Baseline Inventory and Monitoring Procedures on Texas Parks and Wildlife Department Lands

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BASELINE INVENTORY AND MONITORING PROCEDURES ON TEXAS PARKS AND WILDLIFE DEPARTMENT LANDS

I. Introduction

Due to the heterogeneity of habitats across Texas and the great diversity of associated floral and faunal species, a single standardized set of procedures designed to inventory all species is impossible to produce. Instead, a combination of several techniques must be utilized in order to properly sample the flora and fauna on Texas Parks and Wildlife Department (TPWD) lands. These techniques must address differences in behavioral characteristics, seasonal abundance, and habitat requirements for the different species. Inventory and monitoring objectives will vary depending on priorities for each site. Likewise, sampling techniques and intensity will vary based on whether presence/absence (baseline inventory), or species richness, relative abundance, or other data in response to management is to be collected. The purpose of this manual is to present a variety of techniques that could be used to inventory and monitor floral and faunal species based on site objectives. These techniques are offered only as a guide to determine presence, estimate species richness and/or relative abundance. It is recommended that the site managers or biologists first review pertinent literature about these techniques so that a better understanding can be ascertained as to some common problems/questions, as well as additional information on technique procedures. Depending on specific needs and objectives, some of the techniques described may require modification. It is also recommended that a tentative checklist be developed for all species occurring in the area and when these species are active or present. All data collected on baseline inventory and monitoring projects should be georeferenced using the global positioning systems (GPS) and digitized for computer analysis.

When beginning a baseline inventory project, the first step is to georeference the boundaries of the area using GPS. The second step is to prepare a vegetative type map of the area. These can easily be prepared with the aid of soil surveys provided by the Natural Resources Conservation Service and various forms of aerial coverage. It is recommended to use infrared or color aerial photography. Most major vegetative communities are easily delineated on the photographs. The selected site is then ground truthed to determine the major species present. Historic changes in land-use practices and vegetative composition can be determined by obtaining old aerial photographs of the area. Aerial photographs should be obtained at 5-10 year intervals to determine cover changes on the area. The Texas Natural Resource Information System (TNRIS), located in Austin, is a library of photography. The Geographical Information Systems (GIS) Lab at TPWD Headquarters can assist you with obtaining photographs of your area.

Before any surveys are conducted it is imperative that all objectives be determined. The objectives and purpose for conducting baseline inventory will determine the methods that will be implemented. In addition, the objectives will determine what level of detail will be required to meet those objectives. For example, number and length of transects, number of points and traps to be used, and the amount of time involved will vary depending on whether presence/absence or relative abundance data by habitat is to be collected. If abundance data comparing different management practices is the goal, it is recommended that a statistician be involved in developing a monitoring project. This will assure biases are minimal and that objectives are achieved. It can not be over emphasized that objectives must be pre-determined and that proper sampling methods are used to achieve those objectives.

An important point to consider is the development of "multi-use" transects or points. Many methods referred to in this procedure manual require the establishment of permanent transects or

points. These points should be georeferenced with GPS so that they can be readily relocated in the field and the data can be used GIS data analysis. Also, it is recommended that these points or transects be used in conjunction with as many of the sampling methods as possible. For example, the beginning or ending point for vegetation transects can be used as points for conducting point counts for birds, the same transect for vegetation sampling can be used for small mammal trapping, pitfall traps for herps can be installed near a point on the same transect. Establishing "multi-use" transects or points can reduce the time required to conduct an inventory or monitoring project.

Rare, threatened, and endangered species exist within all of the groups discussed in this manual. Since species composition and status will change over time, lists of rare species are periodically updated to reflect those changes. To obtain updated lists, contact the Endangered Resources Branch (ERB, 3000 South I-35, Suite 100, Austin, Texas 78704; phone: (512) 912-7011, fax: (512) 912-7058). Although no specific techniques are offered to inventory or monitor these rare species, the protocol and forms for recording rare species data for entry into the Department's Biological and Conservation Data (BCD) System are included for your use (Appendix I). The BCD, housed in the ERB, functions as a dynamic and updatable inventory of information on rare, threatened, and endangered species and natural communities and the various sources supporting these data. ERB staff track occurrences of these elements of natural diversity on USGS 7.5' topographic maps and interrelated computer databases. Each occurrence record is tied to one or more sources, such that all information is defensible and stands on the merit of its source(s). The protocol and forms for recording data are internationally standardized and, ideally, biologists acquiring data from the field should also record it on the appropriate forms and send the completed forms to the ERB office. However, if circumstances dictate otherwise, the field biologists should transfer the data in whatever form is available to the ERB office in Austin where it can be properly transcribed, abstracted, and filed. Please supply a contact name and phone number in the event of questions during data transcription. Also, contact the Information System Manager at 512/912-7023 if you have any questions.

II. Diversity and Similarity Indices These indices are utilized to measure heterogeneity of sampling areas and similarity between sampling sites. These indices will be most useful in baseline/research activities to compare yearly or seasonal changes in vegetative characteristics or measuring the effects of habitat management practices.

1. Shannon's Diversity Index (H')

   This is the most commonly utilized index to measure diversity, which includes richness (number of species) and evenness (numbers of individuals per species or abundance) (Pielou 1975, Chambers and Brown 1983). The Simpson's Index (Pielou 1975) is somewhat simpler than the Shannon Index and can also be utilized to calculate these measurements.

2. Sorensen's Similarity Index

   This index (or variations of) is derived from richness and/or abundance data and can be utilized to make comparisons of similarity among sites or time frames (season to season, year to year) of a single site (Chambers and Brown 1983).

III. Vegetation

Knowledge of the vegetation composition of an ecosystem is essential to proper management

for game and nongame wildlife. Vegetation structure and composition on any given area is indicative of the ability of that site to support specific types of animals. Because of the diversity of cover types present on TPWD lands across the state, certain sampling techniques will be more appropriate than others in assessing vegetation species composition and abundance from area to area. Multitudes of techniques exist; however, consideration must be given to constraints of manpower, efficiency, and repeatability among observers. The objective of baseline vegetation sampling is to determine what species are present and how much each species contributes to the vegetative composition of a given area. This section will discuss techniques, which can be applied to most vegetative communities throughout the state. Whenever possible, vegetation monitoring techniques should be standardized for TPWD lands. Vegetation sampling techniques can also be utilized in research and monitoring activities in assessing trends in relative abundance, species composition, and other vegetative characteristics as a result of management activities or the effects of "no management" (exclosures).

Vegetation sampling techniques and frequency will depend on habitat type and objectives of the sampling. Long-term monitoring or specific research projects may dictate different sampling intensities. Prior to any vegetation sampling activities, an adequate sample size will need to be determined to insure validity. Various statistical formulas can be utilized to determine a satisfactory sample size (Pielou 1975, Chambers and Brown 1983, Bonham 1989). Once sample sizes have been determined, random sample points must be established. These locations can be random points throughout a sampling area or random points located along transects which derive from a baseline (Chambers and Brown 1983). Transect random points should be recorded by GPS location and be marked on an aerial photograph, topo map, other area map, or GIS map layer for future reference. In general, vegetation on newly acquired areas, areas with little background data, or areas under an active management program, should be monitored during the spring and fall of each year to gather data on cool and warm season species. On areas where little yearly management occurs or where sufficient baseline data exists, transects can be monitored once yearly at a standardized time during the growing season. There are four vegetative characteristics, which are most often measured: cover/structure, frequency/composition, density, and biomass.

A. Cover

This parameter is generally characterized as the amount of canopy or basal coverage of a vegetative class or species present in a given area at a given time. Both horizontal and vertical cover can be measured.

1. Line Intercept

The line intercept method can be utilized to measure horizontal cover of both woody and herbaceous vegetation (Canfield 1941, Chambers and Brown 1983), as well as submergent vegetation (Robel 1960, 1961). This technique is widely utilized to measure woody plant canopy cover.

a. Procedures

1. Line intercepts randomly placed within a given habitat generally range between 20 and 100 m in length. Longer and/or more intercept lines will generally increase the accuracy in estimating plant canopy coverages (Brown 1954).
2. From a random starting point, a measuring tape (intercept line) is placed in a

random direction to a pre-determined length. The distance in which each individual plant's canopy enters and exits the tape along the intercept is recorded. A wooden dowel can be useful is lining up tree and shrub canopies with intersection points on the tape.

3. This information is usually presented as percent canopy coverage by each species. This method can also be utilized to measure herbaceous vegetation (usually grasses) basal cover. An example of a field data sheet for recording cover using the line intercept method is provided in Figure 1.

2. Vegetation Profile Board

(VPB) This method is widely utilized to measure vertical coverage (structure) of woody vegetation (Nudds 1977).

a. Procedures

1. Vegetation profile boards consist of a 2.5 m by 30.5 cm wide board which is painted in alternating one half meter segments (usually black and white).
2. The board is erected 15 m from a random point. This location can be along a line intercept.
3. Coverage is estimated at various height increments on the VPB (0-0.5 m, 0.5-1 m, 1-1.5 m, 1.5-2 m, >2 m) by assigning a numerical value to percent coverages (1 = 0-20%, 2 = 21-40%, 3 = 41-60%, 4 = 61-80%, 5 = 81100%) (see Figure 1). Height increments may be modified to accommodate taller vegetation.
4. By designating a number to represent a relatively wide range of percent cover, observer bias can be minimized.

3. Daubenmire Frame

These plots are commonly utilized to estimate herbaceous plant canopy coverage, as well as litter coverage and percent bare ground (Daubenmire and Daubenmire 1968, Bonham 1989).

a. Procedures

1. Daubenmire frames are 20 cm x 50 cm plots which can be constructed from PVC pipe, re-bar, or some other appropriate material with a diameter or width of < 2.54 cm.
2. Frames can be painted to delineate 5, 20, 25, 50, 75, and 95 percent coverages.
3. Plots can be randomly placed within a sampling area, or to facilitate data collection, placed at equal intervals along a line intercept (i.e. every 2 m).
4. Percent coverage by vegetation class (forbs, grasses) or species can be visually estimated. Estimating exact percent coverages (within 0-5%) can lead to bias if observers change. To account for this bias, a numerical system similar to that associated with the vegetation profile board can be utilized. Six cover classes can be utilized (1 = 0-5%, 2 = 5-25%, 3 = 2550%, 4 = 50-75%, 5 = 75-95%, 6 = 95-10%) (Daubenmire 1959). Figure 2 is an example of a field data sheet for estimating cover using the Daubenmire frame.

4. Point-Frame

This technique is suitable for estimating herbaceous vegetative cover (Chambers and Brown 1983).

a. Procedures

1. The point-frame method consists of a point or pin frame with usually ten pins which can slide down through the frame. Pins are lowered down through the frame into the vegetative canopy or basal area and hits (when a needle comes in contact with vegetation, litter, bare ground, etc.) are recorded by species. If a pin hits a species more than once, only the first hit is recorded.
2. Percent aerial cover for a given species equals the sum of all first hits for that species divided by the total of all possible hits. The percent composition equals the percent cover a given species divided by the sum of all first hits on all vegetation (Bonham 1989).
3. Point-frames can be placed randomly within a sampling area, or along intercept lines as described for the Daubenmire frame method.

5. 35mm Slide Photographv

This method can also be utilized for herbaceous vegetation (Chambers and Brown 1983).

a. Procedures

1. This method entails taking a slide photograph of a vegetative plot at a random location as previously described.
2. The slide is projected onto a grid with 100 squares which has the exact same proportions as the vegetative plot.
3. The number of squares that cover a given species is equal to the percent coverage for that species.
4. Limitations for this method are that the vegetative plot can not be larger than 0.5 m so that the plot can fit into the viewfinder of most standard camera lenses, and vegetation must be lower than one meter in height.

6. Point Intercept

The point intercept method and many variations thereof (Gysel and Lyon 1980) is commonly used to determine vegetation canopy coverage, as well as species composition and relative abundance along permanent transects in prairie, mixed grassland, and emergent marsh areas. In homogeneous vegetation, point intercept sampling can be less labor intensive and subject to less sampling error than quadrat sampling. An example of how the point intercept method has been used on the Texas coast is provided below.

a. Procedures

1. To initiate the point intercept technique, permanent transect(s) should be randomly located in each specific habitat type or management unit within a study area (Figure 3). The permanent starting and ending points are picked at random within habitat types or management units.

2. Poles with reflectors or flagging tape can be utilized to permanently delineate transects. Several poles placed along the transect (depending on vegetation height and density) will aid in marking the transect line.
3. Transects can be any length; however, 1000 m total for a single transect or multiple transects in a habitat type has been successfully used on the coast, and is recommended.
4. To run a transect, a random point is picked within each 100 m segment of the transect. For example, if the transect was 1000 m long, there would be 10 random points (Figure 4).
5. Transects should be run at least once per year, preferably in the fall after peak growth.
6. Vegetation is recorded at ten points (1 pace intervals) perpendicular to the transect line at the random point. Vegetation that hits a small diameter rod at each pace interval is recorded (Figure 4).
7. Open water, litter, and bare ground are also recorded. See example of a field data sheet (Figure 5) following this section.
8. Summary results are expressed as percent cover by species (Figure 6). Preliminary analysis has indicated that this point intercept method will allow for determining a 15% change in vegetative community cover.

7. Aerial Photography

Depending on water clarity, evaluation of aerial photographs is generally the easiest and most effective method for assessing cover, abundance, and distribution of submergent vegetation (Anderson and Jones 1980, Wallsten and Forsgren 1989). Employing techniques similar to those of the 35mm method, aerial photography can also be utilized to estimate woody cover in heavily timbered habitat types in which there is a clear delineation between tree canopies and other vegetation classes.

B. Density

Generally defined as the number of a given species present in a given area.

1. Plots/Frames

This is the most common method for estimating vegetation densities (Chambers and Brown 1983, Bonham 1989).

a. Procedures

1. For woody vegetation, plots can be incorporated into intercept lines. For example, a 20 m line intercept can be modified into a 20 m x 1.5 m plot.
2. To facilitate data collection, a wooden dowel 1.5 m in length (or what ever length is being utilized) can be moved perpendicular along the transect tape and each woody plant that is encountered by the dowel recorded.
3. Total numbers of each species are recorded for each plot. Numbers can be extra-polated into number of plants of a given species per hectare or other unit of area.
4. Randomly located vegetative quadrats not associated with transects or line intercept locations can also be utilized, with a popular dimension utilized being 4 m x 4 m.
5. Circular quadrats with radi of 3.57 m and 5.09 m are commonly utilized for

shrubs and trees.

6. Plots and quadrats may not be suitable in areas with sparse woody vegetation.
7. Vegetative plots/frames for herbaceous vegetation and submergent vegetation are generally one meter or one foot square frames. Frame can be placed along line intercepts or randomly located throughout a habitat type.
8. The number of each species is counted in each frame to determine species density per square m/foot which can be then converted to the desired unit of land measurement.

2. Nearest Neighbor and Random Pairs Method

These are plotless methods of determining woody plant density (Bonham 1989). These methods can be utilized in forested habitats, as well as grassland habitats in which woody vegetation may be sparse or widely scattered. Both methods utilize distances between individual plants to estimate density. These methods can be conducted from random points along a transect.

a. Procedures

1. The nearest neighbor method entails locating the woody plant nearest a given random point and measuring the distance between this plant and its nearest neighbor. Estimated density is derived by multiplying mean distance between plants by a correction factor of 1.67, then dividing the square of that value into the total area of the habitat being sampled.
2. The random pairs method is similar to the nearest neighbor technique in that the woody plant closet to a given random point is located. The observer then faces this plant and utilizing outstretched arms, forms an 180 degree exclusion angle. The distance between the selected plant and its closest neighbor from behind the exclusion angle is recorded. Estimated density is calculated the same as for the nearest neighbor method with the exception of the correction factor being 0.87

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3. Bitterlich's Variable Radius Method

This technique can be utilized to estimate tree densities in forested habitats (Chambers and Brown 1983). Foresters for determining basal area and wood production utilize this same method.

a. Procedures

1. From a randomly selected point, an observer utilizes a prism (a 10 factor prism is most commonly utilized) to tally trees within a complete circle around the point. Trees in which the stem at breast height is not completely offset when viewed through the prism are counted.
2. Trees are grouped into diameter classes usually 5.1 cm intervals starting at 10.2 - 15.2 cm diameter breast height (DBH).
3. Total basal area is estimated by multiplying the total tally by the prism factor.
4. Trees per acre by diameter class are determined by dividing the basal area per acre per diameter class by the basal area per tree of that diameter class. The sum of these figures for all diameter classes will provide total trees per acre.

C. Frequency/Composition

Generally defined as the relative occurrence of a species or vegetative class. The methods described in the Cover section and quadrat/plot/frame technique outlined in the Density section can be utilized to determine frequency. If utilizing a vegetative plot for instance, a record is kept each time a given species occurs anywhere within the plot perimeter. Percent frequency is calculated by dividing the number of plots in which a given species was present by the total number of plots.

D. Biomass

Generally defined as the amount of a species or vegetative class by weight present in a given unit of area.

1. Harvest Method

Vegetative quadrats, plots, and frames as described in the Density section are most commonly utilized to estimate vegetative biomass and production with this technique (Chambers and Brown 1983).

a. Procedures

1. For herbaceous vegetation, all above ground vegetative material is removed from the plot by clipping and separated by species or class.
2. Samples are oven-dried at 60-70 C until a constant weight is obtained. Samples are weighed and dry weights recorded. Weights (biomass/production) can then be converted to kilograms/hectare.
3. This method can also be applied to submergent vegetation.
4. When estimating woody plant biomass, usually only leaves and current year's twig growth are clipped and recorded.

2. Double-Sampling by the Weight-Estimate Method

With this technique, vegetation production is estimated in the majority of plots sampled, while only a few randomly selected plots are clipped and processes as outlined in the harvest method (ChDmbers and Brown 1983). With this method, sample plots must be estimated then actually processed by the harvest method to develop a correction factor that will be utilized to adjust estimations of nonharvested plots. Limitations with this technique are that personnel must undergo extensive training and practice to accurately estimate vegetation biomass; however, this method can allow a trained observer to sample more plots in a shorted time than the harvest method.

3. Robel Pole

Robel pole measurements are correlated to vegetation biomass (Robel 1970) and extrapolated measurements for biomass can be utilized in place of the harvest methods.

E. Vegetation Height

Robel Pole Robel pole readings can be utilized to assess vegetation height at strategic locations along a transect.

a. Procedures

1. The Robel pole consists of 1 m of PVC or wooden dowel, marked at 5 cm or 10 cm intervals along with 4 m of string or rope (Robel et al. 1970).
2. Robel pole readings can be taken at random points within a habitat type or along a transect or line intercept.
3. Photographs can be taken at Robel pole locations to provide a visual record of vegetative conditions.

F. Suggested Literature Review for Vegetation

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Figure 1. Example of field data sheet for line intercept sampling in mixed brush habitat

WOODY VEGETATION SAMPLING DATA SHEET

CHAPARRAL WILDLIFE MANAGEMENT AREA

LINE INTERCEPT AND VEGETATION PROFILE BOARD

OBSERVER(S):									**TRANSECT:**			
DATE:												
SHRUBS, CACTI, & VINES												
Acacia berlandieria	Acacia greggi	Acacia rigidula	Acacia schaffneri	Acacia smallii	Aloysia gratissima	Bumelia celastrina	Castela texana	Celtis laevigata	Celtis pallida	Cissus incisa	Colubrina texensis	Condilia hookeri
Cynanchum spp.	Diospyros texana	Echinocereus enneacanthus	Ephedra spp.	Eysenhardtia texana	Forestiera angustifolia	Guaiacum angustifolium	Gymnosperma glutinosum	Jatropha dioica	Karwinshia humboltiana	Koeberlinia spinosa	Lantana horrida	Lantana macropoda
Leucophyllum frutescens	Lycium berlandieri	Opuntia engelmannii	Opuntia leptocaulis	Parkinsonia aculeata	Parkinsonia texana	Prosopis glandulosa	Salvia ballotaeflora	Schaefferia cuneifolia	Zanthoxylum fagara	Ziziphus obtusifolia		
								VEGETATION PROFILE BOARD (VPB)				
								Level	**0.0 - 0.5**	_____	**0% - 20% = 1**	
									0.5 - 1.0	_____	**21% - 40% = 2**	
									1.0 -1.5	_____	**41% - 60% = 3**	
									1.5 - 2.0	_____	**61% - 80% = 4**	
									> 2.0	_____	**81% - 100% = 5**	
								vpb is read 15 m (49.2 ft) N of transect post				

Figure 2. Example of field data sheet for Daubenmire frame sampling of herbaceous vegetation.

HERBACEOUS VEGETATION SAMPLING DATA SHEET - CHAPARRAL WMA

DAUBENMIRE FRAME DATA

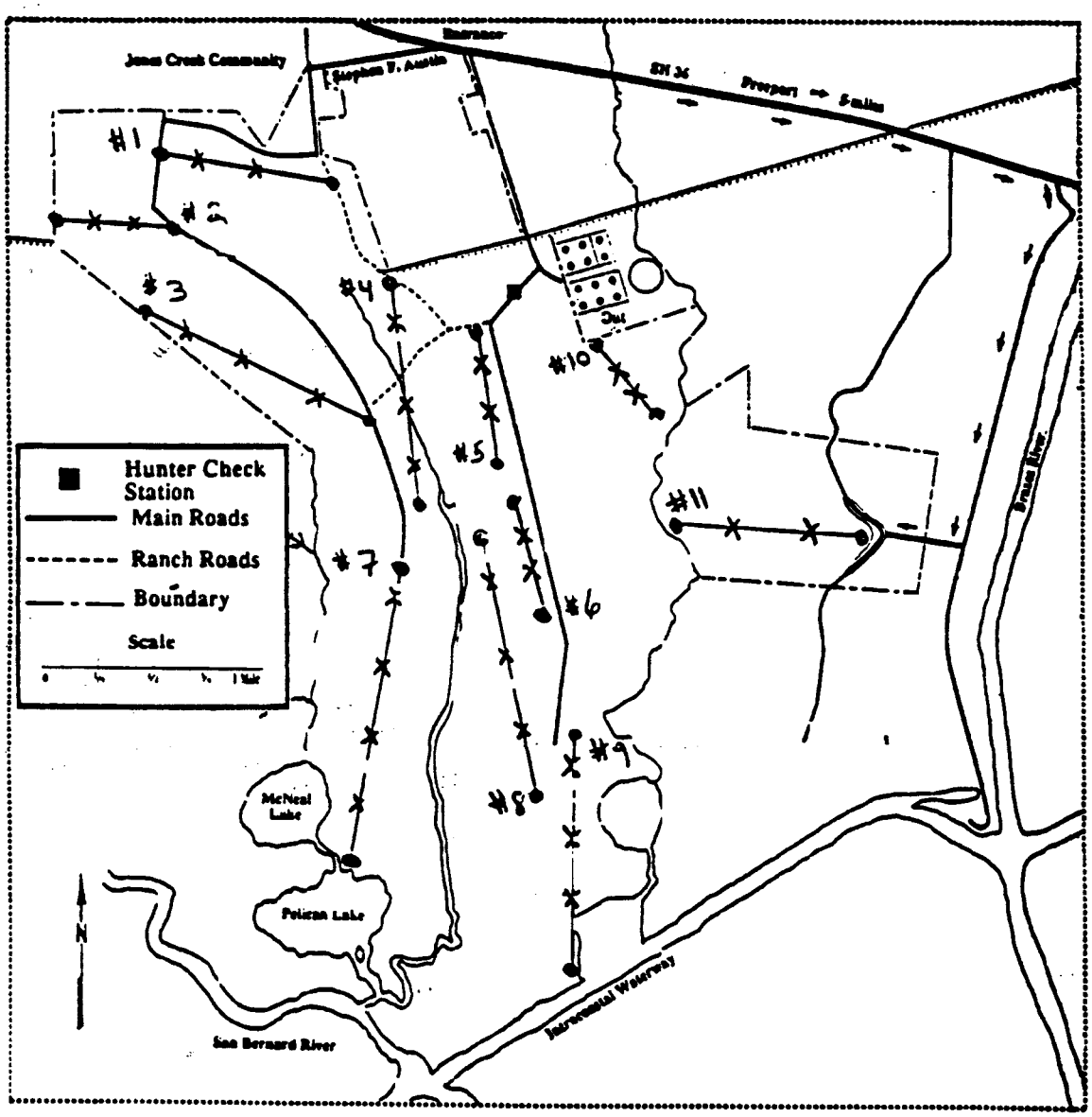
OBSERVER(S):

DATE: **TRANSECT NO.:**

FRAME 1														
GRASSES	**% COVER =**		Brachiaria	Bouteloua	Cenchrus	Cenchrus	Digitaria	Digitaria	Chloris	Chloris	Eragrostis	Eragrostis	Eragrostis	Eragrostis
Aristida	Carex	Panicum	ciliatissima	hirsuta	incertus	ciliaris	cognata	patens	cucullata	pluriflora	lehmanniana	sessilispica	curtipendicellata	secundiflora
Pappophorum	Paspalum	Paspalum	Setaria	Setaria	Sporobolus	Tridens	Tridens							
bicolor	setaceum		texana		cryptandrus	muticus	eragrostoides							
FORBS	**% COVER =**										**% LITTER =**		**% BARE GROUND =**	
Lesquerella	Croton	Commelina	Evolvulus	Diodia	Palafoxia	Chamaecrista	Ambrosia	Portulaca	Sida	Verbena	Monarda	Verbesina		
FRAME 2														
GRASSES	**% COVER =**		Brachiaria	Bouteloua	Cenchrus	Cenchrus	Digitaria	Digitaria	Chloris	Chloris	Eragrostis	Eragrostis	Eragrostis	Eragrostis
Aristida	Carex	Panicum	ciliatissima	hirsuta	incertus	ciliaris	cognata	patens	cucullata	pluriflora	lehmanniana	sessilispica	curtipendicellata	secundiflora
Pappophorum	Paspalum	Paspalum	Setaria	Setaria	Sporobolus	Tridens	Tridens							
bicolor	setaceum		texana		cryptandrus	muticus	eragrostoides							
FORBS	**% COVER =**										**% LITTER =**		**% BARE GROUND =**	
Lesquerella	Croton	Commelina	Evolvulus	Diodia	Palafoxia	Chamaecrista	Ambrosia	Portulaca	Sida	Verbena	Monarda	Verbesina		
FRAME 3														
GRASSES	**% COVER =**		Brachiaria	Bouteloua	Cenchrus	Cenchrus	Digitaria	Digitaria	Chloris	Chloris	Eragrostis	Eragrostis	Eragrostis	Eragrostis
Aristida	Carex	Panicum	ciliatissima	hirsuta	incertus	ciliaris	cognata	patens	cucullata	pluriflora	lehmanniana	sessilispica	curtipendicellata	secundiflora
Pappophorum	Paspalum	Paspalum	Setaria	Setaria	Sporobolus	Tridens	Tridens							
bicolor	setaceum		texana		cryptandrus	muticus	eragrostoides							
FORBS	**% COVER =**										**% LITTER =**		**% BARE GROUND =**	
Lesquerella	Croton	Commelina	Evolvulus	Diodia	Palafoxia	Chamaecrista	Ambrosia	Portulaca	Sida	Verbena	Monarda	Verbesina		
FRAME 4														
GRASSES	**% COVER =**		Brachiaria	Bouteloua	Cenchrus	Cenchrus	Digitaria	Digitaria	Chloris	Chloris	Eragrostis	Eragrostis	Eragrostis	Eragrostis
Aristida	Carex	Panicum	ciliatissima	hirsuta	incertus	ciliaris	cognata	patens	cucullata	pluriflora	lehmanniana	sessilispica	curtipendicellata	secundiflora
Pappophorum	Paspalum	Paspalum	Setaria	Setaria	Sporobolus	Tridens	Tridens							
bicolor	setaceum		texana		cryptandrus	muticus	eragrostoides							
FORBS	**% COVER =**										**% LITTER =**		**% BARE GROUND =**	
Lesquerella	Croton	Commelina	Evolvulus	Diodia	Palafoxia	Chamaecrista	Ambrosia	Portulaca	Sida	Verbena	Monarda	Verbesina		
FRAME 5														
GRASSES	**%COVER =**		Brachiaria	Bouteloua	Cenchrus	Cenchrus	Digitaria	Digitaria	Chloris	Chloris	Eragrostis	Eragrostis	Eragrostis	Eragrostis
Aristida	Carex	Panicum	ciliatissima	hirsuta	incertus	ciliaris	cognata	patens	cucullata	pluriflora	lehmanniana	sessilispica	curtipendicellata	secundiflora
Pappophorum	Paspalum	Paspalum	Setaria	Setaria	Sporobolus	Tridens	Tridens							
bicolor	setaceum		texana		cryptandrus	muticus	eragrostoides							
FORBS	**% COVER =**										**% LITTER =**		**% BARE GROUND =**	
Lesquerella	Croton	Commelina	Evolvulus	Diodia	Palafoxia	Chamaecrista	Ambrosia	Portulaca	Sida	Verbena	Monarda	Verbesina		

Figure 3. Layout of permanent vegetation transects at Peach Point WMA. The transects vary in length and are associated with major habitat types and/or management units, such as moist-soil management areas or grazing pastures.

PEACH POINT WILDLIFE MANAGEMENT AREA



–X----X----X-- VEGETATION TRANSECTS

Figure 4. Example of vegetation transect showing 100 meter segments, random points in each 100 meter segment and the 10 points for recording vegetation within each segment.

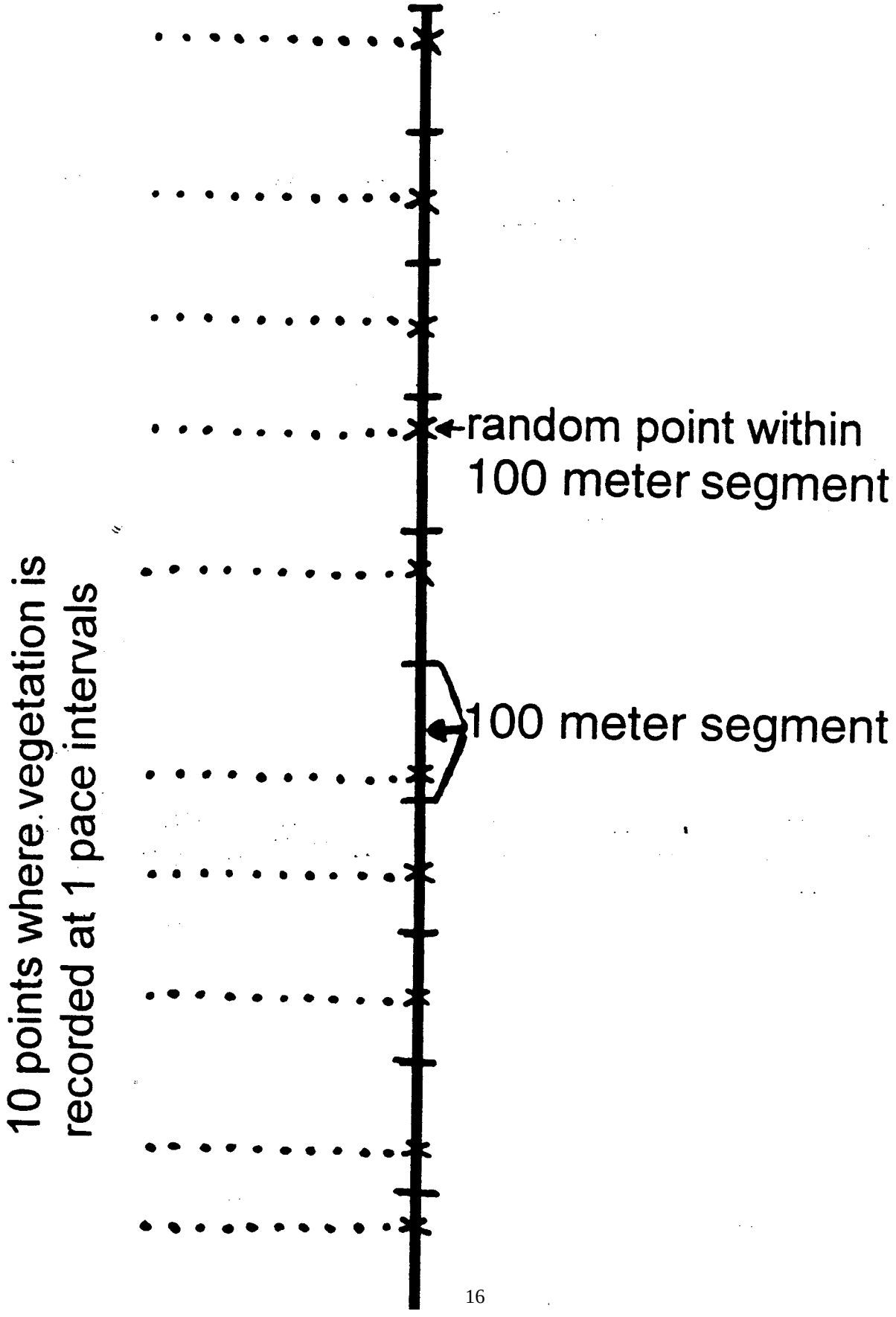


Figure 5. Example of field data sheet for point intercept sampling in coastal prairie/marsh habitat along permanently marked transects.

VEGETATION TRANSECT FIELD DATA SHEET

WMA: Peach Point DATE: April 29, 1996

TRANSECT # & NAME #1 Redfish Prairie TRANSECT TYPE: Point Intercept

Seg. (RN)	Point	Species	Seg. (RN)	Point	Species
01(25)	1	Gulf Cordgrass	_3( )	6	Marsh Hay, Distichlis
	2	"		7	"
	3	", Marsh Hay		8	Saltgrass, Sea Oxeye
	4	", "		9	", "
	5	", "		10	Marsh Hay
	6	"	04 (52)	1	Sea Oxeye, Marsh Hay
	7	Bare ground		2	", "
	8	Narrow leaved Iva		3	", "
	9	"		4	", "
	10	"		5	", "
02 (50)	1	Open Water		6	", Iva Frutescens
	2	"		7	"
	3	"		8	"
	4	"		9	Sea Oxeye
	5	Bare ground		10	"
	6	Marsh Hay, Narrow leaved Iva	05 (91)	1	Gulf Cordgrass
	7	", "		2	"
	8	", "		3	", Marsh Hay
	9	", "		4	", "
	10	", "		5	", "
03 (33)	1	Saltgrass, Leafy 3 square		6	", "
	2	"		7	Marsh Hay
	3	", Leafy 3 square		8	"
	4	"		9	"
	5	"		10	"

Figure 6. Summary of data generated in marsh habitat using point intercept sampling along a transect**.**

TRANSECT SUMMARY

Management Area Guadelupe Delta (Calhoun Co.)

Transect # and Name Number 5, Alligator Line Date 10-07-1992

Number of Segments 28

Number of Intercepts 280

Number of Species Encountered 24
Grasses 7
Forbes 17

Robel Pole Readings Beginning 71.25 cm.
2nd pole 170.00 cm.
3rd pole 146.25 cm.
End 205+ cm.

Salinity Readings seg. 2 Ditch 0 ppt.
Seg. 3 Sheetwater 1 ppt.
Seg. 5,7,8 and 10
Alligator S. Lake 0 ppt.
Seg 17 Sheetwater 0 ppt.
Seg. 19 Sheetwater 0 ppt.
Seg 28 Sheetwater 0 ppt.

SPECIES CODE	INTERCEPTS	%OCCURRENCE	SPECIES CODE	INTERCEPTS	%OCCURRENCE
019	57	34	041	3	2
051	55	32	094	3	2
064	47	28	003	2	1
053	17	10	061	2	1
076	14	8	001	2	1
037	13	8	089	2	1
065	10	6	084	1	<1
006	10	6	028	1	<1
088	9	5	042	1	<1
008	8	5	082	1	<1
083	8	5			
024	6	4			
050	5	4			
035	5	4			
023	4	2			
090	3	2			

Comments: 110 of the intercepts were in Alligator Slide Lake and were recorded as open water. These intercepts were not used in calculating percent occurrence of vegetation. 170 intercepts were used in calculations.

IV. Reptiles and Amphibians

A. Estimating Species Richness and/or Relative Abundance

1. Drift Fences with Pitfall and Funnel Traps (Array system)

This widely accepted technique is used to determine species richness and provide an index of the relative abundance of the most common amphibian and reptile species. This technique by itself does not reliably sample all species in a habitat (most notably turtles and large snakes) and must, therefore, be coupled with specific search techniques for those species less likely to be taken in the trapping system (Campbell and Christman 1982). Drift fences are designed to impede an animal's movement and divert it into a funnel or pitfall trap. Pitfall traps are useful in collecting most ground-dwelling lizards, toads, small snakes, and skinks (also insects, small rodents, and shrews). Funnel traps (optional) are used to capture small to medium-sized snakes, frogs, lizards, and some species of salamanders.

a. Supplies and Materials (1 array)

1. Twenty-two and one-half meters of aluminum or galvanized flashing (or valley tin), 30 - 45 cm high.
2. Four, 19 liter (5 gal) plastic buckets.
3. Six funnel-type minnow traps approximately 30 - 45 cm in length, with two 5 cm entrance holes, constructed of aluminum or galvanized steel mesh. Mesh size will be dependant upon target species.
4. Small diameter (0.64 cm) steel rod or rebar to serve as fence supports.
5. Four plywood lids.

b. Procedures

1. A minimum of two arrays per habitat type should be constructed. Depending on environmental variability, more may be necessary in order to detect significant changes in reptile abundance between different habitat management practices.
2. Each array will be composed of three, 7.5 m wings, constructed in a "Y" pattern (Figure 7). Bury the bottom of the flashing in the soil deep enough to discourage animals from digging under. If supports are needed, either attach the fence directly to a rebar stake by punching two holes in the flashing and wrapping around the stake with plastic tie wraps or weld nails to the top of each stake to slip over the top of the flashing.
3. Bury the buckets at the end of each wing and at the junction of the three wings. The top of each bucket should be left approximately 2.5 cm above ground to avoid water runoff. The flashing should overlap each bucket approximately 5 cm. Cut a small notch in the bottom of the flashing where it overlaps the bucket to fit properly. Use dirt or sand to fill any holes along the fence and around the buckets. Cut or drill several holes in the bottom of each bucket to allow water passage. To discourage fire ants, consider using an approved insecticide in and around the hole prior to installing the bucket.
4. Elevate plywood lids 5 cm over buckets with rocks or wooden legs at corners. Shaded buckets increase capture rate and protect animals from exposure.

5. Place 1 funnel trap adjacent to each side of the flashing midway between the buckets at ground level. Recess the trap in the ground or pack loose soil into the funnel to create a more natural entry. Funnel traps should be shaded with an L-shaped piece of flashing covering the side and top.
6. Buckets should be secured with lids or filled with sand when the array is not in use. Place a stick inside the bucket so animals can escape if the lid comes off.
7. All animals may be marked (Cooperrider et al. 1986) to document recaptures. Those caught in funnel traps should be released on the opposite side of the fence.
8. Arrays should be monitored at least 4 consecutive days/month from March through October for most reptilian species. Six to twelve days of constant monitoring would be ideal. Remove lids 1 hour before sunset on day 1 and check the array 1-3 hours after sunrise and 1 hour before sunset each day (1 array-day). Replace the lids 1 hour before sunset on day 4 (3 arraydays/month). During hot weather, blocks of wood or other suitable material can be placed in the bottom of buckets in a fashion so that captured animals can seek shelter. To prevent dehydration of amphibians, a wet sponge can be placed in each bucket each evening.
9. Results can be expressed as number of individuals per array per day and/or total number per habitat type. Amphibians can be collected year round and some species need to be targeted during peak activity periods. Examples of a field data for individual herpetiles and a summary sheet are provided in Figures 8 and 9.

2. Nocturnal Road Cruising

This technique is useful in determining the occurrence and relative abundance of many species of nocturnal reptiles and amphibians not encountered in other trapping methods. Nocturnal road cruising is, however, time consuming and limited to habitats containing navigable roads.

a. Supplies and Materials

l. Vehicle with low-beam headlights and odometer.
2. Spotlight and/or flashlight or headlamp.
3. Collecting materials such as snake tongs, cloth sack, snake leggings, gloves, etc.

b. Procedures

l. Permanent survey routes should be established along navigable roads through as many habitat types as possible.
2. Routes should be run on moonless nights between sunset and sunrise from April through October for most reptiles. For certain amphibian species, census efforts must be concentrated during the period they are most active.
3. Vehicles must be maintained at a speed of 16.1-32.2 km/hour during the route. All species will be captured, identified on the spot and released, or collected for later identification and returned to the capture site.
4. Data can be expressed as number of individuals collected by species; or relative abundance of each species can be obtained by measuring the distance of each habitat type along the route and recording time spent in each habitat. Data can then be expressed as the number of animals seen per kilometer of habitat per hour (Cooperrider et al. 1986).

3. Time-constrained Searches

Time-constrained searches involve an intensive hunt for reptiles and amphibians in a particular habitat type over a specific period of time. This survey method will provide occurrence and/or relative abundance data for many species but results are highly dependent upon the skills of the observers. Habitat damage should be considered before utilizing this technique (Renken 1995).

a. Supplies and Materials

1. Boots, gloves, snake tongs, cloth sack, snake leggings, long pole for turning over logs and rocks.

b. Procedures

1. Delineate boundaries of specific habitat types within the study area.
2. An intensive hunt is organized within a habitat type for a specific period of time (hours) with a known number of searchers.
3. Searchers then turn over logs and rocks, break apart logs, and generally hunt for surface dwelling reptiles and amphibians. Care should be taken to replace logs and rocks to their original position and minimize habitat damage as much as possible.
4. Data can be expressed as number of individuals captured/person hours of searching for each habitat type.

B. Specialized Inventory Techniques

The methods described above are not designed to capture all species of reptiles and amphibians present on a study area. Specialized techniques designed to target a specific species or group must be employed when attempting to produce a verified species checklist. Most of the collection techniques discussed in this section should be used for occurrence data only. Additional information can be obtained from the referenced publication or from other references listed at the end of this section.

1. Hoop Funnel Traps

This technique is used primarily for capturing aquatic turtles. The trap consists of mesh netting connected to 4 aluminum hoops (tubing) to form a large circular trap with one or two funnel-shaped openings. A purse-string regulated opening provides turtles with access through the throat to a piece of suspended bait. A can of sardines with holes punched in it, a head of cabbage, or cat food can be used for bait (Pirnie 1935, Legler 1960, Feuer 1980).

2. Call Counts

Call counts can be used to determine the presence of many species of frogs and toads not normally recorded using capture techniques. This survey simply involves the use of a recorder to tape the vocalization of amphibian species within a study site. The tape can then be played back at a later date for species identification by an experienced

herpetologist or documented on site depending upon the aural acuity and skills of the observer. Call counts should be conducted on moonless nights during peak activity periods. Pre-recorded tapes for identification purposes may be obtained from Cornell University Lab of Ornithology, (607) 254-2400 or from Northward Press, Nature Guide series (1-800-336-6398).

3. Stunning by Rubberband

Many stunning devices have been designed which temporarily immobilize frogs and lizards for collection. Dundee (1950) designed a wooden "gun" for discharging rubber bands (or pieces of tire tubes) with a clothespin triggering device. Neill (1956) utilized a small board with a series of notches cut in it. Each notch holds a rubberband stretched to the end of the board. The device is held to the shoulder and triggered by rolling the rubberband upward over the notch (Balgooyen 1977).

4. Cover Boards

This technique simply involves providing artificial shelter areas by placing a sheet of plywood directly on or slightly above ground level. Lifting the cover board exposes the animals for collection. This technique can be used in conjunction with a drift fence array system.

C. Suggested Literature Review for Herpetiles

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Figure 7. Diagram of drift fence or pitfall trap design.

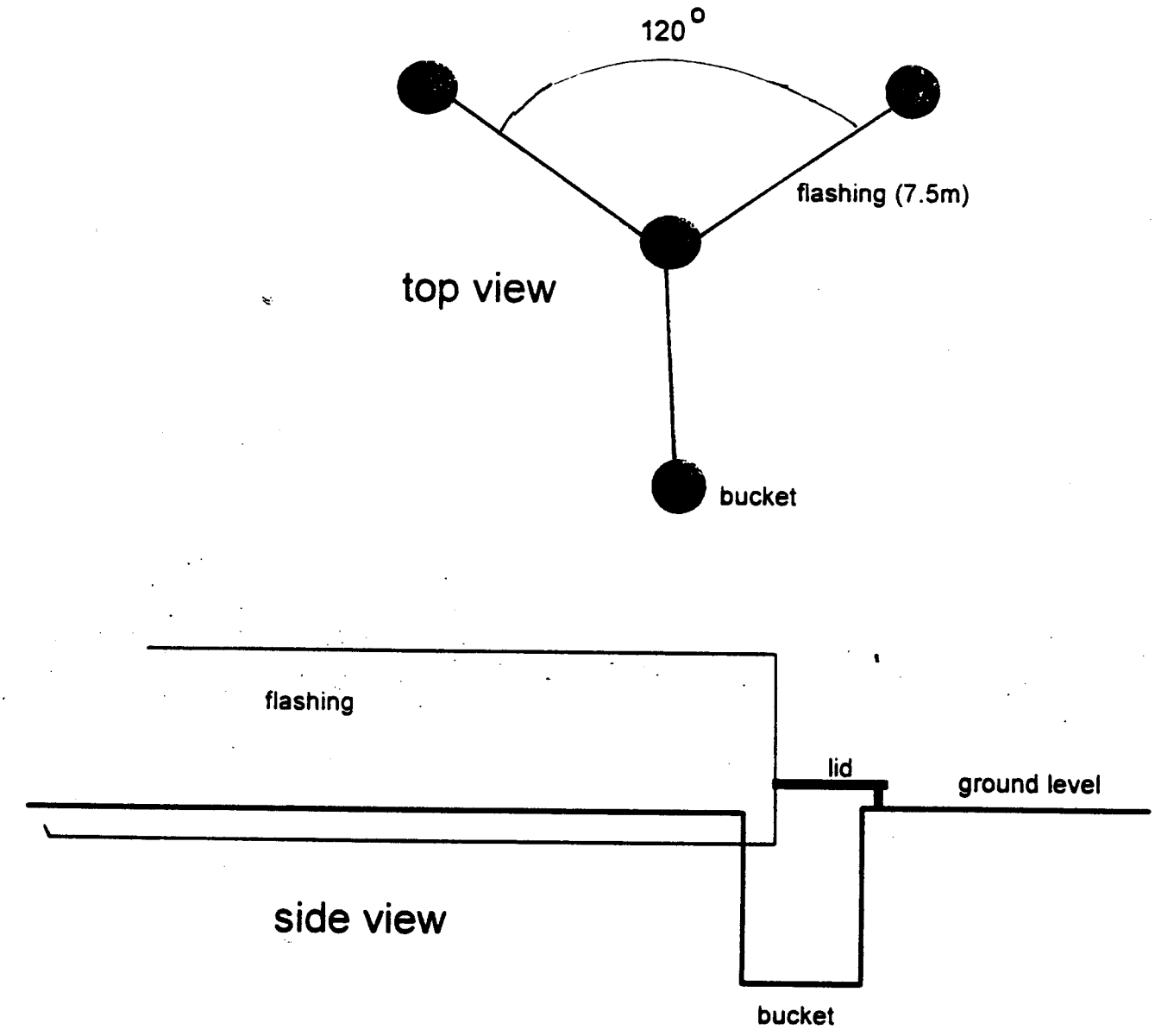

Figure 8. Example of data sheet for individual herptiles.

Date: _____

Time: _____

Drift Fence Array:_____

Bucket: _____

Snout-Vent Length: _____

Total Length: _____

Sex: _____

Recapture: Yes_____ No_____

Capturer's Initials:_____

Notes: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Figure 9. Example of field summary sheet for herptiles.

BASELINE INVENTORY AND MONITORING
SUMMARY DATA SHEET FOR REPTILE/AMPHIBIAN
PIT FALL TRAPS

Date	Array #	Trap #	Habitat or Mgmt Unit	Time or Array Day/ Night	Species	Sex	Snout-Vent Length (mm)	Total Length	Mark-Recapture Notes

V. Birds

A. Systematic Bird Sampling

1. Point Counts

Point counts are the most preferred technique for determining bird species composition, relative population abundance and density by habitat type, as well as monitoring of long-term trends of species composition and abundance. Point counts are best suited for wooded or shrub-type habitats rather than open grasslands or marshes.

a. Procedures

1. This technique should be used just prior to the nesting season (at peak singing, usually mid-April - May) which will vary throughout the state by latitude. The populations primarily to be monitored will be breeding, summer and permanent residents.
2. Point counts should be permanently marked and georeferenced stations, randomly distributed among habitat types. Ideally, a minimum of 50 points, spaced of 250 m apart, should be established per habitat type. In order to adequately detect general trends in population and/or changes in species composition, point count surveys should be conducted once a year during the breeding season,at or near the same date and time of day. (Hamel et al. 1993).
3. Point counts are completed in the mornings under acceptable weather conditions (winds less than 19.3 km/hour and no rain) and should be done by the same competent bird observers each year. Observations should consist of 5 minutes of listening and observing per point. Record birds within and beyond 50 m of the counting station in the first 3 minutes using one type of notation, and in the last 2 minutes using a different notation (circling or underlining). Use the mapped location to judge whether songs are from new or already mapped individuals. Surveys should be performed from l/2 hour before sunrise to 10:00 a.m. (4 hour period). Approximately 15-25 points can be performed per morning.
4. See "A Land Manager's Guide to Point Counts of Birds in the Southeast" (Hamel et al. 1993) for details on how to set up and perform the point count survey. Examples of point count data sheets are provided at the end of this section (Figures 10,11,12). Undoubtedly, adaptations to this technique will need to be made to account for individual area differences in relation to cover types, flushing (disturbance) distances and the size of each area. Sampling consistency between years will be the key to getting the most from this survey technique on each individual area.
5. Point stations should be permanently marked, GPS locations taken, and marked on a map for future reference.

2. Strip Census

This technique may be used in place of point counts in more open habitats such as coastal marshes, upland prairie, or scrub vegetation with little or no overstory. Species composition, relative abundance, and density can be determined with this method. Changes in species richness and relative abundance should be detected if sufficient sampling intensity is performed.

a. Procedures

1. Routes should be randomly established to adequately sample habitat types. If statistical validity is required, the number of routes established will need to be increased based on minimum sample size tests after initial survey data is collected and analyzed. For example, a minimum sample size would need to be determined in order to reliably compare species changes between various habitat treatments, but is generally not necessary to detect long term trends for the site as a whole.
2. Surveys should be performed during the nesting season (May - July) when populations are stable and singing activity is high.
3. Route length can be variable depending on the size and configuration of the area to be surveyed. Routes should be marked with permanent stakes that are visible to the surveyor at all times. As a general guide, survey effort should be such so that a minimum of 3 mornings will be necessary to complete. Data analysis will be needed to refine survey effort needed to detect change.
4. All birds observed within a 50 m band on either side of the transect will be recorded. The width of the band can be adjusted, or an outside band can be added depending on visibility and detectability of target species or the majority of species. Band width and number should be standardized to facilitate comparisons among transects or between different survey areas.
5. Routes should be surveyed by one person who records every bird seen or heard within the belt (90 m wide strip) for the entire length of the transect. Walking speed should be approximately 3.2 km/hour. Surveys can be done from l/2 hour before sunrise to 4 hours after sunrise. Surveys should not be conducted when birds are not active, for example, during inclement weather or mid-day. An example of a field data sheet for the strip census technique is included at the end of this section (Figure 13).

3. Mist Netting

Mist netting will help uncover the presence of secretive species and some migrants (TPWD biologist, Kelly Bryan, was able to increase species list by 10 % at Kickapoo Caverns State Park using this technique).

a. Supplies and Materials

1. Fine nylon mist nets come in various mesh sizes and lengths. Nets with 36 mm (1.5") mesh and 2.13 x 6 m in size, with aluminum poles (electric conduit) approximately 3 m long are typically used for songbirds. Cloth bags or or other restraining device can be used to hold excess birds.

b. Procedures

1. All employees must be permitted or subpermitted under a USFW master banding permit to purchase and use mist nets.
2. Mist nets suspended by poles should be set across flight paths and checked every 10-20 minutes to prevent injury to entangled birds.
3. Mist nets can be used in all seasons in each habitat type, during morning hours or

depending on seasonal presence of birds and levels of activity to be determined by inventory personnel. Most success will occur during early morning and at dusk.

4. Sampling intensity will be determined by the availability of mist nets and the discontinuance of the capture of new species with the technique.
5. Expression of results will be the number of birds per trap time (net-hours) per habitat type by species and season.
6. Banding of captured birds using USFWS leg bands must be done on a long-term research basis to supplement national efforts to study movements, trends, and status of migratory bird populations. Review the USFWS Banding Manual for protocols and details on record keeping. banding may be useful in estimating survivorship and fidelity to existing nesting habitats Contact TPWD Wildlife Division in Austin for this document, and if vou are interested in banding under TPWD's Master Banding Permit. See "Operational Standards and Parameters for Banding Birds on Texas Parks and Wildlife Department Properties" for additional information on banding birds.
7. For netting equipment contact: AVINET, P.O. Box 1103, Dryden, NY 13053-1103. Phone number: (800) 340-6387.

B. Opportunistic Bird Identification

1. Area Search

Opportunistic bird identification by habitat type (area search) assures that a variety of bird groups will be sought and identified because efforts can be directed at a diversity of habitats. This method is useful in estimating presence/absence and developing checklists. Relative abundance may be calculated as described by Pettingill (1970).

a. Procedures

1. All groups of birds should be adequately sampled by this method.
2. This involves intensive birding by individuals using binoculars, spotting scopes and field guides. All habitat types should be surveyed.
3. Sampling should be performed once per month, by season, year round. This will enable the detection of the following categories of birds (Pettingill 1970): Mid-summer Population; summer residents, permanent residents: Mid-winter Populations; winter residents, permanent residents: Mid-spring and Mid-fall Populations; transients, permanent residents, sumrner residents, winter residents.
4. Records of time spent observing and numbers of birds seen or heard by habitat type should be kept. It is recommended that a separate checklist of birds be kept for each habitat type by season.
5. Volunteer help should be used as much as possible to supplement existing TPWD personnel hours available. Students, organizations or private individuals with birding experience can provide extensive data at no cost.
6. Relative abundance of species should be calculated based on percent of occurrences per unit area and per unit of time effort (time/area/count). Abundance categories could be used as described by Pettingill (1970).
7. Birding during the hotter months should be performed from l/2 hour before sunrise until bird activity begins to drop off which generally occurs at

mid-morning.

8. Sampling effort will vary depending on time and manpower available. The greater the effort, the more likely all species and individuals will be detected and abundance ratings will be more reliable.

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Figure 10. Point count field data sheet.

Point Count Field Data Sheet

Location_____County_____Observer_____

Point # _____ Vegetation type (4 letter code)_____ Successional stage (Circle one) 1 2 3 4

Sky (code)_____ Wind (code)_____ Temperature _____F* Date_____
Time_____

Notes:

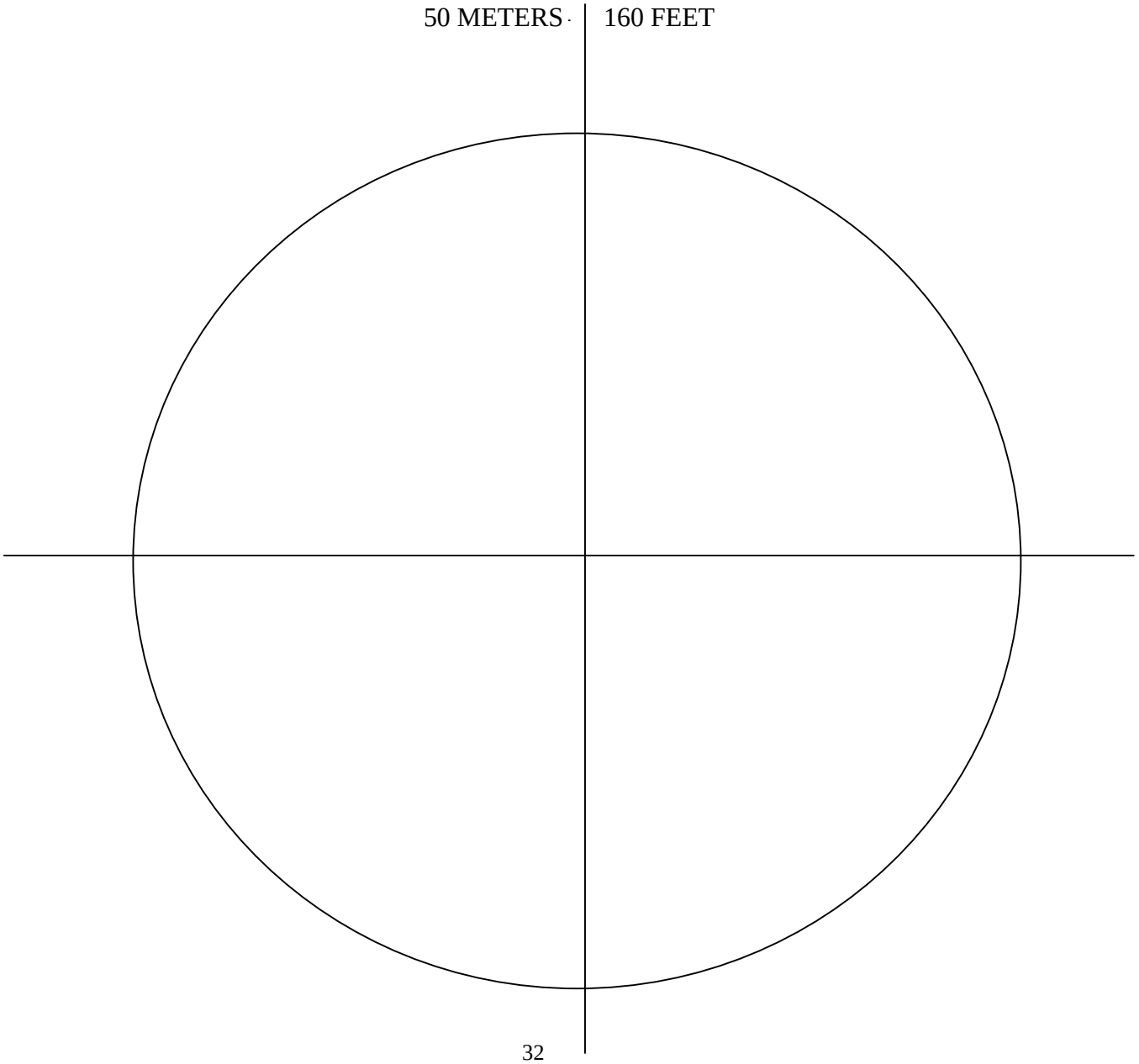

Figure 11. Point count field data sheet.

Point Count Field Data Sheet

Location__________________________ County____________________ Observer_______________________

Point # _____________ Vegetation type (4 letter code)___________ Successional stage (circle one) 1 2 3 4

Sky (code) ________ Wind (code)_______ Temperature ________F* Date____________ Time____________

Notes:

	Minutes 1 through 3			Minutes 4 and 5		
Species	0-50 m	>50 m	Flyover	0-50 m	>50 m	Flyover
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
________________	_______	_______	_______	_______	_______	_______
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Figure 12 Point Count summary form

Point Count Summary Form

Site name:____________________________________ Date:____________________________

County name:_________________________________ Sky code: _______________________

Observer:____________________________________ Weather: Wind code: ______________

Temp: (*F)_____________

Start time Habitat code + Point #	__________ ________	___________ ___________	___________ ___________	___________ ___________	___________ ___________	___________ ___________
Species code	a b c d	a b c d	a b c d	a b c d	a b c d	a b c d
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Figure 13. Strip census survey data sheet.

Strip Census of Bird Populations			
Name of Wildlife Area:	Transect Name or Number:		
Length:	Width:	Acres Sampled:	
Date of Survey:	Start Time:	End Time:	
Temp:	Wind:	% Cloud Cover:	
Name of Surveyor:			
Species	**Number of Times Seen**	**Percent of Abundance**	**Number of Individuals/100 Acres**

VI. Mammals (Terrestrial)

A. Small Mammals

1. Live Trapping

Live trapping is the most common and practical method to determine presence, relative abundance/frequency, and species richness of small mammals. Although live trapping will provide important data for a variety of small mammals, this technique can be biased toward easily trapped species. Some species can not be adequately sampled with live traps; therefore, if the target species is not likely to be captured by this technique, an appropriate technique should be employed. Live trapping can be conducted year round; however, prolonged cold and/or wet weather should be avoided.

a. Supplies and Materials

1. Live traps (Sherman traps are the most common), bait (oatmeal, "sweet feed", birdseed), rubber gloves, plastic sandwich bags. OPTIONAL: ruler, pesola scale, scissors or nail clippers, face mask

b. Procedures for transect sampling

1. A minimum of two transects per habitat type should be established.
2. Each transect should consist of 20 - 25 stations with a minimum of one trap/station (two traps/station are preferred). Stations should be placed no less than 15 m intervals.
3. Traps can be baited with an oatmeal - birdseed mixture, or with only oatmeal, or other preferred bait. In areas where fire ants are present, traps can be baited with "sweet feed" or plain oatmeal.
4. Trapping period should be conducted for three to four consecutive nights.
5. Avoid the period of four days prior to and after the full moon phase.
6. Traps should be closed in the morning after checking and reset in the evening, to prevent diurnal animals from becoming trapped during the heat of the day.
7. During extreme cold weather, the energy demands of thermoregulation require that an adequate supply of food and nesting material (cotton ball) be placed in the traps.
8. Minimum data to be recorded should include date, location, habitat type, species captured and number, and number of trap nights (see Figure 14). Optional data can include: weather conditions; wind speed, temperature, cloud cover, moon phase, etc.
9. Depending on objectives and purpose, captured animals can be weighed, sexed, aged, and marked by toe-clipping, hair dying, or other permanent marker. For specific objectives, small mammals that are captured can be given an unique toe-clip number that identifies that individual. This method can be used to conduct mark-recapture studies to determine density, growth rates, etc.
10. Trapping results can be expressed as animals captured per trap night (or 100 trap nights) by species and habitat type.

c. Procedures for grid sampling

Grid sampling is an alternative sampling methods that is used for more intensive sampling of a given area or habitat type.

1. Place live traps in a 100 m x 100 m grid, with a trap every 10 m (100 stations). A minimum of 2 grids per habitat type should be established, if possible. A 50 m x 50 m grid, with traps every 10 m is acceptable.
2. Follow remaining procedures #3 through #10 as outlined above in transect sampling procedures.

D. General information

The American Society of Mammalogists has established standards (Ad Hoc 1987) for trapping and marking mammals. Sherman live traps, the most common traps used, are manufactured in many sizes and configurations. The most common trap size is 7.62 x 8.89 x 22.86 cm (model LFATDG). Traps constructed of aluminum bodies and galvanized treadles and doors are recommended to prevent small mammals from chewing on the treadles and doors. Solid galvanized traps are difficult to handle because of the added weight. Sherman traps can be purchased in folding and non-folding models. Both are effective; however, if storage space is limited, folding models are recommended. Non-folding models are easier to clean when trapping is completed.

2. Lethal Trapping

Snap traps (Museum Specials) are available for collecting small mammals. We recommend live trapping as described above. However, if it is desired to use snap traps for a specific objective or for a particular species, they can be purchased and used in the same procedures as described above for live trapping. The following lethal trapping methods describe techniques for determining
species and relative abundance of gophers and moles.

a. Supplies and materials

1. Stab traps, body grip traps, wire, anchors.

b. Procedures

1. Place two stab or body grip traps per burrowing system with as many as 5 systems sampled per night to ensure success.
2. Secure traps with wire tied to anchors in the ground or to nearby trees/shrubs.
3. Results can be expressed as animals per trap night by species and habitat type.

3. Nocturnal Road Cruising

Follow procedures as outlined in the Reptiles and Amphibians Section.

4. Incidental Observations

Incidental observations can be used to determine presence of species.

B. Intermediate-size Mammals

1. Live Trapping

a. Supplies and Materials

1. Live traps (Hav-a-hart or Tomahawk), bait (venison, fish, etc.). There are a variety of sizes of live traps to catch anything from chipmunks to foxes.

b. Procedures

1. Traps can be placed with small mammal traps or at a constant spacing interval (0.8 km) at marked and georeferenced locations in each habitat interval (0.8 km) at marked and georeferenced locations in each habitat type.
2. Results can be expressed as animals per trap night for each habitat type.

2. Scent Stations

Scent stations can be used to determine presence, frequency, and population indices (long-term), of intermediate mammals, in particular coyotes, bobcats, and foxes.

a. Supplies and Materials

1. 18 gauge galvanized sheet metal (0.61 x 0.61 m), 98% or greater alcohol, carpenters chalk, paint roller, fish oil (bait), plaster of Paris, small dixie cups, 5.08-7.62 cm wide, clear packing tape.

b. Procedures

1. One to 5 routes with 10 stations each should be established in different habitat types along roads or trails. Stations should be 0.8 km apart and altered on each side of the road or trail.
2. Mix 1 pint of alcohol with 4-5 tablespoons of carpenter chalk and roll mixture on sheet metal (plate). Place plate at station, making sure plate is solid on the ground. If not, smooth out soil.
3. Mix plaster of Paris, pour a little in dixie cups and let dry. These will serve as scent tabs. Soak or squirt fish oil on plaster of paris tabs and place in the center of the plate.
4. Tracks will be left on the plate; unidentified tracks can be lifted off the plate with clear packing tape and identified later.
5. Run stations for 2-3 consecutive nights.
6. Results can be expressed as number of visits per number of operable stations (scent station nights) by species.

3. Nocturnal Road Cruising

Follow procedures as outlined in Reptiles and Amphibians Section

4. Incidental Observations

Incidental observations, as well as sign, can be used to determine if a species is present. Sign may include burrows, dens, scat, houses, and tracks.

C. Hantavirus

With the dangers associated with the zoonotic disease hantavirus, special precautions must be exercised

when trapping small mammals. Contraction of this virus, which is carried by small rodents, can result in fatality. Therefore, field personnel must take precautions when handling small rodents (Mills et al. 1995). Leather or rubber gloves should be worn at all times when trapping. When a trap is tripped, stay on the upwind side of the trap, and hold the trap at arm length to peer into the trap. Goggles, protective clothing, and a respirator, although not required, provide additional safety. When finished trapping, hands and protective clothing should be washed thoroughly, immediately after the trap line is completed. In addition, when a trap period is complete, all traps must be thoroughly washed. If a hantavirus outbreak occurs in the local area, discontinue small mammal trapping. In summary, use good common sense.

D. Suggested Literature Review for Small and Intermediate Size Mammals

Ad Hoc Committee on Acceptable Field Methods in Mammalogy. 1987. Acceptable field methods in Mammalogy: preliminary guidelines approved by the American Society of Mammalogists. J. Mammal. 68:Sl-S18.

Andrews, R. D. 1979. Furbearer population surveys and techniques: their problems and uses Iowa. Pages 45-55 in Proc. Midwest Furbearer Conf., Coop. Ext. Serv. Kansas State Univ., Manhattan. 186pp.

Frederickson, L. 1979. Furbearer population surveys: techniques, problems and uses in South Dakota. Pages 62-70 in Proc. Midwest Furbearer Conf., Coop. Ext. Serv. Kansas State Univ., Manhattan. 186pp.

Hatcher, R. T., and J. H. Shaw. 1981. A comparison of three indices to furbearer populations. Wildl. Soc. Bull. 9:153-156.

Linhart, S. B., and F. F. Knowlton. 1975. Determining the relative abundance of coyotes by scent station lines. Wildl. Soc. Bull. 3: 119-124.

Mills, J. N., T. L. Yates, J. E. Childs, R. R. Parmenter, T. G. Ksiazek, P. E. Rollin, and C. J. Peters. 1995. Guidelines for working with rodents potentially infected with hantavirus. J. Mammal. 76:716-722.

Roughton, R. D. 1979. Developments in scent station technology. Pages 17-44 in Proc. Midwest Furbearer Conf., Coop. Ext. Serv. Kansas State Univ., Manhattan. 186pp.

Rybarczyk, W. B., R. D. Andrews, E. E. Klaas, and J. M. Kienzler. 1981. Raccoon spotlight survey technique: a potential population trend indicator. Pages 1413-1430 in J. A. Chapman and D. Pursley, eds. Worldwide Furbearer Conf. Proc.,Frostburg, MD. Vol. 2:653-1552.

E. Bats

There are several techniques that can be utilized to sample bats. Each of these techniques has benefits and disadvantages that will be briefly discussed. Because many studies show little positive correlation between species richness and total number of individuals present at most caves or roost sites, it is important to sample a variety of areas and habitat types on each study area to fully determine species richness. All of the following methods described will be useful to assess species richness.

Although less than 0.50% of bats are known to contract rabies, some precautions are warranted to avoid contraction. For those regularly handling bats, it is recommended they receive three pre-exposure immunity injections, available from local doctors and public health facilities. If a bat is easily caught during the day and acts "sick", it would not be a good idea to handle that individual. There is no evidence to suggest humans can contract rabies through bat urine or feces; however, it is recommended that an air filtering face mask be worn when entering roost sites that may have other inhabitants such as rodents to avoid contracting other diseases such as hantavirus.

1. Mist Netting

There are many sizes and types of mist nets available on the market today (Avinet). Generally, a four shelf, black terylene (softer, more durable but more difficult to remove bats from) or braided nylon, 36mm (1 l/2") mesh or 70 denier/2ply, 6 - 36 m long is used. Nets used for birds can also be used for bats. Nets with less sag and shallower shelves will reduce tangling with each capture. Because of some of the difficulties associated with removing bats from nets and injuries while doing so, other techniques have evolved. Training is recommended in removing the entangled bats before this technique is used because of the skill required to untangle the bat without harm.

a. Supplies and Materials

Mist nets, two pvc poles or conduit, rope to steady poles for each net, rubber gloves, reliable light source, headlamp, cotton or canvas "holding" bags, leather gloves (close-fitting, pliable and light weight will work best for small species [10- 30 grams], thicker for larger species), small crochet hook, ruler. OPTIONAL: scale, ladies hair dye, chemiluminescent tags, plastic bird bands.

b. Procedures

1. Sampling should be conducted during the warmer months when bats are present and most active (evening) and before bats migrate or hibernate.
2. Mist nets should be set up at georeferenced positions with pvc/conduit poles on the ends of the net. If the poles cannot be lodged into the ground, they should be stabilized with ropes tied to trees or anchored to the ground.
3. Sampling should occur (dusk to dawn) for three or four consecutive nights once a month (during warmer months) in each habitat type. Most studies suggest that bats are generally active only two hours each night, with peak activity at dusk and scattered activity throughout the evening; however, this is not the activity pattern of all species. To most effectively document species operation the entire night. Netting periods should remain constant over the collection period.
4. If consecutive nights of trapping in the same area are to occur, net locations and configurations should be altered to minimize "net shyness" or familiarity avoidance.
5. Sampling should take place across known flight paths, or over sources of water (streams, ponds and stock tanks). Netting should never be completed at cave openings or abandoned buildings, this may result in roost abandonment or death, due to capturing to many individuals that can be worked in an adequate time period.
6. Higher success rates tend to occur when capture devices are run during dry nights with minimal wind (< 16 km/hour) and the net is strung taut across the designated site.
7. Nets must be constantly attended and captured bats must be removed immediately to reduce the amount of entanglement and to avoid injuries.
8. While a bat is entangled in the net, hold it steady with one gloved hand. The other hand need not be gloved and is free to use a crochet hook or any other necessary means to untangle the bat from the net.
9. If numerous bats are being captured at one time, and they cannot be processed in a timely manner, a holding device such as a canvas sack can be used to minimize stress and injury.
10. After each trapping session, nets must be neatly folded to avoid becoming tangled.
11. Minimum data to be recorded should include sex, age, location, time of capture, date, habitat type, method of capture, species, number captured, and total hours spent trapping. Optional: weather conditions; wind speed, temperature, precipitation, etc.

12. Depending on objectives for capturing bats, they may be uniquely marked by using pit tags or other proven methods for mark - recapture studies.
13. Results of sampling can be expressed as number of bats/trap night or hour by species and habitat type.

2. Trip Lines With this method, a bat flies into closely spaced taut lines inter-strung between numerous points over a water source. The lines are so thin and closely spaced, a bat unable to detect/avoid them, flies into them while attempting to drink water, and falls into the water. The bat can then be collected when it swims to shore. This method may be biased towards bats that tend to fly at certain levels (over water) while foraging.

a. Supplies and Materials

1. Six to eight pound monofilament fishing line, stakes to attach to the monofilament, rubber and leather gloves, flashlight, headlamp, holding bags, ruler. Optional: same as mist netting.

b. Procedures

1. See procedures for mist netting (above) #1, 2, 3, 5, 8, 10, 11, 12, 13.
2. Trip lines are tied between 2 stakes on the edges of a water source or interstrung between several stakes. The lines should be 15 - 20 cm above the water, 10 - 20 cm apart.
3. After the bat hits the line, it will fall into the water and swim to the edge where it can be picked up and handled.
4. Trip lines must be constantly attended.

3. Harp/portable Tuttle Trap

This method is advantageous over the trip line because it is transportable. This method is preferred when trapping at cave openings. Tideman and Woodside (1978) describe this method in great detail, therefore, this section is limited. Another advantage of this technique is that it does not require constant attendance, only regular checks throughout the evening. It is recommended that spacing between lines is 2.5 cm which are strung vertically between two sides of a frame. Some disadvantages include; predators (snakes) raiding the canvas collection bag at the bottom of the lines, as well as, different species in the bag biting or injuring one another or spreading rabies.

4. Bat Detectors

Most bat species emit distinctive echolocating signals that can be detected using ultrasonic detectors or "bat detectors". There are a variety of these available to assist in bat inventories (Exact Electronics, Non-linear systems, Titley Electronics). Bat detectors provide a very useful nontactile method of censussing bat species and depending on the sensitivity and sophistication of the device, can provide very good information. Advantages include not having to handle species (except initially to record species signals), and because of the relatively highly accurate reception of sound, accurate identification. Disadvantages include some species signals overlap and require the simultaneous use of two narrowband detectors on different frequencies to differentiate between them. If the tuning of the detector is not accurate, it may lead to misidentification of species. In addition, information such as sex, age, weight, cannot be obtained.

a. Supplies and Materials

1. Bat detector (2 of same type is preferable to differentiate between similar sounding species), rubber and leather gloves, light source, headlamp, holding sack, ruler.

b. Procedures

1. See procedures for mist netting #1, 2, 4, 5, 10, 11, 13.
2. Initial recording of echolocating bats must be obtained by capture or literature. Fenton and Bell (1981) can provide assistance.

5. Roost Capture

Some bat species may not be captured/detected using the previously described techniques. In these cases, roost site capture may be an option. Minimal intrusion to the roost site should occur and be chosen wisely to minimize disturbance to colonies.

a. Supplies and Materials

1. Long handled tissue forceps, rubber and leather gloves, headlamp, flashlight, canvas holding bags, small hand held insect net, long, small diam pvc or conduit pipe or bamboo pole, ruler, face mask filter.

b. Procedures

1. Roost sites should not be disturbed during rearing periods or during hibernation to avoid mortality as a result of stress related disturbance and abandonment.
2. Sampling should be done before nightly departure occurs, generally late morning, to allow for the bats to resettle and reestablish social contacts.
3. To assist in capture of bats at roost sites, long handled tissue forceps and a small hand held insect net may be useful, along with a long, small diam pvc pipe or bamboo pole to carefully dislodge individuals from high ceilings or deep crevices.
4. See #10, 11, 12, 13 above on mist nets.

F. Suggested Literature Review for Bats

Ahlen, I. 1981. Field identification of bats and survey methods based on sounds.Myotis 18-19:128-136.

Buchler, E. R. 1976. A Chemiluminescent tag for tracking bats and other small nocturnal animals. J. Mammal. 57:173-176.

Downes, C. M. 1982. A comparison of the sensitivities of three bat detectors. J.Mammal. 63:343-345.

Fenton, M. B., and G. P. Bell. 1981. Recognition of species of insectivorous bats by their echolocation calls. J. Mammal. 62:233-243.

Forbes, B., and E. M. Newhook. 1990. A comparison of three models of bat detectors. J. Mammal. 71:108-110.

Hall, R. E., and K. R. Kelson. 1959. The mammals of North America, Vol. I Ronald Press Co. 546 pp.(l39pp. cover bats, this has good descriptions and Identification key)

Kunz, T. (ed.). 1988. Ecological and behavioral methods for the study of bats. Smithsonian Institution Press. 533 **pp.(this is the most helpful and comprehensive book for doing bat research)**

Schmidly, D. J. 1991. The bats of Texas. Texas A&M University Press. 188pp. Simmons, J. A. et al.

1979. Apparatus for research on animal ultrasonic signals. Life Sci. Misc. Publ. Royal Ontario Mus, 31 pp.(this describes how to make one type of "bat detector"- the Leak detector)
Tidemann, C. R. and D. P. Woodside. 1978. A collapsible bat-trap and comparison of results obtained with the trap and mist nets. Australian Wildlife Research Vol. 15, pages 355-362.
Tuttle, M. D. 1974. An improved trap for bats. J. Mammal. 55:475-477.

G. Material Sources for Mammals

1. Live traps
   Small Mammals - H.B. Sherman Traps, Inc. P.O. Box 20267, Tallahassee, FL 32316, Phone number (904) 575-8727
   Intermediate Mammals - Tomahawk Live Trap Company, P.O. Box 323, Tomahawk, WI 54487, Phone number (715) 453-3550
2. Forceps (long tissue- Model #46125) Edward Weck and Company Inc., 4 Idyl Wilde Circle, Marshfield, MA 02050
3. Net (small insect type for catching bats) BioQuip-Products, PO Box 61, Santa Monica, CA 20245
4. Mist Nets
   - Avinet Inc., PO Box 1103, Dryden, NY,13053-1103. Phone number (800) 3406387, e-mail AVINET@LIGHTLINK.COM, Web page http://www.avinet.com
   - Northeastern Bird Banding Assoc., Manomet Bird Observatory, Box 936, Manomet, MA 02345
   - EBBA Net Committee, Biology Dept., Indiana U. of Penn., Indiana, PA, 15701
5. Plastic bands (to individually mark animals)
   -A.C. Hughes, 1 High Street, Hampton Hill, Middlesex, TW121NA, England
   - L&M Bird Leg Bands,PO Box 2943,San Bernadino, CA 92406
6. Bat Detectors
   - QMC Instruments Ltd., 357 Mile End Rd., London, El 4AA, England
   - Skye Instrument Inc., Llandrindod Well, Powys, Wales, Ldl 6DF
   - Holgates of Totton, Commercial Rd., Southhampton, HANTS, England
   - Titley Electronics, Ballina, Australia

Figure 14. Example of field summary sheet for small mammals.

BASELINE INVENTORY AND MONITORING
SUMMARY DATA SHEET FOR SMALL MAMMALS
TRAP ARRAY/TRANSECT

SITE:_____

Date	Transect #	Trap #	Habitat or Mgmt Unit	Time or Trap Night	Species	Sex	Length: Total, Tail, Hind Foot, Ear (mm)	Age	Mark-Recapture Notes

APPENDIX I

Texas Biological and Conservation Data Systems
Terms and Definitions

Biological and Conservation Data System- A permanent and dynamic atlas and data bank on the existence, identity, characteristics, numbers, condition, status, location and distribution of the elements of natural biological and ecological diversity, of the individual occurrences of these elements in the landscape, of existing managed areas, and of courses of additional information and documentation. The focused goal being to conserve biological and ecological diversity.

Element - Elements of natural biological and ecological diversity are individual plant and animal species (especially rare or vulnerable species), natural community types, and an 'other' category that includes colonial waterbird nesting sites, significant bat and invertebrate caves, migratory songbird fallout sites, etc.

Element Occurrence - Element occurrences are individual examples of the various element types at specific geographic localities, such as localities of special plant or animal species populations.

General Information - Individual data centers all employ highly standardized methods and procedures. This standardization facilitates the exchange of information and allows the programs collectively to form a large and growing information network. Besides the individual programs, the network includes the Conservancy's central data unit at its Arlington, Virginia, headquarters and the task force units in the Conservancy's regional offices. The Conservancy's Latin American office is being brought in along with the Conservation Data Centers of the Caribbean and South and Central America. By combining data from various states, range-wide status of various elements can be ascertained, regional or national priorities can be determined, etc.

Factual Information - The system does not deal much in generalities. The data system is population with a tremendous number of discrete facts; what the actual individual elements are, what their characteristics are, exactly where on the landscape their occurrences can be found, etc. This data system is continuously updated to incorporate new information.

Standardization - Standardization of the inventory methods is crucial for easy exchange of data, efficient research and development, orderly system evolution and effective service to data users

Objective Neutrality - The inventories are devices for ascertaining, as near as we can, what the truth is. Using the data and the system's analytical procedures for assessing relative biological and ecological importance, the staff "calls them the way they see them." Objectivity is imperative to protect the integrity of the data and maintain credibility as a dependable information source.

Utility - These data and systems get tremendous use. They are well-adopted to many uses; such as , environmental impact review, natural resource management, scientific research and educational applications. State and federal agencies, private consultants, engineering firms and utility districts are among the most frequent users of the system.

What Constitutes a Source?

A source can be a published or unpublished report/article, book, field survey, illustration or photo, journal or periodical, map, organization/agency/institution, person or personal communication, specimen record or other unpublished materials. A source can contain information on one or more occurrence records pertaining to one or more elements, or may not contain any EO information at all. It may just contain valuable information that should be cited in a Source Abstract for others to reference.

The Source Abstract (SA)

The SA is the formal citation and abstract of source (not EO) information. Please note that specimens are not cited on this form, but simply appear on the EOR.

What is the standard citation for this source (generally in name, date, title/subject order)? **CITATION**

Where is the physical source shelved/filed? **SHELFNOTE**

If specific to an identifiable area, what is the locality? **GEOCOVER**

Brief abstract or pertinent information? **ABSTRACT**

Which subjects are specifically addressed or have useful information provided on them? Subject Checkoffs

Is this a Heritage publication? **HERPUBL**

How useful is this source? **URATING**

Pertinent keywords/terms? **KEYWORDS**

Is there any other information that would be useful, but really no designated place to include it on this form? **COMMENTS**

Were any EO's extracted? **DIGESTNOTE**

If abstracting a person, on what subject(s) is s/he especially knowledgeable? **EXPERT**

Who transcribed this source and date? **UPDATE**

Source Abstract

Identifiers:
SOURCECODE:_____
CITATION: *_standard citation format of author, date, title – sources can include published reports/articles, unpublished reports, field surveys, personal communication, person, map, book, specimen:*
_____
_____
_____

SHELFNOTE: *_location where source is kept for reference*_____
GEOGCOVER: *_geographic locality if source is specific to an identifiable area*_____
ABSTRACT: *_abstract of information contained in this source*_____
_____
_____
_____
_____
_____

Subject Checkoffs: *check subjects covered in the source*

COMMUNITY:_____	FLORA:_____	FAUNA:_____	HYDRO:_____
TERECOMMUN:_____	AQFLORA:_____	AQFAUNA:_____	GEOLOGY:_____
FOREST:_____	TERFLORA:_____	TERFAUNA:_____	SOILS:_____
SAVANNA:_____	NONVASCPL:_____	MOLLUSCS:_____	CLIMATE:_____
GRASSLAND:_____	VASCPL:_____	INSECTS:_____	BIOLOGY:_____
SHRUBLAND:_____		CRUSTACEAN:_____	ECOLOGY:_____
DESERT:_____	MICROORG:_____	OTHARTHRO:_____	ECOFUNCT:_____
ALPINE:_____		OTHERINVERT:_____	NATDIVER:_____
OTHTERREST:_____		FISHES:_____	INVENTORY:_____
AQCOMMUN:_____		AMPHIBIANS:_____	RSRCHTECH:_____
PALUSTRINE:_____		REPTILES:_____	MA:_____
LACUSTRINE:_____	SITEINFO:_____	BIRDS:_____	MGMTPLANS:_____
RIVERINE:_____		MAMMALS:_____	MGMTTECH:_____
ESTUARINE:_____			IMPACTSTUD:_____
MARINE:_____		PHYSSCI:_____	PROTORG:_____
SUBTERRAN:_____		PHYSIOTOPO:_____	PROTTOOLS:_____

Supplemental Source Date:
HERPUBL: _____
URATING: _____ (codes below)
1)Very Useful; supplies EO info
2) Moderately Useful; no EO info
3) Not Useful; at least at present

KEYWORDS: *_list of special species, communities, ___ _managed area names, etc. to apppear in _*
_an indexed list_____
_____

COMMENTS: *_any additional comments not fitting elsewhere on form*_____
_____
_____
DIGESTNOTE: *_note if one or more occurrence records were transcribed from this source – i.e., EO's extracted*
_____
_____

Optional Fields: (indicate 'EXPERT' then list expertise)
EXPERT: *_if abstracting knowledgeable individual, list their areas of expertise*
_____
_____

Record Maintenance: UPDATE: _____ - _____ - _____ _____ *Date of transcription and initials*

Source Abstract

Identifiers:
SOURCECODE:_____
CITATION:_____
_____
_____
_____
_____

SHELFNOTE:_____
GEOGCOVER:_____
ABSTRACT:_____
_____
_____
_____
_____
_____
_____
_____

Subject Checkoffs:

COMMUNITY:_____	FLORA:_____	FAUNA:_____	HYDRO:_____
TERECOMMUN:_____	AQFLORA:_____	AQFAUNA:_____	GEOLOGY:_____
FOREST:_____	TERFLORA:_____	TERFAUNA:_____	SOILS:_____
SAVANNA:_____	NONVASCPL:_____	MOLLUSCS:_____	CLIMATE:_____
GRASSLAND:_____	VASCPL:_____	INSECTS:_____	BIOLOGY:_____
SHRUBLAND:_____		CRUSTACEAN:_____	ECOLOGY:_____
DESERT:_____	MICROORG:_____	OTHARTHRO:_____	ECOFUNCT:_____
ALPINE:_____		OTHERINVERT:_____	NATDIVER:_____
OTHTERREST:_____		FISHES:_____	INVENTORY:_____
AQCOMMUN:_____		AMPHIBIANS:_____	RSRCHTECH:_____
PALUSTRINE:_____		REPTILES:_____	MA:_____
LACUSTRINE:_____	SITEINFO:_____	BIRDS:_____	MGMTPLANS:_____
RIVERINE:_____		MAMMALS:_____	MGMTTECH:_____
ESTUARINE:_____			IMPACTSTUD:_____
MARINE:_____		PHYSSCI:_____	PROTORG:_____
SUBTERRAN:_____		PHYSIOTOPO:_____	PROTTOOLS:_____

Supplemental Source Date:
HERPUBL: _____
URATING: _____ (codes below)
1)Very Useful; supplies EO info
2) Moderately Useful; no EO info
3) Not Useful; at least at present
KEYWORDS: _____
_____
_____
_____
COMMENTS: _____
_____
_____
DIGESTNOTE:_____
_____
_____

Optional Fields: (indicate 'EXPERT' then list expertise)
EXPERT: _____
_____
_____

Record Maintenance: UPDATE: _____ - _____ - _____ _____ *Date of transcription and initials*

What Constitutes an Element Occurrence?

The Element Occurrence (EO) is the basic building block of the Heritage Inventory. It is a record representing the location of a population of a special species, collection site, natural community, an area consistently used for wintering, breeding or fallout or site of some other significant feature such as bat/invertebrate cave or bird rookery. See "element" definition in packet. To maintain an effective and defensible records system, certain criteria must be met in order to qualify as an EO. These criteria are based on differences in the basic biology of the different types of elements. For example, a Peregrine Falcon flying over would not constitute an EO, whereas an eyrie location would.

The Element Occurrence Record (EOR)

An EOR is a record of an EO. Mandatory fields to be filled in during transcription, where information is available/applicable:

What is the species, natural community or other feature? **SNAME, SCOMNAME**
Was it accurately identified? **IDENT**
How precisely can this EO be mapped, if known? **PRECISION**
What county(s) is it located in and on what topo quad(s)? **COUNTYNAME, QUADNAME**
Where is it exactly? **DIRECTIONS**
If applicable, is there a name for this location, prairie, cave, etc? **PLACENAME**
When was it first/last observed or surveyed for, if known? **LASTOBS, FIRSTOBS, SURVEYDATE**
If personally observed, what is the quality of this EO, along with comments identifying why? **EORANK, EORANKDATE, EORANKCOM**
What was actually seen, i.e. element specific information? **EODATA**
What did the area/habitat look like at this location, including associates if significant? **GENDESC**
Size of area or EO if known. **SIZE**
Is this EO located within/partially within a managed area? **MANAME, CONTAINED**
Do you have any commentary on management or protection needs? **MGMTCOM, PROTCOM**
If known, who/what entity owns the property on which this element is located? **OWNER, OWNERINFO, OWNERCOM**
Is there any other information that would be useful, but really no designated place to include it on this form? **COMMENTS**
Do you feel this EO should be considered data sensitive (Y)? **DATASENS**
For 'S' and 'SC' records, is there a drawn boundary (Y)? **BOUNDARIES**
What is the most relevant or best source of information relating to this EO? **BESTSOURCE**
Are there any other sources for this EO? **SOURCECODE**
If this is a specimen record, what is the museum/herbarium citation(s) for this locality? **SPECIMENS**
Name and date of who transcribed this EOR, please also provide the three-digit initials of transcriber? **EDAUTHOR, EDITION**

Element Occurrence Record

y–accurate id;
n–misid; ?–questionable id

Elcode EO# State:
EOCODE: _____ _*_____ * TX FONUM:_____ IDENT:_____Y,N,?_
SNAME *scientific name*
SCOMNAME:*common name*
ELEMENT RANKS: GRANK:_____ NRANK:_____ SRANK:_____
NATION: U.S. SITECODE: S.USTXHP* (Computer generated code in SBR)
SITENAME:
SURVEYSITE:
PRECISION: *sc,s,m,g* COUNTYCODE: COUNTYNAME: LOCALJURIS:
sc–seconds confirmed TX _____ _county name_____ _____
s–seconds precise TX _____ _____ _____
m–minutes precise TX _____ _____ _____
g–general to place/quad MARG DOT TEN LAT:_____ S:_____
QUADNAME: QUADCODE NUM NUM TEN: N:_____
quad name(s) E:_____
W:_____

_____ _____ _____ _____ _____
_____ _____ _____ _____ _____
_____ _____ _____ _____ _____

DIRECTIONS:*directions to this occurrence of this element*

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

NAT.REGION:_____ _____ _____ _____ _____
PLACENAME:*If applicable, name of prairie, cave, rookery, etc.*
DSDIRECTIONS: *data sensitive directions, if site or element is sensitive*
DSBESTSOURCE: *data sensitive source information, if Eo is sensitive*

WATERSHED:_____ _____ _____ _____
date surveyed Yr Mo Da *last observed* Yr Mo Da *first observed* Yr Mo Da
SURVEYDATE:____ ____ ____ LASTOBS:____ ____ ____ FIRSTOBS: ____ ____ ____
EORANK:_____ (see key code) EORANKDATE:_____-_____-_____ *date of quality ranking*
EORANKCOM: *comments concerning quality rank, if assigned*
EODATA: *data pertaining to this species at this locality; i.e. flowering, fruiting, nesting, numbers, etc.*

CONTACTID:____ CONTACT.NAME:_____ CONTACT.NOTE:_____
EOTYPE:
GENDESC:*general description of the area/habitat at this location for this particular occurrence of this element*
MINELEV:_____feet MAXELEV:_____feet SIZE:_____acres
MACODE: MANAME: MATYPE: CONTAINED:
M.USTXHP*... *managed area name(s)*_____ _____*(see code key)*
M.USTXHP*..._____ _____
MORELAND:_____ MOREPROT:_____ MOREMGMT:_____ TNCINVOLVE:_____
MGMTCOM: *management comments, if any*
PROTCOM: *protection comments, if any*
OWNER: *if known or private or blank* OWNERINFO:_____
OWNERCOM: *owneer address/phone or other information, i.e., knows of EO/protects*
COMMENTS: *other comments not fitting elswhere on the record*
ADDTL TOPICS:
TOPIC.KEYWORDS:
DATASENS: *y–data sensitive* BOUNDARIES: y–*drawn boundary* PHOTOS: *y–yes photos*
BESTSOURCE: *citation for best source of information for this EO, source providing best information and/or most current information data or location*
SOURCECODE: SPECIMENS: (citation info for specimens)
-list other sources for this EO specimen citation(s)

TRANSCRIBR:____ -____-_____ CDREV:_____ MAPPER:_____-____-____ QC:_____
DATARESP:TXHP EDITION: *date* EDAUTHOR: *transcriber of this record*
Maintenance History: INITIALS:_____ CHANGE.DATE_____(yr/mo/da)
MANUAL.FILE.NOTE:

ELEMENT OCCURRENCE RECORD KEY

ELEMENT OCCURRENCE RANK (EORANK)

A - Excellent
B - Good
C - Marginal
D - Poor
E - Extant/Present
H - Historical/No Field Information
O - Obscure
X - Destroyed/Extirpated

AI - Excellent, Introduced
BI - Good, Introduced
CI - Marginal, Introduced
DI - Poor, Introduced
EI - Extant, Introduced
HI - Historical, Introduced
OI - Obscure, Introduced
XI - Destroyed, Introduced

GLOBAL RANK (GRANK)

G1 - Critically imperiled globally, extremely rare, 5 or fewer occurrences [Critically endangered throughout range.]
G2 - Imperiled globally, very rare, 6 to 20 occurrences. [Endangered throughout range.]
G3 - Very rare and local throughout range or found locally in restricted range 21 to 100 occurrences. [Threatened throughout range.]
G4 - Apparently secure globally.
G5 - Demonstrably secure globally.
GH- Of historical occurrence through its range
G#T# "G" = species rank; "T" = rank of variety or subspecies taxa.
GU - Possibly in peril range-wide, but status uncertain.
G#G# Ranked within a range as status uncertain.
GX - Believed to be extinct throughout range.
Q - Qualifier denoting questionable taxonomic assignment.
? - Not ranked to date; or , Qualifier denoting uncertain rank.
C - Captive population exists.

STATE RANK (SRANK)

S1 - Critically imperiled in state, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences.
S2 - Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences.
S3 - Rare or uncommon in state, 21 to 100 occurrences.
S4 - Apparently secure in state.
S5 - Demonstrably secure in state.
SA - Accidental in state.
SE - An exotic species established in state.
SH - Of historical occurrence in state. May be rediscovered.
SP - Potential occurrence in state.
SR - Reported, but without persuasive documentation.
SRF- Reported in error, but error persists in literature.
SU - Possibly in peril in state, but status uncertain.
SX - Apparently extirpated from state.
SZ - Migratory/transient in state to irregular/dispersed locations.

B - Basic rank refers to the breeding population in the state.
N - Basic Rank refers to the non-breeding population in the state.
? - Not ranked to date; or, Qualifier denoting uncertain rank.
C - Captive population exists.

FEDERAL STATUS (USESA)

LE - Listed Endangered.
LT - Listed Threatened.
LELT Listed Endangered in part of range, Threatened in a different part.
PE - Proposed to be listed Endangered.
PT - Proposed to be listed Threatened.
E(S/A) or T(S/A) - Listed Endangered or Threatened on basis of Similarity or Appearance.
DL - Delisted Endangered/Threatened
C1 - Candidate, Category 1. USFWS has substantial information on biological vulnerability and threats to support proposing to list as endangered or threatened. Date are being gathered on habitat needs and/or critical habitat designations.
C1* - C1 but lacking known occurrences.
C1-** C1, but lacking known occurrences, except in captivity/cultivation
C2 - Candidate, Category 2. Information indicates that proposing to list as endangered or threatened is possibly appropriate, but substantial data on biological vulnerability and threats are not currently known to support the immediate preparation of rules. Further biological research and field study will be necessary to ascertain the status and/or taxonomic validity of the taxa in Category 2.
C2* - C2, but lacking known occurrences.
C2-** C2, but lacking known occurrences, except in captivity/cultivation.
3 - Taxa no longer being considered for listing as threatened or endangered. Three subcategories indicate the reasons for removal from consideration.
3A - Former Candidate, rejected because presumed extinct and/or habitat destroyed.
3B - Former Candidate, rejected because not a recognized taxon; i.e. synonym or hybrid.
3C - Former Candidate, rejected because more common, widespread or adequately protected.
XE - Essential Experimental Population.
XN - Non-essential Experimental Population.

STATE STATUS (SPROT)

E - Listed Endangered by the State.
T - Listed Threatened by the State.

PRECISION

S - Second: Accuracy within 3-second radius of latitude/longitude.
M - Minute: Accuracy within 1-minute radius of lat/long, approx. 2 km or 1.5 mi radius.
G - Occurrence mapped general to quad or place name precision only, precision within about 8 km or 5 mi radius.
U - Unmappable record.

WATERSHED

From USGS Hydrological Units Map, first 2 digits indicate region:

11 = Arkansas-Red-White Region
12 = Texas-Gulf Region
13 = Rio Grande Region

SIZE

Size = acres encompassed by occurrence, “0" = less than one acre.

MANAGED AREAS (CONTAINED) (Code following managed area name)

Y - Element occurrence contained within the managed area boundaries.
N - Element occurrence is not entirely contained within the managed area boundaries.
? - Whether the element occurrence is wholly contained or not within the managed area boundaries is disputed.
blank-No information available.

ELEMENT OCCURRENCE RECORD (EOR) Field Transcription Sheet

(Fill in **bolded** fields with known information. Refer to Transcription Sheet for definitions and additional fields)

NAME: **SCIENTIFIC NAME**

SCOMNAME: **COMMON NAME**

PLACENAME:

IDENT: **IDENTIFIED** (Y,N,?)
COUNTYNAME(S):

QUADNAME: (Attach copy from relevant portion of 7.5 topo map)

DIRECTIONS:

DATE SURVEYED: (year-mo-da)
LAST OBSERVED: (year-mo-da)
FIRST OBSERVED: (year-mo-da)
ELEMENT OCCURRENCE RANK (A,B,C,D,E,H,O,X,I)
EORANKCOM: **ELEMENT OCCURRENCE RANK COMMENTS**

EODATA: **ELEMENT OCCURRANCE DATA**

GENDESC: **GENERAL DESCRIPTION**

SIZE: (acres, only for EO)

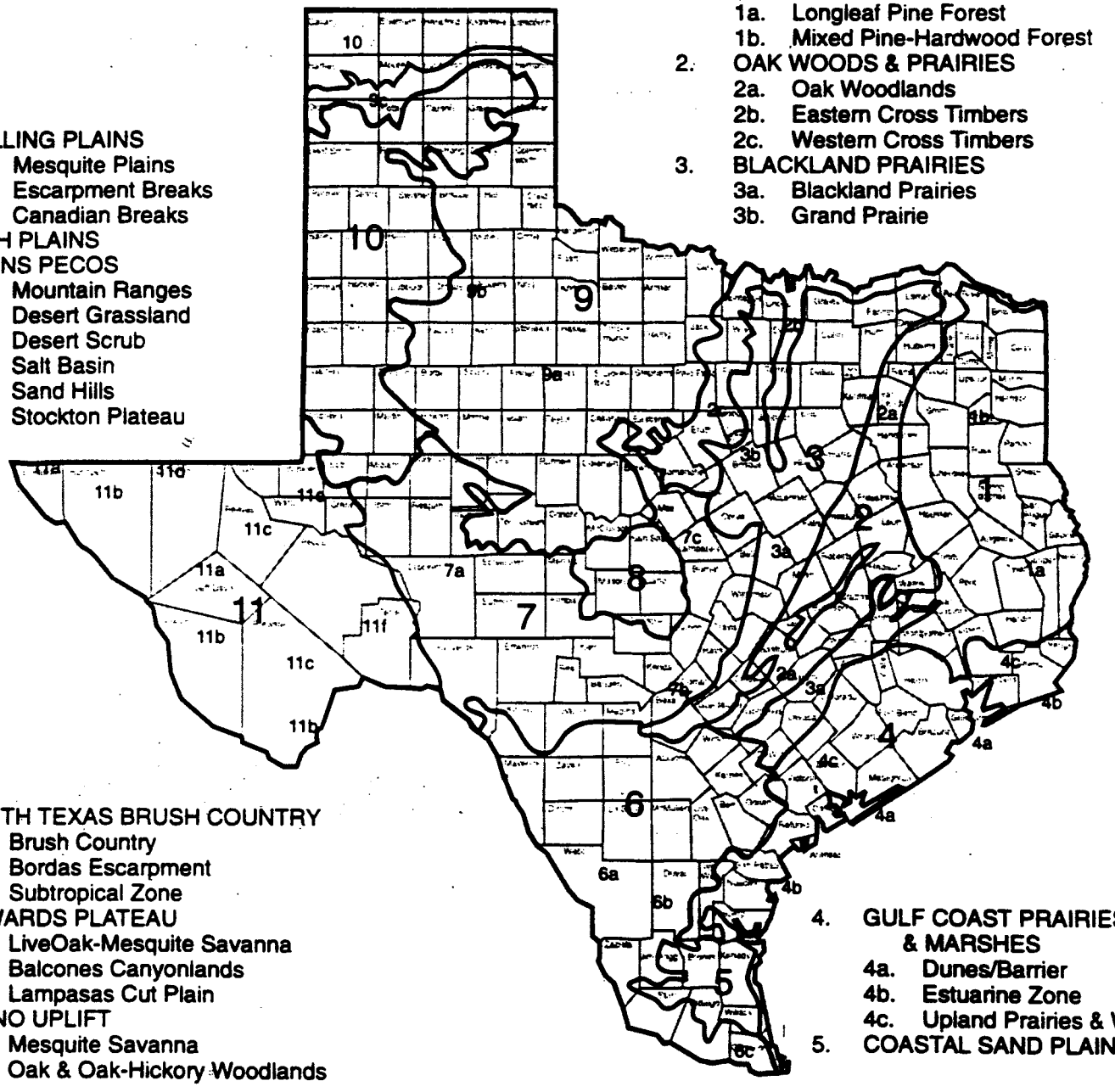
MANAME: **MANAGED AREA NAME(S) + CONTAINED:** (Y=contained, N=not entirely contained)

OWNER:
OWNERCOM: **OWNER COMMENTS**

COMMENTS:

DATASENS: **DATA SENSITIVITY** (Y, blank)
BESTSOURCE:

EDITION: (year-mo-da)
EDAUTHOR: **EDITION AUTHOR** (name-initials-phone#)



1. PINEY WOODS
   - 1a. Longleaf Pine Forest
   - 1b. Mixed Pine-Hardwood Forest
2. OAK WOODS & PRAIRIES
   - 2a. Oak Woodlands
   - 2b. Eastern Cross Timbers
   - 2c. Western Cross Timbers
3. BLACKLAND PRAIRIES
   - 3a. Blackland Prairies
   - 3b. Grand Prairie
4. GULF COAST PRAIRIES & MARSHES
   - 4a. Dunes/Barrier
   - 4b. Estuarine Zone
   - 4c. Upland Prairies & Woc
5. COASTAL SAND PLAINS
6. SOUTH TEXAS BRUSH COUNTRY
   - 6a. Brush Country
   - 6b. Bordas Escarpment
   - 6c. Subtropical Zone
7. EDWARDS PLATEAU
   - 7a. LiveOak-Mesquite Savanna
   - 7b. Balcones Canyonlands
   - 7c. Lampasas Cut Plain
8. LLANO UPLIFT
   - 8a. Mesquite Savanna
   - 8b. Oak & Oak-Hickory Woodlands
9. ROLLING PLAINS
   - 9a. Mesquite Plains
   - 9b. Escarpment Breaks
   - 9c. Canadian Breaks
10. HIGH PLAINS
11. TRANS PECOS
    - 11a. Mountain Ranges
    - 11b. Desert Grassland
    - 11c. Desert Scrub
    - 11d. Salt Basin
    - 11e. Sand Hills
    - 11f. Stockton Plateau
12. MARINE DEVELOPMENT