FINAL REPORT

As Required by

ENDANGERED SPECIES ACT, SECTION 6

TEXAS

Project No: E-1-3

ENDANGERED AND THREATENED SPECIES CONSERVATION

Job No. 2.3: Puzzle Sunflower Status Report Update

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January 28, 1992

ABSTRACT

Potential habitat for the puzzle sunflower was identified through the use of soil surveys, topographic maps, and locations of springs and marshes (Brune 1981). Geologic maps were not of particular use. Known puzzle sunflower sites are from cienegas on the Balmorhea soil series. These cienegas have an associated plant community with plant species specific to them. Of the 74 identified sites, 33 locations at 15 sites were field checked. Forty-five sites were deemed not worthy of surveying, usually due to spring failure or lack of a marsh. Fifteen sites still need to be evaluated. No new sites were found in Texas for puzzle sunflower. However five potential introduction sites were identified. Unless the springs can be protected from over-pumping of groundwater, there is little hope for the puzzle sunflower.

PERFORMANCE REPORT

STATE:	Texas	**PROJECT NO.:**	E-1-3

PROJECT TITLE: Endangered and Threatened Species Conservation.

PERIOD COVERED: September 1, 1990 - August 31, 1991

JOB NUMBER: 2.3

JOB TITLE: Puzzle sunflower (Helianthus paradoxus) status report update

JOB OBJECTIVE: Locate all possible sites for the puzzle sunflower.

SEGMENT OBJECTIVES: Identify and ground-truth potential habitat sites for the puzzle sunflower.

ACCOMPLISHMENTS

See Attachment.

SIGNIFICANT DEVIATIONS

Aerial photographs were not used as an ex situ indicator for puzzle sunflower habitat because photographs would have to have been taken in September or October when puzzle sunflowers are in flower and even then there might be confusion with similarly colored flowers in the same habitat. Due to volatile landowner-endangered species conflict in west Texas, surveys were not conducted on private land (except where landowner permission was granted). Instead selected sites were surveyed from public roadways for the presence of the proper plant community and the presence of puzzle sunflower.

PREPARED BY: Jackie M. Poole — January 21, 1992
Date

Botanist
Title

APPROVED BY: Larry D. McKinney, Ph.D. — **Date**
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PUZZLE SUNFLOWER (<u>HELIANTHUS PARADOXUS</u>)

A Status Report Update

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January 1992

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INTRODUCTION

The puzzle sunflower (Helianthus paradoxus) is currently a Category 1 candidate in the 1990 U. S. Fish and Wildlife Service Notice of Review (USFWS 1990). A status report was done in 1977 recommending that the species be listed as Endangered (Wagner and Sabo 1977). A second status report (Miller et al. 1982) suggested that the species be listed as Threatened. However the species remained in Category 1 as disputes raged over whether the puzzle sunflower was a distinct species or merely part of a hybrid swarm between Helianthus annuus and H. petiolaris (Turner 1981). Morphological evidence presented in Heiser's original description (1958) delimited distinct differences such as strongly 3-nerved lanceolate leaves, ovate-lanceolate to lanceolate phyllaries, nearly glabrous stems, and glabrous pales. In additional to morphological distinctions, Rogers et al. (1982) noted that H. paradoxus flowers quite late in the season (late September through November). Heiser (1965) found highly reduced pollen stainabilities and only 0-20% seed set in crosses of with H. paradoxus with other annual sunflowers. Spring and Schilling (1989) found that H. paradoxus lacked sesquiterpene lactones. Chandler et al. (1986) thought the species to be distinct on a chromosomal basis. Recent electrophoretic and DNA (chloroplast and nuclear ribosomal) work by Rieseberg et al. (1990) has shown that H. paradoxus is a stabilized hybrid derivative of H. annuus and H. petiolaris. Thus there is a considerable amount of evidence to support the conclusion that H. paradoxus is a distinct species.

Another factor that may have delayed the listing of H. paradoxus was the speculation that the species might be extinct. In Heiser's original description (1958), the title for the section on H. paradoxus was "a new and possibly extinct sunflower from Texas." Wagner and Sabo in their 1977 status report stated that the species was "possibly extinct." During the mid-1960s construction of Interstate Highway 10 destroyed a large population of H. paradoxus (Rogers et al. 1982). Widening of a bridge over Leon Creek (also known as Diamond Y Creek) along Highway 18 in July 1980 led to fears that the species might be extinct (Rogers et al. 1982), Seiler et al. 1981). Investigation of historical localities led to the discovery of two populations (Seiler et al. 1981, Rogers et al. 1982). The population at the type locality consisted of "12 small plants in a heavily grazed, marshy area" below a dam which left the researchers "extremely discouraged about the survival" of the species (Rogers et al. 1982) although the population appeared to have been larger in earlier years as evidenced by the number of dead stalks (Seiler et al. 1981). The other population along Leon Creek was very large, consisting of thousands of plants, extending along the creek for almost three-fourths of a mile, and covering about five acres (Rogers et al. 1982, Seiler et al. 1981). Also during the summer of 1980 a small population was found along irrigation ditches adjacent to the Pecos River near Dexter, New Mexico (Rogers et al. 1982, Seiler et al. 1981). As of this report, both the Leon Creek and the Dexter populations (Sivinski 1991) are still extant and the Highway 18 population has reappeared. The status of the population at the type locality is unknown. A large population has been reported from New Mexico on the Bitter Lake National Wildlife Refuge (Sivinski 1991), and a site has been found in the vicinity of the historical Rio Laguna locality (McDonald 1991). Many of the sites which supported or could have possibly supported H. paradoxus in Texas are no longer suitable due to lowering of the water table by groundwater pumping for irrigation.

Helianthus paradoxus is a plant of marshy sites (Heiser 1958 and 1969, Wagner and Sabo 1977, Rogers et al. 1982, Seiler et al. 1981, Miller et al. 1982). The species appears to be limited to habitats with harsh circumstances: standing water or shallow water tables, heavy soils, and very saline conditions (Seiler et al. 1981). Apparently in presettlement times there were many such marshy areas in Pecos and Reeves Counties. Soil surveys show areas of soils formed in spring-fed marshes (Rives 1980, Jaco 1980). However beginning around 1946, groundwater levels fell as much as 120 meters in Pecos County and 150 meters in Reeves County causing almost all of the springs to go dry (Brune 1981). This reason for the water table drop is attributed to heavy pumping for irrigation (Brune 1981). Even though groundwater pumping has lessened in the last decade due to the higher cost of removing the water from deeper within the ground, raising of the water table or resumption of spring flow should not be expected (Brune 1981). As the springs dry up, the vegetation changes from rushes, sedges, saltgrass, and various salt-tolerant herbs to mesquite and sacaton, or in extreme cases creosote bush and other desert shrubs. The soil is no longer saturated with water and only occasionally inundated by floods. These conditions favor H. annuus rather than H. paradoxus. Thus H. paradoxus may have once been more prevalent than it is at present. The amount of habitat loss has been dramatic, and any chances for H. paradoxus to recolonize its former habitat are linked to the unlikely probability of a rise in the water table and the return of spring flow.

METHODOLOGY

The study area consisted of Pecos and Reeves counties as all historical locations of Helianthus paradoxus are from these counties. Although no historical localities are known from Culberson County, it was added to the study area due to the presence of large spring-fed marshes in the northeastern corner of the county as indicated by the Reeves County soil survey (Jaco 1980). Jeff Davis County was at one time part of the study area due its proximity to potential habitat in Reeves County. However no Balmorhea or similar soils are mapped for the county. Only two possible spring sites occur in Jeff Davis County. San Martin Spring is on the Jeff Davis - Reeves - Culberson county line, and is discussed under the latter counties. Phantom Lake Springs, about 4 miles west of Toyahvale, once supported a cienega. However the springs have long been altered, and the water is carried away in a concrete irrigation canal (Brune 1981).

Currently known Texas localities for H. paradoxus (Diamond Y and Leon Creeks) were characterized as to soil type, geologic formation, topography, and plant community. Using the resulting habitat profile similar sites were located ex situ using soil surveys, topographic maps, and Springs of Texas (Brune 1981). Ground-truthing of sites consisted of viewing the sites from public road right-of-way. Plant communities at each site were evaluated visually and mentally compared to the Diamond Y/Leon Creek site.

Historical locations for H. paradoxus were tied with spring or soil type sites in most cases (in Pecos County see East Escondido Springs, Middle Escondido Springs, Tunas or West Escondido Springs, Leon and Diamond Y Springs, and Comanche Springs; in Reeves County see Toyah Lake North and Toyah Lake South). A collection (Warnock 46763) from Pecos County "about 5 miles north of Fort Stockton" could not be correlated with soils or springs. Perhaps the locality information is incorrect or the label has a typographical error. A report (Warnock 1974) from Pecos County "about 15 miles north of Fort Stockton near 'flowing wells' which is now dry" could not be precisely located as there are many flowing wells marked on the topographic maps 12-18 miles north of Fort Stockton. Some of these flowing wells are within the Balmorhea soils or near to Monument Springs, but many are distant from either Balmorhea soils or larger springs.

RESULTS

Seventy-four sites were identified. Thirty-three locations at 15 sites were surveyed, but no new sites were found for Helianthus paradoxus. Of the remaining sites, it was decided that 45 did not require survey as the springs were dry, the soil type was incorrect, or a marsh had never been reported from the area. Another 15 warrant survey. These are Leon Lake and Creek, Monument Springs, Tunas Creek, Pecos Spring, Salt Creek, Toyah Lake, Toyah Creek around Balmorhea, Giffin Springs, Ash Springs, San Martin Springs, Delaware Springs and River, Screwbean Springs and Draw, Willow Springs to the Delaware River, Maverick Spring to Salt Creek, and Horseshoe Springs. However five sites (Monument Springs, Salt Creek, Toyah Lake, San Solomon Springs, and Rustler Springs) were identified which might be potential introduction sites. Numerous sites which according to soil and spring data may have at one time supported H. paradoxus were no longer capable of supporting the habitat.

Plant community type was the best indicator of the presence of H. paradoxus. However the community type must be field-verified, and thus cannot be used as an ex situ tool. Soil type was the best ex situ indicator of this habitat. Even when the springs have ceased flowing, the soil type remains, revealing their former presence. However soil surveys may not always indicate small soil pockets and published soil surveys are not available for all counties. Another good indicator of spring-fed marshes were the presence of springs although not all springs produce marshes. Brune's 1981 Springs of Texas is an excellent source for descriptions of the surrounding vegetation. Topographic maps were somewhat useful, but they indicate only large marsh areas and some springs. Geologic formations were the least useful indicator as springs issue from many different formations but none are specific indicators of spring-fed marshes.

The plant community in which H. paradoxus occurs is an association of four distinct habitats that are apparently associated with distinct changes in water regime, disturbance (flooding) regime, and salinity. Along the flowing water of the spring run, Scirpus olneyi forms a narrow, nearly mono-dominant community. In slightly elevated, narrow bands along the stream that lack standing surface water is a more diverse complex of species including Helianthus paradoxus, Flaveria chloraefolia, Limonium limbatum, and Samolus cuneatus. In well-watered, slightly more elevated and more extensive stream floodplains that lack perennial water at the surface is another almost mono-dominant community of Distichlis spicata. Finally on the fairly extensive elevated secondary floodplains is a mixture of Distichlis spicata and Sporobolus airoides.

In Texas the two known populations (Diamond Y/Leon Creek and Highway 18) are found on a particular soil type: the Balmorhea Association. These deep, somewhat poorly drained loamy soils are found on flood plains (Rives 1980). They were formed in calcareous loamy or silty materials that were formerly spring-fed marshes (Jaco 1980; Rives 1980). These areas are now rarely flooded because most of the springs which fed these marshes have now ceased to flow (Rives 1980). Only in periods of heavy rainfall is short duration flooding likely as the soil is poorly drained, permeability is moderately slow, and surface runoff is slow (Rives 1980). Erosion from water action is slight while wind erosion is moderate (Jaco 1980, Rives 1980). The soil can have a surface layer of clay, silty clay, silty clay loam, or clay loam, but usually the surface layer is a moderately saline, dark grayish brown silty clay loam about 25 inches deep (Jaco 1980). Beneath this to about 53 inches is a strongly saline, dark gray silty clay loam (Jaco 1980) that has many fine concretions of calcium carbonate (Rives 1980). Below this to 60 inches is a strongly saline, dark gray silty clay loam (Jaco 1980). The soil is moderately alkaline and calcareous throughout (Jaco 1980). Balmorhea soils are classified as fine-silty, mixed (calcareous), thermic, Cumulic Haplaquolls (Jaco 1980; Rives 1980). Balmorhea soils comprise 1% of Pecos County (Rives 1980) and 0.6% of Reeves

County (Jaco 1980). Figures 1 and 2 show the Balmorhea soil areas in Pecos and Reeves Counties.

Using Brune's Springs of Texas (1981) all springs in Pecos, Reeves, and Culberson County were mapped (figures 3-5). Most springs in Culberson County are still flowing (21 out of 27), however in Pecos County (6 out of 36) and Reeves County (7 out of 25), very few springs remain flowing primarily due to heavy groundwater pumping (Brune 1981). Helianthus paradoxus requires continually wet soil during its growth period, and thus it is highly unlikely that it would occur at sites where the springs are no longer flowing.

Topographic maps indicated only one marsh (along Salt Creek in Culberson County). Although Brune (1981) and the Pecos and Reeves Counties soil surveys identified many other marshy areas, the vast majority of these dried up before the topographic maps were produced.

All identified sites are reviewed in Appendix I as to soil type, geologic formation, topographic features, presence of springs, presence or absence of Helianthus paradoxus, and suitability of the site for introduction of this species.

DISCUSSION

Helianthus paradoxus occurs in cienegas, or spring-fed marshes in west Texas and New Mexico, primarily along the Pecos River drainage. It is fidel to a particular plant community which consists of four vegetative belts spreading out from the permanent surface water. The soils in which H. paradoxus grows are deep, somewhat poorly drained loamy soils that formed on what were formerly spring fed marshes (Jaco 1980; Rives 1980). Although this habitat was never widespread, it has been severely reduced in the last 100 years due to groundwater pumping. Also removal of ground cover through overgrazing has led to reduction in recharge of the water table. Thus H. paradoxus may have once been more widespread but now is restricted to those few remaining sites with adequate water.

CONCLUSIONS AND RECOMMENDATIONS

A dramatic rise in the water table in this area is not likely as agricultural, residential, and industrial uses all continue to grow. Sites which currently support H. paradoxus may be short-lived, and thus establishment of other populations may only be a stop-gap measure. Water sources for the H. paradoxus spring systems need to identified and entire watersheds protected through management agreements to ensure adequate spring flow. The disappearance of Helianthus paradoxus and the cienegas in which it occurs should be a reminder that we are not managing the system wisely. The next species to disappear could be our own.

FIGURE 1. Balmorhea soils in Pecos County, Texas (after Rives 1980)

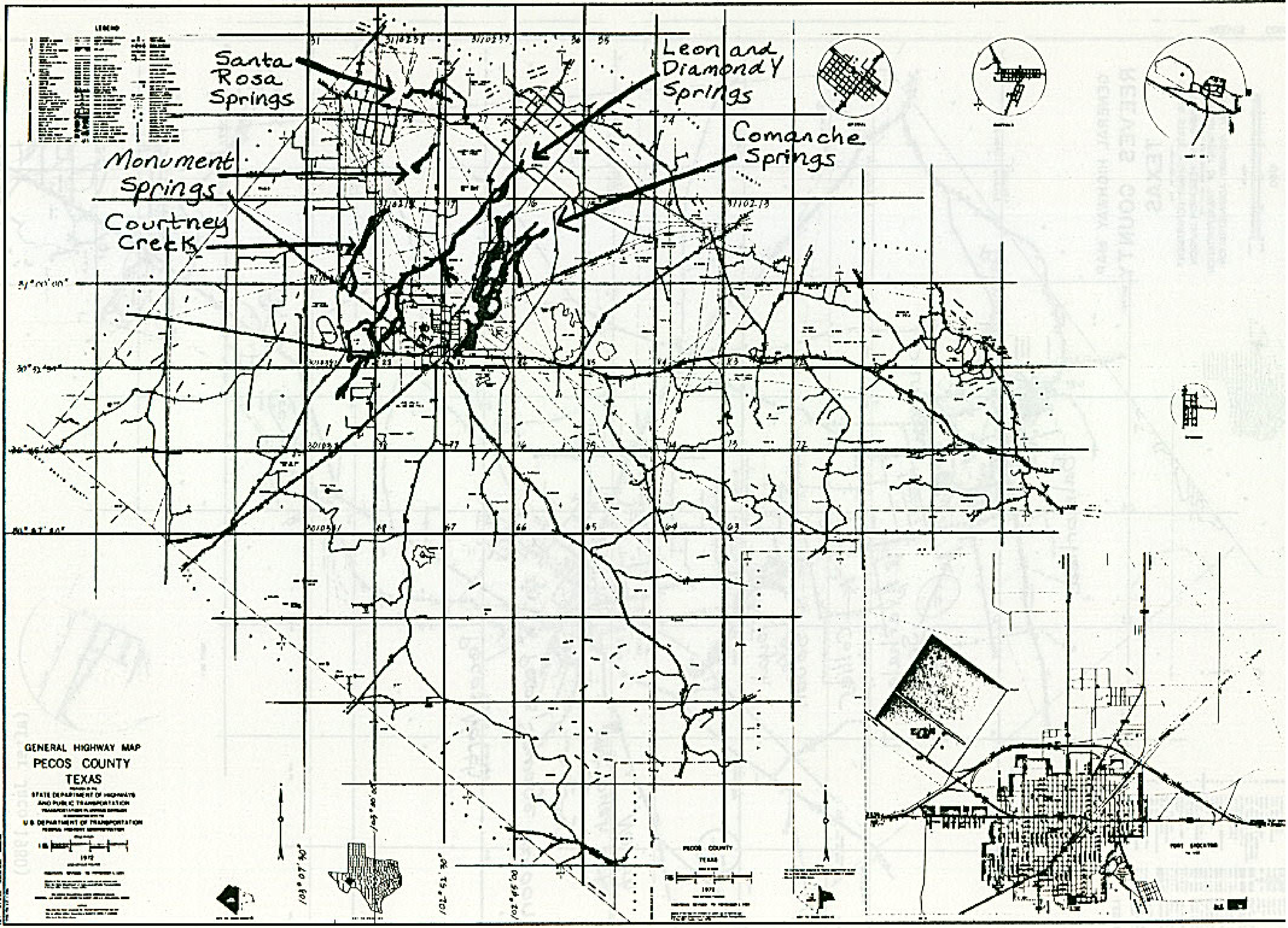

FIGURE 2. Balmorhea Soils in Reeves County, Texas
(after Jaco 1980)

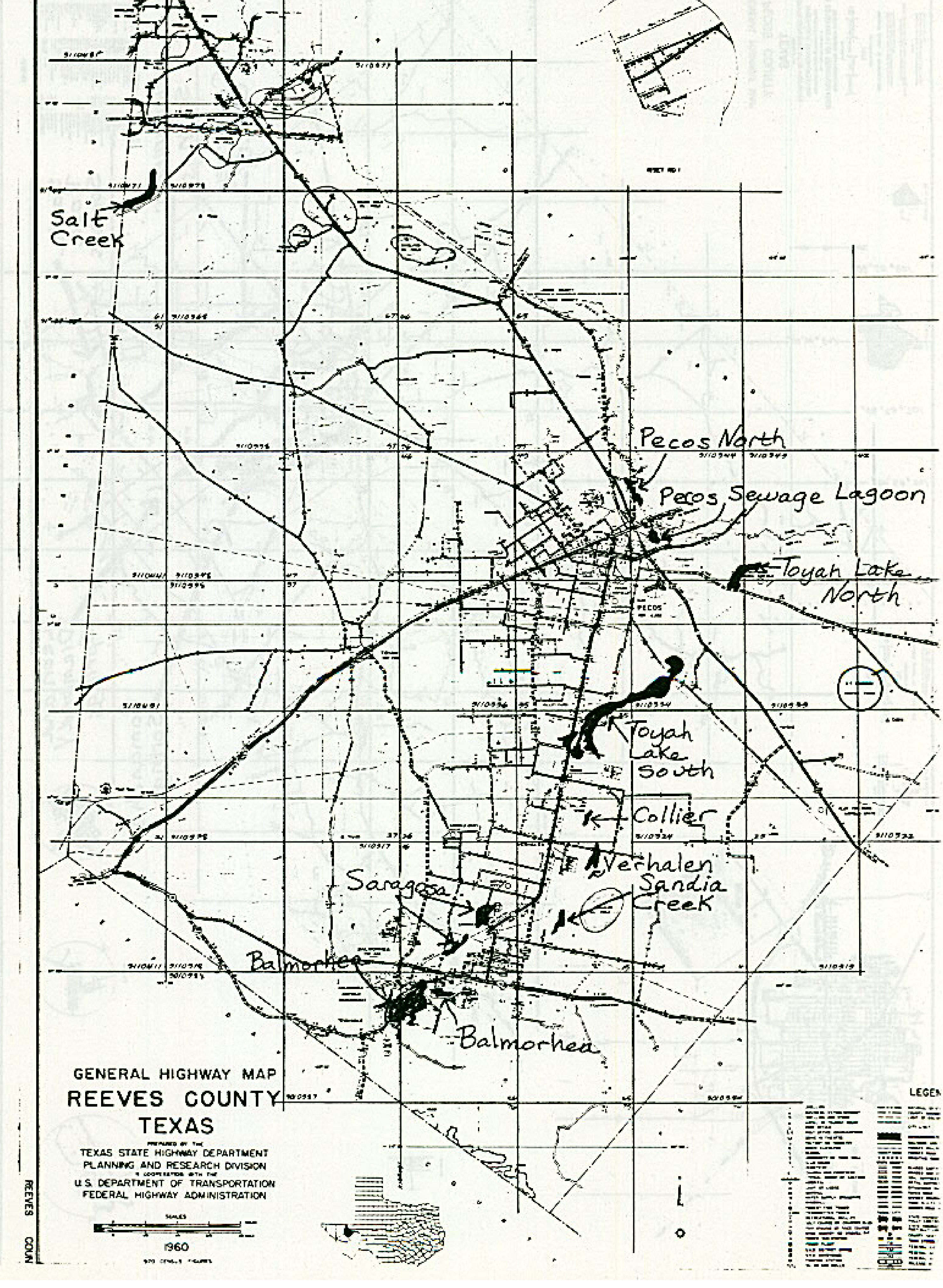

FIGURE 3. Springs of Pecos County, Texas (after Brune 1981)

Numbering system according to Brune (1981)

1-13	Comanche Springs - dry
14	Cedar Spring - dry
15	Sulphur Springs - dry
17	Adobe Springs - dry
18	San Simon Springs - dry
19	Travertine or Casa Blanca Springs - dry
20	Keechi Springs - dry
21	Johnson Springs - dry
22	Agua Bonita - dry
23	Threemile Springs - dry
24	Whiskey Springs - seep flow (<0.028 cfs)
25	Hackberry Ponds - dry
26	unnamed springs 5 km southwest of King Springs - dry
30	Leon Springs - dry
31	San Pedro Springs - dry
32	Cold Springs - dry
33	Diamond Y or Deep Springs - medium flow (2.8-28 cfs)
34	Monument Springs - very small flow (0.028-0.28 cfs)
35	Santa Rosa Springs - dry
36	King Springs - seep flow (<0.028 cfs)
37	East Escondido Springs - dry
38	Middle Escondido Springs - dry
39	Tunas or Pears or West Escondido Springs - dry
40	Pecos Springs - medium flow (2.8-28 cfs)

FIGURE 3. Springs of Pecos County, Texas (after Brune 1981)

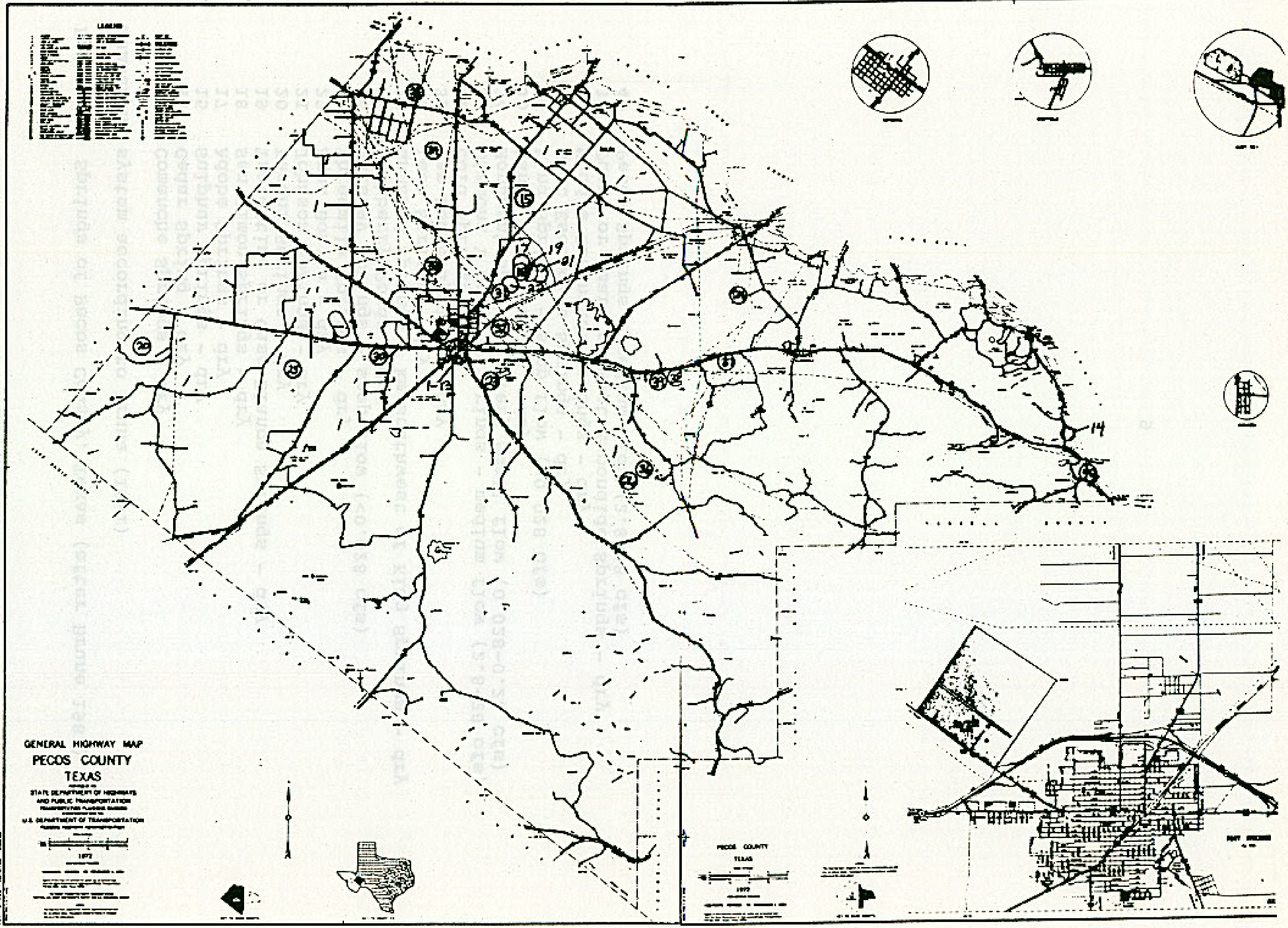

FIGURE 4. Springs of Reeves County, Texas (after Brune 1981)

Numbering system according to Brune (1981)

1 Alamo or Mitchell Springs - dry
2 Liege or Bone Spring - dry
3 Petican or Petrikin or Pelican Spring - small flow (0.28-2.8 cfs)
4 Toyah Springs - dry
5 VH Springs - dry
6 Irving Springs - dry
7 Hoban Springs - dry
8 Santa Isabel or Sulphur Springs - dry
10 Keechi Springs - dry
12 Saragosa and Toyah Creek Springs - small flow (0.28-2.8 cfs)
13 West Sandia Springs - medium flow (2.8-28 cfs)
14 East Sandia Springs - medium flow (2.8-28 cfs)
15 San Solomon Springs - large flow (280-2800 cfs)
16 Giffin Springs - moderately large flow (28-280 cfs)
20 Ash or Lindsey Springs - dry
21 Twin Springs - dry
22 Weinacht Spring - dry
23 Splittgarber Springs - dry
24 Torez or Coyote Spring - dry
25 Burnt Spring - dry
26 Canyon Spring - dry
27 Turin Springs - dry
28 Johnson Spring - dry
29 Buck Springs - dry
35 many small springs along the Pecos River near Red Bluff Reservoir - small flow (0.28-2.8 cfs)
A Ninemile Springs - dry
B San Martin Springs - small flow (0.28-2.8 cfs)

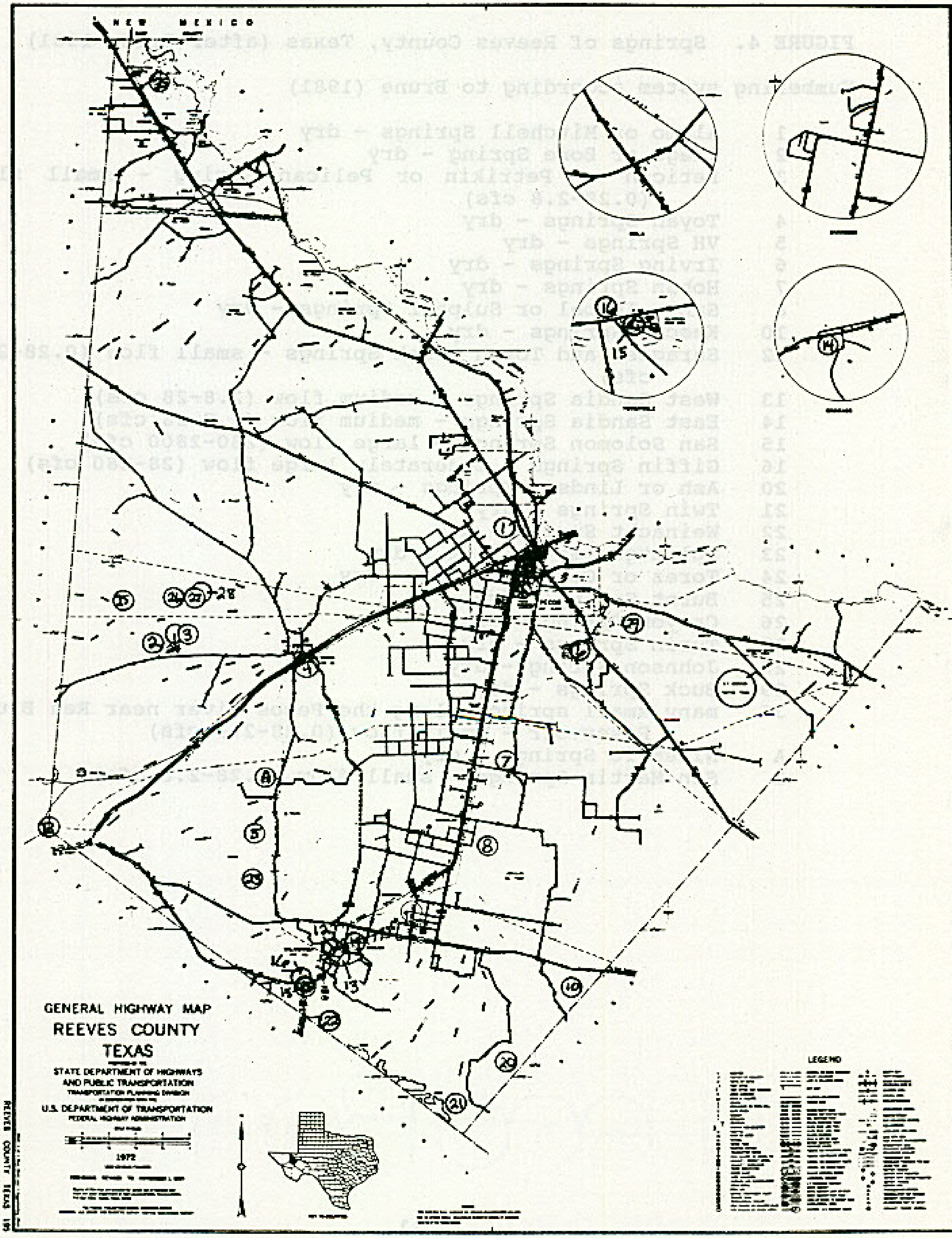

FIGURE 4. Springs of Reeves County, Texas (after Brune 1981)

FIGURE 5. Springs of Culberson County, Texas (after Brune 1981)

Numbering system according to Brune (1981)

1	Pine Springs - very small flow (0.028-0.28 cfs)
2	Upper Pine Springs - very small flow (0.028-0.28 cfs)
3	Smith Springs - small flow (0.28-2.8 cfs)
4	Bone Spring - very small flow (0.028-0.28 cfs)
5	Choza Springs - small flow (0.28-2.8 cfs)
6	Soldier Springs - small flow (0.28-2.8 cfs)
7	Independence Springs - small flow (0.28-2.8 cfs)
8	Delaware Springs - medium flow (2.8-28 cfs)
9	Manzanita Springs - small flow (0.28-2.8 cfs)
10	small springs in McKittrick Canyon - medium flow (2.8-28 cfs)
11	Guadalupe Spring - very small flow (0.028-0.28 cfs)
12	Screwbean Springs - medium flow (2.8-28 cfs)
13	Rustler Springs - small flow (0.28-2.8 cfs)
14	Willow Springs - medium flow (2.8-28 cfs)
15	Grapevine Springs - seep flow (<0.028 cfs)
16	Carrizo Spring - dry
17	Van Horn Wells - dry
18	Rattlesnake Springs - seep flow (<0.028 cfs)
19	Maverick Springs - medium flow (2.8-28 cfs)
20	Virginia Springs - medium flow (2.8-28 cfs)
21	Horseshoe Springs - small flow (0.28-2.8 cfs)
22	Pack Springs - seep flow (<0.028 cfs)
25	Hurd Springs - seep flow (<0.028 cfs)
26	Joe Ellis Water Hole - dry
27	very small spring in western end of Apache Mountains - dry
28	springs 8 km east-northeast of Lobo - dry
30	seep-fed lake 8 km east of Hurd Springs - dry
B	San Martin Springs - small flow (0.28-2.8 cfs)

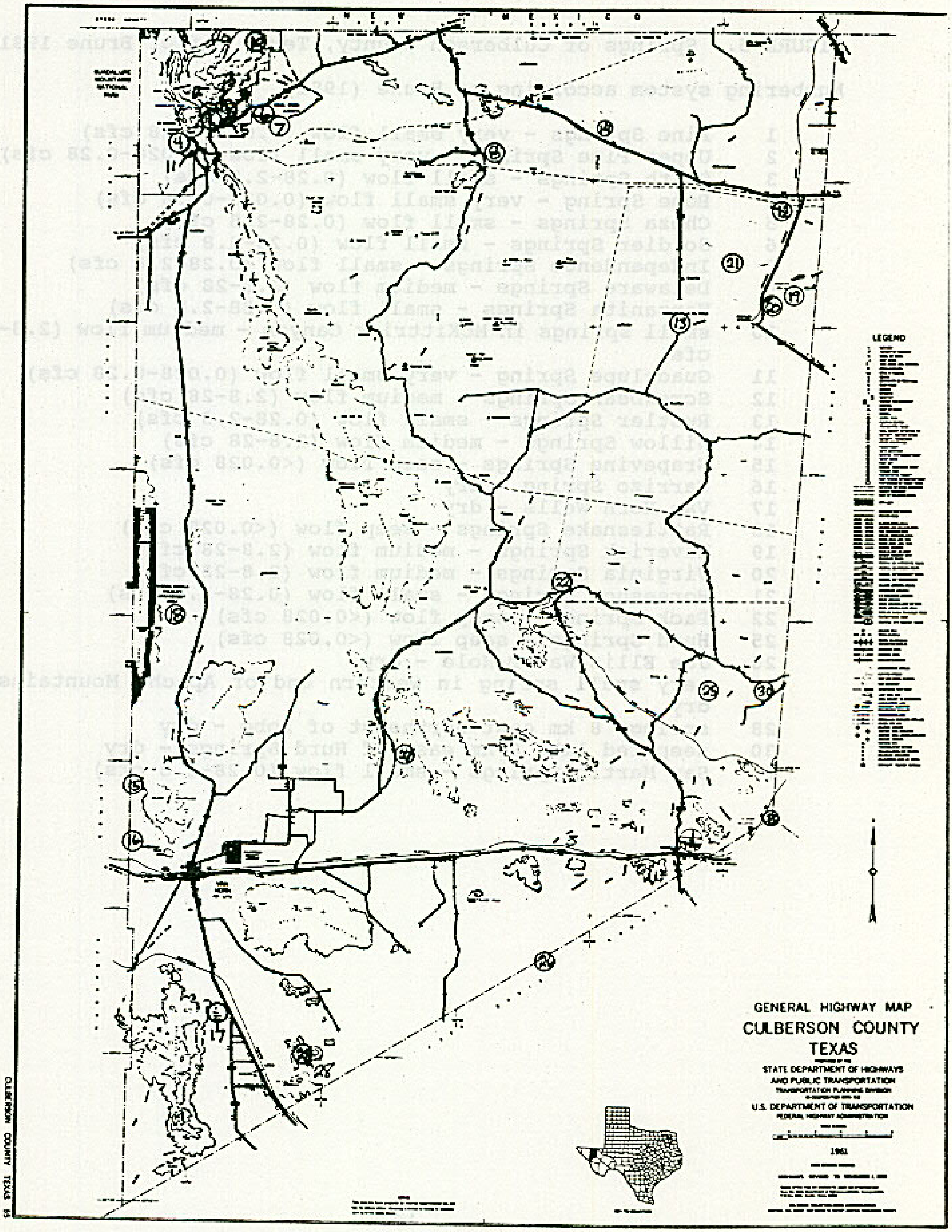

FIGURE 5. Springs of Culberson County, Texas (after Brune 1981)

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APPENDIX

SITES IDENTIFIED FOR THE PRESENCE/ABSENCE OR POSSIBLE INTRODUCTION OF HELIANTHUS PARADOXUS

PECOS COUNTY

Comanche Springs - Fort Stockton to 14 miles north-northeast (figure 3)

Soils: Balmorhea association (Pecos County Soil Survey maps 19, 20, 27, 28, 37, 38, and 50)

Geology: alluvium, fluviatile terrace deposits, and fanglomerate (Pecos and Fort Stockton sheets, Geologic Atlas of Texas). Comanche Springs issue from Comanchean limestones according to Brune (1981).

Topographic maps: springs, intermittent streams, intermittent pools, irrigation ditches, woodland, scrub, and open vegetation (Fort Stockton East, Diamond Y Spring Southeast, Buena Vista Southwest, and Fort Stockton West)

Springs: Comanche Springs complex (1-13), Adobe Springs (17), San Simon Springs (18), Travertine or Casa Blanca Springs (19), Johnson Springs (21), Agua Bonita (22), San Pedro Springs (31), and Cold Springs (32) (Brune 1981)

Areas surveyed and results:

Highway 285 S and E - some standing water; common plants include Helianthus annuus, Sorghum jalapense, Typha latifolia, and Salsola kali; surveyed on 13 September 1988 and 2 October 1990

Comanche Springs - dry and channelized; surveyed on 13 September 1988

Sewage disposal ponds - habitat destroyed; surveyed 4 October 1990

I-10 - dry; common plants include Helianthus annuus, Prosopis glandulosa, Sorghum jalapense, Cynodon dactylon, Trichloris crinata, Tridens sp., Salsola kali, Xanthium strumarium; very small patch of Sporobolus airoides; surveyed 4 October 1990

FM 1053 - dry; vegetation dominated by Sporobolus airoides and Prosopis glandulosa

Highway 290 - dry; on the south side of the road, common plants include Helianthus annuus (to 3 m tall), Sorghum jalapense, Prosopis glandulosa, Xanthium strumarium, and Celtis reticulata (dead); on the north side of the road, dominant vegetation is Distichlis spicata and Sporobolus airoides; Helianthus ciliaris is also found at this site; surveyed 4 October 1990

Areas needing survey: None.

Presence/absence of Helianthus paradoxus - Absent.

Discussion: The Comanche Springs complex once gave rise to a 25 km long creek which flowed through a vast marsh of cattails (Brune 1981). After 1947 spring flow began to fall, and eventually ceased completely in March 1961 (Brune 1981). To the northeast both Cold Springs and San Pedro Springs formed large marshes, but both springs ceased flowing by 1958 (Brune 1981). Also in the vicinity of Cold and San Pedro Springs were several small springs (Agua Bonita, San Simon, Adobe, Travertine, and Johnson) which are also now dry (Brune 1981). From the historical descriptions and the soils, it is quite possible that H. paradoxus once occurred at this site. Perhaps a 1943 specimen of H. paradoxus (Baker 2, TEX) from "Fort Stockton" was collected around Comanche Springs. However at present this site is incapable of supporting H. paradoxus, and it is not a suitable reintroduction site.

Courtney Creek - ca. 14 miles northwest to 17 miles north-northwest of Fort Stockton (figure 3)

Soils: Balmorhea association (Pecos County Soil Survey maps 18, 25, 26, and 35)

Geology: alluvium (Pecos and Fort Stockton sheets, Geologic Atlas of Texas)

Topographic maps: pools, intermittent streams, intermittent pools, irrigation ditches, scrub and open vegetation (Diamond Y Spring, Coyanosa Southeast, and Belding Northeast)

Springs: None.

Areas surveyed and results:

Highway 285 - dry; surveyed 13 September 1988.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus - Absent.

Discussion: Most of this site was inaccessible. However topographic maps indicate little permanent water. The area surveyed is incapable of supporting H. paradoxus, and would not be a suitable introduction site. It is highly likely that the rest of the site is similar.

Leon and Diamond Y Springs - ca. 12 miles west-southwest to ca. 24 miles north-northeast of Fort Stockton (figure 3)

Soils: Balmorhea association (Pecos County Soil Survey maps 12, 13, 19, 20, 26, 27, 35, 36, 37, 48, 49, and 61)

Geology: alluvium, fluviatile terrace deposits, and fanglomerate (Pecos and Fort Stockton sheets, Geologic Atlas of Texas). Diamond Y Springs and Leon Springs issue from a deep hole in Comanchean limestone (Brune 1981).

Topographic maps: springs, lakes, floodpool, pools, streams, intermittent streams, intermittent pools, irrigation ditches, woodlands, scrub, and open vegetation (Diamond Y Spring, Diamond Y Spring Southeast, Diamond Y Spring Northeast, Fort Stockton West, Belding, and Belding Northeast)

Springs: Leon Springs (30), Diamond Y Springs (33), and Sulphur Springs (15) (Brune 1981)

Areas surveyed and results:

Leon Creek and I-10 - dry or channelized, one small marshy site along access road; vegetation dominated by Prosopis glandulosa with Sporobolus airoides, Tamarix sp., Helianthus annuus, Verbesina encelioides, Juncus sp.; surveyed 12 and 13 September 1988

Leon Lake - lake; surrounded by Tamarix sp., Scirpus olneyi, and Suaeda sp.; surveyed 3 and 4 October 1990

Leon Creek and the junction of I-10, Highway 67, and FM 1776 - dry; pockets of Prosopis glandulosa and Sorghum jalapense surrounded by Larrea tridentata; surveyed 3 and 4 October 1990

Leon Creek and Highway 285 - dry; vegetation dominated by Prosopis glandulosa with Helianthus annuus and a mixture of grasses; surveyed 3 and 4 October 1990

Leon Creek and FM 1053 - dry; vegetation dominated by Prosopis with various shrubs and grasses; surveyed 3 and 4 October 1990

Leon Creek and FM 1450 - dry; vegetation dominated by Prosopis glandulosa and Sporobolus airoides with Helianthus annuus, Atriplex canescens, and Verbesina encelioides; surveyed 3 and 4 October 1990

Leon Creek and ATSF Railroad - dry; surveyed 3 and 4 October 1990

Leon Creek and road south of Gomez gas plant - dry; surveyed 3 and 4 October 1990

Diamond Y drainage (including Highway 18 and Leon Creek) - springs with pools and streams; bands of vegetation dominated by Scirpus olneyi, Distichlis spicata, Helianthus paradoxus, Flaveria chloraefolia, and Sporobolus airoides; surveyed 12 and 13 September 1988, 3 and 4 October 1990, and 8 October 1991.

Areas needing survey: Leon Lake and all of Leon Creek to Diamond Y drainage.

Presence/absence of Helianthus paradoxus - Present.

Discussion: Helianthus paradoxus has been known from the Diamond Y drainage for many years. Several collections have been made from this area (Gershenzon 78, TEX; Kolle 1415, SRSC; Rogers et al. 1982). This population is the only currently extant population known to the author in Texas. Rogers et al. (1982) reported a small population at Leon Lake, but this locality was not rechecked. Specimens (Reed 188 and s.n., SMU) and reports (Warnock 1974) indicate a population 6-7 miles west of Fort Stockton. This may either be the Leon Lake site or may have been along the highway which was reported to have a population before I-10 was constructed (Rogers et al. 1982). Although Leon Creek appeared dry at numerous road crossings, the large population of H. paradoxus along Leon Creek just below Diamond Y drainage and the report from Leon Lake justify the survey of the entire creek.

Monument Springs - ca. 4.5 miles south-southwest of the intersection of Highway 18 and FM 1450 (figure 3)

Soils: Balmorhea association (Pecos County Soil Survey maps 11)

Geology: pond deposits, fluviatile terrace deposits, and alluvium (Pecos sheet, Geologic Atlas of Texas)

Topographic maps: small lake and intermittent drainage, open vegetation (Diamond Y Spring Northwest)

Springs: Monument Springs (34) (Brune 1981)

Areas surveyed and results: Not surveyed.

Areas needing survey: Area with Balmorhea soils.

Presence/absence of <u>Helianthus paradoxus</u>: Unknown, but possible.

Discussion: This site was inaccessible from public roads, and thus not surveyed. The Balmorhea soils at this site indicate that there was a marsh here. Brune (1981) states that the spring was still flowing, but that the "swamp" was formerly three times as large. Topographic maps show permanent water in a small lake and an intermittent drainage from it. Thus the area is possibly capable of supporting <u>H. paradoxus</u>, and might be a suitable reintroduction site.

Santa Rosa Springs - ca. 5 miles east-northeast to ca. 4 miles north of the intersection of Highway 18 and FM 1450 (figure 3)

Soils: Balmorhea association (Pecos County Soil Survey maps 2, 4, 5, and 8)

Geology: pond deposits and alluvium (Pecos sheet, Geologic Atlas of Texas). The springs flowed from a Comanchean limestone cavern in a ravine according to Brune (1981).

Topographic maps: intermittent pool, drainage ditch, woodland, scrub, and open vegetation (Diamond Y Spring Northwest, Grandfalls, and Grandfalls Southwest)

Springs: Santa Rosa Springs (35) (Brune 1981)

Areas surveyed and results:

Santa Rosa Springs north floodplain and Highway 18 - dry; vegetation dominated by <u>Sporobolus airoides</u> and <u>Prosopis glandulosa</u>; surveyed 4 October 1990

Santa Rosa Springs south floodplain and Highway 18 - channelized; vegetation dominated by <u>Sporobolus airoides</u> and <u>Prosopis glandulosa</u>

Santa Rosa Springs floodplain and FM 1450 - dry; vegetation dominated by <u>Helianthus annuus</u>, <u>Tamarix</u> sp., and <u>Prosopis glandulosa</u>

Areas needing survey: None.

Presence/absence of <u>Helianthus paradoxus</u>: None in area surveyed, and probably not probable in unsurveyed areas.

Discussion: Part of this site was inaccessible from public roads, and thus not surveyed. The Balmorhea soils at this site indicate that there was a marsh here. However Brune (1981) states that the spring ceased flowing in the 1950s. Thus the area is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Cedar Springs - 8 km north of Sheffield on the west bank of the Pecos River (Brune 1981) (figure 3)
Soils: No Balmorhea soils in this area.
Geology: alluvium (Sonora sheet - Geologic Atlas of Texas)
Topographic maps: river, scrub vegetation (Deer Canyon)
Springs: Cedar Springs (14) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Keechi Springs - near the western boundary of the county and 7 km south of I-10 (Brune 1981) (figure 3)
Soils: No Balmorhea soils in this area.
Geology: alluvium (Fort Stockton sheet - Geologic Atlas of Texas)
Topographic maps: intermittent drainage, open vegetation (Deep Well Ranch Northwest).
Springs: Keechi Springs (20) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Because Balmorhea soils are not found in this area, the springs ceased flowing around 1900 (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Threemile Springs - 5 km southeast [presumably of Fort Stockton] on the southwest side of Threemille Mesa (Brune 1981) (figure 3)
Soils: No Balmorhea soils in this area.
Geology: Washita Group (limestone and marl) (Fort Stockton sheet - Geologic Atlas of Texas)
Topographic maps: On the Five Mile Mesa map, an intermittent pool is shown on the southwest side of Five Mile Mesa which is about 4 miles (6.4 km) southeast of central Fort Stockton. There is also a benchmark named Three Mile on Five Mile Mesa. The geologic map refers to this mesa as Threemile. It is possible that the intermittent pool represents the spring.
Springs: Threemile Springs (23) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Absent.

Discussion: Because Balmorhea soils are not found in this area, the springs ceased flowing about 1905 (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Whiskey Springs - 15 km west-northwest of Bakersfield on the south side of Big Mesa (Brune 1981) (figure 3)

Soils: No Balmorhea soils in this area.

Geology: Washita Group (limestone and marl) (Fort Stockton sheet - Geologic Atlas of Texas)

Topographic maps: On the Bootleg Canyon map, a spring is shown at the head of Bootleg Canyon on the south side of Big Mesa. Probably this is Whiskey Springs.

Springs: Whiskey Springs (24) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Absent.

Discussion: Because Balmorhea soils are not found in this area and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Hackberry Ponds - on Paisano Creek at 30°52'N and 103°11'W (Brune 1981) (figure 3)

Soils: No Balmorhea soils in this area.

Geology: Fanglomerate (Fort Stockton sheet - Geologic Atlas of Texas). According to Brune (1981) water seeped from lower Cretaceous limestones and Quaternary gravel.

Topographic maps: These coordinates are found on the Belding Southwest map in the vicinity of Coyanosa Draw, an intermittent drainage. About five miles further west is Hackberry Draw which crosses the Old Spanish Trail and has a series of intermittent ponds. However it is not at the coordinates of Brune (1981).

Springs: Hackberry Ponds (25) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Absent.

Discussion: Because Balmorhea soils are not found in this area, the ponds are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Unnamed springs - 5 km southwest of King Springs (Brune 1981) (figure 3)

Soils: No Balmorhea soils in this area.

Geology: Segovia Member (cherty limestone and dolomite) (Fort Stockton sheet - Geologic Atlas of Texas)

Topographic maps: Measuring from the coordinates for King Springs (Brune 1981), the resulting area shown on the Rock House Draw Northeast map contains several canyon heads with intermittent drainages but no springs.
Springs: unnamed springs (26) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction

King Springs - 16 km south of Tunas Springs, 30°42'N and 102°33'W (Brune 1981) (figure 3)
Soils: No Balmorhea soils in this area.
Geology: Segovia Member (cherty limestone and dolomite) (Fort Stockton sheet - Geologic Atlas of Texas)
Topographic maps: Using the coordinates (Brune 1981), the resulting area shown on the Rock House Draw Northeast map contains several limestone bluffs. One north-facing bluff with scrub vegetation is close to the coordinates, and is possibly the location of the springs although no springs are indicated on the map.
Springs: King Springs (36) (Brune 1981).
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Because Balmorhea soils are not found in this area and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

East Escondido Springs - 12 km west of Bakersfield on Tunas Creek (Brune 1981) (figure 3)
Soils: No Balmorhea soils in this area.
Geology: possibly fanglomerate, Quaternary deposits undivided (slopewash, alluvial fan deposits, colluvium, and locally older Quaternary deposits), and Fredericksburg Group (limestone, dolomite, chert, and minor marl) (Fort Stockton sheet - Geologic Atlas of Texas)
Topographic maps: Historical records indicate that the springs were at the base of a prominent mountain on the south side of the Old Spanish Trail. From Brune's directions (1981) there is a prominent mesa south of the highway (which follows the Old Spanish Trail). The geologic map also places the springs in this area. On the Bootleg Canyon and Skyscraper Peak topographic maps, there are intermittent drainages coming off of Big Mesa and flowing

into the intermittent Tunas Creek, however there are no springs indicated.

Springs: East Escondido Springs (37) (Brune 1981).

Areas surveyed and results: None.

Areas needing survey: Tunas Creek.

Presence/absence of _Helianthus_ _paradoxus_: Absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting _H. paradoxus_, or being a suitable introduction site. However there is an historical collection (1800s) from Escondido Creek (Bigelow 570, NY), and the area should be surveyed.

Middle Escondido Springs - 8 km west of East Escondido Springs on Tunas Creek (Brune 1981) (figure 3)

Soils: No Balmorhea soils in this area.

Geology: probably Quaternary deposits undivided (slopewash, alluvial fan deposits, colluvium, and locally older Quaternary deposits) (Fort Stockton sheet - Geologic Atlas of Texas). According to Brune (1981), the springs flowed from Comanchean limestone.

Topographic maps: Using Brune's directions (1981) the creek becomes intermittent and there is some scrub vegetation in the area. However there are no springs on the Skyscraper Peak topographic map.

Springs: Middle Escondido Springs (38) (Brune 1981).

Areas surveyed and results: None.

Areas needing survey: Tunas Creek.

Presence/absence of _Helianthus_ _paradoxus_: Absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting _H. paradoxus_, or being a suitable introduction site. However there is an historical collection (1800s) from Escondido Creek (Bigelow 570, NY), and the area should be surveyed.

Tunas or Pears or West Escondido Springs - 4 km west of Middle Escondido Springs on Tunas Creek and 32 km east of Fort Stockton on Interstate 10, 500 meters south of historical marker (Brune 1981) (figure 3)

Soils: No Balmorhea soils in this area.

Geology: probably Quaternary deposits undivided (slopewash, alluvial fan deposits, colluvium, and locally older Quaternary deposits) or Fredericksburg Group (limestone, dolomite, chert, and minor marl) (Fort Stockton sheet - Geologic Atlas of Texas). According to Brune (1981), the springs flowed from Comanchean limestone.

Topographic maps: Using Brune's directions (1981) the Panther Bluff topographic map shows Tunas Creek as an intermittent creek with some scrub vegetation in the area. However there are no springs.
Springs: Tunas Springs (39) (Brune 1981).
Areas surveyed and results: None.
Areas needing survey: Tunas Creek.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site. However there is an historical collection (1800s) from Escondido Creek (Bigelow 570, NY), and the area should be surveyed.

Pecos Springs - 1 mile northeast of Sheffield (figure 3)
Soils: No Balmorhea soils in this area.
Geology: alluvium, Quaternary deposits undivided (alluvial fan deposits, colluvium, caliche, and alluvium), and Fort Terrett (limestone and dolomite) (Sonora sheet - Geologic Atlas of Texas). According to Brune (1981) the springs flowed from Trinity sands.
Topographic maps: Spring, permanent stream; scrub vegetation.
Springs: Pecos Springs (40) (Brune 1981).
Areas surveyed and results: None.
Areas needing survey: Pecos Spring.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Because Balmorhea soils are not found in this area and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site. However as there is still spring flow, the area should be surveyed.

REEVES COUNTY

Balmorhea - immediately east and south of Balmorhea (figure 4)
Soils: Balmorhea silty clay loam and Balmorhea association, saline (Reeves County Soil Survey maps 44 and 45)
Geology: alluvium (Fort Stockton sheet - Geologic Atlas of Texas). Brune (1981) states that the Sandia Springs flow from alluvial sand and gravel, but the water is probably derived from underlying Comanchean limestones.
Topographic maps: lake and canals, intermittent creek and pools; woodland, scrub, and open vegetation (Balmorhea and Toyahvale)
Springs: West Sandia Springs (13) and East Sandia Springs (14) (Brune 1981)

Areas surveyed and results: road to Lake Balmorhea - mixed successional vegetation; surveyed 15 September 1988

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Absent.

Discussion: Even though the springs are still flowing (Brune 1981), this site is not capable of supporting H. paradoxus or being a suitable introduction site as it is too disturbed.

Collier - ca. 2 miles east of Collier (figure 4)

Soils: Balmorhea association, saline (Reeves County Soil Survey map 33)

Geology: alluvium (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: no indication of water; scrub and open vegetation (Verhalen North)

Springs: None

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Because there are no springs or any other sign of water indicated at this site, it is probably not capable of supporting H. paradoxus or being a suitable introduction site.

Pecos Sewage Lagoon - southeast edge of Pecos, south of sewage disposal plant (figure 4)

Soils: Balmorhea silty clay loam (Reeves County Soil Survey map 18)

Geology: fluviatile terrace deposits (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: No indications of water; two spots of scrub vegetation (Pecos East)

Springs: None.

Areas surveyed and results: along paved road south of sewage disposal plant - dry; some areas dominated by Sporobolus airoides and Prosopis glandulosa, other areas with Helianthus annuus, Sorghum jalapense, Cynodon dactylon, Xanthium strumarium, Suaeda detonsa, and Isocoma wrightii; surveyed 3 October 1990.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: None.

Discussion: Because Brune (1981) does not mention any springs in this area and no signs of water are shown on the topographic map, this site is not capable of supporting H. paradoxus, or being a suitable introduction site.

Pecos North - ca. 2 miles north of Pecos, either side of FM 1216 (figure 4)

Soils: Balmorhea association, saline (Reeves County Soil Survey maps 17 and 18)

Geology: fluviatile terrace deposits (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: Irrigation canal; scrub and open vegetation (Pecos East, Pecos West)
Springs: possibly Alamo or Mitchell Springs (1) (Brune 1981).
Areas surveyed and results: FM 1216 and irrigation canal - cultivated and fallow fields; surveyed 12 September 1988 and 3 October 1990
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Because the springs are dry (Brune 1981) and topographic maps indicate only channelized water, this site is not capable of supporting H. paradoxus, or being a suitable introduction site.

Salt Creek - ca. 8 miles southwest of Orla and continuing westward into Culberson County (figure 4)
Soils: Balmorhea association, saline (Reeves County Soil Survey map 5)
Geology: alluvium and low terrace deposits (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: permanent stream and pools, marsh, scrub and open vegetation (Screw Bean Draw East, Derrick Draw)
Springs: None in Reeves County, see Virginia Springs and Maverick Springs in Culberson County.
Areas surveyed and results: None - no access.
Areas needing survey: Salt Creek in Reeves County.
Presence/absence of Helianthus paradoxus: Possibly present.
Discussion: Accessible portions of Salt Creek in Culberson County were surveyed. While no H. paradoxus was found at the survey site, it is possible that H. paradoxus could occur in isolated pockets along the creek. This site might be a suitable introduction site.

Sandia Creek - ca. 2 miles southeast of the intersection of Highway 17 and FM 2448 (figure 4)
Soils: Balmorhea silty clay loam (Reeves County Soil Survey map 41)
Geology: alluvium (Pecos sheet - Geologic Atlas of Texas)
Topographic maps: intermittent creek and pools, open vegetation (Verhalen South)
Springs: None.
Areas surveyed and results: None - no access.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: If there were ever springs at this site, it is appears that they are dry now as the only aquatic surface features are intermittent. Thus it is unlikely that H. paradoxus occurs here, or that it might be a suitable introduction site.

Saragosa - ca. 2 miles north and 2 miles west of Saragosa (figure 4)

Soils: Balmorhea silty clay loam (Reeves County Soil Survey map 40)

Geology: alluvium and other Quaternary deposits (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: intermittent stream and pool, irrigation ditches, open vegetation (Saragosa)

Springs: None.

Areas surveyed and results: A cemetery and surrounding area within the site was surveyed on 3 and 4 October 1990. The entire area appeared to be presently or formerly cultivated.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Absent from area surveyed.

Discussion: Due to the high amount of disturbance at this site, it is unlikely that H. paradoxus occurs here, or that it might be a suitable introduction site.

Toyah Lake North - ca. 5 miles east of the junction of FM 1450 and Highway 285 east of Pecos (figure 4)

Soils: Balmorhea association, saline (Reeves County Soil Survey maps 18, 19, and 25)

Geology: fluviatile terrace deposits (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: intermittent creek, aqueduct, scrub and open vegetation (Toyah Lake, Pecos East, Quito Draw)

Springs: probably Buck Springs (29) (Brune 1981)

Areas surveyed and results: Toyah Creek and FM 1450 - dry; vegetation dominated by Prosopis glandulosa, Sporobolus airoides, and Atriplex canescens, with Verbesina encelioides, Xanthocephalum sp., Helianthus annuus; surveyed 12 and 14 September 1988.

Areas needing survey: Toyah Lake.

Presence/absence of Helianthus paradoxus: Absent from area surveyed.

Discussion: As H. paradoxus (or a hybrid with H. annuus) was collected at the "Salt Lakes" south of Pecos (Warnock 23034, TEX and SMU), this area needs to be thoroughly searched. Also some specimens of H. annuus at the site surveyed had an occasional elongate phyllary (perhaps an indication of at least the former presence of H. paradoxus). It is highly probably that H. paradoxus occurs here, and the site might also be a suitable introduction site.

Toyah Lake South - along Toyah Creek southwest of Toyah Lake, ca. 10-20 miles south of Pecos (figure 4)

Soils: Balmorhea silty clay loam and Balmorhea association, saline (Reeves County Soil Survey maps 24, 25, and 33)

Geology: alluvium, fluviatile terrace deposits, and Tahoka Formation (lacustrine clay, silt, sand, and gravel) (Pecos sheet - Geologic Atlas of Texas). Brune (1981) states that the springs flow from sand, silt, and peat, and possibly from underlying Cretaceous limestones.

Topographic maps: intermittent stream, lake, and pools, dry salt lake, scrub and open vegetation (Toyah Lake, Verhalen North, and Worsham)

Springs: possibly Irving Springs (6) (Brune 1981)

Areas surveyed and results:

Toyah Lake, northwest side - very dry; vegetation almost exclusively Tamarix sp.; surveyed 12 and 14 September 1988

Little Toyah Lake, northwest side - very dry; vegetation dominated by Tamarix sp.; surveyed 12 and 14 September 1988

Toyah Creek and northeast of Highway 17 and FM 869 - dry; surveyed 12 and 14 September 1988

Toyah Creek east of Valley Farm - dry; vegetation dominated by Helianthus annuus; surveyed 12 and 14 September 1988

Toyah Creek at Valley Farm - dry; common vegetation includes Salsola kali, Trichloris crinata, Prosopis glandulosa, Amaranthus sp., Helianthus annuus, Atriplex canescens, Sporobolus airoides, and Gutierrezia sp.; surveyed 12 and 14 September 1988

Cherry Creek and Highway 17 - dry; vegetation dominated by Prosopis glandulosa and Sporobolus airoides, with Helianthus annuus, H. ciliaris, Atriplex canescens, Verbesina encelioides, Salsola kali, and Setaria sp.; surveyed 3 and 4 October 1990

Areas needing survey: Toyah Lake.

Presence/absence of Helianthus paradoxus: Absent from areas surveyed.

Discussion: Irving Springs was described by early explorers as a cienega or marsh (Brune 1981). However the springs ceased flowing after 1949 (Brune 1981). The dry peat bog which remained caught fire in 1968 and burned for several months (Brune 1981). As H. paradoxus (or a hybrid with H. annuus) was collected at the "Salt Lakes" south of Pecos (Warnock 23034, TEX and SMU), this area needs to be thoroughly searched. It is highly probably that H. paradoxus occurs here, and the site might also be a suitable introduction site.

Verhalen - just east of Toyah Creek ca. 3 miles east of Verhalen (figure 4)

Soils: Balmorhea association, saline (Reeves County Soil Survey map 41)

Geology: alluvium and fluviatile terrace deposits (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: no indication of water, open vegetation (Verhalen South)

Springs: Santa Isabel Springs (8) is presumable nearby in Toyah Creek (Brune 1981)

Areas surveyed and results: None - no access.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because there is no indication of surface water on the topographic map and the only springs in the area are dry (Brune 1981), it is unlikely that H. paradoxus occurs here, or that the site might be a suitable introduction site.

Liege or Bone Spring - ca. 11.5 miles west of Toyah (figure 4)
Soils: no Balmorhea soils in area
Geology: Toy limestone (fresh-water limestone) (Pecos sheet - Geologic Atlas of Texas)
Topographic maps: Bone Spring, scrub vegetation (Toyah Southwest)
Springs: Liege or Bone Spring (2) (Brune 1981)
Areas surveyed and results: None - no access.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Petican or Petrikin or Pelican Spring - ca. 9 miles west-northwest of Toyah (figure 4)
Soils: no Balmorhea soils in area
Geology: Toy limestone (fresh-water limestone) and Gatuña Formation (sand, marl, conglomerate, gypsum, silt, shale, and limestone) (Pecos sheet - Geologic Atlas of Texas)
Topographic maps: Pelican Spring, intermittent drainage and pools, scrub and open vegetation (Toyah Southwest)
Springs: Petican or Petrikin or Pelican Spring (3) (Brune 1981)
Areas surveyed and results: None - no access.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because Balmorhea soils are not found in this area and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Toyah Springs - in Toyah (figure 4)
Soils: no Balmorhea soils in area
Geology: alluvium and other Quaternary deposits (Pecos sheet - Geologic Atlas of Texas)
Topographic maps: intermittent drainage, irrigation canals, scrub and open vegetation (Toyah)
Springs: Toyah Springs (4) (Brune 1981)
Areas surveyed and results: None.

Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

V H Springs - 8 km north of Splittgarber Springs which are 17 km west of Saragosa (Brune 1981) (figure 4)
Soils: no Balmorhea soils in area
Geology: alluvium, other Quaternary deposits (alluvium, colluvium, caliche, and gypsite) (Pecos sheet - Geologic Atlas of Texas). Brune (1981) states that the springs flowed from bolson gravel.
Topographic maps: intermittent drainage, scrub and open vegetation (Florenzo Hill)
Springs: V H Springs (5) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: The exact location of these springs is uncertain as there are no marked springs on the map in the vicinity indicated by Brune (1981). Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Hoban Springs - 28 km south of Pecos and 4 km east of Hoban Station in Toyah Creek (Brune 1981) (figure 4)
Soils: Balmorhea soils to the north (see Toyah Lake South)
Geology: fluviatile terrace deposits (Pecos sheet - Geologic Atlas of Texas)
Topographic maps: intermittent pools and channelized intermittent creek, scrub and open vegetation (Verhalen North)
Springs: Hoban Springs (7) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: The exact location of these springs is uncertain as there are no marked springs on the map in the vicinity indicated by Brune (1981). However there are several small intermittent pools. Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Keechi Springs - ca. 16 miles east-southeast of Balmorhea; 3 km south of IH-10 in Barilla Draw close to the Pecos County line (Brune 1981) (figure 4)

Soils: no Balmorhea soils in area

Geology: alluvium (Fort Stockton sheet - Geologic Atlas of Texas)

Topographic maps: intermittent drainage, scrub and open vegetation (Deep Well Ranch Northwest)

Springs: Keechi Springs (10) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: The exact location of these springs is uncertain as there are no marked springs on the map in the vicinity indicated by Brune (1981). Because Balmorhea soils are not found in this area, the springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site.

Saragosa and Toyah Creek Springs - 4 km southwest of Balmorhea and in Balmorhea near the FM 2093 bridge along Toyah Creek (Brune 1981) (figure 4)

Soils: There are no Balmorhea soils at these springs but there are Balmorhea soils to the south and east.

Geology: alluvium (Fort Stockton sheet - Geologic Atlas of Texas). Brune (1981) states that the springs flow from alluvial gravel and sand, probably from underlying Comanchean limestones.

Topographic maps: Saragosa Spring, permanent and intermittent creek, woodland, scrub and open vegetation (Balmorhea and Toyahvale)

Springs: Saragosa and Toyah Creek Springs (12) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: Toyah Creek around Balmorhea.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Because Balmorhea soils are not found in the immediate area, Saragosa Springs are dry (Brune 1981), and Brune (1981) does not mention the presence of a marsh in this area, this site is probably not capable of supporting H. paradoxus, or being a suitable introduction site. However as there is still some spring flow and the topographic maps show dense vegetation, it might be worthwhile to quickly survey the area.

San Solomon Springs - in Balmorhea State Park at Toyahvale (figure 4)

Soils: There are no Balmorhea soils at these springs but there are Balmorhea soils to the east.

Geology: alluvium (Fort Stockton sheet - Geologic Atlas of Texas). According to Brune (1981) the springs flow from a fault between impervious upper Cretaceous rocks and the water-containing lower Cretaceous limestones.

Topographic maps: swimming pool, permanent and intermittent canals, scrub and open vegetation (Toyahvale)

Springs: San Solomon Springs (15) (Brune 1981)

Areas surveyed and results: Balmorhea State Park - The area around the swimming pool is highly manicured (Cynodon dactylon and Populus deltoides). However in the northeastern corner of the park along a steep-sided canal with permanent water are the remnants of a marsh community. Typha latifolia occupies the stream channel with a band of Scirpus olneyi at the water's edge and on the bank. Beyond this and at a slightly higher elevation non-native plants such as Cynodon dactylon and Xanthium strumarium have invaded the habitat once probably occupied by Distichlis spicata and various herbaceous species, possibly even Helianthus paradoxus. This area was surveyed on 27 June 1989.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Absent.

Discussion: Although Balmorhea soils are not found in this area, San Solomon Springs are among the strongest springs in west Texas (Brune 1981). Before the springs were converted into a swimming pool, they discharged into a "swamp of considerable size that drained into Toyah Creek" (Maxwell 1970). Thus although H. paradoxus is not presently found at the site, the edge of the canal would be a suitable introduction site. However all H. annuus within pollinator flight distance would have to removed.

Giffin Springs - just north of the intersection of Highways 290 and 17 at Toyahvale (figure 4)

Soils: There are no Balmorhea soils at these springs but there are Balmorhea soils to the east.

Geology: alluvium (Fort Stockton sheet - Geologic Atlas of Texas). According to Brune (1981) the springs flow from a fault between impervious upper Cretaceous rocks and the water-containing lower Cretaceous limestones.

Topographic maps: Giffin springs (5 spring symbols), permanent canals, scrub vegetation (Toyahvale)

Springs: Giffin Springs (16) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: Immediate area around Giffin Springs.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Although Balmorhea soils are not found in this area and there is no mention of a marsh at the site (Brune 1981), there was a marsh at the adjacent San Solomon Springs and spring flow is still moderately large (Brune 1981). However the site appears from the topographic maps to be highly altered, and may not be suitable for H. paradoxus. Still the site should be checked, especially as a introduction site.

Ash or Lindsey Springs - southern corner of Reeves County, 30° 51' N, 103° 33' W (Brune 1981) (figure 4)

Soils: No Balmorhea soils in the area.

Geology: possibly alluvium, landslide deposits, fanglomerate, Star Mountain rhyolite, and Huelster Formation (mostly tuff, thin layers of sandstone and conglomerate, lenses of nonmarine limestone and mafic lava) (Fort Stockton sheet - Geologic Atlas of Texas)

Topographic maps: There are many springs on the map (Barilla Mountains East) within a mile radius of the coordinates, but none are identified as Ash or Lindsey Springs. Other features in the area are intermittent drainages and pools, and open vegetation.

Springs: Ash or Lindsey Springs (20) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: Immediate vicinity of Ash Springs.

Presence/absence of <u>Helianthus paradoxus</u>: Probably absent.

Discussion: Although Balmorhea soils are not found in this area, the topographic maps show little indication of surface water, and Ash Springs are dry according to Brune (1981), there was a marsh at the site (Brune 1981). Thus the site should be surveyed, to both check for the presence of <u>H. paradoxus</u>, and for a introduction site.

Twin Springs - 7 km west of Ash Springs (southern corner of Reeves County, 30° 51' N, 103° 33' W) (Brune 1981) (figure 4)

Soils: No Balmorhea soils in the area.

Geology: possibly alluvium, landslide deposits, fanglomerate, Star Mountain rhyolite, and Huelster Formation (mostly tuff, thin layers of sandstone and conglomerate, lenses of nonmarine limestone and mafic lava) (Fort Stockton sheet - Geologic Atlas of Texas)

Topographic maps: There are no springs on the maps (Barilla Mountains East and Barilla Mountains West) specifically identified as Twin Springs. On the Barilla Mountains West map there are two springs less than 0.5 miles apart, however these are several miles further west than Brune's coordinates. In the vicinity of his directions are many small intermittent drainages and ponds.

Springs: Twin Springs (21) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of <u>Helianthus paradoxus</u>: Probably absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support <u>H. paradoxus</u>, not would it be a suitable introduction site.

Weinacht Springs - 6 km south of Toyahvale (Brune 1981) (figure 4)

Soils: No Balmorhea soils in the area.

Geology: possibly alluvium, landslide deposits, older Quaternary deposits, and Star Mountain rhyolite (Fort Stockton sheet - Geologic Atlas of Texas)

Topographic maps: There are no springs on the map (Toyahvale) specifically identified as Weinacht Springs. In the vicinity of Brune's directions are many small intermittent drainages and tanks with open vegetation.

Springs: Weinacht Springs (22) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support H. paradoxus, not would it be a suitable introduction site.

Splittgarber or Dobe or Splittgarber Springs - 17 km west of Saragosa (Brune 1981) (figure 4)

Soils: No Balmorhea soils in the area.

Geology: probably alluvium (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: There are no springs on the map (Meier Hills) specifically identified as Splittgarber Springs. In the vicinity of Brune's directions is Cowan Springs as well as intermittent drainages and open vegetation.

Springs: Splittgarber Springs (23) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support H. paradoxus, not would it be a suitable introduction site.

Torez or Coyote Springs - ca. 10 miles west-northwest of Toyah (figure 4)

Soils: No Balmorhea soils in the area.

Geology: Toy limestone (fresh-water limestone) (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: Coyote Springs, scrub vegetation (Toyah Southwest)

Springs: Torez or Coyote Springs (24) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support H. paradoxus, not would it be a suitable introduction site.

Burnt Springs - ca. 13 miles west-northwest of Toyah (figure 4)

Soils: No Balmorhea soils in the area.

Geology: alluvium (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: Burnt Springs, open vegetation (Toyah Northwest)

Springs: Burnt Springs (25) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of <u>Helianthus</u> <u>paradoxus</u>: Probably absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support <u>H</u>. <u>paradoxus</u>, not would it be a suitable introduction site.

Canyon Springs - ca. 10.5 miles northwest of Toyah (figure 4)

Soils: No Balmorhea soils in the area.

Geology: Gatuña Formation (sand, marl, conglomerate, gypsum, silt, shale, and limestone) (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: Canyon Springs, intermittent drainage, open vegetation (Toyah Northwest)

Springs: Canyon Springs (26) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of <u>Helianthus</u> <u>paradoxus</u>: Probably absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support <u>H</u>. <u>paradoxus</u>, not would it be a suitable introduction site.

Turin or Twin Springs - ca. 9 miles northwest of Toyah (figure 4)

Soils: No Balmorhea soils in the area.

Geology: gypsite (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: Twin Springs, open vegetation (Toyah Northwest)

Springs: Turin or Twin Springs (27) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of <u>Helianthus</u> <u>paradoxus</u>: Probably absent.

Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support <u>H</u>. <u>paradoxus</u>, not would it be a suitable introduction site.

Johnson Spring - ca. 8 miles northwest of Toyah (figure 4)

Soils: No Balmorhea soils in the area.

Geology: gypsite (Pecos sheet - Geologic Atlas of Texas)

Topographic maps: Johnson Spring, open vegetation (Toyah Northwest)

Springs: Johnson Spring (28) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because Balmorhea soils are not found in this area, the springs are dry according to Brune (1981), and there was not a marsh at the site (Brune 1981), the site probably does not support H. paradoxus, not would it be a suitable introduction site.

Red Bluff Reservoir - Red Bluff Reservoir and up the Pecos River to Amerada Fall, 1.6 km north of the New Mexico state line (Brune 1981) (figure 4)
Soils: No Balmorhea soils in the area.
Geology: Permian Rustler limestone and dolomites (Brune 1981)
Topographic maps: lake, drowned river (Red Bluff)
Springs: many small springs along the Pecos River (35) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because Balmorhea soils are not found in this area, there was not a marsh at the site (Brune 1981), and most of the site is under water, the site probably does not support H. paradoxus, nor would it be a suitable introduction site.

Ninemile Springs - ca. 10 miles south-southwest of Toyah (figure 4)
Soils: No Balmorhea soils in the area.
Geology: alluvium (Pecos sheet - Geologic Atlas of Texas)
Topographic maps: Ninemile Spring, intermittent drainage, scrub vegetation (Florenzo Hill)
Springs: Ninemile Springs (Brune give no number, identified as A on map in this report) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because Balmorhea soils are not found in this area, there was not a marsh at the site (Brune 1981), and the springs are dry (Brune 1981), the site probably does not support H. paradoxus, nor would it be a suitable introduction site.

San Martin Spring - ca. 3 miles northwest of the intersection of IH-10 and IH-20 (figure 4)
Soils: No Balmorhea soils in the area.
Geology: alluvium and low terrace deposits, old Quaternary deposits (alluvium, colluvium, caliche, and gypsite), and Gomez tuff (Van Horn-El Paso sheet - Geologic Atlas of Texas). Brune (1981) states that the springs flow from volcanic rocks, primarily rhyolite, on top of a bentonitic tuff.

Topographic maps: San Martine Spring, intermittent drainage, open vegetation (Gomez Peak)
Springs: San Martin Spring (Listed by Brune in Jeff Davis County, indicated as B on maps in this report)
Areas surveyed and results: None.
Areas needing survey: Immediate vicinity of San Martin Spring.
Presence/absence of <u>Helianthus</u> <u>paradoxus</u>: Probably absent.
Discussion: Although Balmorhea soils are not mapped in this area, there was once a marsh at the site (Brune 1981). As the springs are still flowing (Brune 1981), this site should be surveyed to determine if <u>H.</u> <u>paradoxus</u> occurs there, or if the site would be a suitable introduction site.

CULBERSON COUNTY

There is not a published soil survey available for Culberson County.

Pine Springs - ca. 0.6 miles northwest of Pine Springs (figure 5)
Geology: Cherry Canyon Formation (sandstone, siltstone, and limestone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Pine Spring, open vegetation (Guadalupe Peak)
Springs: Pine Springs (1) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of <u>Helianthus</u> <u>paradoxus</u>: Probably absent.
Discussion: As there was not a marsh indicated at the site (Brune 1981), there is little likelihood that <u>H.</u> <u>paradoxus</u> occurs at the site, or that the site would be a suitable introduction site.

Upper Pine Springs - ca. 0.7 miles north of Pine Springs (figure 5)
Geology: Cherry Canyon Formation (sandstone, siltstone, and limestone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Upper Pine Spring, intermittent drainage, woodland (Guadalupe Peak)
Springs: Upper Pine Springs (2) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of <u>Helianthus</u> <u>paradoxus</u>: Probably absent.
Discussion: As there was not a marsh indicated at the site (Brune 1981), there is little likelihood that <u>H.</u> <u>paradoxus</u> occurs at the site, or that the site would be a suitable introduction site.

Smith Springs - ca. 1.9 miles north-northeast of Pine Springs (figure 5)

Geology: Bell Canyon Formation (sandstone and limestone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Smith Spring, intermittent drainage, woodland and open vegetation (Guadalupe Peak)
Springs: Smith Springs (3) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: As there was not a marsh indicated at the site (Brune 1981), there is little likelihood that H. paradoxus occurs at the site, or that the site would be a suitable introduction site.

Bone Spring - ca. 3.4 miles south-southwest of Pine Springs (figure 5)
Geology: Brushy Canyon Formation (sandstone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Bone Spring, intermittent drainage, open vegetation (Guadalupe Peak)
Springs: Bone Spring (4) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: As there was not a marsh indicated at the site (Brune 1981), there is little likelihood that H. paradoxus occurs at the site, or that the site would be a suitable introduction site.

Choza Springs - ca. 1 mile northeast of Pine Springs (figure 5)
Geology: Cherry Canyon Formation (sandstone, siltstone, and limestone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Choza Spring, intermittent drainage, scrub vegetation (Guadalupe Peak)
Springs: Choza Springs (5) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: As there was not a marsh indicated at the site (Brune 1981), there is little likelihood that H. paradoxus occurs at the site, or that the site would be a suitable introduction site.

Soldier Springs - ca. 1.5 miles northeast of Pine Springs (figure 5)
Geology: Cherry Canyon Formation (sandstone, siltstone, and limestone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Soldier Spring, intermittent drainage, scrub vegetation (Guadalupe Peak)
Springs: Soldier Springs (6) (Brune 1981)
Areas surveyed and results: None.

Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: As there was not a marsh indicated at the site (Brune 1981), there is little likelihood that H. paradoxus occurs at the site, or that the site would be a suitable introduction site.

Independence Springs - ca. 3 miles south-southeast of Nickel Creek Station (figure 5)
Geology: Cherry Canyon Formation (sandstone, siltstone, and limestone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Independence Spring, intermittent drainage, aqueduct, scrub vegetation (Independence Spring)
Springs: Independence Springs (7) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: As there was not a marsh indicated at the site (Brune 1981), there is little likelihood that H. paradoxus occurs at the site, or that the site would be a suitable introduction site.

Delaware Springs - ca. 5 miles south-southwest of the intersection of FM 652 and FM 1108 (figure 5)
Geology: alluvium and low terrace deposits (Van Horn-El Paso sheet - Geologic Atlas of Texas). Brune (1981) states that the springs flow from gravel deposits overlying the Bell Canyon limestone.
Topographic maps: Delaware Spring, Delaware River, intermittent drainage, woodland and scrub vegetation (Delaware Spring)
Springs: Delaware Springs (8) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: Delaware Spring and Delaware River.
Presence/absence of Helianthus paradoxus: Possibly present.
Discussion: Historical writings tell of a marsh at the springs (Brune 1981). This area should be surveyed as it is possible that H. paradoxus occurs at the site, or that the site would be a suitable introduction site.

Manzanita Springs - ca. 1.6 miles northeast of Pine Springs (figure 5)
Geology: Old Quaternary deposits (alluvium, colluvium, caliche, and gypsite) (Van Horn-El Paso sheet - Geologic Atlas of Texas). According to Brune (1981) the springs flow from a gravel and cobble bajada on top of limestone.
Topographic maps: Manzanita Spring, intermittent drainage, open and scrub vegetation (Guadalupe Peak)
Springs: Manzanita Springs (9) (Brune 1981)

Areas surveyed and results: In the fall of 1991 Vidal Davila, then Resource Manager for Guadalupe Mountains National Park, surveyed the springs and detected no Helianthus.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Absent.

Discussion: Historical writings tell of a marsh at the springs (Brune 1981). However a survey of this area did not reveal any species of Helianthus. As the area is no longer a marsh, the site would not be a suitable introduction site.

small springs in McKittrick Canyon - 8 km northeast of Juniper Spring (Brune 1981) (figure 5)

Geology: Old Quaternary deposits (alluvium, colluvium, caliche, and gypsite), alluvium, and Capitan limestone (Van Horn-El Paso sheet - Geologic Atlas of Texas)

Topographic maps: intermittent stream, large wash, open and woodland vegetation (Guadalupe Peak)

Springs: small springs in McKittrick Canyon (10) (Brune 1981)

Areas surveyed and results: The author has hiked McKittrick Canyon numerous times, and never observed Helianthus paradoxus or the community in which it occurs.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Absent.

Discussion: As the proper plant community does not exist in the area, the site would not be a suitable introduction site.

Guadalupe Spring - ca. 2.1 miles southwest of Pine Springs (figure 5)

Geology: alluvium and low terrace deposits (Van Horn-El Paso sheet - Geologic Atlas of Texas)

Topographic maps: Guadalupe Spring, intermittent drainage, scrub vegetation (Guadalupe Peak)

Springs: Guadalupe Spring (11) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Because a marsh was never recorded from this area, the site probably does not support H. paradoxus, nor would it be a suitable introduction site.

Screwbean Springs - ca. 2 miles southwest of railroad crossing on RR 652, 4 miles west of the Salt Creek crossing of RR 652 (figure 5)

Geology: alluvium and low terrace deposits, gypsum of Rustler and Castille Formations undivided (gypsum in collapse structures) (Van Horn-El Paso sheet - Geologic Atlas of Texas)

Topographic maps: Screw Bean Spring, intermittent drainage, permanent (dammed?) and intermittent ponds, irrigation ditch, scrub and open vegetation (Screw Bean Draw East)

Springs: Screwbean Springs (12) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: Screw Bean Springs and Draw.
Presence/absence of Helianthus paradoxus: Possibly present.
Discussion: Although there is no record of a marsh from this area, the site is similar to Delaware and Rustler Springs, and might support H. paradoxus or be a suitable introduction site.

Rustler Springs - ca. 12.5 miles south-southwest of the intersection RR 652 and RR 2185 (figure 5)
Geology: alluvium and low terrace deposits, and Rustler Formation (limestone, siltstone, sandstone, gypsum, and clay) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Rustler Spring, permanent stream, man-made impoundment, open vegetation (Rustler Hills)
Springs: Rustler Springs (13) (Brune 1981)
Areas surveyed and results: Linear cienega, same plant community as Diamond Y Spring except Helianthus paradoxus; surveyed 15 September 1988.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Absent.
Discussion: Although H. paradoxus was not found at the site, it appeared to be a suitable introduction site. However the water may contain too much sulphur as do many other springs and creeks in the area.

Willow Springs - ca. 2.3 miles east of where the Delaware River crosses RR 652 (figure 5)
Geology: Castile Formation (gypsum, anhydrite, and limestone) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Willow Spring, intermittent and permanent streams, drains into Delaware River, woodland, scrub, and open vegetation (Outlaw Spring)
Springs: Willow Springs (14) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: Willow Spring to the Delaware River.
Presence/absence of Helianthus paradoxus: Possibly present.
Discussion: Although there are no reports of marshes in the area, the spring and vicinity due to their proximity to the Delaware River should be surveyed as H. paradoxus might occur there, or the site might be a suitable introduction site.

Grapevine Springs - ca. 7.5 miles northwest of Van Horn on the northwest side of the Beach Mountains (figure 5)
Geology: issues from a fault between the Hazel Formation (interbedded sandstone and conglomerate) and Van Horn sandstone (Van Horn-El Paso sheet - Geologic Atlas of Texas, Brune 1981)
Topographic maps: Grapevine Spring, intermittent drainage, open vegetation (Sheep Peak)

Springs: Grapevine Springs (15) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of <u>Helianthus paradoxus</u>: Probably absent.
Discussion: Because there are no reports of marshes in the area and the topographic features indicate little surface water, it is unlikely that <u>H. paradoxus</u> occurs in the area, or that the site might be a suitable introduction site.

Carrizo Springs - 10 km north of Van Horn on the Hudspeth County line (figure 5)
Geology: Van Horn sandstone (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: There is no spring by this name in Brune's location. However there is a Carrizo Spring Windmill, and Brune mentions a windmill well which led to the demise of the spring. The windmill is along an intermittent drainage in open vegetation on the Hackett Peak topographic map.
Springs: Carrizo Springs (16) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of <u>Helianthus paradoxus</u>: Probably absent.
Discussion: Although the translation of Carrizo is reeds, presently there is no longer a marsh in the area. Also the spring is dry. Thus it is highly unlikely that <u>H. paradoxus</u> occurs here, or that the site might be a suitable introduction site.

Van Horn Wells - 10.3 miles south of Van Horn, ca. 0.5 miles west of Highway 90 (figure 5)
Geology: issues from a fault between the Hogeye tuff (an upper sandstone unit and a lower vitric tuff with lenses of conglomerate) and young Quaternary deposits (colluvium and fan deposits) (Marfa sheet - Geologic Atlas of Texas, Brune 1981)
Topographic maps: Van Horn Wells, intermittent drainage, open vegetation (Van Horn Wells)
Springs: Van Horn Wells (17) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of <u>Helianthus paradoxus</u>: Probably absent.
Discussion: Although there are historic reports of permanent pools of water surrounded by reeds and willows, the springs are now dry. Thus it is unlikely that <u>H. paradoxus</u> occurs in the area, or that the site might be a suitable introduction site.

Rattlesnake Springs - 35 km north of Van Horn, near the mouth of Victorio Canyon, 31° 21' N and 104° 51' W (figure 5)

Geology: alluvium and low terrace deposits (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: intermittent drainage, wash, open vegetation (Victorio Peak)
Springs: Rattlesnake Springs (18) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: Because there are no reports of marshes in the area, it is unlikely that H. paradoxus occurs in the area, or that the site would be suitable for introduction.

Maverick Springs - 3 km east and northeast of the Duval sulphur plant (Brune 1981) (figure 5)
Geology: gypsum of Rustler and Castile Formations undivided (gypsum in collapse structures) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: unnamed spring, intermittent drainage, permanent pond, channelized intermittent streams, flows into Salt Creek (permanent stream, marsh), open vegetation (Derrick Draw)
Springs: Maverick Springs (19) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: Spring to Salt Creek.
Presence/absence of Helianthus paradoxus: Possibly present.
Discussion: As there are marshes in the area, it is possible that H. paradoxus occurs in the area, or that the site might be a suitable introduction site.

Virginia Springs - 25 km southwest of Orla, and just northeast of the Duval sulphur plant, 31° 43' N and 104° 06' W (Brune 1981) (figure 5)
Geology: gypsum of Rustler and Castile Formations undivided (gypsum in collapse structures) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: spring, permanent stream, marsh, woodland, scrub and open vegetation (Derrick Draw)
Springs: Virginia Springs (20) (Brune 1981)
Areas surveyed and results: The General Land Office owns a section of land in the marsh along Salt Creek. The portion of the marsh surveyed was heavily invaded by Tamarix sp. and smelled strongly of sulphur. Distichlis spicata was dominant in mesic areas while Sporobolus airoides occupied the more xeric grasslands. Atriplex canescens, Limonium limbatum, and Allenrolfea occidentalis are found in the more alkaline, saline areas. The site was surveyed on 3 October 1990.
Areas needing survey: Entire marsh area and Salt Creek.
Presence/absence of Helianthus paradoxus: Absent from site surveyed, but possibly present in other areas.

Discussion: As there is a large marsh in the area, it is possible that H. paradoxus occurs in unsurveyed parts of the area. Although the surveyed area did not seem suitable for introduction due to the high level of disturbance, other unsurveyed sites in the area might be.

Horseshoe Springs - ca. 4.6 miles north-northwest of the sulphur plant at the end of RR 2119 (figure 5)
Geology: Rustler Formation (limestone, siltstone, sandstone, gypsum, marl, and clay) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: Horseshoe Springs (four spring symbols), intermittent stream, scrub and open vegetation (Rustler Hills)
Springs: Horseshoe Springs (21) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: Horseshoe Springs and immediate vicinity.
Presence/absence of Helianthus paradoxus: Possibly present.
Discussion: As there are a several springs in the area and the drainage feeds into Salt Creek with its many marshes, it is possible that H. paradoxus occurs in the area, or that suitable introduction sites might exist.

Pack Springs - 31° 22' N and 104° 22' W (Brune 1981) (figure 5)
Geology: Rustler Formation (limestone, siltstone, sandstone, gypsum, marl, and clay) (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: intermittent and permanent drainages, series of permanent and intermittent ponds, open vegetation (Hopper Draw West and Dome Hill)
Springs: Pack Springs (22) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: As there are no mapped springs in the area and the site sounds highly disturbed from Brune's description (earth tanks surrounded by Tamarix sp.), it is unlikely that H. paradoxus occurs in the area, or that suitable introduction sites exist.

Hurd Springs - 31° 15' N and 104° 12' W (Brune 1981) (figure 5)
Geology: alluvium and low terrace deposits (Van Horn-El Paso sheet - Geologic Atlas of Texas)
Topographic maps: intermittent drainages, scrub and open vegetation (Hopper Draw East and Iron Mountain)
Springs: Hurd Springs (25) (Brune 1981)
Areas surveyed and results: None.
Areas needing survey: None.
Presence/absence of Helianthus paradoxus: Probably absent.
Discussion: As there are no mapped springs in the area and little indication of surface water from the topographic

maps, it is unlikely that H. paradoxus occurs in the area, or that suitable introduction sites exist.

Joe Ellis Water Hole - 19 km southwest of Kent (Brune 1981) (figure 5)

Geology: San Martine limestone (Marfa sheet - Geologic Atlas of Texas)

Topographic maps: In the area indicated by Brune there are no springs, only intermittent drainages and open vegetation on the Boracho Peak topographic map.

Springs: Joe Ellis Water Hole (26) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: As there are no mapped springs in the area, little indication of surface water from the topographic maps, and the springs are dry according to Brune (1981), it is unlikely that H. paradoxus occurs in the area, or that suitable introduction sites exist.

very small spring - 32 km northeast of Van Horn in the west end of the Apache Mountains (Brune 1981) (figure 5)

Geology: Capitan limestone (Van Horn-El Paso sheet - Geologic Atlas of Texas)

Topographic maps: In the area indicated by Brune there are no springs, only intermittent drainages and open vegetation on the Goat Canyon topographic map.

Springs: very small spring (27) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: As there are no mapped springs in the area, little indication of surface water from the topographic maps, and the springs are dry according to Brune (1981), it is unlikely that H. paradoxus occurs in the area, or that suitable introduction sites might exist.

springs - 8 km east-northeast of Lobo (Brune 1981) (figure 5)

Geology: Garren Group undivided (Tertiary igneous intrusive rocks) (Marfa sheet - Geologic Atlas of Texas)

Topographic maps: In the area indicated by Brune there are no springs, only intermittent drainages and pools, and open vegetation on the Chispa Mountain topographic map.

Springs: springs (28) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: As there are no mapped springs in the area, little indication of surface water from the topographic maps, and the springs are dry according to Brune (1981), it is unlikely that H. paradoxus occurs in the area, or that suitable introduction sites exist.

seep-fed lake - 8 km east of Hurd Springs near Reeves County line (Brune 1981) (figure 5)

Geology: alluvium and low terrace deposits (Van Horn-El Paso sheet - Geologic Atlas of Texas)

Topographic maps: small intermittent lake, open vegetation (San Martine)

Springs: seep-fed lake (30) (Brune 1981)

Areas surveyed and results: None.

Areas needing survey: None.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: As there are no mapped springs in the area, little indication of surface water from the topographic maps, and the springs are dry according to Brune (1981), it is unlikely that H. paradoxus occurs in the area, or that suitable introduction sites exist.

San Martin Spring - ca. 3 miles northwest of the intersection of IH-10 and IH-20 (figure 5)

Geology: alluvium and low terrace deposits, old Quaternary deposits (alluvium, colluvium, caliche, and gypsite), and Gomez tuff (Van Horn-El Paso sheet - Geologic Atlas of Texas). Brune (1981) states that the springs flow from volcanic rocks, primarily rhyolite, on top of a bentonitic tuff.

Topographic maps: San Martine Spring, intermittent drainage, open vegetation (Gomez Peak)

Springs: San Martin Spring (B)

Areas surveyed and results: None.

Areas needing survey: Immediate vicinity of San Martin Spring.

Presence/absence of Helianthus paradoxus: Probably absent.

Discussion: Although Balmorhea soils are not mapped in this area, there was once a marsh at the site (Brune 1981). As the springs are still flowing (Brune 1981), this site should be surveyed to determine if H. paradoxus occurs there, or if the site would be a suitable introduction site.