QUAIL HARVEST GUIDELINES FOR SOUTH TEXAS: CONCEPTS, PHILOSOPHY, AND APPLICATIONS

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ABSTRACT

We present a scientific basis for implementing quail harvest guidelines in South Texas. The first step is to make an estimate (number of birds per acre or number of acres per bird) of how many quail are present in a particular pasture. Helicopters are an excellent platform for collecting bobwhite density estimates in rangeland habitats. The proportion of a quail population—in our examples the northern bobwhite—that can be sustainably harvested in South Texas is about 20% per year during years when population density is greater than about 1 quail per 3 acres. We suggest considering no harvest during years of extremely low (1 bird per 10 to 20 acres) population densities. The 20% harvest rate should include a correction factor for crippling losses that approximates 20% of the total harvest. For example, if a harvest prescription for a particular pasture is 100 birds, then the actual number of birds bagged should be 80 total because it is assumed 20 additional birds will be shot and not recovered. In South Texas, bobwhite abundance is closely linked with spring and summer rainfall. The highly variable precipitation in this region results in wide swings in population abundance and, thus, hunting opportunities from year-to-year. We conclude with examples of such variation during recent (2007–2014) years.

Introduction and Background

Bobwhite hunters in Texas are allowed to harvest 15 birds per day over a 120-day hunting season that begins in early October and ends in late February. In his chapter on Quail Regulations and the Rule-making Process in Texas, Jerry Cooke (2007) described the complex and colorful history that led up to the adoption of this regulation by the Texas Parks and Wildlife Commission. Prior to passage of The Wildlife Conservation Act of 1983 in Texas, there were still 13 of 254 counties that were not subject to authority of the Texas Parks and Wildlife Commission, and 70 other counties that were under only partial authority of this Commission. Additionally, there were 30 more counties where Texas Parks and Wildlife Commission regulations needed to be approved by county commissioners. To say this was a chaotic situation would be an understatement.

The current quail harvest regulations in Texas assume that harvest has no impact on quail populations *at the state-wide level*. While this is probably a safe assumption, it is important to realize that this fixed, liberal bag limit and season length does have the potential to negatively impact quail populations at the local (ranch or pasture) scale. Although no quail hunter does this, a dedicated hunter could theoretically kill up to 1,800 birds in a season (15 birds per day × 120 days). However, regulating harvest at the local level is not what the current quail bag limit and season length in Texas were designed to do.

The current quail harvest regulations in Texas were designed to allow quail hunters *flexibility and opportunity* to harvest more birds during years of good production and fewer birds during years of low production. These harvest regulations assume that quail hunters will

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The number of calling male bobwhites during the nesting season should not be used to set harvest prescriptions; helicopter sampling is more reliable (see Box 1).

"self-regulate" when the birds are scarce. Based on a survey of Caesar Kleberg Wildlife Research Institute (CKWRI) Quail Research Program donors in 2001, all 60 respondents mentioned that they implemented some type of harvest regulations that were more stringent—and in most cases much more stringent—than the state-wide regulations. For example, these self-imposed restrictions ranged from decreasing the season length by almost 50%, to imposing a "truck limit" on hunters that was far lower than a 15-bird-per-day limit. Also, many quail hunting operations rotated hunting pressure in pastures by only returning to the same pasture after 2 weeks passed. Other self-imposed regulations involve taking only 2 or 3 birds from a covey and then moving on. Still, others stop quail hunting in mid- to late-February if they see the quail are pairing up.

During 2009, hunting lease managers on the King Ranch were asked to answer a quail management questionnaire. Based on that questionnaire, the most common responses to *"How does your lease manage quail harvest?"* were (1) limit of 3 birds harvested per covey, (2) limit number of hunters per truck, (3) do not harvest from a covey of less than 8 birds, (4) rotate and-or distribute hunting pressure, and (5) reduce the hunting season length. When asked, *"What do you think the maximum sustainable quail harvest should be?"* the most common answers were (1) maximum of 1 bird per 10 acres, followed by (2) maximum of 1 bird per 20 acres. In addition, nearly all the hunting lease managers felt that the most important tool a manager has in making a decision to allow or prohibit quail hunting is the ability to shut down harvest at any time during the season if the population crashes or environmental conditions deteriorate.

Managing quail harvest is a moving target among years and within seasons. Managers should keep a pulse on the population throughout the hunting season and, if necessary, shut down the season. It is crucial to never paint yourself into a corner by setting rigid harvest quotas or strict schedules for hunters without a Plan B. While the above responses for the most part were made with a lack of specific scientific data relating to the properties being managed, these responses illustrate that experienced managers have an intuitive sense of the need to regulate harvest based on density. It is also recognition that in an area with as much extreme weather and rainfall volatility as South Texas, a prudent manager realizes that ensuring adequate carryover of brood stock is paramount to quick recovery in bobwhite populations following drought conditions. Similar examples of self-regulation are common among quail hunters in other parts of Texas and other states (Guthery et al. 2004).

Other Factors to Consider

The speed at which quail hunting takes place can have a huge bearing on the number of birds killed during a day of hunting. Hardin et al. (2005) showed that increasing hunting truck speed from about 2 miles per hour to about 6 miles per hour could potentially increase daily harvest by a factor of 4. Thus, a slow, leisurely hunt, instead of a "run and gun hunt" can help regulate quail harvest and expand the hunting experience with the hunters hardly noticing. It is important to understand that quail hunting is a cherished tradition governed by a special culture and legacy. A successful quail hunt for the majority of hunters is not judged by how many birds were bagged during a particular hunt or day.

A factor that may increase harvest efficiency is the use of outriders, or cowboys on horseback scouting for coveys ahead of the hunting truck. During years of low bobwhite abundance (see Table 1 for examples) managers should consider discontinuing the use of outriders.

During the past several years of drought, many landowners and leases have stopped quail hunting for

an entire hunting season because of the fear that they would be killing the few surviving birds needed to recover populations when favorable weather conditions returned. For example, in 2009 South Texas experienced devastating "exceptional" drought conditions. Although the King Ranch makes quota recommendations to their lessees, but currently does not impose concrete limits, lessees and other stakeholders only harvested a ranch-wide total of 667 quail in the 2009–2010 season, and these were only harvested for data collection purposes. This is only 2 to 3% of the long-term average annual ranch-wide quail harvest. Not harvesting quail (or severely limiting harvest) during years of drought is the ultimate act of self-regulation. Lately, it has been more common than one might think in South Texas.

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It is important to preserve quail hunting for future generations. Take a young person quail hunting, even if they only watch others hunt at first.

What are Good Harvest Guidelines for Quail in South Texas?

In South Texas, there are approximately 10 million acres of habitat that will produce bobwhites if rainfall is adequate. This "if" is a huge "if" because the amount of rainfall from April through August explains more than 90% of the year-to-year variation in bobwhite productivity (Tri et al. 2013) on areas with good habitat. Habitat sets the table, and rainfall puts the food on the plates when it comes to producing quail in South Texas. The question then becomes: "How can I have my cake and eat it, too?" Or, in other words: "How can I hunt quail and not drive their population to localized extinction?"

Developing a quail harvest guideline that is self-imposed at the ranch level is similar to making a cash withdrawal from a bank account, with one exception. The bobwhite bank account loses money during the winter (quail mortality) and gains money or interest during the summer (quail reproduction/recruitment). In any event, if you withdraw all the money at once, the account is then empty, just like over-harvesting wild bobwhites can cause local population extinction. However, if you make a partial withdrawal, and the account recovers the amount you withdrew, and possibly more, by gaining interest, then you are on track to having a

Table 1. Examples of variation in annual bobwhite harvest on a 5,000-acre pasture with a range of different fall densities, based on a recommended 20% harvest rate.

Fall Density of Bobwhites	Total Number of Bobwhites Present	Recommended Harvest [a]	Comments
1 bird per acre	5,000	1,000 birds	probably as good as it gets!
1 bird per 1.5 acres	3,500	700 birds	still quite good
1 bird per 2.0 acres	2,500	500 birds	an average year?
1 bird per 3.3 acres	1,500	300 birds	start worrying
1 bird per 10 acres	500	100 birds	consider no harvest
1 bird per 20 acres	250	50 birds	definitely no harvest

[a] Total recommended harvest values include a 20% estimate for bobwhite crippling loss. Thus, in the 1,000 bird harvest recommendation on the top line of the table values, 800 birds can be bagged, because 200 birds (20% of 1,000) are assumed to be lost from being wounded and not recovered by hunters. The 20% estimate of crippling loss applies across the range of densities in this example.

Box 1. Counting Quail in Rangeland Habitats using Helicopter Surveys

Four-person helicopters (R-44 and similar models) are an excellent tool for counting quail in rangeland habitats. Details about how to use helicopters to count quail can be found in CKWRI Technical Publication No. 2 by DeMaso et al. (2010), which is available as a free PDF download at http://www.ckwri.tamuk.edu/fileadmin/user_upload/docs/TechnicalPublications/TechPubNo2.pdf.

Below are some basic concepts that pertain to surveying quail populations with helicopters.

1. In addition to the pilot flying the helicopter, 3 observers are used to detect and count quail: a front-seat observer to detect coveys directly in front of the helicopter and 2 rear-seat observers to detect coveys on the left and right sides of the helicopter.
2. Surveys should be flown at a velocity of approximately 23 miles per hour and at an approximate altitude of 23 to 33 feet.
3. When quail are detected, the person who detected it shouts "covey" and the helicopter pilot will hover for 10 to 15 seconds so that a count can be made of the number of quail present.
4. After the survey is complete, abundance can then be estimated using the following equation: Bobwhite Density = 0.468(Coveys Seen per Mile) – 0.002 or using the nomogram provided in DeMaso et al. (2010). Note that this technique generates what is called a "point estimate" of abundance that does not have an associated coefficient of variation or confidence interval. In order to obtain confidence estimates of variance for a given survey, actual distance sampling data must be collected and analyzed. For details about training workshops to implement this technique, please see the website: http://www.ckwri.tamuk.edu/.
5. The "best" time to conduct a helicopter survey for quail is during late November or early to mid-December. This is because most of the quail are fully grown at this time and are more detectable than they would typically be during September or October, especially during a year with a late hatch. Coordinating quail surveys with helicopter surveys to count deer, which are usually conducted in September is not recommended because quail counts will be negatively biased. This negative bias (under-counting) is the result of several factors: (1) quail are simply not as detectable from helicopters in September as they are in late November or early to mid-December and (2) helicopter surveys for white-tailed deer are flown higher and faster than what is optimal for a quail survey.

Four-person helicopters (R-44) are excellent platforms for estimating the density of bobwhite populations in rangeland habitats.

sustainable flow of revenue, or from the standpoint of this publication, bobwhites.

Thus, when it comes to developing quail harvest guidelines, the bank account metaphor is especially apt. This is because before you make your withdrawal, you need to know how many dollars are in your bank account or, how many birds are in your quail account. It also helps to know if the account is generating interest or losing money and, if so, at what rate.

The equivalent of knowing the balance of the bank account is knowing how many quail are present on a given area—typically a pasture—at the beginning of the hunting season. In South Texas, we developed the technique for accurately counting quail in rangeland habitat using helicopters. Late November to mid-December is the time of year to conduct this survey (see Box 1 regarding counting quail from a helicopter). We also need to know how many quail we can harvest from this initial population size. Our research shows that winter losses in South Texas can vary greatly, from less than 20% to over 70% (Teinert et al. 2013). In estimating harvest, we typically use 40% overwinter mortality as a compromise. Research has shown that harvesting 20% of the pre-hunt population may maximize long-term harvest while minimizing the probability of population extinction (Guthery et al. 2000, Sands 2010). Another factor a manager might consider is the phenomena of "hot spots" during down years. Years of surveys and observations by managers on the King Ranch indicate

Box 2. Calculating a 20% (0.20) Annual Harvest Prescription

Harvest prescriptions for a given area can be calculated as per the following:

$$H = 0.20 \times N$$

where H is the total harvest for the season and N is the pre-hunt population. For example, assume you document a fall density of 0.7 bobwhites per acre during fall surveys on a 5,000-acre pasture. The pre-hunt population would be 3,500 bobwhites (0.7 bobwhites per acre × 5,000 acres). Thus, the allowable harvest for the season would be

$$H = 0.20 \times N$$

$$H = 0.20 \times 3{,}500 \text{ bobwhites}$$

$$H = 700 \text{ bobwhites}$$

Once the 700th bobwhite is bagged (including an estimate of crippling loss), hunting would cease on that pasture. Implementing a 20% harvest rate can result in a wide range in the number of bobwhites harvested from a pasture during years when densities vary (Table 1).

that when exceptional habitat is interlaced by regular feed lanes, bobwhites can become concentrated (such as seeing lots of quail along a feed lane) to the extent that the casual observer would be led to believe overall population density is much greater than the density actually is over the entire pasture. When armed with this kind of information, we can make a reasonable estimate of how many birds we might be able to bag and still have a viable quail account at the end of the hunting season.

What do we mean by having a *"viable quail account at the end of the hunting season?"* Simply stated, a "viable quail account" is a quail population that has the potential to produce summer gains through nesting and successful broods so that there are huntable numbers in the fall-winter hunting season. This is the kind of viability we are looking to sustain. There is also another kind of viability, which is minimizing the risk of the quail population going extinct and is part of this equation.

Annual Harvest Prescription

A CKWRI study by Sands (2010) concluded that a 20% annual harvest rate for bobwhites in South Texas provided the largest sustained number of birds that could be harvested over time. A 20% harvest rate also virtually guaranteed that local bobwhite populations would not be driven to extinction. The analyses by Sands (2010) were based on a combination of field data and population simulations that compared annual harvest rates ranging from 10 to 40% over a 100-year time span.

Consider a 1,000-acre pasture with 1 bobwhite per acre. This means there will be 1,000 birds present at the beginning of the hunting season. A 20% harvest rate would mean that 200 birds would be available for harvesting from that pasture during that particular hunting season (see Box 2 for specific calculations). The actual number of birds brought back to camp would be lower (most likely in the range of 150–160 birds or about 80%) than the 200-bird prescription to account for a 20% crippling loss.

Harvest prescriptions for bobwhites can vary widely from year-to-year, based on the number of birds estimated to be present at the beginning of the hunting season. Table 1 provides some examples of such variation for a 5,000-acre pasture, along with some comments about how such populations should or should not be hunted at different levels of abundance.

Factoring in Crippling Losses

Crippling loss involves quail that are shot— whether noticed by the hunter or not—and not retrieved. Haines et al. (2009) reviewed the literature on crippling losses related to bobwhite hunting. They concluded that while

Most quail hunting operations in South Texas bag only 3 birds from a particular covey during a hunting trip.

Box 3. Additive versus Compensatory Mortality

Quail spend the winter in coveys to maximize their chance of surviving so that they can reproduce during the following spring and summer. Thus, overwinter mortality in a quail population is like having a bank account that only draws negative interest, or loses money, over a given period of months.

The basic concept behind additive versus compensatory mortality in quail populations is that some amount of "natural" or non-hunting mortality is going to take place over the winter period. If an individual quail survives through the winter months, but is then shot on the last day of quail season in February, the loss of that individual is considered to be "added" to the overall mortality of that population for that winter. If an individual quail is shot on the opening day of quail season in late October, the loss of that individual can be considered from the standpoint that it would probably be "compensated" or otherwise lost to non-hunting factors such as predation or weather by the time quail hunting season ends in February.

The management implication of additive versus compensatory mortality is to encourage hunters to avoid inflicting the majority of hunting pressure on quail populations late in the hunting season. The idea behind this implication is that as the birds survive through the hunting season, the ones that make it to late February are the survivors who are recruited into the breeding population of bobwhites.

The concept of additive mortality in quail populations, while cause for concern, should not be taken as an excuse to cut the quail season short by weeks or months, especially in South Texas. In South Texas, most quail hunting begins in mid-late December and runs through the end of February. Not much quail hunting takes place in October or November for various reasons such as heat, rattlesnake activity, heavy cover (if it was a good growing season with ample precipitation), or a late-summer hatch (which is more prevalent with bobwhites in South Texas than we previously thought). Thus, because quail hunting in South Texas trends toward the last half of the season there is potential for inflicting additive mortality.

Managing hunting pressure is the key to avoiding the chance of inflicting additive mortality. As previously mentioned, many quail hunting operations in South Texas implement self-imposed regulations to work to minimize additive mortality (whether they know it or not). Self-imposed restrictions such as spreading out hunting pressure by resting pastures for at least 2 weeks between quail hunts, only shooting 2 or 3 birds from a covey, only shooting a truck limit of 12–15 birds when the 3 hunters on that truck could legally bag 45 birds all work to help minimize the chance that hunting mortality will be excessively additive to natural mortality.

There is great enjoyment in anticipating a covey rise in prime South Texas bobwhite habitat.

many studies have reported estimates of crippling loss, comparisons among studies have been difficult because of a lack of standardized definitions and methods of calculation. Some studies report crippling loss as a percentage of the recorded harvest, others as a percentage of total kill. For example, if 25 birds were harvested and retrieved and 5 birds were shot but not retrieved (i.e., crippling loss), then crippling loss may be reported as 20% if reported as a percentage of recorded harvest (i.e., 5 ÷ 25) or as 17% if recorded as a percentage of total kill (i.e., 5 ÷ 30). The literature indicates that crippling loss for bobwhites can range from 5–31% of recorded harvest and 5–24% of the total kill.

Crippling loss is a component of harvest and should be considered as part of the harvest quota. That is, if the harvest quota is 200 bobwhites, harvest should cease when total harvest (i.e., bagged bobwhites + crippling loss) reaches this quota, not when the number of bagged bobwhites equals 200. The latter approach would not consider crippling loss and, therefore, result in a harvest beyond the desired quota. Thus, it is important to factor in crippling loss so that harvest may cease when the appropriate harvest quota is reached.

Assumptions Behind the Guidelines

A quail harvest prescription is based on a quail population estimate. All wildlife population estimates are based on a series of assumptions. The examples

presented herein for bobwhites in South Texas are no exception. Some key assumptions behind our analyses are as follows:

1. Overwinter mortality is approximately 40%, as noted above.

2. We consider the harvest guidelines presented here to be at least partially additive, especially as the hunting season progresses. This means some losses to harvest are in addition to losses from predators, weather, etc. especially as the hunting season progresses. See Box 3 for a discussion on additive versus compensatory mortality in bobwhites that also applies to other game species.

3. We consider there is negligible influence of density dependence on either summer gain or overwinter mortality for bobwhites within South Texas. Although we know that density dependence operates in ways that influence reproductive success (usually greater reproductive success with lower density) and overwinter mortality (greater mortality with higher density), the effect of density dependence on bobwhite populations most likely varies in space and time and can be temporarily overlooked for the simple examples presented in this publication. See Box 4 for a discussion on density dependence in bobwhite populations.

4. Areas on which hunting occurs represent fully usable space in which populations tend to be stable or increasing from year-to-year.

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Good production is the key to having a sufficient number of bobwhites for the upcoming hunting season.

Box 4. Density Dependence in Bobwhite Populations

The concept of density dependence in bobwhite populations goes back more than 50 years to a long-term study in Iowa by Paul Errington (1945). During the 15 years he studied bobwhites in Iowa, Errington noticed 2 important things: (1) after harsh winters with high mortality, bobwhites typically had highly productive breeding seasons and (2) when winter losses were relatively minimal and breeding populations were relatively high, bobwhites did not have highly productive breeding seasons. Errington called this the principle of "inversity." When breeding populations were abundant, they reproduced at a rate that was considerably lower than when they were not so abundant. A couple of decades later, a long-term population study in Southern Illinois by John Roseberry and Willard Klimstra (1984) corroborated Errington's observations from Iowa.

Density dependence also operates in bobwhite populations during winter; when density is high, overwinter survival is relatively low, and vice versa. Research by DeMaso et al. (2013) has shown that density dependence most likely operates in South Texas bobwhite populations during both the winter and the breeding season. From the standpoint of managing quail harvest, however, it is extremely difficult to predict the extent to which density dependence will influence summer population gains and winter population losses in South Texas. This is because the dynamic nature of South Texas weather is much less predictable than places such as Iowa and Illinois. A hot dry summer in South Texas can completely shut down quail production whether the population at the beginning of the breeding season was high or low. Thus, density independent factors such as weather play a far greater role in regulating quail populations in South Texas than density dependent factors. Nevertheless, density dependence is present and plays a role that influences bobwhite population dynamics in South Texas. As Fred Guthery (2002:54) wrote: "The phenomenon of density dependence lurks quietly but crucially within the chaos of quail demography."

Yearly Variation in Bobwhite Production: From One Extreme to Another

The differences in recommended annual bobwhite harvest within a single pasture (Table 1) illustrate the challenges faced by managers. In South Texas especially, the only constant that can be counted on is a huge amount of annual variation in precipitation and, therefore, a huge amount of annual variation in bobwhite abundance. Variability in year-to-year production in the

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In South Texas, good spring and summer precipitation, good habitat, and good dogs provide for a GREAT bobwhite hunting experience.

8 years from 2007 through 2013–2014 provides some great illustrative examples of this fundamental point.

2007.—The summer of 2007 was one of the wettest on record for South Texas with more than 27 inches of rainfall occurring from March through September (King Ranch, Inc. ranch-wide rainfall data). Bobwhite production during the 2007 nesting season was excellent. However, beginning in October 2007 it nearly stopped raining for months. From October 2007 through March 2008 there were only 3.5 inches of precipitation (King Ranch, Inc. ranch-wide rainfall data). Shortly after Thanksgiving wildlife managers were reporting mysterious disappearances and die-offs of bobwhites that were apparently the result of the fall-winter drought. While it is possible this is an example of winter density dependence being expressed (high mortality in relation to high density) it is not provable. What we do know, however, is that a promising hunting season turned into quite a disappointment almost overnight.

2008.—Although the late winter and spring months of 2008 were bone dry (6.3 inches of rain from October 2007 through June 2008, King Ranch, Inc. ranch-wide rainfall data), graduate students from the CKWRI were able to trap and radio-mark more than 90 bobwhite hens for 3 different studies along the Highway 285 corridor near Riveria, Falfurrias, and Hebbronville. Curiously, from April through June (2.8 inches of rainfall, King Ranch, Inc. ranch-wide rainfall data) only about 5 or 6 of these radio-marked hens attempted to nest. In fact, during these months, pairs often aggregated back into small coveys of 4 to 6 birds. During early July, tropical storm Dolly made landfall near Brownsville, Texas, and dumped more than 8 inches of precipitation across Kleberg, Brooks, and Jim Hogg counties. Within 10 to 12 days after Dolly made landfall, more than 75 radio-marked hens were on nests and laying clutches of eggs. The 2008–2009 quail season in South Texas was one of the best in recent memory.

2009.—This was the beginning of the disastrous drought that we are still enduring at the time of this writing (2014). A CKWRI graduate student trapped more than 60 bobwhite hens near Falfurrias in April of that year. There was little or no spring-to-summer rain (3.5 inches from March through August, King Ranch, Inc.

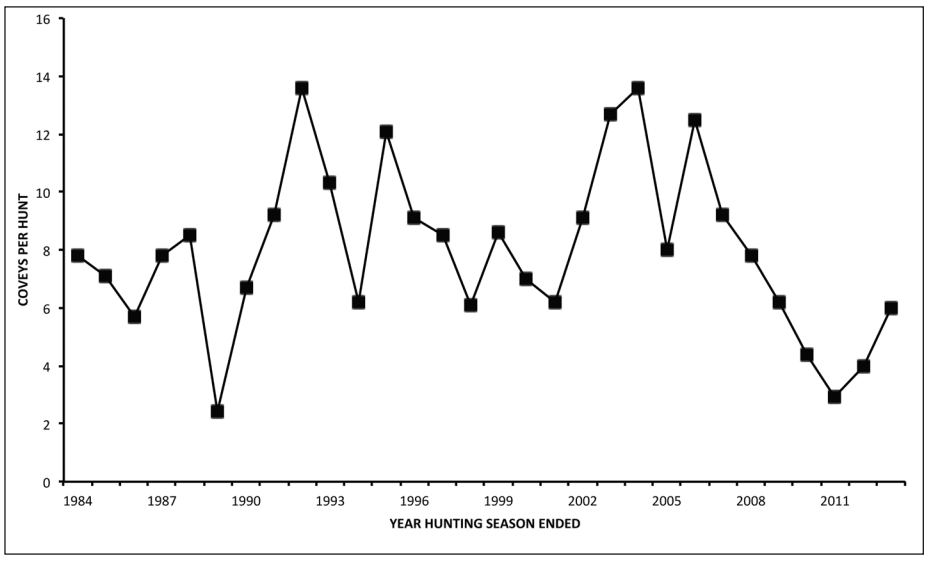

Figure 1. Annual variation in coveys flushed per half-day hunt on a 3,422-acre pasture in South Texas over 29 hunting seasons. Note the wide range of annual variability in coveys seen per hunt from a low of 2 coveys per hunt in 1989 to a high of nearly 14 coveys per hunt in 1992 and in 2004. Despite the wide amount of variability across years, there is not an increasing or decreasing trend in the 29-year span of these data. This indicates that bobwhites on this pasture have been harvested in a sustainable manner for nearly 3 decades.

ranch-wide rainfall data), and record heat accompanied these harsh conditions. By the third week of July, all 60 radio-marked hens were dead, and there was essentially no production that year. After 3 successive years of declining hunting success (Figure 1), many South Texas quail operations did not hunt that year, and those that did had a difficult season.

2010.—Excellent spring and summer rain in 2010 (21.4 inches from March through August, King Ranch, Inc. ranch-wide rainfall data) resulted in a fair-to-good recovery in quail numbers for the 2010–2011 hunting season. However, as the hunting season wore on, it became obvious that a full recovery from the 2009 disaster had not happened. Bobwhite hunting across South Texas was spotty, running from good to terrible in the same pasture. Clearly, it takes more than a single summer of above average rainfall for quail populations to recover from a collapse.

2011 and 2012.—These were 2 of the worst seasons of quail production on record for South Texas (4.0 inches of rainfall from March 2011 through December 2011 and 11.8 inches from March 2012 through December 2012, King Ranch, Inc. ranch-wide rainfall data). The fact that they occurred back-to-back only made a bad situation worse. Most did not hunt, or if they did, the number of bobwhites bagged, if any, was severely curtailed. During the summer of 2012, scattered and highly localized thunderstorms provided isolated rain events that were limited to individual pastures. This provided opportunities for scattered pockets of bobwhite production that, if nothing else, helped populations persist, even if the low numbers of birds dictated little or no hunting.

2013.—This was a tale of 2 regions in South Texas, both with positive outcomes.

Region One.—In early June, the Upper Nueces River Watershed near Cotulla and Carrizo Springs east towards Interstate 37 received a series of rainfall events that dropped 6 to 10 inches of precipitation in the area. This part of South Texas also received some rainfall in the summer of 2012 and, in the summer of 2013, quail populations responded positively in a major way. Ranches in this region of South Texas reported record quail numbers. CKWRI graduate students in this region had no problem luring hundreds of quail into their traps for banding and radio telemetry studies.

Region Two.—None of the June rain events seen in western South Texas made it to the Sand Sheet area in Brooks and Jim Hogg counties. However, in late August and early September, significant late-summer rains fell (9.1 inches, King Ranch, Inc. ranch-wide rainfall data) and the bobwhites went to work. Nesting occurred through September and bobwhite chicks were hatching out well into October. There were still partially-grown birds as late as mid-January because it takes 12 weeks for a bobwhite to reach 75% of adult size and weight. As it turned out, late January and February 2014 provided some of the best quail hunting in South Texas anyone had seen since 2010.

Harvest Guidelines from Lessons Learned

What can we reasonably expect from quail harvest guidelines in South Texas when the key factor that controls quail production—spring-summer rainfall— is out of our control? Quail hunting guidelines for South Texas will probably never be able to be precise, given how close population productivity is tied to rainfall, and how unpredictable rainfall patterns are in this region. However, it turns out that there are a number of lessons that can be learned that pertain to implementing quail harvest guidelines in South Texas.

1. Although peak bobwhite nesting activity in South Texas usually occurs during May and June, there

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Because nesting activity can extend into late summer and early fall in South Texas, helicopter surveys are best conducted from late November to mid-December to "capture" these young birds in the pre-hunting survey.

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It is better to slow down hunt trucks than maximizing hunting opportunities when populations are not optimal; this also provides hunters with a better experience.

are also years when nesting is delayed until mid or late summer due to lack of precipitation. The 2013–2014 hunting season was an extreme example of this when late summer rains pushed the hatch well into September and October, and many birds were still partially grown in early January. This is why it is best to conduct helicopter censuses in late November to mid-December.

2. Based on the above point, and given the unpredictability of spring rainfall in South Texas, it follows that late-season hatches from mid-to-late summer rainfall events are probably more important for producing bobwhites in South Texas than we previously appreciated.

3. Taken together, points 1 and 2 above mean that it is absolutely imperative that quail managers implement some form of quail census—usually from a helicopter sometime between late November and mid-December—in order to make an objective decision about bobwhite harvest, or whether to even hunt quail at all.

4. If you decide to hunt quail, consider making some basic harvest estimates using a 20% harvest prescription (including crippling losses) similar to the examples presented in Table 1.

5. It is necessary to manage hunting pressure on a pasture-by-pasture basis. While pastures on South Texas ranches are often huge (1,000 to over 10,000 acres), they provide a convenient way to keep track of census data, hunts, and so on. Year-to-year variation in bobwhite numbers can be staggering, even within a single pasture (see Figure 1). Additionally, recent work using helicopter censuses on the King Ranch has shown that even within a given pasture there are quail "hot-spots" that ebb and flow from year-to-year (see Figure 2).

6. Manage harvest efficiency by slowing down quail trucks and forgo the use of outriders during those lean years.

7. Hunt when you can, where you can, but be conservative with harvest prescriptions to maximize the chance for carry-over of as many birds as possible into the breeding season. There can be variation in survey results based on the timing of nesting, and poor fall conditions can quickly and drastically reduce bobwhite numbers as we saw during the 2007–2008 hunting season. Thus, quail management is as much art as it is science. Experience, including years of observation and awareness of current conditions will aid the manager as much as any research paper. Anyone can manage during the high rainfall years. The real test comes when conditions become challenging. The rule of thumb should be *if you are in doubt or are in possession of little data, be conservative.*

8. It is important to keep the large blocks of habitat intact and in place. "Unless the habitat is maintained, there will be little wildlife left to hunt or to see." (A. S. Leopold 1978)

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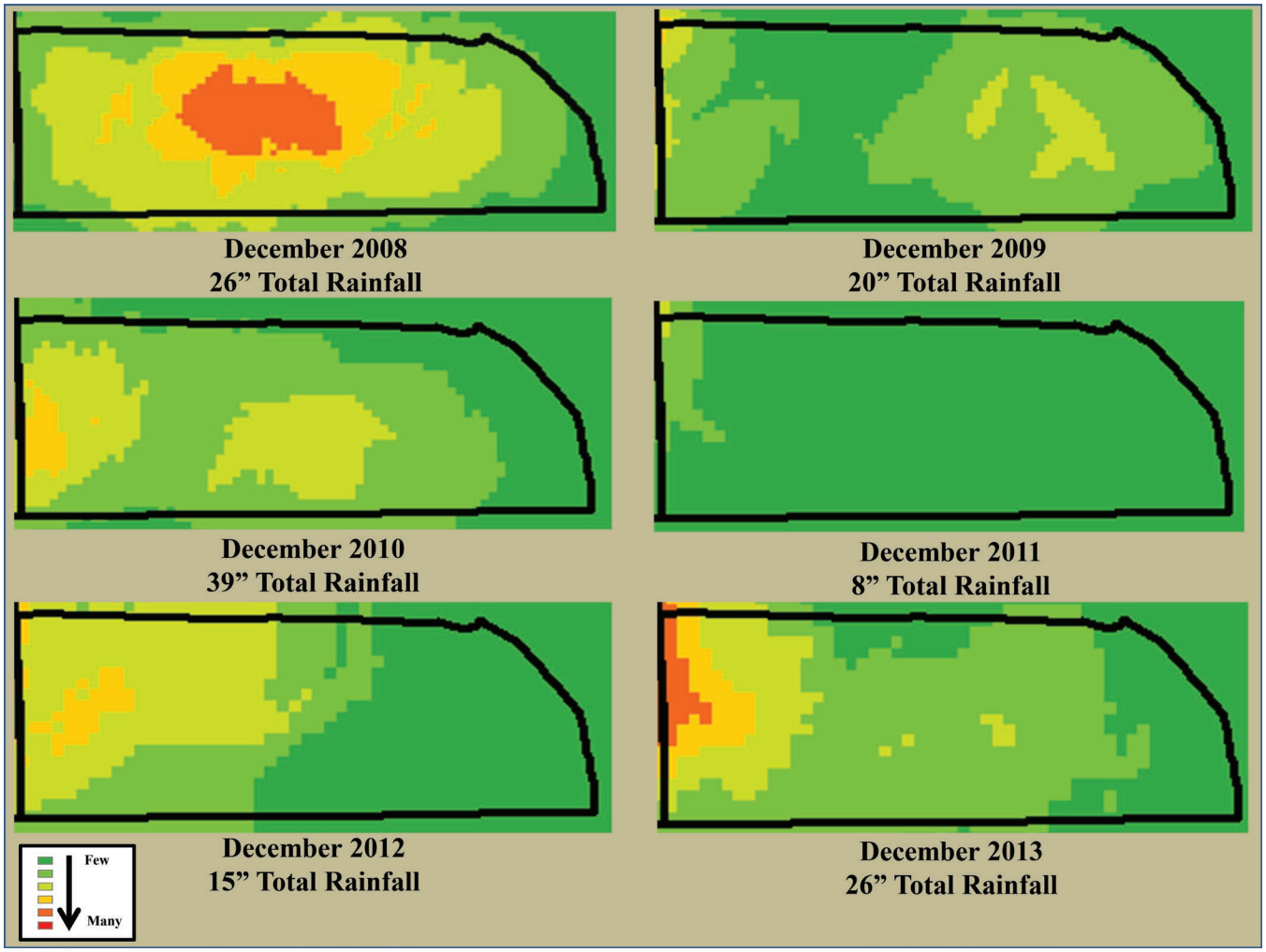

Figure 2. Annual variation in abundance of bobwhites estimated from a December helicopter census on a 7,200-acre pasture in South Texas over a 6-year period (2008 to 2013). Abundance ranges from relatively high (red) to moderate (yellow) to low (green). Rainfall values represent cumulative precipitation from March through September of each year.

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