Efficiency of the Conservation Reserve Program in Context of Focused Landscape Management for Northern Bobwhites and Associated Species

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Executive Summary

Northern Bobwhite and other grassland-associated bird species have been declining for decades because of the loss and degradation of grasslands. Private land conservation initiatives such as the Conservation Reserve Program (CRP) aim to reverse these declines by incentivizing landowners to convert agricultural production lands into wildlife habitat. Many CRP practices create grassland specifically, but the context of the landscape (e.g., composition and configuration of land features surrounding the conservation field) and spatial arrangement of conservation fields may dictate population response. The National Bobwhite Conservation Initiative's Coordinated Implementation Program (CIP) is a multi-state adaptive management program designed to understand how creating and maintaining habitat for Northern Bobwhite at landscape-scales influences population trends across their range. There are currently 19 states enrolled in the CIP. Each participating state records habitat management activities and measures habitat quality and bird response in a focal area (i.e., a managed area) and a reference area (i.e., no focal management for bobwhites). Many of these CIP landscapes are privately owned, so there is either some portion of the CIP area that is enrolled in CRP or there is potential for CRP enrollment. This presents the opportunity to understand how CRP fields contribute to Northern Bobwhite population recovery in context of coordinated landscape-scale management. Broadly, our objectives were to understand how CRP influences Northern Bobwhite populations at landscape-scales, and to uncover any differences in the efficiency of CRP in focal landscapes versus reference landscapes. Native CRP practices were much more efficient in managed landscapes compared to unmanaged landscapes. For example, in a focal area landscape, an increase in 5% native whole-field practices was predicted to increase local bobwhite populations by 0.34 males in the breeding season and 0.92 coveys in the non-breeding season. In reference area landscapes, native whole-field practices had a much lower probability of positively influencing bobwhite populations. Additionally, the extent of the landscape that mattered to bobwhite differed between the breeding and non-breeding season, which has implications for conservation targeting. In both seasons, the importance of CRP fields to local populations declined with distance. In the breeding season, any CRP field farther than 2 km away from a local population had no influence on that population. In the non-breeding season, any CRP field farther than 8 km away had no influence on local populations. The CRP is the cornerstone of private land conservation in the United States. Here, we uncovered differences in the efficiency of CRP depending on how the landscape surrounding conservation fields was being managed. This highlights the importance of the landscape-scale, targeted approach to conservation in fragmented systems such as farmlands. Additionally, we demonstrated that CRP in isolation is less efficient that clusters of CRP. Finally, we identified high variability in the effects of CRP, indicating that the effects of CRP may differ in different regions or landscapes, depending on the amount or arrangement of resources that are complimentary to those added by CRP. The implications of this study are that CRP can be efficient, but there are major information gaps that need to be filled before optimization of these practices is attainable.

Introduction

Native grasslands have been fragmented and reduced by agricultural expansion and intensification. As a result, grassland associated birds have declined (Murphy and Moore 2003). The Conservation Reserve Program (CRP) is the largest private land wildlife conservation program in the United States. Dozens of conservation practices (CPs) within the program have objectives related to improving wildlife habitat. Many of these practices have been used to improve Northern Bobwhite (*Colinus virginianus*; hereafter bobwhite) habitat. Bobwhites are an economically, socially, and ecologically important game bird that while declining throughout much of its range, are still hunted in localized areas. Reversing the decline of bobwhite is going to require a national-scale, targeted effort (Hernández et al. 2013).

Converting fields of exotic grass or row-crop agriculture to fields with native prairie grasses and forbs results in improved resource quality for bobwhite and other grassland-associated birds (Washburn et al. 2000, Monroe et al. 2016). The CRP not only can improve habitat quality of individual land parcels, they can result in increased local abundance of bobwhite and other grassland birds (Best et al. 1998, Riffell et al. 2008, Evans et al. 2014). However, impacting these species at a population level may require landscape-scale benefits, i.e., benefits that extend outside of targeted land parcels (Kleijn et al. 2011). There is evidence for landscape-scale effects of CRP that translate to population-level benefits for bobwhite (Yeiser et al. 2018). The context of the landscape in which CRP is enrolled likely moderates the degree to which CRP fields contribute to population recovery.

Landscape context may be especially critical for bobwhite, who require a variety of resources throughout their life history that are typically scattered across agricultural landscapes (Stoddard 1931, Rosene 1984). In the breeding season, bobwhite require herbaceous vegetation for nesting materials. For brood rearing during summer months, bobwhite require herbaceous cover with bare ground suitable for foraging and ample insect abundance to fulfill diet requirements of chicks. During the non-breeding season during autumn and winter, bobwhite form coveys and traverse the landscape foraging for food. Throughout the year bobwhite require woody cover to escape from predators or harsh temperatures. Having these elements in close proximity to each other reduces the distance bobwhite have to travel to get the resources they need, and ostensibly increases their survival and fitness.

The National Bobwhite Conservation Initiative (NBCI) has worked with 25 state wildlife agencies and the Science Subcommittee of the National Bobwhite Technical Committee (NBTC) to develop the Coordinated Implementation Program (CIP) (www.quailcount.org). This science-based approach to restoring and managing bobwhite populations is based on hypotheses relating quail population response to quality and quantity of habitat. A key principle is that resource management agencies establish and manage a minimum of 1,500 acres of habitat that comprise at least 25% of the focal area. Many CIP focal areas are primarily private land (e.g., Iowa, Kentucky, Missouri, Nebraska, Ohio, Oklahoma, and Texas), and thus Farm Bill programs are key avenues for focal area establishment and management in those states. Understanding the density of CRP within these areas and in the surrounding landscape is an important step to understanding how CRP and the CIP interact to deliver bobwhite habitat. Furthermore, participating states collect data on grassland birds in the spring (including bobwhite) and bobwhite in the fall, both within focal areas and paired reference areas with no active management.

The CIP provides an opportunity to understand whether focused habitat management at the landscape scale influences the efficiency of CRP enrollment. By identifying CRP within focal and reference areas and their surrounding landscapes we can understand the contribution CRP makes (in terms of acres) to focal area efforts. We can also use statistical modeling to understand the relationship between CRP in the surrounding landscape and bobwhite abundance, and how this relationship differs in landscapes with intensive habitat management (focal areas) and without any management (reference areas). Most importantly, the CIP presents an opportunity to understand what it takes to maximize the efficiency of CRP enrollment for bobwhite and grassland bird conservation.

Objectives

1. To identify existence of CRP in National Bobwhite Conservation Initiative Coordinated Implementation Program areas in Iowa, Kentucky, Missouri, Nebraska, Ohio, Oklahoma, and Texas.
2. To develop statistical models to investigate the relationship between landscape-scale density of CRP and bobwhite populations. The relationship between CRP and songbirds will also be considered, but model development will be less advanced for these species.

3. To describe suitability of CRP for bobwhites as it exists in select NBCI Coordinated Implementation Program areas.
4. To better understand relationships between population responses of bobwhite to presence of lands enrolled in CRP in the NBCI Coordinated Implementation Program.
5. Identify possible efficiencies for CRP outcomes.

The Coordinated Implementation Program

The Coordinated Implementation Program (CIP) was designed to be a scalable approach to habitat restoration planning and action. This approach begins with identifying focal areas comprised of land that has a high potential for bobwhite restoration. These areas are designed to increase the probability of reaching state-defined bobwhite density targets over a period of 10 years through strategic habitat management efforts. The size of these areas must reflect the minimum amount of area needed to sustain a bobwhite population through time, regardless of landscape context. The CIP hypothesizes that after prescribed habitat management is applied, at a bare minimum 1,500 acres and 25% of the focal area must be bobwhite habitat. For example, if a habitat manager plans for 100% of a focal area to be high quality habitat at the end of the 10-year term, the minimum size of the focal area must be 1,500 acres. If a habitat manager plans for 25% of a focal area to be high quality habitat, the minimum size of the focal area must be 6,000 acres to reach the 1,500-acre minimum of habitat after management. Conversely, if a manager identifies a larger 10,000-acre focal area, to meet the requirements, the amount of habitat after management must be 2,500 acres or 25% of the area. Additionally, focal areas must have a reference area of similar size and landscape composition to act as a control. Focal areas would ideally be nested inside a larger focal landscape (e.g., soil and water district, cluster of counties, etc.) which would then be nested again in a larger focal region, with the goal of scaling-up effective habitat management strategies to restore bobwhite habitat over a large area. General descriptions of specific areas included in this study can be found in the Appendix.

The CIP bins habitat management practices into 24 different categories: chemical brush management, mechanical brush management, creation of brush piles, partial disking, whole-field disking, edge feathering, herbaceous cover establishment (planting native grasses or forbs for the benefit of bobwhite), shrub establishment (for the benefit of bobwhite), tree establishment (for the benefit of bobwhite), fallowing/idling, dormant-season burns, growing-season burns, food plot establishment (for the benefit of bobwhite), clear cutting (>5 acres), creating a forest opening through cutting (1-5 acres), forest thinning, deferred grazing, emergency grazing, patch-burn grazing, rotational grazing, deferred haying, emergency haying, herbaceous chemical control via broadcast spraying, and herbaceous chemical control via spot treatment. These focal areas have employed many different habitat management practices with the majority being chemical and mechanical brush management, partial and whole-field disking, growing-season and dormant-season prescribed burns, edge feathering, forest thinning, as well as multiple types of grazing, haying, and herbaceous chemical control.

From 2013 through 2018, the top three habitat management practices that affected the most area were dormant-season burns at 10,236 acres total, rotational grazing at 5,652 acres total, and herbaceous chemical control (broadcast spraying) at 4,659 acres total. The top three most frequently used habitat management practices were herbaceous chemical control (broadcast spraying), whole-field disking, and herbaceous cover establishment (this is defined as planting native grasses or forbs for the benefit of bobwhite).

Materials and Methods

Those who participate in the CIP are required to monitor both bird abundance and habitat changes. The CIP calls for two types of bird monitoring: spring breeding bird counts and fall covey counts. When placing survey points it was required that the total number of points covers 20% or greater of the focal area. Points were randomly selected along roads for ease of access, though 50% of points may be placed off road if deemed necessary.

Spring Breeding Bird Count Protocol

Spring breeding bird counts took place annually and were required to take place twice during the breeding season and peak calling period for bobwhites. This window of time was approximately six weeks and the timing may have differed depending on what region of the US the focal area is located in. Bobwhite and other species of interest within the state were recorded during a five-minute point count survey. Sampling points were at least 500 m apart to ensure independence. Before the count began, field workers recorded the date, temperature (degrees Fahrenheit), cloud cover (%), wind speed (using the Beaufort scale), noise level (ranging from silent to constant noise), as well as the start time of the survey. Field workers used an aerial map to mark the estimated location of the bird, the species, the one-minute time interval in which it was heard, and note if a visual observation was made. It was recommended that replication occurred within two weeks of the first count to maximize chances of capturing peak calling. These counts were also required on the reference area.

Fall Covey Count Protocol

Fall covey counts took place annually and repeated visits to survey locations were encouraged. Fall covey counts were not required on the reference areas though recommended. If there was greater than 75% cloud cover, the wind index was greater than four on the Beaufort scale, or it was raining or snowing, it was recommended that the survey did not take place. The window of time for surveys was approximately six to eight weeks in order to capture the peak calling period but was terminated before hunting season began. The listening radius was set at 500 meters and a minimum of 1000 meters between points was adhered to unless otherwise restricted due to access constraints. The survey began 45 minutes before sunrise and lasted until sunrise. Before the count began, field workers recorded the date, sunrise time, cloud cover, noise level, wind speed (using the Beaufort scale), barometric pressure at 1:00 AM, barometric pressure at 7:00 AM, and the start time of the survey. During the survey, field workers used an aerial map to mark locations of coveys and time of detection. If multiple calling bobwhite were perceived to be greater than 30 meters apart, they were classified as multiple coveys and were recorded as such. It was recommended that at least ten coveys were flushed during a sampling season to count the number of individuals per covey though it was not required. Additional subjective data was acquired including the observer’s confidence in location placement of the covey and their confidence in the number of individuals counted in a flushed covey. Upon survey completion, results were taken into a GIS software to calculate the distance to the covey from the observer.

Statistical modeling

We fit a hierarchical distance sampling model to our data using the Markov Chain Monte Carlo method in a Bayesian framework. The number of birds detected at a point was a result of the true latent abundance that varied with environmental covariates, the vocalization rate of the birds (availability) informed by time-to-removal, and the ability of observers to perceive vocalizations (perceptibility) informed by distance-to-observer information (Amundson et al. 2014).

We modeled true latent abundance as a random Poisson process, where the expected number of individuals on the log scale varied by state, year, whether the point was in a focal or reference area, the landscape-scale density of CRP field types (i.e., not whole-field, whole-field, whole-field – erosion control, whole-field – tree plantings, Table 1), and the interaction of focal area and landscape-scale density of CRP field types. We assumed the expected number of individuals for each state was a random draw from a Normal distribution with some global mean and standard deviation. These global parameters represent the expected distribution of bird abundance at a given point across the entire study area. We also modeled each year for each state as a random draw from a Normal distribution with the state-level mean (randomly estimated as described above) and a state-level standard deviation. This random year-state effect was the model intercept. Landscape-scale CRP covariates were scaled and centered. We directly estimated the spatial scale at which CRP features influenced local abundance using a kernel smoother embedded in the linear model (Chandler and Hepinstall-Cymerman 2016, Yeiser et al. 2018). The effect of focal area vs reference area for each state was drawn from a global Normal distribution with a mean and standard deviation. These global parameters were interpreted as the global effect of focal areas, i.e., what one would expect the baseline difference in point-level abundance to be between a point that was on a focal area and a point that was on a reference area.

We modeled availability of individuals as a multinomial process, where each individual present in the sampling area had some probability to vocalize in one of Z consecutive time periods. On the logit scale, we estimated the likelihood of and individual vocalizing in the first time period ($pa_{s,1}$) as a random Normal process with a state-level mean and standard deviation (indexed by s for each state). As with expected abundance, state-level means were drawn from a global Normal distribution. We estimated the probability of individuals vocalizing in subsequent time periods (indexed by z) as: $pa_{s,z} = pa_{s,1}\left(1 - pa_{s,1}^{z}\right)$. We divided observations into B distance bins and modeled perceptibility as a multinomial process, where the probability of an observer perceiving a calling individual declined in a half normal fashion with distance (Yeiser et al. 2018). The intercept of perceptibility on the log scale varied as did true abundance, where each state-year combination had its own random intercept. We ran models in the program JAGS using the R package 'rjags' (Plummer 2003, 2016, R Core Team 2018). We ran 3 parallel Markov Chain Monte Carlo chains and ran models until each chain converged sufficiently

(Gelman and Rubin 1992). We ran an adaptive phase for each model and discarded this phase as well as an appropriate number of beginning iterations to ensure that there was no influence of starting values on posterior distributions.

Results

Conservation Reserve Program density and field size

The number of CRP contracts and the land area they contained varied greatly among study areas and landscapes (Table 2). Study areas in Iowa and Missouri had the greatest amount of CRP within and surrounding study areas. The mean field size was 2.35 acres (± 3.36 SD) for partial field practices, 12.35 acres (± 17.51 SD) for whole-field practices, 13.12 acres (± 17.06 SD) for whole-field erosion control practices, and 12.86 acres (± 12.58 SD) for whole-field tree plantings. The types of practices within and around study areas varied substantially (Table 3). There were not many acres of whole-field tree plantings across the CIP study area (Table 3), therefore, we did not summarize effects of whole-field tree plantings.

Breeding season bird counts

We summarized counts for those grassland-associated species with a substantial number of counts (approximately >40 total). The most common species was Northern Bobwhite (total counts: n = 9,914), followed by Dickcissel (n = 3,768), Field Sparrow (3,065), Eastern Meadowlark (2,337), Rink-necked Pheasant (n = 1,950), Prairie Warbler (n = 729), Eastern Towhee (n = 520), Bobolink (n = 358), Western Meadowlark (n = 137), Henslow's Sparrow (n = 114), Scissor-tailed Flycatcher (n = 79), Grasshopper Sparrow (n = 73), Bell's Vireo (n = 72), and Brown-headed Cowbird (n = 39). For many of these species, including Dickcissel, Field Sparrow, Northern Bobwhite, Prairie Warbler, and Ring-necked Pheasant, trends in data indicate that counts were greater in focal areas compared to reference areas (Table 4). For some species like Eastern Meadowlark, trends indicate that abundance may be greater in focal areas some years, but greater in reference areas in other years (Table 4).

Breeding season Northern Bobwhite modeling

In the breeding season, there was a 78.1% probability that bobwhite abundance would be higher at any given focal area sampling point compared to a reference area sampling point (Figure 1).

The median global difference between focal and reference area bobwhite abundance per point was 1.59 (-2.51–18.82, 95% Bayesian Credible Intervals [BCI]). There was substantial variation in effect of focal areas among states, and the global effect was largely driven by data from Missouri (Figure 2).

The effect of CRP on bobwhite populations in the breeding season decreased with distance (Figure 3). All else being equal, a CRP field 0.5 km away was twice as important to a bobwhite population than a CRP field 1 km away, and approximately 31*x* more important than a field 2 km away.

In reference landscapes, partial field practices had no clear effect on bobwhite abundance (log-scale effect size = -0.02, -0.18–0.15 95% BCI, 41.6% chance of having a positive effect). Whole-field native practices had a 62.5% probability of having a negative effect on bobwhite abundance in reference landscapes (log-scale effect size = -0.01, -0.08–0.06 95% BCI). For every 5% increase in whole-field native practices in reference landscapes, there was a decrease in 0.01 males per point (-0.05–0.04 95% BCI). Whole-field erosion control practices had a 100% chance of having a positive effect on bobwhite abundance in reference landscapes (log-scale effect size = 0.16, 0.10–0.22 95% BCI). For every 5% increase in whole-field erosion control practices in reference landscapes, there was an increase in 0.18 males per point (0.10–0.25 95% BCI).

In focal landscapes, partial field practices had a 97.1% probability of having a positive effect on bobwhite populations (log-scale effect size = 0.17, -0.01–0.33 95% BCI). For every 5% increase in partial-field native practices in focal landscapes, there was an increase in 0.54 males per point (-0.02–1.15 95% BCI). Whole-field native practices in focal landscapes had a 100% probability of having a positive effect on bobwhite population abundance (log-scale effect size = 0.37, 0.29–0.45 95% BCI). For every 5% increase in whole-field native practices in focal landscapes, there was an increase in 0.34 males per point (0.26–0.44 95% BCI). In focal landscapes, whole-field erosion control practices had an 85.0% probability of having a negative effect on bobwhite abundance (log-scale effect size = -0.05, -0.16–0.05 95% BCI). For every 5% increase in whole-field erosion control practices in focal landscapes, there was a decrease in 0.05 males per point (-0.15–0.05 95% BCI).

Non-breeding season Northern Bobwhite modeling

In the non-breeding season, there was a 94.8% probability that covey abundance would be greater at a focal area sampling point compared to a reference area sampling point (Figure 4). The median global difference between focal area and reference area abundance per point was 3.12 coveys, but there was substantial uncertainty around the magnitude of this effect (-0.57–24.21 95% BCI). As in the breeding season, there was variation in focal area vs reference area effects across states (Figure 5).

The effect of CRP on bobwhite populations in the non-breeding season decreased with distance, but at a lesser rate than in spring, meaning a larger expanse of the surrounding landscape matters to bobwhite populations in the non-breeding season (Figure 6). A CRP field 0.5 km away was 1.03*x* more important than a field 1 km away, 1.17*x* more important than a field 2 km away, 1.99*x* more important than a field 4 km away, and 14.96*x* more important than a field 8 km away.

In reference landscapes, there was a 73% probability that partial-field practices had a negative effect on local covey abundance (log-scale effect size = -0.64, -2.69–1.77 95% BCI). For every 5% increase in partial-field practices in reference landscapes, there was a decrease in 1.37 coveys per point, however, this prediction had relatively high uncertainty (-2.70–14.21 95% BCI). There was a 78.9% probability that whole-field native practices had a negative effect on local covey abundance in reference landscapes (log-scale effect size = -0.27, -0.98–0.44 95% BCI). For every 5% increase in whole-field native practices in reference landscapes, there was a decrease in 0.18 coveys per point (-0.50–0.43 95% BCI). In reference landscapes, there was a 92.6% probability that whole-field erosion control practices had a positive effect on covey abundance (log-scale effect size = 0.50, -0.17–1.35 95% BCI). For every 5% increase in whole-field erosion control practices in reference landscapes, there was an increase in 0.72 coveys per point (-0.17–3.12 95% BCI).

In focal area landscapes, there was a 65.7% probability that partial-field practices had a positive effect on local covey abundance (log-scale effect size = 0.36, -1.75–2.60 95% BCI). For every 5% increase in partial-field practices in focal area landscapes, there was an increase in 1.23 coveys per point, however there was a large amount of uncertainty with this prediction (-2.39–36.06 95% BCI). There was a 97.8% probability that whole-field native practices in focal landscapes had a positive effect on local covey abundance (log-scale effect size = 0.77, 0.02–

1.54 95% BCI). For every 5% increase in whole-field native practices in focal area landscapes, there was an increase in 0.92 coveys per point (0.01–2.91 95% BCI). There was an 86.2% probability that whole-field erosion control practices had a negative effect on local covey abundance in focal landscapes (log-scale effect size = -0.42, -1.31–0.30 95% BCI). For every 5% increase in whole-field erosion control practices in focal landscapes, there was a decrease in 0.38 coveys per point (-0.80–0.39 95% BCI).

Discussion

Landscape context modifies the effectiveness of conservation practices in fragmented ecosystems (Youngentob et al. 2013, Reiley and Benson 2019). The NBCI focus area approach centers on habitat restoration and management at spatial scales large enough to foster robust bobwhite populations. Bobwhite, as well as other species, require multiple patches of different land cover types in order to meet their life history requirements (Stoddard 1931), and patches that are closer together generally are more beneficial to population growth (Yeiser et al. 2018). Conservation in fragmented systems needs to be optimized in two ways in order to have population-level benefits: optimizing where conservation is targeted (i.e., landscape context) and how conservation is enrolled across that landscape (i.e., the spatial arrangement of conservation practices). There are three main findings that emerged from this study: the focal area approach has a 78.1% chance of improving breeding season bobwhite populations and a 94.8% chance of improving non-breeding season populations, the focal area approach greatly improved the efficiency of native CRP practices, but not erosion control practices, and the spatial arrangement of conservation fields impacts breeding bobwhite populations differently than non-breeding bobwhite populations. The increased efficiency of erosion control practices in reference areas could be driven by data in a few areas with relatively great abundance due to suitable landscape context (e.g., Missouri 2C).

Much of the bobwhite range encompasses areas that are privately owned, and the motivations and values of these landowners varies tremendously. Even lands owned by state or federal agencies will likely have stakeholders with competing objectives. This fragmentation of bobwhite habitat and competition of management objectives make bobwhite population restoration a great challenge (Williams et al. 2004, Fidel et al. 2013). Any one conservation action, e.g., enrollment of a 50-acre native grassland field, may be counteracted by detrimental actions of a neighboring landowner. We must optimize the efficiency of conservation in fragmented landscapes if we are going to make substantial improvements to wildlife population growth (Merckx et al. 2009). The focused approach investigated here produced more abundant bobwhite populations in both the breeding and non-breeding season. This underscores the importance of a landscape-scale approach to bobwhite conservation. Resource management agencies should make concerted conservation efforts that involve entire public management areas or large communities of landowners. This includes not only enrolling land in conservation, but properly managing that land across the entire focal area.

Understanding the distance at which a conservation field impacts a local population can guide enrollment strategies. If the goal is to improve breeding season bobwhite populations, conservation efforts should be spaced no more than 0.5–1.0 km apart. This scale is comparable to what other similar studies on bobwhite have found (Yeiser et al. 2018). If the goal is to improve non-breeding season bobwhite abundance, conservation practices should be placed no more than 4–8 km apart. In both scenarios, every effort should be made to arrange complementary management actions as close together as possible. It is important to note that effects of conservation practices on a population decrease with increasing distance to that population. In practice this means that increasing CRP in the total landscape area (i.e., a 10-km radius circle) may not translate to the same amount of increased CRP for a bobwhite population of interest (Box 1).

Differences in the extent of landscapes that matter to bobwhite in breeding and non-breeding season may reflect different resources being selected, which requires greater movement. Bobwhite in the spring are relatively more sedentary after pair-bonding and nest production. The presence of high-quality nesting habitat, such as native CRP, in the immediate vicinity of bobwhite populations as coveys begin to break up is likely vital to nesting bobwhite. This indicates that management of CRP fields or areas adjacent to CRP fields is especially important for breeding populations. Farther distances traveled while signaling for mates likely increases predation risk. Alternatively, in the non-breeding season, bobwhite are gregarious and thus have greater potential for vigilance against predators (Williams et al. 2003). This may allow them to utilize more of the surrounding landscape as they forage for waste grains and native seeds or seek shelter from harsh conditions. Understanding the mechanisms behind variation in the size of landscapes that matter to different species is an ongoing endeavor (Jackson and Fahrig 2012), and our study indicates that more research is needed to understand what dictates variation within species as well.

Habitat management by resource management agencies within focal areas likely produced resources that were supplementary or complementary to the grassland land cover established by CRP sign-ups. Bobwhite need different resources throughout different times of the year, and the resources that limit populations can vary across their geographic range (Janke and Gates 2013, Yeiser et al. 2018). Focal area management actions, such as establishing scrub-shrub patches and conservation cover (e.g., food plots, brood fields), can create thermal and escape cover and food resources that complement the nesting resources added by CRP. Similarly, nesting resources are one of the main components limiting grassland birds in agricultural landscapes (Benton et al. 2002), CRP supplements the benefits of nesting resources added by resource management agencies in focal areas through native grassland species establishment. Furthermore, the management of vegetative composition and structure through appropriate intervals of management such as prescribed fire, herbicide application, and disking enhances the quality of resources available to bobwhite populations (Osborne et al. 2012, Yeiser et al. 2015). Holistic management that is targeted to one large geographic area increases the quantity, quality, and diversity of resources for bobwhite populations.

Targeted management of bobwhite is thought to benefit other grassland-associated species that require similar resources. Our results indicate that many species are likely benefiting from the focal area approach to bobwhite management (Table 4). To fully address the impacts of the focal area approach on different avian species, modeling approaches similar to what we present here are needed. Understanding how each species responds to different CRP practices, the spatial scale at which each species responds, how stakeholders value each species, and the financial or logistical constraints involved with enrolling CRP fields would equip us to optimize CRP enrollment across space and time.

The Coordinated Implementation Program is a national scale, coordinated management regime whose framework is constructed to complement existing private land conservation initiatives. Fragmentation of resources makes bobwhite recovery across their range difficult. When CRP is established within landscapes that have focused and extensive habitat management, efficiency increases substantially. Prioritizing enrollment should revolve around selecting landscapes that are being managed actively or have the potential to be managed in the future, and a consideration of how effects of land management decrease with increasing distance to local populations.

Conservation Reserve Program efficiencies

We made substantial findings about CRP efficiency. Native practices were much less efficient in landscapes that were not being actively managed. This could relate to the complementary nature of these practices in areas where there are other resources being managed for bobwhite, or it could relate to the increased likelihood that these native CRP fields themselves are being managed in focal areas. Understanding the influence of the amount and configuration of these native practices (e.g., the influence of native CRP next to a hardwood forest stand vs the influence of native CRP next to a row-crop field) could inform prioritization of contract enrollments, leading to increased efficiency of these practices at national-scales.

Furthermore, we uncovered that CRP is less efficient in isolation than when it is in groups. This is evidence by the clear indication of landscape-scale effects in our results. For CRP to have a population-level, synergistic effect on bobwhite in the breeding season, fields need to be much closer together (< 1-2 km) than in the non-breeding season (approximately < 6–8 km). Giving higher priority to potential contracts that would be within 1–2 km of another CRP field or area managed for bobwhite would increase the efficiency of CRP for bobwhite populations in both the breeding and non-breeding season.

There was relatively high uncertainty around some of our model estimates, likely because of differences among different geographies. Climate, predator communities, landscape context, and many other variables differ among the regions considered in this analysis. Further modeling that incorporates these data, as well as potential threshold effects, would likely account for extraneous variation found in this study. Increasing the accuracy of predictive models could help improve the efficiency of CRP enrollment.

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Table 1. Groupings of CRP practices for analysis and their overall distribution across study areas.

Conservation practice grouping (*Practices*)	Percentage of total CRP
Partial field (*5A*, *8*, *8A*, *12*, *15A*, *15B*, *21*, *22*, *29*, *30*, *33*, *38E-12*)	10.66
Whole-field (*2*, *4D*, *10*, *25*, *38E*, *38E-10*, *38E-2*, *38E-25*, *38E-4D*, *42*, *88*, *88A*)	48.67
Whole-field erosion control (*1*, *38E-1*)	32.13
Whole-field tree planting (*11*, *3*, *3A*, *36*, *38C-3*, *38D-36*)	4.80

Table 2. Summary of CRP contracts within study areas and in surrounding 10-km radius landscapes. Gray rows indicate CIP focal areas.

Area	Area scale			Landscape scale (10-km buffer)		
	# contracts	Acreage	% of area	# contracts	Acreage	% of landscape
IA Reference Area	12	821.99	14.39	428	20,393.47	15.73
IA Ringgold Focal Area	14	681.68	10.53	370	17,666.19	13.16
IA Shawtee Focal Area	11	82.23	1.41	231	3,022.64	2.23
KY Crittenden Reference Area	1	52.90	0.92	152	5,294.69	4.03
KY Livingston Focal Area	17	1,197.69	20.52	138	5,118.43	3.82
KY Wendell Ford Training Center Focal Area	0	0.00	0.00	40	816.66	0.69
MO 2C Control	2	313.50	6.01	467	16,990.45	13.32
MO 2C Focal Area	35	1,303.57	24.87	607	18,906.54	14.19
MO Bee Ridge Control	3	29.83	0.59	254	7,466.15	5.93
MO Bee Ridge Focal Area	25	593.42	10.65	284	7,578.77	5.42
NE Meridian Focal Area	30	649.37	4.47	208	3,964.92	2.11

NE Meridian Reference Area	55	1,373.99	8.81	243	4,353.32	2.42
OH Fallsville Focal Area	94	851.74	7.70	688	6,319.15	4.06
OH Fallsville Reference Area	6	10.29	0.10	208	793.95	0.49
OK Altic Reference Area	0	0.00	0.00	0	0.00	0.00
OK Jackson Reference Area	0	0.00	0.00	0	0.00	0.00
TX Austin Focal Area	1	23.57	0.09	1	23.57	0.01
TX Austin Reference Area	0	0.00	0.00	1	23.57	0.01

3

Table 3. Percentage of each class of conservation practice within and surrounding each study area. Gray rows indicate a focal area.

	Local (%)				Landscape (%)			
Area	Partial field	Whole field	Whole field erosion control	Whole field tree planting	Partial field	Whole field	Whole field erosion control	Whole field tree planting
IA Reference Area	0.00	72.57	22.13	0.00	3.18	57.45	35.47	0.01
IA Ringgold Focal Area	1.01	69.29	22.88	0.00	5.56	51.01	36.94	0.38
IA Shawtee Focal Area	37.46	61.08	1.46	0.00	26.09	34.53	11.63	0.26
KY Crittenden Reference Area	0.00	100.00	0.00	0.00	10.48	51.39	36.80	1.11
KY Livingston Focal Area	6.13	86.85	3.15	3.87	17.48	58.61	15.99	6.16
KY Wendell Ford Training Center Focal Area	0.00	0.00	0.00	0.00	24.45	56.01	17.26	0.00
MO 2C Control	0.00	12.12	87.88	0.00	8.20	50.96	40.05	0.51
MO 2C Focal Area	11.34	78.54	9.79	0.33	7.27	52.02	40.07	0.45

MO Bee Ridge Control	11.06	63.69	25.24	0.00	9.26	14.10	63.95	1.21
MO Bee Ridge Focal Area	20.49	27.94	47.26	0.00	9.83	22.13	56.98	0.47
NE Meridian Focal Area	16.47	83.53	0.00	0.00	11.93	86.59	0.27	0.26
NE Meridian Reference Area	5.56	94.14	0.00	0.00	9.85	89.03	0.56	0.00
OH Fallsville Focal Area	36.32	50.22	13.45	0.00	35.74	58.92	2.63	2.25
OH Fallsville Reference Area	100.00	0.00	0.00	0.00	76.05	21.80	1.40	0.00
OK Altic Reference Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OK Jackson Reference Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TX Austin Focal Area	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
TX Austin Reference Area	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00

Table 4. Counts per visit for grassland-associated species of greatest conservation need with approximately > 40 counts total. Gray rows indicate data from focal areas.

Species	Counts per sampling visit					
	2013	2014	2015	2016	2017	2018
Bell's Vireo	0.00	0.01	0.01	0.01	0.02	0.01
	0.00	0.02	0.01	0.01	0.00	0.03
Brown-headed Cowbird	0.00	0.01	0.04	0.00	0.00	0.00
	0.00	0.01	0.01	0.01	0.00	0.00
Bobolink	0.15	0.07	0.07	0.05	0.04	0.06
	0.12	0.03	0.06	0.07	0.03	0.04
Dickcissel	0.73	0.47	0.61	0.42	0.44	0.50
	1.14	0.77	0.71	0.61	0.63	0.60
Eastern Meadowlark	0.65	0.23	0.37	0.41	0.39	0.39
	0.79	0.35	0.41	0.30	0.32	0.28
Eastern Towhee	0.06	0.09	0.04	0.05	0.02	0.08
	0.09	0.19	0.11	0.11	0.08	0.09
Field Sparrow	0.25	0.27	0.36	0.32	0.31	0.36
	0.63	0.70	0.58	0.61	0.61	0.71
Grasshopper Sparrow	0.04	0.00	0.00	0.02	0.01	0.01
	0.08	0.00	0.00	0.01	0.00	0.01
Henslow's Sparrow	0.01	0.03	0.01	0.01	0.01	0.01
	0.04	0.02	0.04	0.01	0.02	0.03
Northern Bobwhite	1.39	1.11	1.48	1.20	1.15	1.13

	1.92	1.81	2.46	1.75	1.77	1.91
Prairie Warbler	0.09	0.06	0.06	0.06	0.04	0.04
	0.24	0.30	0.13	0.12	0.11	0.19
Ring-necked Pheasant	0.17	0.13	0.23	0.36	0.38	0.26
	0.21	0.25	0.38	0.44	0.42	0.32
Scissor-tailed Flycatcher	0.08	0.02	0.01	0.00	0.00	0.00
	0.07	0.02	0.01	0.01	0.01	0.01
Western Meadowlark	0.00	0.01	0.01	0.00	0.02	0.01
	0.00	0.01	0.05	0.02	0.05	0.05

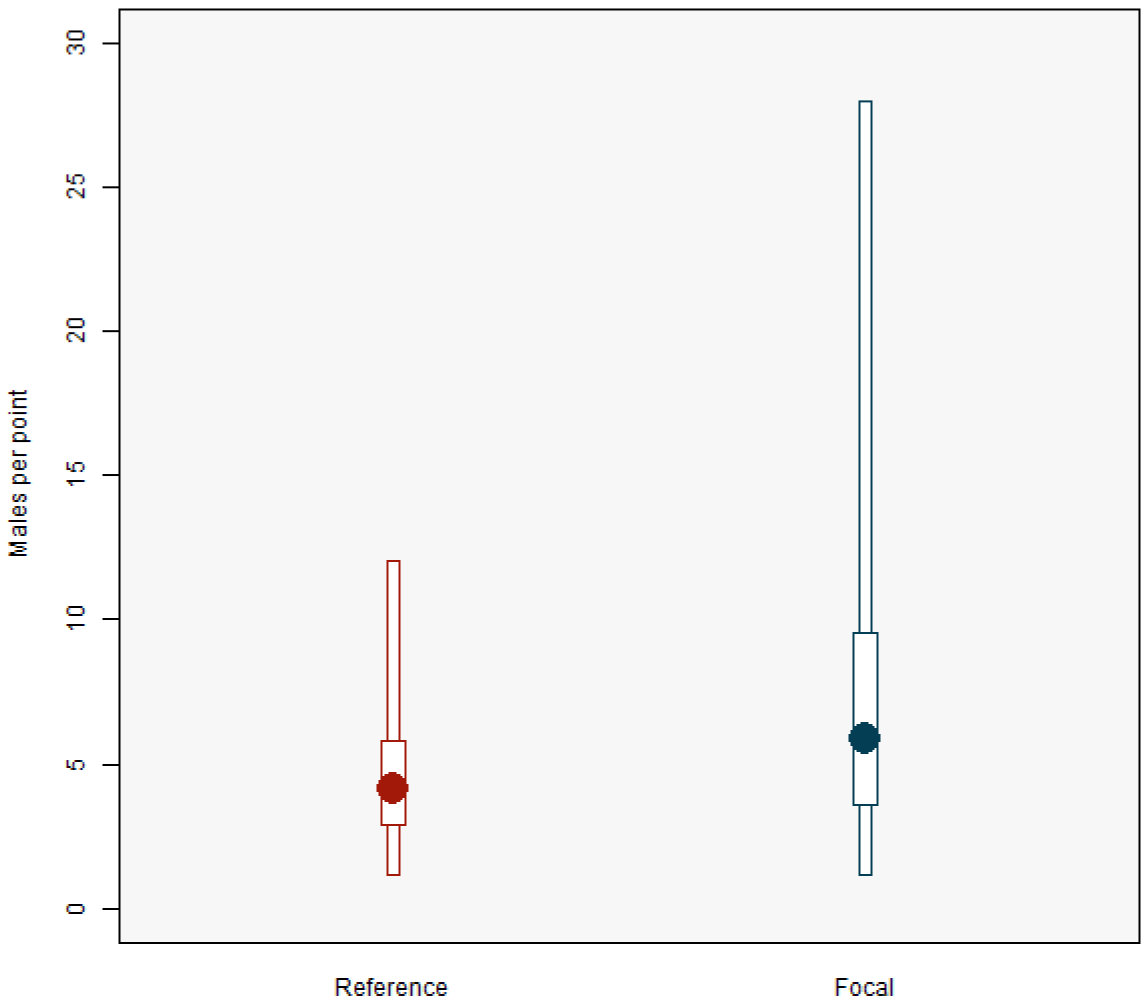


Figure 1. The predicted global effect of Focal Area vs Reference Area in the breeding season. Thinner rectangles represent the 95% Bayesian Credible Interval, wider rectangles represent the 50% Bayesian Credible Interval, and the points represent the median prediction.

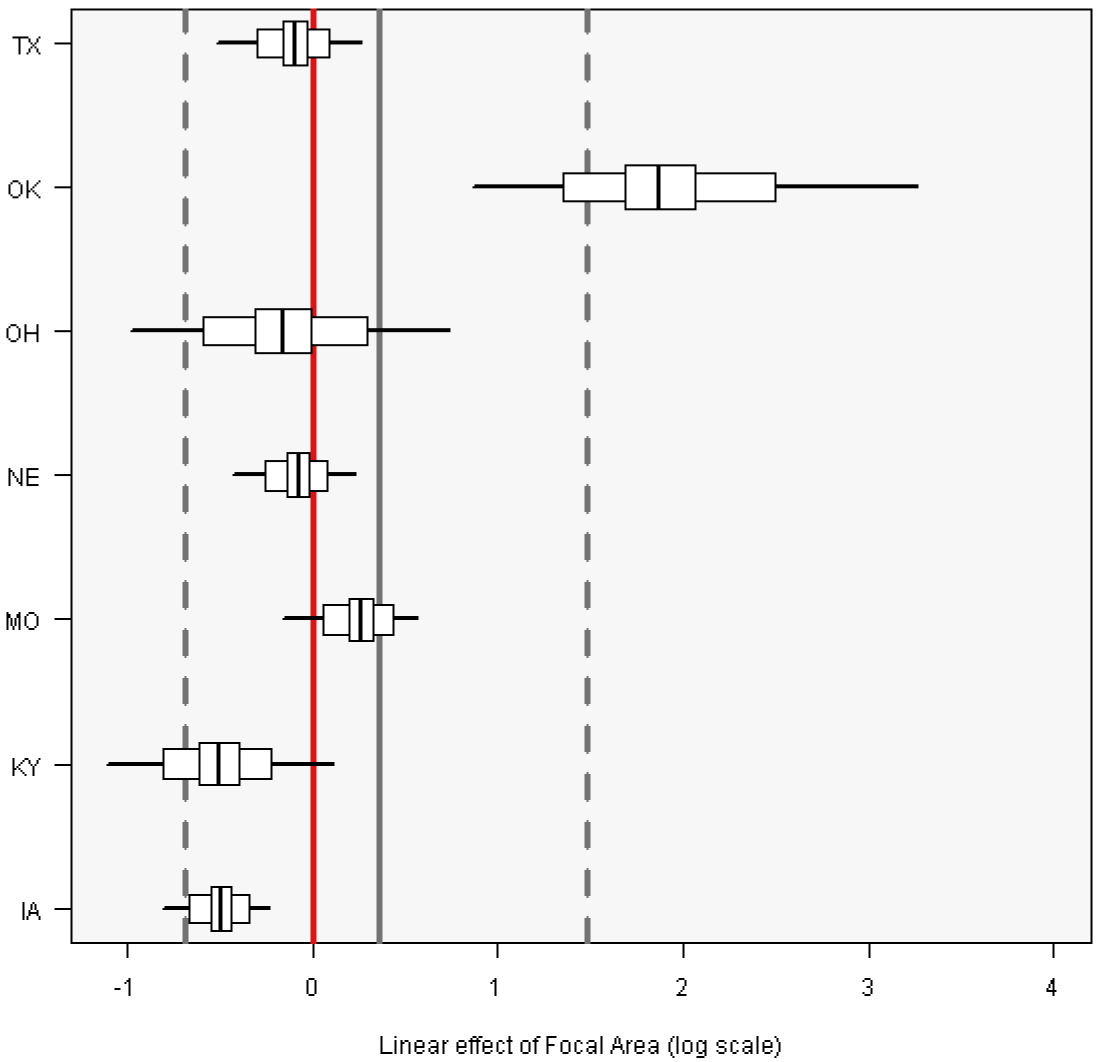


Figure 2. State-level effects (on log scale) of Focal vs Reference Areas during the breeding season. The vertical red line represents no effect, thus estimates to the right of it indicate a positive effect and estimates to the left a negative effect. The vertical solid gray line represents the global effect of Focal vs Reference area, and the vertical dashed gray lines represent the 95% Bayesian Credible Interval of that global effect. For each state on the y-axis, horizontal lines represent the full range of predicted effects, the thin rectangles represent 95% Bayesian Credible

Intervals, the thicker rectangles represent 50% Bayesian Credible Intervals, and the center line represents the median estimate.

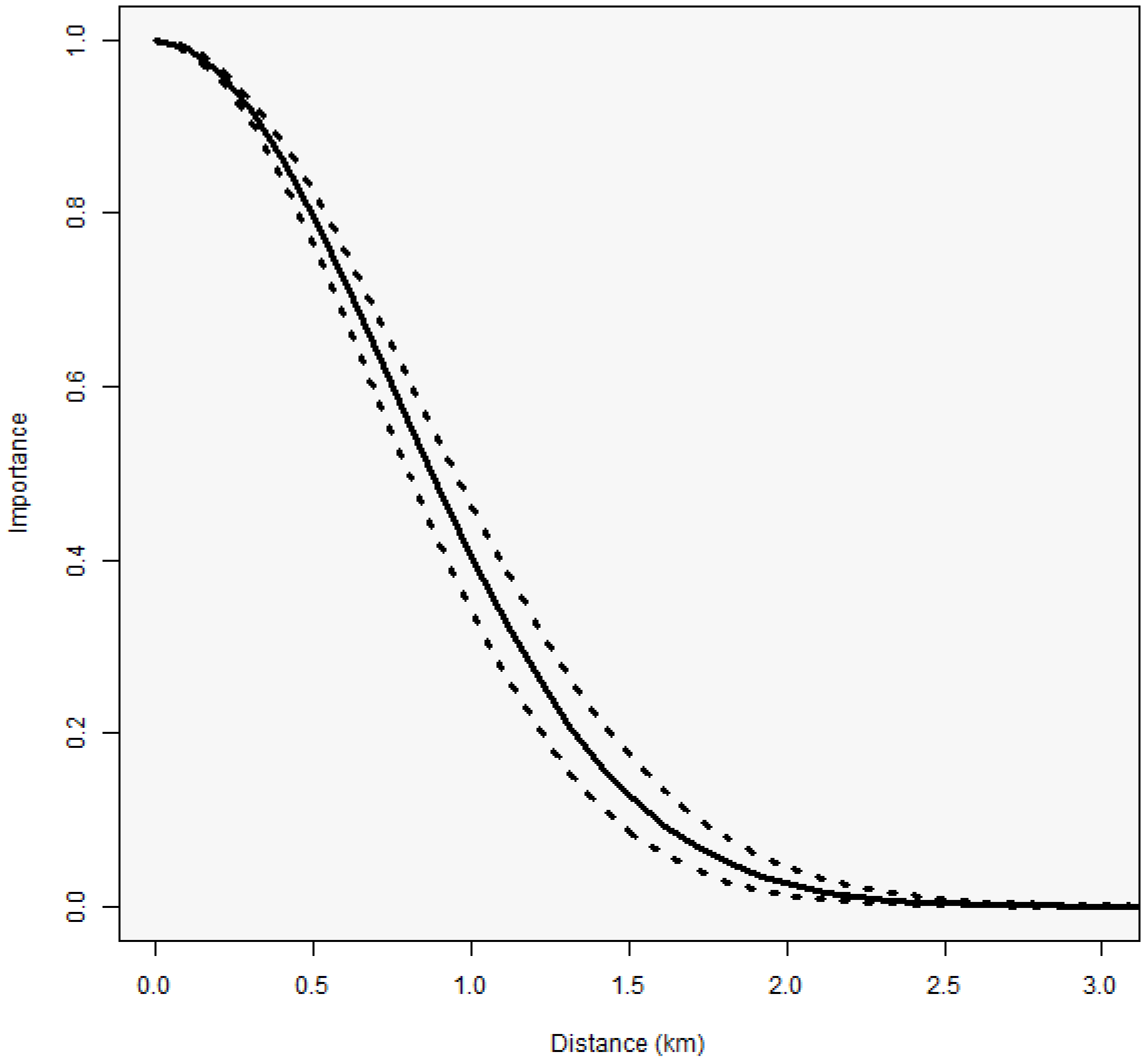


Figure 3. The relationship between relative importance of Conservation Reserve Program fields to local bobwhite population abundance and distance in the breeding season. The solid line represents the median estimate and dashed lines represent lower and upper bounds of 95% Bayesian Credible Intervals.

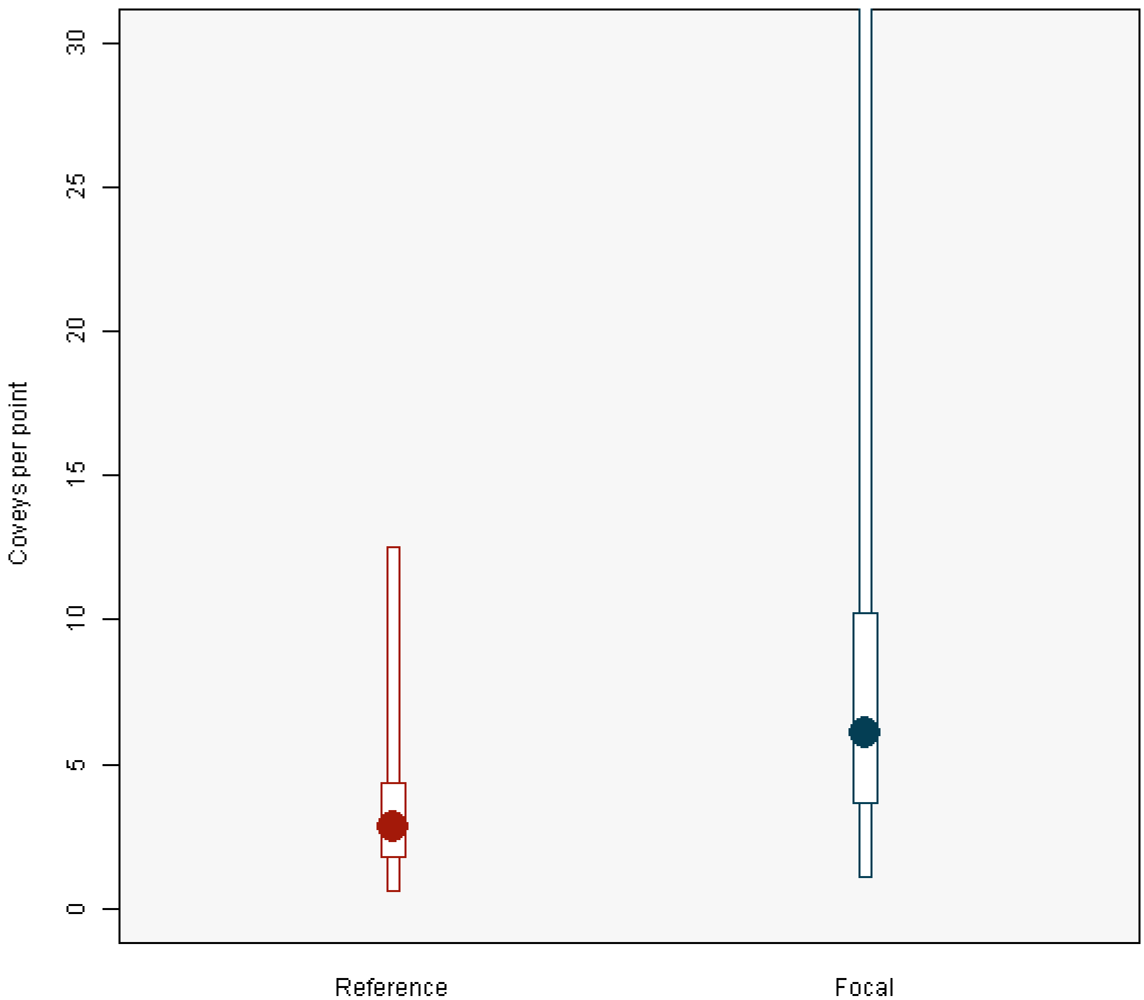


Figure 4. The predicted global effect of Focal Area vs Reference Area in the non-breeding season. Thinner rectangles represent the 95% Bayesian Credible Interval, wider rectangles represent the 50% Bayesian Credible Interval, and the points represent the median prediction.

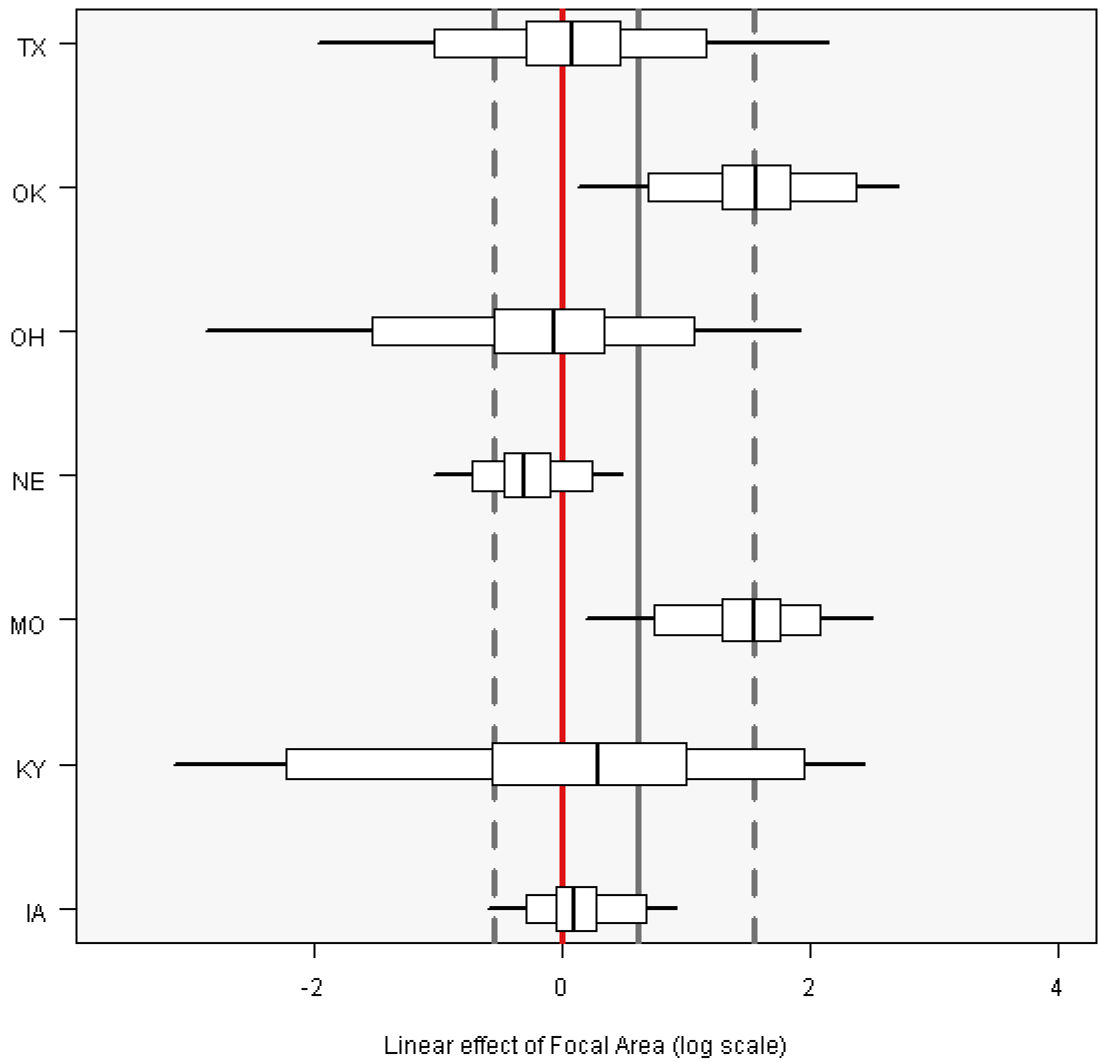


Figure 5. State-level effects (on log scale) of Focal vs Reference Areas during the non-breeding season. The vertical red line represents no effect, thus estimates to the right of it indicate a positive effect and estimates to the left a negative effect. The vertical solid gray line represents the global effect of Focal vs Reference area, and the vertical dashed gray lines represent the 95% Bayesian Credible Interval of that global effect. For each state on the y-axis, horizontal lines represent the full range of predicted effects, the thin rectangles represent 95% Bayesian Credible

Intervals, the thicker rectangles represent 50% Bayesian Credible Intervals, and the center line represents the median estimate.

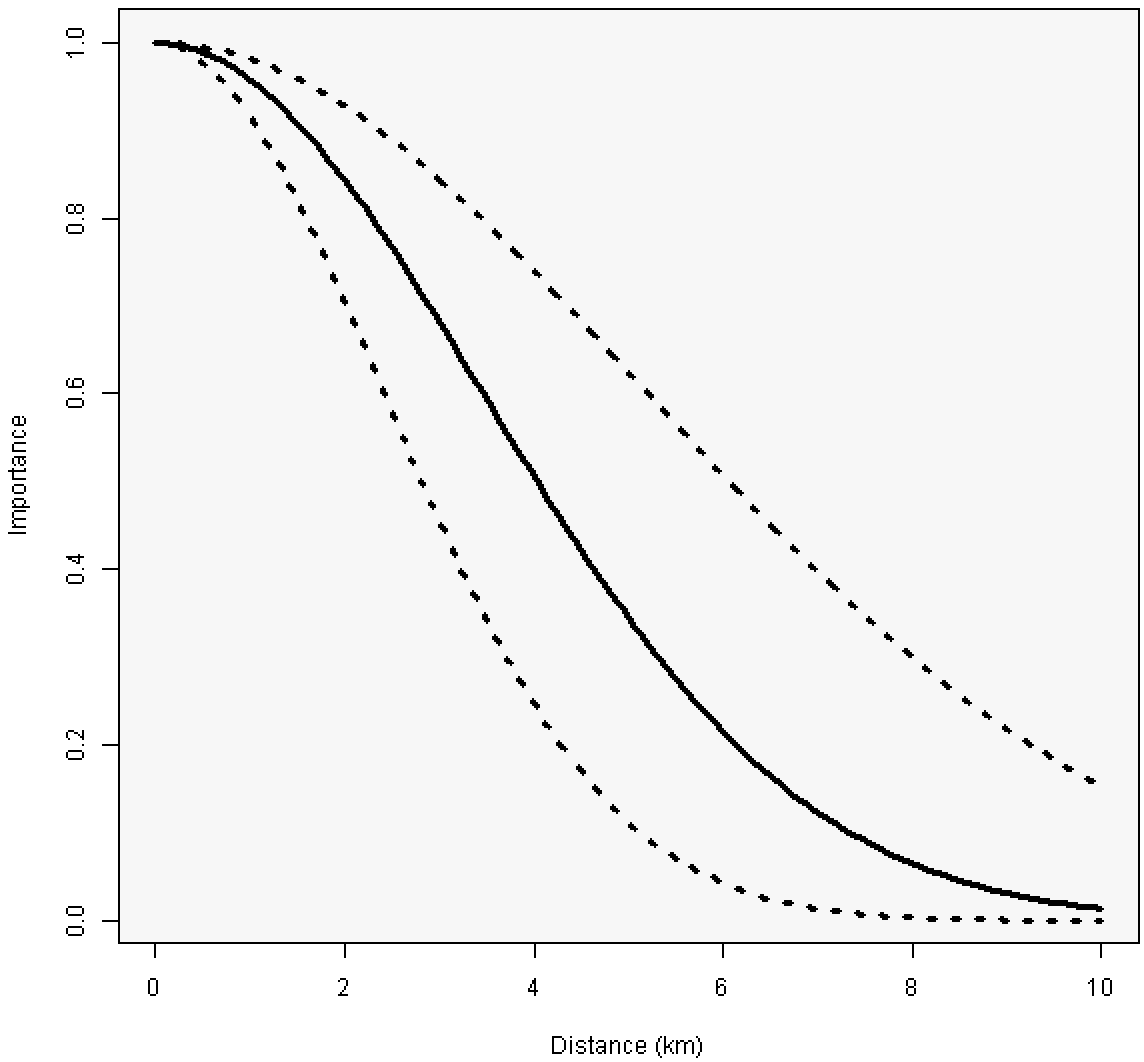
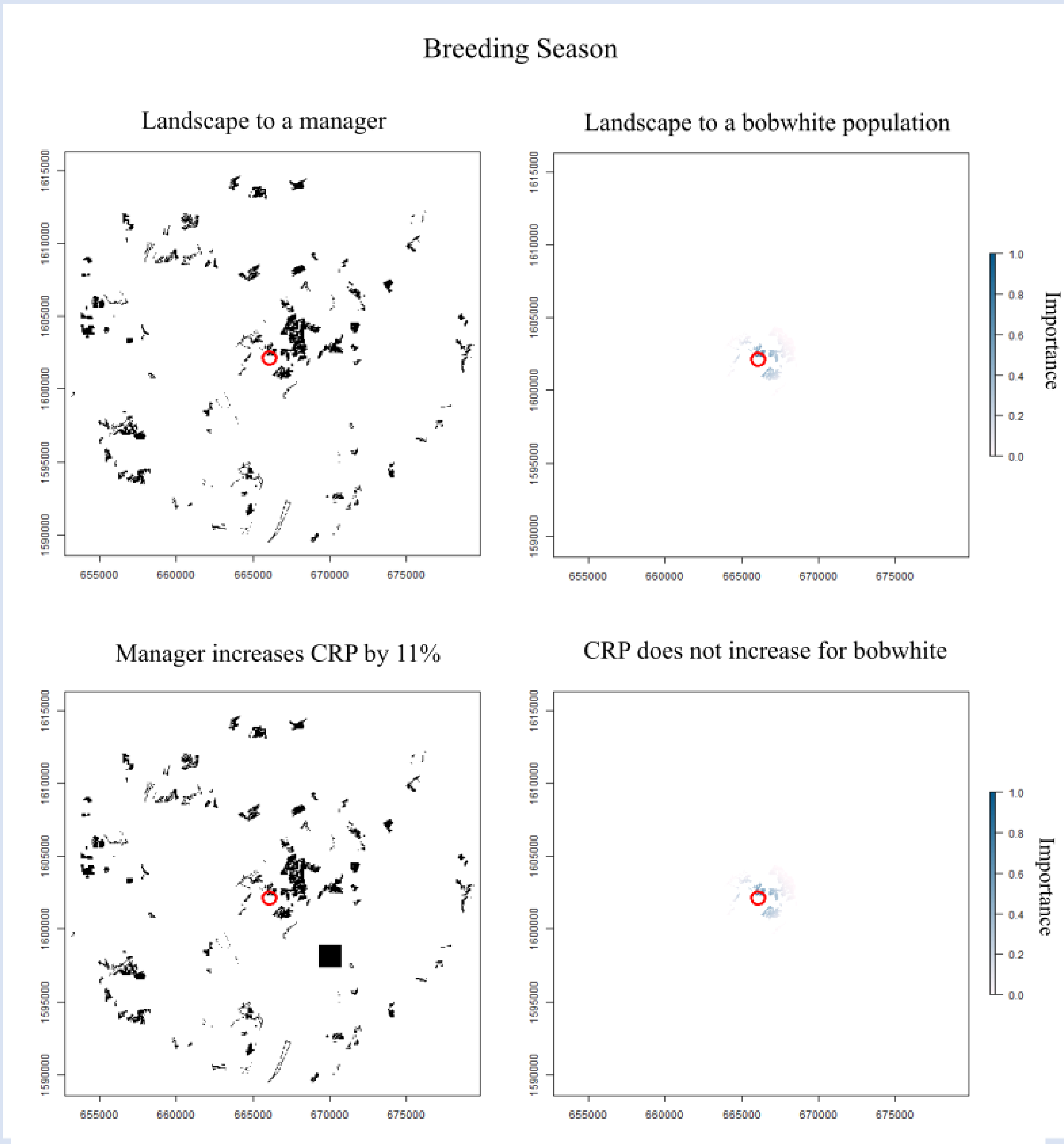
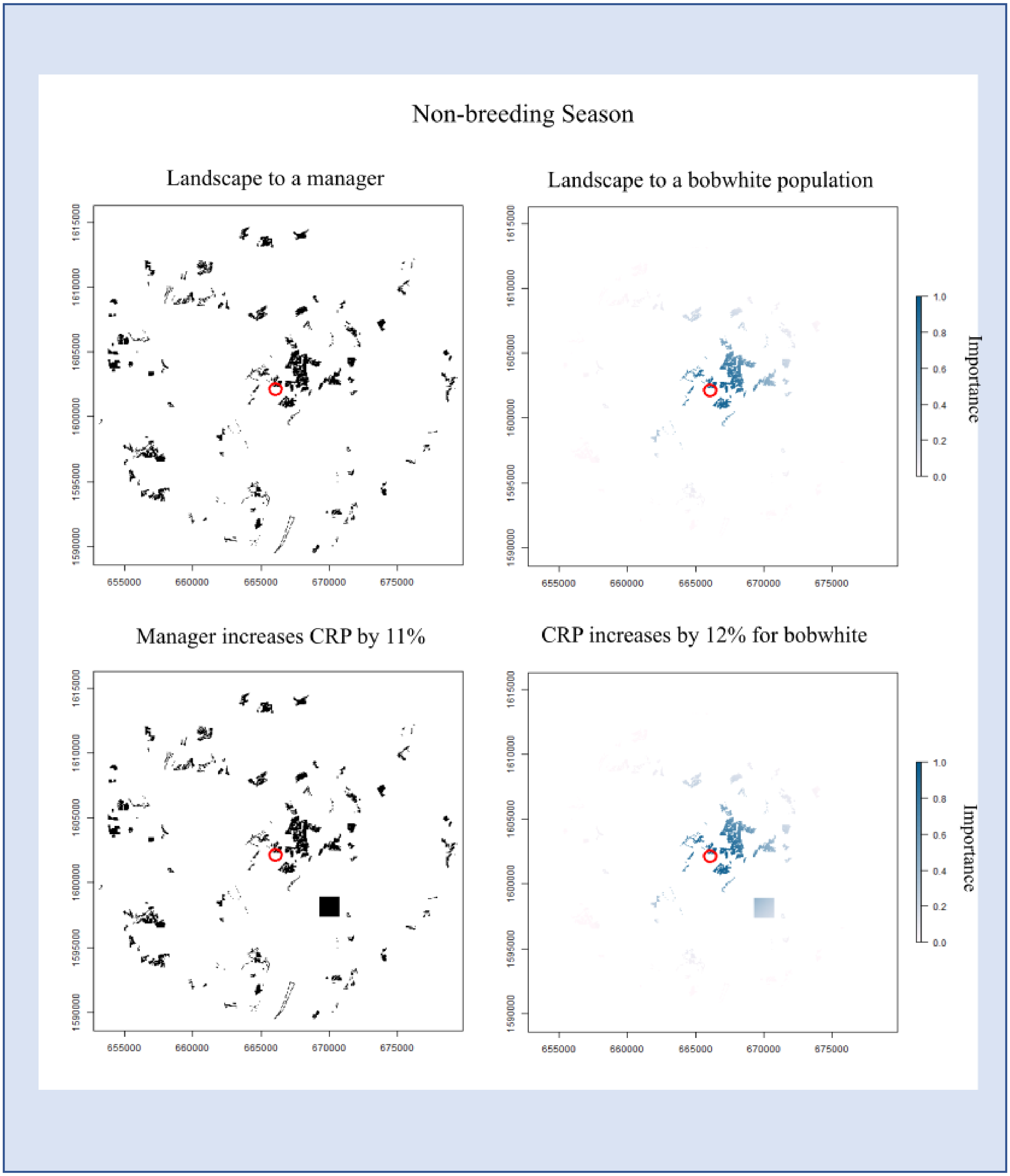


Figure 6. The relationship between relative importance of Conservation Reserve Program fields to local bobwhite population abundance and distance in the non-breeding season. The solid line represents the median estimate and dashed lines represent lower and upper bounds of 95% Bayesian Credible Intervals.

Box 1. Adding CRP to the landscape will have different effects on bobwhite populations depending on the time of year and where the CRP fields are being enrolled. In the hypothetical CRP landscapes depicted below, a manager has convinced a large landowner to enroll in CRP, increasing CRP density by 11%, but how does this influence a bobwhite population (represented by a red circle) across their life cycle? Based on our results, this particular 11% increase would have no effect on the breeding bobwhite population (top) because the newly enrolled fields are outside of the bobwhite landscape, i.e., they are too far away to have any effect on abundance. Conversely, this landscape change is likely to influence non-breeding season abundance greatly (bottom). In this case, when viewed through the lens of what matters to bobwhite, CRP has increased by 12%.




Non-breeding Season
Landscape to a manager
Landscape to a bobwhite population
Manager increases CRP by 11%
CRP increases by 12% for bobwhite
Importance
Importance
1.0
0.8
0.6
0.4
0.2
0.0
655000
660000
665000
670000
675000
1590000
1595000
1600000
1605000
1610000
1615000

Appendix

Table A1. Summary of total CRP acres on Iowa's Reference Area and in the surrounding 10-km radius, categorized by practice. The reference area is 5,713 acres primarily composed of upland and agricultural habitat. 100% of the area is private land. The 10-km landscape boundary overlaps with Iowa's Ringgold Focal Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	431.75	7523.57
CP-2 (Native Grass, Forb, and Legume Establishment)	41.55	1050.06
CP-3A (Hardwood Tree Planting)	0.00	2.00
CP-4D (Permanent Wildlife Habitat)	588.92	1815.58
CP-5A (Field Windbreak Establishment)	0.00	3.35
CP-8A (Grass Waterway)	0.00	1.72
CP-9 (Shallow Water Areas for Wildlife)	0.00	14.76
CP-10 (Grass Already Established)	75.15	317.59
CP-12 (Wildlife Food Plot)	0.00	73.06
CP-17A (Living Snow Fence)	0.00	6.82
CP-21 (Grass Filter Strips)	0.00	402.84
CP-22 (Riparian Buffers)	0.00	153.88
CP-23 (Floodplain Wetland Restoration)	87.10	817.04
CP-25 (Rare and Declining Habitat)	0.00	543.27
CP-29 (Wildlife Habitat Buffer (Marginal Pasture))	0.00	9.26
CP-33 (Upland Bird Habitat Buffer)	0.00	9.61
CP-38E (State Acres for Wildlife Enhancement - Grass)	0.00	39.41
CP-38E-2 (SAFE Grass - Native Grass, Forb, and Legume Establishment)	141.36	2643.20
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	230.85	2293.44
CP-38E-25 (SAFE Grass - Rare and Declining Habitat)	0.00	41.64
CP-42 (Pollinator Habitat Establishment)	56.14	3668.15
Total Acres Managed	1652.82	21430.25

Table A2. Summary of total CRP acres on Iowa's Ringgold Focal Area and in the surrounding 10-km radius, categorized by practice. Ringgold Focal Area is 6,475 acres primarily composed of upland and agricultural habitat. 60% of the area is public land and 40% is private land. The 10-km landscape boundary overlaps with Iowa's Reference Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	259.49	6706.55
CP-2 (Native Grass, Forb, and Legume Establishment)	0.00	1799.30
CP-3A (Hardwood Tree Planting)	0.00	66.61
CP-4D (Permanent Wildlife Habitat)	147.38	417.32
CP-9 (Shallow Water Areas for Wildlife)	0.00	11.69
CP-10 (Grass Already Established)	42.40	166.80
CP-12 (Wildlife Food Plot)	0.00	102.48
CP-15A (Establishment of Permanent Vegetation Cover - Grass Contour Strip, Non-easement)	0.00	14.18
CP-17A (Living Snow Fence)	0.00	3.59
CP-21 (Grass Filter Strips)	0.00	399.21
CP-22 (Riparian Buffers)	0.00	285.83
CP-23 (Floodplain Wetland Restoration)	84.44	1080.95
CP-23A (Non-Floodplain Wetland Restoration)	0.00	11.81
CP-25 (Rare and Declining Habitat)	0.00	375.95
CP-31 (Bottomland Hardwood Tree Establishment)	0.00	9.86
CP-33 (Upland Bird Habitat Buffer)	0.00	146.51
CP-38E (State Acres for Wildlife Enhancement - Grass)	0.00	25.28
CP-38E-1 (SAFE Grass - Introduced Grass and Legume Establishment)	0.00	87.76
CP-38E-2 (SAFE Grass - Native Grass, Forb, and Legume Establishment)	136.28	2479.30
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	0.00	1505.69
CP-38E-12 (SAFE Grass - Wildlife Food Plot)	0.00	35.45
CP-38E-25 (SAFE Grass - Rare and Declining Habitat)	0.00	299.90
CP-42 (Pollinator Habitat Establishment)	241.18	2194.35
Total Acres Managed	911.17	18226.37

Table A3. Summary of total CRP acres on Iowa's Shawtee Focal Area and in the surrounding 10-km radius, categorized by practice. Shawtee Focal Area is 5,811 acres primarily composed of agriculture. 20% of the area is public land and 80% is private land.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	1.20	355.12
CP-2 (Native Grass, Forb, and Legume Establishment)	1.20	213.19
CP-3A (Hardwood Tree Planting)	0.00	4.90
CP-4D (Permanent Wildlife Habitat)	0.00	1.05
CP-5A (Field Windbreak Establishment)	0.00	2.59
CP-8A (Grass Waterway)	0.00	65.98
CP-9 (Shallow Water Areas for Wildlife)	0.00	101.97
CP-11 (Trees Already Established)	0.00	3.00
CP-12 (Wildlife Food Plot)	0.00	2.97
CP-15A (Establishment of Permanent Vegetation Cover - Grass Contour Strip Noneasement)	0.00	16.88
CP-16A (Shelterbelt Establishment)	0.00	0.91
CP-21 (Grass Filter Strips)	10.20	567.49
CP-22 (Riparian Buffers)	0.00	39.23
CP-23 (Floodplain Wetland Restoration)	0.00	575.70
CP-25 (Rare and Declining Habitat)	1.23	323.77
CP-27 (Farmable Wetland - Wetland)	0.00	28.86
CP-28 (Farmable Wetland - Buffer)	0.00	70.48
CP-33 (Upland Bird Habitat Buffer)	5.60	93.31
CP-38B (State Acres for Wildlife Enhancement - Wetlands)	0.00	10.00
CP-38B-23 (SAFE Wetlands - Floodplain Wetland Restoration)	0.00	42.64
CP-38E-2 (SAFE Grass - Native Grass, Forb, and Legume Establishment)	47.80	350.30
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	0.00	20.01
CP-42 (Pollinator Habitat Establishment)	0.00	135.10
Total Acres Managed	67.23	3025.45

Table A4. Summary of total CRP acres on Kentucky's Crittenden Reference Area and in the surrounding 10-km radius, categorized by practice. Crittenden Reference Area is 5,767 acres primarily composed of deciduous forest and pasture. 100% of the area is private land.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	0.00	1965.39
CP-2 (Native Grass, Forb, and Legume Establishment)	52.93	1063.93
CP-3 (Tree Planting)	0.00	25.82
CP-3A (Hardwood Tree Planting)	0.00	32.92
CP-8A (Grass Waterway)	0.00	7.87
CP-9 (Shallow Water Areas for Wildlife)	0.00	11.60
CP-10 (Grass Already Established)	0.00	181.12
CP-12 (Wildlife Food Plot)	0.00	5.51
CP-21 (Grass Filter Strips)	0.00	303.88
CP-22 (Riparian Buffers)	0.00	171.76
CP-25 (Rare and Declining Habitat)	0.00	873.47
CP-29 (Wildlife Habitat Buffer (Marginal Pasture))	0.00	13.60
CP-33 (Upland Bird Habitat Buffer)	0.00	54.34
CP-38E (State Acres for Wildlife Enhancement - Grass)	0.00	96.00
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	0.00	492.15
CP-38E-12 (SAFE Grass - Wildlife Food Plot)	0.00	1.32
CP-38E-25 (SAFE Grass - Rare and Declining Habitat)	0.00	19.28
CP-42 (Pollinator Habitat Establishment)	0.00	24.73
Total Acres Managed	52.93	5344.69

Table A5. Summary of total CRP acres on Kentucky's Livingston Focal Area and in the surrounding 10-km radius, categorized by practice. Livingston Focal Area is 5,837 acres primarily composed of deciduous forest, agriculture, and pasture. 100% of the area is private land.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	0.00	836.58
CP-2 (Native Grass, Forb, and Legume Establishment)	0.00	138.85
CP-3 (Tree Planting)	0.00	102.67
CP-3A (Hardwood Tree Planting)	0.00	151.14
CP-4D (Permanent Wildlife Habitat)	0.00	7.07
CP-9 (Shallow Water Areas for Wildlife)	0.00	34.65
CP-10 (Grass Already Established)	0.00	271.30
CP-11 (Trees Already Established)	0.00	36.21
CP-12 (Wildlife Food Plot)	1.24	40.85
CP-21 (Grass Filter Strips)	0.00	557.91
CP-22 (Riparian Buffers)	0.00	249.67
CP-25 (Rare and Declining Habitat)	653.79	1613.76
CP-29 (Wildlife Habitat Buffer (Marginal Pasture))	0.00	20.80
CP-31 (Bottomland Hardwood Tree Establishment)	0.00	55.50
CP-33 (Upland Bird Habitat Buffer)	0.00	10.92
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	142.29	392.28
CP-38E-25 (SAFE Grass - Rare and Declining Habitat)	46.16	203.23
CP-42 (Pollinator Habitat Establishment)	0.00	10.56
Total Acres Managed	843.48	4733.95

Table A6. Summary of total CRP acres on Kentucky's Wendell Ford Training Center Focal Area and in the surrounding 10-km radius, categorized by practice. Wendell Ford Training Center Focal Area is 3,088 acres primarily composed of deciduous forest and grassland/herbaceous habitat. 100% of the area is private land.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	0.00	149.59
CP-8A (Grass Waterway)	0.00	4.68
CP-9 (Shallow Water Areas for Wildlife)	0.00	18.61
CP-12 (Wildlife Food Plot)	0.00	0.53
CP-21 (Grass Filter Strips)	0.00	151.66
CP-22 (Riparian Buffers)	0.00	31.03
CP-25 (Rare and Declining Habitat)	0.00	322.48
CP-33 (Upland Bird Habitat Buffer)	0.00	11.91
CP-38E-25 (SAFE Grass - Rare and Declining Habitat)	0.00	90.39
CP-42 (Pollinator Habitat Establishment)	0.00	44.91
Total Acres Managed	0.00	825.79

Table A7. Summary of total CRP acres on Missouri's 2C Reference Area and in the surrounding 10-km radius, categorized by practice. 2C Reference Area is 5,219 acres primarily composed of agriculture. 100% of the area is private land. The 10-km landscape boundary overlaps with Missouri's 2C Focal Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	607.60	7225.39
CP-2 (Native Grass, Forb, and Legume Establishment)	152.00	1221.43
CP-3A (Hardwood Tree Planting)	0.00	85.85
CP-8A (Grass Waterway)	0.00	41.72
CP-9 (Shallow Water Areas for Wildlife)	0.00	5.70
CP-10 (Grass Already Established)	0.00	834.96
CP-12 (Wildlife Food Plot)	0.00	36.99
CP-15A (Establishment of Permanent Vegetation Cover - Grass Contour Strip Noneasement)	0.00	13.41
CP-21 (Grass Filter Strips)	0.00	500.92
CP-22 (Riparian Buffers)	0.00	119.81
CP-23 (Floodplain Wetland Restoration)	0.00	33.52
CP-25 (Rare and Declining Habitat)	0.00	821.03
CP-29 (Wildlife Habitat Buffer (Marginal Pasture))	0.00	15.95
CP-30 (Wetland Buffer (Marginal Pasture))	0.00	23.34
CP-31 (Bottomland Hardwood Tree Establishment)	0.00	8.51
CP-33 (Upland Bird Habitat Buffer)	0.00	390.96
CP-38E (State Acres for Wildlife Enhancement - Grass)	0.00	177.80
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	0.00	1352.47
CP-38E-10 (SAFE Grass - Grass Already Established)	0.00	827.35
CP-38E-12 (SAFE Grass - Wildlife Food Plot)	0.00	144.20
CP-38E-25 (SAFE Grass - Rare and Declining Habitat)	0.00	60.19
CP-42 (Pollinator Habitat Establishment)	0.00	2931.40
Total Acres Managed	759.60	16872.90

Table A8. Summary of total CRP acres on Missouri's 2C Focal Area and in the surrounding 10-km radius, categorized by practice. 2C Focal Area is 5,242 acres primarily composed of pasture and upland habitat. 100% of the area is private land. The 10-km landscape boundary overlaps with Missouri's 2C Reference Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	21.81	7432.59
CP-2 (Native Grass, Forb, and Legume Establishment)	29.80	1607.25
CP-3A (Hardwood Tree Planting)	0.00	91.72
CP-8A (Grass Waterway)	0.00	14.64
CP-9 (Shallow Water Areas for Wildlife)	0.00	24.93
CP-10 (Grass Already Established)	0.00	633.29
CP-12 (Wildlife Food Plot)	0.00	25.86
CP-15A (Establishment of Permanent Vegetation Cover - Grass Contour Strip Noneasement)	0.00	23.01
CP-15B (Establishment of Permanent Vegtation Cover - Grass Contour Strip)	0.00	6.61
CP-21 (Grass Filter Strips)	0.00	352.51
CP-22 (Riparian Buffers)	0.00	185.77
CP-23 (Floodplain Wetland Restoration)	0.00	11.31
CP-25 (Rare and Declining Habitat)	0.00	5.01
CP-29 (Wildlife Habitat Buffer (Marginal Pasture))	0.00	29.65
CP-30 (Wetland Buffer (Marginal Pasture))	0.00	34.63
CP-33 (Upland Bird Habitat Buffer)	47.10	556.67
CP-38E (State Acres for Wildlife Enhancement - Grass)	0.00	219.69
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	0.00	1521.30
CP-38E-10 (SAFE Grass - Grass Already Established)	0.00	1691.26
CP-38E-12 (SAFE Grass - Wildlife Food Plot)	0.00	91.77
CP-42 (Pollinator Habitat Establishment)	0.00	3277.09
Total Acres Managed	98.71	17836.56

Table A9. Summary of total CRP acres on Missouri's Bee Ridge Reference Area and in the surrounding 10-km radius, categorized by CRP practice. Bee Ridge Reference Area is 5,031 acres primarily composed of agriculture. 100% of the area is private land. The 10-km landscape boundary overlaps with Missouri's Bee Ridge Focal Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	7.53	4813.47
CP-2 (Native Grass, Forb, and Legume Establishment)	19.02	595.49
CP-3A (Hardwood Tree Planting)	0.00	90.56
CP-4D (Permanent Wildlife Habitat)	0.00	51.74
CP-8A (Grass Waterway)	0.00	23.08
CP-9 (Shallow Water Areas for Wildlife)	0.00	109.88
CP-10 (Grass Already Established)	0.00	315.62
CP-12 (Wildlife Food Plot)	0.20	40.62
CP-21 (Grass Filter Strips)	3.10	260.37
CP-22 (Riparian Buffers)	0.00	181.75
CP-23 (Floodplain Wetland Restoration)	0.00	750.13
CP-30 (Wetland Buffer (Marginal Pasture))	0.00	30.02
CP-33 (Upland Bird Habitat Buffer)	0.00	130.54
CP-38E (State Acres for Wildlife Enhancement - Grass)	0.00	90.96
CP-42 (Pollinator Habitat Establishment)	0.00	2.20
Total Acres Managed	29.85	7486.43

Table A10. Summary of total CRP acres on Missouri's Bee Ridge Focal Area and in the surrounding 10-km radius, categorized by practice. Bee Ridge Focal Area is 5,574 acres primarily composed of agriculture. 100% of the area is private land. The 10-km landscape boundary overlaps with Missouri's Bee Ridge Reference Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	177.52	4477.52
CP-2 (Native Grass, Forb, and Legume Establishment)	677.70	1627.13
CP-3A (Hardwood Tree Planting)	0.00	38.93
CP-4D (Permanent Wildlife Habitat)	0.00	119.48
CP-8A (Grass Waterway)	0.00	25.16
CP-9 (Shallow Water Areas for Wildlife)	0.00	67.85
CP-10 (Grass Already Established)	88.40	534.01
CP-12 (Wildlife Food Plot)	0.00	53.81
CP-21 (Grass Filter Strips)	0.00	227.07
CP-22 (Riparian Buffers)	61.50	99.52
CP-23 (Floodplain Wetland Restoration)	0.00	751.15
CP-25 (Rare and Declining Habitat)	14.60	27.71
CP-30 (Wetland Buffer (Marginal Pasture))	0.00	54.64
CP-33 (Upland Bird Habitat Buffer)	45.80	343.63
CP-38E (State Acres for Wildlife Enhancement - Grass)	109.60	219.38
CP-38E-10 (SAFE Grass - Grass Already Established)	1642.56	1642.56
CP-42 (Pollinator Habitat Establishment)	520.40	532.89
Total Acres Managed	3338.08	10842.44

Table A11. Summary of total CRP acres on Nebraska's Meridian Focal Area and in the surrounding 10-km radius, categorized by practice. Meridian Focal Area is 14,518 acres primarily composed of agriculture and grassland/herbaceous habitat. 10% of the area is public land and 90% is private land. The 10-km landscape boundary overlaps with Nebraska's Meridian Reference Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	0.00	10.82
CP-2 (Native Grass, Forb, and Legume Establishment)	791.60	2036.61
CP-3 (Tree Planting)	0.00	9.29
CP-3A (Hardwood Tree Planting)	0.00	0.96
CP-4D (Permanent Wildlife Habitat)	0.00	22.43
CP-5A (Field Windbreak Establishment)	0.00	6.64
CP-8A (Grass Waterway)	1.00	19.62
CP-10 (Grass Already Established)	39.55	91.51
CP-12 (Wildlife Food Plot)	1.95	8.89
CP-21 (Grass Filter Strips)	47.71	185.44
CP-22 (Riparian Buffers)	6.84	25.29
CP-25 (Rare and Declining Habitat)	67.51	607.81
CP-27 (Farmable Wetland - Wetland)	0.00	9.99
CP-28 (Farmable Wetland - Buffer)	0.00	27.48
CP-29 (Wildlife Habitat Buffer (Marginal Pasture))	46.16	88.26
CP-33 (Upland Bird Habitat Buffer)	34.92	167.41
CP-38E-12 (SAFE Grass - Wildlife Food Plot)	0.00	4.30
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	236.19	629.22
CP-42 (Pollinator Habitat Establishment)	84.65	347.33
CP-88A (Permanent Native Grasses, Forbs, or Legumes)	0.00	43.52
Total Acres Managed	1358.08	4342.82

Table A12. Summary of total CRP acres on Nebraska's Meridian Reference Area and in the surrounding 10-km radius, categorized by practice. Meridian Reference Area is 15,588 acres primarily composed of agriculture and grassland/herbaceous habitat. 100% of the area is private land. The 10-km landscape boundary overlaps with Nebraska's Meridian Focal Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	0.00	24.47
CP-2 (Native Grass, Forb, and Legume Establishment)	2112.33	3962.41
CP-4D (Permanent Wildlife Habitat)	403.35	479.57
CP-5A (Field Windbreak Establishment)	0.00	18.45
CP-8A (Grass Waterway)	14.54	42.88
CP-9 (Shallow Water Areas for Wildlife)	0.00	4.35
CP-10 (Grass Already Established)	0.00	5.50
CP-12 (Wildlife Food Plot)	0.00	0.78
CP-15A (Establishment of Permanent Vegetation Cover - Grass Contour Strip Noneasement)	0.30	0.30
CP-16A (Shelterbelt Establishment)	12.36	14.22
CP-17A (Living Snow Fence)	0.00	1.91
CP-21 (Grass Filter Strips)	20.70	177.68
CP-22 (Riparian Buffers)	0.00	72.41
CP-25 (Rare and Declining Habitat)	0.00	453.75
CP-27 (Farmable Wetland - Wetland)	0.00	6.20
CP-28 (Farmable Wetland - Buffer)	0.00	6.09
CP-30 (Wetland Buffer (Marginal Pasture))	0.00	4.67
CP-33 (Upland Bird Habitat Buffer)	83.86	129.25
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	788.27	998.44
CP-38E-12 (SAFE Grass - Wildlife Food Plot)	0.00	42.45
CP-42 (Pollinator Habitat Establishment)	49.32	134.47
CP-88 (Permanent Native Grasses, Forbs, or Legumes)	0.00	49.46
Total Acres Managed	3485.03	6629.71

Table A13. Summary of total acres managed on Ohio's Fallsville Focal Area and in the surrounding 10-km radius, categorized by CRP practice. Fallsville Focal Area is 11,058 acres primarily composed of agriculture and deciduous forest. 12% of the area is public land and 88% is private land. The 10-km landscape boundary overlaps with Ohio's Fallsville Reference Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	0.00	165.88
CP-2 (Native Grass, Forb, and Legume Establishment)	440.89	2074.46
CP-3 (Tree Planting)	0.00	91.45
CP-3A (Hardwood Tree Planting)	0.00	50.53
CP-4D (Permanent Wildlife Habitat)	139.11	618.25
CP-8A (Grass Waterway)	0.00	319.22
CP-9 (Shallow Water Areas for Wildlife)	0.00	7.22
CP-10 (Grass Already Established)	0.00	22.48
CP-12 (Wildlife Food Plot)	0.00	1.43
CP-16A (Shelterbelt Establishment)	0.00	4.87
CP-21 (Grass Filter Strips)	234.83	1629.18
CP-22 (Riparian Buffers)	8.22	188.88
CP-23 (Floodplain Wetland Restoration)	0.00	2.22
CP-23A (Non-Floodplain Wetland Restoration)	0.00	15.14
CP-29 (Wildlife Habitat Buffer (Marginal Pasture))	0.00	45.23
CP-33 (Upland Bird Habitat Buffer)	54.53	255.26
CP-38E (State Acres for Wildlife Enhancement - Grass)	269.14	1324.41
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	0.00	210.90
CP-42 (Pollinator Habitat Establishment)	0.00	53.37
Unknown	36.48	36.48
Total Acres Managed	1183.19	7116.86

Table A14. Summary of total CRP acres on Ohio's Fallsville Reference Area and in the surrounding 10-km radius, categorized by practice. Fallsville Reference Area is 10,726 acres primarily composed of agriculture and deciduous forest. 17% of the area is public land and 83% is private land. The 10-km landscape boundary overlaps with Ohio's Fallsville Focal Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-1 (Introduced Grass and Legume Establishment)	0	11.08
CP-4D (Permanent Wildlife Habitat)	0	19.05
CP-8A (Grass Waterway)	4.23	108.18
CP-10 (Grass Already Established)	0	0.38
CP-21 (Grass Filter Strips)	6.05	362.02
CP-22 (Riparian Buffers)	0	38.22
CP-23A (Non-Floodplain Wetland Restoration)	0	5.99
CP-33 (Upland Bird Habitat Buffer)	0	96.22
CP-38E (State Acres for Wildlife Enhancement - Grass)	0	121.9
CP-38E-4D (SAFE Grass - Permanent Wildlife Habitat)	0	20.86
CP-42 (Pollinator Habitat Establishment)	0	10.76
Total Acres Managed	10.28	794.66

Table A15. Summary of total CRP acres on Texas' Austin Focal Area and in the surrounding 10-km radius, categorized by practice. Austin Focal Area is 27,238 acres primarily composed of pasture. 100% of the area is private land. The 10-km landscape boundary overlaps with Texas' Austin Reference Area landscape boundary, however the actual areas do not overlap.

CRP Practice	**Area scale**	**Landscape scale (10-km buffer)**
CP-22 (Riparian Buffers)	23.56	23.56
Total Acres Managed	23.56	23.56

Table A16. Summary of total CRP acres on Texas' Austin Reference Area and in the surrounding 10-km radius, categorized by practice. Austin Reference Area is 26,848 acres primarily composed of pasture. 100% of the area is private land. The 10-km landscape boundary overlaps with Texas' Austin Focal Area landscape boundary, however the actual areas do not overlap.

CRP Practice	Area scale	Landscape scale (10-km buffer)
CP-22 (Riparian Buffers)	0.00	23.56
Total Acres Managed	0.00	23.56