BIOLOGICAL ASSESSMENT

VOLUME I

A STUDY OF DESERT TORTOISE ABUNDANCE AND HABITAT

MAIN AND SOUTH BASE AREAS EDWARDS AIR FORCE BASE, CALIFORNIA

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1.0 PROJECT DESCRIPTION

The Edwards Air Force Base (AFB) Main Base and South Base cantonment areas support the flight test mission at Edwards AFB. There are two active runways used to launch aircraft. Ground support facilities, including hangars, ground equipment storage yards, and fueling operations, etc., are located along the flight lines. Administrative support is located in the main base cantonment area. Dormitories and family housing are provided for approximately 3,000 military personnel. Other services including the base exchange, bank, dining establishments, commissary, and post office, etc., are located within and adjacent to housing areas. Recreation in the Main Base area includes a golf course, library, movie theater, bowling alley, ballfields, and a park.

Runway maintenance activities, new building construction, roadway maintenance, and utility upgrades are routinely performed in support of the flight test mission. Utilities such as water, sewer, electric, and communication lines are in constant need of maintenance and new administrative, service, and ground support facilities will be constructed to meet future flight testing program needs.

This study was designed to estimate densities of desert tortoises on and near the Cantonment Area. Recommendations for mitigating adverse effects on tortoises are discussed.

2.0 PROPOSED STUDY AREA

The Main Base/South Base area includes most of the cantonment areas of Edwards AFB. It includes support areas, housing, and flight test operations buildings. Only the undeveloped portions of this area were surveyed. The study area is approximately 2,150 hectares (5,312 acres) in size and includes land in four townships of Kern County (Table 1, Figure 1).

Table 1 - LEGAL DESCRIPTION OF MAIN/SOUTH BASE STUDY AREA

Township	Range	Sections
10 North	10 West	Portions of 13, 14, 23, 24, 26, 27, 28, 34, 35
9 North	10 West	Portions of 1, 2, 11 (all) ,12
9 North	9 West	Portions of 5, 6
10 North	9 West	Portions of 30, 31

The study area has been heavily impacted by military-related activities. Urbanized areas account for approximately 16 percent of the area. This area is not considered desert tortoise habitat.

Elevations in the study area range from 692 to 762 meters (2,270 to 2,500 feet). The geomorphology transitions from very flat near Rogers Lake (the eastern and southeastern boundary of the study area) into a gradually rising bajada sloping to the southeast. The northwestern extreme of the study area is hilly.

Two distinctive plant communities are found within the survey area, Saltbush Scrub and Creosotebush Scrub (Figure 2). The Saltbush Scrub community can be further divided into the saline phase (*Halophytic*) and arid phase (*Xerophytic*). Arid phase Saltbush Scrub consisting primarily of allscale (*Atriplex polycarpa*) is found on most of the project area while the saline phase is limited to the edge of Rogers Lake and the southern tip of the project area. The remainder of the site is Creosotebush Scrub, dominated by Creosotebush (*Larrea tridentata*) in association with burrobush (*Ambrosia dumosa*). The Creosotebush Scrub community is limited to the northern extreme of the project area. The most abundant plant community in the study area was Arid phase Saltbush Scrub (63 percent), followed by Creosotebush Scrub (20 percent) and Saline phase Saltbush Scrub (17 percent).

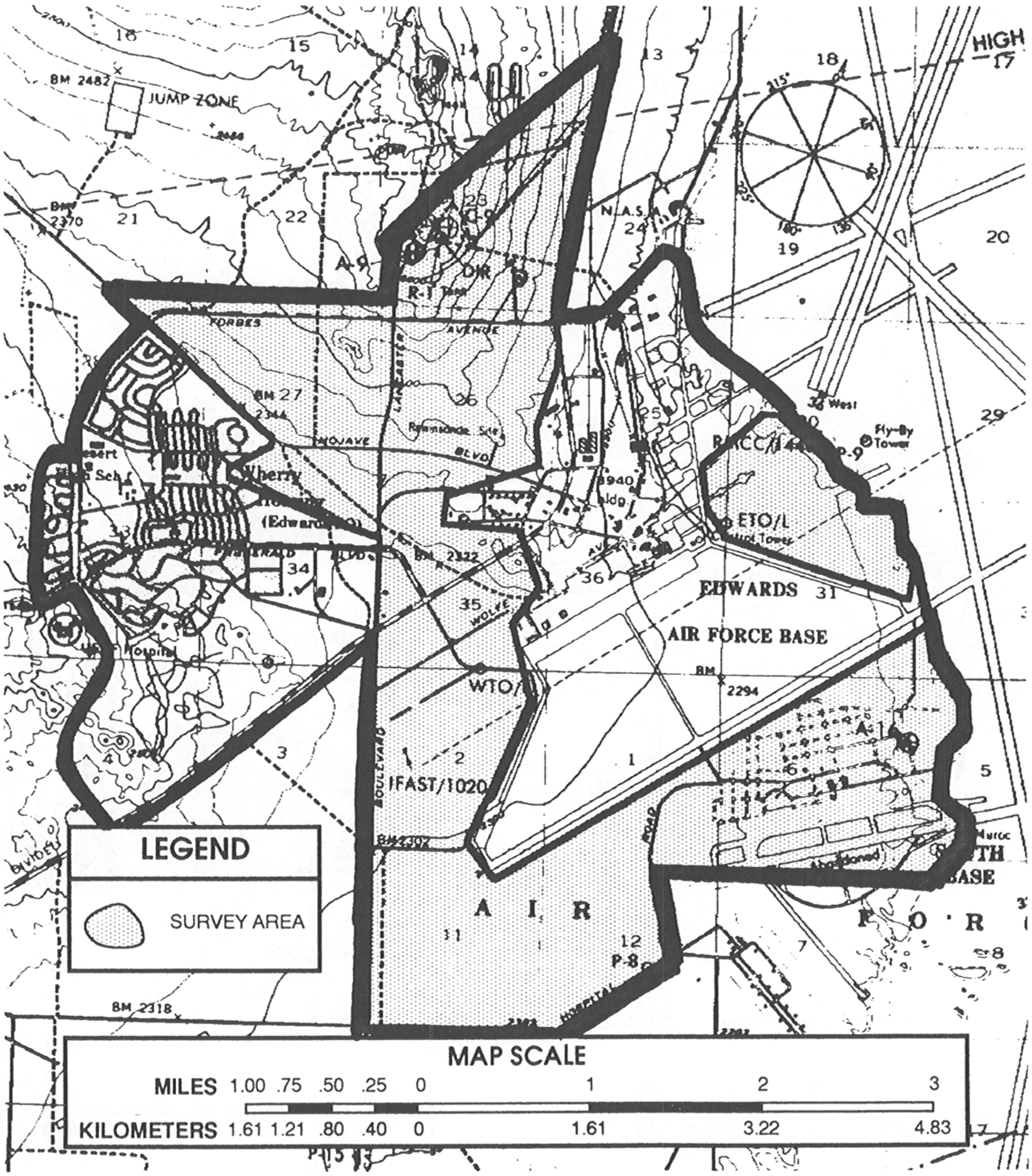


Figure 1 - Edwards A

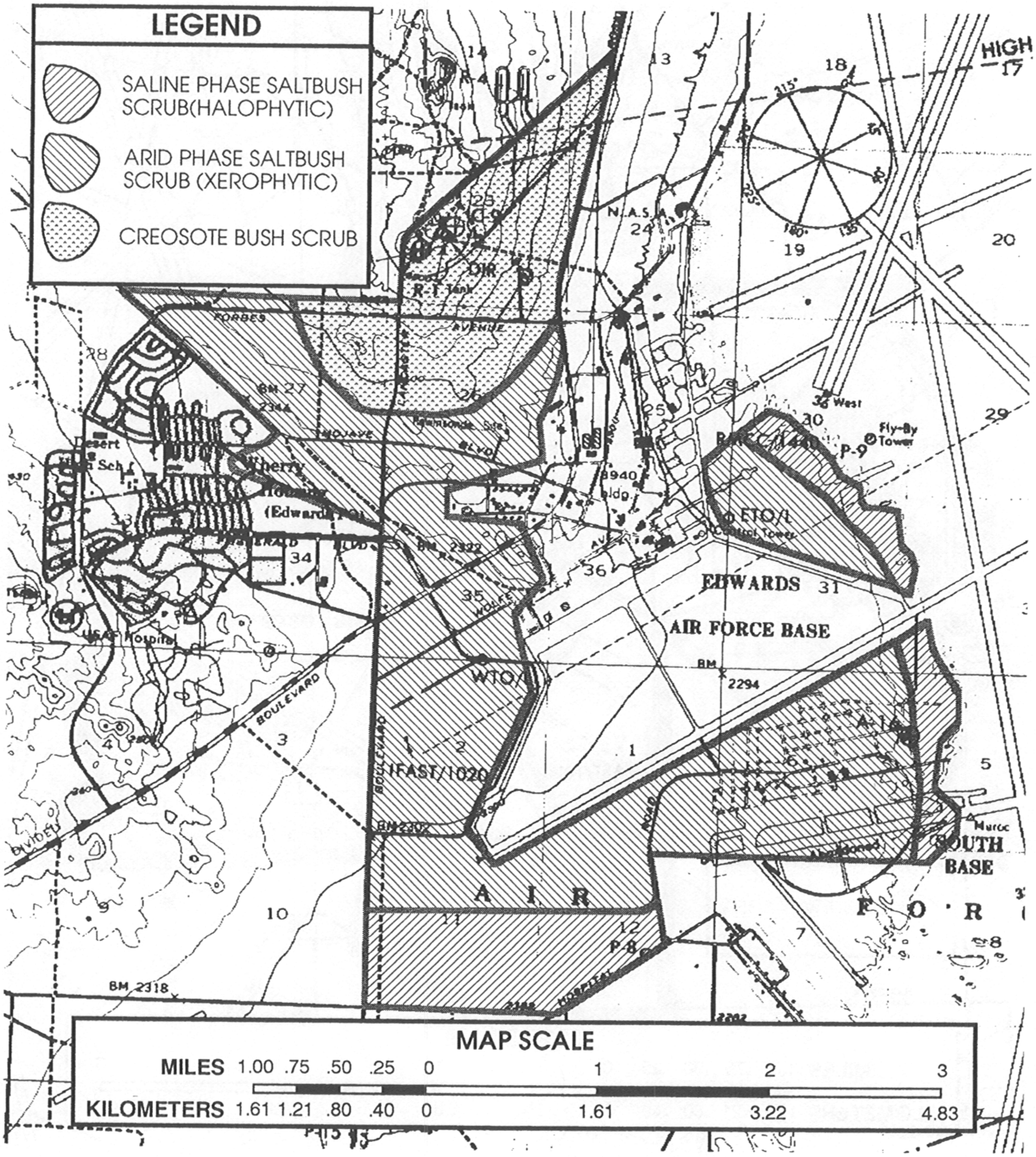


Figure 2 - Edwards Air Force Base Main and South Base, Vegetation Distribution in Study Area

3.0 METHODS

3.1 Technical

Given the extent of the study area, a total coverage survey was deemed logistically and economically unfeasible. Therefore, a different method of surveying capable of estimating desert tortoise populations throughout large areas was utilized. This method basically consisted of breaking the survey area into 160- by 160-meter grids (0.1- by 0.1-mile). A computer-generated, random sample of 30 percent of the gridded area containing habitat was surveyed. The selected grids were sampled using 100-percent coverage according to U.S. Fish and Wildlife Service (USF&WS) protocols. Individual tortoise sign was tallied for each grid.

3.2 Grid Selection

All grids were selected on a legal section basis using a computer-generated, random numbers list. Since habitat type varied geographically, this method produced approximately the same degree of sampling in each habitat type. Topographic maps of the area were updated just prior to beginning field work to include new structures not shown on the 1973 United States Geological Survey (USGS) maps. By using an overlay on these topographic maps, it was determined whether the selected grid intercepted an existing structure. If this occurred, a new random grid was selected.

3.3 Field Team Correlation

A training and standardization program was initiated before test grids were walked. This program consisted of several steps.

An in-house protocol manual precisely describing the methods to be used, and the standards for classification of sign was developed. The 42-page protocol manual was reviewed and approved by Air Force personnel, and then distributed to all field team members. It included a detailed description of each task in the project including precise methods to be used in each phase. General information about desert tortoise was also included.

After the protocol manual was reviewed, the field team spent 1 day near the Desert Tortoise Natural Area to review sign and practice the methods detailed in the protocol manual. Team members recommended more detailed standardization and minor changes in methods. These changes were incorporated prior to survey implementation.

Although this document was not directly reviewed by USF&WS, all ideas and techniques presented in the manual were approved verbally.

Relative density transects were used for practicing sign counts and to test the ability of each investigator to observe sign at the same level as all other investigators. Relative density transects are large equilateral triangles with each side measuring 0.8 kilometer (0.5 mile). Transect width was 10 meters. These were used for standardization because the impacts of each observer could be spread out over a large area. This was to prevent bias due to subsequent observers walking in the footprints of the prior observer, which led to the previously observed burrow or scat. While this would probably lead to very close sign counts, it would not test the ability of the observer. To alleviate this potential problem, each transect was shifted 2 degrees from the previous investigator's transect.

A total of 18 relative density transects were walked at 3 different sites; 6 per site in a standard calibration format. At each site, the apex of the transect triangles began at a common point in the center of the test area. A line from the apex of the triangle bisecting the opposing base of the triangle pointed in each of the four cardinal directions plus northwest and southeast. After successful completion of the relative density transects, several practice grids at Edwards AFB were walked by investigators in order to apply their experience in relative density type transects to 160- by 160-meter (0.1- by 0.1-mile) grids.

3.4 Sample Size Analysis

Prior to the commencement of this project, an effort was made to design a cost-effective sampling regime that would provide accurate representations of tortoise density for large areas. The Total Corrected Sign (TCS) has been recorded for 131 grids previously surveyed at Edwards AFB. A statistical summary of the data from those grids is contained in Table 2.

Table 2 - STATISTICAL SUMMARY OF TCS

Mean:	Standard Deviation:	Standard Error:	Variance:	Coefficient Variance:	Count:
3.443	3.282	0.287	10.772	95.332	131
Minimum:	**Maximum:**	**Range:**	**Sum:**	**Sum of Square:**	**Missing:**
0	17	17	451	2,953	0
t 95 percent:	**95 percent Lower:**	**95 percent Upper:**	**t 90 percent:**	**90 percent Lower:**	**90 percent Upper:**
0.567	2.875	4.01	0.475	2.968	3.918

Minimum sample size was calculated based on these previous grids using the following equation from Daniel (1978):

$$n = \frac{N z^2 \delta^2}{d^2(N-1) + z^2 \delta^2} = 31.71$$

where:

n = minimum sample size
N = number of pilot samples used = 131
z = the reliability coefficient, value from z distribution at desired confidence limits (95 percent) = 1.96
δ = standard deviation of sample, 3.282

and

d =1

The minimum sample size required was between 29 and 32 grids, depending on which statistical program was used. Based on this information, 30 percent of the grids were randomly selected from the available habitat found within each section. For example, if a section consisted entirely of habitat, 30 grids were surveyed. If only a portion of a section was suitable habitat (i.e., the section contained developed areas), the number of grids surveyed was reduced to 30 percent of the available habitat found in the section.

3.5 Surveying and Marking

For the grid based survey to be successful, an accurate grid marked on the ground was established. Grid corners were established on the ground by using a Leitz Set-2 total survey station with an integral electronic distance meter. In operation, one team operated the survey station while three other teams carried range poles with multiple reflecting prisms. The survey station operator directed range pole operators to grid corners by radio communication. Measurement accuracy was within 0.25 centimeter (0.1 inch) distance and 5 seconds of arc.

The grid was marked on the ground by driving a 1.3-meter (4-foot) long piece of rebar into the ground and placing a 3.3-meter (10-foot) tall piece of polyvinylchloride (PVC) pipe over it. Flagging was tied to the top of the pole to enhance visibility and the grid number was written on the PVC pipe. The grid number was assigned to the pole in the northeastern corner of the grid. Only those grids that were randomly selected were established.

For each section, there are 100 grids numbered from 00 in the northwest corner to 99 in the southeast corner (Figure 3). There are 10 grids per row.

3.6 Data Form

A field recording form was designed specifically for this project. Primarily the form is a map of the individual grid with a specified format for recording sign (Figure 4). The categories of sign recorded follow USF&WS recommended protocols. Recorded sign included live tortoises, carcasses, coversites, scats, drinking depressions, and other sign. Further information was recorded on the maps for each category of sign. Sign data recorded included the following:

a. Live tortoises - a number (dependent on location), estimated midline carapace length (MCL), and sex;

b. Carcasses - a number (dependent on location), estimated MCL, sex, and time since death. Time since death was estimated using keys developed by Berry and Woodman (1984). The classes used included:

   1. dead less than 1 year,

   2. dead 1 to 2 years,

   3. dead 2 to 4 years, and

   4. dead over 4 years.

Additional data were recorded on Shell Data Cards (Volume II, Appendix F).

c. Coversites - Location relative to vegetation; land feature; etc.; length; width; height; soil cover at entry; and condition. Condition was described as one of the following:

   1. Excellent - tortoise in burrow or evidence of recent use;

   2. Good - burrow in good condition but no evidence of recent use;

   3. Fair - burrow may be degrading, vegetation in mouth; and

   4. Poor - burrow degraded significantly, may be partially collapsed but still usable by tortoises with some cleanup.

d. Scat - number of scat in location, size (adult, subadult, immature, or juvenile), age (this year or older).

e. Drinking depressions - width and depth.

Sign counts were summed and placed on data forms. The two types of sign counts recorded were total sign and TCS. Total sign is the sum of all individual sign located. The TCS is an adjustment made to the sign count to account for multiple pieces of sign produced by the same tortoise; hence it is normalized. It also does not include carcasses. This number is primarily used on relative density transects for determining population estimates. It is used in this work primarily because it is less variable than total sign.

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

Figure 3 - Sample Grids in Section

RECORDER________
PROJECT EAFB MB/SB
GRID ______ SECTION______
TOWNSHIP____ RANGE_____
COUNTY__KERN_, CA

GEOMORPHOLOGY________
ASPECT_______ SLOPE AVG(%)_______
ELEVATION_______ VEG TYPE________
TRANSECT WIDTH 10 METERS
GRID SIZE 160 m X 160 m

DATE________
START TIME______ FINISH TIME______
TOTAL SIGN______ TCS______
LIVE_____ SHELLS_____ SCATS_____
COVERSITES______ OTHER______

LEGEND	ENTRY FORMAT	
▲ HEALTHY TORTOISE	▲ TORT#, SEX MCL	⌓ LOCATION, CONDITION LENGTH, WIDTH, HEIGHT, SOIL COVER
URDS SYMPTOMATIC TORTOISE		
● SCAT	● NUMBER OF SCAT SIZE (AD, SA, IM, JU) AGE (THIS YEAR, OLD)	○ WIDTH, DEPTH
■ SHELL		
⌓ COVERSITE		
○ DRINKING DEPRESSION	■ MCL, SEX TIME SINCE DEATH	✕ IDENTIFY
✕ OTHER		

Figure 4 - Data Form Used for Recording Sign

An example of these sign categories follows:

> Suppose one finds a burrow with a tortoise inside and five scat in and around the burrow. This would yield a total sign count of seven but a TCS count of one since all of this sign was likely produced from a single tortoise.

Original data forms are contained in Volume II, Appendices D and E. Volume II, Appendix D includes data forms for grids where sign was found. Volume II, Appendix E includes data forms for grids where sign was not found.

3.7 Field Surveys

Surveys were conducted by Gilbert Goodlett, Glenn Goodlett, Kevin Fleming, Eric Holle, Katey Palmer, Mike Walker, Rick Eisenbart, and Ray Romero. All surveyors had significant prior experience with desert tortoises.

Field teams consisted of one person and each person surveyed a single grid at a time. Transects were walked in all grids using a north-south orientation. Transect spacing was maintained at 10 meters with 16 transects walked per grid. Each field team used a movable marker (i.e., an extra 10-foot PVC pipe) to mark transect end locations to keep transects parallel and straight. A total of 533 transect kilometers (331 miles) were walked between 20 November and 8 December 1990.

4.0 RESULTS

4.1 Correlation Trials

At 3 locations, a series of 6 belt transects were walked by each project member for a total of 18 transects per sampler (Table 3). Since the areas all contained high sign counts, TCS could be used to compare observers.

Using a nonparametric Kruskal-Wallis test (Sokol and Rohlf, 1981) for ranked variables, there was no significant difference between the observers (X_2 = 3.898, p 0.1). Original data forms are contained in Volume II, Appendix A (Lucerne Valley), Appendix B (Site 2), and Appendix C (Site 3).

4.2 Surveys

There were 208 grids surveyed within the study area (Table 4). This amounts to an area of 536 hectares (1,325 acres). Within these grids, the observers found 5 carcass remains, 7 scats, and 23 coversites (burrows). No live tortoises were observed. Survey results yielded a total sign of 35 and a TCS of 28 for the entire study area (Figures 5 through 10). Of the sign observed, six were categorized as recent and consisted of three scats and three burrows (Figure 11). Recent sign was defined for each category as follows:

a. Carcasses - less than 1 year estimated time since death

b. Scat - evidence of deposition in 1990

c. Burrows - categorized as good or better

Trash was also counted on a per grid basis (Table 4). Trash was defined as any item of human origin other than buildings, signs, roads, etc. that served or at one time served a purpose. Trash count was used as one measure of habitat quality. It is generally accepted that an inverse correlation exists between the quantity of trash and habitat quality. Trash counts were used in this study as a relative, rough measure of habitat quality. In all, over 17,000 pieces of trash were located on the grids surveyed; an average of 82 pieces per grid.

There was no perceivable distribution of trash such that polygonic mapping could be conducted. For example, a grid with a trash count of 50 might be next to one with a count of over 500. Trash counts tended to be high along roads. Along Lancaster Boulevard, trash counts ranged from 168 to almost 500. On the north and south sides of the South Base area, trash counts were high, often exceeding 500 per grid. Another area with high trash counts was found east of the residential housing area between Mojave Boulevard and Fitzgerald Boulevard.

Five carcasses were located in the survey area. Most were old and in a state of decay indicating no recent mortality of tortoises in the area (Table 5 and Figure 12). Original shell cards are contained in Volume II, Appendix F.

Table 3 - TCS COUNT RESULTS

Lucerne Valley (Test Site 1)										
Transect	GOG[1]	GCG[1]	KF[2]	KP[3]	EH[4]	MW[5]	RR[6]	RE[7]	Mean	STD DEV[8]
North	28	43	26	25	26	21	18	25	26.5	7.4
South	15	25	15	26	16	19	16	16	18.5	4.5
East	21	32	19	29	27	8	19	30	23.1	8.0
West	11	5	8	11	10	9	9	9	9.0	1.9
Southeast	13	22	19	33	18	17	35	20	22.1	7.8
Northwest	14	12	20	10	14	11	15	13	13.6	3.1
Test Site 2										
North	32	25	23	51	25	21	9	21	25.9	12.0
South	13	15	20	21	7	15	25	13	16.1	5.6
East	16	15	19	14	20	11	18	18	16.4	3.0
West	32	18	22	38	25	19	24	20	24.8	6.9
Southeast	13	17	24	14	16	19	19	12	16.8	3.9
Northwest	29	22	48	32	39	27	21	28	30.8	9.0
Test Site 3										
North	---	---	20	13	10	11	23	18	15.8	5.3
South	---	---	19	25	17	25	20	17	20.5	3.7
East	---	---	15	7	13	17	8	6	11.0	4.6
West	---	---	13	14	11	11	11	20	13.3	3.5
Southeast	---	---	9	26	13	18	15	14	15.8	5.8
Northwest	---	---	17	8	12	5	16	6	10.7	5.1
Mean	19.8	20.9	19.8	22.1	17.7	15.8	17.8	17.0	18.4	5.6

[1]Gilbert (GOG) and Glenn (GCG) Goodlett did not walk Site 3 due to illness.

[2]Kevin Fleming

[3]Katey Palmer

[4]Eric Holle

[5]Mike Walker

[6]Ray Romero

[7]Rick Eisenbart

[8]Standard deviation

Table 4 - SIGN AND REFUSE COUNTS BY GRID (Continued)

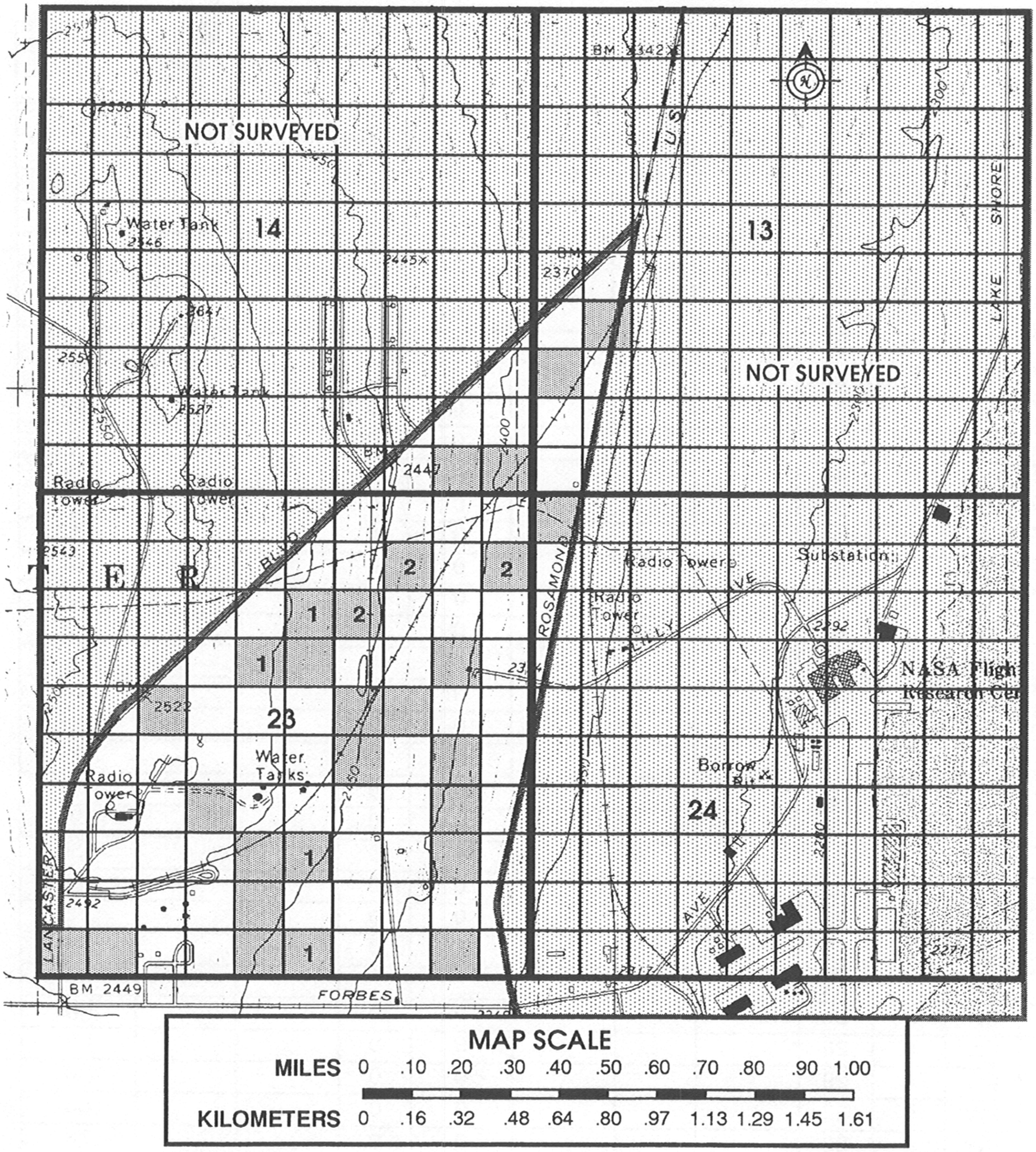
T	R	SEC	GRID	SHELLS	SCAT	COVER SITES	TOTAL SIGN	TCS	# OF RECENT SIGN	RECENT SIGN TYPE	TRASH COUNT
10N	10W	28	19			1	1	1			60
10N	10W	28	29				0	0			
10N	10W	34	4				0	0			230
10N	10W	34	6				0	0			90
10N	10W	34	9				0	0			85
10N	10W	34	15				0	0			300
10N	10W	34	16				0	0			200
10N	10W	34	18			1	1	1			
10N	10W	35	0				0	0			108
10N	10W	35	2				0	0			100
10N	10W	35	20				0	0			>500
10N	10W	35	21				0	0			280
10N	10W	35	22				0	0			85
10N	10W	35	32				0	0			200
10N	10W	35	35				0	0			41
10N	10W	35	42				0	0			171
10N	10W	35	43				0	0			46
10N	10W	35	44	1			1	0			35
10N	10W	35	50				0	0			236
10N	10W	35	51				0	0			368
10N	10W	35	56			1	1	1			100
10N	10W	35	60				0	0			144
10N	10W	35	64				0	0			109
10N	10W	35	65				0	0			101
10N	9W	30	53				0	0			15
10N	9W	30	63				0	0			24
10N	9W	30	64				0	0			57
10N	9W	30	85				0	0			290
10N	9W	30	96				0	0			78
10N	9W	31	0				0	0			180
10N	9W	31	1				0	0			133
10N	9W	31	2				0	0			112
10N	9W	31	5				0	0			271
10N	9W	31	17				0	0			121
9N	10W	1	77				0	0			>500
9N	10W	1	85				0	0			64
9N	10W	1	86				0	0			>500
9N	10W	1	93				0	0			29
9N	10W	1	94				0	0			38
9N	10W	1	96				0	0			>500
9N	10W	1	98				0	0			>500
9N	10W	2	6				0	0			144
9N	10W	2	10				0	0			123

Table 4 - SIGN AND REFUSE COUNTS BY GRID (Continued)

T	R	SEC	GRID	SHELLS	SCAT	COVER SITES	TOTAL SIGN	TCS	# OF RECENT SIGN	RECENT SIGN TYPE	TRASH COUNT
9N	10W	2	16				0	0			333
9N	10W	2	17				0	0			111
9N	10W	2	20				0	0			157
9N	10W	2	30				0	0			148
9N	10W	2	42				0	0			38
9N	10W	2	43				0	0			24
9N	10W	2	46				0	0			29
9N	10W	2	52				0	0			40
9N	10W	2	54				0	0			68
9N	10W	2	55				0	0			60
9N	10W	2	62				0	0			17
9N	10W	2	63				0	0			24
9N	10W	2	64				0	0			7
9N	10W	2	65				0	0			20
9N	10W	2	91			1	1	1			68
9N	10W	2	92			1	1	1	1	BURR.	15
9N	10W	2	93				0	0			51
9N	10W	11	1				0	0			27
9N	10W	11	2				0	0			13
9N	10W	11	11				0	0			91
9N	10W	11	20				1	0			168
9N	10W	11	30				0	0			232
9N	10W	11	35				0	0			163
9N	10W	11	44				0	0			100
9N	10W	11	45				0	0			44
9N	10W	11	47				0	0			4
9N	10W	11	48				0	0			8
9N	10W	11	51				0	0			21
9N	10W	11	54				0	0			10
9N	10W	11	56				0	0			42
9N	10W	11	59				0	0			40
9N	10W	11	61				0	0			20
9N	10W	11	64				0	0			10
9N	10W	11	67				0	0			4
9N	10W	11	68				0	0			9
9N	10W	11	70				0	0			309
9N	10W	11	71				0	0			28
9N	10W	11	72				0	0			9
9N	10W	11	74				0	0			10
9N	10W	11	76				0	0			26
9N	10W	11	82				0	0			7
9N	10W	11	83				0	0			4
9N	10W	11	86				0	0			2

Table 4 - SIGN AND REFUSE COUNTS BY GRID (Concluded)

T	R	SEC	GRID	SHELLS	SCAT	COVER SITES	TOTAL SIGN	TCS	# OF RECENT SIGN	RECENT SIGN TYPE	TRASH COUNT
9N	10W	11	87				0	0			29
9N	10W	11	98				0	0			
9N	10W	11	99				0	0			40
9N	10W	12	3				0	0			27
9N	10W	12	5				0	0			14
9N	10W	12	14				0	0			4
9N	10W	12	15				0	0			10
9N	10W	12	21				0	0			14
9N	10W	12	30				0	0			202
9N	10W	12	31				0	0			43
9N	10W	12	34				0	0			4
9N	10W	12	42				0	0			44
9N	10W	12	50				0	0			40
9N	10W	12	53				0	0			112
9N	10W	12	55				0	0			83
9N	10W	12	56				0	0			122
9N	10W	12	60				0	0			25
9N	10W	12	80			1	1	1			
9N	9W	5	1				0	0			184
9N	9W	5	12				0	0			117
9N	9W	5	21				0	0			121
9N	9W	5	22				0	0			304
9N	9W	5	42				0	0			591
9N	9W	5	52				0	0			338
9N	9W	5	90				0	0			224
9N	9W	6	16				0	0			73
9N	9W	6	17				0	0			86
9N	**9W**	**6**	**24**								
9N	9W	6	26				0	0			142
9N	9W	6	28				0	0			470
9N	9W	6	29				0	0			252
9N	9W	6	32				0	0			63
9N	9W	6	33				0	0			73
9N	9W	6	34				0	0			>500
9N	9W	6	35				0	0			
9N	9W	6	39				0	0			>500
9N	9W	6	48				0	0			>500
9N	9W	6	98				0	0			240
9N	9W	6	99				0	0			182
TOTALS			**208**	**5**	**7**	**23**	**35**	**28**	**6**		**>17637**

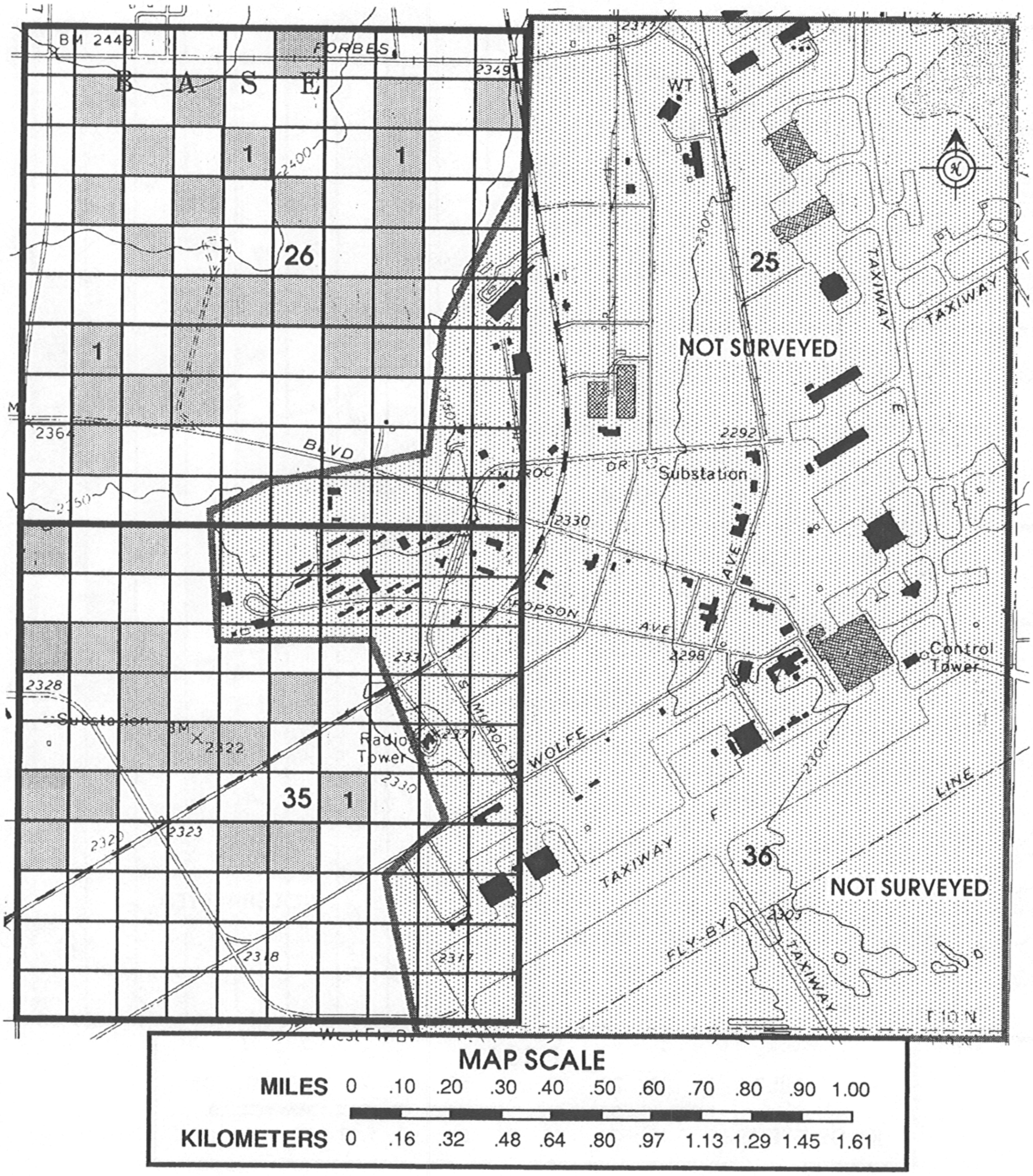


Grids surveyed.

1 Numbers in grids indicate TCS.

Not surveyed.

Figure 5 - Township 10N, Range 10W, Sections 13, 14, 23, and 24 Kern County

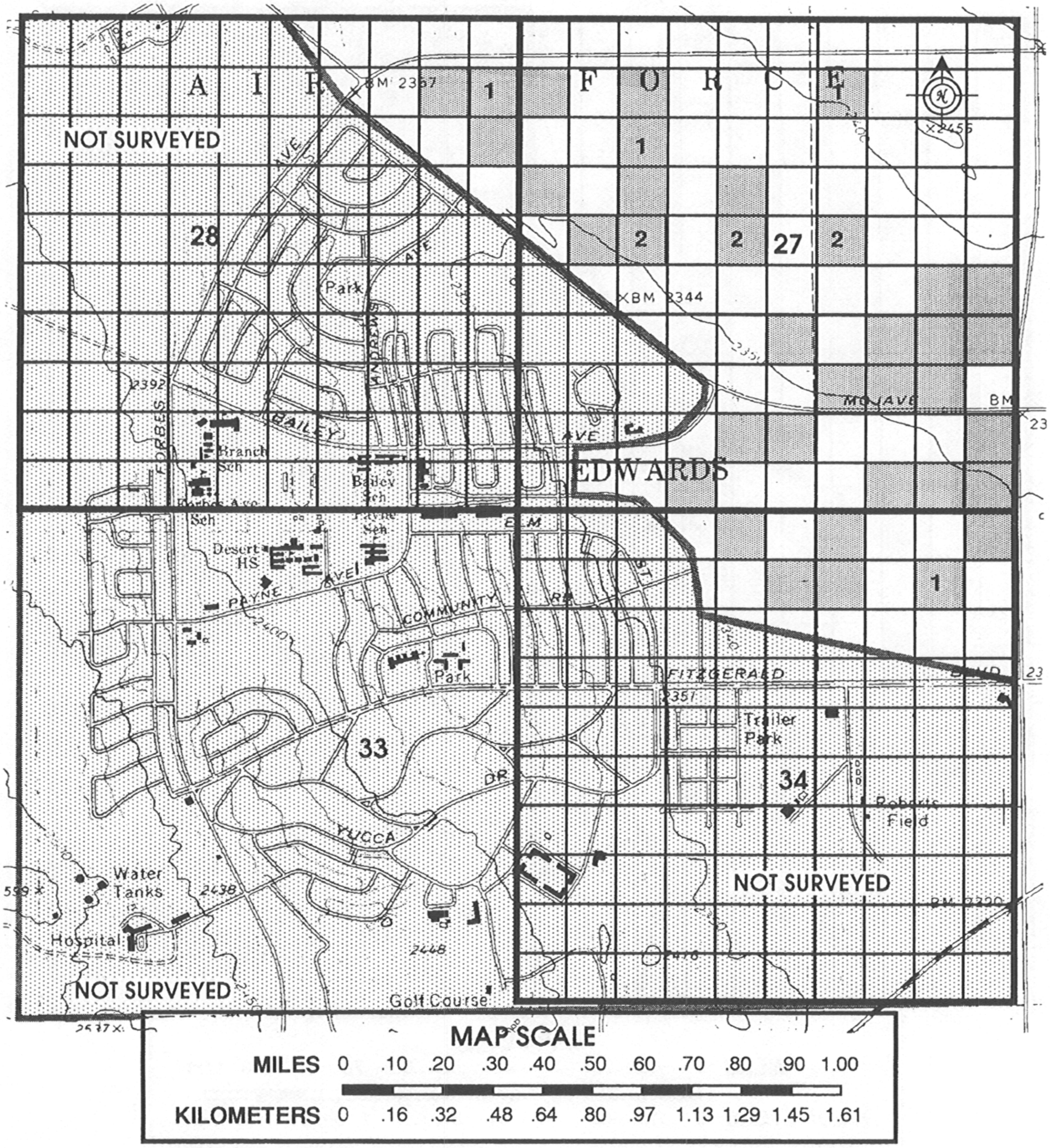


Grids surveyed.

Numbers in grids indicate TCS.

Not surveyed.

Figure 6 - Township 10N, Range 10W, Sections 25, 26, 35, and 36 Kern County

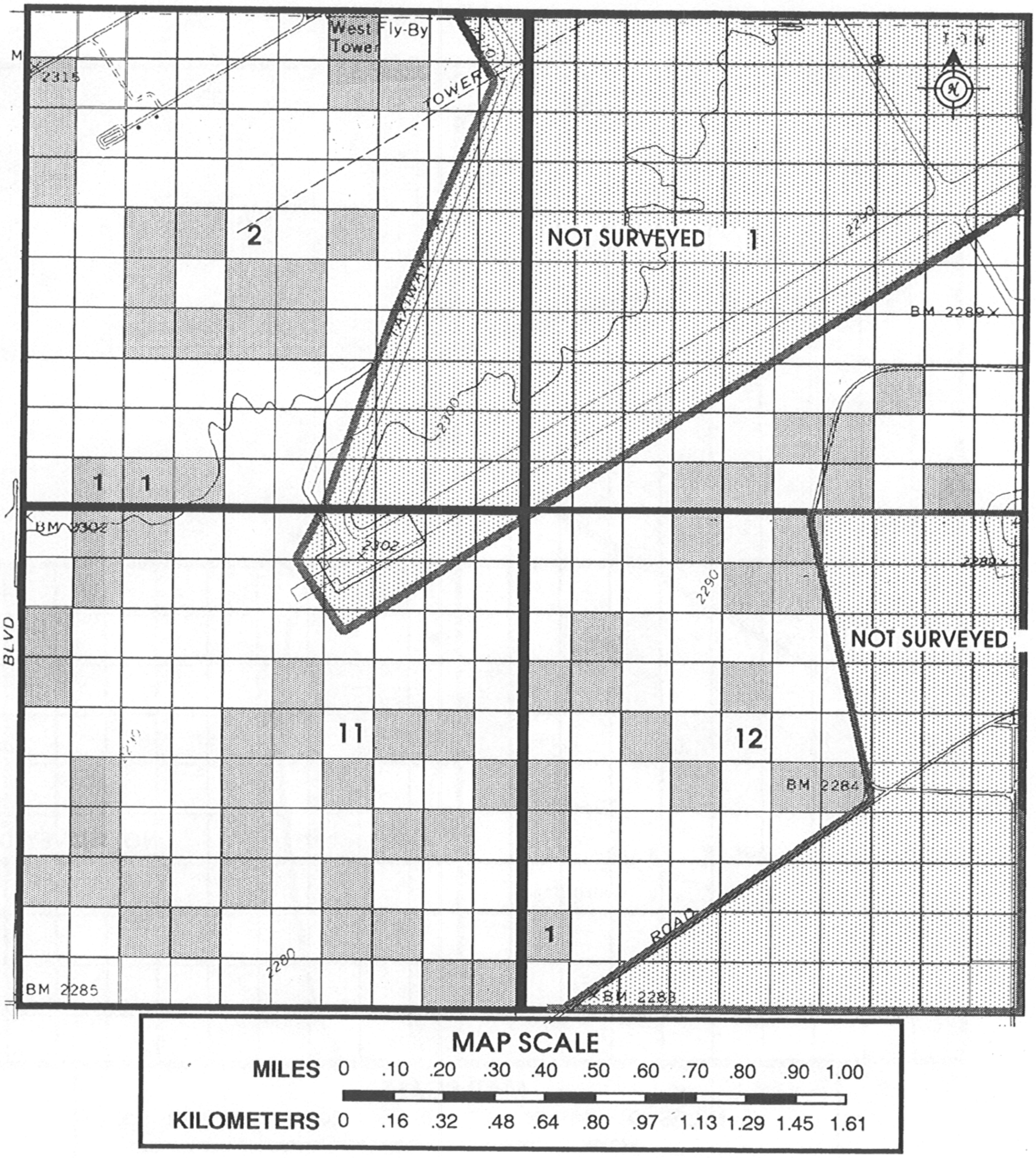


Grids surveyed.

Numbers in grids indicate TCS.

Not surveyed.

Figure 7 - Township 10N, Range 10W, Sections 27, 28, 33, and 34 Kern County

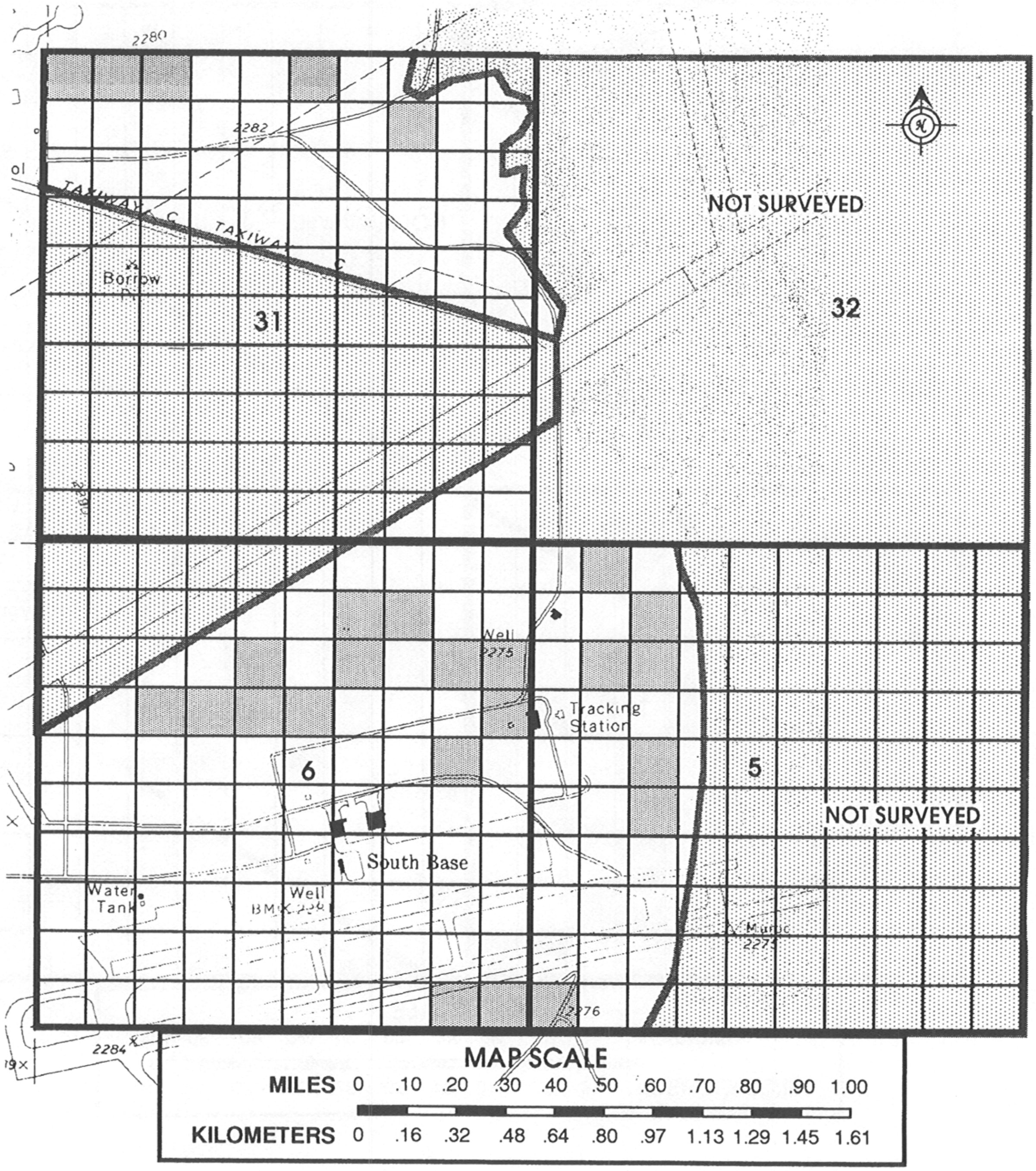


Grids surveyed.

1 Numbers in grids indicate TCS.

Not surveyed.

Figure 8 - Township 9N, Range 10W, Sections 1, 2, 11, and 12 Kern County

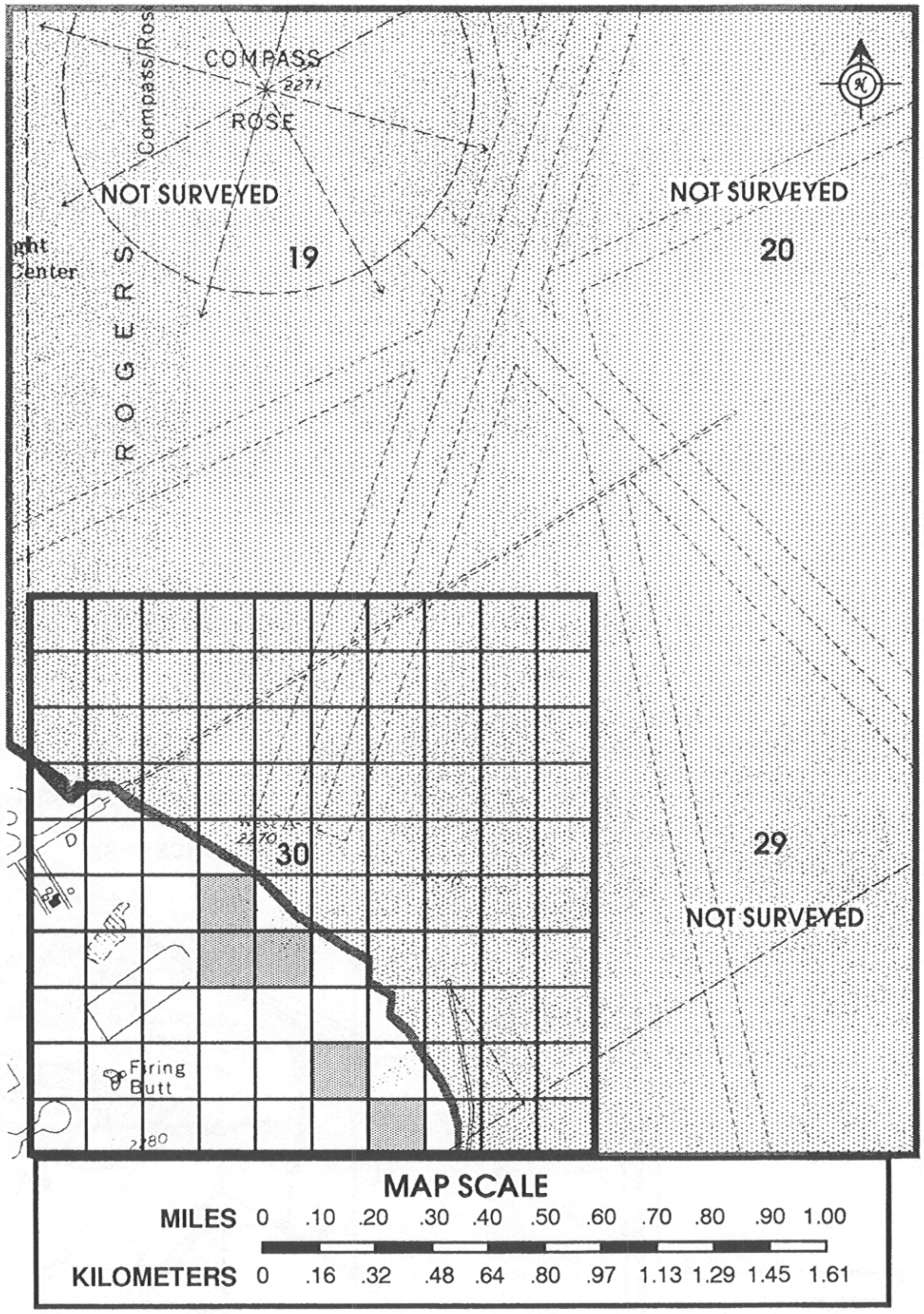


Grids surveyed.

Numbers in grids indicate TCS.

Not surveyed.

Figure 9 - Township 10N-9N, Range 9W, Sections 6, 5, 31, and 32 Kern County



Grids surveyed.

1 Numbers in grids indicate TCS.

Not surveyed.

Figure 10 - Township 10N, Range 9W, Sections 19, 20, 29, and 30 Kern County

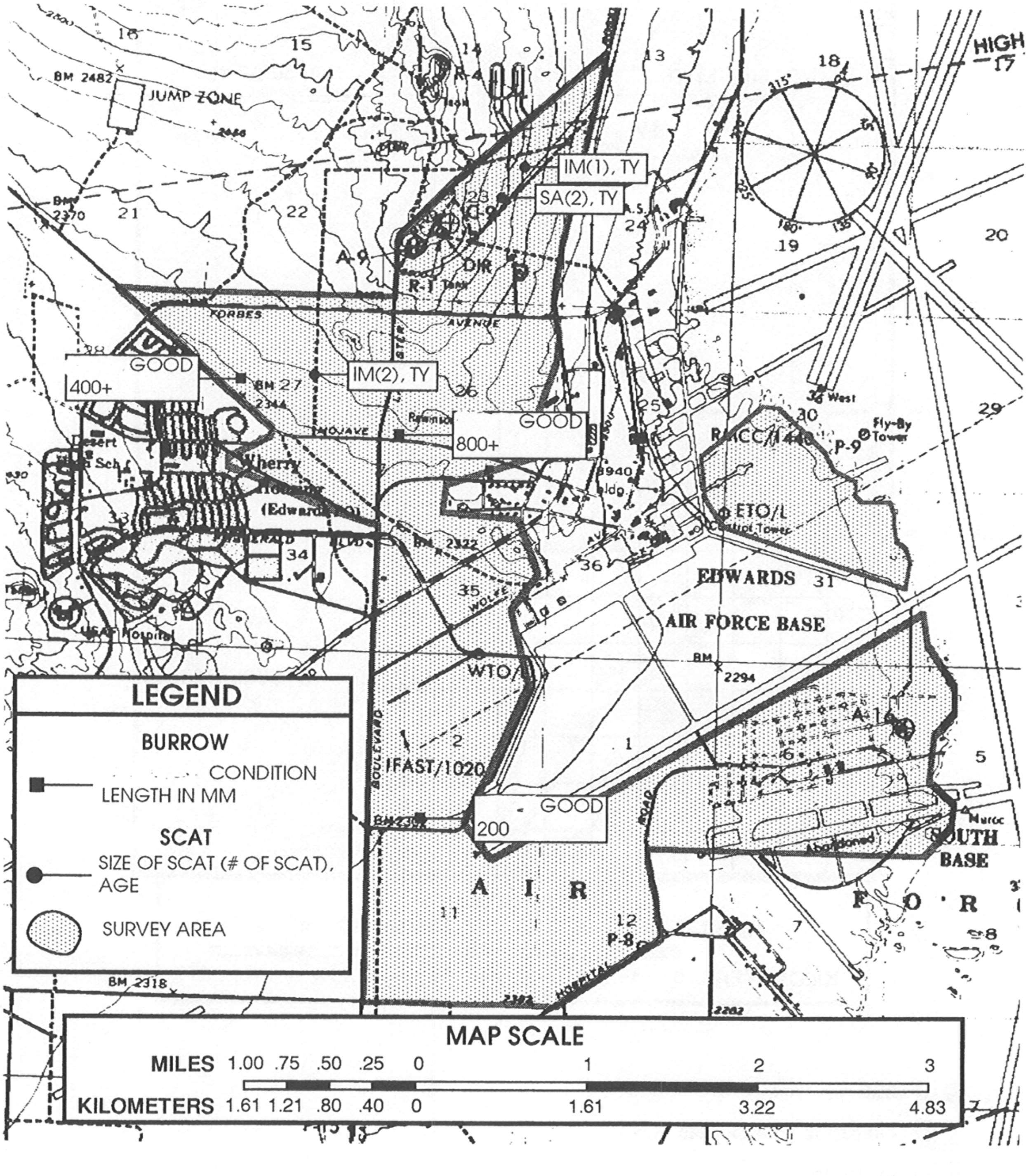


Figure 11 - Recent Sign Locations

Table 5 - TIME SINCE DEATH OF FIVE CARCASSES

	Less than 1 year	1 to 2 years	2 to 4 years	Greater than 4 years
Number of Animals	0	1	1	3

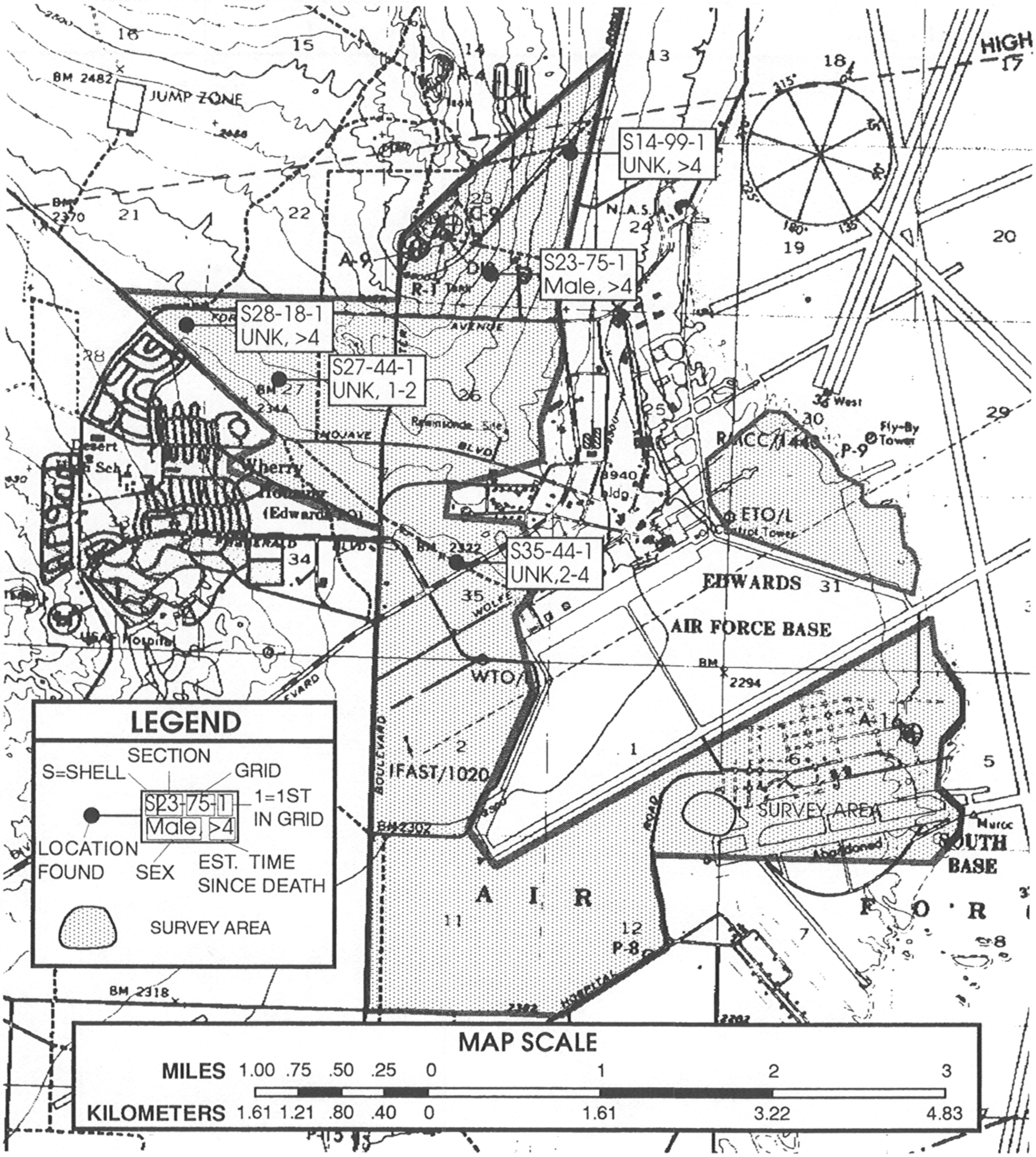


Figure 12 - Locations of Desert Tortoise Carcasses

5.0 DISCUSSION OF RESULTS

5.1 Validity of Sample Size

The results of the minimum sample size analysis were simplified in the application to this project. However, it did not effect the validity of sample size on this particular project because of the small standard deviation of TCS for surveyed grids. If the standard deviation was larger, there could be potential problems with sample size on future projects.

There are several problems with the approach used which include:

a. A sample size of 32 from the equation in Section 4.2 refers to the actual number of samples (grids) required to determine TCS (±1 TCS) with a 95-percent confidence of the area encompassed by the pilot samples. The analysis of sample size assumed a project area of 259 hectares (640 acres). This application oversimplified the Main and South Base survey since each legal section was treated as a single project within a larger project. Yet, the data upon which the minimum sample size was based on the 131 grids previously surveyed at Edwards AFB (drop zone, TTU), or a total area of 339 hectares (838 acres). Therefore, the sample size should have been 32 grids sampled of 131 grids total.

b. For many grids in this survey, there were zero sign. The occurrence of zero values is problematic because the sample values are expressed as plus or minus a certain confidence interval. In this study, while there is confidence in the zero values obtained for various randomly selected grids within a section, evaluation of the section as a whole is not possible (to an acceptable degree of statistical confidence). In the analysis, 95-percent confidence intervals and bounds of +1 sign were used; therefore, it is 95-percent confident that 0 to 1 sign is present in the section.

c. In areas of high sign counts, the use of TCS rather than total sign has the advantage of reducing variability of observer bias. However, when the relative sign counts are low (as they were in the study) then the reduction of variability through the use of TCS artificially suppresses the estimate of sample size. If total sign counts had been used rather than TCS, then the increased variability would have increased the sample size requirement.

Despite the problems that were encountered, sampling a statistically significant portion of the project area can offer a viable and cost-effective alternative to 100-percent coverage providing that steps are taken to ensure proper sample size. Even under optimal conditions, the numbers calculated for an area bound by confidence limits and zero values are not as certain as if an area was surveyed 100 percent.

Prior to surveying for sign, grids should be selected at random throughout the study area. These grids would then be sampled as per USF&WS protocol. If there is sufficient sign present, resultant variances would be compared. From this information, sample size requirements can be calculated on a per site basis. In cases where the sign counts are low, the sampling of grids would have to continue, possibly reaching 100-percent coverage.

To summarize, a statistically valid sampling technique would include the following:

a. Determine the total project area.

b. Mark grids on the ground throughout the project area.

c. Randomly select grids in the project area. Thirty percent would be a good starting point.

d. Survey grids using standardized methods to reduce observer bias.

e. Calculate the minimum sample size based on the variance of the total sign data obtained.

f. Determine if sufficient numbers of grids have been sampled. If so, then field work is complete.

g. Continue sampling until the minimum sample size is reached if sufficient grids have not been sampled.

h. Recalculate the minimum sample size based on the original plus the additional data. If sufficient numbers of grids have been sampled, then field work is complete.

i. Continue random sampling if the new data indicate that sufficient numbers of grids have not been sampled. Repeat items f through i until the constantly updated data set indicates that the minimum sample size has been achieved. This approach is iterative and requires continually sampling and recalculation of sample size.

5.2 Assessment of Observer Bias

The approach used to standardize procedures and minimize observer bias was highly effective. This cannot be entirely attributed to the methods discussed in Section 2.3. The personnel involved all had significant prior experience (more than 60 field days) in conducting desert tortoise surveys. If experienced personnel had not been used, the potential for significant variations in observer bias would be expected.

5.3 Surveys

Given the size of the area surveyed, very little tortoise sign was located. Based on these data, it is apparent that the study area does not support viable desert tortoise populations. Correlations of sign counts with population density were not conducted because the very low sign counts would have been of limited value. If population could be estimated, the values would be extraordinarily low. The probability of encountering tortoises would be expected to vary proportionally with TCS (Figure 11). This map is the actual sign located, not an extrapolation to expected sign based on 30-percent coverage. To obtain the expected TCS, it is necessary to multiply the figures by 3.33. The following proportions of the project area were in each sign category: zero sign per square mile, 40 percent; 1 sign per square mile, 36 percent; or more than 1 sign per square mile, 24 percent.

The data collected does provide sufficient information for a limited assessment of distribution. It was observed that most of the recent sign was located in the northern half of the study area (Figure 11). The only exception to this observation is a burrow in good condition that is 200 millimeters deep, section 2 of T9N, R10W. This burrow is very shallow and would be used by a tortoise only as a temporary resting place, not as a residence capable of protecting the animal from extreme temperatures.

Carcasses are definite, unmistakable historical evidence that tortoises inhabited the study area. Like the distribution of recent sign, carcasses are concentrated in the northern half of the study area (Figure 12).

From maps of recent sign (Figure 11), carcass remains (Figure 12), TCS (Figures 5 through 10), and observations of the habitat condition in and around the study area, it is observed that the potential for desert tortoise presence increases as one moves to the north. In some areas, no tortoise sign was located at all. This included Sections 5 and 6 of Township 9 North, Range 9 West and Sections 30 and 31 of Township 10 North, Range 9 West. Tortoises are expected to be at extremely low levels or possibly absent in these areas

5.4 Project Summary and Recommendations

Since no specific projects have been proposed, no specific mitigation recommendations can be made. The following points should be considered:

a. No live tortoises were observed. This is not surprising given the time of year the survey was conducted (winter). Historical evidence of desert tortoise habitation and use of the area does exist. There were six pieces of recent evidence. This establishes those areas where sign was found as desert tortoise habitat, albeit low quality habitat.

b. In the areas where no tortoise sign was located, it cannot be assumed that tortoise sign does not exist since only 30 percent of the habitat was surveyed (Figure 13). The statistical model used has bounds of one TCS. Therefore, zero sign is actually zero to one sign. However, the probability of encountering tortoises in the zero sign area is considered extremely low, and if tortoises were present in this area, they are not at viable population levels. It cannot be concluded that no tortoises are present in any of the areas surveyed, even those where zero sign was located because of the statistical constraints. However, the probability of encountering tortoises in the zero sign count areas is extremely low. No tortoises are expected; therefore, no further surveys are recommended.

c. In the one TCS category, the chance of encountering tortoises seems only slightly higher than in the zero sign category (Figure 13). Tortoises that may inhabit this area would not be at viable population levels.

d. The greater than one TCS category (Figure 13) is of primary concern in the study area. Even in this category, the sign counts do not suggest viable population levels. However, these areas occur on the extreme northern and northwest boundaries of the surveyed area. They may represent the fringes of viable tortoise populations outside of the project area. Development activity, where possible, should be conducted in other areas. The zero or one TCS areas would be preferable areas for development from the standpoint of desert tortoise management..

e. In areas with one or greater TCS, preconstruction type surveys (as defined by the USF&WS) should be conducted prior to executing projects that would impact desert tortoise habitat.

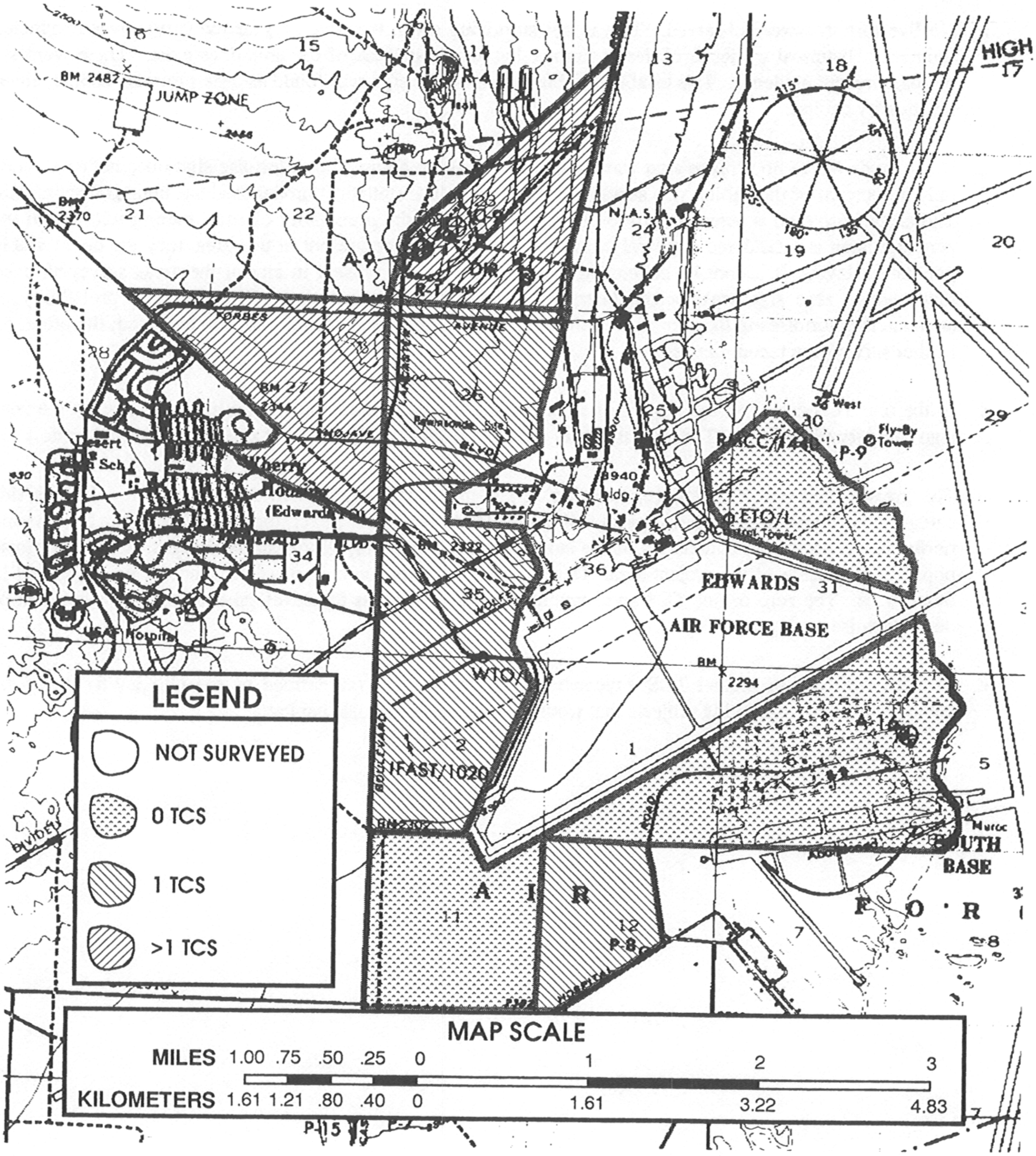


Figure 13 - Distribution of Sign Counts in Each of Three Categories

6.0 LITERATURE CITED

Berry, K.H., and Woodman, A.P., 1984. Methods used in analyzing mortality data for most tortoise populations in California, Nevada, Arizona, and Utah. Appendix VII in Berry, K.H. (ed.), The Status of the Desert Tortoise (*Gopherus agassizii*) in the United States. Rept. from the Desert Tortoise Council to the U.S. Fish and Wildlife Service, Sacramento, California; Order Number 11310-0083-81.

Berry, K.H., and Nicholson, L.L., 1984. The distribution and density of desert tortoise populations in California in the 1970s. Chapter 2 in Berry, K.H. (ed.), The Status of the Desert Tortoise (*Gopherus agassizii*) in the United States. Rept. from the Desert Tortoise Council to the U.S. Fish and Wildlife Service, Sacramento, California; Order Number 11310-0083-81.

Daniel, W.W., Biostatistics: A Foundation for Analysis in the Health Sciences. New York: John Wiley and Sons, 1978.

Sokol, R.R. and Rohlf, F.J., Biometry - The Principles and Practice of Statistics in Biological Research. New York: W. H. Freeman and Company, 1981.

U.S. Fish and Wildlife Service, 1990. Field Survey protocol for any action that may affect the desert tortoise in California. Memo from Field Supervisor, U.S. Fish and Wildlife Service, dated February 15, 1990.

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