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ABSTRACT—Over the past century, the interactions between agricultural land use and government cropland retirement programs have affected pheasant population change. Two government land retirement programs that returned croplands to grasslands, Soil Bank in the 1960s and the current Conservation Reserve Program (CRP), help to illustrate these connections. From 2007 to 2010, South Dakota lost 41% of its CRP lands and experienced an 18% decline in pheasants per mile. However, because of where CRP expirations have occurred and where pheasant populations are found, some regional variability is seen. Western South Dakota (Region 1) had an 80% increase in pheasants per mile and a 51% decrease in CRP land, while central South Dakota (Region 2) had a 22% increase in pheasants per mile and a 42% decrease in CRP land. Region 3 saw a 51% decrease in pheasants per mile and a 25% decrease in CRP land, and Region 4 had a 45% decrease in both pheasants per mile and land in the CRP. These differences are explained by regional land use and land cover, the extent to which row crop agriculture dominates each region, and the variability in the abundance of pheasants found in each region.

Key Words: Conservation Reserve Program, pheasants, South Dakota

INTRODUCTION

The ring-necked pheasant (*Phasianus colchicus*), hereafter pheasant, is an economically important species and cultural symbol in South Dakota (Fig. 1). In 2009, 167,000 people hunted pheasants in South Dakota, adding over $219 million to the state's economy (South Dakota Department of Game, Fish and Parks 2010a). Successfully introduced to the state in 1909 (Switzer 2009b), by 1945 the pheasant population reached 16 million, the highest number on record according to the South Dakota Department of Game, Fish and Parks.

Since then, population has fluctuated as a result of complex interactions between human and natural systems. The two dominant factors affecting pheasants are (1) the natural system of weather and related ecosystem or habitat response and (2) the human land management system that can provide pheasants with ample suitable habitat for nesting, food, and protection from the elements, especially the harsh winter conditions that are common in eastern South Dakota. When weather is fair and habitat abundant, pheasants thrive. When weather is fair and habitat is less abundant, populations can still be sustained. However, when winter weather produces blizzard conditions and winter habitat is not available for protection, populations can decline precipitously.

In this article I highlight the effects on pheasant populations of weather events, habitat availability, agricultural land use, and government land retirement programs. First, I present a historical summary that details how changes in land management, coupled with weather events, have shaped pheasant numbers since the 1920s. I then focus on what is currently happening in South Dakota, specifically regarding the loss of Conservation Reserve Program habitat, and how those changes have affected pheasant populations.

CONSERVATION RESERVE PROGRAM, WILDLIFE, AND DRIVING FORCES OF CHANGE

The Food Security Act of 1985 established the Conservation Reserve Program (CRP), which has created opportunities for enhancing fish and wildlife populations on millions of private farmland acres (Miller and Bromley 1989). The CRP has been shown to increase abundance and nesting success for many grassland bird species from

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Figure 1. The male ring-necked pheasant (*Phasianus colchicus*). Photo by Terry Sohl. Used with permission.

Indiana to Nebraska (Best et al. 1997). In the Prairie Pothole Region of North Dakota, the addition of 1.9 million hectares of CRP land was shown to have added 12.4 million waterfowl to the region in the early 1990s (Reynolds et al. 2001). Other species that have benefited from the increase in CRP land are white-tailed deer in South Dakota (Gould and Jenkins 1993), Henslow's sparrows in Illinois (Herkert 1997), and northern bobwhite quail in Missouri (Greenfield et al. 2002).

Over the past half-century, wildlife biologists have linked habitat changes to decreases in pheasant populations (Patterson and Best 1996; Eggebo et al. 2003; Riddle et al. 2008), while others have studied how pheasants are adversely affected by severe weather events (Nelson and Janson 1949; Kozicky et al. 1955; Martinson and Grondahl 1966; Gabbert et al. 1999). Some have looked specifically at the changes in the amounts of CRP lands and how those changes affected pheasants (Riley 1995), and others have investigated negative impacts of the removal of protected lands and adverse weather conditions on upland game species (Erickson and Wiebe 1973; Nielson et al. 2006). Others, taking a social science approach, have investigated changes to local agricultural and recreational (pheasant hunting) economies (Bangsund et al. 2004; Scallan 2008) in the United States and abroad.

Integrated studies of social and natural systems (Lambin et al. 2001; Rindfuss et al. 2004) have revealed new and complex patterns and processes not evident when studied by social or natural scientists *separately* (Liu et al. 2007). With the exception of site-specific studies done mostly by wildlife biologists (Leif 2005; Giudice and Haroldson 2007), little work related to pheasants has been done in larger geographic areas over longer time frames.

Historic Summary of Pheasant Population Change

Since 1908, South Dakota pheasant populations have gone through boom and bust cycles driven by integrated changes in agricultural policy, land use, and weather. Laingen (2009) explores these population dynamics in greater detail. The following points, referenced in Figure 2, give specific, abbreviated explanations of how these changes have affected historic pheasant populations in South Dakota.

A. During the Dust Bowl years, long-term drought and economic depression led to abandoned farmland (Trautman 1982); a new land retirement program, the Agricultural Conservation Program, increased grasslands and pheasants flourished.
B. In 1937, subzero temperatures and 180 cm of snow killed 80% of the pheasant population, yet in only a few years' time, the population rebounded. This is an example of how a devastating weather event can be overcome if habitat in subsequent years is available.
C. During World War II, tractor fuel was rationed and farmers were sent overseas to fight in the war. Agriculture declined and abandoned farmland and grasslands expanded. Weather conditions were also optimal. Rainfall filled prairie potholes, creating sturdy stands of wetland vegetation needed for winter cover. Pheasant population exploded to an estimated 16 million birds, the highest ever counted (South Dakota Department of Game, Fish and Parks 2010a).
D. At the end of World War II, soldiers came home and grasslands were returned to cropland. Abnormal spring temperatures (1946) and severe winter weather (1947–48), coupled with habitat loss, increased bag limits, and the hunting of hen pheasants (which ended in 1946), led to a major decline.
E. Under the Soil Bank Program, cropland was taken out of production and returned to perennial legumes and grasses. Populations quickly increased to an estimated 11 million birds.

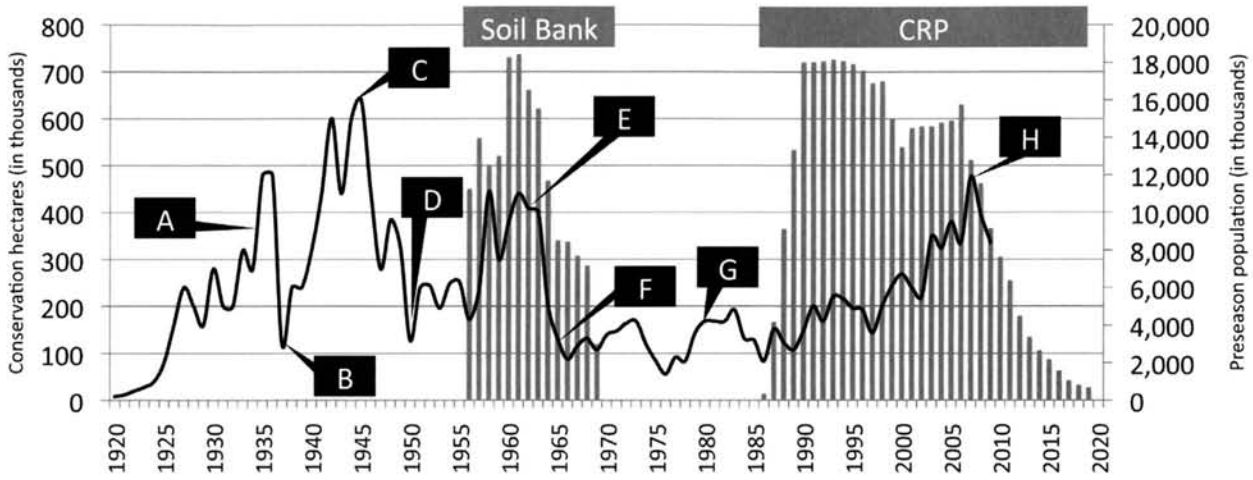

Figure 2. Preseason South Dakota pheasant population (black line) from 1920 to 2009 and total hectares per year of the Soil Bank and Conservation Reserve Program (gray bars), including projected hectares that will expire though 2020. Letters A–H are explained in the section of the text entitled "Historic Summary of Pheasant Population Change." Sources: Berner 1988; USDA 2008; South Dakota Department of Game, Fish and Parks 2010a. Graph by author.

F. Soil Bank grasslands were lost when droughts forced haying in the early 1960s. The severe winters of 1964–65 and a blizzard in 1966 killed an estimated 86% of the pheasant population because habitat had been returned to cropland.

G. Grain exports due to new markets in the Soviet Union and China led to increased cropping, and the U.S. government changed its policy from conservation to production (Hart 1991). A severe blizzard struck in 1975; any headway pheasant population made was diminished due to lack of winter habitat. Fencerow-to-fencerow farming practices kept populations at or near record lows throughout the 1970s and into the early 1980s.

H. The Conservation Reserve Program was created in 1985 as a federal program to retire highly erodible and environmentally sensitive cropland and pasture in 10- to 15-year contracts (USDA 2010a). Pheasant population rebounded as 6.5% of South Dakota's croplands were retired. Above-normal springtime rain events in the mid-1990s filled in prairie pothole wetlands, creating habitat. Severe winters in 1997 and 2001 did kill some pheasants, but because habitat was plentiful, numbers quickly rebounded.

Over the past 90 years, pheasant population size has been a function of both human and natural systems. Some of the most devastating losses have occurred when habitat loss was coupled with some abnormal or severe weather event. Habitat loss may be driven by numerous factors, but as of late, most factors involve reactions to agricultural policies outlined in contemporary U.S. farm bills, specifically land usage related to the CRP.

Contemporary Summary of Pheasant Population Change

Because CRP contracts are normally 10 years long, and because the program started in 1986, we have a good idea of when large tracts of retired grasslands may be coming up for contract renewal. Between 1986 and 1989, South Dakotans had enrolled just over 526,000 hectares of cropland into the CRP. Those same contracts were up for their first renewal between 1996 and 1999. As Figure 2 shows, the vast majority of those acres were renewed, mostly because government payments for CRP contracts ($23 per hectare) were competitive with what farmers could earn by farming that same land or renting it out ($22 per hectare) (Janssen et al. 2007; USDA 2008).

Ten years later (2006 to 2009), this is no longer the case. In 2007, farmers in eastern South Dakota could earn, on average, $26 per hectare on land in the CRP and over $36 per hectare in cash rental rates (Janssen et al. 2007; USDA 2008). Consequently, South Dakota lost 86,000 hectares, or 14%, of its total CRP acreage in 2007 and 2008 (USDA 2010a). Contracts that expired between 2008 and 2010 added another 214,000 hectares to that total loss. Continued losses could cause a more significant pheasant loss than the 1960s post–Soil Bank decline because today's

agricultural landscape is much less diverse. Although the new 2008 U.S. farm bill states that it will continue to support the CRP by enrolling 13 million hectares into the program (USDA 2010b), CRP rental payments may not yet be substantial enough to compete with today's cash rental payments and high crop prices.

SUMMER BROOD SURVEYS OF 2008 AND 2009

In the few years since CRP lands have been converted back to cropland in portions of eastern South Dakota, decreases in pheasant numbers have already been seen in the annual August roadside surveys by the South Dakota Department of Game, Fish and Parks (2010b). During these surveys, which begin in late July and continue through mid-August, South Dakota Department of Game, Fish and Parks staff drive, at no greater speed than 32 km per hour, on 110 48-km routes, observing, identifying, and collecting information on all pheasants seen within 0.2 km of the roadway. The objectives of the brood surveys are to "annually determine reproductive success, population trends, and relative densities throughout the pheasant range in South Dakota" (South Dakota Department of Game, Fish and Parks 2010b).

Changes at the State Scale, 2007 to 2009

To see how the current loss of CRP habitat has begun affecting pheasant populations, I mapped the annual roadside survey data from the South Dakota Department of Game, Fish and Parks for 2007, 2008, and 2009 into two maps, one illustrating the change in pheasants per mile (PPM) from 2007 to 2008 and a second showing the change in PPM from 2008 to 2009 (Fig. 3). The circles are placed at the midpoint of each of the 48-kilometer routes driven by department employees (see Fig. 5), and the size of the circles is proportional to the amount of change that occurred.

Though South Dakota lost 146,000 hectares in the CRP in 2007, from 2007 to 2008 the statewide pheasant-per-mile index actually increased by 9% (Switzer 2009a). It was the highest PPM index since the Soil Bank years of the early 1960s. Much of the increase in pheasant abundance occurred in the region near the James River or farther west between the James and Missouri Rivers, where grasslands are common and CRP loss was less pronounced (Fig. 3). It was east of the James River, however, that South Dakota experienced most of its 2007 to 2008 CRP loss. This region of the state has more productive soils and a higher percentage of cropland in row crops. In areas near Brookings, Watertown, Sioux Falls, and Mitchell, pheasant abundance declined between 17% and 36%, as vital nesting habitat was replaced by cropland.

Weather during 2007 to 2008 was also optimal. Winter conditions were mild, and though heavy snow and blizzard conditions did occur in late March and early April, the events were short lived and little mortality was reported (Switzer 2009a). Significant rainfall events and below-normal temperatures occurred across much of the state in May and early June. However, this only helped to create ideal summer nesting conditions, and precipitation and temperatures during the brood-rearing season were optimal.

A much different story unfolded in 2009. The 2009 statewide pheasant-per-mile index declined by 26% compared to the 2008 survey (Switzer 2010). An additional 45,000 hectares in the CRP were lost in 2008, and in their brood survey report, state wildlife biologists stated that "without a doubt, CRP has helped build and maintain high pheasant densities in South Dakota during the past years" (Switzer 2010), indicating that the current decline in CRP land was linked to pheasant loss. Northeastern South Dakota experienced the biggest impact, losing another 18% of its CRP hectares in 2008 and a total of over 89,000 hectares since 2007.

Losses in the 2009 pheasant population could be the result of lag time, as the effects of CRP losses in 2007 and 2008 were finally made evident. Coupled with habitat loss, the winter of 2008–9 brought normal winter weather conditions back into much of the northern Great Plains. Cold temperatures and persistent snow cover, coupled with a decrease in winter CRP habitat, stressed the importance of ample suitable habitat for South Dakota's pheasants (Fig. 4). Spring 2009 also brought challenges. Below-normal temperatures occurred during the nesting season and early stages of the hatch, which likely decreased chick survival, and locally heavy rainfall events likely resulted in re-nesting attempts, which typically result in smaller clutch sizes.

Changes at the Regional (Multicounty) Scale, 1986 to 2009

State-level population dynamics reveal an association between quantity of CRP lands and pheasant population. While informative, the coarseness of that analysis does not provide an adequate description of both the spatial and temporal variability associated with distribution and quantity of CRP lands or pheasants. To that end, a more detailed, regional-scale assessment is necessary. Brood

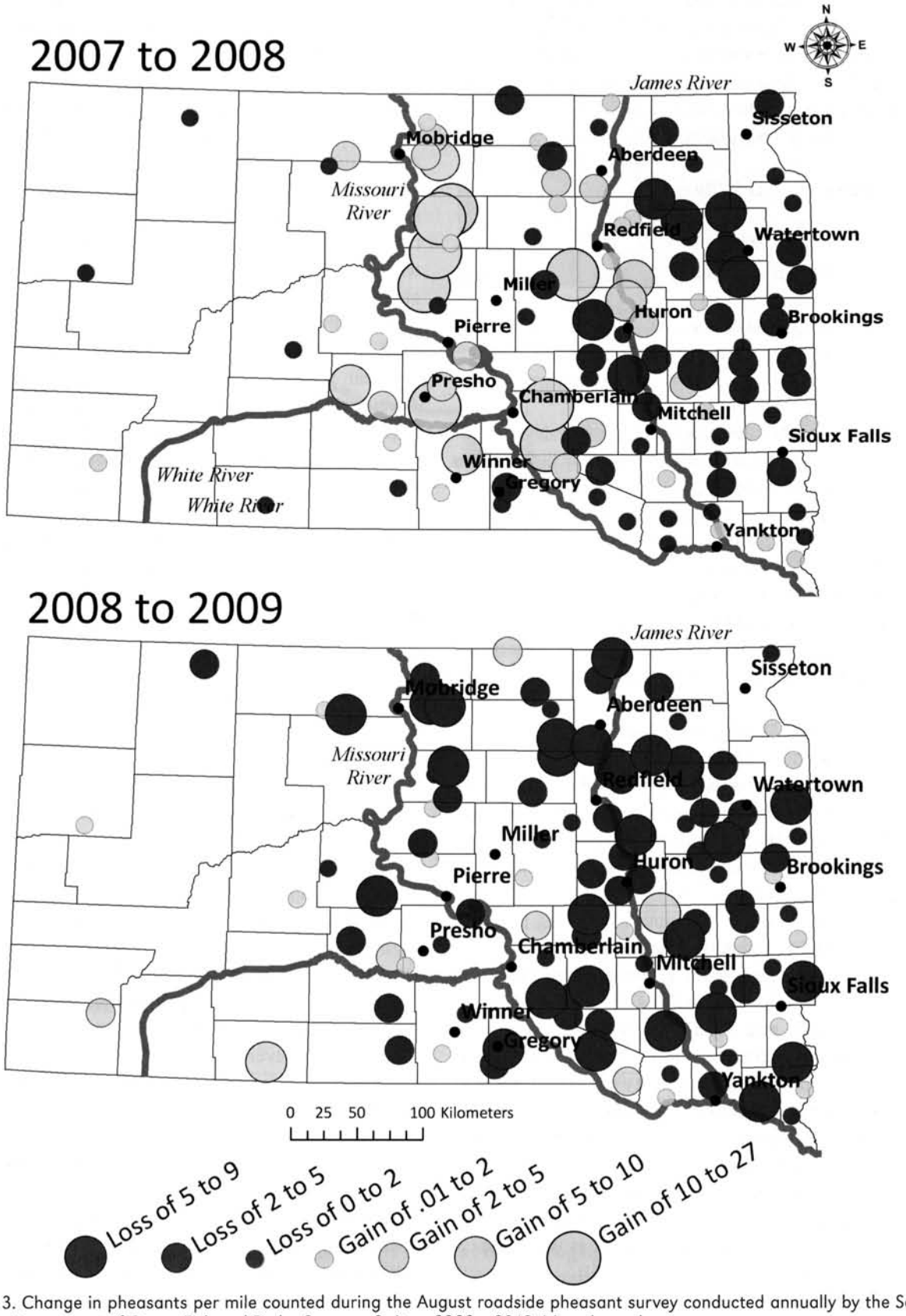

Figure 3. Change in pheasants per mile counted during the August roadside pheasant survey conducted annually by the South Dakota Department of Game, Fish and Parks. Sources: Switzer 2009a, 2010. Maps by author.

Figure 4. A pheasant attempts to seek shelter in a snow-covered harvested cornfield in Kingsbury County, SD. Photo by Wade Harkema. Used with permission.

survey routes cannot be analyzed at a county-level scale. However, according to Travis Runia, wildlife biologist for the South Dakota Department of Game, Fish and Parks, brood route data can be aggregated into the administrative region (multicounty scale) in which each route is located (Fig. 5) (T. Runia, pers. comm. 2010).

Patterns of change found in Region 1 (13 counties in western South Dakota) show that temporal changes in CRP hectares and pheasant counts do not correspond well to one another. This is because (1) Region 1 is large, (2) it contains only five survey routes, and (3) the western part of South Dakota is not and has not historically been a region where pheasants have been found in large numbers. While small pockets of suitable habitat do exist, land cover in this region consists mainly of rangeland (as well as the Black Hills) and shortgrass prairie, and lacks the mix of grassland, wetland, and agricultural land cover preferred by pheasants.

Region 2 consists of 20 counties bordering the Missouri River and its tributaries. Here, pheasants are found in higher numbers, especially in the glaciated areas east of the Missouri River and west of it in the counties of Lyman, Gregory, and Tripp in south-central South Dakota. While CRP lands are an important component of this region's land cover, the diversity of agricultural land cover that is already present (row crops, small grains, wetlands, and pasturelands) diminishes the importance of the Conservation Reserve Program and the overall effects that any loss of CRP land has on pheasants. As the CRP has declined, loss of CRP hectares in this region has not affected pheasants to the extent that it has in Regions 3 and 4.

Regions 3 and 4 are in eastern South Dakota. The physical geography of this portion of the state is unique. Having been glaciated, these regions contain soils that are conducive to row crops—especially corn and soybeans—and the area planted to corn and soybeans has greatly increased over the past 40 years (Hart 2003:24). Since 1970, over 1.7 million hectares of new corn and soybeans have been planted. This increase in row-crop-intensive agriculture has been shown to be detrimental to pheasant populations not only in South Dakota but also in other states such as Illinois (Warner et al. 1984) and Nebraska (Taylor et al. 1978). It also stresses the importance of long-term government land retirement programs for sustaining pheasant populations.

Here, the connection between decreasing amounts of CRP land and decreasing pheasant populations is more apparent. As shown in Figures 3 and 5, Regions 3 and 4 were the first to see both the large-scale expiration of CRP contracts between 2007 and 2008 as well as the first decline in pheasants. This should not be surprising. With eastern South Dakota having some of the most productive soil in the state, as soon as landowners were able to get out of their CRP contracts in 2007, they did just that. During the following year, the trend of expiring CRP lands continued to become more widespread in Regions 3 and 4 but also continued westward into the eastern portions of Region 2, where initial declines in pheasant populations were also seen.

THE FUTURE

The Dakotas, Minnesota, and Iowa will likely see the biggest decline in CRP lands over the next five years (USDA 2008). In simple terms, as more CRP land disappears each year, all that stands between another post–Soil Bank population crash are consecutive years of increased habitat loss coupled with severe winters that produce high mortality or abnormal spring weather, which influence nesting and breeding success. Results of the 2007–9 pheasant brood surveys suggest the importance of quality habitat for maintaining robust pheasant populations.

Certainly, severe winter weather does levy a toll on pheasants regardless of habitat availability. Winter weather in the 1990s and early 2000s was relatively mild with the exceptions of the severe winters of 1996–97 and 2000–2001, when high levels of pheasant mortality occurred. However, populations rebounded rapidly because of ample breeding and nesting habitat provided by the CRP. Winter weather remained mild into 2007 and 2008, minimizing the short-term effects of the most recent habitat loss. The winter of 2009–10 was a different story. Winter arrived in early December. Arctic air, snowstorms,

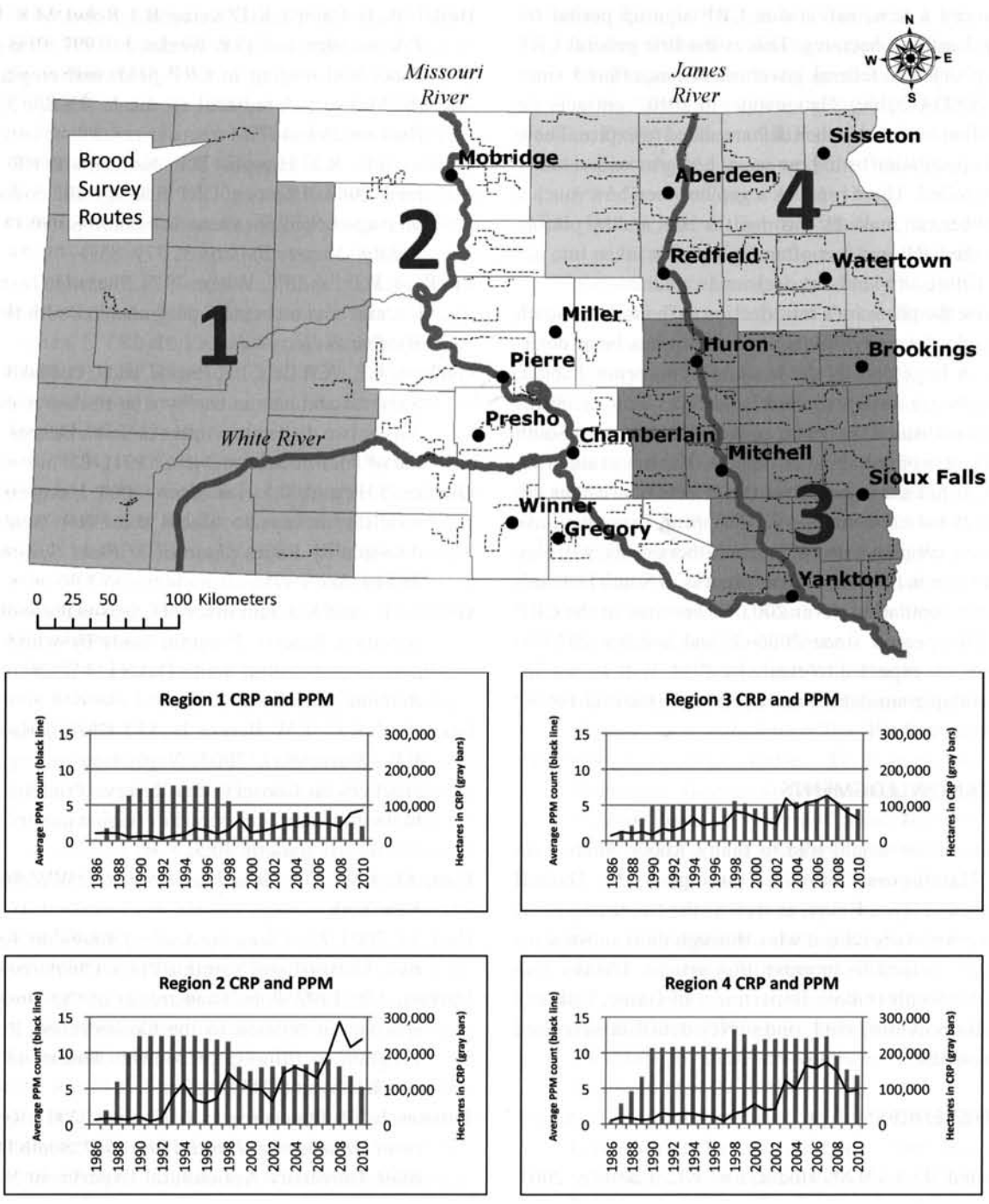

Figure 5. Brood survey routes and administrative regions of the South Dakota Department of Game, Fish and Parks (top). Variation in the relationship between Conservation Reserve Program (CRP) hectares and pheasant-per-mile (PPM) counts by administrative region (bottom). Sources: USDA 2008; South Dakota Department of Game, Fish and Parks 2010a. Maps and graphs by author.

and sleet pounded the state for most of the winter, no doubt raising winter mortality rates above normal. The effects of the winter of 2009–10 can be seen in the eastern regions of South Dakota where pheasants-per-mile numbers continue the declines that began in 2007 and 2008.

While predicted CRP loss may not be as extensive as once thought, regional variations of land use, created by agriculturally driven land-use decisions, will continue to highlight the important role the CRP plays in certain regions within the state. In July 2010 the USDA

announced a new, nationwide CRP sign-up period for nearly 2 million hectares. This is the first general CRP sign-up that the federal government has offered since 2006 (USDA 2010c). Nationwide, in 2010, contracts for 1.8 million hectares in the CRP are slated to expire. There is still speculation as to how many hectares will actually be reenrolled. There remains a gap between how much a landowner can make by farming the land and by putting it into the CRP, and it is often *the* variable taken into account before any land-use decision is made.

Since the pheasant's introduction to the state of South Dakota in the early 1900s, its success has been determined in large part by the availability of prime habitat. Pheasants are extremely hearty and resilient creatures that can withstand the brutal continental climate of South Dakota, *if* proper habitat is present. Habitat availability is key. If habitat is available, the effects of weather are muted. If habitat continues to disappear, those land-use decisions, coupled with extreme weather events, will play a larger role in the year-to-year success of South Dakota's pheasant population. Over 200,000 hectares in the CRP have disappeared since 2006–7, and another 202,000 hectares are expected to expire by 2013. Will we see another collapse similar to what occurred in the mid-1960s? Only time will tell.

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