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Habitat Monitoring for Quail on Texas Rangelands

Habitat Monitoring for *Quail* on Texas Rangelands

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***Deceased**

Quail are generalists, meaning they can live in a wide range of different habitats, from the wetter regions in Texas' eastern half to the much drier zones in the western half of the state. Rather than a single optimum habitat, an assortment of suitable quail habitats exists.

Land treatments such as prescribed burning, disking, livestock grazing and brush management can create habitat patchworks, which have different degrees of value from a quail's perspective. For instance, brush in Texas commonly is removed by mechanical methods like grubbing, chaining or roller chopping. Immediately following these treatments, habitat value will be low, because treated areas have little remaining cover, but as time passes, grasses and forbs will regrow, making a site more valuable for quail. Because treatments are done at different times and are scattered throughout a property, quail habitat is always in transition.

Numbers of plants, their structure (i.e., short, tall, broad or narrow canopy, etc.) and their arrangement across the landscape all are important features to quail. Quail occupy habitats having a good mixture of areas that provide ample food, numerous grass clumps for nesting, open areas (nearly bare or bare ground) for foraging and dusting, and brushy sites for protection from predators and weather extremes. Conversely, large expanses of cultivated crops, coastal Bermuda grass, or overgrazed rangeland, lacking many of these qualities, provide little usable space for quail. The quail manager's goal should be to identify the amount of usable space available and then to optimize it.

Monitoring quail habitat can help quail managers better understand the amount of usable space available, the results of management efforts, and the potential of a property to produce quail. Numerous techniques for monitoring quail habitat have been described in both scientific and popular literature. However, the majority of these techniques have never gained broad appeal or widespread implementation among average landowners simply because such techniques are too technical, too time consuming, or both. *This publication outlines a stepwise simple-to-complex approach useful for monitoring rangelands for the benefit of quail.*

A straightforward ***Level-One*** approach encourages landowners and managers to begin monitoring quail habitat. As landowners/managers become more comfortable with monitoring, they can gather additional information using a ***Level-Two*** approach. For operations faced with particularly important issues or for more ambitious resource managers, a ***Level-Three*** approach may be appropriate. The guidelines in each level will help determine what needs to be monitored, where to focus efforts, and how to get the best information for the amount of time invested.

Why Should I Monitor?

Successful wildlife management depends on habitat management. The most effective way to document changes to wildlife habitat is to adopt a monitoring program that gains a better understanding of vegetative resources; determines the effectiveness of habitat management practices; and develops adaptive data-based management strategies.

Developing a habitat monitoring program depends on determining *what*, *where* and *when* to monitor. Taking the time now to consider these points thoroughly will pay dividends later by ensuring that the items most important to quail are monitored and that time is allocated most efficiently.

What Should I Monitor?

Some quail biologists believe a property must contain at least 3,000 acres to sustain healthy numbers of quail for long periods. However, owners of smaller tracts of land still can enhance quail populations by joining with like-minded neighbors to develop quail co-ops, thus increasing the effective size of the land-holding to be managed.

No matter a property's size, great care must be given to selection of monitoring techniques and of vegetation attributes measured. One of the most common mistakes in monitoring programs is incorrectly selecting what to monitor. No manager wants to invest hours in a monitoring scheme only to find that efforts were in vain because the wrong information was gathered. To collect habitat information pertinent to quail management, monitor these key components:

- Vegetation change through time
- Precipitation
- Potential nest sites
- Vegetation cover
- Forb and grass diversity
- Grass stubble heights

Where Should I Monitor?

Select monitoring sites for each different habitat found on a property. Monitoring-data should be representative of a property. Habitat features often change with differences in soil and/or in elevation; consequently, a soil survey map can aid site placement. Such maps can be acquired at local Natural Resource Conservation Service (NRCS) offices. Sites should not be located near livestock water sources, mineral licks or livestock trails or other areas with higher-than-normal traffic.

We recommend at least one but no more than three monitoring sites for each range-site type or vegetation type on a ranch. Ideally, each pasture would contain one monitoring site for each range-site or vegetation type found there, but such intensity may not be possible due to time or manpower constraints. *We suggest that, at the beginning, landowners/managers plan to spend no more than three to four days each year engaged in formal monitoring activities.* Such an approach will prevent becoming overwhelmed with the process. As the landowner or manager becomes more comfortable with the monitoring program and procedures, time investment can be increased.

When Should I Monitor?

Given time limitations, we suggest beginning a new monitoring program at the end of the summer growing season (e.g., September or October). This period is not optimum for all monitoring techniques described in this manual, but it will work for managers pressed for time. If time permits, acquire the best information possible by following the specific monitoring timelines set forth in this manual. *It is important that data be collected from each monitoring site at least once a year.* Failing to monitor land on a yearly basis will cause "information gaps" and will not provide a complete picture of what is actually happening on the land.

Level-One Monitoring

Level-One is the simplest of the three monitoring levels covered by this publication. An observer's Level-One time investment should prove minimal but should provide valuable information for those not previously monitoring their land for the benefit of quail.

Summary of Level-One Monitoring Activities:

Monitoring Activities:

1) Fixed Photo Points
2) Precipitation Records
3) Nest Clump Survey

Equipment Needed:

- USGS topographic map or aerial photo
- Camera
- Steel t-posts and driver
- Hammer
- Compass (or handheld GPS unit)
- Five one-foot-long posts (rebar or angle iron)
- Dry-erase marker board
- Erasable felt-tip pen
- Hula hoop or PVC pipe frame (1 square yard)
- Three-ring binder
- Rain gauge
- Mineral oil
- Clear plastic photo-storage sheets
- Quail Habitat Monitoring Data Sheet (Appendix A)
- Precipitation Data Sheet (Appendix B)
- Nest Clump Survey Data Sheet (Appendix C)

Time Line for Activities:

1) Fixed Photo Points - Photos can be taken throughout the year at the end of each season, if time permits. If not, take photos at the end of each year's growing season.
2) Precipitation Records – Monitor gauges year-round.
3) Nest Clump Survey - These surveys should be done at the end of the growing season, then again in early spring, particularly if pastures have been grazed during the winter. If not, then one survey in early spring should be sufficient.

Monitoring Activities:

1) Installing Fixed Photo Points

We recommend taking two photographs at each monitoring site, one at a landscape-level photo point and one at a ground-level photo point. Photographs should be taken at the end of the growing season. Taking the photograph on the same day every year is not necessary, but pictures should be taken during the same week each year. In addition, attempt to take subsequent photographs at the same time of day to avoid problems associated with changing shadows.

Each photo-point site should be marked with a steel t-post. Facing north, back up flush against the t-post, and mark off a distance of 15 feet. Drive a rebar stake into the ground at this point to mark a permanent site for the dry-erase marker board. Prop the marker board against the rebar stake so the board can be seen clearly in the photograph. Record pasture name, photo-point number, and date on the marker board. Take more than one photo from this location in case the first photo does not turn out well.

Livestock can be attracted to fence posts for rubbing and scratching, altering vegetation, so ground-level photo points should be placed at least 10 feet away from steel t-posts to guarantee representative vegetation composition and ground cover. Drop the hula hoop or PVC frame on the ground to create a sample area to photograph. Then, hammer four, one-foot-long rebar pieces or angle iron stakes into the ground at four different locations along the inside edge of the hula hoop. These stakes delineate a permanent location over which to drop the hula hoop for future sampling efforts.

Stand on the north side of the hula hoop, to avoid casting shadows on the sample plot. Then, stand directly above the circle created by the hula hoop and take a photograph. Make sure the marker board with pasture name, photo-point number, and date is placed within the photograph but outside the hula hoop.

On the Photo Points Data Sheet (Appendix A), thoroughly document and describe each photo-

point location so that another individual can find it should you be unavailable to take the photos the following year. For example, record any prominent landscape features at the photo-point site. Hand-held GPS units are useful for locating photo-point sites. Also record the photo-point site on a USGS Topographic Map or on an aerial photograph.

After developing the photographs, place them in clear photo-storage sheets. Ground-level photos should be placed into one clear sheet, and land-scape-level photos should be placed into a separate sheet in such a way that four-years-worth of photos can be examined in one clear plastic sheet. Photos should be placed into the binder next to datasheets.

Many ranches also have historic or family-gathering photographs showing landscape-level views of rangeland. Copies of these kinds of photos can be placed in the same three-ring binder and may show changes in rangeland conditions, such as encroachment of brush. Short narrative descriptions also may be included with these photos.

2) Recording Precipitation

Precipitation should be recorded following each rainfall event and may help explain yearly differences observed in photographs. If such information is not collected locally, landowners or managers will have to refer to the closest weather station, which is often too far away to accurately reflect precipitation on the ranch. Ideally, one rain gauge should be placed in each pasture; put a small amount of mineral oil in the gauge to prevent evaporation. Where possible, place rain gauges next to monitoring locations. Precipitation amounts should be recorded on the Precipitation Data Sheet (Appendix B). Use one sheet for each rain gauge.

3) Conducting Nest Clump Surveys

Quail nest on the ground, primarily in clump grasses, not under brush. While quail have been documented nesting in blackbrush in southern Texas, brush is not their primary nesting material. Nest clump surveys can provide an estimate of the availability on a property of adequate nesting sites for quail.

For landowners wanting to assess nesting habitat across an entire ranch, the key-habitat method is the most effective approach to obtaining an overall estimate. In this case, transects (rectangular areas of defined length and width) should be established on all key habitats. Once key habitats have been selected, identify the most representative areas within these key habitats and place a transect in each of them. Proceed as follows to ensure that plot placement will represent each individual key habitat accurately:

1) Establish permanent nest-clump transects using three, 6-foot t-posts for each transect. Do not move these plots once they have been established.

2) The goal is to survey an area 0.1 acre in size for each nest clump transect. The length and width of the transect will be determined by the surveyor's height, as a person's arm span is approximately equal to his or her height. Look up your height in Table 1 to determine transect length. For example, if you are 5'10" tall, your transects will be the width of your arm span and 249 yards long; with your arms outstretched, you will survey about 0.1 acre.

Table 1. Height is closely correlated with arm span. Based on arm-span width and transect lengths, ~0.1 acres can be surveyed for the presence of quail nest clumps.

Transect Guidelines for Nest Clump Surveys	
Observer's Height	**Transect Length**
5′ 4″	272 yds
5′ 5″	268 yds
5′ 6″	264 yds
5′ 7″	260 yds
5′ 8″	256 yds
5′ 9″	253 yds
5′ 10″	249 yds
5′ 11″	245 yds
6′ 0″	242 yds
6′ 1″	239 yds
6′ 2″	235 yds
6′ 3″	232 yds
6′ 4″	229 yds
6′ 5″	226 yds
6′ 6″	223 yds
6′ 7″	221 yds

a) Drive a t- post at the beginning of the transect, then step off half the distance (~125 yards) of the transect. Drive a t-post at this location, then walk the remaining length of the transect. When you reach the end, drive in another t-post. The middle t-post will help you stay on course in the event you cannot see the end t-post during your survey.

b) The objective of the survey is to count the number of potential nest-clump sites rooted within your arm span (Fig. 1). A clump of grass roughly the diameter and height of a basketball is the minimum size needed for adequate quail nesting cover (Fig. 2). *Clumps of prickly pear at least the size of a hula hoop also count as adequate nesting habitat* (Fig. 3). Keep your eye on the middle t-post to avoid getting off course.

Figure 1. Counting clump grasses along a transect.

3) On the Nest Clump Data Sheet (Appendix C), record the length of transect surveyed and the number of nest sites counted within the transect. Multiply the number of nests counted by 10 to get the number of estimated nests per acre.

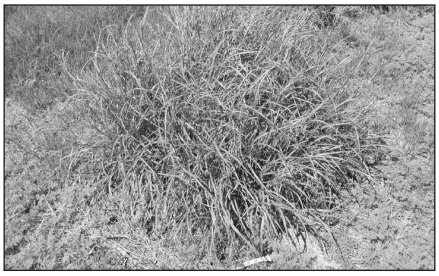


Figure 2. Two examples of grasses that produce clumps and could be used as nesting sites by quail.

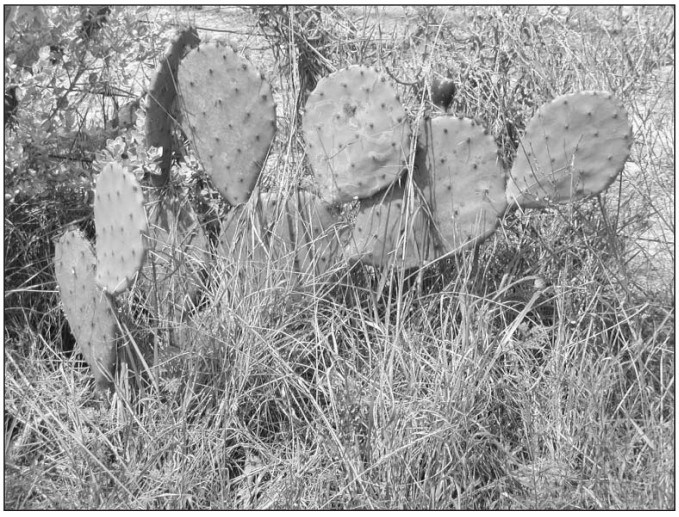


Figure 3. An example of a prickly pear clump that could be used for nesting cover by quail.

Level-Two Monitoring

Of the three monitoring levels covered by this publication, Level-Two monitoring is intermediate in intensity. Time investment by observers will prove to be somewhat intense but should not be overwhelming. Level-Two monitoring efforts can yield valuable information about a property's quail habitat.

Summary of Level-Two Monitoring Activities:

Monitoring Activities:

1) Fixed Photo Points
2) Precipitation Records
3) Nest Clump Survey
4) Cover Survey

Equipment Needed:

- Same equipment used in Level-One, plus
- Cover Survey Data Sheet (Appendix D)

Time Line for Activities:

1) Fixed Photo Points — Refer to Level-One.
2) Precipitation Records — Refer to Level-One.
3) Nest Clump Survey — Refer to Level-One.
4) Cover Survey — These surveys should be conducted at the end of the growing season.

Monitoring Activities:

1) Installing Fixed Photo Points

Follow procedures outlined in Level-One.

2) Recording Precipitation

Follow procedures outlined in Level-One.

3) Conducting Nest Clump Surveys

Follow procedures outlined in Level-One.

4) Conducting Cover Surveys

Adequate amounts of brush, grass and bare ground in an area are vitally important for the survival of quail. Too little brush leaves quail exposed to the elements and to predators. Too much brush hampers quail's ability to evade predators through flight and reduces forbs and grasses on which they rely on for food and for nest sites. Bare ground is important for foraging areas where quail pick up hard-coated grass seeds and soft mast (berries and fruits).

A cover survey can help determine the amount of woody and/or grass cover in an area and can lead to informed decisions about whether or not to remove any of that cover. Identify representative areas within key habitats and place cover transects in those locations. Plot placement is important, so to avoid introducing bias, do not select locations that are free of brush motts or free of clumps with thorny shrubs. To reduce set-up time, conduct cover surveys along the same transects used for the nest-clump surveys.

A cover survey includes these steps:

1) Establish permanent cover transects (or simply use the same transects created for nest-clump surveys). Do not move these plots once they have been established.

2) Record the amount of brush, grass and bare ground encountered along the transect. Rock and litter encountered should be recorded as bare ground, while any prickly pear encountered should be recorded as brush.

3) Recall that the transect length will vary according to the surveyor's height (Table 1) and that the area surveyed will be approximately 0.1 acre. Starting at the first t-post, take a full step (approximately 1 yard long) with your left foot, then with your right. Each time your right foot hits the ground, record an "X" for brush, grass, forbs or bare ground on the Cover Survey Data Sheet (Appendix D). If the toe of your right boot touches or is under the canopy of any woody species, regardless of its height, you will record that as a "hit" for brush. Keep your eye on the middle t-post to avoid getting off course.

4) Count the number of Xs recorded in each column on the data sheet (Appendix D). Then add together each column total for a grand total, roughly representing the percentage, respectively, of brush, grass, forb cover or bare ground along that transect. For example, if you had 10 Xs for brush in the first column, 5 in the second, 5 in the third, 10 in the fourth and 5 in the fifth, you would have a grand total of 35 Xs. This would represent a brush cover of approximately 35 percent.

Level-Three Monitoring

Level-Three is the most difficult of the three monitoring levels covered by this publication. Time investment is significant, so sincere commitment to the monitoring program is necessary. However, Level-Three monitoring efforts will collect valuable information, and the resulting data will provide great insight into both the deficiencies and the virtues of a property's quail habitat.

Summary of Level-Three Monitoring Activities:

Monitoring Activities:

1) Fixed Photo Points
2) Precipitation Records
3) Nest Clump Survey
4) Cover Survey
5) Forb and Grass Diversity
6) Grass Stubble-Height Survey

Equipment Needed:

- Same equipment used in Level-Two, plus
- Yardstick
- Flat metal washer (at least 1 inch in diameter)
- Grass and Forb Diversity Data Sheet (Appendix E)
- Grass Stubble Height Data Sheet (Appendix F)

Time Line for Activities:

1) Fixed Photo Points — Refer to Level-One.
2) Precipitation Records — Refer to Level-One.
3) Nest Clump Surveys — Refer to Level-One.
4) Cover Surveys — Refer to Level-Two.
5) Grass and Forb Diversity Surveys — Counts can be done at the end of each season throughout the year, if time permits. If not, do counts only at the end of the growing season of each year.
6) Grass Stubble-Height Surveys — These surveys should be conducted as livestock rotation dates approach for pastures of interest. If a pasture is not grazed, then one survey in January should be sufficient.

Monitoring Activities:

1) Installing Fixed Photo Points
Follow procedures outlined in Level-One.

2) Recording Precipitation
Follow procedures outlined in Level-One.

3) Conducting Nest Clump Surveys
Follow procedures outlined in Level-One.

4) Conducting Cover Surveys
Follow procedures outlined in Level-Two.

5) Conducting Grass and Forb Diversity Surveys

Research has shown that the more diverse a habitat is with regard to composition and structure, the more beneficial it is for quail. Quail use a variety of hard-seeded grasses and forbs for food throughout the year. Texas panic, Hall panicum, plains bristlegrass, barnyard grass, switchgrass and Johnsongrass are just a few of the important components of quail diets. Forbs such as croton, careless weed, ragweed, American basketflower, partridge pea, and pricklypoppy supply important seeds for quail as well. These plants, as well as others, are necessary for maintaining an adequate year-round food supply for quail.

Conduct grass and forb diversity surveys inside the area delineated by the hula hoop (same site used for ground-level photo points). When conducting photo-point surveys, also count the number of different hard-seeded grasses and forbs within each hula hoop. Count the number of different species within the hula hoop, not the total number of individual plants. Enter the number of different grass and forb species into the Grass and Forb Diversity Data Sheet (Appendix E). The ability to identify grasses and forbs within a sample is an important skill, which should be developed over time. While the main idea is to count the number of different plant species within a sample area, quail managers will benefit from learning to identify plant species, memorizing their names, and understanding their value as quail food.

6) Conducting Grass Stubble Height Surveys

Grass stubble height can impact individual plant health, rainfall capture, soil stability, and wildlife cover. A good range manager can estimate residual stubble heights in his or her pastures and can use this information as a trigger for moving livestock from one pasture to another. In addition, grass stubble-heights can tell a manager if average grass height is adequate for quail nesting and screening.

Grass stubble-height surveys will be conducted along the same transects as cover surveys. When conducting cover surveys, also measure the height of any grass that the toe of your right boot touches and record that data on the Grass Stubble Height Data Sheet (Appendix F). However, because you are unlikely to encounter a grass at every location, you will need to employ the "nearest neighbor method": when you fail to encounter a grass, measure the height of the grass plant nearest your survey line.

For example, if you encounter a brush plant at your recording location, record that brush plant as a hit on the Cover Survey Data Sheet (Appendix D). Then, look for the grass plant nearest your right boot; drop the flat metal washer next to your boot heel to mark where you stopped your paces. Now, move about as necessary to find the nearest grass plant and determine its stubble height.

The most common way of measuring grass stubble height is to measure "leaf length" by putting the end of a yardstick on the ground next to the grass plant, then gently grabbing the plant and stretching it out to measure its entire length. However, for quail's benefit, we are interested in how high grass plants lie naturally, so measure the height of the plant as it lies, without interference or manipulation. For those grasses with a seed head rising much higher than the rest of the plant, do not measure the height of the seed head; measure only the height of the grass's main vegetative portion.

Once you have finished measuring the height of a grass, move back to the washer and continue your paces. Unless grasses are abundant, you may use the nearest neighbor method often. It may be necessary to use this method to get measurements from 100 grass plants at a transect site.

Interpreting Your Monitoring Results

Photo Points:

- Use landscape-photo evidence of changes in brush cover or density to help make decisions about brush management. Such photos also may provide evidence of other changes, such as erosion.
- Use ground-level photo evidence of changes in grass cover and bare ground to help make decisions about the success of past practices such as disking or grazing.

Precipitation:

- Use rainfall records to differentiate between management-caused and weather-caused changes in the herbaceous (grasses and forbs) component of the habitat.
- Precipitation can account for as much as 50 percent of annual variation in quail numbers.
- Maintain low-to-moderate stocking densities during times of moderate drought (depending upon location). Complete destocking may be necessary during an extreme, prolonged drought.

Nest Clump Surveys:

- Manage for a minimum of 300 nest clumps per acre, as fewer clumps severely limit suitable nest sites. *Research has shown that dummy nests (man-made nests) were more likely to survive predation if located in areas having more nest clumps (416 to 541 clumps per acre), than if located in areas with fewer nest clumps (302 clumps per acre).*
- Pastures with inadequate nesting habitat may require rest from, or reduced use by, livestock and/or exotic big game.
- When planting grasses to increase nesting habitat, avoid mat-forming grasses such as bermudagrass. Bunch grasses such as little bluestem, side-oats grama, big bluestem, or cordgrass provide the type of cover quail need for nesting.

Cover Survey:

- Between 5 percent and 20 percent brush cover is ideal for quail.
- Quail need between 25 percent and 75 percent bare ground for foraging.
- Disking or prescribed grazing may be necessary in areas where grass cover exceeds 50 percent.
- During summer and early fall, an abundance of single-stemmed, large-canopy forbs such as broomweed will enhance quail-chick survival.

Grass and Forb Diversity:

- Generally speaking, the greater the diversity of food items, the better-off quail will be.
- Weather-pattern fluctuations can cause large variations in forb diversity and abundance. Such variations, especially in annual species, often are beyond a land manager's control, so are not necessarily indicative of poor management.
- Plant diversity is desirable, including both annuals and perennials.

Grass Stubble Height:

- Maintain a minimum 8-inch stubble height for grasses to ensure adequate nesting substrate. For good nest clumps, 12- to-14-inch stubble height is even better.
- Good range stewardship (wise use of soil and vegetation resources) requires a 6-to-8-inch minimum stubble height for mid-grasses such as side-oats grama and threeawns and a 12-to-14-inch minimum for tallgrasses like big bluestem, yellow indiangrass and switchgrass.

List of Appendices

A. Photo Points Data Sheet
B. Precipitation Data Sheet
C. Nest Clump Survey Data Sheet
D. Cover Survey Data Sheet
E. Grass and Forb Diversity Data Sheet
F. Grass Stubble Height Data Sheet

Appendix A – Photo Points Data Sheet

Ranch Name _____ **Pasture** _____

Class and Number of Livestock _____ **Date In** _____ **Date Out** _____

	Key Habitat Name and Location	Date	Time	Photographer	Landscape Photo (Y/N)	Ground Level Photo (Y/N)	Comments
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Appendix B – Precipitation Data Sheet

Pasture Name _____ **Habitat Type** _____

Rain Gauge Number _____

Record Number	Observer	Date	Amount (Inches)	Cumulative Total
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Appendix C – Nest Clump Survey Data Sheet

Observer	Date	Pasture Name	Habitat Type	Transect Number	Nest Clumps Counted	Multiplication Factor	Nest Clumps Per Acre
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	
						10	

Appendix D – Cover Survey Data Sheet

Observer _____ **Date** _____

Pasture Name _____ **Habitat Type** _____

Transect Number _____

Bare Ground																						
Forbs																						
Grass																						
Brush																						
Step #	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	Tot	
Bare Ground																						
Forbs																						
Grass																						
Brush																						
Step #	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	Tot	
Bare Ground																						
Forbs																						
Grass																						
Brush																						
Step #	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	Tot	
Bare Ground																						
Forbs																						
Grass																						
Brush																						
Step #	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Tot	
Bare Ground																						
Forbs																						
Grass																						
Brush																						
Step #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Tot	

Grand Total– Bare Ground	Grand Total– Forbs	Grand Total– Grass	Grand Total– Brush

Appendix E – Grass and Forb Diversity Data Sheet

	Key Habitat Name and Location	Date	Observer	Number of Different Grass Species	Name of Grasses Observed	Number of Different Forb Species	Names of Forbs Observed
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
			Total:		Total:		
Average number of different grass species counted across all sites (total # of grasses divided by # of sites):							
Average number of different forb species counted across all sites (total # of forbs divided by # of sites):							

Appendix F – Grass Stubble Height Data Sheet

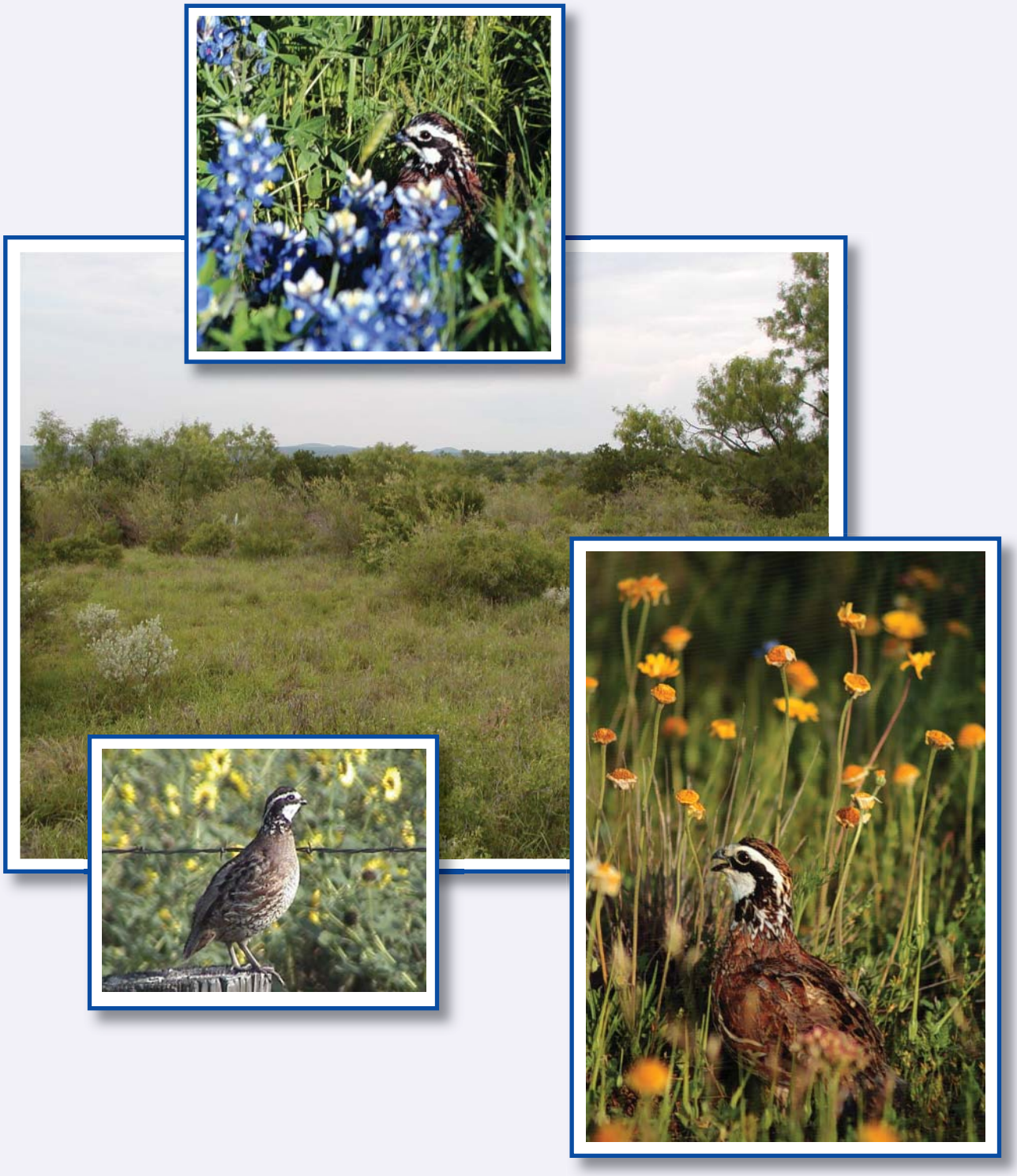
Observer _____ **Date** _____

Pasture Name _____ **Habitat Type** _____

Transect Number _____

Step #	Grass Height	Step #	Grass Height	Step #	Grass Height	Step #	Grass Height	Step #	Grass Height
1		21		41		61		81	
2		22		42		62		82	
3		23		43		63		83	
4		24		44		64		84	
5		25		45		65		85	
6		26		46		66		86	
7		27		47		67		87	
8		28		48		68		88	
9		29		49		69		89	
10		30		50		70		90	
11		31		51		71		91	
12		32		52		72		92	
13		33		53		73		93	
14		34		54		74		94	
15		35		55		75		95	
16		36		56		76		96	
17		37		57		77		97	
18		38		58		78		98	
19		39		59		79		99	
20		40		60		80		100	
Tot		Tot		Tot		Tot		Tot	

Grand total from all columns		Divided by 100 =		Average stubble height



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