FINAL REPORT

As Required by

THE ENDANGERED SPECIES ACT, SECTION 6

TEXAS
Project No: E-1-4

ENDANGERED AND THREATENED SPECIES CONSERVATION

Job No. 2.1

Comanche Springs Pupfish (Cyprinodon elegans) Status Survey

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January 31, 1993

ABSTRACT

A two-year monitoring program of the Comanche Springs Pupfish (Cyprinodon elegans) and its habitat in the springs and associated canals near Balmorhea and Toyahvale, Reeves and Jeff Davis Counties, was conducted. Fish numbers were counted and selected water quality parameters measured at 6 sampling points 3 times a year. The pupfish population in the refugium canal at Balmorhea State Recreation Area continues to be robust. Pupfish occur downstream of Giffin and San Solomon Springs in Toyah Creek and associated irrigation canals, but these habitats are highly impacted, ephemeral, and very dependent upon local irrigation practices and other water-use patterns. The populations of this species, particularly the one at Phantom Lake Springs, continue to be precarious because of the completely artificial nature of the remaining habitat to which they are restricted. An opportunity to observe the Phantom Lake Spring population in its natural habitat occurred when unusually heavy rainfall leading to heavy spring flows recreated Phantom Lake in late summer and fall of 1990. Seventy-three pupfish from this distinctive subpopulation of Cyprinodon elegans were collected and taken to the Federal Fish Hatchery at Uvalde to establish a refugium stock. The Pupfish Refugium Management Plan for Balmorhea State Recreation Area has been updated and is included in this report.

Threats to the species continue to include (1) the reliability of spring flows and the provision of adequate quantities of water to support robust populations, (2) current and projected land-use patterns, such as the use of chemicals associated with agricultural activities, in the area surrounding the springs and canals occupied by this fish, and (3) the introduction of exotic congeners and/or predatory species of fish into the system. Two separate projects to recreate and secure refugium habitats mimicking the original desert cienegas in which this species evolved have recently been initiated, involving several state and federal agencies, local landowners and NGOs. Success of these projects would improve the long-term security of this species.

FINAL REPORT

STATE: Texas **PROJECT NO.:** E-1-4

PROJECT TITLE: Endangered and Threatened Species Conservation.

PERIOD COVERED: September 1, 1991 through August 31, 1992.

JOB NUMBER: 2-1

JOB TITLE: Comanche Springs Pupfish (Cyprinodon elegans) status survey.

JOB OBJECTIVE: To investigate the current distribution and abundance of the Comanche Springs Pupfish (Cyprinodon elegans), assess the nature of threats to the species, and prepare and institute a comprehensive ecological monitoring plan.

ACCOMPLISHMENTS

See attached report.

SIGNIFICANT DEVIATIONS

None.

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TABLE 1. Sampling site descriptions and locations for the Comanche Springs Pupfish (Cyprinodon elegans) in the Balmorhea springs and canals system.

Site #1. Phantom Lake Spring outflow canal, Jeff Davis County, Texas. 30°56'06"N, 103°50'56"W.

A concrete diversion canal outside the mouth of Phantom Springs Cave, carrying the spring water historically destined for nearby Phantom Lake (now normally a dry grassy playa) eastward. The substrate is gravel with a few larger rocks and boulders, largely devoid of any submergent vegetation and with virtually no emergent vegetative cover at the sampling point.

Site #2. Highway canal between Balmorhea and Toyahvale, Reeves County, Texas. 30°58'15"N, 103°46'03"W.

A concrete drainage canal with some submergent vegetation growing along the bottom, otherwise with a concrete substrate. Several extremely large (pecan?) trees hang over the site, otherwise emergent vegetative cover is absent.

Site #3. Toyah Creek at Interstate 10, Reeves County, Texas. 31°00'17"N, 103°43'28"W.

A partially channelized streambed, with a silt bottom upstream of the highway bridge and a rocky/gravelly substrate downstream. Emergent vegetative cover is provided along the banks by reeds, grasses and Tamarisk. Cover is also provided by the bridge itself and attendant anthropogenic sources. The water quality samples are taken upstream from the bridge.

Site #4. "Carpenter Hill" canal between Balmorhea State Park and Lake Balmorhea, Reeves County, Texas. 30°57'12"N, 103°45'40"W.

A concrete drainage canal with an enlarged pool at the sample point. Silt substrate is present in the pool and deeper portions of the canal, otherwise the bottom is of concrete. Considerable emergent vegetative cover is provided by reeds, grasses, mesquite and acacia.

TABLE 1 cont.

Site #5. Pupfish refugium canal, Balmorhea State Park, Reeves County, Texas. 30°56'43"N, 103°47'05"W.

A shallow canal with a deep silt bottom and considerable submergent vegetation, predominately Chara, which fluctuates considerably in extent on a seasonal (?) basis. Emergent reedbeds (Scirpus and Typha) south of the Headquarters building and at the eastern bend of the canal were cut down between the May and September sampling periods. The canal is 240 m in length from the park entrance road to the outflow junction with the main canal draining San Solomon Springs.

Site #6. Phantom Lake Spring outflow canal downstream from Joe Kingston ranch house, Reeves County, Texas. 30°56'06"N, 103°49'26"W.

A concrete drainage canal with a shallow silt bottom and no submergent vegetation. A few scraggly acacia and mesquite provide minimal emergent vegetative cover.

TABLE 2. Abiotic environmental parameters measured at 6 sites within the Balmorhea springs and canals system supported the Comanche Springs Pupfish (Cyprinodon elegans). Refer to Table 1 and Maps 1-3 for site locations.

SITE	1	2	3	4	5	6
TEMP (°C)						
FEB 90	24.8	22.5	17.1	22.1	15.8	16.4
MAY 90	25.8	23.8	18.9	21.8	24.9	20.5
SEP 90	22.1	22.8	18.7	22.0	22.5	23.3
JAN 91	24.5	20.0	12.5	20.5	20.7	24.1
MAY 91	25.4	26.3	26.8	30.7	22.0	27.7
NOV 91	24.1	20.5	15.8	20.7	21.0	23.1
pH						
FEB 90	6.9	7.9	7.3	7.9	7.9	7.8
MAY 90	6.7	7.6	7.2	7.5	7.4	7.7
SEP 90	6.8	7.9	8.0	7.5	7.2	7.1
JAN 91	6.5	7.7	9.0	7.7	7.4	7.1
MAY 91	6.3	7.3	7.5	7.6	6.8	7.2
NOV 91	6.2	7.2	7.2	6.7	6.4	6.8
DISSOLVED OXYGEN (mg/L)						
FEB 90	1.8	9.2	10.9	8.8	11.7	7.7
MAY 90	1.7	8.1	7.7	7.5	7.5	7.5
SEP 90	7.1	7.7	8.0	8.3	6.2	7.9
JAN 91	1.2	9.1	9.8	9.7	13.4	7.1
MAY 91	1.2	8.5	8.0	9.0	6.2	7.7
NOV 91	2.0	8.5	9.9	7.7	3.9	6.8
CONDUCTIVITY (uS/cm)						
FEB 90	3640	3440	4650	3420	3470	3710
MAY 90	3330	3140	4090	3170	3140	3370
SEP 90	384	1358	642	1411	1429	359
JAN 91	3380	2630	3420	2620	2470	3370
MAY 91	3500	3120	3990	3120	3160	3490
NOV 91	3210	2220	3180	2230	2150	3070
TOTAL PHOSPHORUS (ug/L)						
FEB 90	<20	<20	25	25	<20	<20
MAY 90	<10	18	26	<10	28	<10
SEP 90	48	307	131	33	<20	55
JAN 91	<20	53	26	39	56	<20
MAY 91	<20	20	20	20	<20	30
NOV 91	63	104	54	130	90	68

TABLE 2 cont.

CHLORIDE (mg/L)

FEB 90	---	---	---	---	---	---
MAY 90	---	---	---	---	---	---
SEP 90	100	200	75	225	200	25
JAN 91	625	450	575	450	425	625
MAY 91	---	---	---	---	---	---
NOV 91	---	---	---	---	---	---

NITRATE (mg/L)

FEB 90	0.1	0.1	0.2	0.1	<0.1	0.1
MAY 90	0.2	0.2	0.2	0.2	0.2	0.1
SEP 90	1.4	1.4	1.2	1.4	1.8	1.5
JAN 91	0.6	0.6	1.4	0.7	1.6	0.3
MAY 91	.08	.10	.90	.10	.10	.03
NOV 91	.21	.46	.44	.79	1.56	.26

SULFATE (mg/L)

FEB 90	---	---	---	---	---	---
MAY 90	---	---	---	---	---	---
SEP 90	33	203	85	220	230	25
JAN 91	630	450	730	460	430	630
MAY 91	---	---	---	---	---	---
NOV 91	---	---	---	---	---	---

HARDNESS (mg/L)

FEB 90	810	770	1030	770	780	810
MAY 90	810	800	970	770	760	840
SEP 90	100	300	100	300	200	100
JAN 91	750	600	600	600	500	700
MAY 91	---	---	----	---	---	---
NOV 91	842	528	588	432	363	690

ALKALINITY (mg/L)

FEB 90	229	222	275	211	209	223
MAY 90	223	224	281	229	223	228
SEP 90	130	100	110	110	190	90
JAN 91	230	260	290	220	210	220
MAY 91	296	230	258	192	248	235
NOV 91	234	242	318	311	111	218

TOTAL SOLIDS (mg/L)

FEB 90	2410	2260	3100	2260	2230	2420
MAY 90	----	----	----	----	----	----

TABLE 2 cont.

SEP 90	----	----	----	----	----	----
JAN 91	----	----	----	----	----	----
MAY 91	----	----	----	----	----	----
NOV 91	---	---	---	---	---	---

TOTAL DISSOLVED SOLIDS (mg/L)

FEB 90	2370	2190	3040	2170	2190	2270
MAY 90	2360	2150	2870	2160	2140	2270
SEP 90	236	657	313	686	807	87
JAN 91	2085	1593	2164	1566	1481	2070
MAY 91	2300	2049	2680	2029	2018	2278
NOV 91	1945	1322	1951	1944	1151	1930

CHEMICAL OXYGEN DEMAND (mg/L)

FEB 90	6	6	9	6	20	16
MAY 90	<5	<5	<5	<5	<5	<5
SEP 90	<10	<10	<10	<10	<10	<10
JAN 91	<10	<10	<10	<10	<10	<10
MAY 91	<1	<1	2	<1	<1	1
NOV 91	<5	<5	<5	<5	<5	<5

FLOW (m/s)#

FEB 90	0.02	0.07	0.02	0.003	0.003	0.11
MAY 90	0.003	0.41	0.003	0.003	0.003	0.13
SEP 90	0.47	1.05	1.00	0.003	0.100	1.05
JAN 91	0.2	1.32	====	0.2	0.001	0.41
MAY 91	0.12	1.49	++++	0.001	0.010	0.19
NOV 91	N/A	N/A	N/A	N/A	N/A	N/A

DEPTH (cm)#

FEB 90	65	45	15	70	39	30
MAY 90	79	40	27	76	49	20
SEP 90	**	65	130	95	41	75
JAN 91	100	37	===	60	50	56
MAY 91	88	41	+++	42	39	48
NOV 91	N/A	N/A	N/A	N/A	N/A	N/A

WETTED PERIMETER (m)

FEB 90	2.4	1.6	7.2	6.4	3.7	1.5
MAY 90	---	---	---	---	---	---
SEP 90	***	2.1	8.6	5.4	4.6	2.5
JAN 91	2.4	1.35	7.7	6.9	---	3.2
MAY 91	2.45	1.45	7.8	6.5	4.1	2.2
NOV 91	---	---	---	---	---	---

TABLE 2 cont.

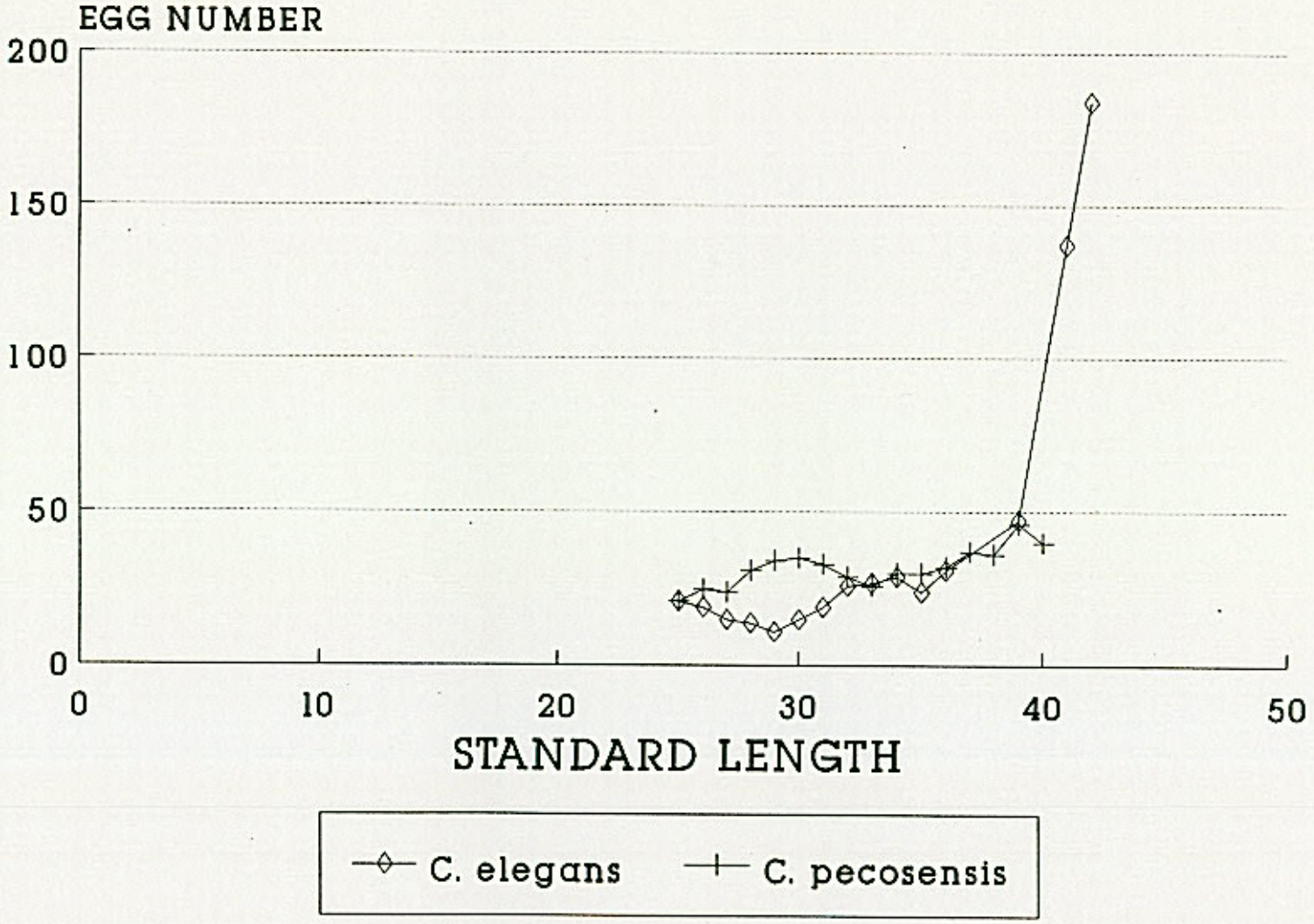
**** The physical situation at Phantom Lake Spring had changed radically. Heavy rains locally during the preceding 6 weeks had markedly increased springflow, overflowing the discharge canal and reconstituting Phantom Lake. Width and depth point estimates were meaningless. A videotape record of the event was made.

++++ Toyah Creek was a braided stream at the sampling point at this time, with two distinct channels separated by a gravel-silt bar. The "slow" channel had a depth of 8 cm and flow of 0.14 m/sec. The "fast" channel had a depth of 25 cm, flow of 0.66 m/sec, and was 2.4 m wide.

==== Toyah Creek was a braided stream at the sampling point at this time, with two distinct channels separated by a gravel-silt bar. The "slow" channel had a depth of 16 cm and flow of 0.21 m/sec. The "fast" channel had a depth of 39 cm and flow of 0.85 m/sec.

The February and May 1990 flow measurements were taken with a portable flow meter at a depth of 1 meter where possible, or at the deepest point, in mid-channel at each sampling station. The remaining flow measurements were taken with the "floating orange" method. Depth measurements were taken at mid-channel. Temperature, pH, dissolved oxygen, and conductivity were measured on-site with a Hydrolab, Series 4000. All other water quality analyses were conducted by the contaminants laboratory of the Resource Protection Division, Texas Parks and Wildlife Department, located at the A. E. Wood Fish Hatchery in San Marcos, Texas, from water samples collected and preserved in the field using standard methods. Original data sheets are on file at that facility, copies with the Endangered Resources Branch of TPWD in Austin, Texas.

FIGURE 1. Fecundity comparison between Cyprinodon elegans (this study) and C. pecosensis (data from Garrett, 1981, "Variation in reproductive strategy in Pecos Pupfish, Cyprinodon pecosensis", Ph.D. Diss., University of Texas at Austin). Data are for fish collected in May of 1990 and 1991 (C. elegans) and May and June, 1978 (C. pecosensis). Both data sets have been smoothed by a 3-point, floating average method.


EGG NUMBER
200
150
100
50
0
0
10
20
30
40
50
STANDARD LENGTH
C. elegans
C. pecosensis

APPENDIX 1. Summary of the biological results of the monitoring program for the Comanche Springs Pupfish (Cyprinodon elegans) in the Balmorhea springs and canals system.

Site #1

February 1, 1990

A 55 m section of the outflow canal (from 100 m below the cave to below the USGS gaging station) was seined beginning at 0900 hrs. 187 Gambusia nobilis and 19 Cyprinodon elegans (3 males, 14 females, 2 juveniles) were collected, all of which were returned to the water. Lepomis cyanellus were seen but not collected. A preserved collection of the other fish species encountered was made.

A 13 m section of the canal (2.5 m wide, 0.5 m deep) in front of Joe Kingston's ranch house was seined twice. Three Cyprinodon elegans (1 female and 2 juveniles) and 219 Gambusia nobilis were collected, and returned to the water.

May 15, 1990

Seining began at 1530 hrs., and a preserved sample of the fish collected was made. Many Astyanax mexicanus escaped the seine in the main canal. One seine haul in the isolated slough formed by the diversion outlet to Phantom Lake yielded 2 A. mexicanus, 16 Cyprinodon elegans (7 males, 8 females, 1 juvenile), 37 Gambusia nobilis and 40 G. geiseri. Another seine haul at the first diversion below the cave yielded a combined total of 446 G. geiseri and G. nobilis (74 males, 89 females, 283 juveniles). One seine haul below the USGS gaging station yielded 6 juvenile C. elegans and a combined total of 93 (20 males, 31 females, 42 juveniles) G. geiseri and G. nobilis.

One seine haul in front of Joe Kingston's ranch house yielded 16 Cyprinodon elegans (1 male, 3 females, 12 juveniles) and approximately 1200 Gambusia nobilis (250 males, 300 females, 650 juveniles).

September 25, 1990

Phantom Lake had been reconstituted by an extraordinary rainfall event, and the flow from Phantom Lake Springs had been in excess of 20 cfs for several weeks (Bill Williams, Reeves County Water District No. 2, pers.

comm.). We began seining at 1245 hrs. There were many small Astyanax mexicanus and Lepomis cyanellus throughout the cienega, along with many Gambusia. The following preserved collection was made: A. mexicanus (93), Gambusia geiseri (4), G. nobilis(12) and L. cyanellus (31). Very few (< 15)Cyprinodon elegans were encountered in open water of any depth throughout the system. We returned to Phantom Lake at 1730 hrs. and obtained approximately 50 C. elegans in organic detritus at the edges of flooded brush (mostly mesquite) with dipnets.

The flooded areas around Joe Kingston's ranch house yielded mostly Astyanax and a few C. elegans. The extent of the flooding in the Phantom Lake Springs system was documented on videotape.

January 8, 1991

The cienega had been drained by the local water district, and only 2 small pools remained. The canal in front of the Joe Kingston ranch house was almost totally devoid of vegetation. The following species were counted in the main canal from Phantom Lake Spring at 1245 hrs: Astyanax mexicanus (70), Gambusia geiseri (366), G. nobilis (47), and Lepomis cyanellus (44).

May 15, 1991

The following species were counted in the main canal from Phantom Lake Spring at 1500 hrs: Astyanax mexicanus (38), Cyprinodon elegans (6), Gambusia geiseri (219), and G. nobilis (20).

November 11, 1991

Spring flow had been up sufficiently in the recent past to flood the old cienega once again, and once again it had recently been drained by the local water district. The following species were counted in the main canal from Phantom Lake Spring: Astyanax mexicanus (31), Cyprinodon elegans (5), Gambusia geiseri (256), and G. nobilis (83).

Site #2

February 1, 1990

A preserved collection of the fish sampled here was made at 1130 hrs. Two Gambusia nobilis and one juvenile Cyprinodon elegans were collected, and 20

Dionda episcopa were frozen for biochemical work.

May 16, 1990

Very few fish were observed at 0930 hrs., although a preserved collection was made. One Gambusia nobilis and 5 Dionda episcopa were counted.

September 25, 1990

The flow was too high to seine and dipnets were used in the main canal. The following were collected at 1030 hrs. (bold indicates specimens taken in a quiet side canal): Astyanax mexicanus (8), Cyprinodon elegans (2 males, 1 female, 7 juveniles), Dionda episcopa (1), Gambusia geiseri (2) and G. nobilis (4 + 2).

January 8, 1991

Intermittent beds of submerged filamentous algae were present in dark water. The following fish were counted at 1000 hrs: Astyanax mexicanus (5), Dionda episcopa (2), Gambusia geiseri (5), G. nobilis (1), and Ictalurus lupus (13).

May 15, 1991

The following fish were counted at 1645 hrs: Astyanax mexicanus (10), Ictalurus lupus (3), and Lepomis cyanellus (1).

November 11, 1991

The following fish were counted: Astyanax mexicanus (6), Dionda episcopa (1), Ictalurus lupus (2), Ictalurus sp. (10), Lepomis cyanellus (1), L. megalotis (5).

Site #3

February 1, 1990

A preserved sample of the fish collected at 1320 hrs. was made. Eight Cyprinodon elegans (2 males, 3 females, 3 juveniles) and 350 Gambusia nobilis were counted.

May 16, 1990

The following were collected at 1015 hrs.: Cyprinodon elegans (1), Lucania parva (26), Gambusia affinis (93),

G. geiseri (8), Lepomis megalotis (1) and Micropterus salmoides (1). More than 60 G. affinis and approximately 30 L. parva were released.

September 25, 1990

The flow at 0940 hrs. made seining difficult and unproductive; numerous attempts yielded 2 Gambusia affinis which were not retained.

January 8, 1991

The water level was down considerably from the previous sampling period, and flecks of white foam were present in the sampling area. The high grass present along the banks previously was gone. Floating mats of algae constricted the flow into channels throughout a 100 m stretch above the bridge, and long filamentous algae was also present submerged in these channels. Sampling at 0900 hrs yielded no fish.

May 15, 1991

Two distinct channels were present at the sampling site, one shallow with slow flow and one deeper with faster flow. The following fish were counted at 1622 hrs: Astyanax mexicanus (2), Dionda episcopa (29), Gambusia affinis (2), G. geiseri (4), and Lepomis cyanellus (4).

November 11, 1991

The channel has been altered; there is now one continuous channel across with smooth, laminar flow. There has been considerable bank erosion under the bridge. The water is clear with minimal submerged algae, and the substrate is mostly clear silt and cobble. The following fish were counted: Dionda episcopa (7), Gambusia geiseri (13).

Site #4

February 1, 1990

A preserved sample of the fish collected at 1515 hrs. was made. Nine Cyprinodon elegans (1 male and 8 females) and more than 300 Gambusia affinis were counted.

May 16, 1990

The following were collected at 0900 hrs: Astyanax mexicanus (8), Cyprinodon elegans (7 males, 7 females, 16 juveniles), Dionda episcopa (8), Gambusia affinis (117) and G. geiseri (15). An additional 6 juvenile C. elegans and approximately 50 G. affinis were returned to the water.

September 25, 1990

The canal from the pool downstream to the main feeder canal to Lake Balmorhea was seined at 1110 hrs. The following were collected: Cyprinodon elegans (3 males, 6 females, 14 juveniles), Dionda episcopa (34), Gambusia affinis (298), G. geiseri (58) and G. nobilis (1).

January 8, 1991

Water was up, with high swirling flow in the pool and high velocity in the channels with the islands submerged. The following fish were counted at 1100 hrs: Astyanax mexicanus (1), Dionda episcopa (6), Gambusia affinis (27), and G. geiseri (10).

May 15, 1991

The following fish were counted at 1715 hrs: Dionda episcopa (9), Cyprinodon elegans (2 males, 4 females, 12 juveniles), Gambusia affinis (38), and G. geiseri (91).

November 12, 1991

Water flow is simply roaring through here, with the water level higher than it ever has been during this project. Sampling at 0830 hrs yielded no fish.

Site #5

February 1, 1990

Three 10 m sections of the refugium canal were sampled to estimate the total population of Cyprinodon elegans at 1645 hrs. A block-off seine was placed at one end of each section, and the fish were herded into it by means of a second seine; both seines spanned the width of the canal. See table below for comparisons between sampling periods. In addition, 17 Gambusia nobilis were counted in the three samples.

May 16, 1990

The following preserved collection was made at 1115 hrs: Astyanax mexicanus (24), Dionda episcopa (7), Gambusia geiseri (59), unidentified cyprinid (1). Approximately 53 Gambusia nobilis were counted.

September 26, 1990

One of the park rangers told us he had recently removed 6 catfish from the refugium canal that had gained access during the flooding from the main canal draining San Solomon Springs. An additional catfish was observed during the course of seining, which began at 0910 hrs. The spring flow has been in excess of 50 cfs for several weeks (Bill Williams, Reeves County Water District No. 2, pers. comm.); the extent of the effects locally are documented on videotape. The following additional fish species were counted and a representative preserved collection made from the three sampling points: upstream segment (5 m only) -- Astyanax mexicanus (23), Dionda episcopa (4), Gambusia geiseri (993), G. nobilis (219); middle segment -- A. mexicanus (35), D. episcopa (3), G. geiseri (11), G. nobilis (10); downstream segment -- A. mexicanus (35), D. episcopa (5), G. geiseri (438), G. nobilis (50).

January 8, 1991

The water level was down some compared to previous sampling periods. The upstream and middle sampling segments exhibited almost solid mats of submerged algae, whereas the downstream segment had a virtually bare silt substrate. In addition to the pupfish detailed below, 83 Gambusia nobilis (32 males, 51 females) were counted at 1600 hrs. Gambusia geiseri were not enumerated, but outnumbered G. nobilis by at least 100 to 1.

May 16, 1991

In addition to the pupfish detailed below, the following fish were counted at 0930 hrs: Astyanax mexicanus (5), Dionda episcopa (40), Gambusia geiseri (1,807), and G. nobilis (521).

November 12, 1991

In addition to the pupfish detailed below, the following fish were counted: Astyanax mexicanus (73), Gambusia geiseri (3,885), G. nobilis (180), and Lucania parva (1).

Cyprinodon elegans taken at the 3 sample points in the Refugium Canal at Balmorhea State Park

		downstream	middle	upstream	total
FEB 90	male	0	1	22	23
	female	1	3	67	71
	juvenile	49	6	81	136
	TOTAL	50	10	170	230
MAY 90	male	19	12	3	34
	female	23	28	6	57
	juvenile	2	28	0	30
	TOTAL	44	68	9	121
SEPT 90	male	65	3	8	76
	female	141	9	23	173
	juvenile	309	53	199	561
	TOTAL	515	65	230	810
JAN 91	male	22	2	9	33
	female	93	9	16	118
	juvenile	294	39	50	383
	TOTAL	409	50	75	534
MAY 91	male	52	51	25	128
	female	147	97	31	275
	juvenile	65	40	15	120
	TOTAL	264	188	71	523
NOV 91	male	13	7	1	21
	female	20	20	17	57
	juvenile	270	16	15	301
	TOTAL	303	43	33	379

Site #6

February 1, 1990

A 9 m section of the canal was seined at 1045 hrs. Seven Gambusia nobilis and 47 Cyprinodon elegans (2 males, 21 females, 24 juveniles) were counted.

May 16, 1990

The following preserved collection was made from one seine haul with a block-off seine at the eastern end of the canal at the road underpass at 0800 hrs.: Astyanax mexicanus (11), Cyprinodon elegans (3 males, 2 females) and Gambusia geiseri (18).

September 25, 1990

The flow was too high to seine, and the overflow in nearby pastures too brushy. Astyanax mexicanus, Gambusia nobilis and Lepomis cyanellus were caught with dipnets and not retained.

January 8, 1991

The following fish were counted at 1500 hrs: Astyanax mexicanus (40), Dionda episcopa (1), Gambusia geiseri (28), G. nobilis (1), and Lepomis cyanellus (6).

May 15, 1991

The following fish were counted at 1530 hrs: Astyanax mexicanus (6), Gambusia geiseri (1), Cyprinodon elegans (1), and Lepomis cyanellus (20).

November 11, 1991

The following fish were counted: Astyanax mexicanus (46).

The following sites were sampled incidentally:

Giffin Spring, Reeves County, Texas
(30°56'41"N, 103°47'29"W)

May 15, 1990

Thousands of Gambusia were counted; 99.5% of them were G. geiseri. One male Cyprinodon elegans was counted 100 m downstream in San Solomon Creek.

West Sandia Spring, Reeves County, Texas
(30°59'12"N, 103°44'10"W)

May 16, 1990

The outflow from this spring, a shallow (0.01 m), narrow (0.3 m), sluggish, silt-bottomed stream of apparent poor quality flowing through a field of Giant Cane (Arundo donax), producing substantial erosion, was sampled and yielded 3 Gambusia affinis and 1 Dionda.

East Sandia Spring, Reeves County, Texas
(30°59'27"N, 103°43'43"W)

May 16, 1990

A deep (1 m +), open cienega surrounded by Scirpus and Typha. The water is very dark and the bottom is a thick (0.5 m) layer of silt, mud and organic detritus. Cyprinodon variegatus, Gambusia geiseri and G. nobilis were the only species counted, and a representative preserved collection was made.

Life History Characteristics of Cyprinodon elegans

Female fish from site #4 (1990 - 5 fish; 1991 - 4 fish) and site #5 (1990 - 7 fish; 1991 - 7 fish) were examined for fecundity data, and preliminary results are shown in Figure 1. Cyprinodon elegans appears to be qualitatively similar to at least one other congener, C. pecosensis, in size-specific egg production.

Quantitative diet characteristics were not determined. Examination of the specimens used in the above reproductive analysis along with additional male specimens revealed that C. elegans feeds on detritus.

Pupfish Refugium Management Plan
Balmorhea State Recreation Area
Texas Parks and Wildlife Department

The refugium at Balmorhea State Recreation Area was constructed in 1975 to provide suitable lasting habitat for the Comanche Springs pupfish (Cyprinodon elegans), a small endangered fish which is endemic to spring runs in the Balmorhea area. The department's objective is to maintain this refugium to provide the best available habitat for the pupfish as well as for another small endangered fish, the Pecos gambusia (Gambusia nobilis), a co-inhabitant. Following are procedures which will maintain habitat suitable for the continued conservation of the two endangered fish species occupying the refugium.

Vegetation in the refugium.

(1) Limited vegetational growth should be encouraged.

(2) When aquatic plants are essentially continuous for longer than 50 feet, mechanically remove (by hand, no chemicals) ten-foot-wide swaths perpendicular to the channel for every 50 feet of aquatic plants throughout the length of the refugium. Rotate placement of swaths so as to remove aquatic plants where most dense.

(3) Cattails and other emergent vegetation should be mechanically removed.

(4) A series of photographs depicting adequate vegetation control levels will be prepared to facilitate"Monitoring (3)."

Substrate thickness.

If substrate depth exceeds 6 inches, contact David Riskind.

Water quantity/quality in the refugium.

(1) Water flow through the refugium must be maintained at no less than 50 percent of normal flow. The auxiliary pump should be used to maintain greater than 50 percent normal flow. Normal flow is 1 cfs.

(2) Chemical pesticides and herbicides should never be used in the park area if they could enter the refugium directly or indirectly.

(3) The refugium auxiliary pump will be adequately tested two weeks prior to the periodic draining of the swimming pool for cleaning and maintenance. This is to allow time for pump repair or acquisition of a replacement pump if needed.

Other animal species in the refugium.

(1) Predators such as green sunfish, catfish, and water snakes should be removed from the refugium by monitoring team members whenever recommended by "Monitoring (5) or (6)."

(2) No fish species of any kind are to be introduced into the refugium, swimming pool, or nearby canals without a permit from the Resource Management Section who will coordinate such introductions with the appropriate specialists.

(3) Removal of specimens of endangered fish species from the refugium require federal, state, and state park permits.

Landscaping changes in the vicinity of the refugium.

(1) Landscaping changes in the vicinity of the refugium are to be avoided: no new shrubs or trees are to be planted where their shade may cast onto the refugium. Landscape modifications require coordination with the Resource Management Section.

(2) No changes in contour which would affect runoff and thus affect sedimentation in the refugium are to be made.

Education.

(1) Interpretive materials regarding the refugium and the endangered fishes therein will be prepared and made available to Park Headquarters for distribution to the public.

(2) Interpretive displays currently describing hydrology of the area, portraying general water needs of the region, and depicting how the park is solving the problems of providing a continual adequate water supply for the refugium will be revised to reflect changes recommended by appropriate specialists.

(3) Introduction of live fish into the park is prohibited. Introductions of nonnative fishes would increase the dangers of predation, competition, and hybridization. While signs are not recommended, park personnel should be ever alert to the need to inform the public, particularly those who fish in nearby Lake Balmorhea, of the prohibition of introductions and why.

Monitoring.

(1) Daily by park personnel to ensure adequate water flow through the refugium and to remove all litter, both organic and of human derivation.

(2) Weekly by park personnel to ensure adequate control of predators and to ascertain that fish populations in the refugium are at normal and healthy levels.

(3) Monthly during the warm months by park personnel to ensure that aquatic plant growth and emergent vegetation are at acceptable levels in the refugium. Refer to the series of labeled photographs on file at Park Headquarters as an aid in determining acceptable vegetation levels.

(4) Auxiliary pump will be tested bimonthly (every other month) to ensure that it is in good working order; repair or replace if necessary.

(5) Quarterly by a TPWD monitoring team, to sample fish populations for genetic stability and population health. Recommendations to park personnel with regard to the need to control predator numbers and/or vegetation will also be made as necessary.

(6) Unscheduled by appropriate specialists to ascertain any and all of the above.

Stability.

(1) Any change in conditions should be reported to David Riskind.

(2) Be conservative in making any change which could affect the refugium - it's generally doing quite well in its present condition regarding stream flow, substrate, and overhead cover.

(3) Any change regarding the refugium or which could affect the refugium must first be cleared through the Parks Resource Management Section. This section will then establish review process prior to change being effected.

Consultants.

Persons to be contacted for advice in any case not covered by above instructions, but which could have an adverse impact on the fish species we are protecting. Report problems as soon as noted, don't wait until it's too late.

(1) Supervisors will be notified of problems which arise, particularly those not routine.

(2) David Riskind, Parks Resource Management Section, Austin (1-800-792-1112, x 4897).

(3) Dr. Gary Garrett, Fisheries Research Biologist, Heart of the Hills Research Station, HC 7 Box 62, Ingram, Tx 78025 (210-866-3356).

(4) Jack Ralph, Resource Protection Chemist, San Marcos, (512-353-3474) for fish kills and water quality.

(5) Terry James, Texas Water Commission Biologist, Odessa, (915-332-5122) for fish kills and water quality.

(6) Dr. Clark Hubbs, Rio Grade Fishes Recovery Team Leader, Austin, (512-471-1176).

(7) Dr. James Scudday, Biologist, Alpine, (915-837-8084).

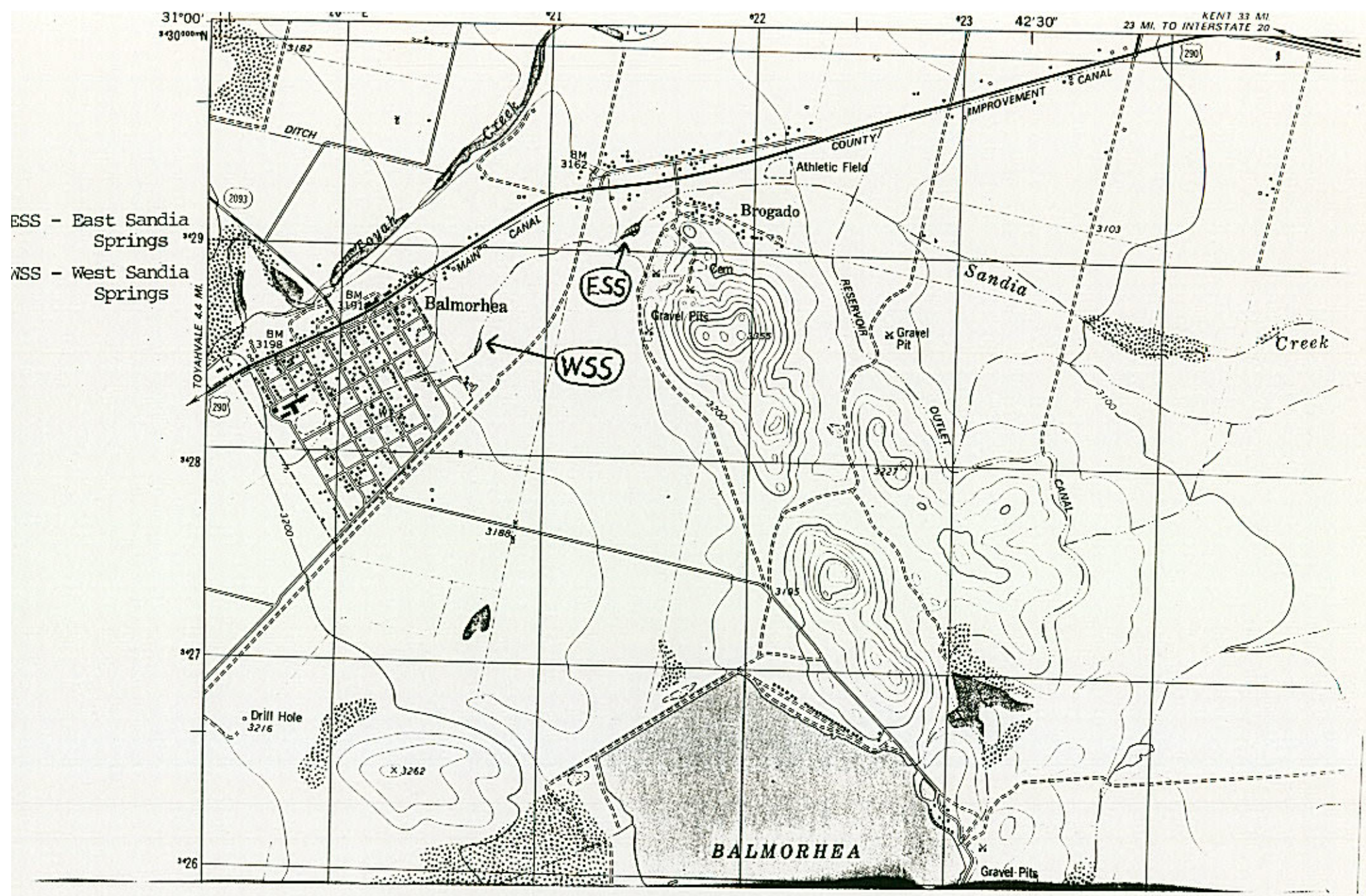


Figure 2. Sample sites - Balmorhea Quadrangle.

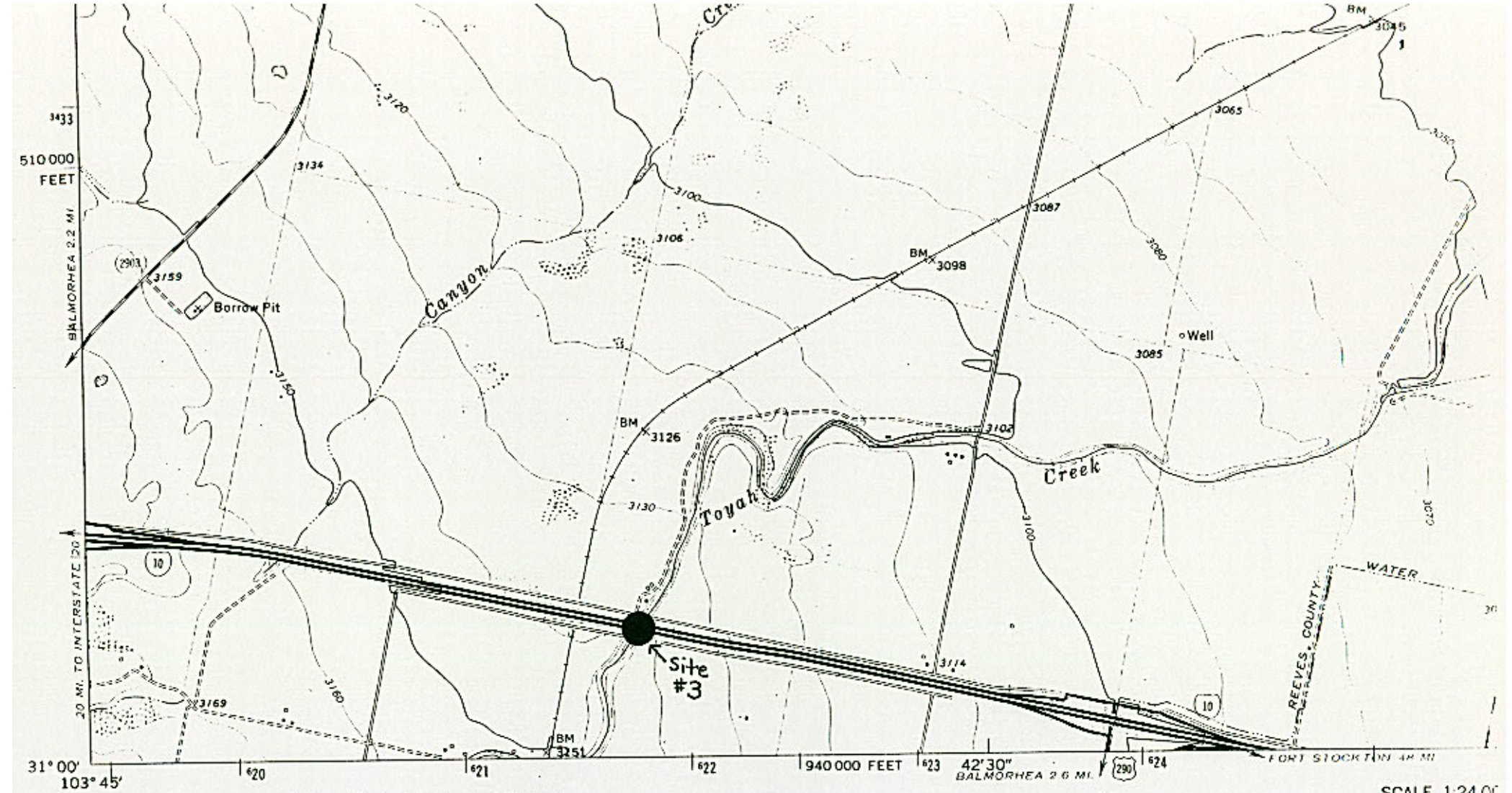


Figure 3. Samples sites - Saragosa Quadrangle.

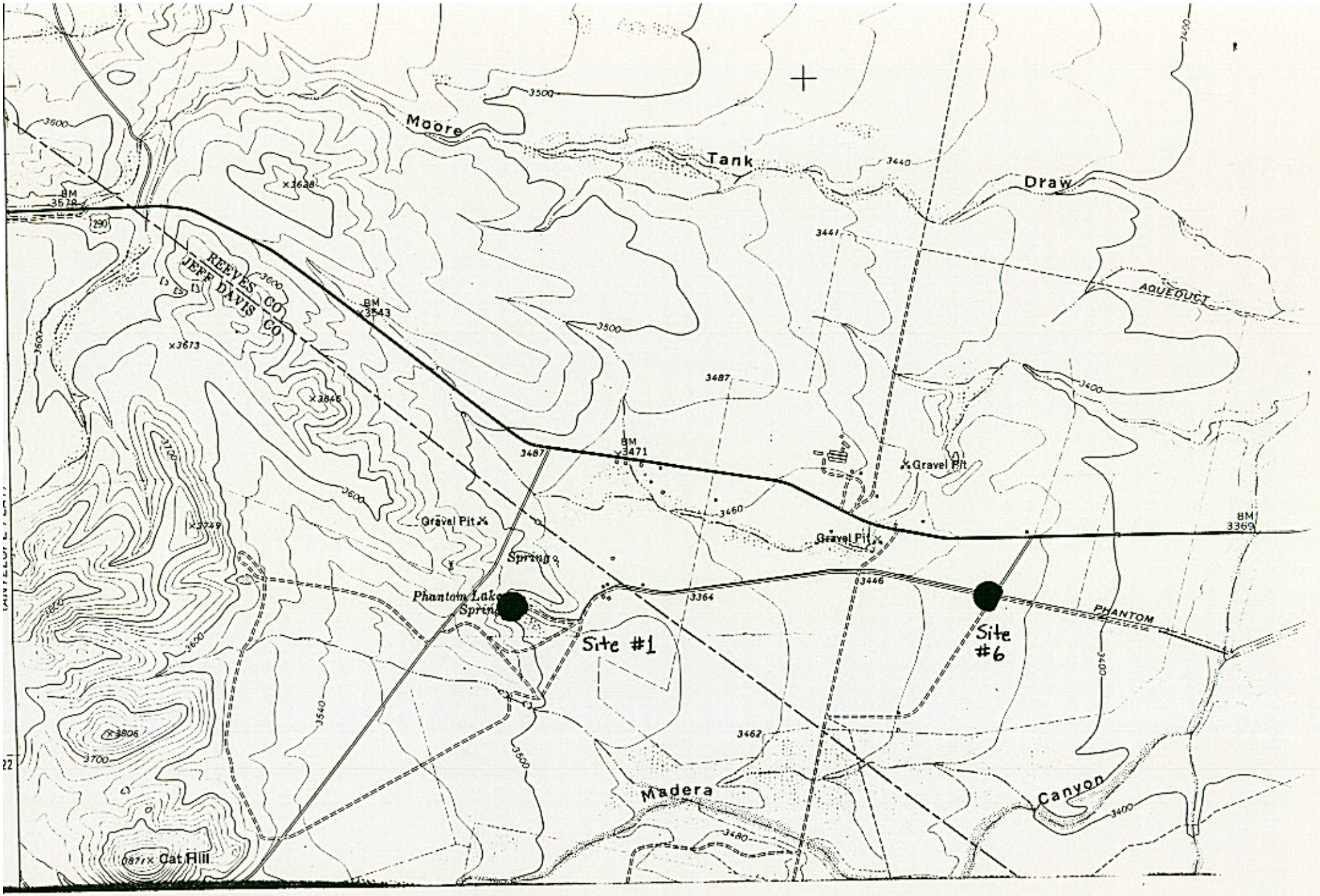


Figure 4. Sample sites - Toyahvale Quadrangle.

Figure 5. Sample sites - Toyahvale Quadrangle