	53
18-Dec-01	114
26-Dec-01	31
12-Jan-02	19
16-Jan-02	38
20-Jan-02	28
21-Jan-02	10
25-Jan-02	9
26-Jan-02	21
3-Feb-02	57
10-Feb-02	17
1-Mar-02	24
9-Mar-02	28
11-Mar-02	5
13-Mar-02	9
14-Mar-02	7
16-Mar-02	3

Data was collected by roadside counts using binoculars and a spotting scope. All Mountain Plovers were observed on or near plowed corn or sorghum fields.

I also received an E-Mail from Tom and Nancy Langschied of Kingsville, TX that stated while they were conducting a Burrowing Owl survey in the Laureles division of King Ranch, located directly east of Kingsville, they located five Mountain Plovers on a plowed field (see attached E-Mail).

Mountain Plover *Charadrius montanus*

Summer Distribution Map



http://www.mbr-pwrc.usgs.gov/bbs/htm96/map617/ra2810.html

WebMail - RE: [TEXBIRDS] Call for Mountain Plover sightings in Texas

Delete | File | Create | Reply | Reply All | Forward | Previous | Next | Options | Index | Help

Date Sent: Thursday, October 04, 2001 8:33 AM

From: Petra Hockey <phockey@tisd.net> Add to Address Book

To: mr50509

Subject: RE: [TEXBIRDS] Call for Mountain Plover sightings in Texas

Status: Urgent New

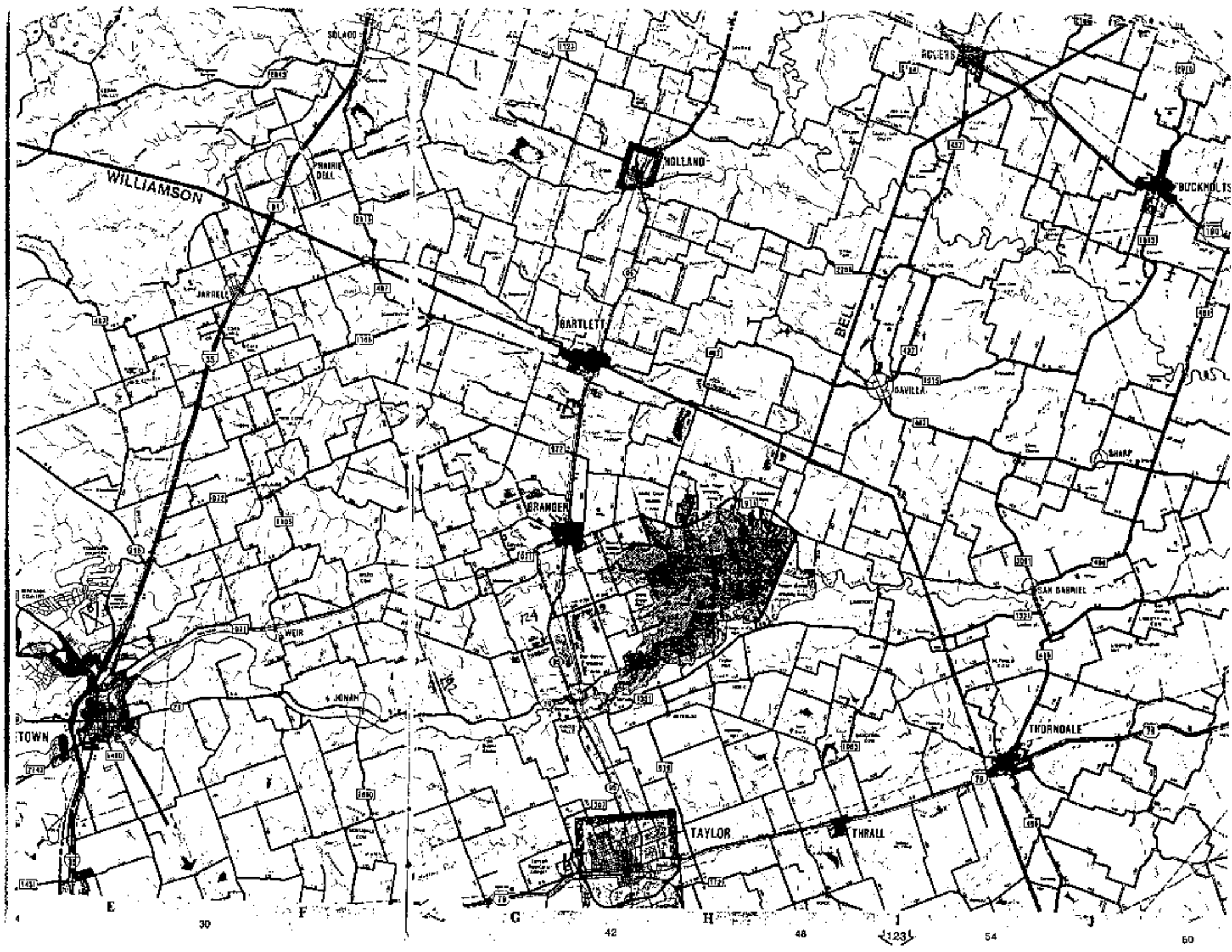
Marsha,

nothing on the positive site ... yet. It looks like there were no summer Mountain Plovers in the Davis Mts. this year. I asked several locals during the TOS convention; nobody knew of any.

I imagine that Tim Fennel or Brush Freeman will be some of the first folks to find the Granger area MOPLs when they return to their wintering grounds. Those sightings will likely get posted to TexBirds but I know that at least Brush does not always read TexBirds and will likely not send you a separate note. Therefore, even though Haaseth just confirmed his already known "moron status" once again it might be a good idea to check the TexBirds archives every once in a while with a search for MOPLs, but I would suggest you also check the on-line Clearinghouse (I can give you the address if you don't have it) for sightings when the time is right. Brush and Tim always report their important stuff. If the Clearinghouse does not contain enough required details on behavior, etc. you can always ask the reporter for additional details. I am sure they'll be happy to cooperate.

Petra Hockey ----------
>From: mr50509 <mr50509@SWT.EDU>
>To: TEXBIRDS@LIST.AUDUBON.ORG
>Subject: [TEXBIRDS] Call for Mountain Plover sightings in Texas
>Date: Wed, Oct 3, 2001, 7:00 PM
>

>Hello Texas Birders:
>Have you seen any Mountain Plovers in Texas lately?
>If you have, please let us know. We are interested in how many were observed,
>here (direction and milage from the closed town), when you observed one or
>more Mountain Plovers(please include time of day), what behavior was observed
>(flying overhead, foraging, etc.) and what were the weather conditions. Photos
>are always welcome. Thank you.
>
>Please send information on your sightings to:
>
>Marsha M. Reimer
>Texas Nature Trackers



SOLADO
WILLIAMSON
PRAIRIE DELL
JARRELL
HOLLAND
ROGERS
BUCKNOLTS
BARTLETT
BELL
GAVILLA
SHARP
GRANGER
SAN GABRIEL
WEIR
JONAH
TOWN
THORNDALE
TAYLOR
THRALL
E
F
G
H
I
J
30
42
48
54
60

Granger Mountain Plover 2/4/95- 3/14/98

These are misc. records referenced to the locations listed in the 2000/2001 report.

2/4/95
50+, no details

11/28/97
15 @ Location 3

1/19/98
117 @ Location 5

1/24/98
10+ @ Location 5

1/31/98
2 @ 9:00 am, 35 @ noon @ Location 5

2/16/98
10 @ Location 5 (10 @ NW corner of CR 347/346 intersection @ 1:00 pm, spooked by two Red-tails)

19 @ Location 5 (19 @ SE corner of CR 346/345 intersection @ 2:00 pm; 13 roosting at 5:45 pm)

17 @ Location 6 @ 2:20 pm; 9 roosting @ 5:30 pm

3/2/98
5 @ Location 5

20 @ Location 6

3/14/98
12 @ Location 5

2 @ Location 6

Granger Mountain Plover: October 10, 1998 - March 1,1999

10/10/98
About 10:00 am, Brush Freeman and I had at least 41 Mountain Plover north of Granger Lake. To reach the location, take Co. Rd. 359 (about 1 mile west of the dam on FM971) north for 1.5 to 2 miles until you reach a "T" and turn left (west) on this road. Drive about .5 mile until the road turns sharply to the right(north). The plover were in the fields to the west of this sharp turn (and south of the farm track that runs through the fields). They were actively feeding in a field of stubble.

10/21/98
From 6-6:30 pm, I had 8 Mountain Plover in the same location as above. The birds were actively feeding.

10/22/98
From 5- 5:30 pm I had 17 plover in the same location as above. About a mile to the north of this location, as I turned east onto Alligator Road, I noticed two flocks of shorebirds wheeling back and forth over a heavily-grazed, very wet pasture to the south of Alligator. One was a flock of 10 Mountain Plover and the other was a flock of 11 Long-billed Curlew. Both flocks were vocalizing. The two flocks briefly flew together and then the curlew landed in the field and began to feed. The plover continued to wheel back and forth over the field for another minute or so and then disappeared flying to the north of Alligator Road. I never saw the plover flock on the ground in the pasture. The total time the flocks were seen in flight was about 5 minutes.

10/25/98
28 Mountain Plover in the fields (lightly furrowed field with some stubble, not plowed since last weeks rain) NW of the Co. Rd. 346/347 intersection. Weather: Sunny, clear, calm,60's Observed from 7:00 - 7:35 am. From 7:00 - 7:25, 2 were feeding, 8 were standing and preening and 18 were roosting on their bellies. At 7:25, 11 plover were seen flying. I couldn't tell if they were new arrivals or some of the roosting birds after having taken flight. By 7:35 when I left, any birds seen were feeding or flying around the fields.

11 Mountain Plover in the same fields (lightly furrowed field with some stubble, not plowed since last weeks rain) as 10/10 (at sharp bend on Co. Rd 360, about .5 miles west of intersection with Co. Rd. 359). Weather: Sunny, clear , wind~ 5 mph, 70's. Observed from 10:35- 11:00am. All birds actively feeding. 50+ American Pipits in the same fields.

11/7/98
From 7:00 -9:00am, > 50 Mountain Plover on west side of bend described on 10/10 and 11(some on edge of road) on east side. Observed with Brush Freeman, Alvin Cearly and Andy Donnelly. At 7:00 am, only a few roosting birds

were visible on the west side of the sharp bend. By 8:00 am all the birds seen were actively foraging.

11/11/98
At 9:30 am , one Mountain Plover at the 10/10 location. Also a flock of 15 Chesnut-collared Longspurs.

12/6/98
I had a group of 17 Mountain Plovers actively foraging in a field of stubble at 12:30 pm today. The location was .5 mile south of the intersection of HWY 95 and Co. Rd. 338 on the east side of HWY 95 between Granger and Taylor. I did not see them at any of their other usual haunts today.

12/12/98
14 Mountain Plover @ 8:30 AM at the 90 degree bend on Co. Rd. 357 . The birds were north of the of the bend and on the west side of the road (take FM 971 past Friendship Park turnoff, turn left on County Road 359, go to the "T" intersection with County Road 360, turn left, go 1/4 to 1/2 mile to the 90 degree bend in the road and look in the fields here)

7 Mountain Plover @11:45 AM .5 mile east of the intersection of County Roads 346 and 347. The birds were on the north side of Co. Rd 346 between the road and the white farmhouse.

11 Mountain Plover @ 12:15 PM on the north side of Co. Rd.346 between the railroad tracks and the first house to the east of the railroad tracks.

The birds on all locations were actively foraging in stubble fields.

12/20/98
2 Mountain Plover @ 9:30 AM .5 mile east of the intersection of County Roads 346 and 347. The birds were in the stubble field on the north side of Co. Rd 346 between the road and the white farmhouse.

4 Mountain Plover @ 10:30 AM in the stubble field south of the intersection of Co. Rds. 124 (labeled 338 on most maps) and 340 (labeled 337 on most maps). This is the first time in several years that I have seen them west of HWY 95. Co. Rd. 124 runs west off of HWY 95 about two miles north of the HWY 95/HWY 29 intersection (north of Taylor). The intersection with Co. Rd. 340 is 2-3 miles west of HWY 95.

1/3/99
2 Mountain Plover @ the intersection of Co. Rd. 124 and 340 (west of 95)

1/10/99

After spending the day birding the Granger/Lake Alcoa area, I decided to check the usual Mountain Plover fields. After an hour, I had no luck. As I started for home at 4:30, I spotted what I thought could be some longspurs in a field at the northeast corner of
the intersection of Williamson Co. Rds.345 and 347. It turned out to be American Pipits and they were part of strange mix of feeding birds. In this freshly plowed, red dirt field were 1000's of Common Grackles, Red-winged Blackbirds, Brown-headed Cowbirds and Starlings, 100's of American Pipits, ~ 50 Meadowlarks, ~ 20 Killdeer, ~ 10 American Robins and 22 Mountain Plover. As all of these species were sometimes in the same scope view, it was a very strange sight indeed!

I usually see Mountain Plover in big, empty fields. They looked very out of place foraging next to all of these other species. I couldn't determine what the birds were eating. When a Red-tail passed over the field, the activity and different flight styles of this "mixed species flock" was quite a show also.

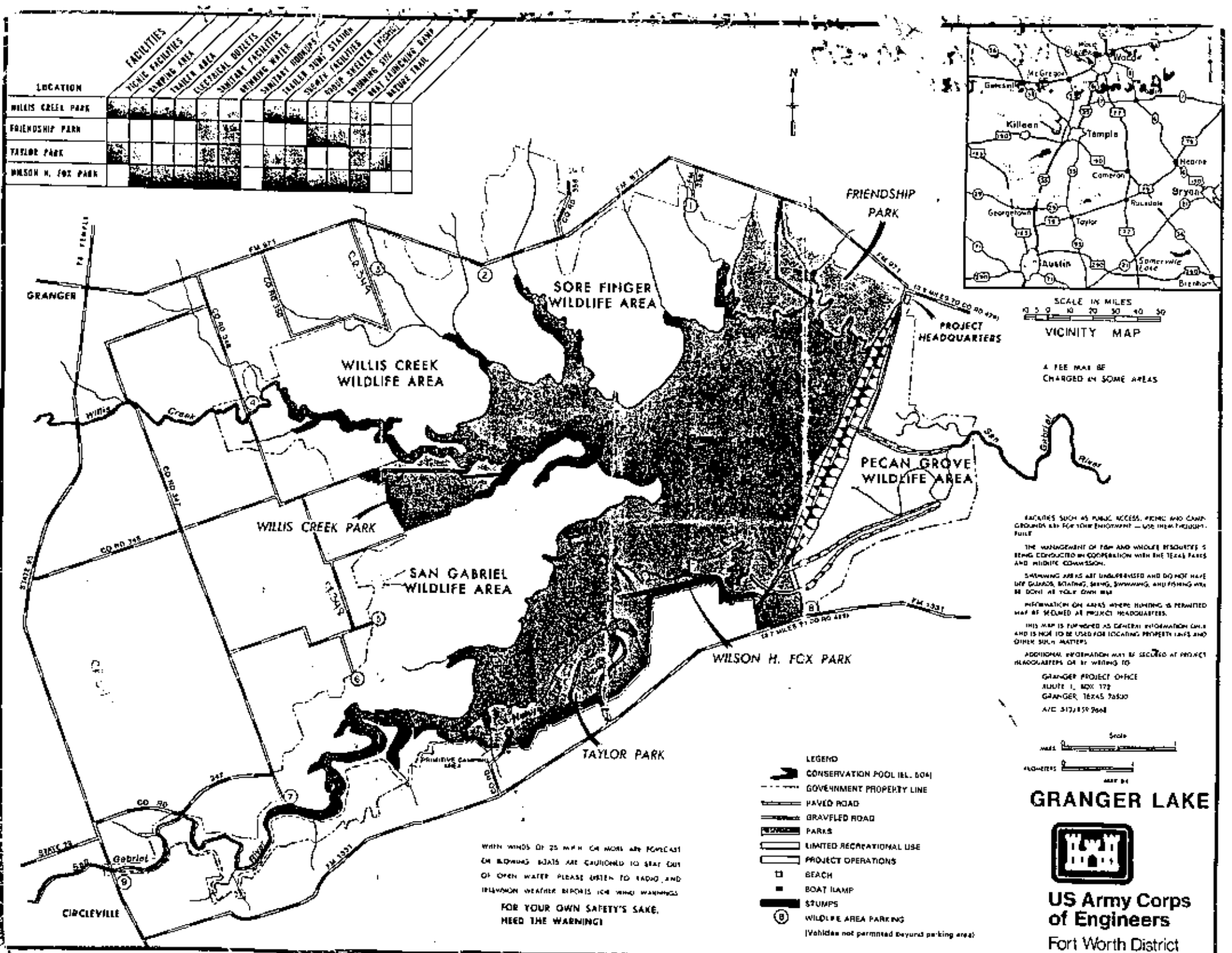
As I continued home, I saw two more plover about 1.5 miles west of HWY 95 on Co. Rd. 124. One was on the north side of 124 and the other on the south side. Both were foraging in the more usual fields of stubble.

1/24/99
At about 10:00 am, 15 Mountain Plover in stubble fields on the east side of Co. Rd. 345. These birds were about a mile south of the 345/346 intersection and just south of the only inhabited farm buildings on the road.

2/20/99
21 Mountain Plover (@ 12:30 pm) at the same location as 1/24. Some green weeds were growing in the lightly tilled soil.

3/1/99
Between 5:40 - 5:50pm (70's, clear, slight breeze), 17 Mountain Plover in a freshly plowed field on the east side of HWY 95 opposite where Co. Rd. 124 "T's" into HWY 95. Three were roosting, 5 preening and 9 actively feeding (more could have been roosting but hard to tell). Four Mourning Dove, 1 Killdeer and 2 Meadowlark species in same area.

I looked on 3/7 and 3/21 and could not and could not find any.


FACILITIES
LOCATION
PICNIC FACILITIES
CAMPING AREA
TRAILER AREA
ELECTRICAL OUTLETS
SANITARY FACILITIES
DRINKING WATER
SANITARY HOOKUPS
TRAILER SANI. STATION
SHOWER FACILITIES
GROUP SHELTER (PICNIC)
SWIMMING SITE
BOAT LAUNCHING RAMP
NATURE TRAIL
WILLIS CREEK PARK
FRIENDSHIP PARK
TAYLOR PARK
WILSON H. FOX PARK
N
Killeen
Temple
Waco
McGregor
Gatesville
Hearne
Cameron
Bryan
Rockdale
Georgetown
Taylor
Austin
Somerville Lake
Brenham
SCALE IN MILES
VICINITY MAP
FRIENDSHIP PARK
SORE FINGER WILDLIFE AREA
PROJECT HEADQUARTERS
A FEE MAY BE CHARGED IN SOME AREAS
GRANGER
WILLIS CREEK WILDLIFE AREA
Willis Creek
PECAN GROVE WILDLIFE AREA
San Gabriel River
WILLIS CREEK PARK
SAN GABRIEL WILDLIFE AREA
WILSON H. FOX PARK
TAYLOR PARK
PRIMITIVE CAMPING AREA
CIRCLEVILLE
Gabriel
FACILITIES SUCH AS PUBLIC ACCESS, PICNIC AND CAMP-GROUNDS ARE FOR YOUR ENJOYMENT — USE THEM THOUGHT-FULLY
THE MANAGEMENT OF FISH AND WILDLIFE RESOURCES IS BEING CONDUCTED IN COOPERATION WITH THE TEXAS PARKS AND WILDLIFE COMMISSION.
SWIMMING AREAS ARE UNSUPERVISED AND DO NOT HAVE LIFE GUARDS. BOATING, DIVING, SWIMMING, AND FISHING ARE DONE AT YOUR OWN RISK
INFORMATION ON AREAS WHERE HUNTING IS PERMITTED MAY BE SECURED AT PROJECT HEADQUARTERS.
THIS MAP IS FURNISHED AS GENERAL INFORMATION ONLY AND IS NOT TO BE USED FOR LOCATING PROPERTY LINES AND OTHER SUCH MATTERS
ADDITIONAL INFORMATION MAY BE SECURED AT PROJECT HEADQUARTERS OR BY WRITING TO
GRANGER PROJECT OFFICE
ROUTE 1, BOX 172
GRANGER, TEXAS 76530
A/C 512/859-2668
WHEN WINDS OF 25 M.P.H. OR MORE ARE FORECAST OR BLOWING BOATS ARE CAUTIONED TO STAY OUT OF OPEN WATER PLEASE LISTEN TO RADIO AND TELEVISION WEATHER REPORTS FOR WIND WARNINGS
FOR YOUR OWN SAFETY'S SAKE, HEED THE WARNING!
LEGEND
CONSERVATION POOL (EL. 504)
GOVERNMENT PROPERTY LINE
PAVED ROAD
GRAVELED ROAD
PARKS
LIMITED RECREATIONAL USE
PROJECT OPERATIONS
BEACH
BOAT RAMP
STUMPS
WILDLIFE AREA PARKING
(Vehicles not permitted beyond parking area)
Scale
MILES
KILOMETERS
MAP BY
GRANGER LAKE
US Army Corps of Engineers
Fort Worth District

Granger Mountain Plover: October 17, 1999 - March 25 ,2000

Key for Sighting Locations:

3009774 **Location 1** = plowed "megafield "of sorghum and/or corn stubble bounded by Alligator Road on the north, CR 352 on the east and CR 353 on the south, Williamson Co.

3009773 **Location 2** = plowed field of cotton stubble located north of "T" intersection of Aubrey Messer Road and Alligator Lane, Bell Co.

3009773 **Location 3** = plowed field of sorghum and/or corn stubble at the sharp curve on CR 359/Friendship Lane, Williamson Co.
For specific directions see stop 85.2 on Bert Frenz's web site at :
http://www.bafrenz.com/birds/Granger.htm

3009763 **Location 4** = plowed field of cotton stubble on north side of FM 971, .6 mile west of CR 358, Williamson Co.

3009764 **Location 5** = plowed field of sorghum and/or corn stubble northwest corner of CR 346/CR 347 intersection, Williamson Co.
1003

3009764 **Location 6** = plowed field of sorghum and/or corn stubble on the east side of CR 345, Williamson Co.

Summary of Sightings:

10/17/99
11 at **Location 1**. These birds were seen by Brush Freeman. This is the first report I am aware of from this season.

10/24/99 (50's – 70's, sunny, light wind)
27 from10:00- 10:30 am actively foraging at **Location 1**, seen from Alligator Road.

10/30/99 (70's-50's, front blew through about 9:00am, became very windy with rain)
146 from 10:00 am to 2:00pm (not continual observation time, about 1 hour of observation time during breaks in the rain as a front passed through) at **Location 1**. One group of 83 seen from Alligator Road, these birds alternated between many short (~ 4 yards) flights, chasing each other and roosting on belly or while standing, 12 Killdeer were mixed in with the flock; another group of 63 seen from CR 353, one bird of which made low , drawn whistled call, most of these birds were roosting on their bellies, a few seemed to be foraging; a coyote was patrolling the field between the two groups

Other Observers: Brush Freeman, Bert Frenz, Petra Hockey

11/7/99 (50's -80's, sunny, light wind)
41 at 8:30am at **Location 1**. Flying and calling "k k r r r" above Alligator Road, just east of its intersection with CR 352, then flying north into Bell County.

Other Observers: Jeff Hanson, Karl Kosciuch and Chris Merkord

11/11/99 (50's -70's, sunny, light wind)
42 from 8: 30- 9:00am at **Location 1.** Actively foraging in a unusually tight group (perhaps because they were aware of my presence, seen from CR352. Close enough (~.1 mile) to check for bands but none seen; Merlin (female columbarius) and a coyote patrolling the field.

11/14/99 (50's -70's, sunny, light wind)
10 at 10:30am at **Location 1**. Seen flying low over the center of field but disappeared in the heat haze when they landed. Also 200+ McCown's Longspur flying back and forth in smaller groups from the same area of the "Megafield" (could see these longspurs and the plover in flight at the same time) to the stock pond in the pasture north of Alligator Rd and "Megafield", about 1 mile east of CR 352/Alligator Road intersection. The longspurs were drinking on the wing.

Other Observer: Brush Freeman

12/22/99 (40- 50's, overcast, no wind)
22 at 10:30 am at **Location 1**. One group of 17 first seen flying in east of CR 352; foraged with flock of McCown's and Lapland Longspurs.
Other Observer: Chris Merkord

1/2/00 (60's - 70's, very windy, partly cloudy)
58 at **Location 2.** First saw 17 birds fly low over field at 10:50 am and joined flock already on ground, by 11:26 am about half were roosting while the others foraged, many Meadowlarks (probably Westerns) and a flock of 20 Killdeer in the field but not mixed with plovers.

1/8/00 (50's- 60's, cloudy, heavy rain the night before)
82 from 10:30 - 11:00 am at **Location 3.** Two large rain puddles were right next to the road and groups of plovers were coming to these puddles to bath and feed while others foraged or roosted in the rest of the field. The normally silent (or maybe normally too far out in a field to hear!) plover were vocalizing continuously (most common call sounded like "kuurut kuurut" with occasional whistles mixed in). The puddles seemed to be prized real estate as constant squabbles were taking place among groups of 4 to 7 plovers. One plover would lower its head and charge the others and drive them off. It would then feed in the puddle until it was driven off. I have decent photos of some of these birds as they bath and one that may have a worm(?) hanging from its bill.

1/17/00 (50's -70's, sunny, light wind)
162 at **Location 4.** Fifty birds were first seen wheeling back and forth over this field at 10:30am but then disappeared to the north. As I drove by this field again at 1:00pm, I could see plover on the ground. Although many were standing within 30-50 yards of FM 971, the majority was visible only as heads sticking out above the clods as they roosted. When I drove back by the field at ~ 4:00pm, many more plover were visible as most were now feeding. At this time, I was able to count 162. I was able to see about 100 of the birds' legs but no bands were visible. Many birds were lined up in the deepest furrows. I have distant photos that show this.

Other Observers (for 10:30am sighting): Karl Kosciuch, Russell Nelson

22 at ~ 3:30pm at **Location 2**. All birds roosting.
I believe these two flocks were separate (as I drove straight from one to the other) and represent 184 birds for the day.

1/22/00 (40's- 70's, sunny, light wind)
130 from ~ 9:00- 9:30am at **Location 4**. These birds were 30- 50 yards from the road. At any one time, about a third of the flock were roosting, a third were foraging and a third were wheeling back and forth over the field.
Other Observers: Leslie Simons, Roxie Rochat, Jean Martin, Joan Richardson, Larry LaBrant, Nancy LaBrant, other participants of TAS Field Trip

1/30/00 (20's- 40's, partly cloudy, light wind)
78 from 10:30- 11:00am at **Location 1**. Foraging 30 yards west of CR352, about 1 mile south of Alligator Road.

Other Observers: Brush Freeman, Randy Pinkston

2/5/00 (40's- 70's, sunny, light wind)
80+ from10:00- 11:00am at **Location 1**. At one point, 21 of these birds were seen foraging 30 yards west of CR352, about 1 mile south of Alligator Road. The rest were seen in the distance as they wheeled back and forth over field.

18 at 2:45pm at **Location 5**. These birds were in flight.

93 from 4:45- 5:00pm at **Location 4**. Roosting in the furrows

Other Observers: Brooke Nicotra, Russell Nelson, Brush Freeman, Petra Hockey, other participants of TOS Field Trip.

Given the time between these three sightings, I believe 111 birds is the safest total for the day.

2/6/00 (40's- 70's, sunny, light wind)
24 from 1:00- 1:15pm at **Location 6**. Foraging south of the only active farm on this road, about 1 mile south of the CR346/345 intersection. Also present in the field (but separate from the plover) were ~ 10 Killdeer, many Meadowlarks (probably Westerns) and a large (200+) mixed blackbird flock that at least contained Red-winged Blackbirds and Common Grackles.

52 from 4:00-4:10pm at **Location 5**. Actively foraging as close as 20 yards from CR346.

9 from 4:20-4:30pm at **Location 6**. Foraging north of the farm house. Possibly some of the same birds as seen at 1:00pm. Mixed in with a flock of about 200 McCown's Longspurs.

76 birds is the safest total for the day.

2/16/00 (70's, partly cloudy, no wind)
8 5:45- 5:50pm at **Location 2.** Six birds were roosting and two were fussing with each other. Also 100+ Mourning Doves were in the field. A tractor was plowing the field near them but had not gotten to their location yet.

3/4/00 (50's, sunny, windy)
22 from 7:45- 7:55am at **Location 5.** Half were roosting and half were foraging. . A tractor was plowing on the west side of this field but had not gotten to their location yet.

3/13/00 (40's – 60's, sunny morning, overcast afternoon, light wind)
186from 2:00- 2:30pm at **Location 6.** Actively foraging in a freshly plowed field, with shallow furrows, that was roughly .2 mile by .2 mile. This particular plowed portion of the field began .2 mile north of the CR345/CR347 intersection. The plovers were scattered fairly evenly over the field and were feeding to within 20 yards of the road. Many had the broad black forecrown and black loral line of breeding plumage. No bands were visible on the 100 or so birds whose legs were visible. Many were making a "buzzing-chattering" type of vocalization (I know it's a bad description but I'm definitely not confusing it with the Eastern Meadowlark's call). Occasionally, pairs of birds would "hassle" each other. Occasionally, 1- 12 birds would fly low to the ground 10-20 yards and resume feeding. I first found a flock of 51 Mountain Plovers feeding in this field, along with ~ 10 Killdeer, 100+ Savannah Sparrows, 100+ Meadowlarks (both species), and ~ 50 Brown-headed Cowbirds, from 7:40- 7:50am. All of these species, except the cowbirds, were present from 2:00- 2:30pm but with their numbers reduced by about half. Distant photos obtained.

15 from 9:30- 9:40am at **Location 3.** Actively foraging in
this recently worked ("flattened") but not actually plowed field with shallow furrows. Two Killdeer were near, but not associating with, the Mountain Plover flock.

Given the time between sightings, I belive 186 birds is the safest total for the day.

3/25/00 (upper 60's, partly cloudy, light wind from south)
5 from 7:45- 8:00am at **Location 6.** Actively foraging in a recently plowed , with shallow furrows, that was roughly .2 mile by .2 mile. This particular plowed portion of the field began .2 mile north of the CR345/CR347 intersection. All five plover had broad black forecrown and black loral line of breeding plumage. About 25 Mourning Doves were feeding in the field as well. Not present at 8:30 am but two coyotes were prowling the edges of the field.

I looked on 4/2 and 4/15 and could not find any.

Submitted by Tim Fennell, 4/2/00.

Granger Mountain Plover: October 4, 2000 - March 28, 2001

Key for Sighting Locations:

3009774 **Location 1 =** plowed "megafield "of sorghum and/or corn stubble bounded by Alligator Road on the north, CR 352 on the east and CR 353 on the south, Williamson Co.

3009773 **Location 2 =** plowed field of cotton stubble located north of "T" intersection of Aubrey Messer Road and Alligator Lane, Bell Co.

3009773 **Location 3 =** plowed field of sorghum and/or corn stubble at the sharp curve on CR 359/Friendship Lane, Williamson Co.
For specific directions see stop 85.2 on Bert Frenz's web site at :
http://www.bafrenz.com/birds/Granger.htm

3009763 **Location 4 =** plowed field of corn stubble on north side of FM 971, .6 mile west of CR 358, Williamson Co.

3009764 .003 **Location 5 =** plowed fields of sorghum and/or corn stubble centered on intersection of CR 346/CR 347 intersection, Williamson Co.

3009764 **Location 6 =** plowed field of sorghum and/or corn stubble on the east side of CR 345/west side of CR 346, Williamson Co.

3009764 **Location 7 =** plowed field of sorghum and/or corn stubble on the north side of CR 124, Williamson Co.

3009764 **Location 8 =** plowed field of sorghum and/or corn stubble on both sides of CR 300, ~ 1 mile west of end of Davilla Street in Granger, Williamson Co.

3009764 **Location 9 =** plowed fields of sorghum and/or corn stubble on the north side of CR 345/ CR 346 intersection and both sides of train tracks, Williamson Co.

3009765 **Location 10 =** plowed field of sorghum and/or corn stubble west side of CR 192, 1- 1.5 miles north of HWY 29, Williamson Co.

Summary of Sightings:

10/04/00

E-mail from Brush Freeman:

Tim...Had 6 MOPLs at Granger today on 157, nervous birds I think due to the presence of numerous accipiters in the area They were in the air for several minutes which was the key to my discovery. They eventually came down in the low "valley" on 157 and to the south of the road a couple of hundred yds. out.
3009765 I did not stay up there very long as I remembered that I had left the coffee maker turned on which had me anxious to get back home while I still had one. Only looked at the lake briefly..

Brush

10/9/00 (50's F, cloudy, light rain at times, little to no wind; no heat haze)

1 bird from 5:30- 5:45 pm @ **Location 6** (~ 1.1 miles south of CR 345/ CR 347 intersection). This bird seemed to be associating with two Killdeer, forming a "foraging line" as they moved across the field. They all changed direction in unison three separate times during the observation. They formed a line perpendicular to and about 100 meters from the road that I was standing on so judging distances was difficult. However it appeared the MOUP was closer to one of the Killdeer (~ 10 meters) than the two Killdeer were to each other. I have seen MOUP form these foraging lines many times. As much as I searched, I could not find any other MOUP (or any other birds for that matter) in the field. Conditions were perfect for viewing with no heat haze and the ground was wet so there is a good chance that I did not miss roosting MOPL's. Unfortunately, I could not observe the birds longer than 15 minutes as I had an appointment to keep.

10/20/00 (70's F, partly cloudy, light breeze, rained earlier in the day; perfect viewing conditions with absolutely no heat haze; ~ 700 m to birds)

7 birds from 6:00- 6:15 pm @ **Location 1**. One bird first seen foraging on edge of stubble and bare muddy patch. Others seen preening as they settled in to roost. Probably more than 7 birds but hard to distinguish roosting individuals as birds were >500 meters away.

Other observers: Mark Adams

10/22/00 (60's- 70's F, cloudy, breezy, rained earlier in the day; good viewing conditions with no heat haze; ~ 800 m to birds)

18 birds from 10:30- 11:20 am @ **Location 1**. Four birds foraging in the stubble were seen from CR 353. Thirty-two Greater White-fronted Geese were roosting in the field about 100 meters to the south of the MOUP. The other 14 were seen from Alligator Road and were foraging in bare, muddy patches and in the stubble. These plover were > 600 meters away. Standing water was in this area as heavy rains had occurred throughout the area over the previous two days, including that morning. The Mountain Plovers were mixed in with 50+ Killdeer, 4 Long-billed Dowitchers and 2 Lesser Yellowlegs. This loose group of birds was scattered over an area about 100 by 100 meters. Each species of shorebird seemed grouped with others of its own species but, as groups foraged, the species intermixed and some individuals came within a meter of each other. Mark Adams observed one Mountain Plover lower its head and charge a Killdeer from behind, causing the Killdeer to hop up into the air and scurry forward a short distance. At one point, I had 2 Mountain Plovers, 2 Killdeers, 2 Long-billed Dowitchers and a Lesser Yellowlegs in the same field of view of my Kowa scope with the zoom lens set at 45X. Fifty plus Meadowlarks (both Eastern and Western were heard singing in the general area) were in the stubble surrounding this loose group of shorebirds.

Other observers: Mark Adams

10/27/00 (70's F, SW-SE 8-12 mph, partly cloudy; good viewing conditions with no heat haze; ~ 900 m to birds to CR 345 birds and 200- 500 m to CR 346 birds)

20 birds from 5:22- 5:34 pm @ **Location 6** (~ 1.8 miles south of CR 345/ CR 347 intersection). Birds foraging in the stubble ~900 m east of CR 345. Eleven Killdeer and 8 Meadowlarks all working the same area of the field, intermingling at times with the MOUP but no interactions observed.

8 birds from 5:51- 6:03 pm @ **Location 6** (on west side of CR 346, .2 mile south of CR 347/ CR 346 intersection). First seen in flight > 500 m away as they flew low over CR 347, flying from north to south. Landed in a field of stubble and foraged as a tight group ~200 m from road, moving from south to north. There were> 12 Killdeer within 100 m and 5 Meadowlarks within 200 m, no interactions seen between species.

10/29/00 (70's F, 4- 7 mph, cloudy, some standing water; good viewing conditions with no heat haze; ~ 1000 m to birds)

2 birds from 5:15- 5:30 pm @ **Location 1**. Birds seen briefly during this observation as they flew low over the field ~ 1 km away (black tail tip, tan upperparts and pale underparts seen well). They landed in the stubble and disappeared from view. Also in the field were > 100 Killdeer, 1 Black-bellied Plover,

24 Sandhill Cranes, 5 Greater Yellowlegs, 1 Lesser Yellowlegs, 7 Least Sandpiper and 1 extremely late Buff-breasted Sandpiper. None of these birds were closer than 50 m to the MOUP.

11/4/00 (low 70's F, N 4-7 mph, cloudy, preceded by flooding the previous two days, as much as 4 inches of rain had fallen in the area the previous day; good viewing conditions with no heat haze; ~600 m to CR 345 birds and ~ 200 m to FM 971 birds)

11 birds from 9:26- 9:58 am @ **Location 6** (On east side of CR 345, 1.3 miles south of CR 345/ CR 347 intersection). One first seen @ 9:26 am foraging in corn stubble along edge of standing water separating corn and cotton stubble. Ten more flew into cotton stubble on north end of standing water @ 9:33 am. After about a minute, they flew low to the north and looped back south over the standing water. At this point the solo bird joined them as they repeated the low flight back to the north (~1 km) and then looped back to cotton stubble on west side of standing water and began foraging. Flock flew off to the north (calling) @ 9:58 am. Nine Ring-billed Gulls, 2 Greater White-fronted Geese, > 60 Killdeer, 2 Lesser Yellowlegs, 3 Greater Yellowlegs, 1 Long-billed Curlew and > 20 Meadowlarks were around the same body of standing water. The solo MOUP intermingled with the other birds (I had it, a Killdeer and the Curlew in the same field of view of my Kowa TSN822 @ 60X). As a flock of 11, they stayed more separate but still intermingled with Killdeer (No interactions seen but I had 2 MOUP, 3 Killdeer and a Ring-billed Gull in the same field of view of my scope @ 45X). Some poor JPEG's showing these birds together were obtained.

61 birds from 11:56 am - 12:15 pm @ **Location 4**. Birds were roosting ~ 200 m north of FM 971. A few were standing. No other birds seen in the field.

11/19/00 (~50 F, N 4-7 mph, sunny; some heat haze on distant birds; 10- 600 m to birds)

22 birds from 9:55 – 10:01 am @ **Location 6** (On east side of CR 345, 1.7 miles south of CR 345/ CR 347 intersection). Birds were actively foraging along a line of puddles of standing water that were perpendicular to CR 345. The 14 closest MOUP flew to north when I got out of my car. The most distant 8 MOUP flew to more distant part of field after 6 minutes. Also present in field were 3 Killdeer and 50+ longspur species. (a stop from 1:00- 1:05pm yielded at least 3 MOUP still foraging at this location)

(14 birds from 10:15- 10:42 am @ **Location 6** (On east side of CR 345, 1.1 miles south of CR 345/ CR 347 intersection). Assume they were the birds flushed from observation above. Actively foraging about 200 m from CR 345. Also present in field were 10+ Killdeer, 3 American Pipits and 2 Meadowlark species. JPEGs obtained of these MOUP.)

12/2/00 (~ 50 F, N 13- 18 mph, partly cloudy; good viewing conditions with some heat haze; 200- 300 m to birds)

8 birds from 11:22- 11:30 am @ **Location 7**. Actively foraging in portion of field with visible furrows, .4 mile west of HW# 95.

12/9 and 12/23/00

Searched for but could not find any MOUP.

12/26/01 (40's F, N 5-10 mph, cloudy, light rain; good viewing conditions except for some scope shake; 50 - 300 m to birds)

8 birds from 9:50- 10:20 am @ **Location 5** (2 MOUP ~100 m SW of CR 346/347 intersection w/ 1 Killdeer in same field, 8 MOUP ~ 50 NW of CR 346/347 intersection, 4 MOUP ~ 50 m NE of CR 346/347 intersection w/ 10+ Meadowlark species in same field and 4 MOUP ~ 300 m NW of CR 346/CR 348 intersection w/ 4 Killdeer, 150+ Blackbirds (Red-winged and Brewer's and Common Grackles), and 10+ Meadowlark species in same field). All MOUP were actively foraging.

12/30/01 (~ 50 F, light breeze, clear; heat haze @ 12:20, excellent viewing conditions @ 4:30 pm; 50 - 200 m to birds)

18 birds from 12:10- 12:30 pm and 4:30- 4:50 pm @ **Location 8.** All birds actively foraging. Four of the MOUP were on the west side of CR 300 @ 12:10 pm. All MOUP on east side of road @ 4:30 pm. Present in the same fields were 5+ Meadowlark species.

Other Observers: Brush Freeman, Andy Donnelly and Todd Council @ 12:10 pm.

1/5/01 (~ 50 F, N 8 mph, clear; some heat haze and scope shake; 200- 500 m to birds)

28 birds @ **Location 8.** Five MOUP foraging and 8 in flight on east side of CR 300/CR 381 from 10:00- 10:10 am and from 300- 500 m away from road with one American Pipit and ~ 10 Meadowlark species present in same field. Fifteen MOUP actively foraging on the north side of CR 381, .4 mile west of CR 300 from 10:15- 10:30 am and from 200- 300 m away from road with 2 American Pipits and ~ 15 Meadowlark species (at least one Western singing) in same field with some green weed growth. JPEGs obtained of second group of MOUP.

1/16/01

Searched for but could not find any MOUP.

1/20/01 (50's F, no wind, sunny; heat haze on distant birds; 50- 350 m to birds)

67 birds @ **Location 9.** Twenty- two MOUP foraging @ CR 336/HWY 95 intersection from 12:30- 12:45 pm and from 50- 200 m away from CR 336 (3 of the MOUP were actually in the dirt driveway of the farm house at this location). Forty-five MOUP foraging in field immediately north of CR 346/CR 345 intersection from 12:50- 1:00 pm and from 50- 350 m away from CR 346 with ~ 20 Meadowlark species in same field.

Other Observers: Brush Freeman, TOS Field Trip participants

2/6/01 (40-50 F, W 13- 18 mph, clear; excellent viewing conditions with no heat haze; 50- 200 m to birds)

33 birds from 8:45- 9:45 am @ **Location 10.** All birds actively foraging in this very flat field of stubble. A 10 m strip of freshly plowed soil seemed to be the eastern limit of their movement. Twice groups of MOUP (one group of 8 and another group of 6) flew short distances (< 100 m) and then resumed foraging. Also present were one Northern Harrier, one American Kestrel, Horned Larks (heard only), Lapland Longspurs (heard only) and 20+ Meadowlark species. Many JPEGs were obtained. This location is three miles further west than the previous westernmost locations, Locations 7 and 8.

3/4/01 (50's F, N 8 mph, sunny; excellent viewing conditions; ~ 300 m to birds)

9 birds from 9:30- 9:44 am @ **Location 3.** At beginning of observation, 3 MOUP were seen foraging in stubble and in new, green weeds along farm track that leads west from sharp turn in road. Three more flew in from south to join these and all six then moved into grass about 10 inches tall. Nine MOUP flew out of this grass to the west at the end of the observation. A few Meadowlark species were also in the stubble.

Other Observers: Randy Pinkston

3/11/01 (60's F, SE 10 mph, cloudy; excellent viewing conditions with slight scope shake; 30- 150 m to birds)

38 birds from 9:30- 10:00 am @ **Location 6** (On east side of CR 345, 1.7 miles south of CR 345/ CR 347 intersection). All MOUP were actively foraging in portion of field not worked recently with new, green weeds growing in it. MOUP seemed to prefer zone with > 30% coverage by weeds. A few birds were showing developing dark bar on forecrown. Killdeer calls were heard and about 10 Meadowlark species were intermixed with the MOUP but no interactions observed. Good JPEGs obtained.

3/15/01 (60's F, N 5 mph, sunny; excellent viewing conditions; ~ 150 m to birds)

2 birds from 5:55- 6:10 pm @ **Location 6** (On east side of CR 345, 1.7 miles south of CR 345/ CR 347 intersection). Birds were actively foraging in zone with few weeds. Also present were ~ 15 Mourning Doves and ~ 5 Meadowlark species.

3/25/01 (60's F, N 5- 10 mph, sunny; poor viewing conditions with abundant heat haze; 300- 400 m to birds)

13 birds from 4:20- 4:30 pm @ **Location 6** (On east side of CR 345, 1.7 miles south of CR 345/ CR 347 intersection). Birds were actively foraging in zone with few weeds. Also present were 2 Mourning Doves.

3/28/01 (Upper 40's F, no wind, cloudy, heavy rain previous two days; marginal viewing conditions with some haze for CR 345 MOUP and excellent conditions for the CR 300 MOUP; 150- 400 m to birds)

6 birds from 4:20- 4:30 pm @ **Location 6** (On east side of CR 345, 1.7 miles south of CR 345/ CR 347 Intersection).). Birds were actively foraging 300- 400 m from CR 345 in a zone with few weeds and some standing water. Also present were a Cooper's Hawk and an American Crow perched on low posts about 200 m S of MOUP.

4 birds from 5:20- 5:35 pm @ **Location 9**. Birds were actively foraging 150- 200 m from and on the northwest side of CR 300. Field had abundant new, green weeds growing in it and pool of standing water on south end. Also present and foraging were 6 American Golden Plovers and two Meadowlark species. The MOUP and AMGP did not seem to be interacting but I did have a MOUP and an AMGP in the same scope view at one point for a nice comparison. At least two of the MOUP were in almost complete alternate plumage.

4/1/01 and 4/2/01

Searched for but could not find any MOUP.

Submitted by Tim Fennell, 4/2/01.

Granger Mountain Plover: October 13, 2001 - March 16, 2002

Key for Sighting Locations:

3009774 **Location 1 =** plowed "megafield "of sorghum and/or corn stubble bounded by Alligator Road on
014 the north, CR 352 on the east and CR 353 on the south, Williamson Co.

3009773 **Location 2 =** plowed field of cotton and sorghum and/or corn stubble located north of "T"
016 intersection of Aubrey Messer Road and Alligator Lane, Bell Co.

3009763 **Location 3 =** plowed field of sorghum and/or corn stubble at the sharp curve on
737 017 CR 359 (or CR 360- confusing signs)/Friendship Lane, Williamson Co.
For specific directions see stop 85.2 on Bert Frenz's web site at :
http://www.bafrenz.com/birds/Granger.htm

3009763 **Location 4 =** plowed field of corn stubble on north side of FM 971, .6 mile west of
018 CR 358, Williamson Co.

3009764 **Location 5 =** plowed fields of sorghum and/or corn stubble centered on the
.003 003 CR 346/CR 347 intersection, Williamson Co.

3009764 **Location 6 =** plowed field of sorghum and/or corn stubble on the east side of
003 CR 345/west side of CR 347, Williamson Co.

3009765 **Location 7 =** plowed field of sorghum and/or corn stubble on the north side of CR 124, Williamson
003 Co.

3009764 **Location 8 =** plowed field of sorghum and/or corn stubble on both sides of CR 300, ~ 1 mile
020 west of end of Davilla Street in Granger, Williamson Co.

3009764 **Location 9 =** plowed fields of sorghum and/or corn stubble on the north side of CR 345/ CR 346
003 intersection and both sides of train tracks, Williamson Co

3009765 **Location 10 =** plowed field of sorghum and/or corn stubble west side of CR 192,
021 1- 1.5 miles north of HWY 29, Williamson Co.

3009763 **Location 11 =** plowed field of sorghum and/or corn stubble on both sides of CR 359, .5 - 1
019 mile north of FM 971, Williamson Co.

Summary of Sightings:

Location: 1 **Date and Time:** 10/13/01; 10:22- 11:05 AM, 2:00- 2:05 PM

Number of birds: 41 in AM, 25+ in PM **Distance to birds:** ~ 300 m in AM, ~400 m in PM

Weather: AM- 50's F, overcast, NW 15 mph, heavy rains and storm the night before; PM- 60's F, partly cloudy, NW 15 mph

Viewing conditions: Excellent (no heat haze or scope shake, using car as windbreak)

Behavior and habitat: @10:22, 12 MOUP seen foraging w/6 KILL in relatively bare muddy patch of tilled field of corn stubble; @ 10:35, 23 MOUP foraging and 10 flying back and forth low over field, "kr kr" call seemed to be coming from the flying birds; @ 10:55, 23 MOUP flew high and disappeared to the east (some calling); @ 11:00, 18 MOUP flying back and forth low over the field (some calling) and landed in the muddy spot @ 11:05 and began foraging; don't know how all of these separate groups relate to each other but at least 41 present; @ 2:00, 25+ foraging in the field

Other species present: 6 KILL, 1 "peep", 1 Prairie Falcon found dead on north side of field on Alligator Road (sent to TX Cooperative Wildlife Collection @ TX A&M)

Poor JPEG's obtained

Location: 8 **Date and Time:** 10/13/01; 12:30- 1:22 PM

Number of birds: 32 **Distance to birds:** 50- 400 m

Weather: 50's F, overcast, NW 15 mph, raining during most of observation

Viewing conditions: Excellent (no heat haze or scope shake, using car as rain/windbreak)

Behavior and habitat: Foraging in relatively bare, muddy section of field of stubble; intermingling with KILL

Other species present: 29 KILL intermingling with MOUP **Good JPEG's obtained**

Location: 8 **Date and Time:** 10/20/02; 9:20- 9:25 AM

Number of birds: 4 **Distance to birds:** ~ 60 m

Weather: 70's F, sunny, no wind **Viewing conditions:** Excellent

Behavior and habitat: In low flight and calling above tilled field of stubble

Other species present: 1 calling KILL, 2 WEME **Other Observers:** Marsha Reimer

Location: 9 **Date and Time:** 10/20/01; 10:00- 10:45 AM

Number of birds: 97 **Distance to birds:** 30- 200 m

Weather: 70's F, sunny, S 10 mph **Viewing conditions:** Good (some heat haze and scope shake)

Behavior and habitat: @ 10:00 AM, most foraging in tilled field of stubble with several small flocks (5- 15 birds) in flight over field, many calling ("grrt" and "kirp"); by 10:30 AM, ~80% of birds roosting in field

Other species present: 10+ KILL, Barn Swallows, 2+ WEME, 2 SPPI flyovers

Other Observers: Marsha Reimer **Good JPEG's obtained**

Location: 9 **Date and Time:** 10/27/01; 8:30- 8:50, 9:00- 9:05 AM

Number of birds: 36 **Distance to birds:** 200- 700 m 1st observation, 50- 100 m 2nd observation

Weather: 60's F, partly cloudy, no wind **Viewing conditions:** Excellent

Behavior and habitat: @ 8:30, 18 MOUP roosting and preening in tilled field of stubble; @ 8:35, 13 calling MOUP flew into field from the south; @ 8:37, 5 more calling MOUP flew into field from south; by 8:50 all were foraging in most distant part of field to the north; @ 9:00, relocated these MOUP from a closer vantage point and observed 12+ foraging in a very rocky part of the field

Other species present: 5 AMPI flyovers, 1 SPPI flyover, several calling WEME, and 1 Black-bellied Plover flyover

Poor JPEG's obtained of MOUP from 2nd vantage point

Location: 9 **Date and Time:** 11/4/01; 7:00- 8:20 AM, 11:20 AM

Number of birds: 116 **Distance to birds:** 50- 300 m

Weather: 50- 60's F, sunny, N 7 mph (@11:20, 80's F, sunny, no wind)
Viewing conditions: Excellent (poor @ 11:20)

Behavior and habitat: @ 7:00, MOUP roosting and foraging in tilled field of stubble; @ 8:20, 60 + still roosting; throughout observation, small groups of 8- 14 MOUP would fly low across field to different part of field; some calls heard ("grrt"); @ 8:20, one isolated group of 8 birds foraging NW of CR 346/347 intersection; when passed back by @ 11:20, 104+ roosting in field

Other species present: 10+ AMPI, 10+ WEME singing, 1 KILL roosting within 1 m of group of roosting MOUP, 1 AMKE flyover

Other Observers: Jean and Gary Roberts **Decent JPEG's obtained**

Location: 9 **Date and Time:** 11/10/01; 10:35-11:05 AM

Number of birds: 36 **Distance to birds:** 50-300 m

Weather: 60's- 70's F, sunny, N 3 mph

Viewing conditions: Good with some heat haze

Behavior and habitat: 24 MOUP foraging and 12 roosting in tilled field of stubble

Other species present: 2 KILL feeding side by side with MOUP (same field of view) 2 WEME singing

Other Observers: Jeff Hanson **Decent JPEG's obtained**

Location: 9 **Date and Time:** 11/12/01; 5:25- 5:35 PM

Number of birds: 66 **Distance to birds:** ~ 200 m

Weather: 60's F, cloudy, no wind **Viewing conditions:** Excellent

Behavior and habitat: roosting in a fairly tight group (all within ~ 50 m of each other) in tilled field of stubble

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Location: 9 **Date and Time:** 11/20/01; 4:30- 4:40 PM

Number of birds: 56 **Distance to birds:** 50- 300 m

Weather: 60's F, sunny, N 5 mph **Viewing conditions:** Excellent

Behavior and habitat: Foraging in tilled field of corn stubble

Other species present: KILL calling, WEME

Location: 9 **Date and Time:** 11/23/01; 11:10- 11:41 AM

Number of birds: 29 **Distance to birds:** 75- 150 m

Weather: 70 F, partly cloudy, S 15 mph **Viewing conditions:** Excellent, some scope shake

Behavior and habitat: foraging; 11 first seen flying low over field; @ 11:25, 9 flew calling to the south side of the road; foraging birds roosted at times

Other species present: 1 KILL, 2 WEME **Other Observers:** Julia Fennell

Location: 9 **Date and Time:** 12/1/01; 7:30- 7:45 AM

Number of birds: 11 **Distance to birds:** ~ 100 m

Weather: 40's F, partly cloudy, no wind

Viewing conditions: Excellent

Behavior and habitat: Roosting in stubble field

Other species present: 2 WEME singing, 1 SPPI calling **Good JPEG's obtained**

Location: 1 **Date and Time:** 12/1/01; 10:10- 10:15 AM

Number of birds: 12 **Distance to birds:** > 300 m

Weather: 50's F, sunny, no wind

Viewing conditions: Poor, heat haze

Behavior and habitat: Flying low over stubble field, east to west; one flock of 8 and another of 4

Other species present: Longspurs, WEME

Location: 1 **Date and Time:** 12/13/01; 10:35- 10:55 AM

Number of birds: 40 **Distance to birds:** ~ 200 m

Weather: 40's F, light rain, NW 10- 15 mph

Viewing conditions: Good (using car as windbreak)

Behavior and habitat: foraging in field of stubble

Other species present: 1 KILL (within ~ 10 m of 2 MOUP), 1 calling GRYE, and 1 WEME singing

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Location: 9 **Date and Time:** 12/13/01; 11:30- 11:40 AM

Number of birds: 53 **Distance to birds:** 50- 300 m

Weather: 40's F, driving rain, NW 10-15 mph **Viewing conditions:** good from car

Behavior and habitat: Foraging in tilled field of cotton stubble

Other species present: 3 KILL (one foraging in same line as MOUP), 10+ Meadowlark species

Location: 5 **Date and Time:** 12/18/01; 2:50- 3:00 PM

Number of birds: 114 **Distance to birds:** 50- 300 m

Weather: 50's F, partly cloudy, SW 15 mph **Viewing conditions:** Good

Behavior and habitat: Foraging in field of stubble

Other species present: 5+ AMPI, 2+ Meadowlark species, 1 Crested Caracara in tree on north edge of field

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Location: 9 **Date and Time:** 12/26/01; 10:00- 10:10 AM

Number of birds: 31 **Distance to birds:** ~300 - 400 m

Weather: 40's F, clear, N 10- 15 mph **Viewing conditions:** Poor (some heat haze, wind shake)

Behavior and habitat: Foraging in field of stubble

Location: 5 **Date and Time:** 1/12/02; 8:30- 8:45 AM

Number of birds: 19 **Distance to birds:** ~ 300

Weather: 40's F, sunny, no wind **Viewing conditions:** Good

Behavior and habitat: Roosting in field of stubble, a couple preening

Other Observers: Lester Faigley

Location: 5 **Date and Time:** 1/16/02; 5:15- 5:25 PM

Number of birds: 38 **Distance to birds:** ~ 300 m

Weather: 60's F, partly cloudy, S 5 mph **Viewing conditions:** Excellent

Behavior and habitat: @ 5:15, ~ 15 roosting and preening, the rest foraging in field of stubble; by 5:25, almost all are roosting

Other species present: ~ 30 Meadowlark species

Location: 5 **Date and Time:** 1/20/02; 8:00- 8:15 AM

Number of birds: 28 **Distance to birds:** ~ 300 m

Weather: 30's F, partly cloudy, variable ~5 mph **Viewing conditions:** Excellent

Behavior and habitat: Roosting in field of stubble

Other species present: KILL heard, 2 Coyotes about 300 m east of MOUP

Other Observers: Bill Reiner

Location: 5 **Date and Time:** 1/21/02; 9:40- 9:45 AM

Number of birds: 10 **Distance to birds:** ~300 m

Weather: 50's F, sunny, no wind **Viewing conditions:** poor, extreme heat haze

Behavior and habitat: Roosting in field of stubble

Location: 5 **Date and Time:** 1/25/02; 4:50- 5:00 PM

Number of birds: 9 **Distance to birds:** ~ 300 m

Weather: 60's F, sunny, light variable winds **Viewing conditions:** Excellent

Behavior and habitat: 3 roosting and 6 foraging in field of stubble

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Location: 5 **Date and Time:** 1/26/02; 8:00- 8:30 AM

Number of birds: 9 **Distance to birds:** ~300 m

Weather: 30's – 40's 's F, sunny, no wind **Viewing conditions:** Excellent

Behavior and habitat: Roosting in field of stubble

Other observers: TOS field trip participants

Location: 3 **Date and Time:** 1/26/02; 8:50 - 9:00 AM

Number of birds: 21 **Distance to birds:** ~ 200 m

Weather: 40's F, sunny, calm **Viewing conditions:** Good, some heat haze

Behavior and habitat: Foraging in field of stubble **Other observers:** TOS field trip participants

Location: 3 **Date and Time:** 2/3/02; 8:50- 8:55 AM

Location 3

Number of birds: 18 **Distance to birds:** ~300 m

Weather: 30's F, cloudy, no wind **Viewing conditions:** Excellent

Behavior and habitat: @ 8:50 heard MOUP calling, saw flock fly in from the north, flew just above ground, back and forth over field to west of road until disappeared over a small rise to the west @ ~ 8:55

Other species present: McCown's Longspurs heard

Location: 1 **Date and Time:** 2/3/02; 9:10- 9:20 AM

Number of birds: 57 **Distance to birds:** ~ 400 m

Weather: 30's F, cloudy, no wind **Viewing conditions:** Good

Behavior and habitat: Foraging in large area of short, green grass in the middle of a field of stubble. First time I have seen them in this habitat.

Other species present: Longspurs and WEME heard

Location: 5 **Date and Time:** 2/3/02; 1:20 – 1:35 PM

Number of birds: 39 **Distance to birds:** ~300 m

Weather: 40's F, cloudy, no wind **Viewing conditions:** Good

Behavior and habitat: Foraging in field of stubble

Other species present: 3 Meadowlark species

Location: 1 **Date and Time:** 2/10/02; 10:25 – 10:40 AM

Number of birds: 17 **Distance to birds:** ~ 300 m

Weather: 40's F, partly cloudy, N 20 –25 mph **Viewing conditions:** Decent with car as windbreak

Behavior and habitat: Foraging in bright green, short grass in middle of a field of stubble

Location: 1 **Date and Time:** 2/23/02; 10:15- 10:25 AM

Number of birds: 13 **Distance to birds:** ~150 m

Weather: 60's F, sunny, SW 15-20 mph **Viewing conditions:** poor, extreme heat haze

Behavior and habitat: Foraging in field of stubble

Other species present: 1 Meadowlark species, 3 KILL **Other observers:** Brush Freeman

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Location: 3 **Date and Time:** 3/1/02; 4:00 – 4:20 pm

Number of birds: 18 **Distance to birds:** 75 - 150 m

Weather: 40's – 50's F, cloudy, S 5 mph, light mist **Viewing conditions:** Excellent

Behavior and habitat: Foraging in field of stubble; moved as a flock east down dirt farm track through the stubble, sometimes straying into stubble, flew as a flock to the east once; one individual lowered head and charged another from behind; flock disappeared as I was taking photos.

Other species present: WEME and longspurs heard **Good JPEG's obtained**

Location: 5 **Date and Time:** 3/1/02; 5:40- 5:55 PM

Number of birds: 24 **Distance to birds:** ~ 200- 300 m

Weather: 40's – 50's F, cloudy, S 5 mph, light mist **Viewing conditions:** Excellent

Behavior and habitat: Foraging in a intensively tilled area (less stubble than other areas of field) in field of extensive stubble cover

Other species present: 8 KILL foraging among the MOUP

Location: 11 **Date and Time:** 3/9/02; 8:10- 8:25 AM

Number of birds: 28 **Distance to birds:** ~ 10- 150 m

Weather: 40's F, sunny, N 20-25 mph **Viewing conditions:** Excellent from in car

Behavior and habitat: Foraging in field of stubble on both sides of road, extensive weeds growing in area on east side of road, little stubble on west side, put to flight by passing Turkey Vulture

Other Observers: Bill Eddie, Roxie Rochet **Possible 35 mm photos**

Location: 6 **Date and Time:** 3/11/02; 11:55 AM – 12:20 PM

Number of birds: 5 **Distance to birds:** 20 -60 m

Weather: 50's F, cloudy, S 10-15 mph **Viewing conditions:** Excellent

Behavior and habitat: Foraging in a line in a field of stubble, one MOUP developing dark loral stripe and forecrown of alternate

Other species present: 2 KILL within 30 m of MOUP **Good JPEG's, Possible 35 mm photos**

Location: 11 **Date and Time:** 3/11/02; 1:10 – 1:19 PM

Number of birds: 3 **Distance to birds:** ~100 m

Weather: 50's F, cloudy, S 10-15 mph **Viewing conditions:** Excellent

Behavior and habitat: Foraging in field of stubble

Other species present: 3 KILL, 2+ AMPI, 10+ WEME singing

Location: 11 **Date and Time:** 3/13/02; 5:05- 5:15 PM

Number of birds: 9 **Distance to birds:** ~100 m

Behavior and habitat: Foraging in recently tilled field of stubble, two MOUP developing dark loral stripes and forecrown of alternate

Other species present: 10+ AMPI, 3 Meadowlark species

Location: 6 **Date and Time:** 3/13/02; 6:05- 6:15 PM

Number of birds: 8 **Distance to birds:** ~75- 200 m

Behavior and habitat: Foraging in recently tilled field of stubble, three MOUP developing dark loral stripes and forecrown of alternate

Other species present: 3 KILL, 5+ Meadowlark species

Location: 6 **Date and Time:** 3/14/02; 8:45- 9:00 AM

Number of birds: 7 **Distance to birds:** ~75- 300 m

Weather: 60's F, cloudy, S 20 mph

Behavior and habitat: @ 8:45, one foraging on north side of road and one foraging on south side of road, five calling birds flew from north of road and began foraging with bird on south side of road in field of stubble

Other species present: 2 KILL, 2+ Meadowlark species **Good JPEG's obtained**

Location: 11 **Date and Time:** 3/14/02; 9:20 – 9:30 AM

Number of birds: 4 **Distance to birds:** ~ 150 m

Weather: 60's F, cloudy, S 20 mph

Behavior and habitat: Foraging in field of stubble

Other species present: 1 SPPI calling, 5+ Meadowlark species

Location: 9 **Date and Time:** 3/16/02; 8:30 – 8:45 AM

Number of birds: 3 **Distance to birds:** ~ 300 m

Weather: 50's F, cloudy, N 15-20 mph

Behavior and habitat: Foraging in field of stubble

Other species present: 2 Mourning Doves

I searched 3/20, 3/24 and 4/6 and did not find any MOUP in the area.

Submitted by Tim Fennell, 7/1/02

WebMail - Mountain Plovers in Kleberg County

Delete | File | Create | Reply | Reply All | Forward | Previous | Next | Options | Index | Help

Date Sent: Saturday, January 26, 2002 12:27 AM

From: Tom & Nancy Langschied <tnlangs@GCOL.NET> Add to Address Book

To: TEXBIRDS <TEXBIRDS@LIST.AUDUBON.ORG>

Subject: Mountain Plovers in Kleberg County

Status ☐ Urgent ☐ New

While conducting a Burrowing Owl survey on Thursday (01/24/02) in the Laureles division of King Ranch (located directly east of Kingsville). We located five Mountain Plovers on the plowed fields of this division. I would recommend to anyone who is birding the Corpus Christi area or west and are interested in this species to check the plowed fields between Driscoll and Chapman Ranch, since this area is directly north of that portion of Laureles division.

Other species seen include:

Snow Goose 115
Ross' Goose 60
Northern Harrier 2
Merlin 1 Black-bellied Plover 1
Burrowing Owl 1
Sprague's Pipit 2

The number of Burrowing Owls were lower than usual which may be due to a significant cold front (extremely high winds)moving through the area at the time.

Tom Langschied
Kingsville, TX

For answers to questions about this listserve, visit
the Texbirds Reference Page at http://www.moonmountaingroup.com/texbirds

For up to date Texas Birding Links, visit
the Texas Birding Links Page at
http://www.moonmountaingroup.com/texbirds/links.html

Secure mode active.

Literature Cited

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Knopf, F. L. 1996. Mountain Plover (*Charadrius montanus*). *In* The Birds of North America, No. 211 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

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REPORT ON

EAST TEXAS RARE BAT SURVEY: 1997

By

Peggy Horner, Endangered Species Biologist
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East Texas Rare Bat Survey: 1997

by
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The East Texas Rare Bat Survey began in the spring of 1994 to document the current distribution and roost locations for the southeastern myotis (*Myotis austroriparius*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) in the forests of east Texas. Prior to 1994, the southeastern myotis (SEM) was reported from nine counties (Bowie, Panola, Newton, Tyler, Hardin, Liberty, Orange, Harris, and Montgomery) and the Rafinesque's big-eared bat (BEB) was known from eight counties (Marion, Nacogdoches, Sabine, Polk, Newton, Hardin, Montgomery and Liberty (Schmidly et.al., 1977; Schmidly, 1983; Schmidly, 1991; Davis and Schmidly, 1994)). It has since been determined that the BEB record for Montgomery County is an error (see discussion). Most of these records were based on specimen collections and information on roosts was very limited.

During the first year's survey, nine sites in seven counties were mist netted from May to August, and 41 SEM and 2 BEB were captured in three counties (Horner, 1995). Jasper County was a new county record for both species, and Walker County was also added for the BEB by Dr. Monte Thies from Sam Houston State University (Thies, 1994).

A more intensive summer effort in 1995 covering 27 counties resulted in the capture of 43 SEM in 6 counties and 27 BEBs in 5 counties (Horner and Mirowsky, 1996). Cass, Shelby, and Polk County records were added for the SEM, and San Jacinto and Trinity County records were added for the BEB. Roost searches and radio telemetry were used to locate three SEM roosts in live hollow trees (two were maternity roosts) and four BEB roosts (three in manmade structures, one in a live hollow tree, one known maternity roost).

In 1996, a one-year roost characterization study was initiated (Mirowsky and Horner, 1997). Mist netting was again conducted during the summer months resulting in the capture of 38 SEM and 6 BEB. Six new counties were added for the SEM (Houston, Marion, Sabine, Smith, Walker, and Wood), and one county (Harris) for the BEB. Additional county records reported during this year included Leon and Freestone Counties for the SEM (Walker et al, 1996) and for the BEB, Shelby County (Yancey and Jones, 1997) and San Augustine County (Brian Keeley, pers. comm.) were added. More significantly, however, was the discovery of 8 new SEM roosts (two were maternity roosts in live hollow trees, 6 seasonal roosts in manmade structures) and 3 new BEB roosts (one was a maternity roost in a manmade structure). Occasionally, a roost was temporally or spatially occupied by both species.

The objective of the 1997 field season was to monitor the known roosts of these two bat species in east Texas. This report summarizes the monitoring efforts, describes five newly discovered roosts, and further summarizes the county occurrence records and the current status of the species.

Methods

Most roosts had a designated person or agency responsible for monitoring. Roosts were monitored opportunistically and a standardized form was completed to record date, observer, species presence (estimated number if possible), and weather within the last 24 hours. Observers were instructed to be as unobtrusive as possible by minimizing people, noise, and time spent in the roost, and using red filters over light sources when necessary to observe dark spaces. Roosts were to be visited no more than once per month.

There was no organized effort to search for new roosts this year. However, during the past 3 years, many biologists and natural resource managers have been alerted to the need to report locations of discovered roosts. When a roost was located on public land, the location and descriptive information was recorded as precisely as possible. Roost characterization information collected included date of discovery, exact location, distance from a permanent water source, type (structure, tree, etc.), condition and description of roost, location of bats within the roost, surrounding vegetation, and the potential for disturbance, detection, or destruction. If a roost was reported on private property, state law requires the landowner's written permission to observe and record information, and exact location was not required.

Results

In 1997, ten roosts were added to our list of known roosts. Roosts 14-18 were newly discovered and Roosts 19-23 were previously known but had not been part of our monitoring efforts.

Roost 14 was reported from Village Creek State Park. An abandoned house just outside the Park property was donated to the Park, and when the house was inspected in February for possible relocation onto the Park, a small cluster of BEB was discovered roosting in the attic. One of the bats was previously banded from Roost 12, a summer maternity roost less than two miles away. A cluster with a banded bat was again observed in December. A solitary BEB was discovered in a new tree (Roost 15) at Martin Dies Jr. State Park in Jasper County in May while monitoring Roost 1. This is the second tree roost discovered in this park. A second tree roost (Roost 16) was also discovered on the Little Sandy Hunting and Fishing Club in October. The manager found the roost when the area was surveyed for oil exploration, and although positive identification of the bats using the roost has not yet been verified, the tree characteristics and number of bats in the roost indicate that it could be SEM. Since discovery, floods have precluded us from returning to make a positive identification. A solitary male SEM was netted from tree Roost 17 in July at Ratcliff Lake Recreation Area in Houston County. The specimen was not collected, but measurements and a photograph were taken. In November, a US Forest Service biologist reported observing several BEB roosting in a cement culvert (Roost 18) under a rural road in the Angelina National Forest. This location is less than 5 miles from maternity Roost 9. No bands were noted.

Roosts 19-22 were the SEM roosts previously discovered and reported by Walker et. al. (1996). These roosts were all cement box culverts along Interstate 45 in Leon and Freestone Counties. Roost 23 is in San Augustin County on private property, and although added to our list of known roosts, it was not monitored since permission was not granted. However, there

are photographs of BEB occupying the roost, and because it is a new county record, is has been added to our list.

Therefore, since the study began in 1994, 23 roosts have been discovered, documented, and characterized (Table 1, Figure 1). Of these, 11 roosts have contained only SEM, 10 have contained only BEBs, and 2 have had both species present.

Eleven roosts are in live hollow trees and 12 are in man-made structures. Of the tree roosts, 4 are in black gums (*Nyssa sylvatica*), 3 are water tupelos (*Nyssa aquatica*), 2 are in sweetgums (*Liquidambar styraciflua*), 1 is a willow or water oak (*Quercus phellos* or *Q. nigra*) and the last is a beech (*Fagus grandifolia*). Of the structures used, 3 are wooden structures and 9 are made from concrete, cement, or cinder blocks.

Sixty-one percent of the roosts used by SEM are tree roosts. To date, all maternity roosts for SEM have been in trees. When SEM have been found in man-made structures, it is usually in the fall or winter months and they are usually alone or in very small numbers compared to the other bat species present.

Sixty-seven percent of the all the roosts and 100% of all the maternity roosts used by BEB are in man-made structures. BEB were found in trees during all seasons, but there were only one or two individuals present when visited.

The monitoring efforts for 1997 are summarized for SEM in Table 2 and for the BEB in Table 3. SEM were always present when Roost 7 was checked in Smith County, and usually present in Roost 8 in Wood County. It appears that these roosts are year-round roosts, but may not be occupied 100% of the time. One of the BEB roosts in Jasper County (Roost 9), which is often visited by hikers, was used as a maternity roost throughout the summer, but was vacant during the winter. Unfortunately, because most roosts were not monitored regularly, no other obvious patterns could be detected.

With a mist net capture of one SEM at Stephen F. Austin State University Experimental Forest in Nacogdoches, a new county record was added to the county occurrence map. No new county records were added for BEB. Figure 2 shows a map of all the county occurrences of SEM, and Figure 3 depicts the BEB county occurrences. County records prior to this study were taken from Schmidly, 1991 (see discussion below). Information concerning county records for SEM are listed in Table 4 and for BEB in Table 5.

Discussion

In 1997, we refocused our emphasis from occurrence and distribution surveys to monitoring known roosts. During this transition, we were unable to monitor all the roosts on a regular schedule, but roosts were monitored opportunistically.

In review of the data, it is apparent that not all roosts are equally important to the two species, nor are the two species using roosts in a similar manner. As summarized in our last report (Mirowsky and Horner, 1997) SEM prefer to congregate in large numbers (> 100 individuals)

in maternity roosts located in live, large, hollow, bottomland hardwood trees in close proximity to slow moving rivers, but will roost singly in smaller trees or manmade structures. Big-eared bats, however, tend to be found in maternity roosts in small numbers (<25 individuals) that are located in manmade structures in close proximity to slow moving rivers, but will roost singly in bottomland hardwood trees.

The maternity season for the SEM is typically the end of April to the end of June (Horner and Mirowsky, 1996; Schmidly, 1991). One of the maternity roosts (Roost 1) used by SEM in previous years was not occupied during April or May 1997 but not checked in June. Since this is the period when non-volant young are usually present, we conclude that this tree was not used as a maternity roost in 1997. It is unlikely that our disturbance caused them to abandoned the roost, because there were limited roost checks conducted previous to the maternity season. This provides an initial indication that SEM may not always be faithful to particular maternity roosts. This roost is in an extensive bottomland hardwood area, and undoubtedly they have multiple roosts from which to choose each year. Roost 2 was occupied in June, but not checked earlier, so it's use as a reoccupied maternity roost is inconclusive.

Two SEM maternity roosts (Roosts 7 and 8) were verified to be reoccupied from previous years. Roost 7 is a large hollow water tupelo standing in a clearcut less than 100 yds from the Sabine River. This roost was occupied year-round, and because it is the only live, large, hollow tree within several acres, the bats may not have alternative roosts. Roost 8, a black gum also occupied throughout the year, is within an extensive old growth bottomland hardwood forest.

Three BEB maternity roosts (Roosts 9, 11, 12) are known, but only one (Roost 9) was monitored. This roost, located in an abandoned concrete saw mill, was reoccupied as a maternity roost in 1997 despite heavy visitation by people. The historic mill is on an often-used hiking trail, but the bats continue to use the dark wall and ceiling about 40 feet above the entrance. We suspect that unknowing hikers never see the bats, so intentional disturbance is minimal.

The addition of the four SEM Roosts 19-22 (Walker et. al, 1996) to our monitoring list late in 1997 precluded monitoring efforts for this year. These roosts were reported as winter roosts from 1994-1996, and there may be evidence that some are occupied during other times of the year (Honeycutt, pers. comm.). Therefore, monthly monitoring will be initiated for 1998.

With the discovery of new roosts, the distribution maps are revised. The first record of SEM in Texas was a mummified individual found in an attic in Bowie County in 1962 (Packard, 1966). In 1991, Schmidly noted nine counties records. Now this species is known from 22 counties and the range line has been extended to the west by 100 miles (Walker et. al., 1995). Of the nine original counties, 7 counties have not been reconfirmed to have SEM since 1994. However, efforts to net these counties was low (total of five netting nights from 1994 to 1996).

In reviewing the revised map and catch per unit effort data (Mirowsky and Horner 1997), Jasper, Tyler, and Hardin counties in southeastern Texas may have the highest density of SEM. In the bottomland hardwood habitats in these counties, the SEM is the mostly commonly captured bat. It is possible that this distribution is a function of researcher effort since access to public lands in these counties is more available. However, we suspect that this distribution pattern is more likely correlated with the amount of large protected bottomland hardwood forests such as the Big Thicket National Preserve, Village Creek State Park, Martin Dies Jr. State Park, and The Nature Conservancy Sandylands Preserve. Most of the forested land in northeast Texas is privately owned and in smaller, fragmented parcels that were recently harvested. Such habitat reduces the number of large hollow trees suitable for roosting.

County occurrences for BEB have been inconsistent. In the book Texas Mammals East of the Balcones Fault Zone (Schmidly, 1983), seven county records were noted. The Bats of Texas (Schmidly 1991) also noted seven county records, but Marion and Harrison Counties were not included whereas Montgomery and Liberty Counties were included as Health Department specimens. Apparently there is no Harrison County specimen, so the 1983 record was published in error; similarly, omitting the Marion County record in the 1991 was also an error (D. Schmidly, pers. comm. and B. Burt, pers. comm). This specimen was indeed collected, but has since been lost. Thies (1994) reported a new county record for BEB in Walker County, but in summarizing the county distributions, the Health Department records were mistakenly noted in Harris and Jefferson Counties. We've reviewed the two Health Department records, and one specimen (male, 11 September 1984, #2527) was collected in Dayton (which is in Liberty County, not Chambers County as mistakenly catalogued). The second specimen (male, 13 September 1986, #2127) was collected in Beaumont in Jefferson County. Therefore, it appears the Montgomery County record (Schmidly 1991) and the Harris County record (Thies 1995) are incorrect; the correct locations of these records are Jefferson and Liberty Counties. Yancey and Jones (1997) report a third Health Department specimen from Shelby County which is a new county record and the northernmost documented occurrence of this species in Texas. However, they state that a total of four specimens have been recorded by the Health Department, which we believe is incorrect due to the previous mistakes which persist in the literature.

Therefore, prior to 1994, there were 8 county records (Marion, Nacogdoches, Sabine, Newton, Hardin, Jefferson, Liberty, and Polk) for BEBs, with the first specimens collected from a barn in Polk County in 1965 (Michael and Birch 1967). Now there are 15 county records. Of the 8 counties with known occurrences prior to 1994, six counties have not been reconfirmed to have BEBs since 1994. There has been some netting effort in these counties (17 netting nights since 1994), but this bat is difficult to net due to it's ability to detect the presence of nets.

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Table 1: Known roost sites for southeastern myotis (SEM) and Rafinesque's big-eared bat (BEB) in east Texas.

Roost #	1995 Roost ID	Location	Type	Species/Mat'l	County	Date first found	Status
1	MDJSP 1	Martin Dies Jr SP-Walnut Ridge Unit	Tree	Black Gum	Jasper	1-May-95	SEM 1995 maternity roost; BEB temporary roost
2	VCSP 1	Village Creek SP-Caney Slough	Tree	Water Tupelo	Hardin	26-May-95	SEM maternity roost
3	VCSP 2	Village Creek SP-Caney Slough	Tree	Black Gum	Hardin	4-Oct-95	SEM temporary or solitary roost?
4	VCSP 3	Village Creek SP-Water Oak Trail	Tree	Black Gum	Hardin	26-Oct-95	BEB temporary or solitary roost?
5	VCSP 4	Village Creek SP-Tupelo Swamp	Tree	Water Tupelo	Hardin	30-Jan-96	SEM temporary winter roost?
6		Village Creek SP - Water Oak Trail	Tree	Beech	Hardin	10-Sep-96	BEB temporary roost?
7		Byrd's property-Sabine River	Tree	Water Tupelo	Smith	6-Mar-96	SEM year-round roost
8		Little Sandy Hunting and Fishing Club - Trail 2	Tree	Black Gum	Wood	6-Mar-96	SEM year-round roost
9	SNF 1	Aldridge Saw Mill - Angelina NF	Structure	Concrete	Jasper	27-Jun-95	BEB maternity roost
10	BITH 1	Voth Mill - Big Thicket NP - Pine Island Bayou	Structure	Concrete	Hardin	15-Aug-95	BEB temporary roost
11		Private property - Trinity River	Structure	Wooden	San Jacinto	11-Jul-95	BEB maternity roost
12		Circle G Roost-Village Creek	Structure	Cinder Block	Hardin	16-Jul-96?	BEB year-round roost; SEM temporary roost
13		Lake Houston State Park-San Jacinto	Structure	Cinder Block	Harris	22-May-96	BEB temporary roost

Roost #	1995 Roost ID	Location	Type	Species/Mat'l	County	Date first found	Status
		River					
14		Murphy Roost - Entrance of VCSP	Structure	Wooden	Hardin	3-Feb-97	BEB winter roost
15		Martin Dies Jr. SP-Walnut Ridge campsite # 112	Tree	Willow Oak or Water Oak	Jasper	1-May-97	BEB temporary or solitary roost?
16		Little Sandy Fishing and Hunt Club-Trail 18	Tree	Sweetgum	Wood	Oct-97	SEM roost?
17		Ratcliff Lake Recreation Area	Tree	Sweetgum	Houston	19-Jul-97	SEM temporary roost?
18		Angelina National Forest; R255	Culvert	Cement	Jasper	1-Nov-97	BEB and SEM winter roost?
19		Under I-45 13.6 mi N of Huntsville	Culvert	Cement	Walker	27-Jan-95	SEM winter roost
20		Under I-45 2.4 mi S of Buffalo	Culvert	Cement	Leon	27-Jan-95	SEM winter roost
21		Under I-45 0.8 mi N of Buffalo	Culvert	Cement	Leon	27-Jan-95	SEM winter roost
22		Under I-45 3.2 mi N of Buffalo	Culvert	Cement	Freestone	27-Jan-95	SEM winter roost
23		Central San Augustine Co. on private land	Structure	Wooden	San Augustine	May-89	BEB maternity roost

Table 2: Estimated number of SEM in roosts. Blank cells indicate that the roost was not checked during that month.

Roost	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		0		0	0							0
2						<50	10					
3						1	1					
5							0					
7	10-25	3	10-25		>25	>25			>25		>25	5-25
8	0	>25	>25	>25	>25	>25		0		>25	>25	5-25
12		0										0
16										>25		
17							1					
19												
20		0										
21												
22												

Table 3: Estimated number of BEBs in roosts. Blank cells indicate that the roost was not checked during that month.

Roost	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		0		0	0							0
4						1			1			
6												
9	0	0		4-20	12-14	10-25						0
10		0										0
11		0										0
12		0										11
13						0	0	0	0	0	0	0
14		0-4										3
15					1							
18											6-8	
23												

Table 4: Information of county occurrences for SEM

County	Date	Location	Reference	Other
Bowie	Jul 62	New Boston	Packard 1966	Mummified bat from attic (skull only)
Cass	1 Jul 95	Atlanta SP	Horner and Mirowsky 1996	1 captured in mist net
Freestone	27 Jan 95	North of Buffalo	Walker et. al. 1996	Roost 20-21 discovered in culvert under Interstate Hwy 45
Hardin	18-20 Jul 94; 22 May-1 Jun 95; 1 May-18 Aug 96	Village Creek SP	Horner, 1995; Horner and Mirowsky 1996; Mirowsky and Horner 1997	Total of 56 captured in mist nets during 3 year period; Roosts 2,3,5 and 12 discovered
Hardin	11 Apr-29 Jul 96	Sandylands Nature Preserve	Mirowsky and Horner 1997	8 captured in mist nets
Hardin	31 May 95	Big Thicket NP, Turkey Creek Unit	Horner and Mirowsky 1996	1 adult male captured in mist net
Harris	29 Apr 84	Houston	Schmidly 1991	Department of Health Record #853
Houston	19 Jul 97	Ratcliff Lake Recreation Area	Horner and Maxey 1998	Roost 17 discovered
Houston	6 May 96	Davy Crockett Nat'l Forest	Mirowsky and Horner 1997	Adult Male captured in mist net
Jasper	28 Jun 94	Jasper State Fish Hatchery	Horner 1995	3 captured in mist nets
Jasper	19 May-15 Sep 94; 13 Mar-16 Jul 95; 2 Apr-9 Jul 96	Martin Dies Jr. SP	Horner 1995; Horner and Mirowsky 1996; Mirowsky and Horner 1997; Horner and Maxey 1998	66 total captured in mist nets over entire period; Roost 1 discovered
Leon	27 Jan 95	Buffalo and south of Buffalo	Walker et.al. 1996	Roost 22 discovered in culvert under I-45
Liberty	8 Mar 78	Big Thicket NP near Moss Hill	Schmidly 1983	1 specimen
Marion	29 Jul 96	Lake 'O the Pines/Big Cypress Crk	Mirowsky and Horner 1997	1 adult female post-lactating captured in mist net
Montgomery	15 Apr 84	Conroe	Schmidly 1991	Department of Health Record #743
Nacogdoches	26 Jun 97	Stephen F. Austin Univ. Exp. Forest	Horner and Maxey 1998	1 adult male, 1 adult lactating female captured in mist net
Newton	Feb-Jun 74	Mill and Indian Creek Bay	Inglis, Clark, and Irby and Moehring, 1976	8 specimens, 1 lactating female
Orange	9 Jul 84	Vidor	Schmidly 1991	Department of Health Record #1665
Panola	10 Dec 69	8 mi. SW of Gary in sandstone cave	Michael et. al. 1970	1 adult male specimen
Polk	8 Jun 95; 24 Apr 96	Lake Livingston SP	Horner and Mirowsky 1996; Mirowsky and Horner 1997	1 adult female ('95) and 1 adult male ('96) captured in mist net
Sabine	18 Jun 96	Sabine Nat'l Forest	Mirowsky and Horner 1997	1 Juvenile male captured in mist net
Shelby	19 Jun 95	North Toledo Bend WMA	Horner and Mirowsky 1996	1 adult male captured in mist net
Smith	6 Mar 96	Sabine River - private property	Mirowsky and Horner 1997	Roost 7 discovered
Tyler	Jun-Oct 77 and Jun 78	Big Thicket NP near Town Bluff and Spurger	Schmidly, 1983	7 specimens
Tyler	4 May 95	Magnolia Park Ridge	Horner and Mirowsky 1996	5 adult males captured in mist nets
Walker	27 Jan 95	North of Huntsville	Walker et. al. 1996	Roost 19 discovered in culvert under I-45
Walker	17 Aug 96	Huntsville SP	Mirowsky and Horner 1997	1 adult male captured in mist net
Wood	6 Mar 96; Oct 97	Little Sandy NWR	Mirowsky and Horner 1997; Horner and Maxey 1998	Roost 8 and Roost 16 discovered

Table 5: Information of county occurrences of BEB.

County	Date	Location	Reference	Other
Hardin	17 May 75	7 mi SE Silsbee	Schmidly 1983	Specimen collected
Hardin	27 Oct 95; 16 Jul 96; 10 Sep 96; 3 Feb 97	Village Creek SP and adjacent area	Horner and Mirowsky 1996; Mirowsky and Horner 1997; Horner and Maxey 1998	Roost 4, 6, 12, 14 discovery
Harris	22 May 96	Lake Houston SP	Mirowsky and Horner 1997	Roost 13 discovery
Jasper	28 Jun 94	Jasper Fish Hatchery	Horner 1995	Mist net capture
Jasper	27 Jun 95	Angelina National Forest	Horner and Mirowsky 1996	Roost 9 discovered in abandoned concrete structure
Jasper	13 May 96; 1 May 97	Martin Dies Jr. SP	Mirowsky and Horner 1997	Roost 1 discovered to be used by single Corynorhinus; Roost 15 discovered
Jasper	1 Nov 97	Culvert under Road 255	Horner and Maxey 1998	Roost 18 discovered
Jefferson	13 Sep 86	Beaumont	Schmidly 1991; Thies 1994	Texas Dept. of Health record
Jefferson	15 Aug 95	Big Thicket NP	Horner and Mirowsky 1996	Roost 10 discovered
Liberty	11 Sep 84	Dayton	Schmidly 1991	Texas Dept. of Health record
Liberty	21 Jul 94	Davis Hill SP	Horner 1995	1 adult female captured in mist net
Marion	7 Oct 73	27 mi. W of Jefferson	Schultz, et.al. 1975	Specimen collected from an abandoned dwelling
Nacogdoches	28 Oct-15 Nov 68, 1 Apr 69; 22-27 Nov 74	within 15 mile radius of Nacogdoches	Shultz, et. al. 1975; Schmidly, 1983	22 specimens captured in wells, 1 flying along Angelina River
Newton	Nov-Dec ; June	within 10 mi radius of Burkeville	Schmidly, 1983	Specimens collected in cisterns in late fall and mist netted in June
Polk	31 Oct-4 Nov 66	1 mi. S Neches River, 3 mi. E. Hwy 59	Michael and Birch, 1967; Shultz, et. al. 1975; Schmidly, 1983	First record on this species in Texas. 7 Specimens captured in a barn
Sabine	20-27 Jul 72, 15 Sep 72	3 mi. NE Milan	Shultz, et. al. 1975; Schmidly, 1983	Specimens collected from an abandoned dwelling
San Augustine	summer 1989-1994	central San Angustine County on private land	Mirowsky and Horner, 1997	Maternity Roost 23 discovered in abandoned dwelling monitored annually; about 30 adults and pups present; a few seen in nearby well in fall/winter; photograph taken
San Jacinto	11 Jul 95; May 96	near Shepherd on private land	Horner and Mirowsky 1996; Mirowsky and Horner 1997	Roost 11 discovered and monitored
Shelby	6 Jun 96	Center, Texas	Yancey and Jones, 1997	Texas Dept. of Health record
Trinity	18 July 95	Alabama Creek WMA	Horner and Mirowsky 1996	1 adult female captured in mist net
Walker	7 Sep 93	Huntsville Fish Hatchery	Thies 1994	1 adult male captured in mist net as it emerged from concrete culvert

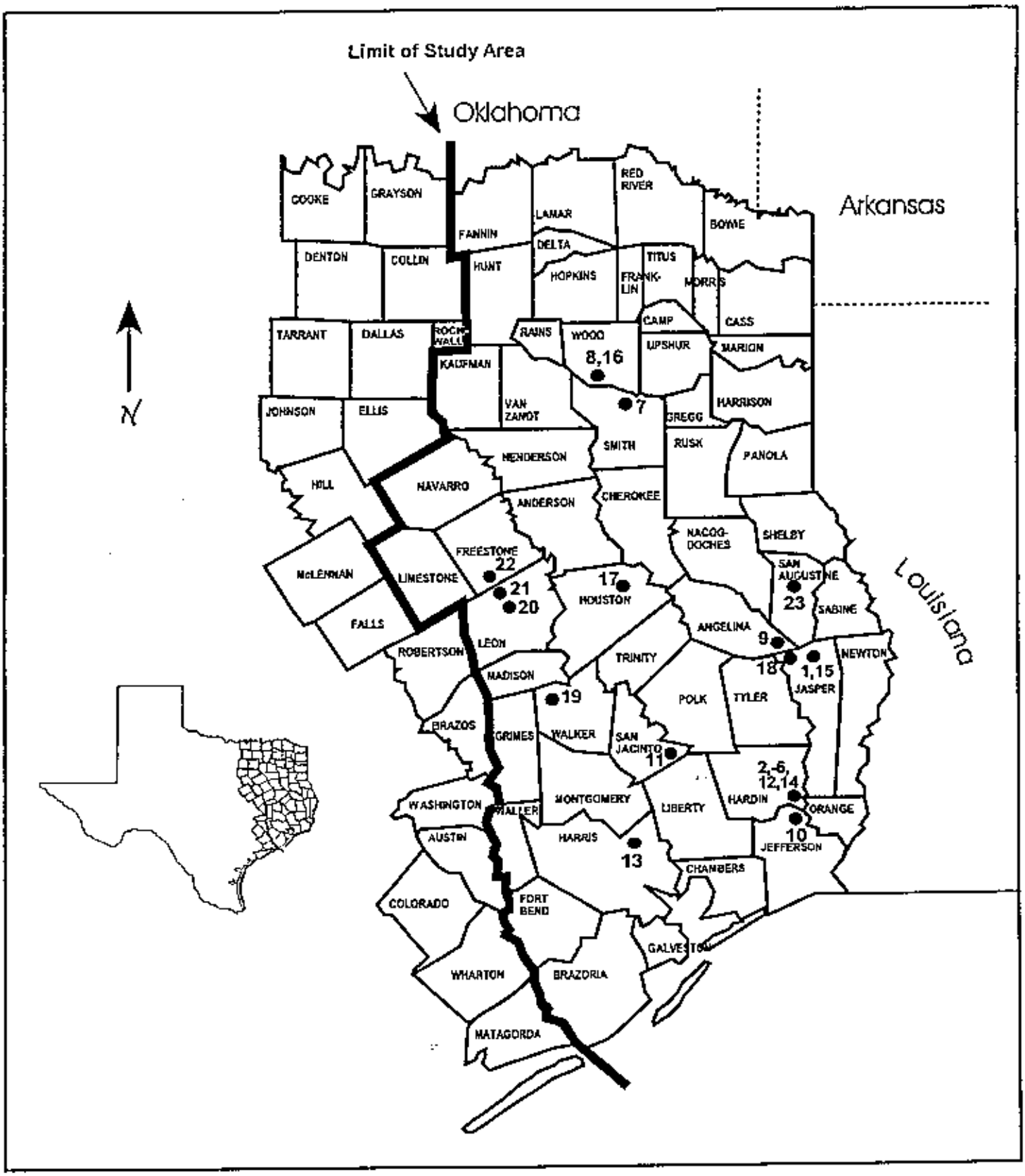


Figure 1: Location of all the known roost sites for SEM and BEB in east Texas (note: Roost 23 is approximate).

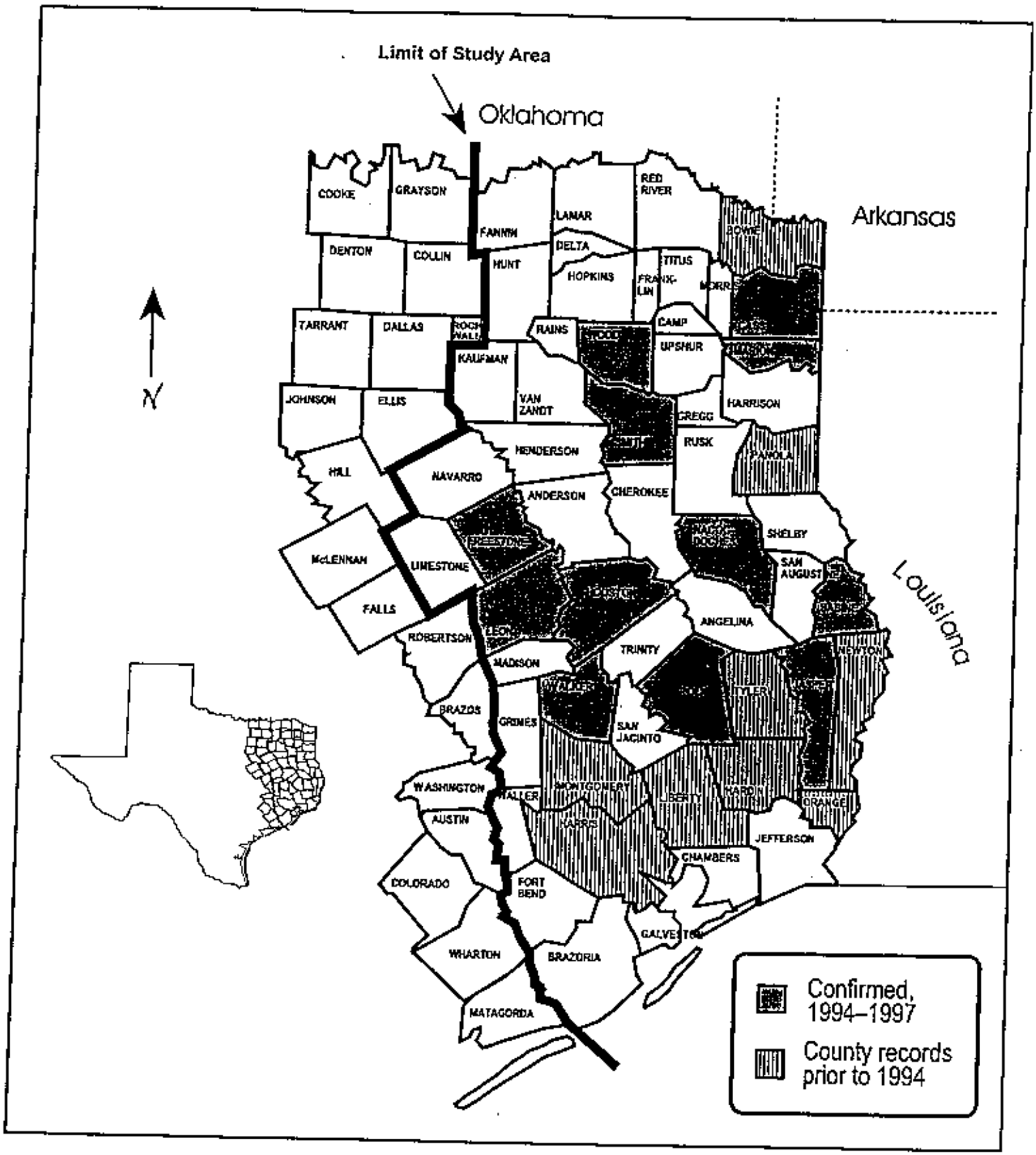


Figure 2: Distribution of SEM by county.

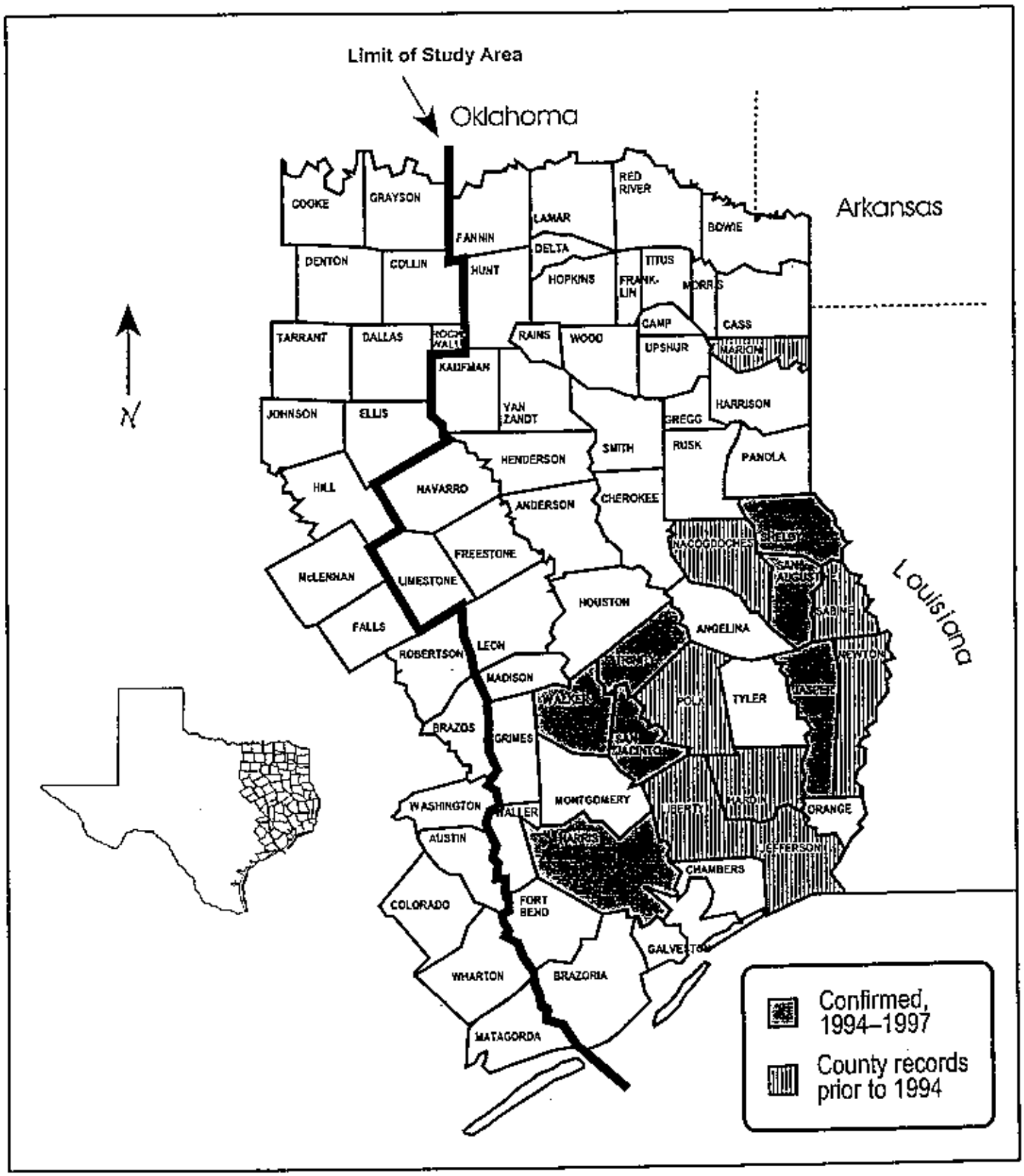


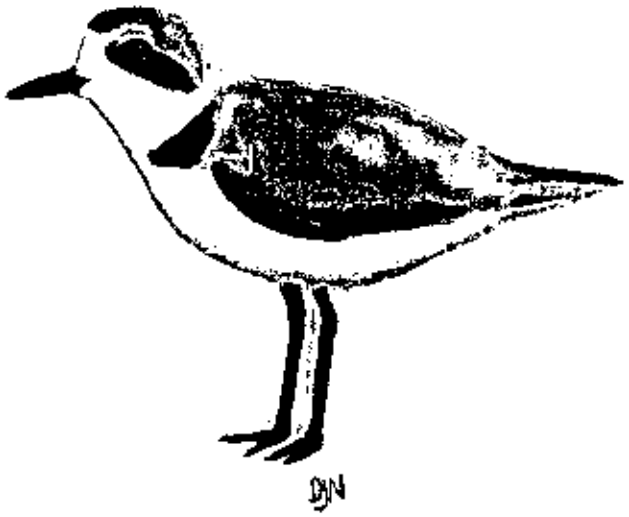
Figure 3: Distribution of BEB by county.

APPENDIX H

Results from contracted research and monitoring projects

1) *Charadrius alexandrinus* – snowy plover
2) *Crotaphytus reticulatus* – reticulate collared lizard
3) *Eumops perotis* – western mastiff bat
4) Independence Creek fishes

CENSUS AND ASSESSMENT OF NESTING ACTIVITY OF THE SNOWY PLOVER (*CHARADRIUS ALEXANDRINUS*) ALONG THE TEXAS CENTRAL COAST, 2002



Prepared for
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CENSUS AND ASSESSMENT OF NESTING ACTIVITY OF THE SNOWY PLOVER (*CHARADRIUS ALEXANDRINUS*) ALONG THE TEXAS CENTRAL COAST, 2002

SUMMARY

This report summarizes the results of a survey conducted to assess the amount of nesting activity of snowy plovers along the Texas Central Coast (May-July 2002). Twenty-seven sites (11 privately owned and 16 non-privately owned) throughout the survey area were visited during the nesting season (mid-May through mid-July) to determine if snowy plovers were present and whether they appeared to be nesting. A map of the area (Fig. 1) and site summaries (Appendices I-IV) are provided within the report. At each site, numbers of adult snowy plovers were recorded, along with evidence of nesting, number of eggs (if nest encountered) and number of young-of-year birds present. Notes regarding vegetation, debris, evidence of potential predation, etc., were also recorded.

Many of the sites which have reportedly provided nesting habitat for snowy plovers in previous years were rendered unusable this summer by high water levels. The two sites where significant numbers of nesting birds were observed are both man-made sites, which benefit in one case, from frequent deposition of new nesting substrate (and limited vegetation) and in the other case, from protection by an elevated berm surrounding the habitat area. Nesting was confirmed in seven of the ten sites where snowy plovers were present. It is the opinion of the authors that a conservative estimate of 80 breeding pairs (based on the surveyed areas and potential habitat in additional areas which could not be assessed by this survey) represents a conservative estimate of the nesting activity of snowy plovers in the survey area in 2002. The true number, contingent upon unassessed areas being predictably productive, may range up to approximately 130 pairs. The capacity may be even greater during years when water levels do not render potential nesting habitat unavailable.

The extent to which the abnormally high water levels (Fig. 2) affected the results of this survey is impossible to determine at present, due to the fact that no prior surveys on nesting snowy plovers have been conducted in this area. Human disturbance, particularly that associated with vehicular access, appeared to be one of the most prevalent forms of potential disruption to nesting activity observed at many of the sites.

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CENSUS AND ASSESSMENT OF NESTING ACTIVITY OF THE SNOWY PLOVER (*CHARADRIUS ALEXANDRINUS*) ALONG THE TEXAS CENTRAL COAST, 2002

INTRODUCTION

The western snowy plover (*Charadrius alexandrinus nivosus*), which occurs in the Texas Coastal Bend, is considered by U.S. Fish and Wildlife Service as a species of concern.

No previous studies have been conducted that address the nesting status and production of snowy plovers along the Texas coast, although an estimate of 500-700 breeding pairs was suggested by Curtis Zonick (*in* Gorman and Haig, 2001). A need for research to survey this population was suggested by Chaney et al. (1996) and Texas Parks and Wildlife Department.

METHODS

The purpose of this study was to provide information on nesting snowy plovers in the Texas Central Coast, encompassing the area from the northern end of Matagorda Island (Pass Cavallo) south to Intracoastal Marker Number 30, south of Baffin Bay (Fig. 1).

An advisory committee consisting of personnel from Coastal Bend Bays and Estuaries Program, Inc. (CBBEP), U.S. Fish and Wildlife Service, U.S. Geological Survey, Padre Island National Seashore, and Aransas National Wildlife Refuge, was established and consulted to prioritize potential habitat sites. Most study sites were located on the supratidal fringes of bay systems, although a few interior (non-adjacent to a tidal water body) sites were also surveyed. Several other potential areas were identified and observed during the survey period. A total of 16 non-privately owned sites (Appendix I and II) were surveyed throughout the nesting survey period. An additional 11 privately owned sites were also surveyed, and these are reported as an "unmapped site in _____ County" (Appendix III and IV).

Sites were visited at least once between May 4 and July 4, 2002. Some larger sites required more than one visit to adequately cover the entire survey area. Sites were visited initially to determine whether snowy plovers were present at the site and to provide a description of the habitat. A follow-up visit towards the end of the survey period was conducted at sites where a high concentration of the birds was initially observed to gather additional information on nesting success.

Fieldwork was conducted during morning hours in order to minimize heat stress to exposed eggs and/or nestlings. Sites were slowly walked through, and observations of birds were recorded along with latitude and longitude coordinates. Observations of scrapes, nests, and distress activity (i.e. broken-wing display) were recorded as nesting

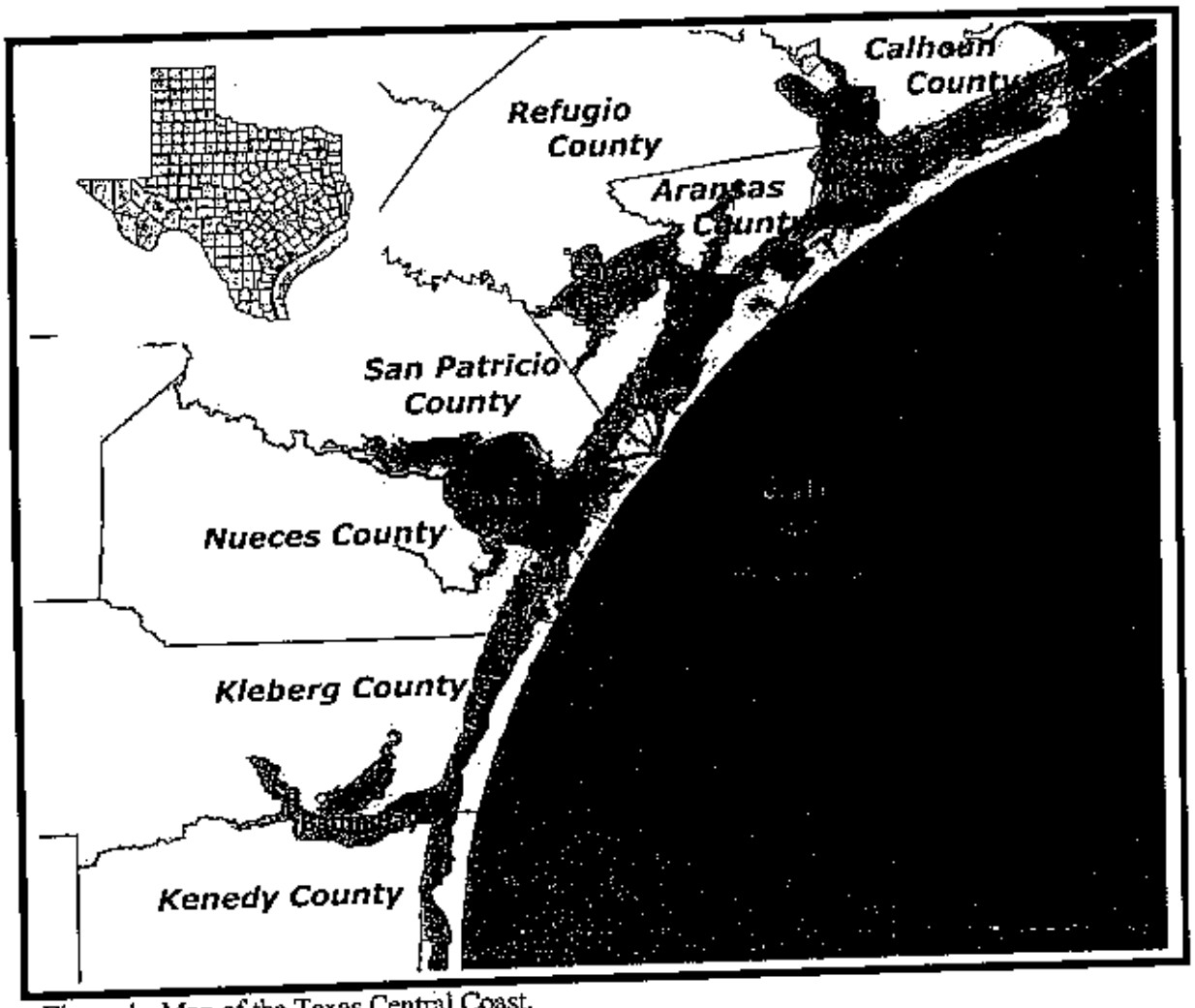

Figure 1. Map of the Texas Central Coast.

activity. When possible, nests were located and a total number of eggs and/or hatchlings was recorded. Additional notes on substrate type, adjacent vegetation or debris, and predator tracks were also recorded.

Acreage of potential available habitat assessed for each of the sites is provided in the site summary tables. For some sites, the area was estimated by the researcher involved. In most cases, ArcView GIS 3.2 software was used to determine area based on aerial photographs (1995 USGS digital orthophoto quadrangles). Many of the sites on the edges of bays are subject to flooding during periods of high water, rendering habitat unavailable. In these cases, acreage is reported as maximum habitat area available (unless otherwise noted).

SUMMARY RESULTS

Due to the survey methodology and the possibility that some birds may have moved between sites during the nesting season, an accurate count of nesting snowy plovers in

the study area is not possible based on this data. However, nesting activity serves as a viable alternative to evaluate potential productivity and habitat usage.

Snowy plovers were observed in 10 of the 27 sites surveyed. Snowy plover nesting activity in the study area was confirmed in 7 of these sites. Nesting success, as indicated by presence of young-of-year (YOY) birds, was observed in 3 of these sites. At all sites where snowy plover nesting was observed, least tern (*Sterna antillarum*) nesting was also noted. Least terns were also observed nesting on at least three of the sites where no snowy plover nesting was evident (this data was not consistently collected by all research personnel).

The highest total number of snowy plovers recorded was at the Carbon Black site. In the initial survey (May 10), 69 birds were observed. In the follow-up survey on June 21, 88 adults and 12 YOY birds were observed (not including one dead in a tire track). Ten scrapes fitting the description of those created by snowy plovers were also noted during this visit, but contained no eggs. It was not discernible whether the scrapes had served as nests already or if they were newly constructed. This site held the second highest density (adult birds/hectare) of all sites.

The highest density (and second highest number) of snowy plovers was found at a privately owned site in Nueces County. Twenty-six birds (plus 10 eggs and 5 YOY) were observed in a 17 ha area.

DISCUSSION

The results of this survey confirm that snowy plover nesting did occur in the Texas Coastal Bend at a limited number of sites in 2002. Several of the sites surveyed were reported to have supported nesting snowy plovers in previous years. Due to several anomalous events and conditions in the season and the fact that no comparable historical data on nesting is available, it is difficult to determine whether the limited nesting activity this year is indicative of an overall population decline, or perhaps due to limited availability of suitable nesting habitat, or a combination of these factors.

Initial visits to many of the sites revealed that bare-ground nesting habitat was submerged by high water levels. Though occasional high water events are not uncommon in areas where tides are predominantly wind-driven, this year water level rose sharply in mid-May and remained higher than normal throughout the period of the survey (Fig. 2).

Additionally, heavy rains in the watershed of the Nueces River from late June through early July resulted in a major flooding event that affected sites in and near Nueces Bay. Fluctuating water levels have been postulated as an important source of nest failure in the mid-continental piping plover population (Espie et al. 1998). If 2002 water levels were indeed anomalous, and not reflective of a long-term trend, much of the potential habitat which was rendered unusable this year may have served as nesting habitat in the past, and may once again become usable in the future.

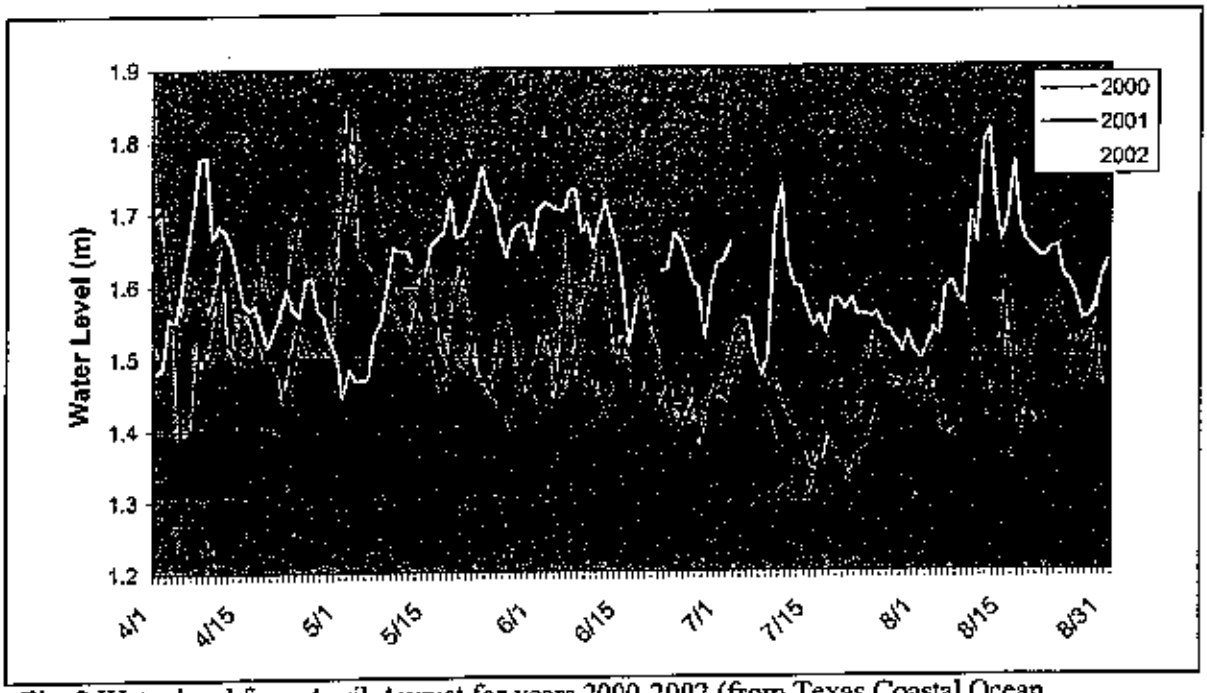

Fig. 2 Water level from April-August for years 2000-2002 (from Texas Coastal Ocean Observation Network Station 001-Naval Air Station, Conrad Blucher Institute for Surveying and Science).

An association between nesting habitat for snowy plovers and least terns (*Sterna antillarum*) has been documented in various other studies (Powell and Collier 2000, Koenen et al. 1996, Hothem and Powell 2000, and others). During this study, least tern nesting activity was noted at all sites where snowy plovers were observed, as well as many others in which they were not observed. The absence of snowy plovers at some sites where least terns were apparently nesting successfully indicates that this species may be more resilient to factors which negatively affect snowy plovers. Although both species apparently have similar habitat preferences, in California snowy plover populations have declined while least tern populations have increased (Powell 1998).

Declines in snowy plover populations correspond with habitat destruction, increased pressure from predators, and increased human disturbance (Page et al. 1995, Lafferty 2001). Since no site-specific baseline data exists for these factors at the sites covered in this survey, the extent to which they may be affecting trends in snowy plover nesting activity could not be determined. However, tracks of potential predators were noted at most of the sites, and included those of coyote (*Canis latrans*), raccoon (*Procyon lotor*), javelina (*Pecari tajacu*) and in one case, Western diamondback rattlesnake (*Crotalus atrox*). Disturbance due to livestock grazing was a potential factor only on private lands. Direct anthropogenic disturbance involved both pedestrian and vehicular access to many of the sites. Vehicle tracks were noted at many of the sites surveyed and probably represents the most disruptive form of disturbance for bare-ground nesting birds in much of the urbanized study area. Vehicular use of these areas was associated with access to popular fishing areas, as well as purely recreational purposes such as ATV and 4-wheel

drive usage. This type of disturbance was particularly acute on non-privately owned lands with unrestricted access.

Snowy plovers are known to exhibit some degree of interannual site fidelity, with males showing slightly stronger fidelity than females. Nesting snowy plovers were found at relatively few sites in this survey, despite suggestions that nesting was more widespread in the past. Since there is no systematic baseline information, it is impossible to determine whether these sites have been "abandoned" as potential nesting sites. In a study of banded west coast snowy plovers, there was no significant correlation between site fidelity and the previous year's nesting density or success. However, male site fidelity declined when the amount of suitable habitat declined, while females returned at a relatively constant rate from year to year (Paton and Edwards 1996). It is possible that several of the sites surveyed may once again support nesting snowy plovers in the near future given favorable environmental conditions. Sites that seemed to be more affected by human disturbance may have a lesser probability of re-initiating nesting, since these disturbances are relatively constant from year to year. In west coast populations, 52 of 80 former coastal nesting locations were abandoned due to impacts from human disturbance (Page and Stenzel 1981).

The two sites which had the highest concentrations of nesting snowy plovers (Carbon Black and an "unmapped site in Nueces County") are man-made sites constructed for other land uses. The Carbon Black site was formed of sandy dredge material excavated for the deepening of the Corpus Christi Ship Channel. Periodic deposition of additional spoil on this site serves to limit the encroachment of vegetation, though the timing of this activity may be disruptive to nesting activity. The "unmapped" site consists of a patchwork of low sandy flats. At this site, the highest number of snowy plover nests was found, and in all cases these were in close association with driftwood debris, usually in the fork of a Y-shaped piece. Placement of driftwood and other debris has been suggested as a management tool in areas created as nesting habitat, in order to mimic natural patterns of cover (Powell and Collier 2000). In an Oklahoma study, nests associated with widely dispersed driftwood were more successful than those associated with debris lines; however, overall the nests associated with debris experienced higher predation than those located in open areas (Winton et al., 2000). This behavior was not noted regularly at any of the other sites, and may represent an adaptation specific to the set of pressures encountered at this unique site.

RECOMMENDATIONS

This survey covered many diverse sites throughout the Texas Coastal Bend. Unfortunately, access to much of the potential habitat in the area is confounded by the difficulties of contacting and gaining access to privately owned lands. Snowy plovers are most broadly distributed and least concentrated during breeding season (Gorman and Haig 2001), and an accurate assessment of the total breeding population would require a great deal of private landowner cooperation which is frequently not forthcoming.

Due to concerns that snowy plovers may be experiencing a breeding range contraction in Texas, a continuation of this effort annually in both the Coastal Bend, as well as southward to the Texas-Mexico border would provide a better basis from which to assess the regional snowy plover population. In a survey covering a broad geographical area, communication and cooperation with agency personnel and others with local knowledge and some expertise in the field are critical. Evaluation of potential habitat using aerial photographs prior to the nesting season would be helpful in identifying priority survey sites. Extending the survey into Mexico (Tamaulipas to northern Veracruz and the Yucatan Peninsula) would provide valuable data on the size of those populations as well (Gorman and Haig 2001).

Accurate assessments of nesting success for particular sites is confounded by a number of factors, including the cryptic appearance of nests and young, and the rapid development of locomotor ability shortly after hatching. Gathering accurate data of this type would require frequent visits, capturing, and banding, in order to effectively measure nesting success. These practices are also, however, a form of disturbance, and injury to breeding birds and desertion of nesting sites due to these disturbances have been reported (Page et al., 1995). Therefore, training of research personnel as well as the frequency and timing of surveys are essential.

ACKNOWLEDGMENTS

We would like to thank the members of the advisory committee and others who served in an advisory capacity, including Mary Kay Skoruppa, Marc Woodin, Jody Mays, Darrell Echols, Robyn Cobb, Lee Elliott, Jennifer Sanchez and Tom Langschied; and the researchers who helped to carry out much of the fieldwork for this project, including Hollis McKinney, Katie Morris, Wayne McAlister, John Eckrote, Richard Gibbons, Shannon Garvon, Maren Harding, and the volunteers for the 2002 Colonial Waterbird Census. Sagely advice (technical and otherwise) from Dr. Liz Smith, Brien Nicolau, Kendall Keyes, and Rick Hay was also invaluable to the completion of this report.

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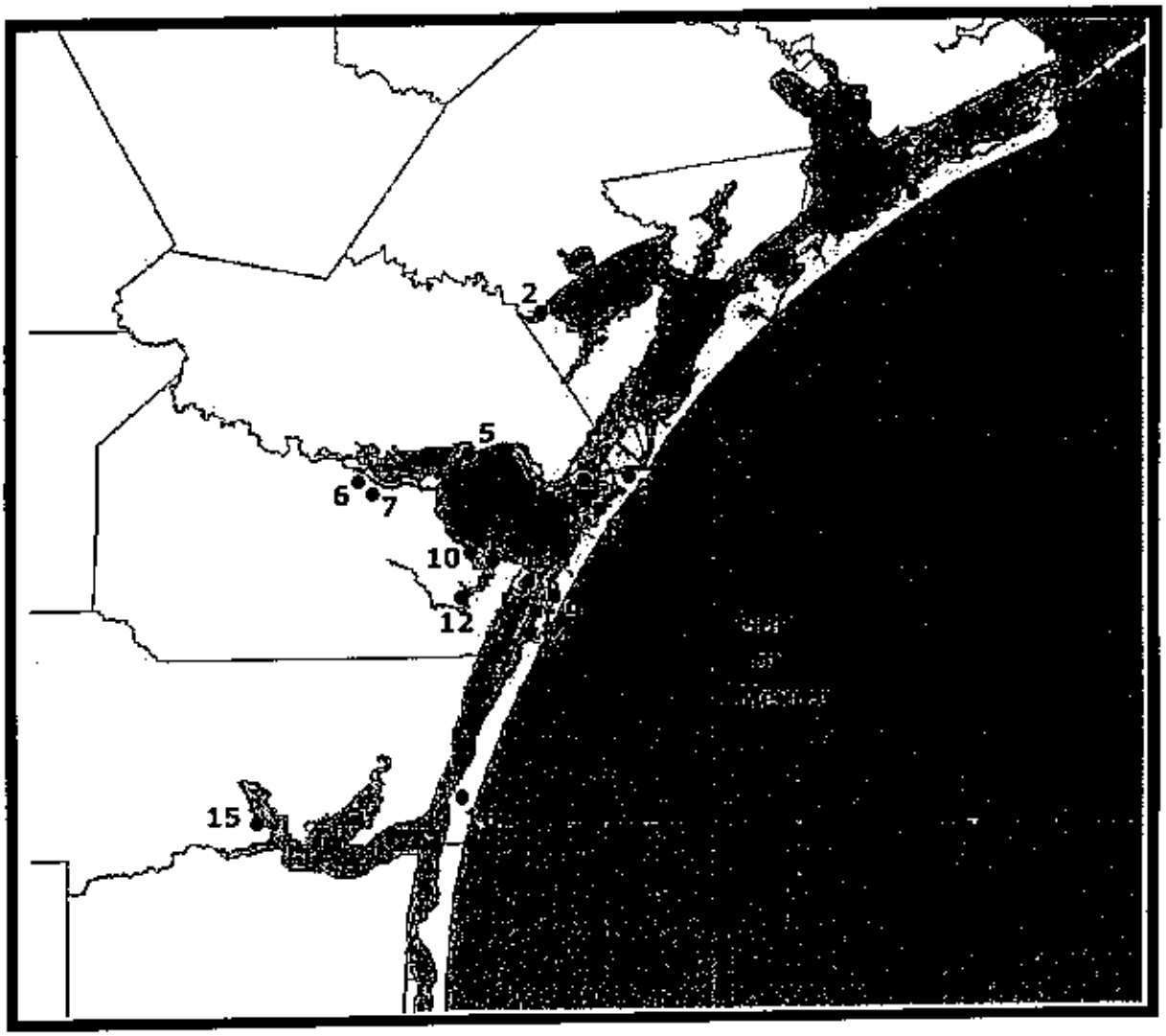
Appendix II. Index map of study area showing locations of non-privately owned survey sites.



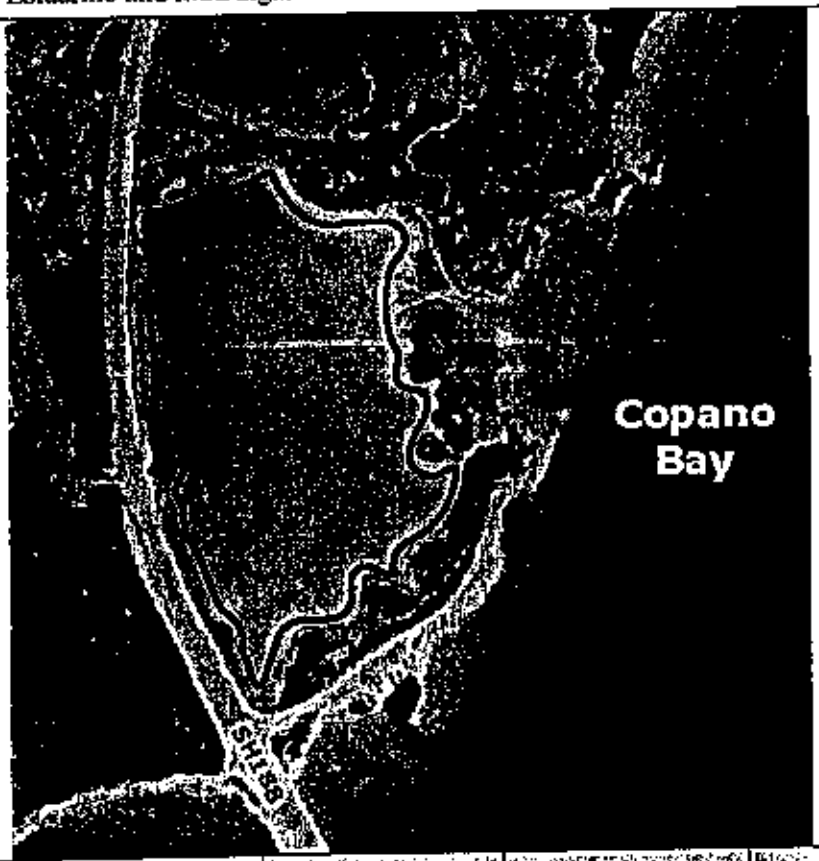
Appendix III. Summaries for non-privately owned survey sites.

1.

Site	Matagorda Island National Wildlife Refuge			
Location	Matagorda Island (south end)			
Tx Zone	Data not provided			
County	Calhoun			
Owner	Federal			
Habitat Area	525 hectare (1,297.30 acre)			
Researcher	Jennifer Sanchez, Wayne McAlister			
Date	5/16/02, 5/27/02			
Weather Conditions	Data not provided			
Description	Sand and mud flats along tidal wetlands			
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	None provided			

Appendix III. Continued

2.

Site	Bayside
Location	South of Bayside and east of SH188
Lat/Long	N 28° 04' 39.1", W 097° 13' 20.4"
County	Refugio
Owner	Texas General Land Office
Habitat/Area	7 hectare (17.30 acre)
Researchers	Gene Blacklock
Date	6/22/2002
Weather Conditions	26.67 °C, average wind speed Southeast at 8.0 mph, overcast 100% cloud cover.
Description	Estuarine and mud/algal flats
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Impacted by high water			

Appendix III. Continued

3.

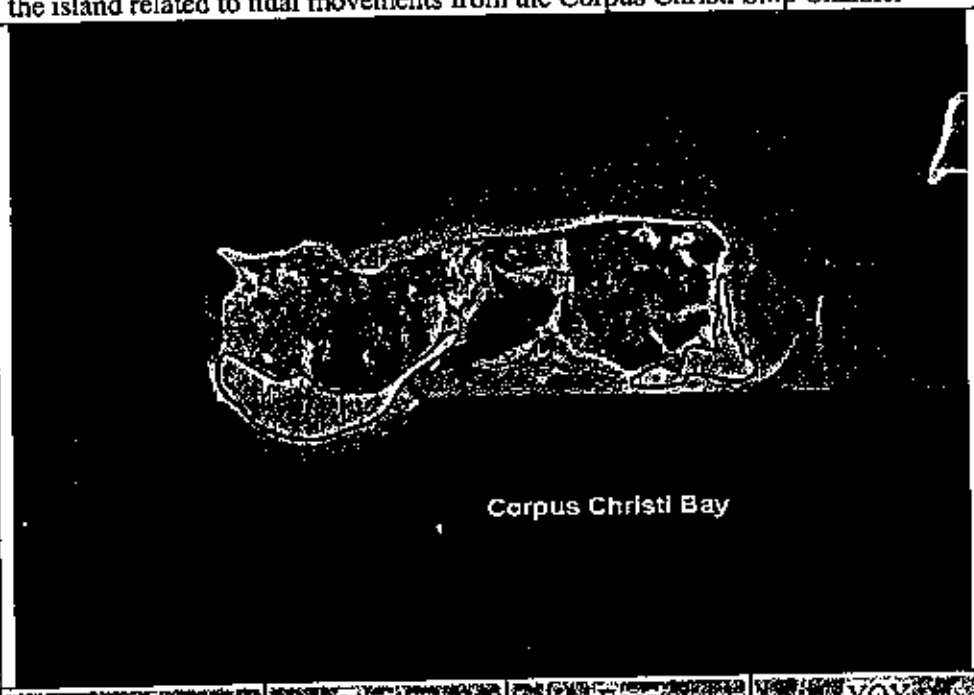
Site	Charlie's Pasture
Location	Port Aransas, adjacent to Port Aransas Wastewater Treatment Plant/Birding Center
Lat/Long	N 27° 49' 55.4", W 097° 04' 46.6"
County	Nueces
Owner	Texas General Land Office
Habitat Area	16 hectare (39.54 acre)
Recorders	David Newstead, Erin Albert
Date	5/24/2002
Weather Conditions	27.4°C, average wind speed East at 6.2mph, 70% cloud cover.
Description	Extensive sand flat area
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-

Comments	Many nesting least tern; appears to be good habitat but may be a little too far from available freshwater; some vehicular disturbance noted

Appendix III. Continued

4.

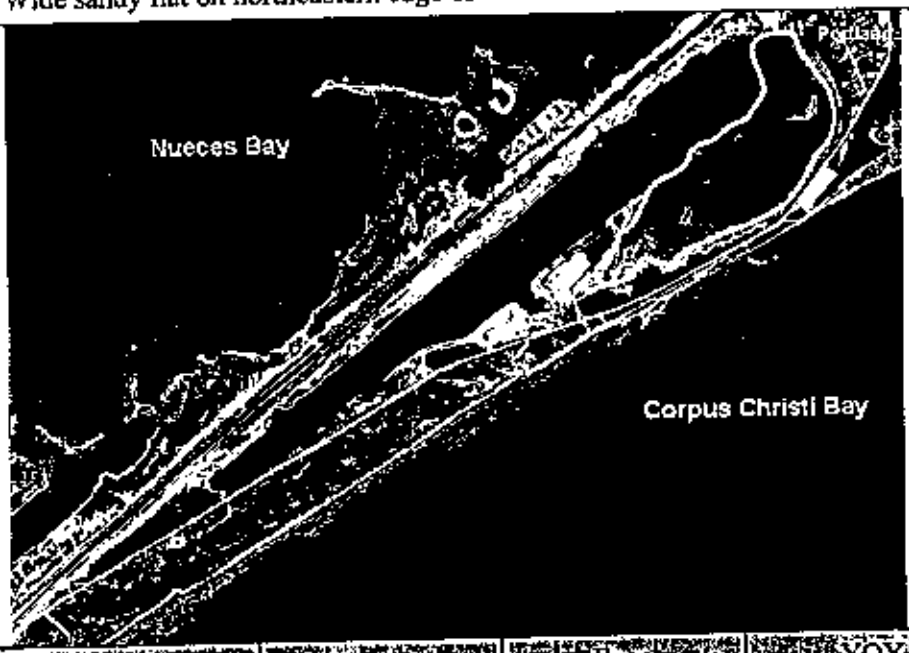
Site	Pelican Island
Location	South of Corpus Christi Ship Channel in Corpus Christi Bay, west of Shamrock Island
Lat/Long	N 27° 48' 57.6", W 097° 08' 47.0"
County	Nueces
Owner	Port of Corpus Christi Authority, Navigation District
Habitat Area	20 hectare (49.42 acre)
Researchers	Colonial Waterbird Census
Date	5/25/2002 – 6/02/2002
Weather conditions	5/25/2002: 29.44°C, average wind speed Southeast at 11.50 mph, 50% cloud cover; 6/02/2002: 23.33°C, average wind speed Southeast at 10.00 mph, 65% cloud cover.
Description	Dredge deposition island; an alluvial fan radiates from the SE and SW corners of the island related to tidal movements from the Corpus Christi Ship Channel
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-

Comments	None provided

Appendix III. Continued

5.

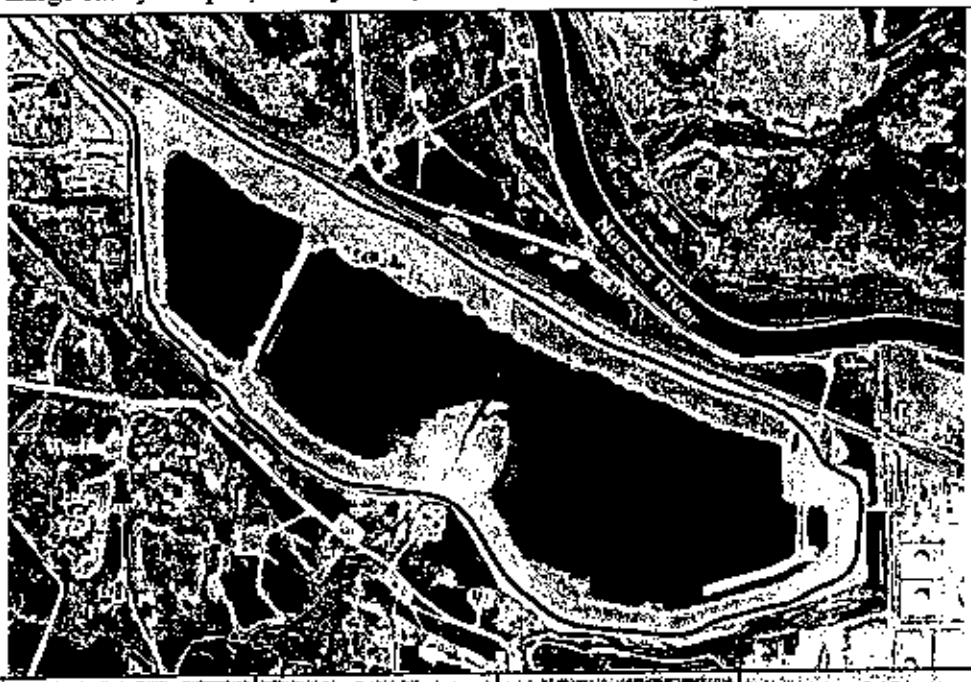
Site/Area	Sunset Lake
Location	Northern area of Indian Point peninsula
Lat/Long	N 27° 52' 13.8", W 097° 19' 45.3"
County	San Patricio
Owner	City of Portland
Habitat Area	20 hectare (49.42 acre)
Researcher	Gene Blacklock (and others)
Date	5/25/2002 – 6/02/2002
Weather Conditions	No data provided
Description	Wide sandy flat on northeastern edge of "lake"
Aerial view	

# adults	Nesting	Eggs	YOY
6	3	0	0

Results	
Comments	This site was monitored regularly over the course of the breeding period; site supported three nesting pairs of snowy plovers this year; nests were not sought, but three YOY were observed later in the season.

Appendix III. Continued

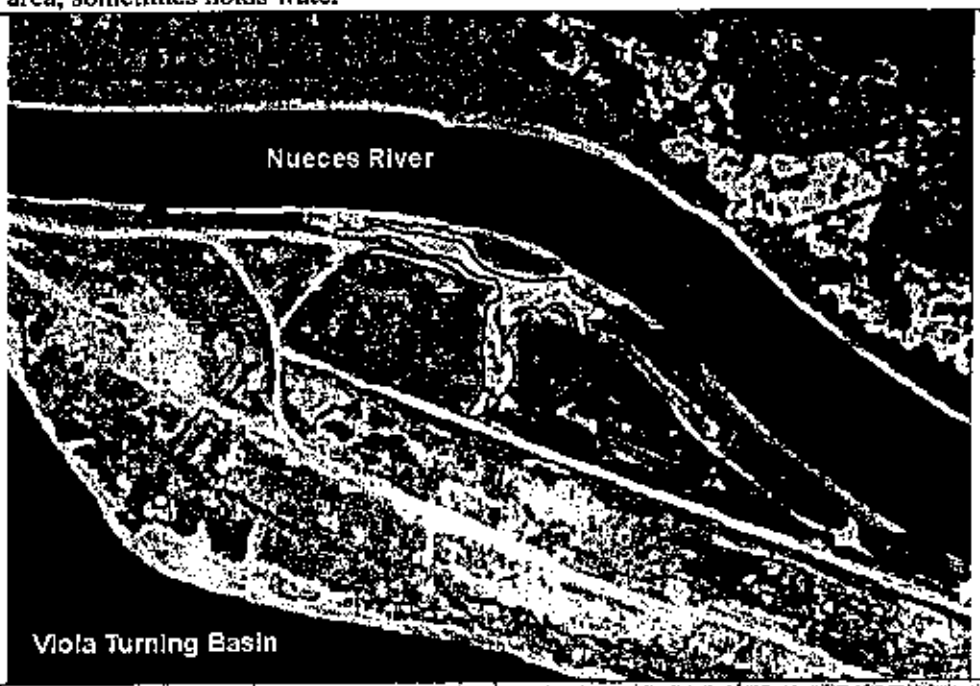
6.

Site Name	Carbon Black
Location	Between Nueces River and Tule Lake Turning Basin in Corpus Christi Ship Channel
Lat/Long	N 27° 50' 46.8", W 097° 32' 54.9"
County	Nueces
Owner	Port of Corpus Christi Authority, Navigation District
Habitat Area	Approx. 130 hectare (321.24 acre) total area; b/w 50-200 acres of this may be inundated; at time of second visit, water was restricted to the lowest areas, surrounded by a hard salty crust
Researchers	Gene Blacklock, David Newstead, Erin Albert
Date	5/10/2002, 6/21/2002
Weather Conditions	5/10/2002: 28.89 °C, average wind speed Southeast at 17.00 mph, 65% cloud cover; 6/21/2002: 27.4 °C, average wind speed Southeast 4.9 mph, 30% cloud cover, rained overnight.
Description	Large sandy salt pan, mostly dried; bounded on all sides by levees
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	88	10	-	12
Comments	The site of highest concentration of Snowy plover adults and young; one YOY observed was dead, apparently run over by a vehicle (laying in a tire track); least terns, common nighthawk also nesting in area; several Wilson's plovers observed			

Appendix III. Continued

7.

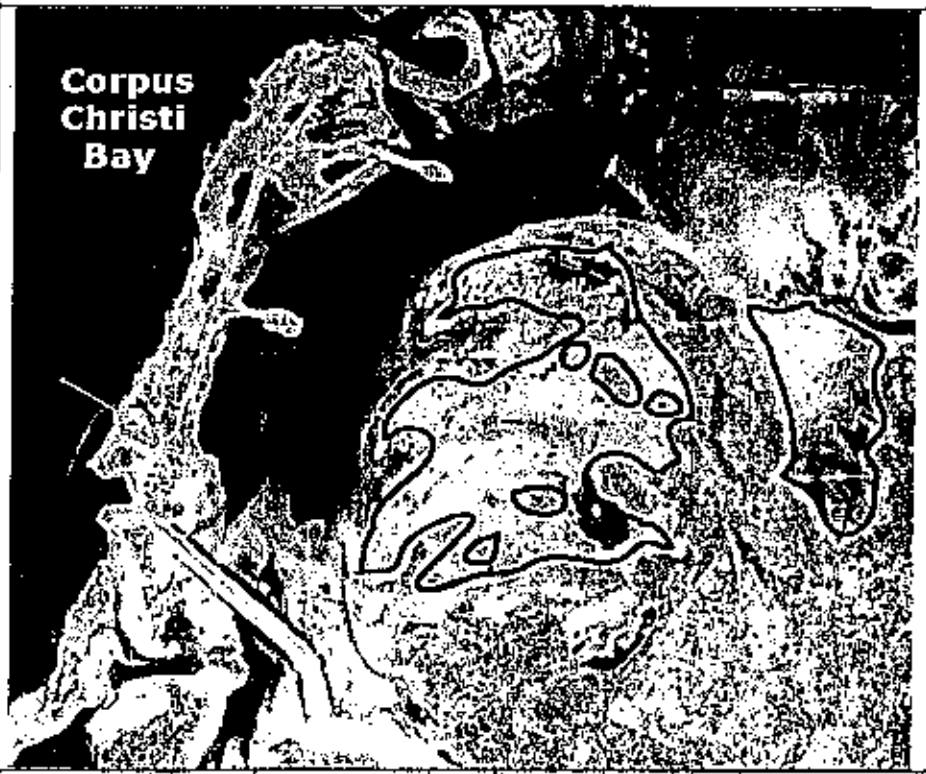
Site	Corn Products
Location	Dredge material immediately north of Corpus Christi Ship Channel and north of Corn Products Road
Lat/Long	N 27° 50' 43.5", W 097° 30' 51.6"
County	Nueces
Owner	Port of Corpus Christi Authority, Navigation District
Habitat Ac	0.5 hectare (1.24 acre)
Recorder	Gene Blacklock
Date	Periodically from 04/19/2002 – 07/13/2002
Weather Conditions	No data provided.
Description	A diked area of dredge material deposition; some alluvial fans spill into diked area, sometimes holds water
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	6	3	-	2

Comments	Once supported higher concentration of nesting snowy plovers and least terns, but encroaching vegetation has limited habitat

Appendix III. Continued

8.

Site	Francine Cohn Preserve
Location	Mustang Island, south of Wilson's Cut
Lat/Long	N 27° 43' 31.6", W 097° 09' 40.3"
County	Nueces
Owner	The Nature Conservancy
Habitat Area	30 hectare (74.13 acre)
Recorder	Gene Blacklock
Date	6/10/02
Weather Conditions	23.89 °C, average wind speed Northeast at 12.00 mph, 70% cloud cover.
Description	Mud and algal flat habitats along with some open water
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Relatively small area potentially suitable for snowy plover nesting; high water in early summer probably rendered it unusable			

Appendix III. Continued

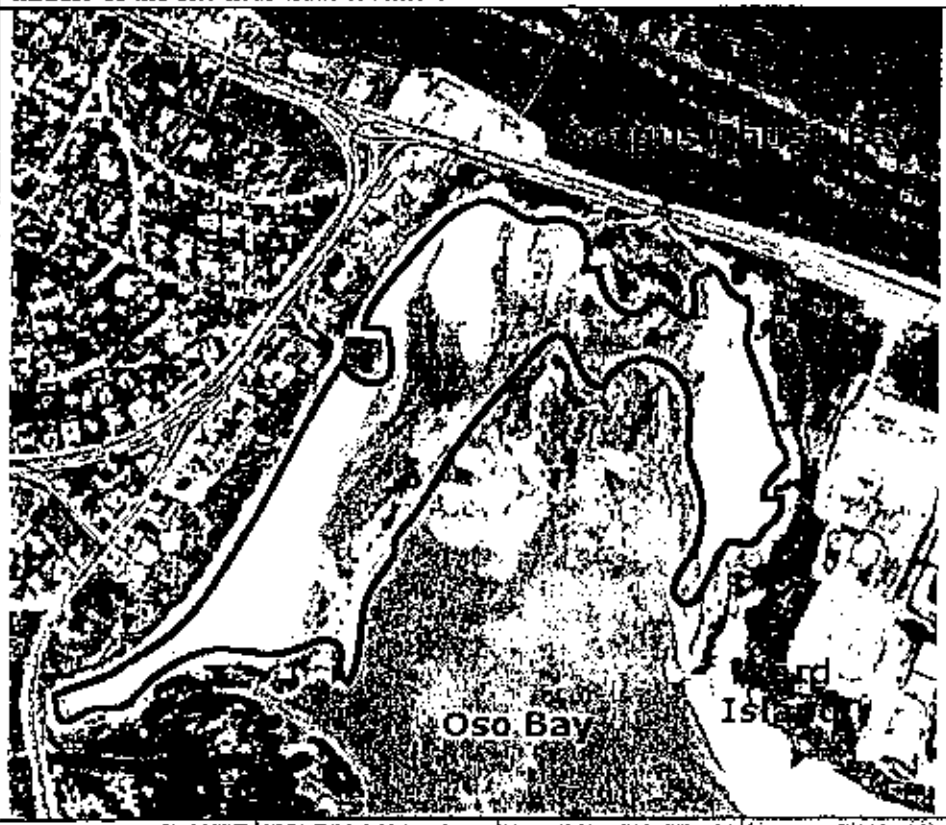
9.

Site	Mollie Beattie Habitat Community
Location	Mustang Island, between Packery Channel and Corpus Christi Pass
Lat/Long	N 27° 38' 14.6", W 097° 12' 30.0"
County	Nueces
Owner	Texas General Land Office
Habitat Area	25 hectare (61.78 acre)
Researchers	David Newstead, Erin Albert, Shannon Garvon
Date	5/4/02, 5/10/02, 5/24/2002, 6/16/2002
Weather Condition	5/10/2002: 28.89 °C, average wind speed Southeast at 17.00 mph, 65% cloud cover; 5/24/2002: 25.5° C, 14.9 mph East wind, 98% cloud cover. 6/16/2002: overcast/ sprinkles, average wind Northeast 5-10 mph.
Description	Extensive areas of silty sand and algal flats between Laguna Madre and SH361, interspersed with tidal channels and some upland patches
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	6	-	-	-
Comments	Used extensively by nesting least tern; may have supported 2-3 nesting pairs of snowy plover, but no strong evidence of such; predators (raccoon, coyote) may be limiting to snowy plover presence/nesting activity			

Appendix III. Continued

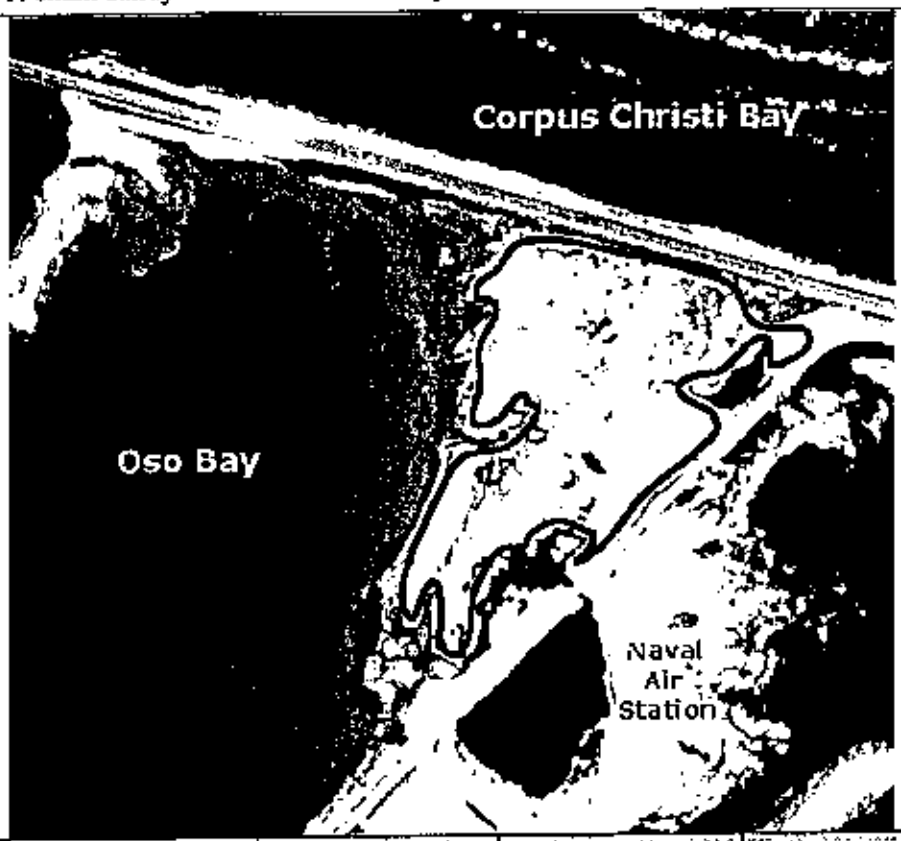
10.

Site	Blind Oso
Location	Area between Ward Island and mainland Corpus Christi south of Ocean Drive
Lat/Long	N 27° 42' 53.3", W 097° 20' 00.8"
County	Nueces
Owner	Texas General Land Office
Habitat Area	Ranged from 0-15 hectare (0-37.07 acres)
Researchers	David Newstead, Maren Harding
Date	5/23/2002
Weather Conditions	27.22 °C, average wind speed Southeast 18.00 mph, 65% cloud cover.
Description	Intertidal sandy algal flat with some halophytic vegetation concentrated in the middle of the site near tidal channels
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Impacted by high water			

Appendix III. Continued

11.

Site	Encinal Peninsula (west shore of NAS)
Location	West shore of peninsula, between NAS boundary fence and Oso Bay shoreline
Lat/Long	N 27° 42' 26.7", W 097° 18' 11.4"
County	Nueces
Owner	Federal
Habitat Area	5 hectare (12.36 acre)
Researcher	David Newstead, Shannon Garvon, Maren Harding
Date	5/23/2002
Weather Conditions	29.4° C, average wind speed East Southeast 15-20 mph, 15% cloud cover.
Description	A small sandy area between Oso Bay and NAS
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Wilson's plover and least tern nesting behavior observed, least tern nests observed, one with newly-hatched young			

Appendix III. Continued

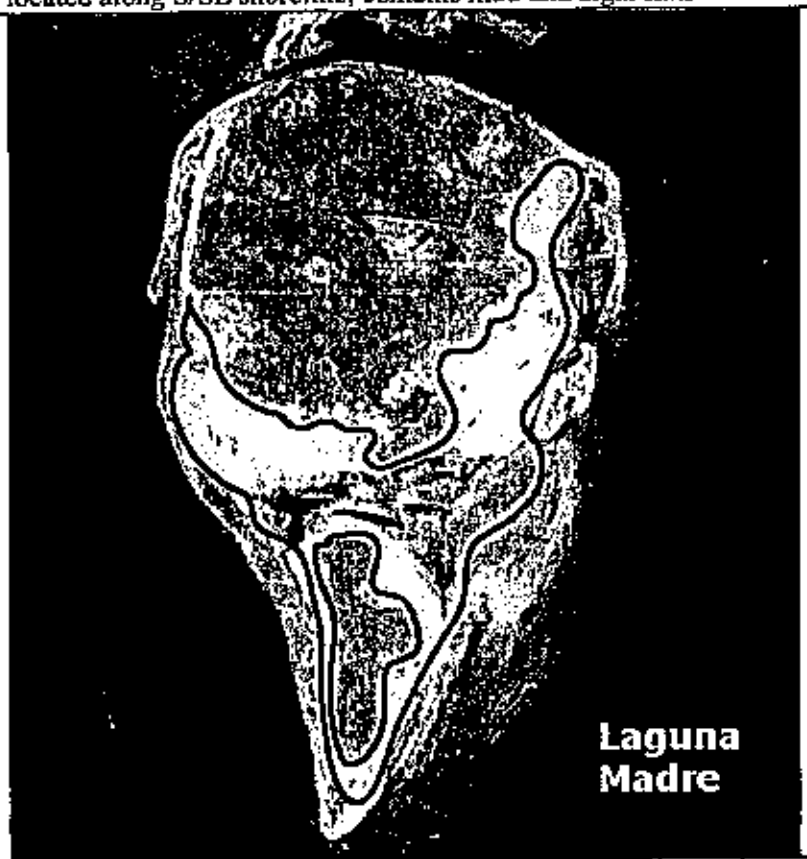
12.

Site	West Oso Shoreline
Location	Along the western shore of Oso Bay between the water and the beginning of upland vegetation
Lat/Long	N 27° 39' 49.1", W 097° 20' 37.8" to N 27° 37' 59.8", W 097° 21' 04.9"
County	Nueces
Owner	Texas General Land Office
Habitat Area	25 hectare (61.78 acre)
Researchers	David Newstead, Erin Albert
Date	5/11/2002
Weather Conditions	26.5 °C, average wind speed Southeast 15.9 mph, 85% cloud cover.
Description	Available habitat composed of alluvial/sand deposits from bay shore to upland vegetation (~20-40m strip)
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Heavy vehicular disturbance south of Yorktown (Mud Bridge); site appears to be used as a dumpsite (appliances, tires, etc.) and gun firing range (shotgun shells); area north of Yorktown apparently less impacted; area behind neighborhood composed of silt and sand – a wider area with numerous freshwater drainages nearby			

Appendix III. Continued

13.

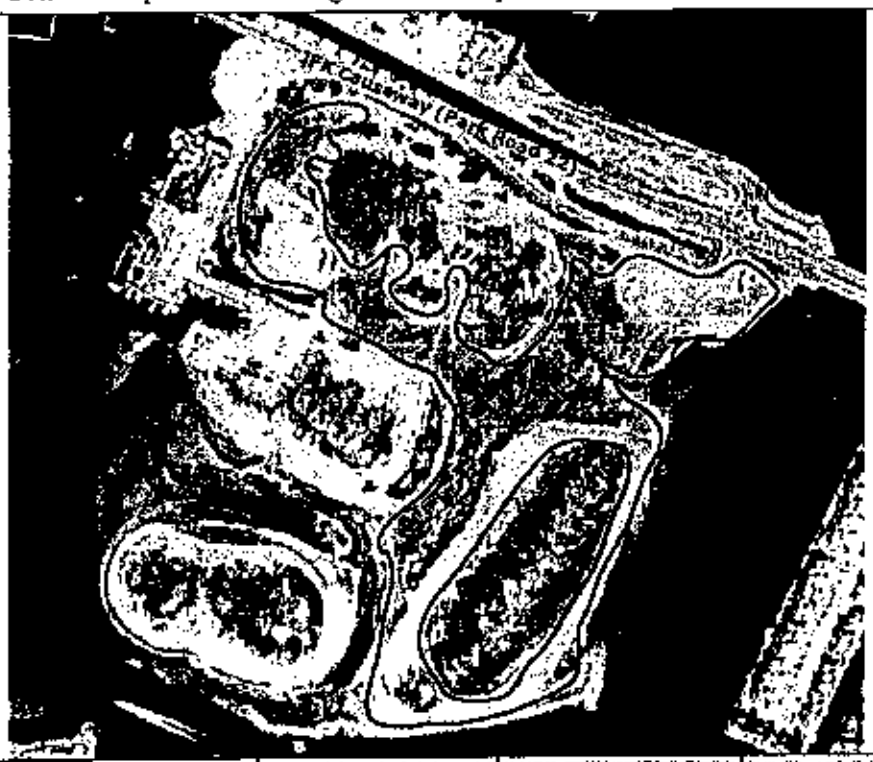
Site	Coyote Island
Location	In Laguna Madre east of Encinal Peninsula
Lat/Long	N 27° 41' 05.1", W 097° 14' 21.5"
County	Nueces
Owner	Texas General Land Office
Habitat Acr	15 hectare (37.07 acre)
Survey	Colonial Waterbird Census
Date	5/25/2002 – 6/02/2002
Weather Condition	5/25/2002: 29.44°C, average wind speed Southeast at 11.50 mph, 50% cloud cover; 6/02/2002: 23.33°C, average wind speed Southeast at 10.00 mph, 65% cloud cover.
Description	Island has been diked and received dredge material deposition; alluvial fan located along S/SE shoreline; contains mud and algal flats
Aerial view	

Results	# adults	Nesting	Eggs	YOY
	0	-	-	-

Comments	Site holds wintering snowy plovers, but none were identified in this year's Colonial Waterbird Census

Appendix III. Continued

14.

Site	The Village
Location	Dredge material island east of Gulf Intracoastal Waterway, south of Park Road 22 (JFK Causeway)
Lat/Long	N 27° 37' 51.8", W 097° 14' 05.0"
County	Nueces
Owner	Texas General Land Office
Habitat Area	4 hectare (9.88 acre)
Researchers	David Newstead, Erin Albert
Date	5/10/2002
Weather Conditions	5/10/2002: 28.89 °C, average wind speed Southeast at 17.00 mph, 65% cloud cover.
Description	Some sand patches with vegetation interspersed
Aerial view	

	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Parts of the available habitat area are disturbed by vehicles, and high water may have been another confounding factor this year; 2 least tern nests found; 2 Wilson's plovers observed			

Appendix III. Continued

15.

Site	Cayo del Grullo
Location	Drainage north of Kaufer-Hubert Memorial Park
Lat/Long	N 27° 19' 08.7", W 097° 41' 11.4"
County	Kleberg
Owner	Texas General Land Office
Habitat Area	Possibly ~15 hectare (37.07 acre) – 20 hectare (49.42 acres), but none was available due to high water
Recorders	David Newstead, Erin Albert
Date	6/13/2002
Weather Conditions	26.67°C, average wind speed Southeast at 12.0 mph, 45% cloud cover.
Description	Estuarine and mud/algal flats
Aerial view	

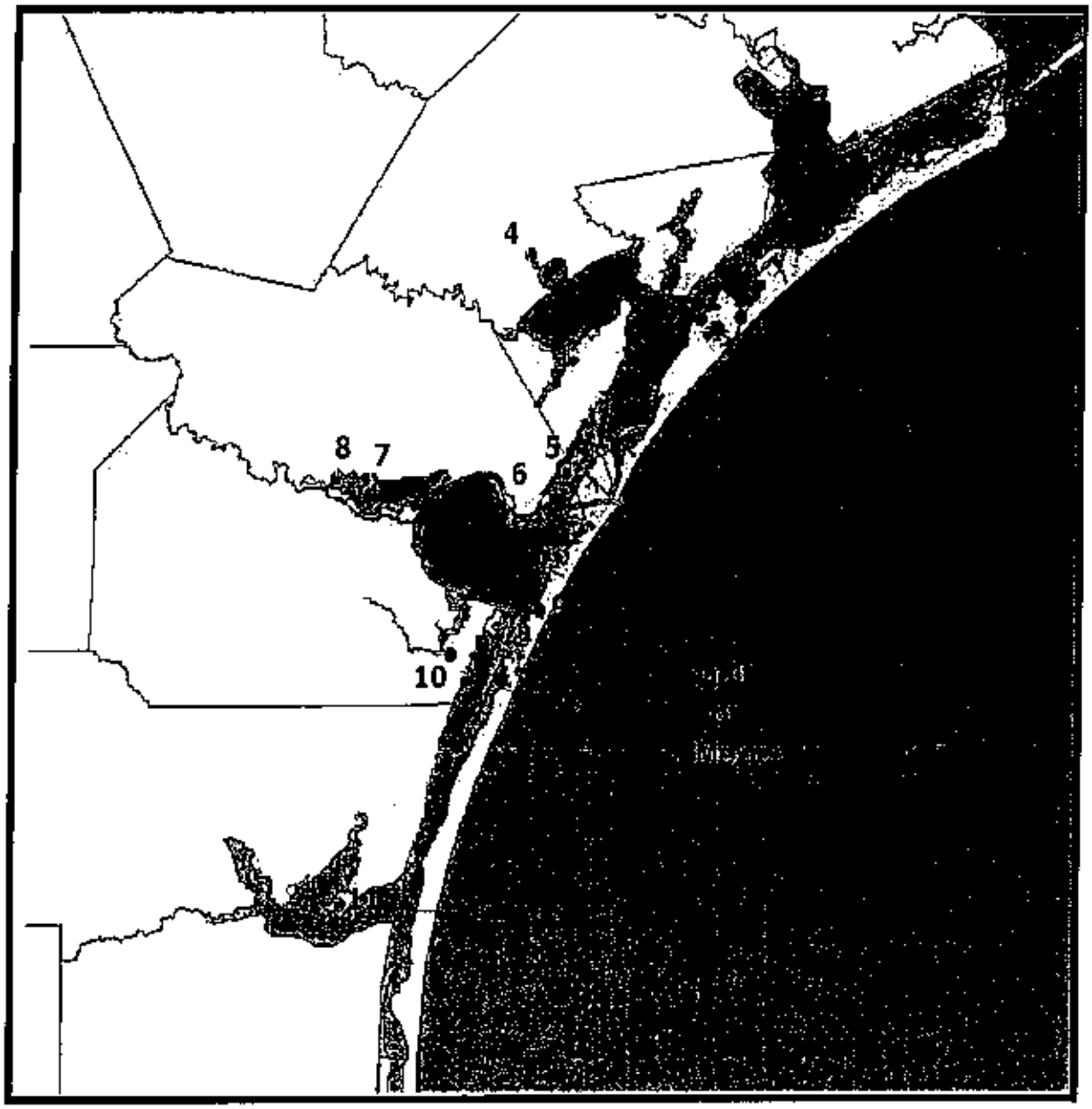
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Impacted by high water			

Appendix III. Continued

16.

Site	Padre Island National Seashore			
Location	Northern boundary of Padre Island National Seashore south to 30-mile marker (Laguna Madre side).			
Lat/Long	N 27° 31' 59.0", W 097° 16' 20.3" to N 26° 45' 18.8", W 097° 20' 17.9"			
County	Nueces/Kleberg			
Owner	Federal			
Habitat Area	800 hectare (1,976.84 acre)			
Recorders	Darrell Echols, Katie Morris, Hollis McKinney, John Eckrote			
Date(s)	6/20/2002, 6/25/2002, 6/26/2002			
Weather Conditions	6/20/2002: "sunny, hot, dry and windy"; 6/25/2002: "hot, partly sunny, windy"; 6/26/2002: "95F, little wind, sunny"			
Description	Sandflats along Laguna Madre shoreline			
	# adults	Nesting	Eggs	YOY
Results	13	2	-	-
Comments	Many least terns and Wilson's plovers observed during surveys			

Appendix IV. Index map of study area showing locations of privately owned survey sites.



Appendix V. Summaries for unmapped (privately-owned) survey sites.

1.

Site	Unmapped site in Aransas and Calhoun County			
Location	Matagorda and San Jose fish pass			
Lat/Long	Data not provided			
County	Aransas and Calhoun			
Ownership	Private			
Habitat Area	Data not provided			
Researchers	Jennifer Sanchez			
Date	5/18/02 & 5/29/02			
Weather Conditions	Data not provided			
Description	Sand and mud flat along tidal fish pass which is currently plugged			
	# adults	Nesting	Eggs	YOY
Results	23	-	-	-
Comments	All birds observed were loafing, no nesting activity observed			

2.

Site	Unmapped site in Aransas County			
Location	North End Beach			
Lat/Long	Data not provided			
County	Aransas			
Ownership	Private			
Habitat Area	140 hectare (345.95 acre)			
Researchers	Jennifer Sanchez			
Date	5/24/02			
Weather Conditions	Data not provided			
Description	Beach between surf and dune line			
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	None provided			

Appendix V. Continued

3.

Site	Unmapped site in Aransas County			
Location	San Jose Island, north end			
Lat/Long	Data not provided			
County	Aransas			
Owner	Private			
Habitat Area	480 hectare (1,186.11 acre)			
Researchers	Wayne McAlister			
Date	5/24/02			
Weather Conditions	Data not provided			
Description	Mud and sand flats on a tidal wetland			
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	None provided			

4.

Site	Unmapped site in Refugio County			
County	Refugio			
Owner	Private			
Habitat Area	25 hectare (61.78 acre)			
Researchers	Gene Blacklock			
Date	6/22/2002			
Weather Conditions	26.67 °C, average wind speed Southeast at 8.0 mph, overcast 100% cloud cover.			
Description	Open areas associated with Mission River estuary and bay			
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	None provided			

Appendix V. Continued

5.

Site	Unmapped site in Nueces County			
County	Nueces			
Owner	Private			
Habitat Area	12 hectare (29.65 acre)			
Researchers	David Newstead, Erin Albert			
Date	7/04/2002			
Weather Conditions	Approximate 32.22 °C, average wind speed Southeast at 12.9 mph, 10% cloud cover.			
Description	Fairly large sand flat, mostly protected by vegetation			
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Some vehicular disturbance; successful least tern nesting observed, and many other terns were observed loafing			

6.

Site	Unmapped site in Nueces County			
County	Nueces			
Owner	Private			
Habitat Area	15 hectare (37.07 acre)			
Researchers	Colonial Waterbird Census			
Date	5/25/2002 – 6/02/2002			
Weather Conditions	No data provided			
Description	Dredge material island			
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Once supported a few pairs of nesting snowy plovers, but land modification and vegetation encroachment have rendered the site unsuitable for nesting			

Appendix V. Continued

7.

Site	Unmapped site in San Patricio County			
County	San Patricio			
Owner	Private			
Habitat Area	20 hectare (49.42 acre)			
Researchers	G. Blacklock			
Date	6/9/02			
Weather Conditions	22.78 °C, average wind speed North 11.5 mph, 100% cloud cover (overcast).			
Description	Alluvial fan composed of estuarine habitats in northern Nueces Bay			
	# adults	Nesting	Eggs	YOY
Results	0	-	-	-
Comments	Water level probably limiting to nesting activity			

8.

Site	Unmapped site in San Patricio County			
County	San Patricio			
Owner	Private			
Habitat Area	20 hectare (49.42 acre)			
Researchers	David Newstead, Erin Albert			
Date	6/5/2002, 6/7/2002			
Weather Conditions	6/5/2002: 28.6°C, average wind speed East Northeast at 6.5mph, 70% cloud cover, sprinkling rain; 6/7/2002: 33.4°C, light variable wind, 50% cloud cover. Hot.			
Description	Several areas exist on this extensive ranch which may provide suitable habitat for snowy plover; the best site observed was a backwash area which is seasonally inundated; silty clay and sandy silt areas			
	# adults	Nesting	Eggs	YOY
Results	6	2	-	-
Comments	Snowy plover nesting activity observed on the lighter sandy areas but feeding throughout site; also nesting area for Wilson's plover, horned lark, common nighthawk, least tern, and towards South Lake, black-necked stilt and probably others			

Appendix V. Continued

9.

Site	Unmapped site in Nueces County			
County	Nueces			
Owner	Private/Texas General Land Office			
Habitat Area	15 hectare (37.07 acre)			
Researchers	David Newstead, Erin Albert			
Date	5/11/2002			
Weather Conditions	28.7° C, average wind speed Southeast 12.9 mph, 15% cloud cover.			
Description	Some sandy areas with sparse low vegetation, extensive silty algal flat			
	# adults	Nesting	Eggs	YOY
Results	1	-	-	-
Comments	Many least tern nesting on the large algal flat area; Wilson's plover observed, displayed nesting behavior; parts of the site are used as a thoroughfare for fishermen, but much of the available habitat appears relatively undisturbed; probably affected by high water this year			

10.

Site	Unmapped site in Nueces County			
County	Nueces			
Owner	Private			
Habitat Area	17 hectare (42.01 acre); an additional ~ 2 hectare (4.94 acre) habitat area nearby revealed no SNPL nesting			
Researchers	David Newstead, Erin Albert			
Date	6/12/2002			
Weather Conditions	28.5°C, average wind speed Southeast at 7.0 mph, 15% cloud cover. Hot.			
Description	Good stable habitat; several fairly extensive sand and algal flats			
	# adults	Nesting	Eggs	YOY
Results	26	10	10	5
Comments	Least terns and probably Wilson's plovers also nesting in area; coyote, raccoon, javelina and snakes are potential predators; almost all nests observed were in close association with driftwood; potentially a more productive site than Carbon Plant, but not quite as large			

Appendix V. Continued

11.

Site	Unmapped site in Kleberg County			
County	Kleberg			
Ownership	Private			
Habitat Area	25 hectare (61.78 acre)			
Researchers	Gene Blacklock, Richard Gibbons, David Newstead, Erin Albert			
Date	6/25/02			
Weather Conditions	32.0°C, average wind speed South at 9.6mph			
Description	Sand and salt flats along bay shore			
	# adults	Nesting	Eggs	YOY
Results	10	1	0	0
Comments	Possibly more nesting had occurred here than we were able to detect; numerous nearby pockets of potential foraging and/or nesting habitat.			

Ecology, Behavior, and Conservation Status of the Reticulate Collared Lizard, *Crotaphytus reticulatus*, in South Texas

Jerry F. Husak

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The reticulate collared lizard (*Crotaphytus reticulatus*) is a large, crotaphytid lizard that exhibits strong sexual dimorphism in body size, with adult males reaching larger sizes than females (Smith, 1946). Male and female adult lizards are both tan in coloration with a white, reticulated dorsal pattern enclosing seven or eight transverse lines of black spots (Montanucci, 1976; McGuire, 1996). Males have a bright yellow coloration on the front limbs and on the anterior dorsum and ventral region of the trunk during the breeding season (McGuire, 1996). The species is restricted to the lower Rio Grande Valley of south Texas and northern Mexico. The reticulate collared lizard is primarily saxicolous and found mainly in rolling terrain with shallow, gravelly soils, but it has been known to utilize flatland habitats where rocks are not present (Montanucci, 1971). Because of its limited geographic distribution and because the area in which it lives is disturbed by humans and introduced grasses, *C. reticulatus* is listed as a state-threatened species in Texas (Dixon, 2000). The project was conducted at Falcon State Park in Starr County, TX. I also found reticulate collared lizards on the dam of Falcon Reservoir and along highway FM 1472 north of Laredo.

The specific long-term objectives of this project are to: 1) determine size, sex ratio, and age distribution of the population, 2) determine activity patterns, 3) determine microhabitat use and compare to microhabitat available, 4) quantify social behavior patterns via focal observations and staged encounters, 5) quantify and describe antipredator behavior via simulated predator encounters, 6) estimate current levels of predation by avian and terrestrial predators, 7)

measure current ectoparasite loads (ticks, mites, others), 8) compare T-6 between two populations - Falcon State Park and the Chaparral WMA, and 9) synthesize the above data to make management suggestions concerning the potential effects of suitable habitat loss, increasing non-native grasses (decreased visibility), and human encroachment. The status of each objective in the project to date will be discussed below.

1) *Demography* - Data collected in 2001 and 2002 revealed interesting patterns in relation to drought conditions in south Texas. The population at Falcon State Park in 2001 was approximately 25 lizards within park boundaries. In 2002, the population was much lower, with only 7 lizards observed within park boundaries. All lizards were in a very emaciated condition, and coloration was very drab (due to a poor diet). Both of these can be reasonably linked to the predominant drought conditions in 2002 compared to 2001. Very few juvenile lizards were observed in either year. I hope to follow up on this objective to examine how increased rains will affect the population.

2) *Activity* - Lizards became active in the morning when air and surface temperatures became suitable for activity (substrate temp. ~35° C). Once the days became too hot (substrate temp. >46° C), lizards retreated until temperatures cooled in the evening (Figure 1).

3) *Microhabitat use* - Lizards used predominantly rocks for thermoregulatory and social purposes, but they also used bare ground and grassy areas, although to a much lesser extent (Figure 2). The majority of their time was spent on rock perches basking and scanning for prey items, as is consistent with their sit-and-wait foraging style (Husak and Ackland 2003). This predominantly sit-and-wait, saxicolous lifestyle is consistent with what is known about other *Crotaphytus* species (McGuire 1996).

4) *Social behavior* - Focal observations and staged interactions were conducted to determine behavior patterns of reticulate collared lizards. Social displays were typical of the well-studied congener *Crotaphytus collaris* (see Fitch 1956). Displays included lateral compression and presentation of the body, head bobs, push-ups, dewlap extension, and gaping. The one notable difference from *C. collaris* was the manner in which male *C. reticulatus* laterally compressed and presented the body to other males and females. *Crotaphytus collaris* laterally compresses and presents the body with all legs typically fully flexed. Reticulate collared lizards typically performed this display with the hindlimbs almost totally flexed, but with the forelimbs mostly extended. This posture created a display with the anterior portion of the lizard depressed near the ground and the posterior portion elevated.

5) *Antipredator behavior* - Due to the low numbers of lizards in 2002, this objective has not been completed yet. I plan to follow up on this objective.

6) *Predation* - The majority of predators observed on the study site were roadrunners (*Geococcyx californianus*). Other potential predators encountered include Harris Hawks (*Parabuteo unicinctus*), Caracaras (*Caracara plancus*), and coachwhips (*Masticophis* flagellum). I counted all potential predators on the study site in Falcon State Park in 2001 and 2002 during my daily censuses and calculated a predation index by dividing the total number of observed predators by the total amount of observation time (Baird et al. 1997, Husak and Ackland 2003). The value obtained of 0.442 predators per hour is quite high compared to populations of *C. collaris* in Oklahoma (Baird et al. 1997). I also quantified predation via the placement of artificial models on the study site in Falcon State Park, but ground squirrels consistently chewed on the models to the extent that limited information is available from them. The models revealed roadrunners to be the major predator, with most attacks (80%) directed at the head.

7) *Ectoparasite loads* - Parasites were not quantified in 2001, but they were in 2002. No ectoparasites were found on any lizards in 2002, but that is most likely attributable to the drought conditions. Ectoparasites are probably fairly common in this species, like in other *Crotaphytus* (McGuire 1996), and I hope to follow up on this objective.

8) *Population comparisons* - This objective was not completed in 2002, again because of the drought conditions and resultant low numbers of lizards. At the Chaparral WMA, I only found two reticulate collared lizards. I hope to also follow up on this objective.

9) *Management suggestions* - Based on my preliminary results, I can make some management suggestions regarding the impact of humans on reticulate collared lizards. From my observations it appears that the species is doing well. Several juveniles were found in areas away from adults, suggesting that dispersal is actively occurring. The species appears to be fairly dependent on rocky substrates, making this habitat type critical for its maintenance. Destruction of rocky areas and introduced grasses will likely negatively impact this species, with the latter causing a decrease in habitat visibility which is important for foraging, predator detection and avoidance, and conspecific interactions.

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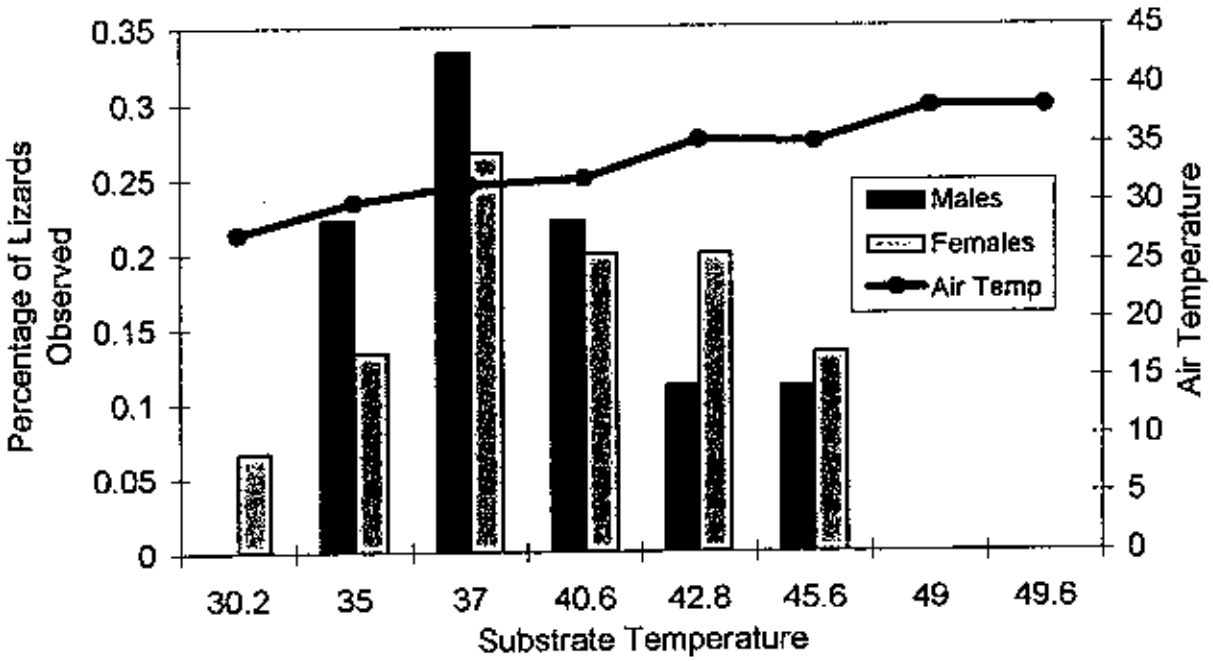

Figure 1. Percentage of reticulate collared lizards observed at Falcon State Park as a function of substrate temperature and air temperature.

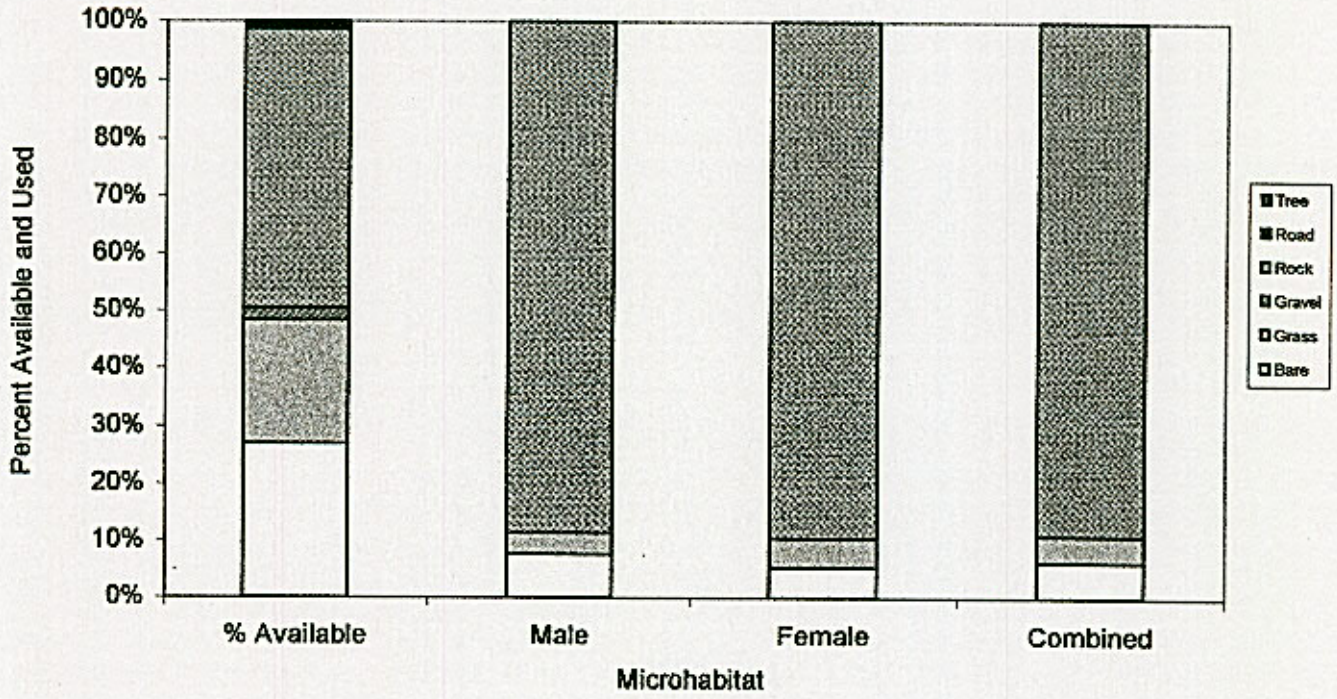

Figure 2. Percent microhabitat available and percent microhabitat used by reticulate collared lizards in Falcon State Park.

Conservation Status of *Eumops perotis* in Texas

Tom Lee, Abilene Christian Univ.

1. Identify, map and revisit all known roost sites and recent capture sites to determine current occurrences. I have conducted extensive field research within the range of *Eumops perotis* for the last 17 years (Lee,1990; Lee and Engstrom 1991; Lee et al., 1989; 1991; 1996; Weyandt et al., 2001). I am familiar with the area and habitat of these bats. Moreover, my student (Sarah Weyandt) and I have recently completed a survey of the bats in Eagle Nest Canyon, Val Verde County, Texas (Weyandt et al., 2001). I have personal contacts with area ranchers who have and will let me on their land to conduct field work. Furthermore, USFW personal have already requested the assistance of Dr. John Patton and I to study the bat fauna of Lake Amistad. They indicated that they could help with boats and other logistical support.

2. Conduct field surveys to identify new roost sites. The good relations I have developed with a rancher in Val Verde County have already produced results that address, in part, this need. I have identified one new roost site and have the location of a new capture site in Val Verde County. A more extensive survey both upstream and downstream from this area should produce more locations where these bats are found and roost. We can refine the knowledge on roost sites which are usually found 3 meters or more above the ground (Best et al., 1996; Ohlendorf, 1972).

Pecos Region of Rio Grande

1. Eagle Nest Canyon (Langtry, 29° 48.8' N, 101° 33.16' W): Two new *Eumops* roost sites were discovered on the west side of Eagle Nest Canyon. The population estimate is approximately 25. The roosts are in cracks in limestone rock overhangs. The cracks are 3 to 7 meters above the ground and have no obstructions. Photographs of *Eumops* roosting in this site have been archived as vouchers. A *Eumops* lower jaw and part of a wing were collected from the base of the roost site. There was a part of a second lower jaw from an unidentified species of bat. This second jaw indicates that the roost is used by bats other than *Eumops*. A *Myotis yumanensis* roost site (25-50 bats) was discovered on the east side of the canyon.

2. Cliffs on the Rio Grande two miles east and west of Eagle Nest Canyon (Langtry): This area has 4 cliff shelters on the Texas side of the Rio Grande. All of the cliff shelters are difficult to get into from the river. Some have possible *Eumops* roosts indicated by the presence of guano. Netting over the river produce one specimen of a female *Eumops*.

3. Comstock Rail Tunnel: The Comstock Rail Tunnel on the Rio Grande (Val Verde Co; 2.5 mi E Pecos River) was checked for *Eumops* and other bats. No *Eumops* were found in the tunnel. The tunnel contained many *Tadarida brasiliensis*, *Myotis velifer*, and *Myotis yumanensis*.

4. Pecos River Canyon: There should be *Eumops* roost sites here. However, no roost were found. Many of the caves are not accessible because of the thick growth of reeds. Netting over the Pecos was not possible at the time of this study because of high river levels.

5. Pump Canyon: We visited Pump Canyon and explored some of its caves. No evidence of *Eumops* was found in this area in August. However, only a small part of Pump Canyon was

explored at that time. A return visit on 27 Sept. 2002 found evidence of four *Eumops* using the canyon for feeding. Visual and auditory identification was based on the loud feeding chirps of *Eumops* plus their large size makes them easy to identify at night. Other bats netted in the canyon were *Antrozous pallidus* and *Tadarida brasiliensis*. Pump Canyon is not accessible (due to a thick growth of reeds) from the Rio Grande making it difficult to get equipment into the canyon.

6. Seminole Canyon: This canyon looks promising. However, netting in the canyon produce no *Eumops*. Night scopes were used and no *Eumops* were seen.

Big Bend Region of Rio Grande

7. Capote Canyon: Capote Canyon is north of Candelaria in Presidio County. This is probably the most significant *Eumops* roost in Texas (Ohlendorf 1972). However, it is on private land and neighboring ranchers do not know who owns this land. Consequently, we could never get in Capote Canyon to survey the roost site.

8. Chilicotal Mountain Northwest Canyon (Big Bend National Park): Chilicotal Mountain (29° 13.44' N, 103° 09.26' W) is composed of intrusive igneous rock. The geology of Chilicotal therefore differs from the Cretaceous limestone of all the other canyons surveyed in this study. While no roost sites were discovered in the north west canyon of Chilicotal Mountain other researchers have found *Eumops* at this site (Constantine, 1961). Two other canyons on the mountain were not explored and could contain *Eumops* roosts.

9. Closed Canyon: Closed Canyon has one *Eumops* roost site. This site is 30 meters from the mouth of the canyon. This new site has only one or two *Eumops*. The site is 3 meters off the floor of the Canyon. A *Myotis velifer* roost was found 100 meters into the canyon.

10. Terlingua Abaja (Big Bend National Park): Netting in this location has resulted in the capture of many *Eumops* (Higginbotham and Ammerman 2002). However, this study found no roost sites around Terlingua Abaja. Nor does there seem to be a possibility of any roost sites. The closest roosting area for Eumops taken at this site would be Santa Elena Canyon or the east cliffs of Sierra Ponce.

11. Hot Springs Canyon (Big Bend National Park): Survey of Hots Springs Canyon produced no bat roosting sites of any species. However, it is limestone and looks as if there should be roost sites.

12. Boquillas Canyon (Big Bend National Park): Survey of Boquillas Canyon produced no bat roosting sites of any species. Although it is limestone and looks like there should be roost sites.

13. Santa Elena Canyon (Big Bend National Park): We canoed from Lajitas to the end of Santa Elena Canyon. Santa Elena Canyon has many possible *Eumops* roosts. However, only one had evidence of *Eumops* roosting. This site was on the Mexican side of the Rio Grande on the

western end of Santa Elena Canyon (103° 43. 00' W, 29° 11.00' N). Most of the other sites in the Canyon were to high in the canyon verify if they had *Eumops*. Many sites that we could verify the presence of bats contained members of the genus *Myotis*.

14. McKinney Springs (Big Bend National Park): Like Terlingua Abaja netting in this location produced *Eumops* and there seem to be no local roost sites (Higginbotham and Ammerman 2002). Possible roost sites may be in the nearby Sierra Del Carmen.

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Status, abundance, and habitat associations of fishes in the Independence Creek drainage (Terrell County, Texas)

Final Report

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In Texas, 19% (47 taxa) of freshwater and diadromous fish species are listed as extinct, endangered, threatened, or of special concern (Hubbs et al. 1991). Approximately 50% of these fishes currently or formerly inhabit streams of the Rio Grande basin, which include the Rio Grande, Pecos River, Devils River and the Rio Conchos in Mexico. In the Pecos River of Texas, species declines or extirpations are attributed to decreased stream flow, species introductions, abnormal algal blooms, and diminishing spring flows from tributaries (Hoagstrom, In press).

Independence Creek is a spring-fed tributary and a major freshwater contributor to the Pecos River. This tributary supports a diverse fish assemblage, which includes two state-listed threatened species (Cyprinella proserpina, Etheostoma grahami), two state-listed species of special concern (Ictalurus lupus, Notropis jemezanus), and two regionally endemic species (Dionda episcopa, Notropis amabilis) (Hubbs et al. 1991). In addition, lower reaches of Independence Creek provide a refuge for fishes of the Pecos River during periods of poor water quality (Rhodes and Hubbs 1992). The presence of threatened species and high water quality led Texas Parks and Wildlife Department (TPWD) to designate Independence Creek as an ecologically significant stream of highest importance. In 1998, The Nature Conservancy of Texas purchased 8,000 ha of land that includes 13 km of Independence Creek and Caroline Springs, the major contributor of freshwater to the creek (flow rate: 0.3 m^3s^{-1}).

The objectives of this study were to assess the current status of fishes in Independence Creek by comparing recent collections to historical collections, to determine fish abundance and distribution in the Independence Creek drainage, and describe habitat associations for threatened, special concern, and regionally endemic

species (here after referred to as species of interest). Information gained from this study will aid efforts to conserve and protect the native fish assemblage of Independence Creek drainage and to extend knowledge of native fish species habits in a minimally disturbed environment.

Methods

Independence Creek is located south of Sheffield, Terrell County, Texas and drains a 1,935-km^2 area of Ector Rock Outcrop soils with rock outcrops (Turner and Fox 1974). The perennial portion of Independence Creek is 16 km in length and supported by a headwater spring (Site 7) and Caroline Springs (Figure 1). At Caroline Springs, two reservoirs were constructed to capture spring flow, and the outflow drains into Independence Creek.

Current and historical fish compositions from Independence Creek

Past records of fish collections were obtained from unpublished field notes and agency reports. For Independence Creek, historical records included fish collections from Hwy 349 crossing with seines in 1958 (Campbell 1959), Hwy 349 crossing with seines in 1964 (Suttkus and Clemmer, unpublished field notes, Tulane University), lower reaches with seines from 1965 through 1966 (Suttkus and Clemmer, unpublished field notes), upstream from Pecos River confluence with seines and hook-and-line in 1970 (Suttkus and Clemmer, unpublished field notes), upstream from Pecos River confluence with seines in 1987 (Linam and Kleinsasser 1996), Hwy 349 crossing with seines and electrofishing in 1990 (Linam et al. 2002), unspecified sites with seines and

electrofishing in 1991 (Garrett 1997), and from lower reaches of Independence Creek by unknown methods in 1993 and 1994 (N. Valdes, unpublished report, Texas A&M University).

For the Pecos River, historical records included fish collections from Independence Creek confluence with gill nets in 1958 (Campbell 1959), downstream from Independence Creek confluence with seines and trammel nets in 1965 (Suttkus and Clemmer, unpublished field notes), downstream from Independence Creek confluence with seines in 1987 (Linam and Kleinsasser 1996), at Independence Creek confluence with seines and electrofishing in 1991 (Garrett 1997), and upstream and downstream from Independence Creek confluence by unknown methods in 1993 and 1994 (N. Valdes, unpublished report).

In December 2001 and May 2002, collections were made from seven sites on Independence Creek and from two sites on the Pecos River. An additional collection was made from four locations (sites 1, 3, 6, and Caroline Spring reservoirs) in July 2002. At each site, fish were collected with seines and backpack electroshocker from all available habitat types. Fish were identified, enumerated, and released except for voucher specimens. Voucher specimens were anesthetized in MS-222 (80 mg/l) and preserved in 10% formalin.

Relative abundance and occurrence data were grouped into historical collections (1958 – 1970) and recent collections (1987 – 2002) and changes between collection eras were compared. Different collections methods (gillnets vs. seines) between eras excluded the use of relative abundance for the Pecos River assemblage so only occurrence data were reported. In addition, occurrences of fish collected in July 2002

were reported instead of the number of species captured since collections were not quantified. Their inclusion was to accurately report fishes that have been observed in Independence Creek.

Abundance and habitat associations for fishes of the Independence Creek drainage

Independence Creek, Caroline Spring reservoirs and outflow, and Pecos River were sampled in May 2002. Seven sites along Independence Creek and the one site in the Caroline spring outflow were sampled with seines (Figure 1). At each site, mesohabitats (i.e., runs, riffles, pools, and backwater) were identified and sampled. Fish were identified and enumerated within each mesohabitat. When available, 30 individuals from each species were measured to the nearest mm (total length). Voucher and unidentifiable specimens were anesthetized with MS-222 and preserved in 10% formalin. All others were released. Percent substrate type, percent woody debris, percent vegetation, stream width, mean current velocity and mean depth (averaged from 3 to 5 measurements along a cross section) were determined for each mesohabitat. Temperature (°C), dissolved oxygen (mg/l), conductivity (uS/cm), and pH were recorded for each site.

Caroline Spring reservoirs were sampled with a boat-mounted electroshocker, gill nets, and seines. Electroshocking consisted of one pass around the perimeter of each reservoir. Gill nets were placed in the middle of each reservoir and near shore. Seining consisted of a 20-m haul in the upper reservoir and an 80-m haul in the lower reservoir. Temperature (°C), dissolved oxygen (mg/l), conductivity (uS/cm), pH, substrate type, and percent vegetation were recorded from each reservoir. In the Pecos River, an upstream and downstream site from Independence Creek confluence was sampled with seines.

Fish were identified, enumerated, and released except for voucher and unidentifiable species. An additional collection trip was conducted in July 2002 from four locations (sites 1, 3, 6, and Caroline Spring reservoirs). Occurrence of fish were recorded but not quantified.

Relative abundance was determined for each species by site. Habitat characteristics (mesohabitat type, substrate type, percent cover, percent vegetation, mean depth, mean current velocity) for each site were weighted by length of mesohabitat type to determine a mean for each parameter. Principle component analysis was used for site ordination in lotic environments, excluding the Pecos River. For species of interest, we assessed substrate, cover, vegetation, current velocity, and depth associations since information is generally lacking for these species. In addition, length frequency histograms were used to assess general population structure (age groups and reproduction season) attributes. Twenty C. proserpina and six E. grahami were retained for gut and reproductive analyses. Fishes were weighed and measured and the stomachs and lower intestines removed. Gut items were identified and weighed. Gonads were removed, weighed, and a gonadosomatic index (100*wt of ovary/wt of fish) was calculated for each.

Results and Discussion

Current and historical fish compositions from Independence Creek

In Independence Creek, 21 species were collected from 1958 through 1970 and 29 species and one hybrid (C. variegatus x pecosensis) were collected from 1987 through 2002 (Table 1). From 1958 through 1970, species with the highest average relative

abundance were Dionda episcopa (48%), Gambusia (14%), Cyprinella lutrensis (11%), Cyprinella proserpina (7%), and Cichlasoma cyanoguttatum (6%). From 1987 through 2002, species with the highest average relative abundance were Dionda episcopa (25%), Gambusia (23%), Cyprinella proserpina (14%), Notropis amabilis (12%), and Cyprinella lutrensis (4%).

Five species collected from 1958 through 1970 were absent from recent collections. Campostoma anomalum has not been collected from Independence Creek since 1966 or from the Pecos River since 1958 (Hoagstrum, In press). Hence, it is assumed extirpated from the Pecos River drainage. Historically, Notropis braytoni was rare in Independence Creek but common in the Pecos River. Its use of Independence Creek was probably transitory and its absence does not reflect a true reduction in species richness. Two other species absent in recent collections, Lepomis microlophus and Pomoxis annularis, are introduced in the Pecos River drainage (Hoagstrum, In press). Likewise, their absences also do not reflect a true reduction in species richness.

Twelve species and one hybrid collected from 1987 through 2002 were not collected from 1958 through 1970. Six species (Dorosoma cepedianum, Pimephales vigilax, Carpiodes carpio, Moxostoma congestum, Ictalurus punctatus, Pylodictis olivaris, G. speciosa) are native to the Pecos River (Hoagstrom, In press) and may be considered transient species in Independence Creek. Four species and one hybrid (C. venusta, C. variegatus, C. variegatus x pecosensis, L. auritus) were the result of introductions into the Pecos River drainage (Hoagstrum, In press). However, L. auritus appeared to be the only introduced species established in Independence Creek. The eleventh species, N. jemezanus, was collected only in 1991. Independence Creek is the

last known collection of N. jemezanus in the Pecos River drainage (Hoagstrum, In press) and, with no recent collection, may be extirpated from the drainage. Historically, N. jemezanus was found throughout the Rio Grande and Pecos rivers but may now only be common in the lower reaches of the Rio Grande (Lee et al. 1980, Platania 1991).

Relative abundance of the two threatened species and one species of special concern fluctuated among collection dates but the population of each was persistent through time and did not indicate long term declines. Minimum and maximum relative abundances were 2% (1964) to 25% (1991) for Cyprinella proserpina, 0.5% (1993/4) to 1.6% (2001) for Etheostoma grahami, and 0.5% (2001) to 2% (1964) for Ictalurus lupus. Near Hwy 349 crossing, large shoals of I. lupus were observed in 2002 that eluded seining and electrofishing. Thus, relative abundance of I. lupus may be slightly higher in Independence Creek than reported in Table 1.

For I. lupus and I. punctatus, the historical record of their abundances may be inaccurate. Morphometric distinction between I. lupus and I. punctatus is tedious and misidentification is common (Kelsch and Hendrick 1986). Nevertheless, both species coexist in Independence Creek, either by I. punctatus emigration from the Pecos River or by I. punctatus introductions into Caroline Springs. The increase presence of I. punctatus in Independence Creek may facilitate the demise of I. lupus similar to the extirpation of I. lupus from the Gulf Slope drainages of Texas (Kelsch and Hendricks 1990).

Relative abundances of two regional endemics also fluctuated through time but remained persistent. Minimum and maximum relative abundances were 4% (1987) to 75% (1958) for Dionda episcopa and 4% (1970) to 27% (1987) for N. amabilis. Dionda episcopa was the most abundant fish in Independence Creek although Hoagstrum (In

press) reports that this species is diminished in its range and abundance in the Pecos River. Notropis amabilis is another abundant species in Independence Creek but considered tenuous in the Pecos River (Hoagstrom, In press).

In the Pecos River, 23 species were collected from 1958 through 1965 and 33 species and one hybrid were collected from 1987 through 2002 (Table 2). Three fishes, Cycleptus elongatus, Ictiobus bubalus, and Fundulus zebrinus, were present in early collections but absent in collections from 1987 through 2002. Cycleptus elongatus, a state-listed threatened species, and Ictiobus bubalus are large body fishes that probably escaped capture by common seines during recent collections. Currently, both species are uncommon in the Pecos River (Hoagstrom, In press). Fundulus zebrinus has not been collected from the Pecos River since 1993 (Hoagstrom, In press) where it has been supplanted by or hybridized with the introduced Fundulus grandis (Hoagstrom 1994).

The Pecos River in the vicinity of Independence Creek supports viable and persistent populations of two, state-listed threatened species, Cyprinella proserpina and Etheostoma grahami, and two regional endemic species, Dionda episcopa and Notropis amabilis. Cyprinella proserpina is considered stable in the lower Pecos River (Hoagstom, In press) and represents a viable population wholly within the river. However, D. episcopa, E. grahami, and N. amabilis are listed as diminished or tenuous by Hoagstrom (In press) though all are persistent in the Independence creek. Thus, Independence Creek may provide a critical function in the life history of the aforementioned species and serves as source for individuals in the Pecos River. Unfortunately, there is a paucity of life history information for these species and the role Independence Creek plays at this time is unknown.

Abundance and habitat associations for fishes of the Independence Creek drainage

Species abundance- We collected 22 species of fishes (n = 5,379) from Independence Creek drainage (Independence Creek, Caroline Spring reservoirs, Caroline Spring outflow) and the Pecos River during May 2002 (Table 3). Two of these species (Cyprinella lutrensis and Pimephales vigilax) were collected only from the Pecos River. Four additional species (Dorosoma cepedianum, Ctenopharyngodon idella, Cyprinus carpio, Pylodictis olivaris) were collected from Independence Creek drainage during July 2002. Thus, a total of 24 species were collected from the Independence Creek drainage. Eighty nine percent of the fish assemblage in the Independence Creek drainage was comprised of five species: Gambusia affinis (28%), G. geiseri (22%), Dionda episcopa (20%), Notropis amabilis (12%), and C. proserpina (7%). Ictalurus lupus and Etheostoma grahami comprised less than 1% of the assemblage. Four of the species (C. idella, Cyprinodon variegatus, G. geiseri, and Lepomis auritis) are introduced species in the Pecos River drainage (Hubbs et al. 1991).

Stream characteristics- Morphological characteristics of Independence Creek changed in a predictable manner along a longitudinal gradient. From its origin (Site 7) to its confluence with the Pecos River (Site 1), stream width, depth, and percent woody cover increased whereas current velocity and size of substrate decreased (Figure 2, Table 4). At sites 4 and 5, the stream incised bedrock outcroppings thereby narrowing stream width. Caroline Springs outflow entered the stream immediately downstream from Site 4, after which, stream width, depth, and percent silt increased. Trends in temperature, dissolved oxygen, pH, and conductivity were not assessed because of the effect of diel fluctuations on each parameter.

The first three PCA axes explained 79.5% of the variation in habitat variables from Independence Creek and Caroline Spring outflow (Figure 3). The first PCA axis (42.4% variation explained) described a gradient from narrow and shallow runs and riffles (Sites 3-7) to wide and deep areas with silt as the predominate substrate (Sites 1-2, spring outflow). Site 2 was located upstream from a road crossing with two, 24" culverts that created a more lentic environment. The second PCA axis (20.4%) described a gradient from areas with high amounts of vegetation (primarily filamentous algae; Site 7) usually in riffle mesohabitats (Site 3) to areas with clean swept strata such as gravel (Sites 4 and 6) or bedrock (Site 5). The third PCA axis (16.7%) described an area (Site 3) with numerous boulders and a large backwater mesohabitat.

Mesohabitat approach- Fishes generally showed a strong association to at least one mesohabitat (Table 5). Ictalurus lupus, C. proserpina, G. geiseri, and N. amabilis were predominately found in runs, E. grahami were predominately found in riffles, and I. punctatus, A. mexicanus, and G. affinis, two cyprinodonts, and all centrarchids were found predominately in pools. Dionda episcopa and C. cyanoguttatum were general in their distribution and were not strongly associated with any particular mesohabitat.

Run inhabitants were most abundant at sites 3, 4, 5, and 6. These sites contained areas of higher current velocities, shallower depths, and predominantly gravel or bedrock substrate (Table 4, Figure 3). For species of interest, C. proserpina was most abundant (90%) at sites 4,5, and 6, N. amabilis was most abundant (86%) at sites 3 and 4, and I. lupus was most abundant (91%) at Site 6.

Etheostoma grahami was the only predominantly riffle inhabitant and all were collected from sites 6 and 7 in Independence Creek. These sites contained areas of

highest current velocities, shallowest depths with cobble substrate. In addition, Site 7 contained a large amount of filamentous algae. Although limited to upper reaches of Independence Creek, eight E. grahami were collected from Caroline Spring reservoirs in areas that lack detectable flows and contained dense mats of aquatic vegetation.

Pool inhabitants were most abundant in Caroline Spring reservoirs (28%), Site 2 (17%), Caroline Spring outflow (16%), and Site 7 (12%). These sites contained areas of lowest current velocities and generally greater amounts of silt substrate and vegetation. In addition, these sites collectively have sustained the largest amount of anthropogenic modification.

Generalist species, D. episcopa and C. cyanoguttatum, were ubiquitous in their distribution but showed a slight affinity to backwater habitats (28% and 16%, respectively) compared to habitat available (2.4%). Dionda episcopa was most abundant at Site 3 (32%), Caroline Spring reservoirs (17%), and Site 7 (16%), all of which contained the greatest amount of vegetation (Table 4, Figure 3).

Species approach- Across all mesohabitats, species were segregated among available habitats. Cyprinella proserpina, N. amabilis, and I. lupus were most abundant in areas with gravel substrate and low amounts of cover and vegetation, E. grahami were most abundant in areas with cobble substrate and high amounts of vegetation, and D. episcopa showed no affinity to any substrate type but were found in greater abundance than expected in areas with vegetation (Figure 4). Along depth and current velocity gradient, E. grahami were most abundant in areas of shallow depths and swift current velocities, C. proserpina and I. lupus were most abundant in areas of moderate depths and moderate current velocities, N. amabilis were most abundant in areas of deeper depths

and slow current velocities, and D. episcopa were most abundant in areas of moderate depths and slow current velocities (Figure 5).

Length frequency histogram for C. proserpina suggested that three age groups (0,1,2) were present in the population (Figure 6). Age-0 fish were <25 mm in total length, age-1 fish were about 44 mm, and age-2 fish were about 60 mm. Length frequency histogram for I. lupus suggested two or possibly three age groups. A large percentage of I. lupus collected from Independence Creek was age 1. Individuals between 150 and 250 mm could represent age-2 or -3 fish assuming similar growth rates to those of I. punctatus (Carlander 1969). Length frequency histograms for N. amabilis and E. grahami suggested one age group in each population whereas several age groups (0,1,2 and possibly 3) were observed in D. episcopa population. Dionda episcopa produces several cohorts each year between January and August (Wayne and Whiteside 1985), which complicates interpretation of modal length distributions.

From this study, C. proserpina was found primarily in run mesohabitats with gravel substrate, mean depth of 21.4 cm, and mean current velocity of 0.331 m/s. Generally, these habitats were void of vegetation. However, Cantu and Winemiller (1997) found them to be common in marsh and vegetated areas near the main channel in the Devils River. It is unknown if the differences in habitat use between Independence Creek and Devils River populations reflect this species plasticity in variable aquatic environments (Harrell 1978), or seasonal use of habitats. In May, gonadosomatic index of eight females ranged from 6 to 9% and all contained mature oocytes. Also, length frequency histogram suggested age-0 fish present in the population. Thus, their habitat associations in this study may reflect use of run habitats during periods of reproduction.

Gut contents of 20 individuals revealed that C. proserpina is primarily insectivorous, consuming individuals from Order Lepidoptera, Order Diptera, Order Trichoptera, and Order Coleoptera. In addition, individuals from Order Amphipoda were consumed.

Ictalurus lupus was found primarily in run mesohabitats with gravel substrate, mean depth of 21.4 cm and a mean current velocity of 0.359 m/s. Their distribution includes the lower Rio Grande, Pecos River, Rio San Fernando, Rio Soto La Marina, and isolated streams in the Cuatro Cienegas basin (Kelsch and Hendricks 1990). However, no habitat description has been reported.

Notropis amabilis was found primarily in run mesohabitats with gravel substrate, mean depth of 33.1 cm, and mean current velocity of 0.205 m/s. Notropis amabilis is endemic to the Edward's Plateau of central Texas (Lee et al 1980) and inhabits channel and riffle areas in the Devils River (Cantu and Winemiller 1997). The presence of small individuals throughout the year in Devils River suggests year-round recruitment (Cantu and Winemiller 1997). However, length frequency histogram reported here does not support this interpretation. Small individuals (age 0) were not detected in Independence Creek.

Etheostoma grahami was found primarily in riffle mesohabitats with cobble substrate, large amounts of vegetation, mean depth of 9.7 cm, and mean current velocity of 0.438 m/s. In addition, several were collected from Caroline Spring reservoirs, which also contained large amounts of vegetation. Female E. grahami deposit their eggs on vegetation during spring and summer (Aguilera et al. 1999) so their association with vegetation observed in this study is likely for reproduction. In fact, two females collected from Site 7 in Independence Creek were gravid (gonadosomatic index: 4.1 and 4.8).

However, it is unknown if E. grahami moved into the reservoirs for reproduction, or they reside year-round and represent an isolated population because of the reservoir construction. Gut contents of six individuals revealed that E. grahami is primarily insectivorous, consuming individuals from Order Lepidoptera, Order Diptera, Order Trichoptera, and Order Ephemeroptera, and Order Hemiptera. In addition, individuals from Order Amphipoda were consumed.

Dionda episcopa was widespread in all mesohabitats and substrate types, but common in areas with moderate depths (21.7 cm) and slow current velocity (0.149 m/s). Dionda episcopa is limited in distribution to spring-fed streams in the Edward's Plateau and Rio Grande basin, feeding primarily on vegetation (Lee et al. 1980). However, the type of vegetation consumed is unknown. Possibly, D. episcopa association with slow current velocity may indicate this species consumption of algae and plankton that settles to the substrate at lower current velocities.

Conclusion

Independence Creek drainage supports a diverse assemblage of native fishes with narrow geographical ranges that has changed little in the last 50 years. Selection of mesohabitats, substrate types, and depth and current velocity gradients suggests that these species of interest are highly specific to lotic environments although with sufficient plasticity to thrive in more lentic-type environments. However, anthropogenic alterations (i.e., road crossings, dams) negatively impact lotic environments by altering flow regime, increasing sedimentation, fragmenting habitats, and improving habitat for species adapted for more lentic environments (Baxter 1977, Stanford and Ward 1979, Bonner and Wilde

2000 Earl and Wood 2002). Thus, habitat management that includes protection of flowing waters is imperative for future conservation of the Independence Creek fish assemblage.

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Table 1. Historical (1958 – 1970) and current (1087 – 2002) relative abundance for fishes of Independence Creek, Terrell County, Texas. The letter "P" denotes fishes that were present but not enumerated.

	Date								
Species:	1958	1964-6	1970	1987	1990	1991	1993/4	2001	2002
Dorosoma cepedianum							0.1		P
Campostoma anomalum	0.4	P							
Cyprinella lutrensis	0.6	0.7	31.2	0.3		18.4	1.2	1.7	
Cyprinella proserpina		2.0	18.2	20.4	2.1	24.8	9.0	13.6	10.9
Cyprinella venusta								0.5	0.03
Cyprinus carpio		P	0.2						P
Dionda episcopa	75.0	58.2	9.3	3.7	10.0	29.0	39.9	42.4	24.9
Notropis amabilis		P	3.7	26.6			4.3	18.8	19.2
Notropis braytoni			0.9						
Notropis jemezanus						P			
Pimephales vigilax						0.2			
Carpiodes carpio								0.1	
Moxostoma congestum					0.6	0.2		0.9	0.2
Astyanax mexicanus	0.9	3.9	0.2	12.4	2.1	0.8	0.6	4.6	0.6
Ictalurus lupus		2.0	1.3			1.0		0.4	1.0
Ictalurus punctatus				0.6	5.2		0.1		P
Pylodictis olivaris					0.2			0.2	P
C. variegatus x pecosensis						0.6			
Cyprinodon variegatus								0.2	0.7
Fundulus zebrinus	9.0	1.3	2.4					0.1	0.6
Lucania parva			2.8			0.4			0.6
Gambusia affinis		P							28.2
Gambusia geiseri					73.1	3.3			6.7
Gambusia sp.	3.6	12.4	26.0	34.7			41.9	12.5	
Gambusia speciosa						7.7			

Table 1 cont. Historical (1958 – 1970) and current (1087 – 2002) relative abundance for fishes of Independence Creek, Terrell County, Texas. The letter "P" denotes fishes that were present but not enumerated.

	Date								
Species:	1958	1964-6	1970	1987	1990	1991	1993/4	2001	2002
Lepomis auritus					2.5	1.7		0.8	3.1
Lepomis cyanellus	6.4	0.7	1.5			0.4		0.4	
Lepomis macrochirus	0.4					0.2			0.1
Lepomis megalotis	0.3	2.0	1.9		2.3		1.4	0.3	0.6
Lepomis microlophus	0.3								
Micropterus salmoides	1.3	P		0.3	0.2	0.4	0.1	0.2	0.3
Pomoxis annularis	0.3								
Etheostoma grahami		0.7		0.9	0.8	1.3	0.5	1.6	1.0
Cichlasoma cyanoguttatum	1.2	16.3	0.4		0.8	0.2	0.9	0.7	1.1
Total	667	153	462	323	480	521	1090	1125	2937

Table 2. Occurrence of fishes collected from the Pecos River near the confluence with Independence Creek. The letter "P" denotes fishes that were present but not enumerated.

	Year	
Species	1958 - 1965	1987 - 2002
Lepisosteus osseus	P	P
Dorosoma cepedianum	P	P
Cyprinella lutrensis	P	P
Cyprinella proserpina	P	P
Cyprinella venusta		P
Cyprinus carpio	P	P
Dionda episcopa	P	P
Macrhybopsis aestivalis	P	P
Notropis amabilis	P	P
Notropis braytoni		P
Pimephales vigilax	P	P
Carpiodes carpio	P	P
Cycleptus elongatus	P	
Ictiobus bubalus	P	
Moxostoma congestum	P	P
Astyanax mexicanus	P	P
Ictalurus lupus	P	P
Ictalurus punctatus	P	P
Pylodictis olvaris	P	P
C. variegatus x pecosensis		P
Cyprinodon variegatus		P
Fundulus grandis		P
Fundulus zebrinus	P	
Lucania parva		P
Gambusia affinis	P	P
Gambusia geiseri		P
Gambusia speciosa		P
Menidia beryllina		P
Lepomis auritus		P
Lepomis cyanellus	P	P
Lepomis macrochirus		P
Lepomis megalotis	P	P
Micropterus salmoides	P	P
Etheostoma grahami		P
Cichlasoma cyanoguttatum	P	P
Total =	119	2721

Table 3. Relative abundance by site of fishes from the Independence Creek drainage (Independence Creek, Caroline Springs reservoirs and outflow) and the Pecos River in May 2002. The letter "P" denotes fishes that were present but not enumerated.

	Independence Creek							Caroline Springs		Pecos River	
	Site										
	1	2	3	4	5	6	7	Reservoirs	Outflow	Upstream	Downstream
Dorosoma cepedianum	P										
Ctenopharyngodon idella								P			
Cyprinella lutrensis										49.6	60.8
Cyprinella proserpina	10.8		1.2	23.1	33.3	17.6	1.8			14.1	11.1
Cyprinella venusta	0.8									11.1	1.1
Cyprinus carpio	P										
Dionda episcopa	37.7	8.3	40.7	12.4	4.2	24.5	34.1	21.3	5.7	2.2	10.4
Notropis amabilis		3.3	38.4	50.5	14.7	3.3				11.1	1.8
Pimephales vigilax										3.7	5.0
Moxostoma congestum		0.3			1.5	0.2					1.4
Astyanax mexicanus	1.5	0.6	1.1	0.5		0.6	0.2	10.2	1.1	0.7	
Ictalurus lupus		0.3				5.7	P		0.1		0.2
Ictalurus punctatus	P		P					0.6			
Pylodictis olivaris			P								
Cyprinodon variegatus	0.8	5.3									1.4
Fundulus zebrinus					5.7						
Lucania parva		0.3	2.4						3.5		
Gambusia affinis	10.0	70.9	10.8		33.6	30.6	46.0	38.7	19.1	2.2	2.0
Gambusia geiseri	2.3	3.0	2.6	7.3	3.9	12.0	13.1	11.0	68.9		0.5
Lepomis auritus	31.5	5.8	0.8	3.9	0.9	0.6	0.4	0.3		2.2	0.9
Lepomis cyanellus								0.5		0.7	0.5
Lepomis macrochirus	2.3									2.2	1.8
Lepomis megalotis	0.8		0.5	1.8		1.0		2.5	1.6		
Micropterus salmoides	0.8	1.9	0.1		0.3		P	11.4	0.1		0.2
Etheostoma grahami						2.4	3.3	1.0			0.2
Cichlasoma cyanoguttatum	0.8		1.4	0.5	1.8	1.6	1.1	2.5	0.1		0.7
Total	130	361	760	386	333	510	457	771	1095	135	441

Table 4. Stream characteristics and water quality parameters by site from Independence Creek, Caroline Springs reservoirs and Caroline Spring outflow in May 2002.

	Independence Creek							Caroline Springs	
	Site								
	1	2	3	4	5	6	7	Outflow	Reservoirs
Temperature (°C)	22	23.7	25.4	25.5	28.7	23.9	24.4	23.4	26
Dissolved oxygen (mg/l)	7.1	7.3	7.5	6.4	8.2	8.0	5.0	7.2	12.2
Conductivity (uS/cm)	1056	1098	1149	1193	1375	1269	1142.5	863	845
pH	8.2	8.2	8.1	8.1	7.4	7.7	7.7	7.9	8.5
Mesohabitat type (%):									
Run	76		35		90	74	63	31	
Run/Pool				100					
Pool	13	100			10			69	
Riffle	11		26			26	37		
Backwater			39						
Substrate type (%):									
silt	79	97	39		5		3	52	100
gravel	13	2	51	90	30	80	13	6	
cobble	8		9		3	20	84	42	
bedrock	1			10	61				
boulder			1						
detritus		1							
Cover (%)	32	29	0.4	5	11	5	3	7	
Vegetation (%)	16	19	33	5	21	28	64	56	100
Stream width (m)	9	17	9	6	7	7	4	7	
Mean depth (m)	0.455	0.480	0.297	0.249	0.208	0.188	0.097	0.410	
Mean current velocity (m/s)	0.052	0.046	0.210	0.283	0.362	0.448	0.089	0.143	
Total distance (m)	173	140	47	37	129	40	18	97	

Table 5. Fishes of Independence Creek drainage (Independence Creek, Caroline Spring reservoirs, and Caroline Spring outflow) grouped by mesohabitat types based on highest abundance. Percent of mesohabitat types in Independence Creek drainage are included to provide mesohabitat availability.

	Run %	Pool %	Riffle %	Backwater %	n
Independence Creek					
By distance	46.8	44.4	6.3	2.4	769 m
Predominate run inhabitants					
Fundulus zebrinus	100.0				19
Ictalurus lupus	93.5	3.2	3.2		31
Cyprinella proserpina	83.6	5.2	10.3	0.9	232
Gambusia geiseri	76.3	20.3	2.4	1.1	1,007
Notropis amabilis	74.9	4.3	3.2	17.6	370
Predominate riffle inhabitants					
Etheostoma grahami	2.9	20.6	76.5		34
Predominate pool inhabitants					
Ictalurus punctatus		100.0			5
Lepomis cyanellus		100.0			4
Pimephales vigilax		100.0			8
Micropterus salmoides	3.0	97.0			99
Cyprinodon variegatus	5.0	95.0			20
Lepomis megalotis	10.9	80.4		8.7	46
Astyanax mexicanus	14.0	78.5		7.5	107
Moxostoma congestum	28.6	71.4			7
Lepomis macrochirus	33.3	66.7			3
Lepomis auritus	34.6	61.5		3.8	78
Gambusia affinis	32.3	59.1	2.8	5.9	1,336
Lucania parva	15.8	52.6	10.5	21.1	57
Generalist					
Dionda episcopa	34.3	29.3	8.0	28.4	909
Cichlasoma cyanoguttatum	31.4	39.2	13.7	15.7	51

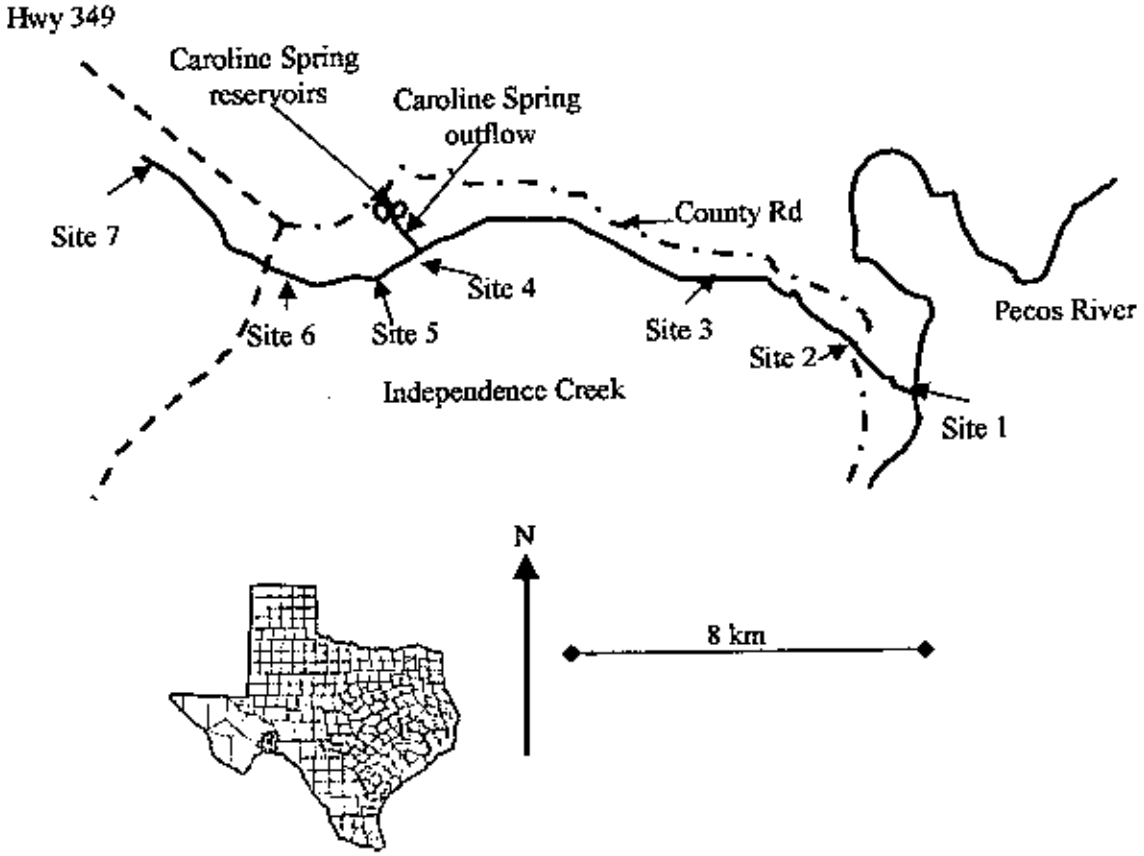

Figure 1. Location of collection sites in Independence Creek, Caroline Spring reservoirs, and Caroline Spring outflow in Terrell County, Texas.

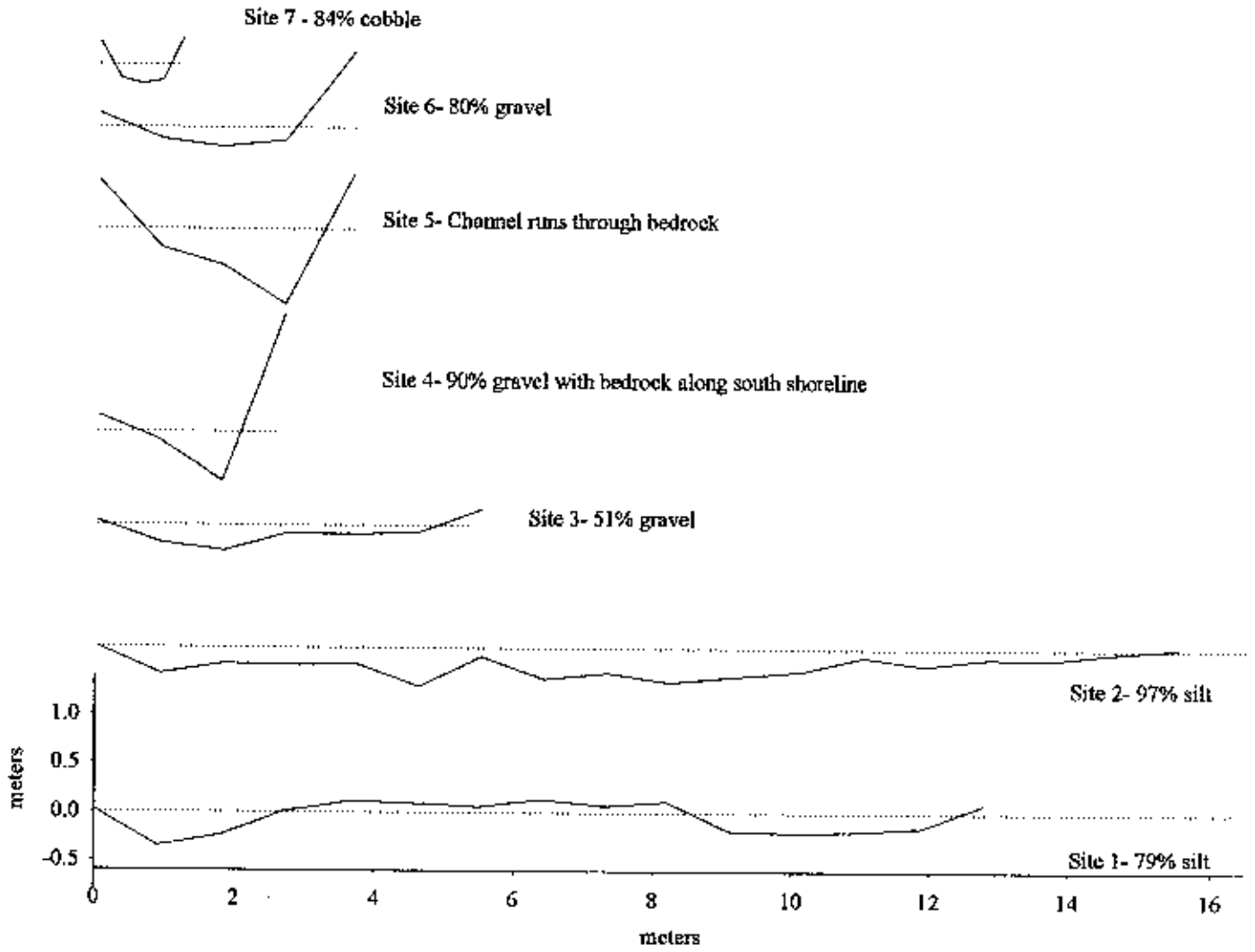

Figure 2. Cross-section profile for sites 1 (near confluence with the Pecos River) through 7 (headwater spring) on Independence Creek in May 2002. Dashed line indicates water level.

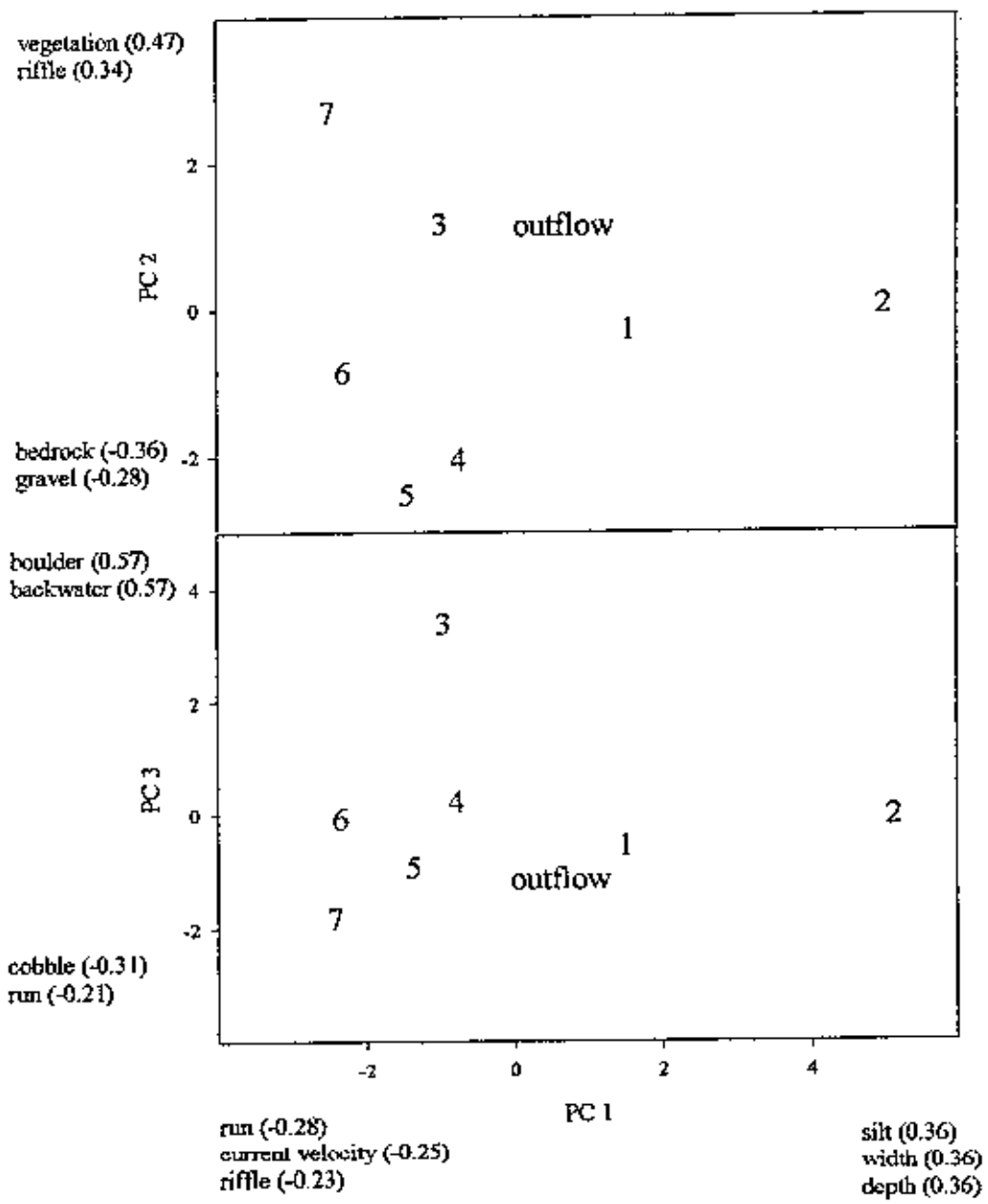

Figure 3. Principle component analyses for site characteristics for sites 1 through 7 and Caroline Spring outflow. Numbers represent site locations.

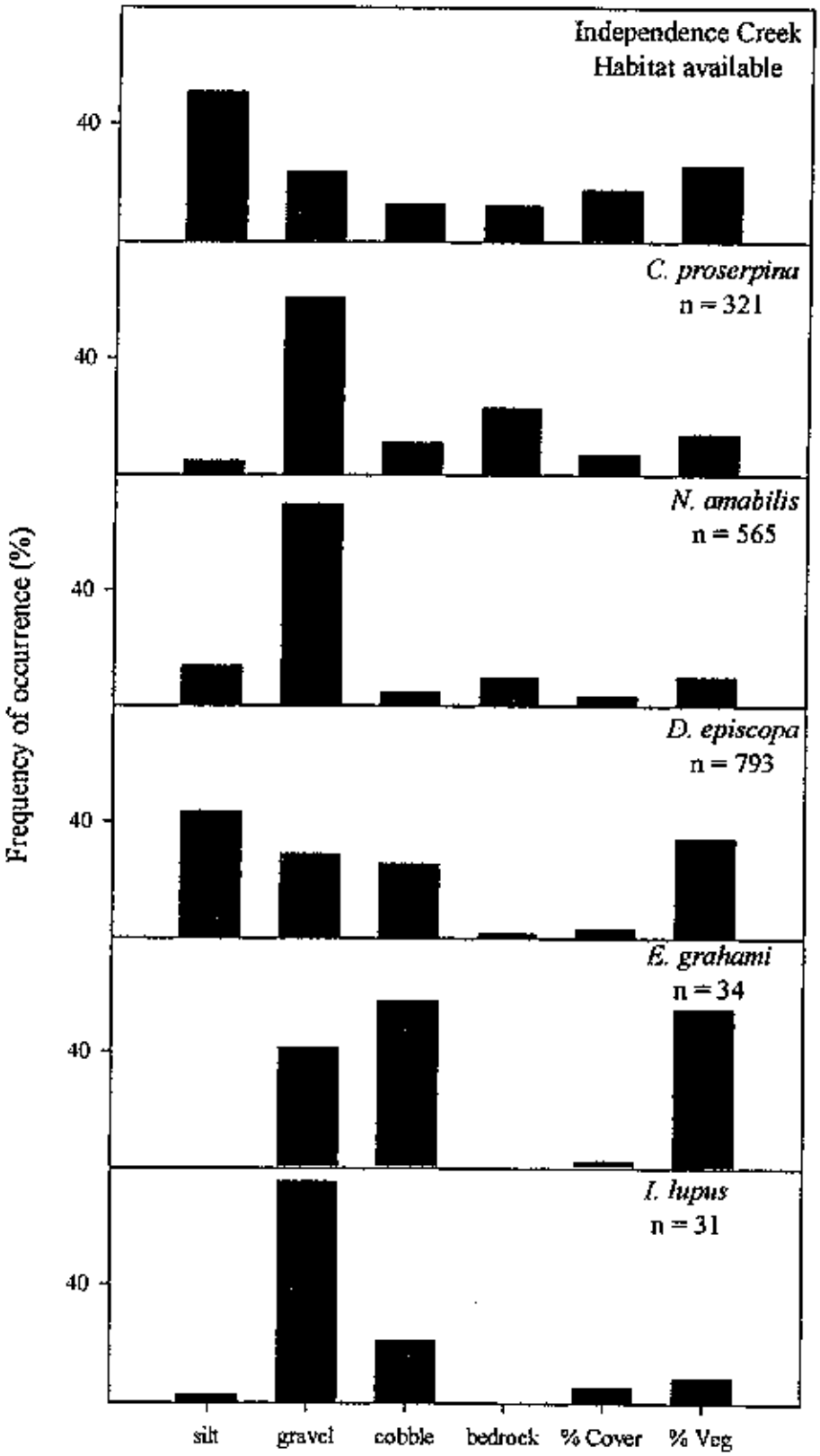

Figure 4. Relative abundance for species according to substrate type, percent cover, and percent vegetation. Percent of mesohabitat types in Independence Creek drainage are included to provide mesohabitat availability.

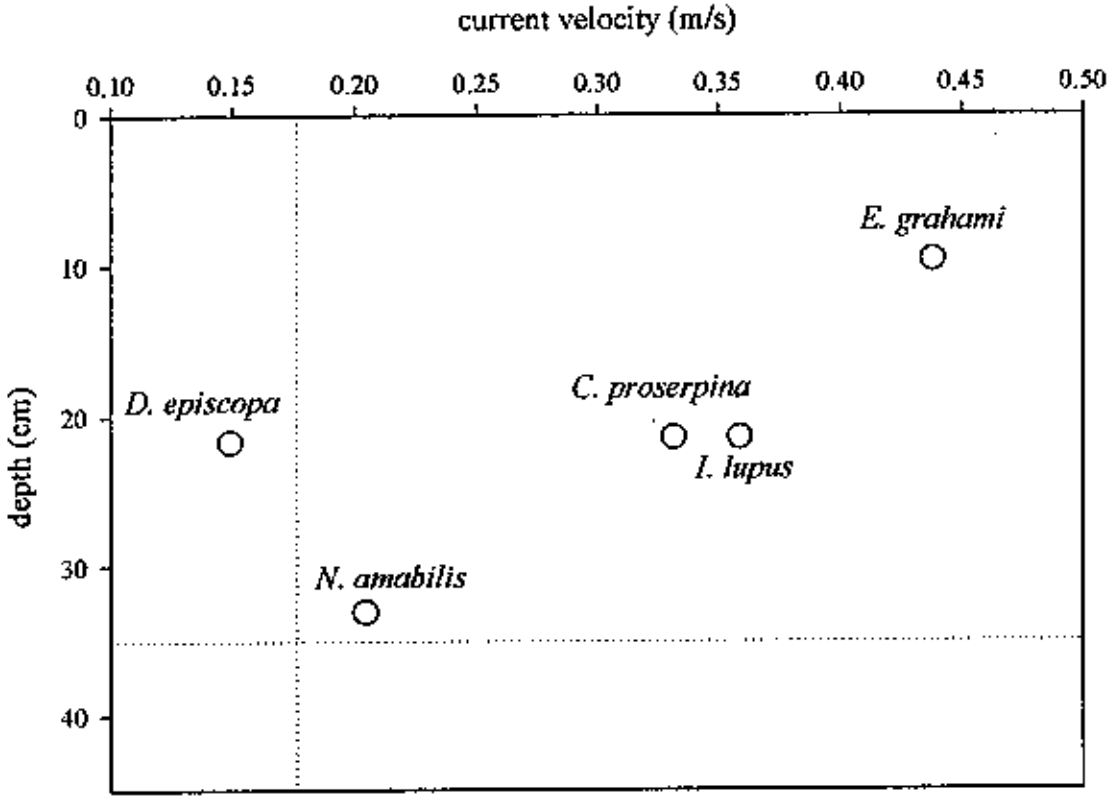

Figure 5. Mean depth and current velocity of mesohabitats for each listed species. Means were weighted by number of individuals collected at each mesohabitat. Mean depth and current velocity (dashed lines) of Independence Creek are included to provide habitat availability.

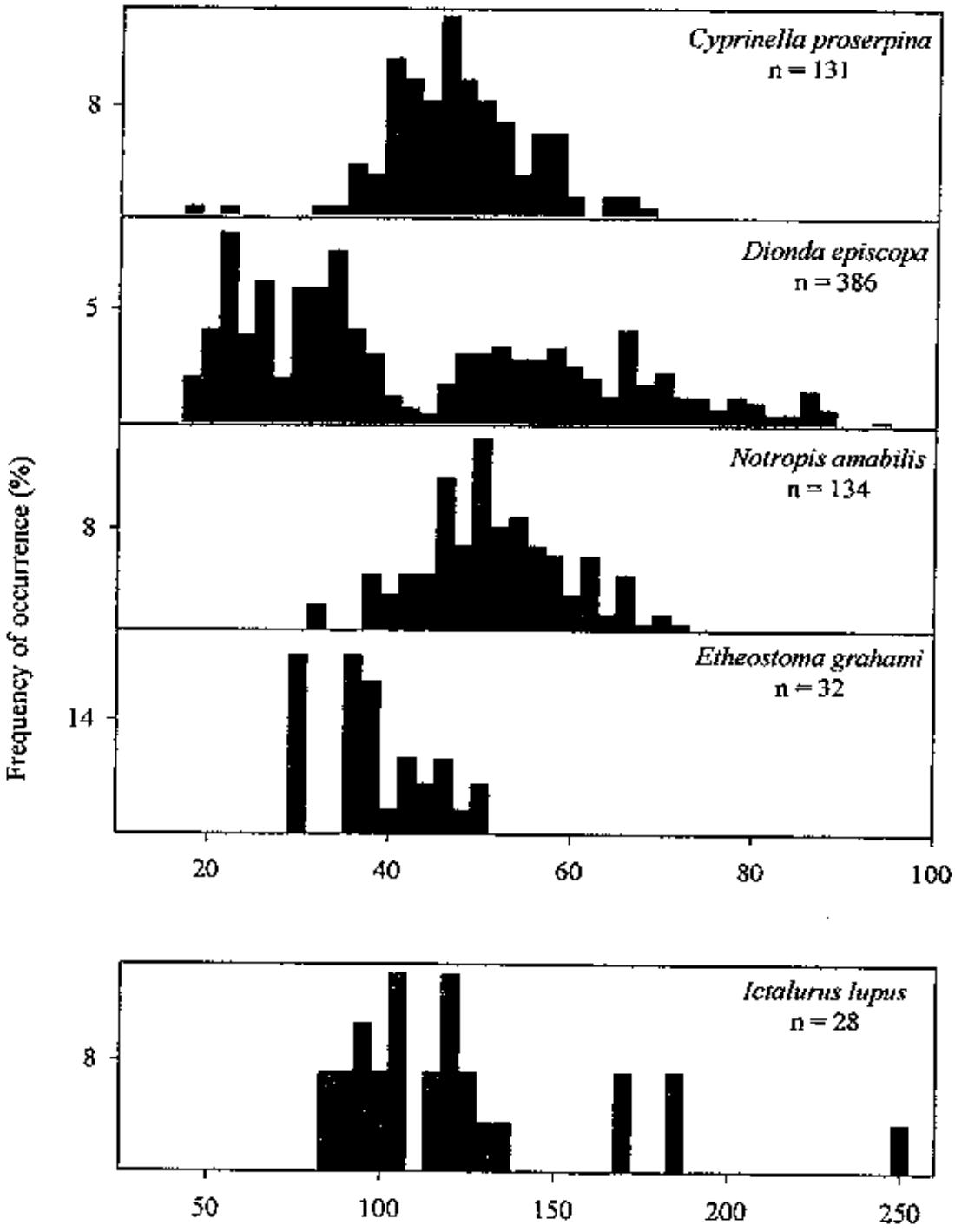

Figure 6. Length frequency histograms for selected fish from Independence Creek drainage, May 2002.

Appendix I
Project documents (proposal and project statement)

E720

TEXAS PARKS AND WILDLIFE DEPARTMENT
SECTION 6 PROJECT PROPOSAL

Project Title: Implementation of Candidate Species Monitoring in Texas

Species Name(s): All C1 and C2 species in Texas

Fish and Wildlife Service Rank*:

State Rank: 4

Present Year Funding Request: FY95 $45,000

Year of Project (Present and Total): 1 of 4

Funding History and Needs:

FY95	$45,000
FY96	$45,000
FY97	$45,000
FY98	$45,000

Joint Project with another State? (Y/N and give state): No

Species Listing/Recovery Priority: NA

Recovery Plan Task Numbers: NA

Recovery Plan Task Priorities: NA

Will threatened or endangered species take be required? (Y/N): No

Are other threatened, endangered, or proposed species in the project area? (Y/N, If Y, list species): Yes, potential overlap with numerous listed species on the study sites

If project is on U.S. Fish and Wildlife Service administered lands, do any Category 1 species occur in the project area? (Y/N/NA; if Y, list species): Unknown

Will project be conducted within designated critical habitat? (Y/N): NA

State Contact/Phone: Mary Candee 512-448-4311 **Date:** Dec. 1, 1994

Fish and Wildlife Service Contact/Phone*:

*Items to be completed by Fish and Wildlife Service field office

E720

PROPOSAL FOR SECTION 6 FEDERAL AID
TEXAS

IMPLEMENTATION OF CANDIDATE SPECIES MONITORING IN TEXAS

A. NEED

There are over 300 species of plants and animals listed as category 1 or category 2 in the state of Texas. As stated in the Federal Register, 50 CFR Part 17, Volume 56, No. 225, "The Service intends to monitor the status of all listing candidates to the fullest extent possible, emphasizing monitoring of species for which available scientific and commercial information indicates imminent threat." With a systematic approach to implementing monitoring efforts over four years, the majority of candidate species will be addressed as planned in this proposal.

B. OBJECTIVE

The objective of this proposal is to implement monitoring efforts on an annual, biennial, or triennial basis (depending upon the species) for candidate plant and animal species occurring in Texas that is deemed to be imminently imperiled. The objective is to develop a strategy for phasing in the monitoring effort through single to multiple species monitoring efforts. This would be accomplished through a statewide network of monitoring candidate species on government, non-government and private lands utilizing agency staff, citizens, universities, non-government organizations, and conservation groups to assist with the ongoing monitoring of the candidate species in Texas.

C. EXPECTED RESULTS OR BENEFITS

The expected results of this would be a pragmatic approach to monitoring the candidate species in Texas. Through this monitoring effort we will be able to track the status of candidate species leading to the prevention of extinction, perhaps the avoidance of need to list, an increased awareness of the general public and greater conservation support through this coordinated multi-agency and organization effort.

D. APPROACH

The current candidate monitoring project will provide completed monitoring plans and enable a broad review of those completed plans which will chart overall species priority, monitoring effort needed, monitoring schedule, locations, and field equipment necessary to initiate a comprehensive monitoring effort.

From that compilation, we will be able to develop a strategy to implement the monitoring plans. We will do this through meeting with state, federal and non-governmental agencies identified as having species on their property needing monitoring. We plan enlist their help

in the implementation of monitoring. As an aid to the monitoring efforts we will develop a training manual for site stewards and local volunteers to insure standardization of field techniques and highlight field etiquette. In addition, there will be an annual review of species to determine if there are any gaps of species previously omitted.

The candidate species fall into the following categories:

A. Species that will require research/monitoring at a high level, probably through specific-separate funding mechanisms, i.g. Section 6. (including species with taxonomic questions.)
B. Species needing to be relocated before monitoring can begin.
C. Species not located in a number of years, not likely to be readily found.
D. Species with known populations, that would/could be monitored by site managers and local interested citizens.

This proposal addresses those candidate species under category-- D. Species with known populations, that would/could be monitored by site managers and local interested citizens, that is, those species not needing high level monitoring or research completed.

The comprehensive review of the completed monitoring plans will highlight those species to be addressed and a strategy developed to implement monitoring on state (Texas Parks & Wildlife Department, Tx Department of Transportation, General Land Office, Texas Forest Service), federal (US Fish & Wildlife Service-National Wildlife Refuges, National Park Service, Department of Defense, US Forest Service), and non-government conservation organization (The Nature Conservancy, Audubon Society) lands. Whenever possible, the plan is also to address populations that occur on private property with intent to build additional private land owner involvement over time.

There would be a phasing in over each successive year of additional species and additional sites to be monitored. There will be annual review of candidate species to determine any changes in status. The initial goal will be to initiate monitoring at, at least two sites per month. The number of species to be monitored will be site dependent. Upon completion of the first year we will be able to better determine the actual number of sites and species that can be monitored

As stated above, we plan to develop a general training manual for agency representatives and on-site volunteers addressing the overall monitoring objectives for candidate species; specific issues for each site and/or species; field etiquette dos and don'ts; liability questions and waiver; where to go for resource assistance; safety concerns; report format; and field equipment and supplies.

LOCATION

Location will occur statewide with initial locations to be on state, federal and non-governmental lands.

ESTIMATED BUDGET

Item/Category	'95	'96	'97	'98
Personnel	38,000	39,140	40,314	41,523
Travel	10,000	10,500	11,000	11,500
Field Equipment	3,976	4,374	4,811	4,811
Misc. Materials	1,400	1,400	1,400	1,400
Operating Expenses	400	800	800	800
Literature Search Costs	250	250	200	200
Training Manual	1,500	1,000	500	300
Total	55,526	57,464	60,025	60,534

Submitted by Mary E. Candee

OMB Approval No 0348-0043

APPLICATION FOR FEDERAL ASSISTANCE

2. DATE SUBMITTED	Applicant Identifier
06/29/01	
3. DATE RECEIVED BY STATE	**State Application Identifier**
08/27/00	TX-W-97-08-27-0001-50-00
4. DATE RECEIVED BY FEDERAL AGENCY	**Federal Identifier**
	E-9 FSC JUL 09 2001 F.A

1. TYPE OF SUBMISSION

Application		Preapplication	
	Construction		Construction
X	Non-Construction		Non-Construction

5. APPLICANT INFORMATION

Legal Name	Organizational Unit
Texas Parks and Wildlife Department	WILDLIFE DIVISION

Address (give city, county, state, and zip code):

4200 Smith School Road
Travis County
Austin, Texas 78744

Name and telephone number of the person to be contacted on matters involving this application (give area code)

Neil E. Carter 512-389-4641
Gareth Rowell 512-912-7053

6. EMPLOYER IDENTIFICATION NUMBER (EIN): 74-1680373

7. TYPE OF APPLICANT: (enter appropriate letter in box) A

A. State — H. Independent School Dist.
B. County — I. State Controlled Institution of Higher Learning
C. Municipal — J. Private University
D. Township — K. Indian Tribe
E. Interstate — L. Individual
F. Intermunicipal — M. Profit Organization
G. Special District — N. Other (Specify)

8. TYPE OF APPLICATION

X New — Continuation — Revision

If Revision, enter appropriate letter(s) in box(es)

A. Increase Award — B. Decrease Award — C. Increase Duration
D. Decrease Duration — Other (specify):

9. NAME OF FEDERAL AGENCY:
U.S.FISH & WILDLIFE SERVICE

Chief
ACTING Federal Aid, Region 2

AUG 17 2001

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: 15.615

TITLE: COOPERATIVE ENDANGERED SPECIES CONSERVATION

11. DESCRIPTIVE TITLE OF APPLICANTS PROJECT:

A CITIZEN-BASED MONITORING PROGRAM FOR SPECIES OF CONCERN IN TEXAS

12. AREAS AFFECTED BY PROJECT (cities, counties, states, etc.):
TEXAS

13. PROPOSED PROJECT:

Start Date	Ending Date
09/01/01	08/31/02

14. CONGRESSIONAL DISTRICTS OF:

a. Applicant	b. Project
10	STATEWIDE

15. ESTIMATED FUNDING:

a. Federal	$ 36,000 .00
b. Applicant	$ .00
c. State	$ 12,000 .00
d. Local	$ .00
e. Other	$ .00
f. Program Income	$ .00
g. TOTAL	$ 48,000 .00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. YES THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:
DATE: 08/27/97

b. NO ☐ PROGRAM IS NOT COVERED BY E. O. 12372
☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

☐ Yes If "Yes" attach an explanation — X No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION PREAPPLICATION ARE TRUE AND CORRECT. THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED

a. Typed Name of Authorized Representative	b. Title	c. Telephone number
Neil (Nick) E. Carter	Federal Aid Coordinator	512-389-4641

d. Signature of Authorized Representative: Neil E. Carter

e. Date Signed: 06/29/01

Previous Editions Not Usable

Standard Form 424 (REV 4-9

02612

E0153-01-a C4

UNITED STATES
DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Division of Federal Aid

GRANT AGREEMENT

State: TEXAS	Grant No.: E-9
(reserved)	Segment No.: 1

Agreement Period
From: 09/01/01
To: 08/31/02

RECD JUL 09 2001

GRANT TITLE: A Citizen-based Monitoring Program for Species of Concern in Texas

GRANT COST DISTRIBUTION:	Private Third Party	%	State Share	%	Federal Share	%	Total Cost	%
Sport Fish Restoration Act (16 U.S.C. 777-777k)				0.0%		0.0%	0.00	
Wildlife Restoration Act (16 U.S.C. 669-669i)				0.0%		0.0%	0.00	
Other (specify): ESA Sec. 6		0.0%	12,000.00	25.0%	36,000.00	75.0%	48,000.00	
TOTAL COST	0.00		12,000.00		36,000.00		48,000.00	

OTHER GRANT PROVISIONS:

Estimated Program Income: $ 0.00
Method of Crediting Program Income: ___ Additive ___ Deductive

Coastal States Allocation:
Freshwater: ____% Marine: ____%

The State agrees to execute this grant in accordance with the appropriate Acts above, the pertinent rules and regulations of the Secretary of the Interior contained in the Code of Federal Regulations, and the previously approved Grant Proposal to the extent encompassed by this Agreement.

STATE AGENCY (Name and Address):

TEXAS PARKS AND WILDLIFE
4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291

Signature:	Title: FEDERAL AID COORDINATOR	Date: 06/29/01

SPECIAL GRANT CONDITIONS:

Pending clarification of policy on the level of cost accounting, the required level of cost accounting for this grant agreement will be at the grant level.

02626

APPROVED FOR THE SECRETARY OF THE INTERIOR

Signature:	Title: ACTING Chief Federal Aid Region 2	Date: 8/17/01

Form 3 - 1552
(Revised January 2000)

OMB Approval No. 1018 - 0049
Approval Expires 09/30/2003

Project WER09: A Citizen-based Monitoring Program for Species of Concern in Texas

(Ongoing Project)

PROJECT STATEMENT

A. Need:

There are over 300 species of plants and animals listed as candidates or recognized as species of concern in Texas. As stated in the Federal Register, 50 CFR Part 17, Volume 56, No. 225, "The Service intends to monitor the status of all listing candidates to the fullest extent possible, emphasizing the monitoring of species for which available scientific and commercial information indicates imminent threat." At the time these regulations were written, Congress had instructed the Service to monitor the status of a large group of species which included both those species now called "candidates" (formerly Category 1 candidates) and "Species of Concern" (formerly Category 2 candidates). Given the advice promulgated from many sources to address conservation needs of species before they become endangered, it would seem prudent to continue to maintain a source of data on the status of these rare species in the state.

The implementation of a broad-scale species monitoring program offers opportunity for public involvement and education in collecting data. Several successful prototypes for this type of approach to biological monitoring exist, including the widespread water quality monitoring programs (including Texas Watch), the Nature Mapping effort used to generate data for Gap Analysis in Washington state, and the international Monarch Watch program. Not only do citizen volunteer programs offer a source of manpower for data collection, they can result in increased public awareness and conservation efforts.

B. Objective:

The objective of this proposal is to implement a monitoring program for species of concern (including candidates) in Texas relying primarily upon citizen volunteers.

C. Expected Results or Benefits:

The expected results of this would be a pragmatic approach to monitoring species of concern in Texas. Through this monitoring effort we will be able to track the status of species of concern leading to the prevention of extinction, perhaps the avoidance of need to list, an increased awareness of the general public and greater conservation support through this coordinated multi-agency and organization effort.

D. Approach:

1. First, we will review medium- and high-priority species (as identified in monitoring plans prepared in a previous project) to assess the utility of citizen volunteers in collecting data. Existing monitoring programs, such as the Breeding Bird Survey and Christmas Bird Counts, will be reviewed. Input will be sought from other agencies and professionals. From this effort a list of strategies and feasible monitoring sites will be constructed.

2. The possibility of broad-scale monitoring programs will be assessed and relevant programs will be developed. Ideas currently under consideration include a Texas Horned Lizard Watch, Texas Mussel Watch (in conjunction with ongoing water quality monitoring programs), Texas Waterbird Watch (in conjunction with the National Audubon Society), and Amphibian Watch. These programs would have centralized coordination. They might have training workshops for volunteers, but would rely on the volunteers to carry out the projects basically on their own with generalized instruction from TPWD.

3. For the majority of species, however, it will be necessary to recruit and train volunteers on a site-specific basis. TPWD staff will contact site managers to request permission to establish a monitoring project, develop instructional materials (including notes on monitoring etiquette) and data sheets, locate suitable volunteers, train volunteers at the location of the population to be monitored, and follow-up with volunteers to ensure that monitoring takes place in a timely manner and that data is received by TPWD. We recognize that some species and volunteers will allow accurate data to be reported with much confidence, while some other situations will limit themselves to simple presenceabsence information. Special care will be taken in sensitive environments and with species subject to collection pressure to ensure that monitoring efforts do not further endanger the population. (For example, state park staff might be the most appropriate volunteers at some sites).

4. For a few species, TPWD Endangered Resources Branch staff will continue to collect monitoring data as work loads and expertise permit.

5. Finally, we will work to develop a recognizable identity for the monitoring project (such as "Texas Wildlife Watch") and utilize many means, including the TPWD Web page and presentations at conferences, to advertise and recruit for the project. We will attempt to coordinate this project as much as possible with other similar monitoring efforts and to take advantage of support from other agency personnel when available. We will acknowledge the support of the U.S. Fish and Wildlife Service through Section 6 funding. While funding is initially requested for five years, we see this project as truly long-term, with the majority of the benefits to be accrued many years down the line when a solid database of information is finally available for some of these species.

E. Location: statewide, Texas

F. Costs (Federal Share):

			Seg. Obj.
E-1-8	FY95	$ 45,000	1-5
E-1-9	FY96	$ 45,000	1-5
E-1-10	FY97	$ 0	1-5
E-1-11	FY98	$ 36,000	1-5
E-1-12	FY99	$ 0	1-5
E-1-13	FY00	$ 36,000	1-5
E-1-14	FY01	$ 36,000	1-5

UNITED STATES
DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Division of Federal Aid

GRANT AGREEMENT

State: TEXAS	Grant No.:
(reserved)	Segment No.: 1
Agreement Period From: 09/01/01 To: 08/31/02	

GRANT TITLE: A Citizen-based Monitoring Program for Species of Concern in Texas

GRANT COST DISTRIBUTION:	Private Third Party	%	State Share	%	Federal Share	%	Total Cost	%
Sport Fish Restoration Act (16 U.S.C. 777-777k)				0.0%		0.0%	0.00	
Wildlife Restoration Act (16 U.S.C. 669-669i)				0.0%		0.0%	0.00	
Other (specify): ESA Sec. 6		0.0%	12,000.00	25.0%	36,000.00	75.0%	48,000.00	
TOTAL COST	0.00		12,000.00		36,000.00		48,000.00	

OTHER GRANT PROVISIONS:

Estimated Program Income: $ 0.00
Method of Crediting Program Income: ___ Additive ___ Deductive

Coastal States Allocation:
Freshwater: _____% Marine: _____%

The State agrees to execute this grant in accordance with the appropriate Acts above, the pertinent rules and regulations of the Secretary of the Interior contained in the Code of Federal Regulations, and the previously approved Grant Proposal to the extent encompassed by this Agreement.

STATE AGENCY (Name and Address):

TEXAS PARKS AND WILDLIFE
4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291

Signature:	Title: FEDERAL AID COORDINATOR	Date: 06/29/01

SPECIAL GRANT CONDITIONS:

APPROVED FOR THE SECRETARY OF THE INTERIOR

Signature:	Title:	Date:

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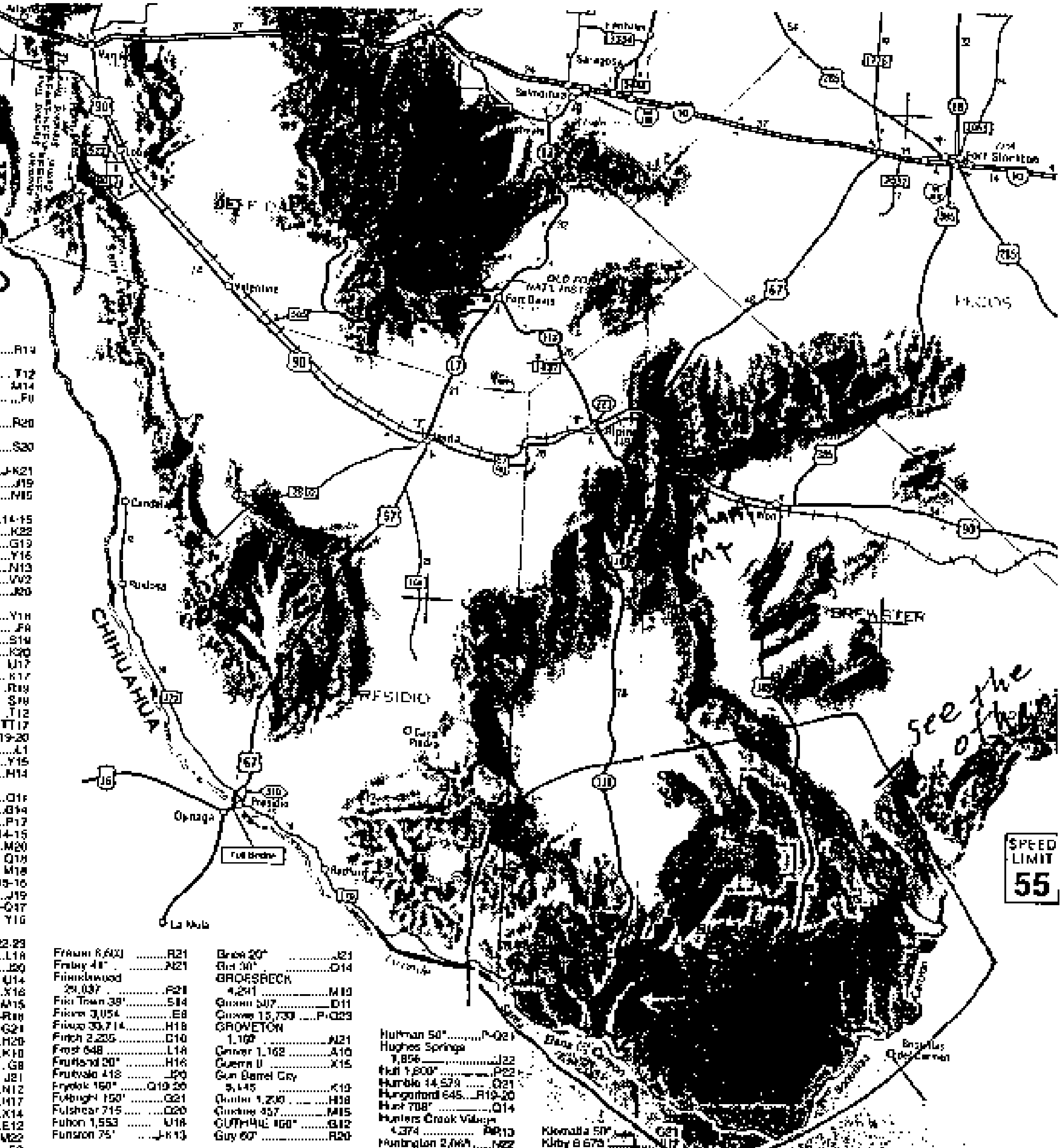


CONROE 36,811 ... P21
Converse 11,508 ... R16
Conway 25* ... D10
Cooks Point
60* ... Q18-19
Cookville 105* ... H21
Cool 162 ... J15
Coolidge 848 ... M18
COOPER 2,150 ... H20
Copeville 131* ... J19
Coppell 35,958 ... RR
Copperas Cove
29,592 ... M16
Cordele 66* ... S19
Corinth 11,325 ... QQ4
Cornudas 3* ... L3
CORPUS CHRISTI
277,454 ... V17
Corrigan 1,721 ... N22
CORSICANA
24,485 ... L19
Coryell City 125* ... M17
Cost 169* ... R17
Cotton Center 200* ... G9
Cottonwood 156* ... L14
Cottonwood 40* ... O20
COTULLA 3,614 ... T14
Country Campus
60* ... O20-21
Coupland 135* ... P17
Courtney 35* ... P19
Covington 282 ... L17
Coy City 30* ... S16
Coyanosa 138 ... N7
Crabbs Prairie
247 ... O20
Crandall 2,774 ... K18
CRANE 3,191 ... N8
Cranfills Gap 335 ... M16
Crawford 705 ... M17
Creedmoor 211 ... Q17
Cresson 320* ... K17
Crews 25* ... L13
Crisp 90* ... K18
CROCKETT
7,141 ... N20
Crosby 1,714 ... Q21
CROSBYTON
1,874 ... G10
Cross 40* ... Q19
Cross Cut 45* ... L14
Cross Plains 1,068 ... L14
Cross Roads 603 ... L20
Crow 20* ... K21
CROWELL 1,141 ... F13
Crowley 7,467 ... K17
Crystal Beach
787* ... R22
CRYSTAL CITY
7,190 ... T13
CUERO 6,571 ... S17
Cumby 616 ... H20
Cuney 145 ... L20
Cunningham 110* ... H20
Cushing 637 ... L22
Cut and Shoot
1,158 ... P21
Cypress 200* ... Q20
Cypress Mill 50* ... P15

D

Dacosta 89* ... T18
DAINGERFIELD
2,517 ... J22
Daisetta 1,034 ... P22
Dale 126* ... Q17
DALHART 7,237 ... B8
DALLAS
1,188,580 ... J18
Dalworthington Gardens
2,188 ... VV4
Damon 535 ... R20
Danbury 1,611 ... R21
Danciger 314* ... S20
Danevang 61* ... S19
Darrouzett 303 ... A12
Davilla 200* ... O17
Dawn 94* ... D9
Dawson 852 ... L18
Dayton 5,709 ... P22
De Berry 191* ... K23
De Kalb 1,769 ... G23
De Leon 2,433 ... L15
Deadwood 106* ... L23
Deanville 130* ... P18
DECATUR 5,201 ... H17
Deer Park 28,520 ... Q21
DEL RIO 33,867 ... R11
Del Valle 300* ... P17
Dell City 413 ... L3

E

Eagle Lake 3,664 ... R19
EAGLE PASS
22,413 ... T12
Early 2,588 ... M14
Earth 1,109 ... F9
East Bernard
1,729 ... R20
East Columbia
95* ... S20
East Mountain
580 ... J-K21
East Tawakoni 775 ... J19
Easterly 61* ... N15
EASTLAND
3,769 ... K14-15
Easton 524 ... K22
Ector 600 ... G19
Edcouch 3,342 ... Y16
Eden 2,561 ... N13
Edgecliff 2,560 ... VV2
Edgewood 1,346 ... J20
EDINBURG
48,465 ... Y16
Edmonson 123 ... F8
EDNA 5,899 ... S19
Edom 322 ... K20
Edroy 420 ... U17
Egan 21* ... K17
Egypt 20* ... R19
El Campo 10,945 ... S19
El Indio 263 ... T12
El Lago 3,075 ... TT17
El Maton 185* ... S19-20
EL PASO 563,662 ... L1
El Sauz 85* ... Y15
Elbert 58 ... H14
ELDORADO
1,951 ... O12
Electra 3,160 ... G14
Elgin 5,700 ... P17
Eliasville 116* ... J14-15
Elkhart 1,215 ... M20
Ellinger 200* ... Q18
Elm Mott 190* ... M18
Elmendorf 664 ... R15-16
Elmo 90* ... J19
Elroy 125* ... P-Q17
Elsa 5,549 ... Y16
Elysian Fields
300* ... K22-23
Embhouse 159 ... L18
EMORY 1,021 ... J20
Encinal 629 ... U14
Encino 177 ... X16
Energy 25* ... M15
Engle 106* ... Q-R18
English 92* ... G21
Enloe 125* ... H20
Ennis 18,045 ... K18
Enochs 164* ... G8
Enon 204* ... J21
Eola 218* ... N12
Era 300* ... H17
Escobas 10* ... X14
Estelline 180 ... E12
Etoile 70* ... M22
Etter 160* ... B9
Euless 46,005 ... RR
Eureka 340 ... L19
Eustace 798 ... K19-20
Evadale 1,430 ... P23
Evant 393 ... M16
Evergreen 50* ... Q21
Everman 5,836 ... VV3

F

Fabens 8,043 ... M2
Fair Oaks Ranch
4,695 ... Q15
FAIRFIELD 3,094 ... M19
Fairlie 80* ... H19
Fairview 2,644 ... K10
Fairy 23* ... L-M16
Falcon 184* ... Y14
FALFURRIAS
5,297 ... W15
Falls City 591 ... S15
Fannett 3,796* ... Q23
Fannin 125* ... T18
Fargo 181* ... F14

Fresno 6,603 ... R21
Friday 41* ... N21
Friendswood
29,037 ... R21
Frio Town 38* ... S14
Friona 3,854 ... E8
Frisco 33,714 ... H18
Fritch 2,235 ... D10
Frost 648 ... L18
Fruitland 20* ... H16
Fruitvale 418 ... J20
Frydek 150* ... Q19-20
Fulbright 150* ... G21
Fulshear 715 ... Q20
Fulton 1,553 ... U18
Funston 75* ... J-K13

G

Gail 202* ... J10
GAINESVILLE
15,538 ... G17
Galena Park
10,592 ... RR15
Gallatin 378 ... L21
GALVESTON
57,247 ... R22
Ganado 1,915 ... S19
GARDEN CITY
293* ... M10
Garden Ridge
1,882 ... FF6
Garden Valley
150* ... K20
Gardendale 1,197 ... E8
Garland 215,768 ... J18
Garrison 844 ... L22
Garwood 975* ... R19
Gary 303 ... L22
GATESVILLE
15,591 ... M16-17
Gause 400* ... O18

Grice 20* ... J21
Grit 30* ... O14
GROESBECK
4,291 ... M19
Groom 587 ... D11
Groves 15,733 ... P-Q23
GROVETON
1,107 ... N21
Gruver 1,162 ... A10
Guerra 0 ... X15
Gun Barrel City
5,145 ... K19
Gunter 1,230 ... H18
Gustine 457 ... M15
GUTHRIE 160* ... G12
Guy 60* ... R20

H

Hagansport 40* ... H21
Hale Center 2,263 ... F9
HALLETTSVILLE
2,345 ... R18
Hallsville 2,772 ... K22
Haltom City
39,018 ... TT3
Hamby 100* ... MM9
HAMILTON 2,977 ... M16
Hamlin 2,248 ... J12
Hamshire 1,507* ... Q23
Hankamer 226* ... Q22
Happy 647 ... E9
Hardin 755 ... P22
Hare 70* ... O17
Hargill 1,349* ... Y16
Harker Heights
17,308 ... N17
Harleton 260* ... J22
Harlingen 57,564 ... Y17
Harper 1,006 ... P14
Harrold 320* ... F14
Hart 1,198 ... F9

Huffman 50* ... P-Q21
Hughes Springs
1,856 ... J22
Hull 1,800* ... P22
Humble 14,579 ... Q21
Hungerford 645 ... R19-20
Hunt 708* ... Q14
Hunters Creek Village
4,374 ... RR13
Huntington 2,068 ... N22
HUNTSVILLE
35,078 ... O20
Hurlwood 115* ... H9
[illegible] 273 ... J17
Hutchins 2,805 ... K18
Hutto 1,250 ... O17
Hye 105* ... P15

I

Idalou 2,157 ... G10
Illinois Bend 67* ... G17
Impact 39 ... MM7
Imperial 428 ... N8
Inadale 8* ... K11
Independence
140* ... P19
Indian Gap 27* ... M15
Indian Lake 541 ... CC20
Indianola 125* ... T19
Industry 304 ... Q18
Inez 1,787 ... S18
Ingleside 9,388 ... V18
Ingram 1,740 ... Q14
Iola 331* ... O19

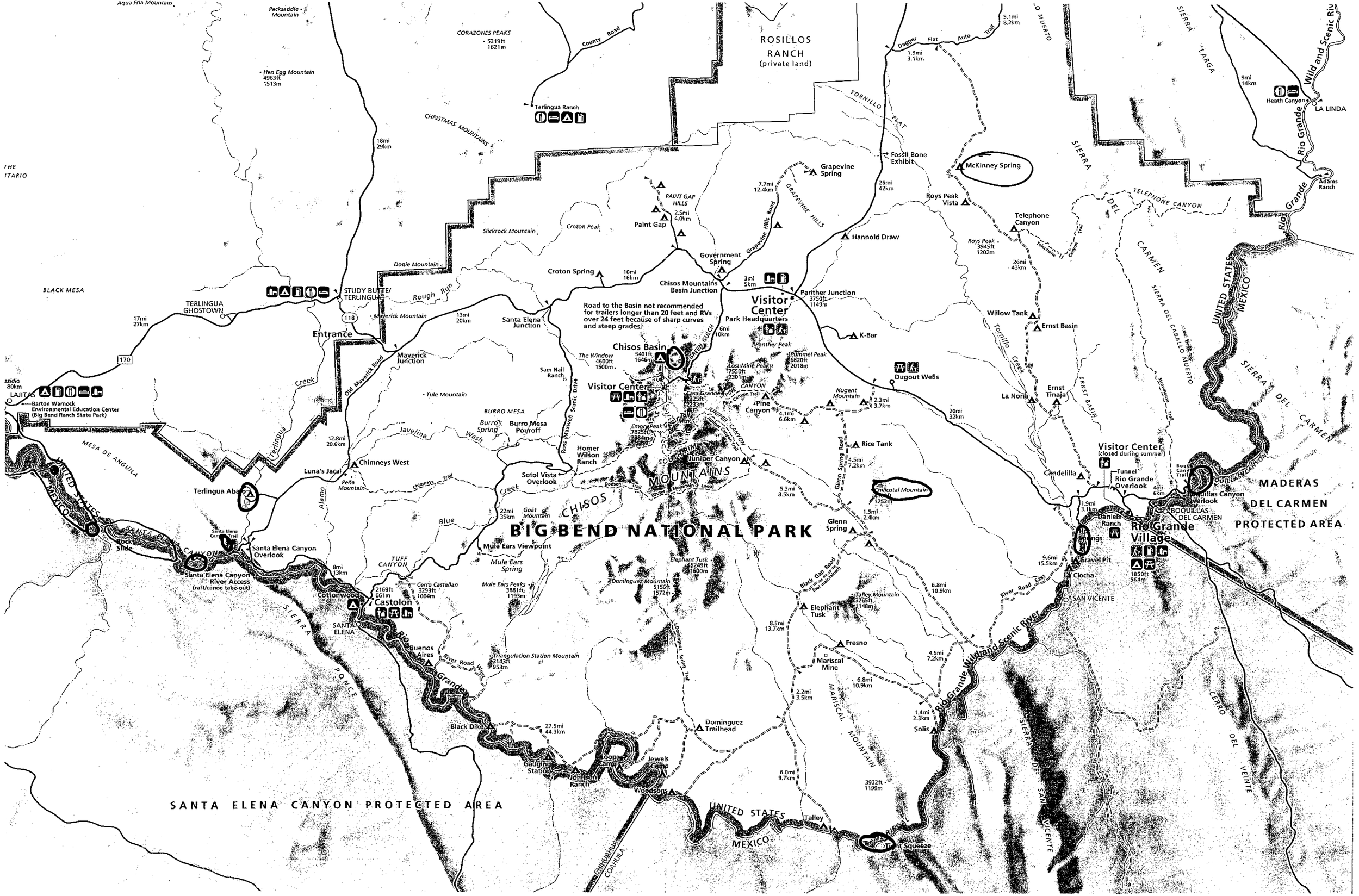
Kiomatia 50* ... G21
Kirby 8,673 ... [illegible]
Kirbyville 2,063 ... O23
Kirkland 44* ... F12
Kirvin 122 ... M19
Knickerbocker 50* ... N11
Knippa 738 ... R13
Knott 685* ... K10
Knox City 1,219 ... H13
Kopperl 225* ... L17
Kosciusko 390* ... S16
Kosse 497 ... N18
KOUNTZE 2,115 ... P23
Kress 826 ... F10
Krum 1,979 ... H17
Kurten 150* ... O19
Kyle 5,314 ... Q16

L

La Blanca 2,351 ... CC18
La Coste 1,255 ... R15
La Feria 6,115 ... Z17
La Gloria 102* ... X15
LA GRANGE
4,478 ... Q18
La Grulla 1,211 ... Y15

LITTLEFIELD
6,507 ... G9
Live Oak 9,156 ... GG3
Liverpool 404 ... R21
LIVINGSTON
5,433 ... O22
LLANO 3,325 ... O15
Lobo 40* ... O4
Lockett 200* ... F14
LOCKHART
11,615 ... Q16-17
Lockney 2,056 ... F10
Lodi 164* ... J22
Lohn 149* ... N14
Lolita 548 ... S19
Loma Alta 30* ... Q11
Lomax 3,554* ... L10
Lometa 782 ... N15
London 180* ... O13
Lone Grove 50* ... O15
Lone Oak 521 ... J19-20
Lone Star 1,631 ... J22
Long Branch 181* ... L22

Mercedes 13,649 ... Z16
Mercury 166* ... N14
MERIDIAN 1,491 ... L17
Merkel 2,637 ... K12-13
Mertens 146 ... L18
MERTZON 839 ... N11
Mesquite 124,523 ... J18
Mexia 6,563 ... M19
Meyersville
110* ... S17-18
MIAMI 588 ... C12
Mico 98* ... R14-15
Midfield 70* ... S19
Midkiff 100* ... M9
MIDLAND 94,996 ... L9
Midlothian 7,480 ... K18
Midway 288 ... N20
Milam 1,329 ... M23
Milano 400 ... O18
Miles 850 ... M12
Milford 685 ... L18
Miller Grove 115* ... J20
Millersview 75* ... N13



BIG BEND NATIONAL PARK
SANTA ELENA CANYON PROTECTED AREA
MADERAS DEL CARMEN PROTECTED AREA
ROSILLOS RANCH (private land)
CHISOS MOUNTAINS
Visitor Center
Chisos Basin
Chisos Mountains Basin Junction
Panther Junction
Park Headquarters
Government Spring
Paint Gap
Grapevine Spring
McKinney Spring
Fossil Bone Exhibit
Roys Peak Vista
Telephone Canyon
Hannold Draw
Dugout Wells
Pine Canyon
Juniper Canyon
Rice Tank
Glenn Spring
Elephant Tusk
Fresno
Mariscal Mine
Solis
Talley
Trent Squeeze
Dominguez Trailhead
Woodsons
Jewels Camp
Loop Camp
Johnson Ranch
Gauging Station
Black Dike
Buenos Aires
Castolon
Cottonwood
Santa Elena Canyon Overlook
Santa Elena Canyon River Access (raft/canoe take-out)
Rock Slide
Terlingua Abajo
Luna's Jacal
Chimneys West
Mule Ears Viewpoint
Mule Ears Spring
Mule Ears Peaks
Sotol Vista Overlook
Homer Wilson Ranch
Burro Mesa Pouroff
Burro Spring
Sam Nail Ranch
Santa Elena Junction
Croton Spring
Maverick Junction
Entrance
STUDY BUTTE/ TERLINGUA
TERLINGUA GHOSTOWN
LAJITAS
Barton Warnock Environmental Education Center (Big Bend Ranch State Park)
Terlingua Ranch
Heath Canyon
LA LINDA
Adams Ranch
Willow Tank
Ernst Basin
Ernst Tinaja
La Noria
Candelilla
Visitor Center (closed during summer)
Rio Grande Overlook
Boquillas Canyon Overlook
BOQUILLAS DEL CARMEN
Rio Grande Village
Daniels Ranch
Gravel Pit
Clocha
SAN VICENTE
Rio Grande Wild and Scenic River
Rio Grande
Wild and Scenic River
UNITED STATES
MEXICO
SIERRA DEL CARMEN
SIERRA DEL CABALLO MUERTO
SIERRA LARGA
SIERRA DE SAN VICENTE
CERRO DEL VEINTE
MARISCAL MOUNTAIN
CHIHUAHUA
COAHUILA
MESA DE ANGUILA
BLACK MESA
CORAZONES PEAKS
CHRISTMAS MOUNTAINS
TORNILLO FLAT
GRAPEVINE HILLS
PAINT GAP HILLS
BURRO MESA
TUFF CANYON
SANTA ELENA CANYON
SIERRA PONCE
Road to the Basin not recommended for trailers longer than 20 feet and RVs over 24 feet because of sharp curves and steep grades.

PERFORMANCE REPORT

As Required By

THE ENDANGERED SPECIES PROGRAM

TEXAS

Grant No. E-1-11

Endangered and Threatened Species Conservation

Project No. WER9(72): A Citizen-based Monitoring Program for Species of Concern in Texas

Prepared by: Lee Ann Linam



Andrew Sansom
Executive Director

John Herron
Program Director, Wildlife Diversity

Gary Graham
Division Director, Wildlife

November 30, 1999

PERFORMANCE REPORT

STATE: Texas **GRANT NUMBER:** E-1-11

GRANT TITLE: Endangered and Threatened Species Conservation

REPORTING PERIOD: September 1, 1998 through August 31, 1999

PROJECT NUMBER: WER9(72)

PROJECT TITLE: A Citizen-based Monitoring Program for Species of Concern In Texas

OBJECTIVE:

To implement a monitoring program for species of concern (including candidates) in Texas relying primarily upon citizen volunteers.

SUMMARY OF PROGRESS:

Monitoring was conducted for 11 species at 17 sites. The majority of site specific projects addressed high priority plant species. TPWD botanist Jackie Poole monitored *Festuca ligulata* at Big Bend National Park and Neches River rose mallow (*Hibiscus dasycalyx*) at three sites. Janice Hartgrove, an instructor at North Harris Community College, conducted initial monitoring of the Houston daisy (*Machaeranthera aurea*) population at the campus located on W.W. Thorne Street. Data from 1998 and 1999 will be forthcoming shortly. Volunteers and TPWD staff also reconfirmed populations of Houston daisy and Texas windmill grass (*Chloris texensis*) at several other sites in Harris county during 1997 and 1998. Students at Calderon Elementary School, under the leadership of teacher Monca Fortunado, monitored Rydberg's scurfpea (*Pediomelum humile*) on school property in Del Rio. The students documented a population increase from 87 plants in 1998 to 98 plants in 1999. Following good rainfall in January and February, the volunteers saw the plants emerge during the first week of March, and by the second week of March 75% of the individuals were flowering. A period of low rainfall followed, however, and the monitors did not detect fruit set. The plants were withered and dried by the end of April. Volunteers for the scurfpea population on highway 277 did not report data in 1999. Ann Miller (TPWD) and Mary Kennedy and other volunteers from Texas Military Institute (TMI) collected data on big red sage (*Salvia penstemonoides*) at the Boerne highway right-of-way for the ninth straight year, and reported that the subpopulation inundated by flooding in 1997 failed to emerge again in 1999. Students from TMI placed second at the state science fair with their presentation of *Salvia* data. TPWD staff, Master Naturalist volunteers, and volunteers from Austin High School and Westlake High School continued to monitor bracted twistflower (*Streptanthus bracteatus*) plots established by David Zippin at Barton Creek and Bee Creek. An attorney for

the landowner at the Mount Bonnell site, however, provided a letter to TPWD denying access for the purpose of monitoring that population. Mary Kennedy and TPWD staff visited the population site at Eisenhower Park but were unable to locate any plants. TPWD staff and volunteer Mary Stiles conducted a roadside survey of reported localities in Medina county, but were able to find twistflowers at only one of five sites reported in 1990-91. Data from these monitoring efforts, where available, are presented in Appendix A.

Spring-dwelling salamander monitoring was conducted at four sites using time-constrained techniques. Due to the sensitive nature of these sites TPWD staff continued to oversee the volunteers. New Braunfels High School students assisted with monitoring Comal Springs *Eurycea* populations in Autumn 1998; however, this site has been discontinued due to concerns about endangered species habitat in the spring runs. Bracken Christian School teacher Linda Walker and students assisted with monitoring *Eurycea neotenes* at Honey Creek State Natural Area in Autumn 1998. Ingram High School teacher Mary Beth Bauer and students conducted monitoring at Stockman Spring at Heart-of-the-Hills Research Station in Autumn 1998 and Spring 1999. Deer Park Middle School teacher Susan Von Rosenberg and students assisted with monitoring Jollyville Plateau salamanders (*Eurycea* sp. 1) at Travis Audubon Sanctuary in Autumn 1998. Results are presented in Appendix A.

Monitoring was conducted for two populations of land snails and for pocket gophers at two sites. TPWD staff, New Braunfels High School teachers Denise Ortiz and Judith Simmons, and students conducted monitoring for the horseshoe liptooth snail (*Polygyra hippocrepsis*) in Landa Park on three dates during 1998-99 using randomly-placed 0.1 m^2 quadrats. TPWD staff, volunteers Bernice Speer, Elizabeth Maxim, Melba Sexton, and 4-H members collected data on the palmetto pill snail (*Euchemotrema cheatumi*) at Palmetto State Park in a similar manner in February 1998. The student volunteers were able to locate a live palmetto pill snail—the first documented in several years. TPWD staff, Miller High School teacher Diane Hartung, and students conducted monitoring of maritime pocket gopher (*Geomys personatus maritimus*) at the TPWD Marine Development Center in Flour Bluff using fresh mound counts. Bernice Speer and TPWD staff provided a more thorough population estimate in one small area of the Naval Air Station in Corpus Christi through use of a two-day mound count. Techniques will be applied to the entire subpopulation next year. Results for each of these projects, where available, are presented in Appendix A.

TPWD staff also visited several sites as possible projects for future years. Species and sites observed in 1998-99 included: Texas meadowrue (*Thalictrum texanum*) at Lick Creek Park and one privately-owned site, Navasota false foxglove (*Agalinis navasotensis*) at one privately-owned site, and southern lady's slipper (*Cypripedium kentuckiense*) at Caddo State Park and Atlanta State Park (not seen there in 1999).

A total of 64 volunteers provided data for the 1998 Texas Horned Lizard Watch. A graduate student intern began development of a GIS database for monitoring sites. The 1999 Texas Horned Lizard Watch was advertised through press releases and Texas Parks and Wildlife magazine. The 1998 annual report is presented in Appendix B.

Workshops for Texas Mussel Watch were held in Athens, San Marcos, and Abilene. Volunteers both within and outside TPWD collected significant information on distribution of some rare species. Results are presented in Appendix C.

Staff developed a program identity called Texas Nature Trackers, along with a program brochure, web page, and newsletter. Texas Nature Trackers provides links to (but no Section 6 monetary support for) other non-Section 6 projects such as Project Prairie Birds, Texas Monarch Watch, Hummingbird Round-up, Swallow-tailed Kite Monitoring, Mid-Winter Bald Eagle Survey, and Texas Amphibian Watch. Significant progress was made in developing Texas Amphibian Watch this year; however, Section 6 funds were not used, and program progress will be described in a separate report. A series of Texas Nature Tracker workshops were held. These activities are described in the progress report for Project 73.

SIGNIFICANT DEVIATIONS:

None.

PRELIMINARY FINDINGS:

See following appendices.

ACTUAL COSTS:

$40,895.56

PREPARED BY: Lee Ann Johnson Linam **DATE:** November 9, 1999

APPROVED BY: Neil E. Carter **DATE:** 1/14/2000

Federal Aid Coordinator

APPENDIX A
RESULTS OF MONITORING CONDUCTED BY TPWD AND VOLUNTEERS

Guadalupe Mountains fescue - *Festuca ligulata - page i*
Neches River rose mallow - *Hibiscus dasycalyx - page ii*
Houston daisy – *Machaeranthera aurea – page iii*
Big red sage - *Salvia penstemonoides - page iv*
Bracted twistflower - *Streptanthus bracteatus - page v*

Eurycea salamanders - *page vi*
Horseshoe liptooth snail - *Polygyra hippocrepsis - page vii*
Maritime pocket gopher - *Geomys personatus maritimus - page viii*

Summary of monitoring data
for Festuca ligulata
Big Bend National Park

	PLOT 1						PLOT 2				
	1998	1997	1996	1994	1993		1998	1997	1996	1994	1993
# plants	7	8	9	17	14	# plants	7	7	7	11	10
# inflor.	28	23	4	14	13	# inflor.	17	25	0	12	1
# spike.	384	439	87	174	193	# spike.	325	645	0	275	17
	PLOT 3						PLOT 4				
	1998	1997	1996	1994	1993		1998	1997	1996	1994	1993
# plants	2	2	4	6	6	# plants	6	37	7	8	7
# inflor.	0	5	0	7	4	# inflor.	7	114	0	2	3
# spike.	0	70	0	98	78	# spike.	75	1990	0	26	39
	PLOT 5						PLOT 6				
	1998	1997	1996	1994	1993		1998	1997	1996	1994	1993
# plants	50	12	35	43	49	# plants	31	51	48	42	89
# inflor.	115	18	3	71	38	# inflor.	52	165	1	44	1
# spike.	1568	305	44	927	499	# spike.	771	3127	15	547	17

TOTAL

	1998	1997	1996	1994	1993
# plants	103	117	110	127	125
# inflor.	219	350	8	150	60
# spike.	3123	6576	146	2047	843

1998 numbers of plants, inflorescences, and spikelets decreased due to drought.
In addition 40 inflorescence stalks were broken off,
lowering the number of spikelets. Breakage was probably due
to the dryness of the plants due to the drought.
It was discovered that Plots 4, 5, and 6 had been mixed up in the past.
Data from these plots needs to be compared
year by year to straighten out the error. Data collected by
David Hernandez and recorded by Jackie Poole on Oct. 14, 1998.

Hibiscus dasycalyx
Monitoring on
Highway Right-of-way

SITE 1 - East of roadside park, west of Neches River, on Highway 94, Trinity County

	1999	1998	1997	1996	1995	1994	1993
# plants	49	13	15	16	41	38	27
#stems	200	25	36	71	140	171	79
# fl/fr	354+	40	141	79	132	60	429

SITE 2 - 2.4 miles southwest of Lovelady on Highway 230, Houston County

	1999	1998	1997	1996	1995	1994	1993
# plants	14	13	6	2	1	4	4
#stems	~50	39	13	7	5	73	43
# fl/fr	~194	9	34	14	3	224	449

SITE 3 - Mud Creek, Cherokee County

	1999	1998	1997	1996	1995	1994	1993
# plants	2	1 (?)	1 (+~75)	1	1	1	1
#stems	9	6	7	5	4	6	5
# fl/fr	~205	25	186	63	100	32?	183

1998 was a year of extreme drought in east Texas. Although the plants were up, they were stunted and not producing many flowers. At the Mud Creek site, the recently rediscovered plants under the bridge were inaccessible due to high water, even though it was a dry year. These plants are shown in parenthesis.

1999 shows the recovery from the drought. Also Hibiscus dasycalyx has begun colonizing the area at Site 1 which TxDOT has left unmowed. Four hybrids were seen at site 1, including some H. dasycalyx X H. moscheutos. Data collected by Kathy Nemec, Ricky Maxey, Jackie Poole, and Stephen F. Austin State University staff. Data recorded by Jackie Poole on August 4 and 5 1999.

Surveys for Houston daisy (*Machaeranthera aurea*) and Texas windmill grass (*Chloris texensis*) in Harris county 1997-98.

Site Description*	EOCode	Species	1997	1998
Cypress - KZ Road	PDAST64050*006	Machaeranthera aurea	C	N
Cypress - Bobcat Rd	PDAST64050*015	M. aurea	C	N
Cypress - Cedar Lane	PDAST64050*013	M. aurea	C	N
Cypress - Kitzmann Rd	PDAST64050*007	M. aurea	C	C
Cypress - Grant Rd.	PDAST64050*003, PDAST64050*012	M. aurea	C	C
Cypress - Kitzmann x Telge Rd.		Chloris texensis	C	C
Cypress - Huffmeister x Church Rd.	PDAST64050*014	M. aurea	C	C
Cypress - Huffmeister x Church Rd.		C. texensis	X	C
Houston Comm. College - Northwest	PDAST64050*016	M. aurea	C	N
Houston Comm. College - Northwest	PMPOA1E0J0*017	C. texensis	X	N
North Harris Comm. College - W.W. Thorne	PDAST64050*004	M. aurea	C	C
North - Rankin Rd.	PMPOA1E0J0*021	C. texensis	N	N
Addicks Reservoir	PDAST64050*022, PDAST64050*023	M. aurea	N	C

KEY: C= presence confirmed
X = surveyed, but not seen
N = site not surveyed

*All locations along roadways were surveyed in the right-of-way only. In 1997 several sites in the Pasadena area with records for both species were visited in a roadside survey. Although some of these "lots" remain undeveloped, no plants were visible from the ROW. Development of these lots is almost certain in the near future. Several other historic locations in the Cypress area were surveyed in 1997, but no populations were present on the ROW.

Monitoring data for big red sage (Salvia penstemonoides) - Boerne IH-10 highway ROW site. 1999 data collected 7/26/99. Collected by TPWD and Texas Military Institute volunteers.

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total # stemmed plants	105	258	125	112	130	67	45	44	42
Total # rosettes	359	318	51	115	85	59	54	98	133
Total primary stems	329	298	263	156	276	154	87	90	99
Average/plant	3.13	1.16	2.10	1.39	2.12	2.30	1.93	2.05	2.36
St. dev.	2.89	0.66	1.87	1.66	2.43	1.95	1.36	1.78	1.90
Total secondary stems	453	592	616	238	527	145	142	51	48
Average/plant	4.31	2.29	4.93	2.13	4.05	2.16	3.16	5.67	6.00
St. dev.	6.68	2.89	4.57	3.03	5.87	3.28	3.02	5.59	5.93
Total flowers/fruits in subsample	3106	1913	2319	1120	2382	531	295	466	145
Average/plant	207.07	127.53	193.25	112.00	119.10	53.10	49.17	77.67	36.25
St. dev.	293.00	126.94	161.30	125.50	127.02	61.73	42.75	95.03	30.66

	Stemmed Plants				
Year	Site 1	Site 2	Site 3	Rosettes	TOTAL
1991	80	20	5	359	464
1992	218	24	16	318	576
1993	72	39	14	51	176
1994	79	20	13	115	227
1995	75	31	24	85	215
1996	38	7	22	59	126
1997	0	13	32	54	99
1998	0	30	14	98	142
1999	0	25	17	133	175

Site 1 - central - between east- and west-bound lanes of IH-10
Site 2 - southeast - near rocky slope

Salvia data by microsite.xls

Number of bracted twistflower (*Streptanthus bracteatus*) plants seen during spring surveys in the Texas Hill Country.

Site	1990	1991	1993	1994	1995	1996	1997	1998	1999
TRAVIS CO.									27-Apr
Barton Creek			411	373	386	62	76	47*	18
Bee Creek			72	32	165	3	18	37	16
Mt. Bonnell			330	28	158	0	86	na	na**
BEXAR CO.									23-Apr
Eisenhower Park					40			2	0
MEDINA CO.									23-Apr
FM 1283 ROW	many	0							0
F91CAR27***		100+							0
CR 274 ROW		3							0
CR270-north fork		29							0
CR270-south fork		3							39

*Incomplete survey conducted in 1998 at Barton Creek.

**Access to Mount Bonnell denied by landowner's attorney.

***Housing subdivision north of FM1283 (Road name not available).

Summary statistics for Travis county bracted twistflower monitoring, 1999.

Site name	Barton Creek	Bee Creek	TOTALS
sample date	27-Apr-99	27-Apr-99	
total area in plots (sq.m.)	37.54	64	101.54
# plants seen	18	16	34
# plants/sq. m.	0.48	0.25	1.64
# plants with flowers	18	6	24
% of plants with flowers	100	38	48
total # flowers	49	49	98
avg. # flowers/flowering plant	2.72	8.17	2.14
# plants with herbivory	9	4	13
% of plants with herbivory	50	25	10

Data collected at Barton Creek by L.A. Linam, A. Miller, M. Burton, M-R Holder, P. Maher, & Austin HS students.

Data collected at Bee Creek by L.A. Linam, A. Miller, P. Pellerin, & Westlake HS students.

Results of Volunteer Monitoring Efforts for Eurycea Salamanders in the Texas Hill Country

Species	Location	Site	Spring 1997			Autumn 1997			Spring 1998			Autumn 1998			Spring 1999		
			T	S	R	T	S	R	T	S	R	T	S	R	T	S	R
Eurycea neotenes	Landa Lake	1	20	3	7												
	Landa Lake	2	20	3	7												
	Landa Lake	3	20	4	5												
	TOTALS		60	10	6												
	Landa Park	4										120	50	2			
	Landa Park	5										70	10	7			
	Landa Park	6										40	4	10			
	Landa Park	7										170	3	57			
	TOTALS											400	67	6			
Eurycea neotenes	Honey Creek SNA	1				60	2	30	0			42	1	42			
	Honey Creek SNA	2				96	5	19	50	1	50	70	0	na			
	Honey Creek SNA	3				15	na		10	0	na	0					
	Honey Creek SNA	4				39	0	na	40	0	na	55	0	na			
	Honey Creek SNA	5				80	5	16	105	5	21	60	2	30			
	Honey Creek SNA	6				0			60	0	na	0					
	TOTALS					290	12	24	265	6	44	227	3	76			
Eurycea neotenes	Heart-of-the-Hills (Stockman's Spring)	A										20	0	na	20	0	na
	" " " " "	B										50	2*	na	0	na	na
	" " " " "	C										10	0	na	20	0	na
	" " " " "	D										20	1	20	50	9	5.6
	" " " " "	E										10	0	na	0	na	na
	" " " " "	F										10	0	na	20	1	20
	" " " " "	G										20	1	20	10	0	na
	" " " " "	H										10	1	10	20	0	na
	" " " " "	I										30	0	na	40	2	20
	" " " " "	J													40	6	6.7
	TOTALS											180	3	60	180	12	15
Eurycea sp. 1	Travis Audubon Sanc.	1 (Baker Spring & spring run)							220	9	24	129	3	43			

KEY: T=time in minutes spent searching; S=number salamanders found; R=encounter rate in minutes/salamander
*sighting uncertain, because habitat was unsuitable

Monitoring results for the horseshoe liptooth snail (*Polygyra hippocrepsis*) in Landa Park, New Braunfels, Texas.

Date	Temp (F)	Last Rainfall	Site	Volunteers	Statistic	# horseshoe liptooth - live	# horseshoe liptooth - dead	Total horse-shoe liptooth	# Polygyra texana	# other snails	TOTAL SNAILS (live & dead)	quadrats sampled
97/10/28	70	97/10/28	Spring Run 1	Churchhill HS	Total number found	1	4	5	132	360	497	20
					Density (/sq m.)	0.50	2.00	2.50	66	180	248.5	
98/09/22	80	98/09/12	Spring Run 1	New Braunfels HS	Total number found	0	1	1	185	316	502	59
					Density (/sq m.)	0.00	0.17	0.17	31.4	53.6	85.1	
98/09/22	85	98/09/12	Spring Run 3	New Braunfels HS	Total number found	0	7	7	128	290	425	54
					Density (/sq m.)	0.00	1.32	1.32	24.2	54.7	80.2	
98/11/17	75	98/11/14	Spring Run 1	NB HS	Total number found	0	5	5	129	308	442	49
					Density (/sq m.)	0.00	1.02	1.02	26.3	62.9	90.2	
98/11/17	80	98/11/14	Spring Run 3	NBHS	Total number found	0	1	1	43	95	139	24
					Density (/sq m.)	0.00	0.42	0.42	17.9	39.6	57.9	
99/04/15	70	99/04/13	Spring Run 1	NBHS	Total number found	0	2	2	237	440	679	43
					Density (/sq m.)	0.00	0.47	0.47	55.1	102	156	
99/04/15	70	99/04/13	Spring Run 3	NBHS	Total number found	0	6	6	109	279	394	51
					Density (/sq m.)	0.00	1.18	1.18	21.4	54.7	77.3	

Maritime Pocket Gopher (*Geomys personatus maritimus*) Volunteer Monitoring Results
TPWD State Fish Hatchery - Flour Bluff, Texas

Site	TPW Marine Development Center						
Date	98-03-12					99-04-17	
Volunteer	Anissa Cates					Diane Hartung	
School	Kaffie Middle School					Miller HS	
Start time	9:30					10:00 a.m.	
End time	12:20					12:00 noon	
Temp (F)	55					75	
Last rain	98-03-07						
Area	*Size (sq. ft)*	*Fresh Mounds*	*Old Mounds*	*Total Mounds*	*Fresh/ Acre*	*Fresh Mounds*	*Fresh/ Acre*
A	51,147	18	953	971	15.33	23	19.59
B	141,777	8	182	190	2.46	37	11.37
C	102,363	22	68	90	9.36	10	4.26
D	15,576	0	89	89	0.00	7	19.58
E	51,446	43	169	212	36.41	19	16.09
F	18,585	4	60	64	9.38	6	14.06
G	75,699	11	121	132	6.33	11	6.33
H	95,480	5	15	20	2.28	8	3.65
I	120,420	0	30	30	0.00	3	1.09
J	24,950	1	12	13	1.75	3	5.24
K							
L	154,019	16	441	457	4.53	38	10.75
M	246,402					10	1.77
N	135,546					16	5.14
Totals	1,233,410	128	2,140	2,268	4.52	191	6.75

Maritime Pocket Gopher (*Geomys personatus maritimus*) Volunteer Monitoring Results
Corpus Christi Naval Air Station

	Apr. 17-18, 1999
Volunteers	Bernice Speer
Area sampled (sq. ft.)	35,393
# Burrow systems marked - day 1	42
Total fresh mounds - day 1	172
New fresh mounds - day 2	40
# Burrow systems active - day 2	22*
% burrows confirmed active	50%
Active burrows/acre	27.1
*one new system located	

APPENDIX B
TEXAS HORNED LIZARD WATCH

TEXAS HORNED LIZARD WATCH ANNUAL REPORT
1998

In 1998 Texas Horned Lizard Watch volunteers again added to our understanding of the status of the state's favorite reptile. A total of 64 people provided information about their efforts to sight horned lizards in 48 counties. Results again provided statistically significant data about Texas Horned Lizards and red imported fire ants and may be revealing some new trends in horned lizard abundance in the rolling plains region of Texas.

During 1998 participants could choose to participate in Texas Horned Lizard Monitoring at three different levels. Eleven volunteers chose to participate at the most intense level, conducting transects that measured quantitative data on horned lizard and ant abundance. Other participants chose to adopt sites, such as a ranch, bachyard, or local park, and provide more generic information about the presence or absence of horned lizards and ants. A total of 58 adopted sites were monitored in 1998. Finally, eight participants chose to conduct county-wide censuses--noting the locations of horned lizard sightings wherever they occurred in the county.

Over one-half of the participants (58% of the sites and transects) saw Texas Horned Lizards in 1998. Densities at the 11 transects ranged from 0 horned lizards/acre to 4.89 horned lizards per acre and averaged 0.82/acre. Data was collected at 43 new sites or transects in 1998, while a second year of data was collected at 26 sites or transects. Although some respondents thought the 1998 drought affected horned lizard numbers, results for the sites revisited in 1998 were very similar to 1997. Ten sites had negative results both years, 12 sites had positive results both years, two sites had negative results in 1997 and positive results in 1998, and two sites had positive results in 1997 and negative results in 1998.

Participation continued to be well-spread across the state. Top counties (in terms of numbers of sites or transects reported) in 1998 were Hidalgo (4), Bexar (3), Jack (3), and Taylor (3). Combining data from 1997 and 1998, we now have participants watching horned lizards in 98 of the 254 counties in the state! The attached map provides an overview of results combined from the first two years of the watch program. The map compares the number of positive sightings versus negative results from each county. Although the general pattern of healthy horny toad populations in the western part of the state and diminished populations in the east holds true, we'd like our volunteers to keep an eye on some areas in the future. Several counties in the panhandle and rolling plains, which previously had not reported declining horned lizard populations, now show mixed results. On the other hand, several participants have reported that Texas horned lizards are still abundant in sandy soils in the coastal counties--we need more watchers in those areas!

Again in 1998 Texas Horned Lizard Watch participants gathered insightful data about fire ants and horned lizards. Volunteers' data on presence versus absence of Texas Horned Lizards and red imported fire ants again showed a negative correlation between the two species.[1] In addition, one participant reported that fire ants were present in Haskell county for the first time this year. Such observations may help us determine how closely the spread of fire ants might be linked with the decline of the horned lizard in Texas.

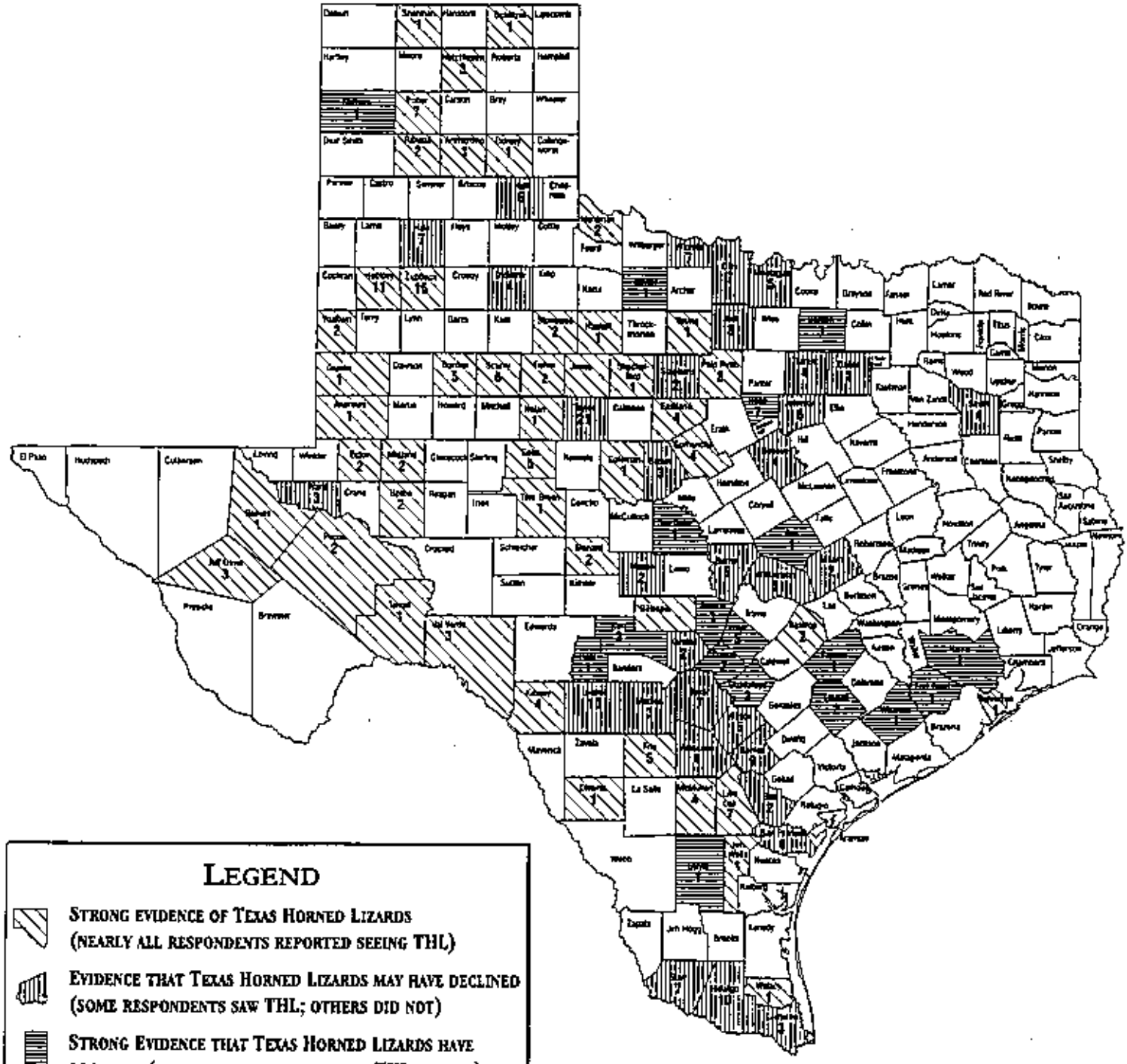
Finally, Texas Horned Lizard Watch volunteers continued to prove themselves enthusiastic and dedicated, with many taking time to write down additional notes about their observations, sending photos, etc. As data is collected from these sites in future years, a very valuable picture of the trends in horned lizard numbers and its habitat is likely to emerge. So, to all our participants, "Thanks, and keep on counting your horny toads....!"

[1]Cochran-corrected chi-square: a=0.05

Zarr, J.H. 1984. Biostatistical Analysis. Prentice-Hall, Englewood Cliffs, N.J. 718 p.

Texas Horned Lizard Abundance

Based on 1997 and 1998 Texas Horned Lizard watch Results



Legend

- Strong evidence of Texas Horned Lizards (nearly all respondents reported seeing THL)
- Evidence that Texas Horned Lizards may have declined (some respondents saw THL; others did not)
- Strong Evidence that Texas Horned Lizards have declined (all respondents reported THL absent)

County n — N = number of reports received from that county (positive or negative)

APPENDIX C
TEXAS MUSSEL WATCH SCIENTIFIC PERMIT REPORT

ANNUAL REPORT TO TEXAS PARKS AND WILDLIFE DEPARTMENT SCIENTIFIC PERMITS FOR SEPTEMBER 1998 – AUGUST 1999

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Texas Parks and Wildlife Department
Heart of the Hills Research Station
HC07, Box 62, Ingram, Texas 78025
(830) 866-3356; fax 866-3549; rhowells@ktc.com
TPWD Collection Permit Number SPR-0798-965 (24 August 1998)

August 1999

INTRODUCTION

The following locations were examined by volunteers associated with the Texas Mussel Watch (TMW) program or by Texas Parks and Wildlife Department (TPWD) staff in activities linked to TMW. Reports from 1998 have already been included in Howells (1999) for the 1998 data set. Samples from 1999 will be included in the corresponding Data Management Series report for the 1999-sampling season that should be completed by early 2000. Terminology, scientific names, counting methods, and condition definitions are defined in Howells (1996a, b). Numbers of specimens listed herein only indicates the species and number of individuals documented during surveys and not disposition of those specimens. In general, living specimens were only retained by the TPWD staff, if at all. Most living animals were enumerated and released. Shells may have been counted but not collected, retained for the TPWD collection, or, in some cases, retained by volunteers to enhance their reference collection used to assist in identification.

RESULTS

Red River

Lake Texoma, Briar Creek boat ramp (N 33°55.455', W 96°51.870'), Marshall County, Texas, 14 January 1999: A random, 10-minute shoreline search by a volunteer produced the following specimens:

Lake Texoma, Briar Creek boat ramp Species	*N* live	*N* shells	Condition	Percentage
White heelsplitter	0	2.0	recently dead	2.6
Pink papershell	0	2.0+0.5x4	recently to long dead	7.7
Mapleleaf spp.	2	67.0+0.5x1	recently dead	89.7

Lake Texoma, Hagerman Wildlife Refuge (N 33° 45.46', W 96° 47.28'), Grayson County, Texas, 4 January 1999: A random, 20-minute shoreline search by a volunteer produced:

Lake Texoma, Hagerman Wildlife Refuge Species	*N* live	*N* shells	Condition	Percentage
Flat floater	0	3.0+0.5x1	recently dead	33.3
Pink papershell	0	4.0	relatively-recently to recently dead	33.3
Pondhorn	0	2.0+0.5x2	relatively-recently dead	33.3

Lake Texoma, Hagerman Wildlife Refuge (N 33° 43.38', W 96° 46.74"), Grayson County, Texas, 4 January 1999: A random, 93-minute shoreline search by a volunteer produced:

Lake Texoma, Hagerman Wildlife Refuge Species	*N* live	*N* shells	Condition	Percentage
Flat floater	0	198.00+0.5x1	recently dead	97.0
Pink papershell	0	1.0+0.5x1	relatively-recently dead	1.0
Giant floater	0	3.0	recently dead	1.5

Mapleleaf spp.	0	1.0	recently dead	0.5
Asian clam - present				

Red River, downstream of Denison Dam at Lake Texoma on the south side of the river (N 33° 49.140', W 96° 33.500'), Grayson County, Texas, 4 January 1999:
A random, 25-minute shoreline search by a volunteer produced:

Red River downstream of Denison Dam				
Species	*N* live	*N* shells	Condition	Percentage
Flat floater	0	1.0	relatively-recently dead	10.0
Wabash pigtoe	0	1.0	recently dead	10.0
Yellow sandshell	0	1.0	recently dead	10.0
White heelsplitter	0	1.0	recently dead	10.0
Fragile papershell	0	1.0	recently dead	10.0
Threehorn wartyback	0	2.0	recently dead	20.0
Pink papershell	0	1.0	recently dead	10.0
Bleufer	0	0.5x1	recently dead	10.0
Giant floater	0	0.5x1	relatively-recently dead	10.0
Asian clam – present				

This collection demonstrates that, despite small numbers of specimens found, a number of unionid species appear to be surviving in the Red River downstream of Denison Dam. The collection of a Wabash pigtoe (or any *Fusconaia*) from the main channel of Red River drainage of Texas is exceptional.

Confluence of the Kiamichi River and Red River, Choctaw County, Oklahoma (opposite Red River County, Texas), 28 October 1998:
Random shoreline collections made by U.S. Fish and Wildlife Service personnel produced (but data submitted by a volunteer in 1999):

Confluence of the Kiamichi and Red rivers				
Species	*N* live	*N* shells	Condition	Percentage
Pocketbook spp. (*Lampsilis*)	0	0.5x1	subfossil	10.0
Yellow sandshell	0	0.5x1	subfossil	10.0
Pink papershell	0	1.0+0.5x7	relatively-recently to long dead	80.0

The high and inflated beaks of this pocketbook specimen suggest it may be sandbank pocketbook.

Trinity River

Lake Lewisville at Lake Dallas boat ramp near U.S. 35, Denton County, Texas, 21 September 1998, volunteer collection:
A random area search of 274 m produced the following specimens during a drought-related low-water period:

Lake Lewisville at Lake Dallas boat ramp Species	*N* live	*N* shells	Condition	Percentage
Threeridge	2	23.0	recently dead	22.3
Louisiana fatmucket	2	3.0+0.5x1	recently dead	5.4
Yellow sandshell	2	3.0	recently dead	4.5
Fragile papershell	1	7.0	recently dead	7.1
Pink papershell	0	1.0	relatively-recently dead	0.9
Bleufer	0	2.0+0.5x1	long dead	2.7
Giant floater	5	many	-	5.4
Southern mapleleaf	6	32.0	recently dead	33.9
Pimpleback spp.	0	7.0	recently dead	6.3
Lilliput	2	0.0	-	1.8
Deertoe	0	0.5x1	recently dead	0.9
Paper pondshell	1	5.0	recently dead	5.4
Asian clam - present (common)				

Juvenile specimens were included among the living specimens of threeridge and southern mapleleaf observed.

Lake Lewisville at Little Elm Reservoir, Denton County, Texas 30 September 1998, volunteer collection:
A random area search of 366 m over 2 hours during a drought-related low-water period produced the following specimens:

Lake Lewisville at Little Elm Reservoir Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	1	1.0	long dead	4.7
Bleufer	4	1.0	recently dead	11.6
Giant floater	5+	12.0+	recently dead	16.3
Southern mapleleaf	3+	3.0+	recently dead	14.0
Paper pondshell	3	4.0	recently dead	16.3
Lilliput	6	0.0	-	14.0

No Asian clams were noted at this location.

Cedar Creek Reservoir at Payne Springs, Henderson County, Texas 16 October 1998, volunteer collection:
A random area search of one hour produced the following specimens:

Cedar Creek Reservoir at Payne Springs Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	0	1.0+0.5x2	long dead	5.1
Giant floater	0	15.0	recently dead	25.4
Southern mapleleaf	0	22.0+0.5x19	recently dead	69.5
Asian clam - abundant				

Lake Livingston, Dad's Creek at Olympia, Trinity County. Texas, 1 April 1999:

A volunteer reported finding the following specimens during a random shoreline search:

Lake Livingston, Dad's Creek at Olympia Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	0	0.5x1	long dead	4.8
Giant floater	0	1.0	relatively-recently dead	4.8
Southern mapleleaf	0	0.5x1	very-long dead	4.8
Southern mapleleaf	0	0.5x6	long dead	28.6
Southern mapleleaf	0	0.5x5	relatively-recently dead	23.8
Texas lilliput	0	2.0+0.5x3	relatively-recently dead	23.8
Texas lilliput	0	0.5x2	long dead	9.5

Lake Livingston, point at Camp Olympia, Trinity County. Texas, two dates:

A volunteer reported finding the following specimens during a random shoreline search:

3 December 1998:

Lake Livingston, Camp Olympia Species	*N* live	*N* shells	Condition	Percentage
Giant floater	0	0.5x1	recently dead	9.1
Giant floater	0	0.5x8	relatively-recently dead	72.7
Southern mapleleaf	0	0.5x2	recently dead	18.2

31 March 1999:

Lake Livingston, Camp Olympia Species	*N* live	*N* shells	Condition	Percentage
Pink papershell?	0	0.5x1	relatively-recently dead	6.3
Giant floater	0	0.5x1	long dead	6.3
Southern mapleleaf	0	2.0+0.5x10	relatively-recently dead	75.0
Southern mapleleaf	0	0.5x2	long dead	12.5
Unidentified fragments	0	fragments		

Lake Livingston, small bay near Camp Olympia, Trinity County. Texas, 31 March 1999:

A volunteer reported finding the following specimens during a random shoreline search:

Lake Livingston, bay near Camp Olympia Species	*N* live	*N* shells	Condition	Percentage
Pink papershell?	0	0.5x2	long dead	11.1
Southern mapleleaf	0	0.5x5	very-long dead	38.7
Southern mapleleaf	0	0.5x5	long dead	22.6
Southern mapleleaf	0	1.0+0.5x4	relatively-recently dead	3.2

Paper pondshell	0	1.0	relatively-recently dead	9.7

Brazos River

Lake Kirby (Clear Fork of the Brazos River drainage), Taylor County, Texas, 16 July 1999:

Exposed reservoir substrates were examined during a low-water period. Deep mud prevented access to areas still retaining water.

Lake Kirby Species	*N* live	*N* shells	Condition	Percentage
Tampico pearlymussel	0	3.0+0.5x5	very-recently to very-long dead	25.8
Giant floater	0	9.0+0.5x3	relatively-recently to relatively-long dead	38.7
Southern mapleleaf	0	7.0	very-recently to relatively-recently dead	22.6
Texas lilliput	0	1.0	long dead	3.2
Pondhorn sp.	0	1.0+0.5x2	very long dead	9.7
Asian clam – present				

Water levels that dropped here in 1998 have remained low. Although numerous unionids were stranded and lost, enough water remains in deeper areas to suggest survivors are still present.

Fort Phantom Hill Reservoir (several sites), Jones County, Texas, 16-17 July 1999:

Locations on this reservoir were examined on 16 July in preparation for a training class on mussel sampling and on 17 July by class members.

Southwest corner access point, 16 July 1999:

Examination of exposed bottoms and shallows with snorkeling in deep water produced:

Fort Phantom Hill Reservoir, southwest corner Species	*N* live	*N* shells	Condition	Percentage
Tampico pearlymussel	2	3.0	relatively-long dead	45.5
Fragile papershell	0	1.0	long dead	9.1
Bleufer	0	1.0+0.5x1	relatively-long dead	18.2
Giant floater	1	0.0	-	9.1
Southern mapleleaf	2	0.0	-	18.2
Pistolgrip	0	fragments	relatively-long dead	-
Asian clam – present				

This location is subjected to heavy wave activity from southern and southeastern winds. Prior low water levels and wave activity appeared to be responsible for restricting most living specimens to water 2 m or more in depth.

Southeastern corner, lakeside of a marina jetty, 16 July 1999; Wading waters to 1.5-m depths adjacent to the jetty and associated rockwork produced:

Fort Phantom Hill Reservoir, southeast corner jetty				
Species	*N* live	*N* shells	Condition	Percentage
Tampico pearlymussel	1	0.0	-	11.1
Giant floater	1	1.0	long dead	11.1
Southern mapleleaf	1	0.0	-	11.1
Pistolgrip	6	0.0	-	66.7
Asian clam – present				

Northeast corner, point adjacent to the east side of the dam, 17 July 1999:
Training class individuals and TPWD personnel examined exposed bottoms and shallow waters with snorkeling in deeper areas. The following specimens were collected:

Fort Phantom Hill Reservoir, northeast corner near dam				
Species	*N* live	*N* shells	Condition	Percentage
Tampico pearlymussel	0	5.0x0.5x23	recently to very-long dead	32.9
Fragile papershell	0	3.0x0.5x4	relatively-recently to long dead	8.2
Southern mapleleaf	0	19.0x0.5x22	very-recently to relatively-long dead	48.2
Bleufer	0	1.0	relatively-long dead	1.2
Pistolgrip	0	5.0x0.5x3	relatively-recent to recently dead	9.4
Asian clam - present				

Hubbard Creek Reservoir, Stephens County, Texas, 29 July 1999:
Volunteers examining shallow waters and exposed bottoms reported the following species in a 1-hr search:

Hubbard Creek Reservoir				
Species	*N* live	*N* shells	Condition	Percentage
Tampico pearlymussel	10	5.0+0.5x1	recently dead – long dead	51.6
Bleufer	8	4.0	recently dead	38.7
Southern mapleleaf	0	3.0	recently dead	9.7

Squaw Creek Reservoir, Squaw Creek Park, 2300 Coats Road, Hood and Somervell counties, Texas, 2 November 1998:
Volunteers using SCUBA examined depths of 3.0-12.7 m and reported the following specimens:

Squaw Creek Reservoir				
Species	*N* live	*N* shells	Condition	Percentage
Fragile papershell	0	0.5x1	-	100.0
Asian clam - abundant				

An earlier attempt by HOH to survey this nuclear power plant cooling water reservoir was thwarted when a gate clerk refused to allow TPWD personnel access to the reservoir. This current data is our first information on bivalves in Squaw Creek Reservoir.

Lake Granbury, west bank at the dam at the Brazos River Authority office, N 32°20'16.25", W 97°41'15.47", Hood County, Texas, 25 August 1997:

Random area searches by Brazos River Authority (BRA) personnel produced only an abundance of Asian clam shells.

Brazos River at S.H. 174 (Kimble Bend Park) upstream of Lake Whitney, Bosque County, Texas, 27 August 1998:

A random shoreline search by BRA personnel found the following specimens:

Brazos River at S.H. 174 Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	0	1.0	very-recently dead	25.0
Fragile papershell	0	1.0	recently dead	25.0
Pink papershell	0	1.0	very-recently dead	25.0
Lilliput	0	1.0	relatively recent	25.0

Lake Whitney, Bosque County, Texas, two dates:

9 August 1998:

A volunteer using SCUBA to examine waters to depths of 24 m found only Asian clams, both living and shells, at 3-12 m, but found none at 24 m..

15 August 1998:

Volunteers using SCUBA examined areas at depths of 3.0-11 m at SCUBA Park and found:

Lake Whitney, SCUBA Park Species	*N* live	*N* shells	Condition	Percentage
Fragile papershell	0	3.0	recently dead - long dead	100.0
Asian clam - shells abundant				

14 August 1999:

Volunteers using SCUBA examined areas at depths of 6.0-12.2 m at two sites at Lofer's Bend Park northeast of the dam and found:

Lake Whitney, Lofer's Bend Park Species	*N* live	*N* shells	Condition	Percentage
Fragile papershell	0	2.0	very recently dead -recently dead	33.3
Pimpleback spp.	0	4.0	long dead	66.7
Asian clam – present (large specimens)				

The pimplebacks in the 14 August 1999 collection were actually reported as Texas pimpleback *Quadrula petrina*; however, this species has never been reported from the Brazos River drainage. These specimens were most probably smooth pimpleback *Q. houstonensis*, that is known to occur in the area.

Lake Waco, Speegileville Park III (N 31°32'18", W 97°14'15" to N 31°31'35", W 97°14'49"), McLennan County,

Texas, 18 January 1999:
A random shoreline search by a volunteer produced:

Lake Waco, Speegleville Park III Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	0	0.5x4	recently to long dead	33.3
Bleufer	0	0.5x2	relatively-recently dead	16.7
Southern mapleleaf	0	0.5x6	recently to long dead	50.0
Asian clam – abundant				

Tehuacana Creek just downstream of the Union Pacific Railroad crossing south of S.H. 6 east-southeast of Waco, N 31°31.64', W 92° 01.91', McLennan County, Texas, 1 September 1998:
Random shoreline searches by BRA personnel located only an abundance of Asian clam shells.

Brazos River at Loop 340 southeast of Waco, N 31°32.37', W 97°4.67', Falls County, Texas, 1 September 1998:
Random area searches by BRA personnel found no bivalves.

Brazos River at S.H. 7 west of Marlin, N 31°17.29', W 96°58.13', Falls County, Texas, 1 September 1998:
Random area searches by BRA personnel found no bivalves.

Deer Creek at S.H. 320, N 31°16'43.2", W 96°58'41.4", west of Marlin and upstream of the confluence with the Brazos River, Falls County, Texas, 3 September 1998:
Random shoreline searches by personnel with the BRA produced:

Deer Creek at S.H. 320 Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	0	3.0	relatively-recently dead	50.0
Bleufer	0	0.5x3	long dead - very-long dead	50.0
Asian clam - abundant				

Brazos River at S.H. 413, N 31°08.03', W 96°49.67', east of Rosebud, Falls County, Texas, 1 September 1998:
Random shoreline searches by personnel with the BRA produced:

Brazos River at S.H. 413 Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	0	0.5x1	relatively-recently dead	50.0
Bleufer	0	0.5x1	very-long dead	50.0

Fryers Creek at U.S. 190, N 31°0.4.23', W 97°21.36', Temple, Bell County, Texas, 17 August 1998:
A shoreline search of this highly-developed area by BRA personnel found dense weed growths; no bivalves were found.

Bird Creek north of S.H. 36, N 31°05.28', W 97°23.14', Temple, Bell County, Texas, 17 August 1998:
A shoreline search of this highly-developed area by BRA personnel found dense weed growths; no bivalves were found.

Bird Creek south of S.H. 36, N 31°04.42', W 97°22.69', Temple, Bell County, Texas, 17 August 1998:
A shoreline search of this highly-developed area by BRA personnel found dense weed growths; no bivalves were found.

Walnut Creek at S.H. 6 (Little Brazos River drainage), N 31°00.59', W 96°42.14', north of Hearne, Robertson County, Texas, 1 September 1998:
Random shoreline searches by personnel with the BRA found no bivalves.

Mud Creek at S.H. 6 (Little Brazos River drainage), N 30°56.81', W 96°38.8', north of Hearne, Robertson County, Texas, 1 September 1998:
Random shoreline searches by personnel with the BRA found no bivalves.

Brazos River at U.S. 79, N 30°49.59', W 96°39.08', west of Hearne, Robertson County, Texas, Texas, 1 September 1998:
Random shoreline searches by personnel with the BRA found no bivalves.

Little Brazos River at S.H. 21, 30°33'47.4"N, 96°31'13.8"W), just upstream of the confluence with the Brazos River, Brazos County, Texas, 17 September 1998:
Only Asian clams were observed during a shoreline examination by BRA personnel.

Sulphur Creek (Lampasas River tributary) at C.R. 8 and east of Lampasas, N 31°05'03.96", W 98°02'58.2", Lampasas County, Texas, 10 August 1998:
Random shoreline searches by BRA personnel found only abundant Asian clam shells.

Sulphur Creek (Lampasas River tributary), east side of Lampasas city, downstream of waste-water treatment plant (N 31°04'15.05", W 98°10'06.57"), Lampasas County, Texas, 29 December 1998:
Random shoreline searches by a volunteer located only Asian clam shells.

Sulphur Creek (Lampasas River tributary), at C.R. 7 Sparks Crossing , 4 km east of Lampasas city (N 31°04'15.31", W 98°08'04.99"), Lampasas County, Texas, 24 November 1998:
Random shoreline searches by a volunteer located only Asian clam shells.

Sulphur Creek (Lampasas River tributary), Deadman's Cut, 2.5 km upstream of C.R. 8 (N 31°04'30.36", W 98°03'52.48"), Lampasas County, Texas, 24 November 1998:
Random shoreline searches by a volunteer located only Asian clam shells.

Lampasas River at C.R. 2313, N 31°07'06.0", W 98°03'24.6", Lampasas County, Texas, 10 August 1998:
Random shoreline searches by BRA personnel found only abundant Asian clam shell.

Rocky Creek at S.H. 963 northeast of Burnet, N 31°07'06.0", W 97°55'36.6", Burnet County, Texas, 10 August 1998:
Random shoreline searches by BRA personnel produced no bivalves or their shells.

Yegua Creek at S.H. 50, N 30°22'06.6", W 96°20'31.02", Burleson County, Texas, 20 August 1998:
Random shoreline searches by personnel with the BRA produced:

Yegua Creek at S.H. 50 Species	*N* live	*N* shells	Condition	Percentage
Yellow sandshell	0	0.5x1	relatively-recently dead	20.0
Fragile papershell	0	0.5x3	relatively-recently dead	60.0
Southern mapleleaf	0	1.0	recently dead	20.0
Asian clam - present				

Tesch's Branch, N 29°38'22.2", W 96°4'56.4", Austin County, Texas, 30 July 1998:
A random area search by BRA personnel produced:

Tesch's Branch Species	*N* live	*N* shells	Condition	Percentage
Texas lilliput	0	0.5x3	very-long dead	75.0
Tapered pondhorn	0	1.0	long dead	25.0

Beason Creek southeast of Courteny and east of the Brazos River, N 30°15.31', W 96°03.13', Grimes County, Texas, 23 July 1998:
A random area search by BRA personnel produced:

Beason Creek Species	*N* live	*N* shells	Condition	Percentage
Threeridge	0	0.5x1	relatively-recently dead	50.0
Southern mapleleaf	0	1.0	recently dead	50.0

Rio Grande

Rio Grande at the confluence of the Rio Conchos (N 29°35"10.07", W 104°25"22.58"), Presidio County, Texas, 10 August 1999:
TPWD staff and a local volunteer examined shoreline and dredge-spoil levees here, but high-volume water releases associated with atypically-heavy rainfall in New Mexico precluded successful sampling at this site. However, neither unionids nor Asian clams were apparent on levees.

Rio Grande at Alamido Creek downstream from Presidio (N 29°31"11.72", W 104°17"26.69"), Presidio County, Texas, 10 August 1999:
TPWD staff and a volunteer examined exposed creek and river bottom areas and exposed substrates as well as wading in deeper areas of the main river channel, but no evidence of any bivalves was detected.

Rio Grande, Hot Springs (N 29°10'46.3", W 102°59"39.2"), Big Bend National Park, Brewster County, Texas, 8 February 1999:
Examination of shorelines and shallow waters here produced no bivalves.

Rio Grande, downstream of Rio Grande Village pumping station (N 29°02'38.9", W 103°06"19.4"), Big Bend National Park, Brewster County, Texas, 9 February 1999:
Examination of shorelines and shallow waters here produced no bivalves. A living Texas hornshell reportedly had been observed in a gravel bar adjacent to this pumping station several years earlier. However, on this occasion, the entire gravel bar was no longer present.

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Howells, R.G. 1996a. Distributional surveys of freshwater bivalves in Texas: progress report for 1994. Texas Parks and Wildlife Department, Management Data Series 120, Austin.

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PERFORMANCE REPORT

State: Texas Grant Number: E-1-12

Grant Title: Endangered and Threatened Species Conservation

Reporting Period: September 1, 1999 through August 31, 2000

Project 72: Monitoring Program for Species of Concern in Texas

I. Objectives:

1. Provide monitoring for high-priority candidates and species of concern in the state through TPWD personnel, other interested researchers, ongoing public efforts (Christmas bird counts, etc.) or recruitment of other manpower.
2. Increase public appreciation for and understanding of rare resources of the various ecoregions of the state.
3. Gain active public participation in meeting monitoring goals on public lands.
4. Seek unique opportunities to generate public involvement in monitoring efforts, especially through cooperative ventures.
5. Provide private landowners with the information to recognize, manage, and monitor rare resources on their land, and, where agreeable, to provide useful information to TPWD.

II. Summary of Progress:

1. Quantitative monitoring was conducted for 12 species at 22 sites. Monitoring packets were prepared for three new species (*Cypripedium kentuckiense*, *Machaeranthera aurea*, and *Thalictrum texanum*). One additional site was visited to assess presence or absence of a species of concern. Houston meadowrue (*Thalictrum texanum*) was confirmed present at Lick Creek Park in Brazos county. The majority of site specific projects addressed high priority plant species. Results are presented in Appendix A.

2. A total of 76 volunteers provided data for the 1999 Texas Horned Lizard Watch. Results of the first three years of the project were presented at several scientific meetings. The 2000 Texas Horned Lizard Watch was advertised through press releases and Texas Parks and Wildlife magazine. The 1999 annual report is presented in Appendix B.

3. Workshops for Texas Mussel Watch were held in College Station, Denton, and Waco. Volunteers both within and outside TPWD collected significant information on distribution of some rare species. During the course of this segment responsibility for compiling Texas Mussel Watch volunteer data was passed from the Inland Fisheries Division to the Wildlife Diversity Program. Wildlife Diversity staff are in the process of compiling volunteer results into a database. A summary of results during this segment is presented in Appendix C.

4. Various other species of concern are being addressed by other research and monitoring efforts not funded under this Section 6 project. In addition, Texas Nature Trackers includes other monitoring projects, such as Hummingbird Round-Up, Texas Monarch Watch, Texas Amphibian Watch, Swallow-tailed Kite Monitoring, Project Prairie Birds, and the mid-Winter Bald Eagle Survey, which are not funded by Section 6.

III. Significant Deviations:

None.

IV. Preliminary Findings:

See attached appendices.

VI. Prepared by: Lee Ann Johnson Linam **Date:** November 9, 2000

Approved by: _____ **Date:** _____

COPY

APPENDIX A
RESULTS OF SITE-SPECIFIC MONITORING CONDUCTED BY TPWD AND VOLUNTEERS

Southern lady's slipper – *Cypripedium kentuckiense* – page i
Neches River rose mallow - *Hibiscus dasycalyx* - page ii
Houston daisy – *Machaeranthera aurea*
& Texas windmill grass (*Chloris texensis)* – pages iii-iv
Rydberg's scurfpea – *Pediomelum humile* – page v
Big red sage - *Salvia penstemonoides* - page vi
Bracted twistflower - *Streptanthus bracteatus* - page vii

Palmetto pill snail – *Euchemotrema cheatumi* – page viii
Horseshoe liptooth snail - *Polygyra hippocrepsis* - page ix
Eurycea salamanders - page x
Maritime pocket gopher - *Geomys personatus maritimus* - page xi-xii

Spring surveys for southern lady's slipper (*Cypripedium kentuckiense*) in East Texas.

Site	Date	# plants	# flowers	Monitor	Last seen
Caddo State Park	13-Mar-00	2	0	Doug Hines	11 in 1999
Atlanta State Park	10-Mar-00	0	0	J. Singhurst	2 in 1996
Sampling methods - Multiple visits in March-April will be made to known sites on public lands. Number of plants and reproductive effort will be noted. The species is somewhat difficult to monitor due to the unpredictability of its emergence.					
2000 - An attempt was made to get monitoring off the ground for this species at two sites. Unfortunately winter drought and late cold snaps appeared to delay emergence at these two known sites. More intensive monitoring will be attempted in future years.					

Hibiscus dasycalyx
Monitoring on
Highway Right-of-way

SITE 1 - East of roadside park, west of Neches River, on Highway 94, Trinity County								
	2000	1999	1998	1997	1996	1995	1994	1993
# plants	17	49	13	15	16	41	38	27
#stems	nd	200	25	36	71	140	171	79
# fl/fr	nd	354+	40	141	79	132	60	429
SITE 2 - 2.4 miles southwest of Lovelady on Highway 230, Houston County								
		1999	1998	1997	1996	1995	1994	1993
# plants	8	14	13	6	2	1	4	4
#stems	nd	~50	39	13	7	5	73	43
# fl/fr	nd	~194	9	34	14	3	224	449
SITE 3 - Mud Creek, Cherokee County								
		1999	1998	1997	1996	1995	1994	1993
# plants	1	2	1 (?)	1 (+~75)	1	1	1	1
#stems	nd	9	6	7	5	4	6	5
# fl/fr	nd	~205	25	186	63	100	32?	183

1998 was a year of extreme drought in east Texas. Although the plants were up, they were stunted and not producing many flowers. At the Mud Creek site, the recently rediscovered plants under the bridge were inaccessible due to high water, even though it was a dry year. These plants are shown in parenthesis.

1999 shows the recovery from the drought. Also Hibiscus dasycalyx has begun colonizing the area at Site 1 which TxDOT has left unmowed. Four hybrids were seen at site 1, including some H. dasycalyx X H. moscheutos. Data collected by Kathy Nemec, Ricky Maxey, Jackie Poole, and Stephen F. Austin State University staff. Data recorded by Jackie Poole on August 4 and 5 1999.

2000 was another drought year. While some sites were just beginning to form buds and flower (Mud Creek), other sites were already in fruit (Lovelady). Due to a lack of time, numbers of stems, flowers, and fruits were not counted. Data collected by Ricky Maxey and Jackie Poole. Data recorded by Jackie Poole on 2 August 2000.

November surveys for Houston daisy (*Machaeranthera aurea*) and Texas windmill grass (*Chloris texensis*) in Harris county.

Site Description*	EOCode	Species	1997	1998	1999	2000
North Harris Comm. College - W.W. Thorne	PDAST64050*004	Machaeranthera aurea	C	C	Q	Q
Cypress - Grant Rd. W	PDAST64050*003	M. aurea	C	C	N	C
Cypress - KZ Road	PDAST64050*006	M. aurea	C	N	N	N
Cypress - Kitzmann Rd	PDAST64050*007	M. aurea	C	C	N	C
Cypress - Grant Rd. E	PDAST64050*012	M. aurea	C	C	N	N
Cypress - Cedar Lane	PDAST64050*013	M. aurea	C	N	N	N
Cypress - Huffmeister x Church Rd.	PDAST64050*014	M. aurea	C	C	N	Q
Cypress - Bobcat Rd	PDAST64050*015	M. aurea	C	N	N	C
Houston Comm. College - Northwest	PDAST64050*016	M. aurea	C	N	Q	N
Addicks Reservoir	PDAST64050*022, PDAST64050*023	M. aurea	N	C	Q	Q
Cypress - Kitzmann Rd	PMPOA1EOJO*007	Chloris texensis	X	X	N	C
Cypress - Grant Rd.	PMPOA1EOJO*016	C. texensis	X	C	N	X
Houston Comm. College - Northwest	PMPOA1E0J0*017	C. texensis	X	N	Q	N
North - Rankin Rd.	PMPOA1E0J0*021	C. texensis	N	N	X	N
Cypress - Huffmeister x Church Rd.		C. texensis	X	C	N	Q
Cypress - Kitzmann x Telge Rd.		C. texensis	C	C	N	X

KEY:	
	C= presence confirmed
	X = surveyed, but not seen
	N = site not surveyed
	Q = quantitative monitoring accomplished

*All locations along roadways were surveyed in the right-of-way only.

In 1997 several sites in the Pasadena area with records for both species were visited in a roadside survey. Although some of these "lots" remain undeveloped, no plants were visible from the ROW. Development of these lots is almost certain in the near future. Several other historic locations in the Cypress area were surveyed in 1997, but no populations were present on the ROW.

Intensive Houston daisy (*Machaeranthera aurea*) monitoring - Harris county, Texas.

Site Description	Date	Area surveyed (sq. m.)	Occupied quadrats	Occupied cells	Data collected by:
Addicks Reservoir - AHT057	10-Nov-99	17.75	40	309	P. Julian
Houston Community College - Northwest Campus	06-Nov-99	2.25	7	59	P. Julian, L. Linam
North Harris Comm. College W.W. Thorne Rd.	05-Nov-99	unknown	85*	823*	J. Hartgrove, A. Miller, L. Linam

*Incomplete sampling

Sample methods - The complete population at each site is assessed using a 0.25 x 0.25 meter quadrat subdivided into 0.01 m^2 cells. An index of canopy cover is determined based upon the total number of 0.01 m^2 cells occupied by Houston daisy.

1999 - More than 150 inflorescences of Texas windmill grass (*Chloris texensis*) were also counted at the Houston Community College NW Campus site.

Monitoring results for Rydberg's scurfpea (*Pediomelum humile*) near Del Rio, Texas

Site	Date	# plants	# plants with flowers
Calderon Elementary	April '98	87	0
	April '99	114	28
	April '00	63	0
Hwy 277 ROW	March '98	13	ns
	1999	ns	ns
	April '00	0	na

Sample methods - Students at Calderon Elementary closely monitor (at least weekly) two clumps of scurfpea in a natural area behind their school. They count total plants and number of plants that bloom. Students at Del Rio High School usually visit the right-of-way site several times each spring to look for and count scurfpea.

2000 - Scurfpea numbers declined at Calderon Elementary, presumably due to a severe winter and early spring drought. No flowering was detected. No plants were detected during several visits by teacher and students to the Hwy 277 site. This site might have received even less rainfall than the Calderon site.

ns = not surveyed

Monitoring data for big red sage (Salvia penstemonoides) - Boerne IH-10 highway ROW site.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total # stemmed plants	105	258	125	112	130	87	45	44	42	7
Total # rosettes	359	318	51	115	85	59	54	98	133	165
Total primary stems	329	298	263	156	276	154	87	90	99	20
Average/plant	3.13	1.16	2.10	1.39	2.12	2.30	1.93	2.05	2.36	2.86
St. dev.	2.89	0.66	1.87	1.66	2.43	1.95	1.36	1.78	1.90	1.95
Total secondary stems	453	592	616	238	527	145	142	51	48	0
Average/plant	4.31	2.29	4.93	2.13	4.05	2.16	3.16	5.67	6.00	0.00
St. dev.	6.68	2.89	4.57	3.03	5.87	3.28	3.02	5.59	5.93	na
Total flowers/fruits in subsample	3106	1913	2319	1120	2382	531	295	466	145	not
Average/plant	207.07	127.53	193.25	112.00	119.10	53.10	49.17	77.67	36.25	counted
St. dev.	293.00	126.94	161.30	125.50	127.02	61.73	42.75	95.03	30.66	

Salvia data by microsite.

Year	Stemmed Plants			Rosettes	TOTAL
	Site 1	Site 2	Site 3		
1991	80	20	5	359	464
1992	218	24	16	318	576
1993	72	39	14	51	176
1994	79	20	13	115	227
1995	75	31	24	85	215
1996	38	7	22	59	126
1997	0	13	32	54	99
1998	0	30	14	98	142
1999	0	25	17	133	175
2000	0	3	4	165	172

Site 1 - central - between east- and west-bound lanes of IH-10
Site 2 - southeast - near rocky slope
Site 3 - northwest - near Frederick Creek

Sample methods - Volunteers from Texas Military Institute follow methods developed by Poole. All big red sage plants in three subpopulations are counted. Primary and secondary stems are counted. Flowers and fruits are counted on every tenth stemmed plant.

2000 - Data was collected on July 27, 2000. Most plants were in a rosette form, perhaps due to extreme drought in the Texas Hill country lasting until April 2000. This population has had severely limited reproduction for the past five years due to a combination of drought and loss of all perennial plants in site 1 during a flood in 1997. Its long-term viability should be closely monitored.

Number of bracted twistflower (*Streptanthus bracteatus*) plants seen during spring surveys in the Texas Hill Country.

Site	1990	1991	1993	1994	1995	1996	1997	1998	1999	2000
TRAVIS CO.									27-Apr	28-Apr
Barton Creek			411	373	386	62	76	47*	18	7
Bee Creek			72	32	165	3	18	37	16	1
Mt. Bonnell			330	28	158	0	86	na	na**	
BEXAR CO.									23-Apr	04-May
Eisenhower Park					40			2	0	13
MEDINA CO.									23-Apr	04-May
FM 1283 ROW	many	0							0	0
CR2700		100+							0	0
CR 274 ROW		3							0	0
CR270-north fork		29							0	0
CR270-south fork		3							39	66

*Incomplete survey conducted in 1998 at Barton Creek.
**Access to Mount Bonnell denied by landowner's attorney.

Sample methods - Medina county: Localities described in the Biological Conservation Database are visited and searched on foot. All bracted twistflower plants seen are counted. In additional roadsides are searched for flowering plants by cruising slowly. Travis county - Data is collected inside plots established by Zippin in 1993. All plants and reproductive bodies are counted. Herbivory is noted. Eisenhower Park - All plants and reproductive bodies are counted at one known population site. Nearby habitats are surveyed to search for additional populations.

2000 - Populations in Travis county continue to be very depressed, likely due to the effects of two back-to-back winter droughts. Some decline in the numbers may be due to geographic shifts in these slope-side populations over time, as several bracted twistflower were seen outside the study plots on Barton Creek. Efforts will be made to count all Streptanthus in the vicinity in future years. Monitoring efforts are too young to predict trends in Bexar and Medina county, although the lack of twistflowers on historic sites in Medina county is worrisome. Local effects of habitat degradation, herbivory, and/or drought should point to concern for this species at all these monitoring sites.

Data at Barton Creek collected by L.A. Linam, A. Miller, M-R Holder, P. Maher, & Austin HS students. Data at Bee Creek collected by Linam, Miller, Holder, P. Pellerin, & Westlake HS students. Data at Eisenhower Park collected by Linam, Miller, M. Kennedy, & Eric Lautzenhauser. Data in Medina county collected by Linam, Miller, & M. Stiles.

Summary statistics for intensive bracted twistflower monitoring, 2000.

Site name	Barton Creek	Bee Creek	Eisenhower Park	TOTALS
sample date	28-Apr-00	28-Apr-00	04-May-00	2000
total area in plots (sq.m.)	37.54	64	unknown	na
# plants seen	7*	1	13	21
# plants/sq. m.	0.19	0.016	unknown	na
# plants with flowers	7	1	10	18
% of plants with flowers	100	100	77	86
total # flowers	43	16	27	86
avg. # flowers/flowering plant	6.14	16	2.7	4.8
# plants with herbivory	1	0	2	3
% of plants with herbivory	14	0	15	14

*An additional 20 plants were seen outside the study plots.

Monitoring results for the palmetto pill snail (*Euchemotrema cheatumi*) in Palmetto State Park, Ottine, Texas

Date	Temp (F)	Last Rainfall	Site	Volunteers	Statistic	# palmetto pill snails - live	# palmetto pill snails - dead	Total palmetto pill snails	# other snails	TOTAL SNAILS (live & dead)	quadrats sampled
99/02/20			Hydraulic pump wetland	Luling 4-H, Speer, & Strong	Total # found	2	2	4	144	148	34
					Density/sq.m	0.59	0.59	1.18	42.35	43.53	
00/02/05	45	00/02/02	Hydraulic pump wetland	Luling 4-H, Speer, & Strong	Total # found	3	2	5	254	264	32
					Density/sq.m	0.94	0.63	1.56	79.38	82.50	

Sampling method - This species is sampled by groups of students who select random 0.1 m2 quadrat locations along a route encircling the hydraulic pump-fed wetland on Palmetto trail. The students search through the litter for all gastropod shells encountered.

1999-2000 - Results were fairly similar for the two years, with volunteers finding that palmetto pill snails were rare in contrast to other gastropod species. Four of the five live palmetto pill snails encountered were found in litter between the roadside and the eastern edge of the pond. Palmetto pill snails encountered in 1999 were found 20+ feet from water, whereas pill snails found in 2000 were found five feet or less from water.

Monitoring results for the horseshoe liptooth snail (*Polygyra hippocrepsis*) in Landa Park, New Braunfels, Texas.

Date	Temp (F)	Last Rainfall	Site	Volunteers	Statistic	# horseshoe liptooth - live	# horseshoe liptooth - dead	Total horse-shoe liptooth	# Polygyra texana	# other snails	TOTAL SNAILS (live & dead)	quadrats sampled
97/10/28	70	97/10/28	Spring Run 1	Churchhill HS	Total number found	1	4	5	132	360	497	20
					Density (/sq. m.)	0.50	2.00	2.50	66	160	248.5	
98/09/22	80	98/09/12	Spring Run 1	New Braunfels HS	Total number found	0	1	1	185	316	502	59
					Density (/sq. m.)	0.00	0.17	0.17	31.4	53.6	85.1	
98/09/22	85	98/09/12	Spring Run 3	New Braunfels HS	Total number found	0	7	7	128	290	425	54
					Density (/sq. m.)	0.00	1.32	1.32	24.2	54.7	80.2	
98/11/17	75	98/11/14	Spring Run 1	NB HS	Total number found	0	5	5	129	308	442	49
					Density (/sq. m.)	0.00	1.02	1.02	26.3	62.9	90.2	
98/11/17	80	98/11/14	Spring Run 3	NBHS	Total number found	0	1	1	43	95	139	24
					Density (/sq. m.)	0.00	0.42	0.42	17.9	39.6	57.9	
99/04/15	70	99/04/13	Spring Run 1	NBHS	Total number found	0	2	2	237	440	679	43
					Density (/sq. m.)	0.00	0.47	0.47	55.1	102	158	
99/04/15	70	99/04/13	Spring Run 3	NBHS	Total number found	0	6	6	109	279	394	51
					Density (/sq. m.)	0.00	1.16	1.18	21.4	54.7	77.3	
99/11/30	67	99/11/27	Spring Run 1	NBHS	Total number found	2	3	5	237	435	672	40
					Density (/sq. m.)	0.5	0.75	12.5	59.3	109	168	
99/11/30	67	99/11/27	Spring Run 3	NBHS	Total number found	2	7	9	69	238	307	36
					Density (/sq. m.)	0.58	1.94	2.5	19.2	66.1	8.53	
00/03/30	70	00/03/26	Spring Run 1	NBHS	Total number found	0	1	1	157	279	436	69
					Density (/sq. m.)	0	0.145	0.145	22.6	40.4	63.2	
00/03/30	70	00/03/26	Spring Run 3	NBHS	Total number found	0	3	3	36	120	156	36
					Density (/sq. m.)	0.00	0.83	0.83	10.00	33.3	43.3	

Sampling method - This species is sampled by groups of students who select random 0.1 m2 quadrat locations along randomly selected transects in wooded habitats along Comal Spring runs in Landa Park. The students search through the litter for all gastropod shells encountered.

1999-2000 - Excitement was generated in November 1999 when four live horseshoe liptooth snails were encountered by students and confirmed by TPW staff. The snails were found at three sites. All three sites were described as containing much leaf litter and detritus. One was at the base of a tree, while another was in the cove of a rock. The sampling date occurred 3 days after a rainfall event. This species continues to be quite rare, as the extensive sampling points over the last three years have sampled many similar microhabitats, resulting in few shells and even fewer live horseshoe liptooth snails encountered.

Results of Volunteer Monitoring Efforts for Eurycea Salamanders in the Texas Hill Country

			Spring 1997			Autumn 1997			Spring 1998			Autumn 1998			Spring 1999			Autumn 1999			Spring 2000		
Species	Location	Site	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R	T	S	R
Eurycea	Landa Lake	1	20	3	7																		
neotenes	Landa Lake	2	20	3	7																		
	Landa Lake	3	20	4	5																		
	TOTALS		**60**	**10**	**6**																		
	Landa Park	4										120	50	2									
	Landa Park	5										70	10	7									
	Landa Park	6										40	4	10									
	Landa Park	7										170	3	57									
	TOTALS											400	67	6									
Eurycea	Honey Creek SNA	1				60	2	30	0			42	1	42				10	0	na			
neotenes	Honey Creek SNA	2				96	5	19	50	1	50	70	0	na				12	0	na			
	Honey Creek SNA	3				15	na		10	0	na	0						0		na			
	Honey Creek SNA	4				39	0	na	40	0	na	55	0	na				0		na			
	Honey Creek SNA	5				80	5	16	105	5	21	60	2	30				0		na			
	Honey Creek SNA	6				0			60	0	na	0						0		na			
	Honey Creek SNA	7																18	1	18			
	TOTALS					**290**	**12**	**24**	**265**	**6**	**44**	**227**	**3**	**76**				**40**	**1**	**40**			
Eurycea	Heart-of-the-Hills	A										20	0	na	20	0	na	40	2	20	10	1	10
neotenes	(Stockman's Spring)	B										50	2*	na	0	na	na	0		na	10	2	na
	" " " " "	C										10	0	na	20	0	na	10	0	na	10	0	na
	" " " " "	D										20	1	20	50	9	5.6	40	16	2.5	30	13	2.3
	" " " " "	E										10	0	na	0	na	na	20	0	na	10	0	na
	" " " " "	F										10	0	na	20	1	20	20	1	20	10	1	10
	" " " " "	G										20	1	20	10	0	na	10	0	na	10	2	5
	" " " " "	H										10	1	10	20	0	na	18	0	na	10	0	na
	" " " " "	I										30	0	na	40	2	20	20	4	5	10	0	na
	" " " " "	J													40	6	6.7	0		na	0		na
	TOTALS											**160**	**3**	**60**	**180**	**12**	**15**	**176**	**23**	**7.7**	**110**	**19**	**5.8**
Eurycea	Travis Audubon Sanc.	1 (Baker Spring & spring run)							**220**	**9**	**24**	**129**	**3**	**43**						dry			dry
sp. 1																							

Sampling methods - A time-constrained methodology is used. Volunteers at these sites search for salamanders by carefully overturning rocks and litter. The amount of time spent searching and the number of salamanders encountered are recorded.

1999-2000 - Salamander monitoring during this year was limited by drought. Only a brief visit was made to Honey Creek State Natural Area with Friends of Honey Creek member Diane Lapierre. Springs were not flowing, but a salamander was found in the stream bed near a seep. Overall encounter rates increased during two visits to Stockman's Spring, but primarily due to shifts in sampling focus. Within habitats encounter rates did not show a significant shift. Most salamanders continue to be encountered in shallow water areas dominated by rocks and watercress. Mary Beth Bauer's advanced biology class continues the sampling at that site. Finally, during two visits to Baker Spring stream flow was non-existent and no salamanders were encountered.

KEY: T=time in minutes spent searching; S=number salamanders found; R=encounter rate in minutes/salamander
*sighting uncertain, because habitat was unsuitable

Maritime Pocket Gopher (*Geomys personatus maritimus*) Volunteer Monitoring Results
TPWD State Fish Hatchery - Flour Bluff, Texas

Site		TPW Marine Development Center										
Date		98-03-12				99-04-17		00-02-26				
Volunteer		Anissa Cates				Diane Hartung		Diane Hartung				
School		Kaffie Middle School				Miller HS		Miller HS				
Start time		9:30				10:00 a.m.		9:00 a.m.				
End time		12:20				12:00 noon		11:00 a.m.				
Temp (F)		55				75		70				
Last rain		98-03-07										
	Size	*Fresh*	*Old*	*Total*	*Fresh/*	*Fresh*	*Fresh/*	*Fresh*	*Fresh/*		*Clusters/*	*Mounds/*
Area	*(sq. ft.)*	*Mounds*	*Mounds*	*Mounds*	*Acre*	*Mounds*	*Acre*	*Mounds*	*Acre*	*Clusters*	*Acre*	*Cluster*
A	51,147	18	953	971	15.33	23	19.59	26	22.1	12	10.2	2.2
B	141,777	8	182	190	2.46	37	11.37	19	5.8	4	1.2	4.8
C	102,383	22	68	90	9.36	10	4.26	10	4.3	6	2.6	1.7
D	15,576	0	89	89	0.00	7	19.58	10	28	3	8.4	3.3
E	51,446	43	169	212	36.41	19	16.09	32	27.1	9	7.6	3.6
F	18,585	4	60	64	9.38	6	14.06	28	65.6	6	14.1	4.7
G	75,699	11	121	132	6.33	11	6.33	1	0.58	1	0.58	1
H	95,480	5	15	20	2.28	8	3.65	1	0.46	1	0.46	1
I	120,420	0	30	30	0.00	3	1.09	1	0.36	1	0.36	1
J	24,950	1	12	13	1.75	3	5.24	1	1.7	1	1.7	1
K												
L	154,019	16	441	457	4.53	38	10.75					
M	246,402					10	1.77					
N	135,546					16	5.14					
Totals	1,233,410	128	2,140	2,268	4.52	191	6.75	129	8.1	44	2.7	2.9

Sampling methods - This species is sampled by students counting all fresh gopher mounds found in sections of levee and roadside at the fish hatchery. In addition, in 2000 students began assigning all fresh mounds within 10 meters of each other to the same "cluster," representing potential active burrow systems.

2000 - An abbreviated survey of this site was made this year due to interruption by rain. Average number of fresh mounds/ acre was increased somewhat from 1999. In addition, an estimate of occupied burrows was attempted this year based on clusters of fresh mounds. Results indicated a total of 44 burrows or 2.7 burrows/acre. Once again active mounds were more common in mown than in unmown habitats.

Maritime Pocket Gopher (*Geomys personatus maritimus*) Volunteer Monitoring Results
Corpus Christi Naval Air Station

	Apr. 17-18, 1999	Feb. 25-26, 2000
Volunteers	Bernice Speer Doyle	Bernice Speer Elizabeth Maxim Doyle
Area sampled (sq. ft.)	35,393	not determined
# Burrow systems marked - day 1	42	not counted
Total fresh mounds - day 1	172	not counted
New fresh mounds - day 2	40	139
# Burrow systems active - day 2	22*	87
% burrows confirmed active	50%	na
Active burrows/acre	27.1	not determined
Fresh mounds/day/burrow	1.8	1.6
Sample methods - Gopher mounds are sampled in an undeveloped field located just off Lexington Road in the southeast portion of the base. Volunteers at this site mark fresh-appearing mounds on day 1 and then revisit the site on day 2. Fresh mounds on day 2 are counted and grouped into		
2000 - All mounds at the site were counted (only a portion of the site was counted in 1999). A total of 87 gophers were estimated to occupy the site. Acreage of the sample area still needs to be determined.		

APPENDIX B
TEXAS HORNED LIZARD WATCH

TEXAS HORNED LIZARD WATCH ANNUAL REPORT
1999

Prepared by: Lee Ann Johnson Linam - Texas Parks & Wildlife Department

In 1999 Texas Horned Lizard Watch volunteers again added to our understanding of the status of the state's favorite reptile. A total of 76 people provided information about their efforts to sight horned lizards in 65 counties, including 15 counties that were new to participation in Texas Horned Lizard Watch. During 1999 participants could again choose to participate in Texas Horned Lizard monitoring at three different levels. Seventeen volunteers chose to participate at the most intense level, conducting transects that measured quantitative data on horned lizard and ant abundance. Other participants chose to adopt sites, such as a ranch, backyard, or local park, and provide more generic information about the presence or absence of horned lizards and habitat variables. A total of 81 adopted sites were monitored in 1999. Finally, 14 participants chose to conduct countywide censuses--noting the locations of horned lizard sightings wherever they occurred in the county.

About two-thirds of the participants (65% of the sites and transects) saw Texas Horned Lizards in 1999. Densities at the 17 transects ranged from 0 horned lizards/acre to 8.42 horned lizards per acre and averaged 1.26/acre (Table 1). Despite the drought, many participants were able to document young Texas Horned Lizards produced in 1999. Many other monitors noted large numbers of roadrunners seen in 1999.

Texas Horned Lizard Watch volunteers have now produced a very valuable set of data over the course of the program's first three years. Since 1997 our 124 participants have provided data from 112 of the state's 254 counties, including 206 sites and transects. At 38 sites we now have two years' of data, while 16 sites have provided data for all three years of the program.

The patterns of distribution (Figure 1) produced by our volunteers validate some earlier studies (as well as our participants' experiences) that Texas Horned Lizards are rare in the Pineywoods, Post Oak Savannah, Blackland Prairie, and Coastal Prairie. They are increasingly rare in the Hill Country of Central Texas, the Rio Grande Valley, and perhaps the Rolling Plains. For now Texas Horned Lizards seem somewhat secure in the South Texas Plains, West Texas, and the Panhandle. Our participants may be shedding some light on exceptions to those patterns (and, thus, perhaps, on factors affecting Texas Horned Lizards). Texas Horned Lizards are not predictably found in Taylor county, despite consistent reports from surrounding counties—perhaps reflecting impacts of the Abilene urban area, including imported red fire ant invasion. On the other hand, unexpected reports of Texas Horned Lizards have been received from Smith county in East Texas and from several counties along the coast, perhaps reflecting an ability of the species to persist in sandy soils.

Much of our analysis of distribution is based on presence or absence of Texas Horned Lizards. Our data does not yet allow us to make quantitative comparisons between regions or years. The first year of data produced density estimates that were highly variable; however, refinements in the transect method have produced less variable results in years two and three (Tables 1, 2, and 3). More transects are needed if we are to be able to analyze regional densities and trends over time.

Perhaps the most significant information gleaned over the first three years of Texas Horned Lizard Watch regards the habitat variables at horny toad sites. The three years of data indicate that distributions of Texas Horned Lizards and red imported fire ants are not independent (Cochran-corrected chi-square, α=0.005)[1], suggesting a negative correlation between the two species. Even when counties outside the distribution of the red imported fire ant are deleted from the analysis, the variables are not independent (α=0.025). Thus, it may not be surprising that the distribution map for red imported fire ants (Figure 2) bears a similarity to the abundance distribution for horned lizards (Figure 1). While a simple presence-absence comparison does not prove that imported fire ants directly caused the decline of the Texas Horned Lizard (horned lizards declined in many areas, including the Rio Grande Valley and Oklahoma before invasion by non-native ants), it does suggest a need for further investigation. Perhaps habitat changes or pesticide use have both benefited the fire ant and harmed the horned lizard. Nevertheless, our volunteers have produced a very valuable and unique data set that will continue to grow in importance as we continue to monitor on the cusp of fire ant expansion into new areas.

Volunteer data have also been used to examine several other relationships between horned lizards and their habitat. The data show a relationship between the presence of Texas Horned Lizards and the presence of harvester ants, their preferred food source (α=0.025). On the other hand, the presence of red imported fire ants and harvester ants seem to be independent of each other at our monitors' sites and transects. An analysis of land use does not seem to indicate a strong influence of these variables on horned lizard presence or absence at this time. In the future we will attempt to refine habitat and land use data to better understand their effect. We will also ask our volunteers to report soil type to better understand its influence on the current distribution of Texas Horned Lizards.

In summary, Texas Horned Lizard Watch volunteers continue to provide unique and valuable data about the official state reptile. Results of the first three years of the monitoring effort validate and refine earlier findings regarding Texas Horned Lizard distribution and prevalence. Results show that horny toad presence appears to be related to presence of harvester ants and absence of red imported fire ants. On the other hand, Texas Horned Lizard presence appears to be independent of land use. Our data set is too young at this time to predict trends in Texas Horned Lizard abundance and distribution, but the program is poised to capture meaningful data as changes in habitat variables, including fire ant distribution, continue to occur. Finally, our program confirms that Texans love horny toads, and that they can do much as citizen scientists to aid our understanding of this species' status and conservation needs.

[1]Zarr, J.H. 1984. Biostatistical Analysis. Prentice-Hall, Englewood Cliffs, N.J. 718 p.

Table 1. Texas Horned Lizard density/acre at Texas Horned Lizard Watch sites

	n	Zero Values	Min.	Max.	Mean	St. Dev.
Year 1	86	43	0.33	436	15.68	56.61
Year 2	11	3	0.035	4.89	0.82	1.40
Year 3	17	6	0.17	8.42	1.26	2.02

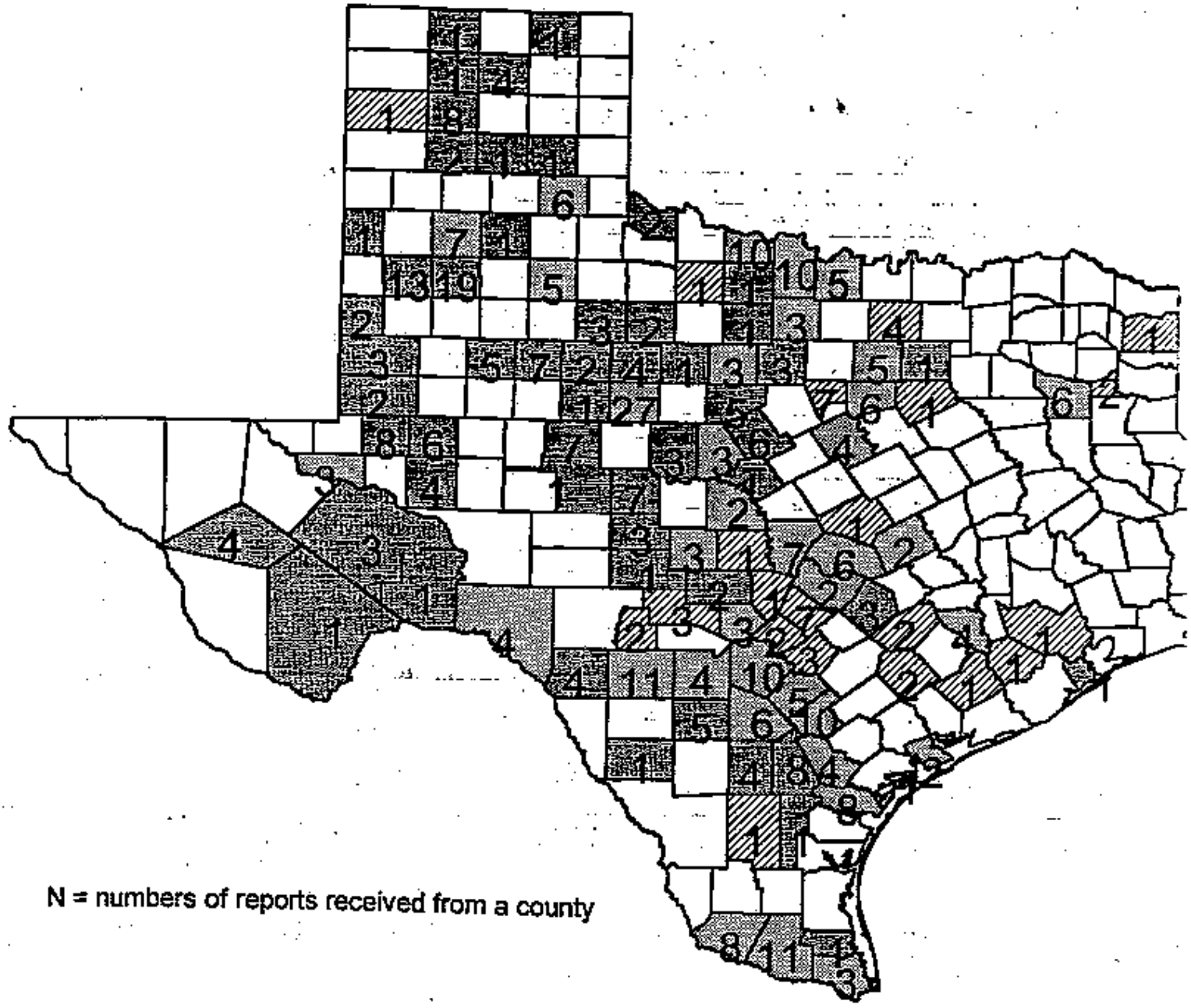
Table 2. Harvester ant mound density/acre at Texas Horned Lizard Watch sites

	n	Zero Values	Min.	Max.	Mean	St. Dev.
Year 1	83	16	0.222	871	36.77	101.19
Year 2	10	0	0.46	42.2	15.56	13.01
Year 3	14	0	0.46	72.56	13.22	17.95

Table 3. Imported red fire ant mound density/acre at Texas Horned Lizard Watch sites

	n	Zero Values	Min.	Max.
Year 1	82	59	.403	145
Year 2	9	5	0.31	4.74
Year 3	14	11	0.92	725.6

Texas Horned Lizard Prevalence
-based on 1997-99 Texas Horned Lizard Watch results



N = numbers of reports received from a county

0 300 600 Miles

N
W E
S

Volunteer Results

- THL apparently stable
- THL apparently declined
- THL populations variable
- No THLW data

APPENDIX C
TEXAS MUSSEL WATCH REPORT

Texas Mussel Watch Annual Report – September, 1999 through August, 2000

Prepared by Ann Miller, Texas Parks & Wildlife Department

Texas Mussel Watch conducted three workshops during this period--one in College Station hosted by the Texas A&M students chapter of the Society for Conservation Biology, one in Denton hosted by the Lewisville ISD Outdoor Learning Center, and one in Waco hosted by the Cameron Park Zoo. This increased the total number of Texas Mussel Watch participants to 91. During this period, we received 86 separate data sheets from over 30 different Texas Mussel Watch volunteers and documented the presence of about 33 mussel species in 10 major Texas watersheds. Volunteer results are presently being compiled into a database. Texas Mussel Watch staff worked with Bob Howells to update the Texas Mussel Watch monitoring manual and data sheets.

We have made some important progress in involving teachers and students in mussel monitoring. One teacher, Al Bartel who works with students at Camp Olympia, Houston ISD's outdoor learning center, sent in 11 data sheets from monitoring sites on Lake Livingston. Another teacher in Luling, Melba Sexton, took her class to monitor sites on the Guadalupe and the San Marcos River. Texas Parks and Wildlife filmed this field trip and will use it on a future TV broadcast. Most recently, Donna Turner, a teacher in Kerrville who attended our August workshop in Waco, sent us classroom activities she used to teach her students about freshwater mussels. These activities will be shared with all our Texas Mussel Watch teachers.

Perhaps the most important discovery during this period was the discovery by Melba Sexton of living golden orbs (*Quadrula aurea*) and a recently dead three-ridge mussel (*Amblema picata*) in the San Marcos River. According to Bob Howells, mussel expert for TP&W, 40 prior collections made by TP&W in the San Marcos and Blanco rivers since 1992 did not turn up any living unionids. The San Marcos River still hosts at least a small mussel population. Also, golden orb, a rare Texas endemic, was previously known from only four other sites. After her first collection of the golden orb last fall, Melba has monitored two other sites on the San Marcos and found recently dead golden orbs at one of those sites. When Melba returned to her first site with Texas Mussel Watch staff, she found another living golden orb, one recently dead shell, and 11 recently dead valves.

Another volunteer found over 35 very recently dead Texas fawnsfoot (*Truncilla macrodon*) specimens in the Brazos River upstream from College Station. Very few have been documented in this area in recent decades. The field trip we took to the Brazos River in conjunction with our College Station workshop in March also recorded Texas fawnsfoot. In the Trinity drainage, a volunteer working with Bob Howells documented living specimens of lilliput (*Toxoplasma parvus*). Bob had only seen 4 living specimens of this species since 1992. Our workshop fieldtrip in August to the Elm Fork of the Trinity below Lewisville dam also confirmed lilliput at this site.

Although this year of drought undoubtedly had a negative effect on many mussel populations, it did provide opportunities for our Texas Mussel Watch volunteers to document the presence of many species in the state. Next year, depending upon rain, our volunteers may be able to make some interesting comparisons about mussel populations at their sites during different climatic conditions.