Iowa Spring Spotlight Survey: 2019 Summary

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ABSTRACT The Iowa Department of Natural Resources (Iowa DNR) conducts nocturnal spring spotlight surveys from mid-March to mid-May, annually. The survey was initiated in 1978 to provide independent indices for Northern raccoon and white-tailed deer populations across Iowa, USA. In 2006, the survey was redesigned to provide a systematic sample of land cover types available to wildlife at a statewide level and to produce standardized population trends for several species. The objectives of the survey are 1) to collect systematic empirical observations for deer, raccoon, and select furbearer species which can be used as independent indices for populations or as supplements to other data collected by the Iowa DNR and 2) to develop a long-term database for the spatial distribution and relative abundance of select wildlife species applicable to population monitoring and conservation efforts. Spotlight surveys are conducted in all 99 Iowa counties and total ~4,790 mi ($\overline{x}$ = ~50 mi/county) of surveyed rural roads. The location and number of animals observed are recorded for ~15 species. In 2019, a total of 22,664 observations were recorded, with deer (*n* = 16,490), raccoon (*n* = 5,390), house cat (*n* = 230), striped skunk (*n* = 194), and Virginia opossum (*n* = 154) being the most frequent species observed. Trends for most species increased in 2019, although observations for opossum decreased significantly from the previous year. Two species of conservation concern in Iowa were observed, including gray fox (*n* = 1) and white-tailed jackrabbit (*n* = 1). The Spring Spotlight Survey provides consistent long-term indices for several Iowa wildlife species and provides empirical animal locations useful for modeling various population parameters for species.

INTRODUCTION

Wildlife data capable of estimating population abundance are often difficult, expensive, and time consuming to collect, particularly for rare or elusive species, or species that exist across large geographic areas. In these cases, standardized sampling methods may be used to provide consistent long-term indices of populations over time. Reliable indices are critical for understanding populations and can provide insight into factors affecting trends, including environmental conditions (Progulske and Duerre 1964, Fujisaki et al. 2011), regulated harvest (Carrillo et al. 2000), and disease (Gehrt et al. 2006). One common method, the nocturnal spotlight survey, has been used since the mid-20th Century and provides a cost-effective and easily implemented option for natural resource managers to sample wildlife populations (SDDGFP 1950; Anderson 1959). Spotlight counts have been used to produce population trends for a variety of species, including Virginia opossum (*Didelphis virginiana*; Gehrt et al. 2006), Northern raccoon (*Procyon lotor*; Gehrt et al. 2002), red fox (*Vulpes vulpes* ; Ruette et al. 2003), and white-tailed deer (*Odocoileus virginianus*; Rybarczyk 1978, Kaminski et al. 2019). By understanding the relationship between wildlife occurrence and environmental or anthropogenic factors, spotlight counts can provide easily interpreted population indices useful for guiding management decisions and conservation programs.

In 1978, the Iowa Department of Natural Resources (DNR; formerly the Iowa Conservation Commission) initiated the Spring Spotlight Survey because of concerns that all-time high raccoon pelt prices threatened an over-harvest and would negatively impact the sustainability of the population (Rybarczyk 1978). Spotlight routes were established along forested areas to survey for raccoon, although white-tailed deer were also included (Appendix A–E). In general, from 1978–1990, 85 spotlight routes were established across the state, and from 1991–1995, 5 additional routes were added. Because forest cover may structure raccoon (Pedler et al. 1997, Beasley et al. 2007) and deer (Volk et al. 2007, Walter et al. 2009)

populations in agricultural landscapes, statewide population trends using these data may be biased (McShea et al. 2011) because selection for other land cover types (e.g., grassland) is not likely equivalent. Regardless, the long-term trends resulting from this survey provided key insight into these growing populations from the 1970s through 2000s.

In 2006, a new survey methodology was developed to address deficiencies in the original design. Rather than using survey routes perpendicular to forest features, routes were oriented in a longitudinal (i.e., east–west) direction to achieve a representative sample of the land cover types across the state and to allow for density estimation of deer. Several additional species were added to the survey, including American badger (*Taxidea taxus*), American mink (*Mustela vison*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), Northern river otter (*Lontra canadensis*), red fox, striped (*Mephitis mephitis*) and Eastern spotted skunk (*Spilogale putorius*), Virginia opossum, weasels (*Mustela* sp.), white-tailed jackrabbit (*Lepus townsendii*), and woodchuck (*Marmota monax*). The new methodology was tested concurrently with the original survey and found to result in similar trends with less variability (Iowa DNR unpublished data). Therefore, in 2012, the new methodology was adopted and the new routes were finalized in all 99 Iowa counties. The new stratified sampling design results in relatively large counts for deer, raccoon, opossum, striped skunk, coyote, and red fox. However, observations for other species (e.g., gray fox, bobcat, river otter, and mink) are more variable due to the secretive nature, low population density, or low visibility for animals, which may result in low detectability for these species. Thus, observations for other species are less common and a low count using this method does not necessarily imply low population abundance.

The goal of the Spring Spotlight Survey is to develop a reliable, standardized, and long-term occurrence dataset for select wildlife species that can be used to inform science-based management decisions in Iowa. The objectives of the survey are 1) to collect empirical systematic observations for deer, raccoon, and select furbearer species which can be used as independent indices for populations or as supplements to harvest and other survey data collected by the Iowa DNR and 2) to develop a long-term database for the spatial distribution and relative abundance of select wildlife species applicable to population monitoring and conservation efforts.

STUDY AREA

The Spring Spotlight Survey was conducted in each of 99 Iowa counties in the 56,239-mi^2 state of Iowa, USA (Fig. 1). The climate is humid continental, characterized by hot, humid summers and cold winters. Average annual precipitation ranges from 24.4 in in the northwest to 37.2 in in the southeast (NOAA 2002*a*). Average annual temperatures ranges from 45.5 °F in the northwest to 50.7 °F in the southeast (NOAA 2002*b*). Land cover consists of agriculture (63%), grassland and pastureland (22%), forest (10%), urban and other developed lands (2%), and wetlands, shallow lakes, and open water (2%; IADNR 2015).

METHODS

The Spring Spotlight Survey is conducted each year, usually after snow-melt occurs (i.e., increased animal movement due to increasing temperature and humidity), and before spring green-up (i.e., increased visibility on the landscape). This period typically occurs between mid-March and mid-May with the date of surveys dependent on local weather conditions and the latitudinal timing of vegetation leaf-out across the state. Surveys are standardized according to weather conditions (Rybarczyk 1978) and conducted during periods of no precipitation, wind speed <15 mph, relative humidity ≥40%, and temperature >32 °F. Surveys consist of 2 longitudinal (east–west) driving routes across each county, one across the northern and southern halves of counties (except for Kossuth which had 3 routes; n = 199). Routes consist of rural unpaved roads totaling ~4,790 mi statewide ($\overline{x}$= 24.1 km/transect, 12.4–45.1 mi; SD=4.3 mi) and are sampled once each spring. Surveys begin 1 hour after sunset and are conducted at speeds ≤20 mi/hour. Surveys consist of 2 observers (1 driver and 1 passenger), both of whom search for wildlife using a spotlight along their respective side of the road. From 2006–2018, the number of individuals and the location for observed wildlife were recorded at the observer position (e.g., vehicle) using a global positioning system (GPS) device. For deer, the distance and bearing to each group of deer (≥1 individual) were also recorded for estimating empirical locations for deer on the landscape. In 2018, Iowa DNR staff in 4 counties (Allamakee,

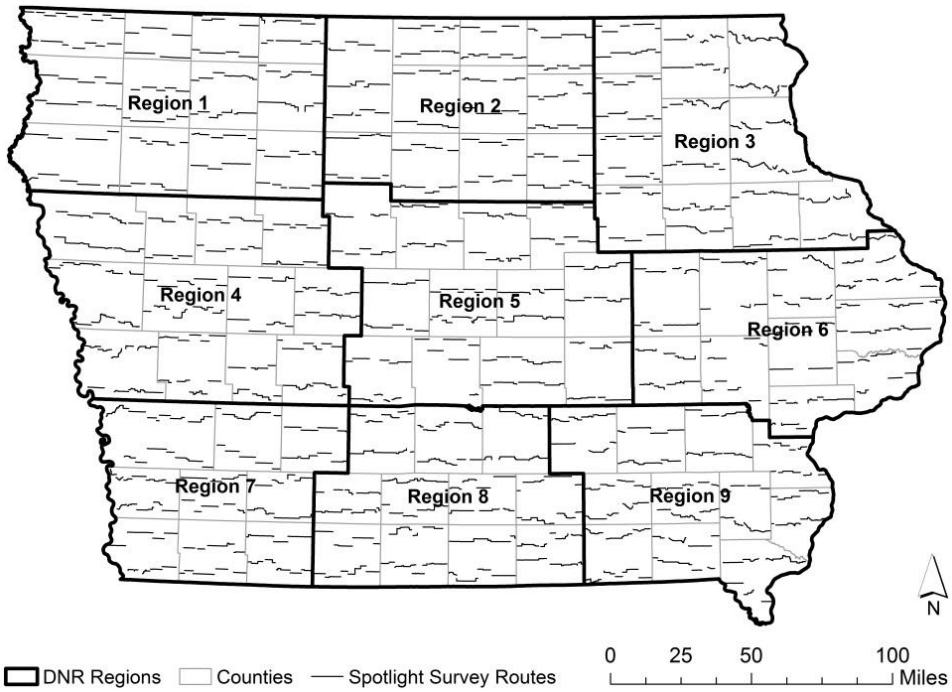

Figure 1. Spring Spotlight Survey routes (*n* = 199) in each county of Iowa, USA, and management regions used for summarizing spotlight count data.

Clayton, Mitchell, and Winneshiek) tested electronic data collection methods (e.g., cell phone and tablet devices) based on satellite geolocations and aerial imagery to record empirical locations for all wildlife observations directly into a geospatial information systems (GIS) database (ArcCollector; Environmental Systems Research Institute, Redlands, CA, USA). The method resulted in fine-scale spatial locations for observed wildlife and was more efficient for conducting spotlight surveys at broad landscape scales; therefore, in 2019, the use of in-field GIS software for collecting data was expanded statewide. The mapping of more exact locations for wildlife on the landscape allows for the application of spatial statistical population estimation and habitat selection modeling techniques, and can provide better estimates of population parameters for informing management and conservation decisions.

Long-term trends for spotlight counts are summarized at two scales for species with typically ≥5 observations recorded per year, including 1) regionally, to provide finer-scale assessment of populations in areas of relatively similar ecological or environmental conditions, and 2) statewide, which is the level at which most harvest or management regulations are applied. Because the number of miles surveyed annually may vary in each county (e.g., due to bridge closures) and some species are observed at very low rates, observations are standardized as either the average number of observations per 1 or 100 miles surveyed for reporting long-term trends and 95% confidence intervals. Furthermore, because animal counts may vary annually due to differences in survey conditions (e.g., spring weather), the 5-year average relative distribution of counts is estimated to contextualize annual observations with recent trends. The average distribution of counts are estimated for each county and the relative distribution is interpolated using the Kriging function in ArcGIS 10.5 (Environmental Systems Research Institute, Redlands, CA, USA) with a spherical semivariogram model and 12 nearest counts. The kriging model is further averaged using the Focal Statistics function in ArcGIS (~15 mi [24-km] circular radius) to produce a smoother and more readily interpretable trend surface across Iowa.

RESULTS

In 2019, 4,772 mi of rural roads were surveyed across all 99 Iowa counties. The number of miles surveyed was 18 mi shorter than the long-term average due to high spring precipitation and wet or flooded conditions along rural roads in riverine areas. In total, 16,490 white-tailed deer, 5,390 raccoon, 230 domestic house cat, 194 striped skunk, 154 opossum, 89

coyote, 58 red fox, 28 badger, 11 mink, 4 bobcat, 1 gray fox, 1 woodchuck, 1 jackrabbit, 0 river otter, and 0 weasel were recorded (Table 1; Fig. 2–49).

The number of white-tailed deer observed statewide was higher (although not significantly) than in 2018. Previously, the 10-year trend was relatively stable, although since 2014, deer counts have gradually increased. Statewide, deer were observed at a rate of 3.4 deer/mi surveyed, with the highest number of deer observed in the south-central (Region 8), SW (7), and NE (3) regions. Deer counts have remained relatively stable across most regions, except the south- and north-central regions where counts have increased during the past 10 years.

Table 1. Average number of animal observations statewide per 100 miles surveyed during the Spring Spotlight Survey in Iowa, 2008–present. Observations are standardized per 100 miles surveyed for consistent comparisons across years (e.g., if the number of miles surveyed varies across years due to bridge closures, etc.). A number of 100 observations per 100 miles survey indicated an average of 1 animal observed per 1 mile surveyed. A number of 50 observations per 100 miles surveyed indicated an average of 0.50 animals observed per 1 mile surveyed or 1 animal observed per 2 miles surveyed.

Year	White-tailed deer	American badger	American mink	Bobcat	Coyote	Gray fox	Northern raccoon	Red fox	Striped skunk	Virginia opossum	House cat
2008	276.60	0.49	0.26	0.10	1.06	0.02	65.01	0.91	3.06	2.52	10.75
2009	269.01	0.31	0.23	0.08	1.45	0.02	66.93	0.69	3.59	2.81	8.47
2010	224.59	0.32	0.21	0.08	1.06	0.00	74.29	0.90	4.37	1.79	8.13
2011	228.89	0.20	0.14	0.08	1.37	0.00	87.09	1.19	4.44	1.77	10.48
2012	194.93	0.18	0.24	0.06	1.92	0.00	68.43	0.75	3.56	2.33	12.49
2013	271.56	0.31	0.12	0.04	1.96	0.02	68.85	0.88	2.89	3.61	9.86
2014	237.07	0.24	0.06	0.06	1.42	0.00	78.33	0.60	2.38	1.79	8.41
2015	254.57	0.26	0.02	0.04	1.49	0.00	73.89	0.64	3.23	3.42	7.03
2016	258.02	0.39	0.27	0.02	2.36	0.00	76.58	0.63	3.06	5.96	5.15
2017	267.69	0.35	0.11	0.08	2.27	0.00	76.38	0.85	2.90	6.27	4.28
2018	316.42	0.39	0.04	0.00	2.14	0.04	97.55	1.03	3.83	6.34	4.32
2019	342.47	0.57	0.26	0.08	1.86	0.02	111.01	1.23	4.12	3.32	5.04

The number of raccoon observed increased in 2018 and again in 2019. This increase was significantly higher than the number observed in 2016. Raccoon were observed at a rate of 1.1 raccoon/mi surveyed, which was the first time that raccoon were observed at a rate >1.0 animals/mi statewide. Prior to 2018, raccoon counts were relatively stable statewide, although in the past 2 years, the counts have increased in all regions of the state.

Observations for striped skunk (4.1 animals/100 mi surveyed), red fox (1.2 animals/100 mi), badger (5.7 animals/1,000 mi), and mink (2.6 animals/1,000 mi surveyed) increased in 2019 compared with the previous year. Skunk observations have fluctuated since 2008 and the number observed in 2019 was similar to high counts in 2010 and 2011. Red fox observations have increased the past 3 years and the 2019 count was similar to the previous high count in 2011. Badger observations have remained stable the past 10 years, although the number of badgers observed in 2019 (n = 28) was 36% higher than in 2018 (n = 18). The number of mink observed has fluctuated every 3–4 years and the count in 2019 was consistent with high counts in 2008, 2012, and 2016. Furthermore, 4 bobcats were observed in 2019, which was higher than in 2018 (n = 0) and consistent with counts in previous years.

Observations for opossum (3.3 animals/100 mi surveyed) and coyote (1.9 animals/100 mi) decreased in 2019 compared with the previous year. Opossum observations decreased 48% from 2018, although the count was similar to high counts reported from 2008–2014. Coyote observations steadily decreased the past 3 years, although the 10-year trend has remained relatively stable. Furthermore, house cat observations (5.0 animals/100 mi) have decreased 62% since 2012, although counts have stabilized the past three years.

DISCUSSION

In general, spotlight counts for most species remained stable or increased in 2019. The number of deer observed in 2018 and 2019 was higher than previous years, although deer counts are likely closely associated with winter and spring weather conditions, which may affect annual counts. Observations in 2012 were lower than expected likely because atypical mild conditions during the winter of 2011–2012 (above average temperatures and below average snowfall; Hillaker 2012) and subsequent early spring vegetation green-up likely affected deer foraging behavior. Our spotlight survey is based on increased deer use of open areas during spring, which increases the likelihood that deer will be observed (Kaminski et al. 2019). Deer were likely less available for observation if forest vegetation provided early spring forage and reduced their use of pastures and agricultural fields for feeding during the survey. Alternatively, in 2018 and 2019, winter weather conditions persisted into March or April across much of the state (Glisan 2018, Glisan 2019*a*). Late winter conditions and below average temperatures in early spring likely increased deer use in open areas for foraging compared with typical years, resulting in higher overall counts. Future research is necessary to evaluate the relationship between weather conditions and wildlife observations to understand annual variability in counts and to provide reliable metrics for standardizing trends.

Raccoon observations increased the past 2 years, which coincides with decreased trapping license sales (i.e., decreased trapping effort) and reduced harvest related to low pelt prices in the fur market (Evelsizer 2018). It is unclear, however, whether reduced harvest resulted in a true population increase or whether environmental conditions during the past 2 springs resulted in ideal survey conditions for raccoon (e.g., raccoon activity is positively correlated with humidity; Rybarczyk 1979). Additional research is needed to standardize raccoon observations according to environmental factors and to integrate harvest and other survey data (i.e., the Iowa Bow Hunter Observation Survey; Harms et al. 2019) into a cohesive population trend for raccoon.

The most notable change in observations occurred for opossum in which counts decreased 48% from 2018. Opossum rarely live more than 2 years (Gillette 1980) and low annual survival (<25%) in agricultural landscapes has been reported (Gipson and Kamler 2001). Opossum are sensitive to winter temperatures (Gehrt et al. 2006) and foraging activity decreases sharply below freezing, and movements from den sites may not occur in temperatures below 14 °F (Gillette 1980). Recent spotlight trends appear to correlate with winter weather conditions for opossum. In 2014, the opossum count was the third lowest since 2008, which coincided with the 6th coldest and 14th wettest winter in recorded history in Iowa (Hillaker 2014). Similarly, opossum counts increased 70% in 2016 following above normal temperatures in February and March that ranked in the upper 25% of the historical records for their respective months (Hillaker 2014). Therefore, the decrease in counts observed in 2019 may be attributed to harsh conditions during late winter (i.e., 16th coldest and 7th wettest winter in recorded history; Glisan 2019*b*), although further analysis is warranted. Opossum populations, however, have the ability to rebound quickly because females are capable of producing 2 litters per year consisting of a large number of young (13 joeys/litter; Gipson and Kamler 2001).

Red fox and striped skunk observations have shown similar fluctuating patterns since 2008. The 2019 counts were similar to highs observed in 2011, although populations gradually decreased in the 3 subsequent years following 2011. Therefore, it is unknown whether the red fox and skunk counts will follow recent increasing trends in 2020 or whether a population regulating mechanism (e.g., disease) will reduce populations in the coming years. Alternatively, fall observations collected during the Bow Hunter Observation Survey (Harms et al. 2019) indicate stable to decreasing trends for these species. Spotlight surveys for canids and skunks are challenging and bow hunter observations may provide a more reliable index for these populations. Spotlight detections for red fox may be low due to their small size or evasive behaviors (Ruette et al. 2003). Similarly, spotlighting is most effective for species that are readily detectable by eye shine (e.g., white-tailed deer, raccoon). Skunks are rarely identified by eye shine and must be close to the observer for detection (Gehrt et al. 2006). Regardless, spotlight counts for fox and skunk provide independent and consistent indices for populations, and the observations provide fine-scale spatial locations for animals applicable to various statistical techniques not possible with other types of survey data in Iowa.

The spotlight survey provides one of the only indices for mink in Iowa and indicates that populations fluctuate every 3–4 years. However, mink observations are rare because surveys do not focus on riparian or wetland areas typical of mink habitat use. Reliable population trends for mink are possible using spotlight observations; however, annual counts may be highly variable for our one-time surveys (Waller 2010) and because annual observations are low for our survey ($n < 15$).

Observations for badger and coyote have been mostly stable during the past 10 years and parallel fall bow hunter observations in Iowa. Alternatively, house cat observations have stabilized the past 3 years but indicate a 62% decline in counts since 2012. A similar pattern was observed for bow hunter observations, although the reason for these declines is unclear and may be related to several interacting factors (e.g., disease, predation, or declining rural human populations; Warner 1985). Predation by house cats on native fauna poses a serious conservation concern in North America, particularly for birds and small mammals (Dauphine and Cooper 2009). The effect of potentially declining rural cat populations on native fauna remains unknown, although may provide positive population effects for several wildlife taxa across the state.

MANAGEMENT IMPLICATIONS

The Spring Spotlight Survey provides consistent long-term population indices for several wildlife species in Iowa. Population trends derived from the survey are critical for monitoring populations and informing science-based management decisions at regional and statewide levels. When paired with long-term harvest trends and other survey data, the development of population abundance or growth models may be possible for a number of species and provide more robust metrics for evaluating wildlife populations in the future.

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We thank all current and past Iowa DNR staff and volunteers who traveled thousands of miles of gravel roads across the state, often until early morning hours, to complete the Spring Spotlight Survey each year. We appreciate the opportunity to present these data on their behalf. W. J. Suchy (former Iowa DNR Wildlife Research Section supervisor) developed the current study design for the Spring Spotlight Survey; we appreciate his efforts to expand the survey statewide and across multiple species taxa to improve the quality of the data collected for managing Iowa's wildlife resources for current and future generations.

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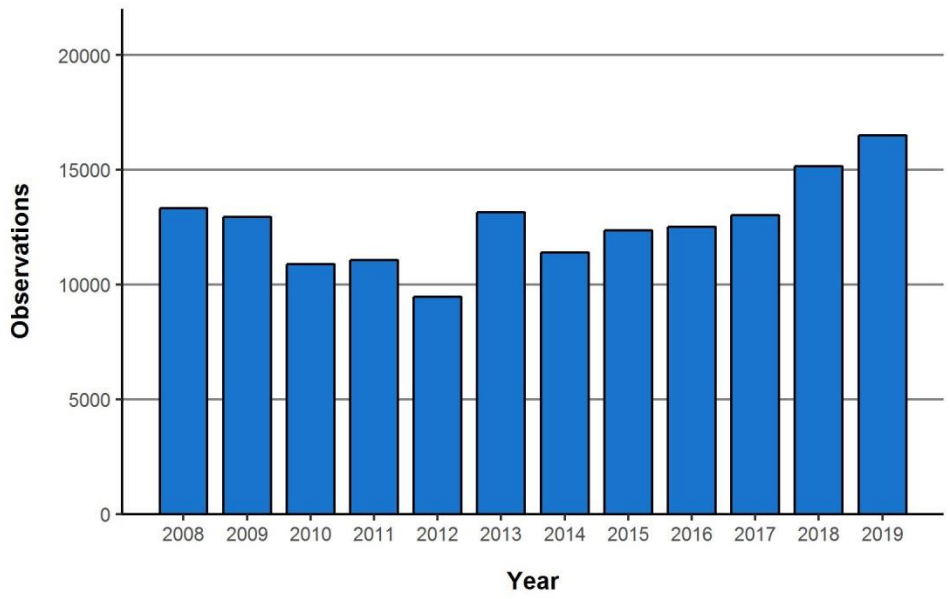


Figure 2. Total statewide white-tailed deer observations during the Iowa Spring Spotlight Survey, 2008–present.

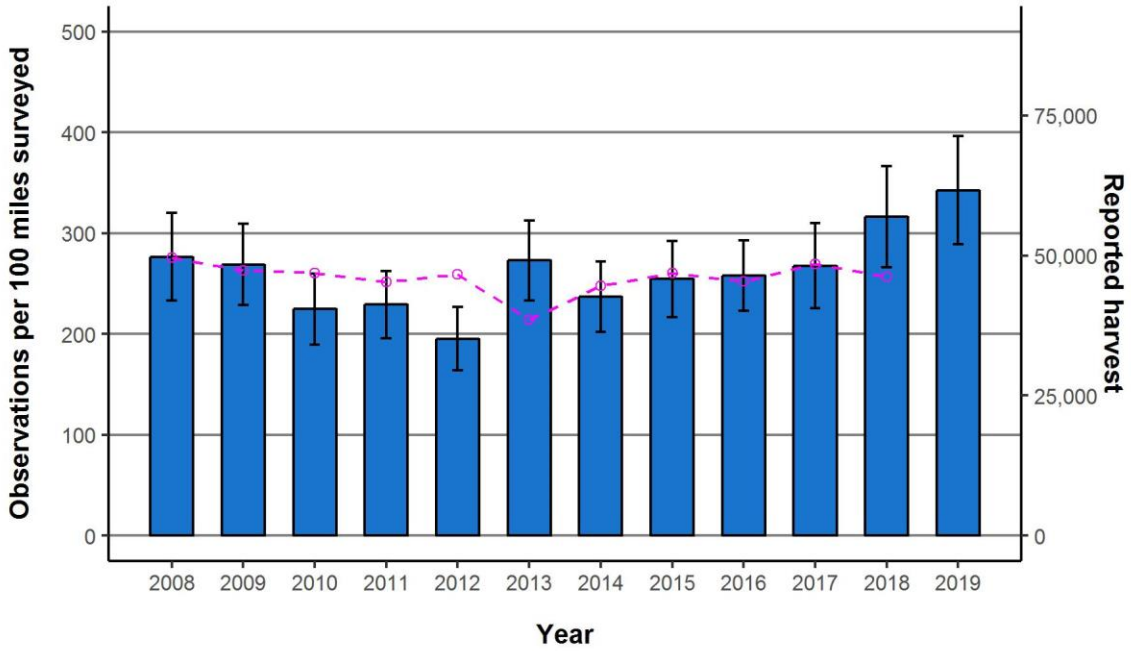


Figure 3. Average white-tailed deer observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide buck harvest as a consistent harvest trend for deer; i.e., buck harvest quotas, or the number of any-sex harvest tags available for purchase, do not change annually unlike county-specific antlerless deer tags, which may vary by year and county.

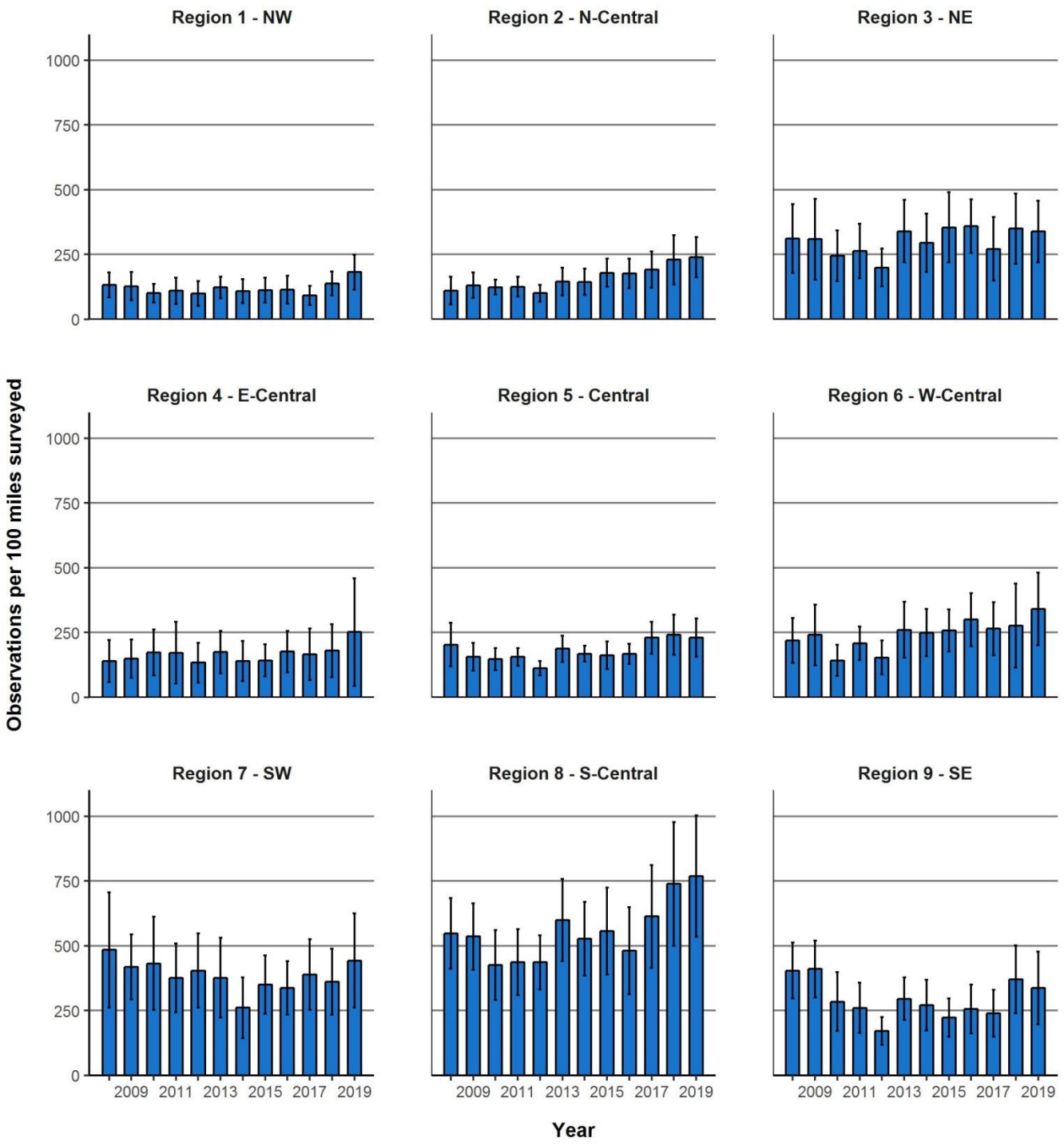


Figure 4. Average white-tailed deer observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

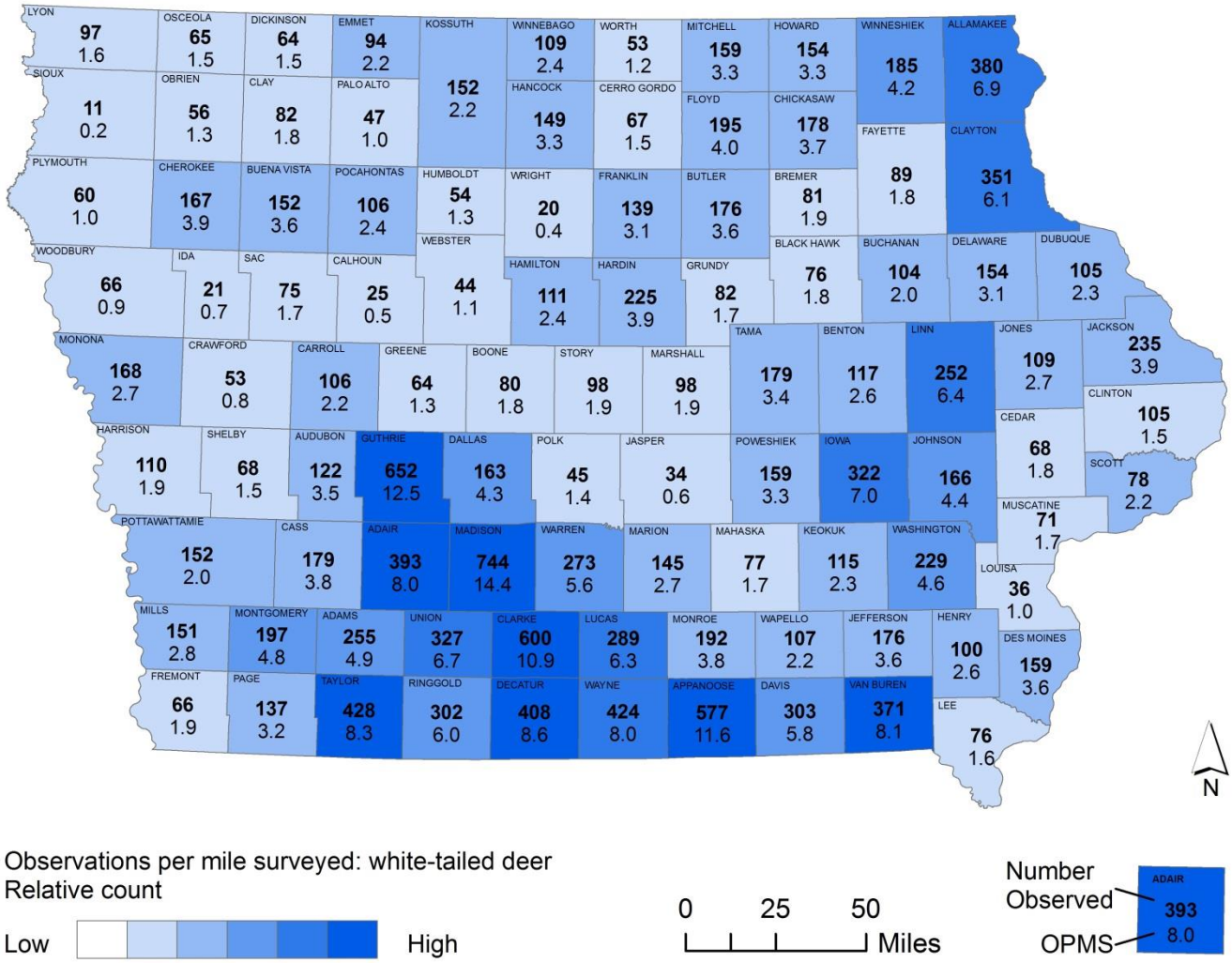


Figure 5. Total number of white-tailed deer observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

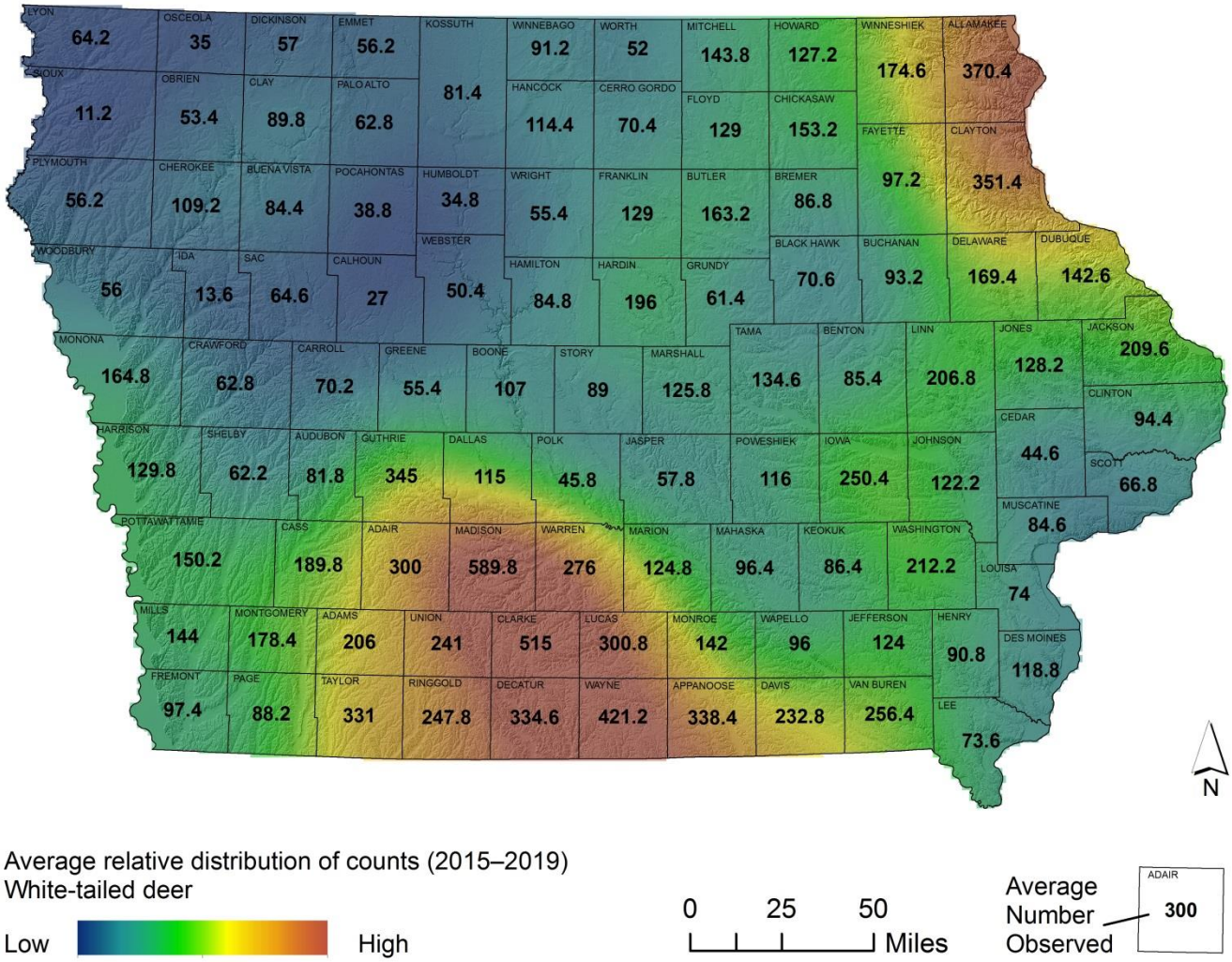
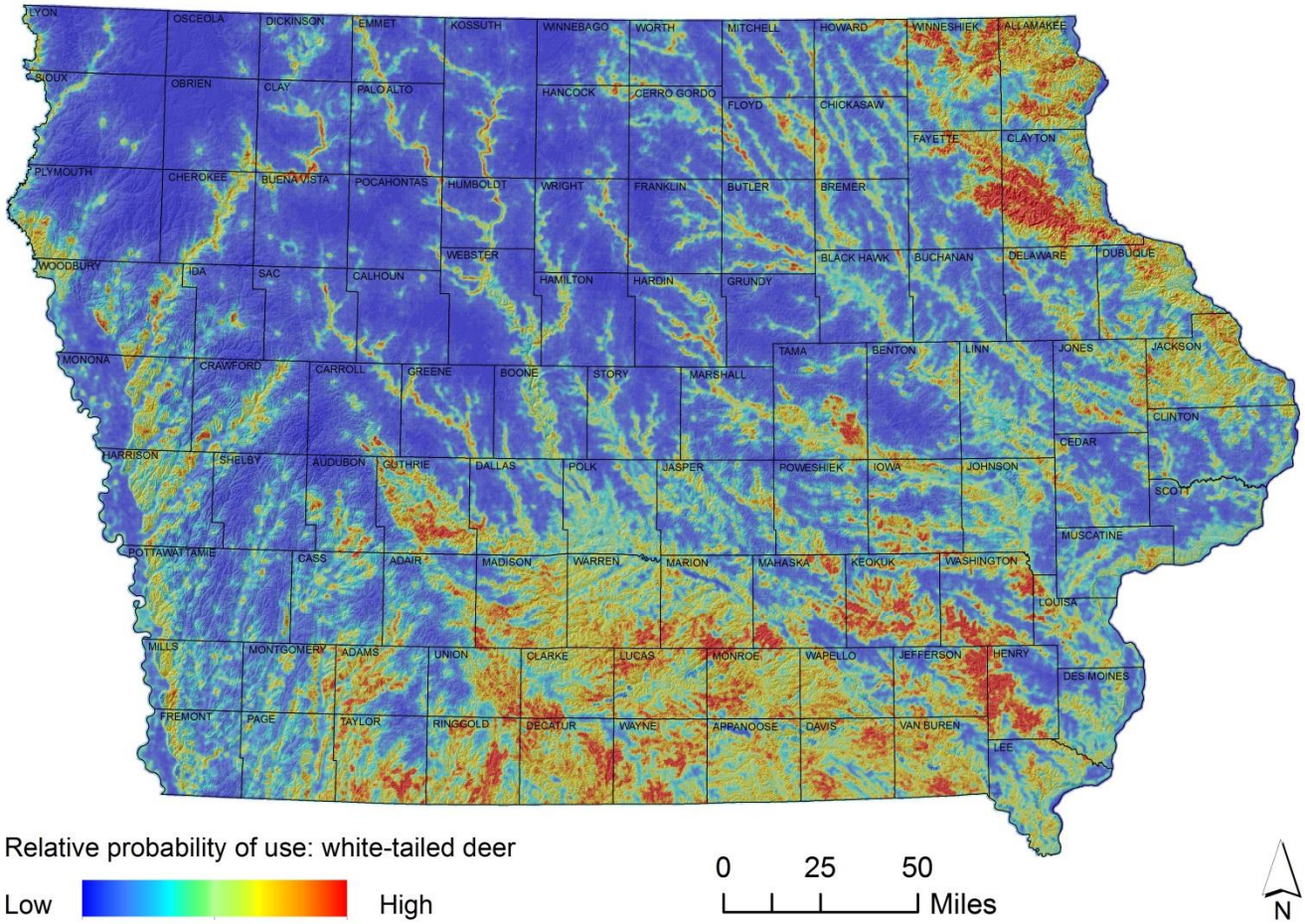


Figure 6. Relative distribution of average spring spotlight observations for white-tailed deer during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

Figure 7. Relative probability of use for white-tailed deer in Iowa, USA, based on a resource selection function (RSF) model using a presence-only study design and 11 land cover variables (see Kaminski et al. 2019 for details). The RSF model was predicted using spotlight observations from 2012–2016 and the fit of the model was tested using 2017 observations and *k*-fold cross validation and linear regression (R^2 = 0.95; Johnson et al. 2006). Predictions are equivalent to habitat suitability in which high values indicate areas of higher relative habitat quality for deer (as a measure of habitat selection) and low values indicate lower habitat quality.



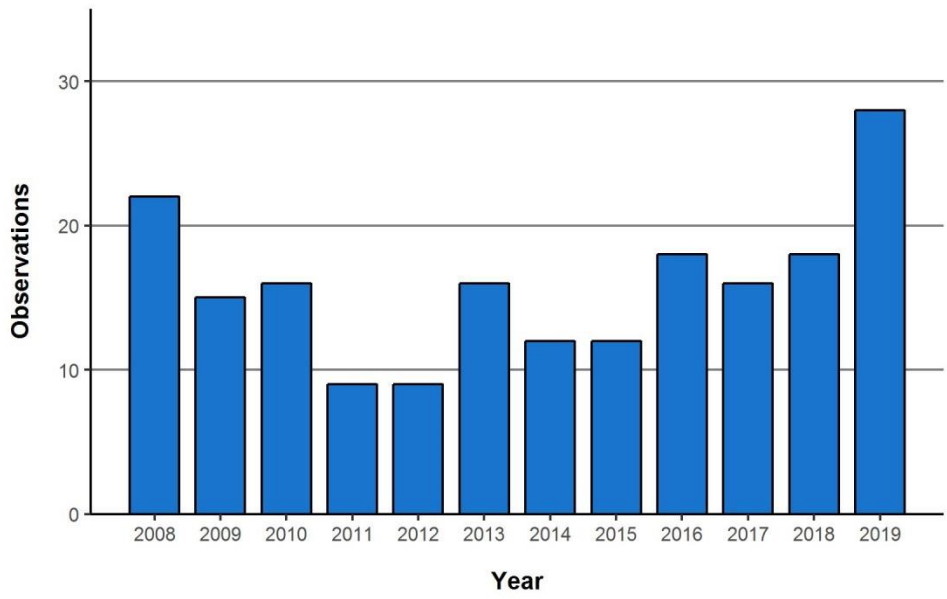


Figure 8. Total statewide American badger observations during the Iowa Spring Spotlight Survey, 2008–present.

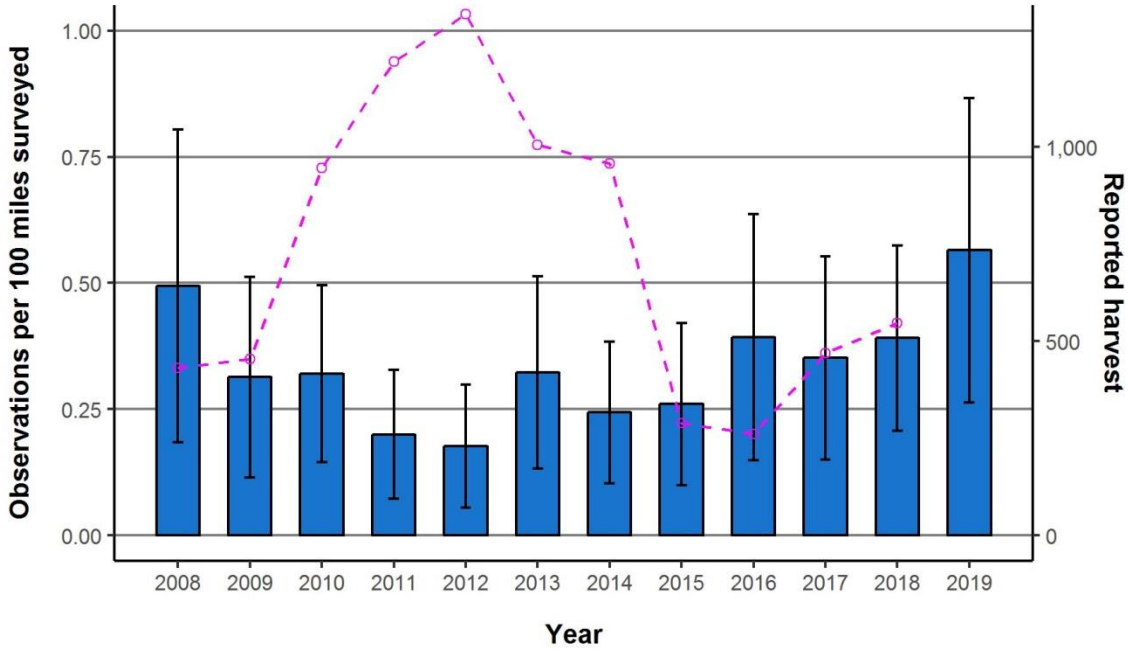


Figure 9. Average American badger observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide harvest.

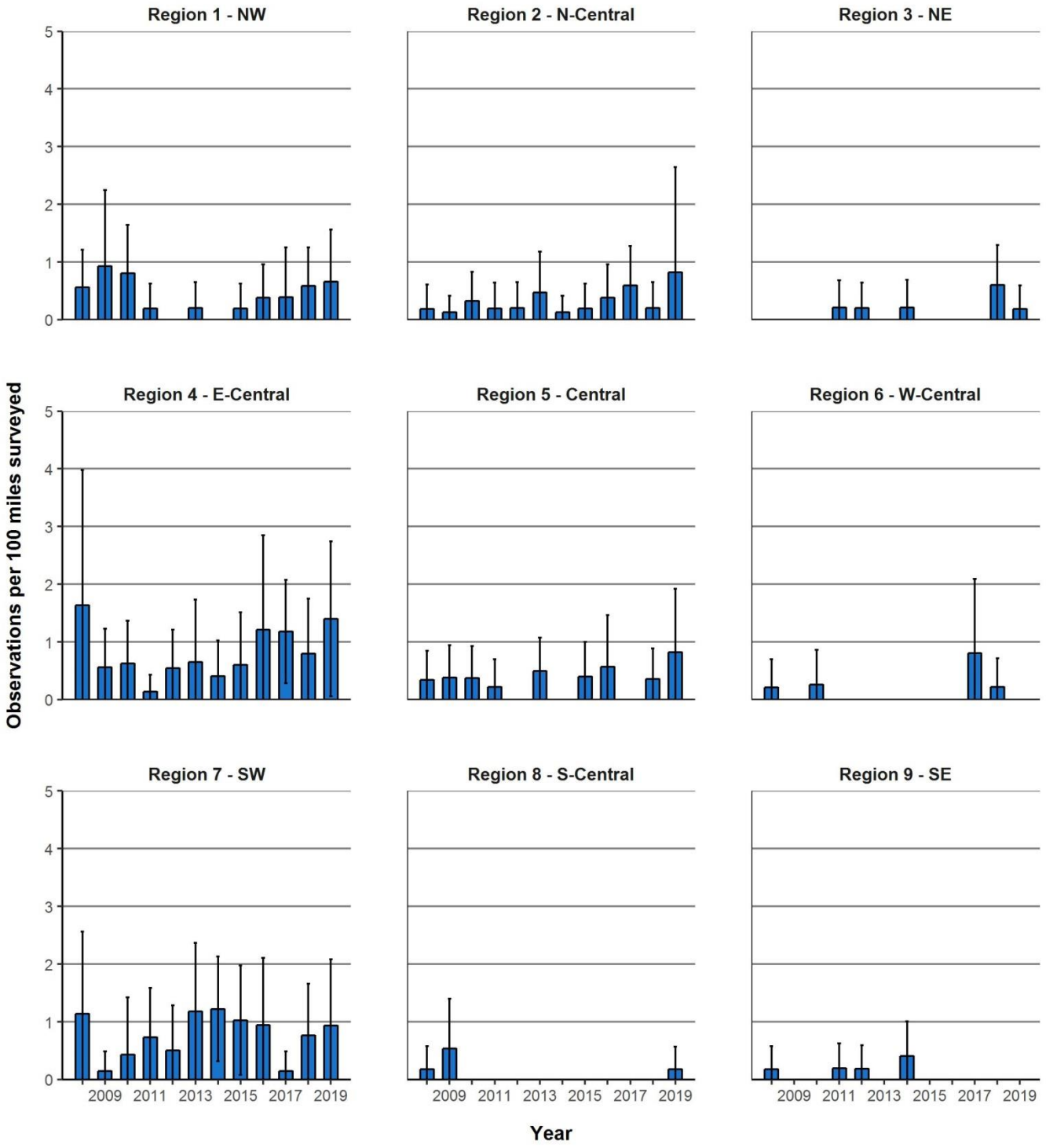


Figure 10. Average American badger observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

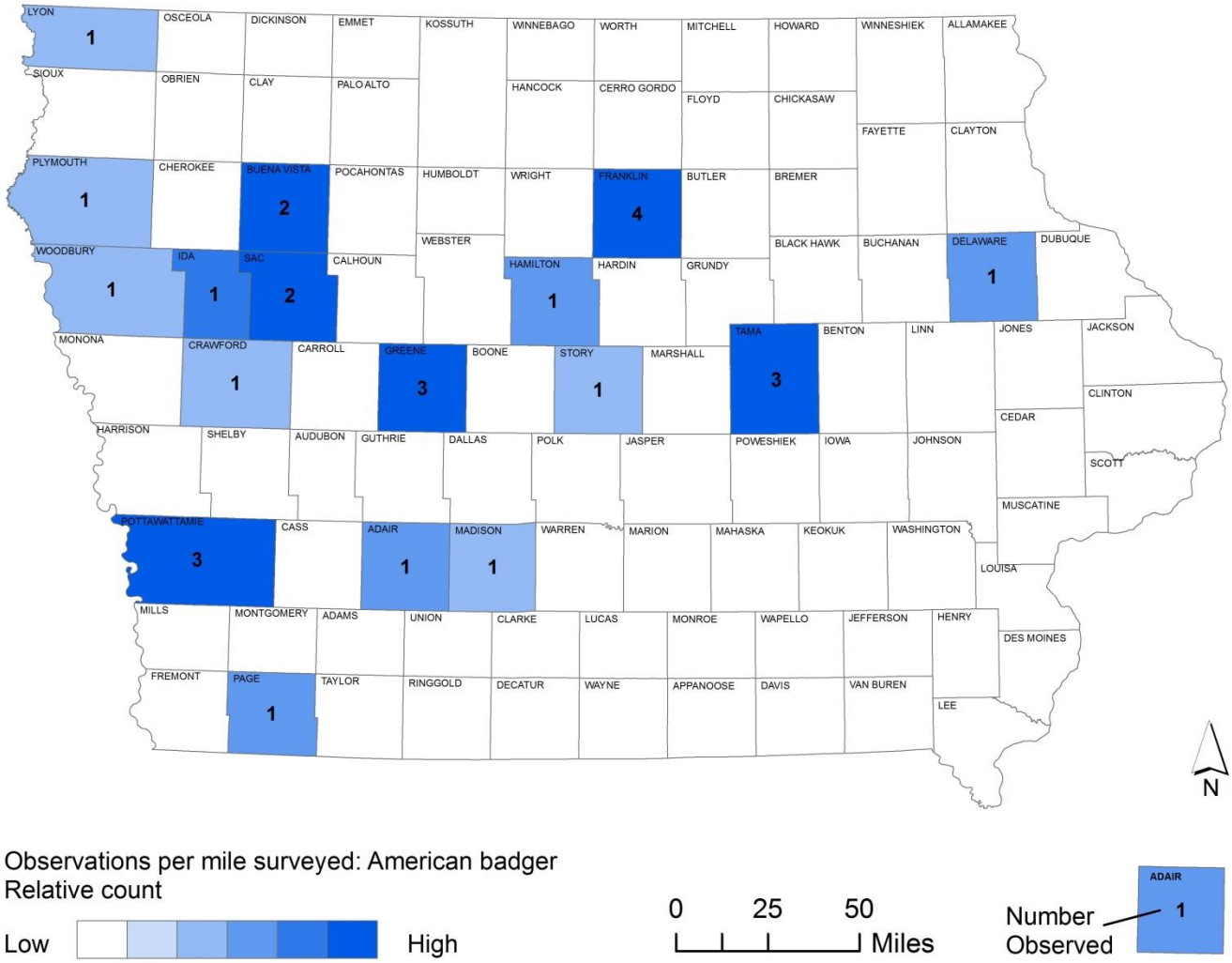


Figure 11. Total number of American badger observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

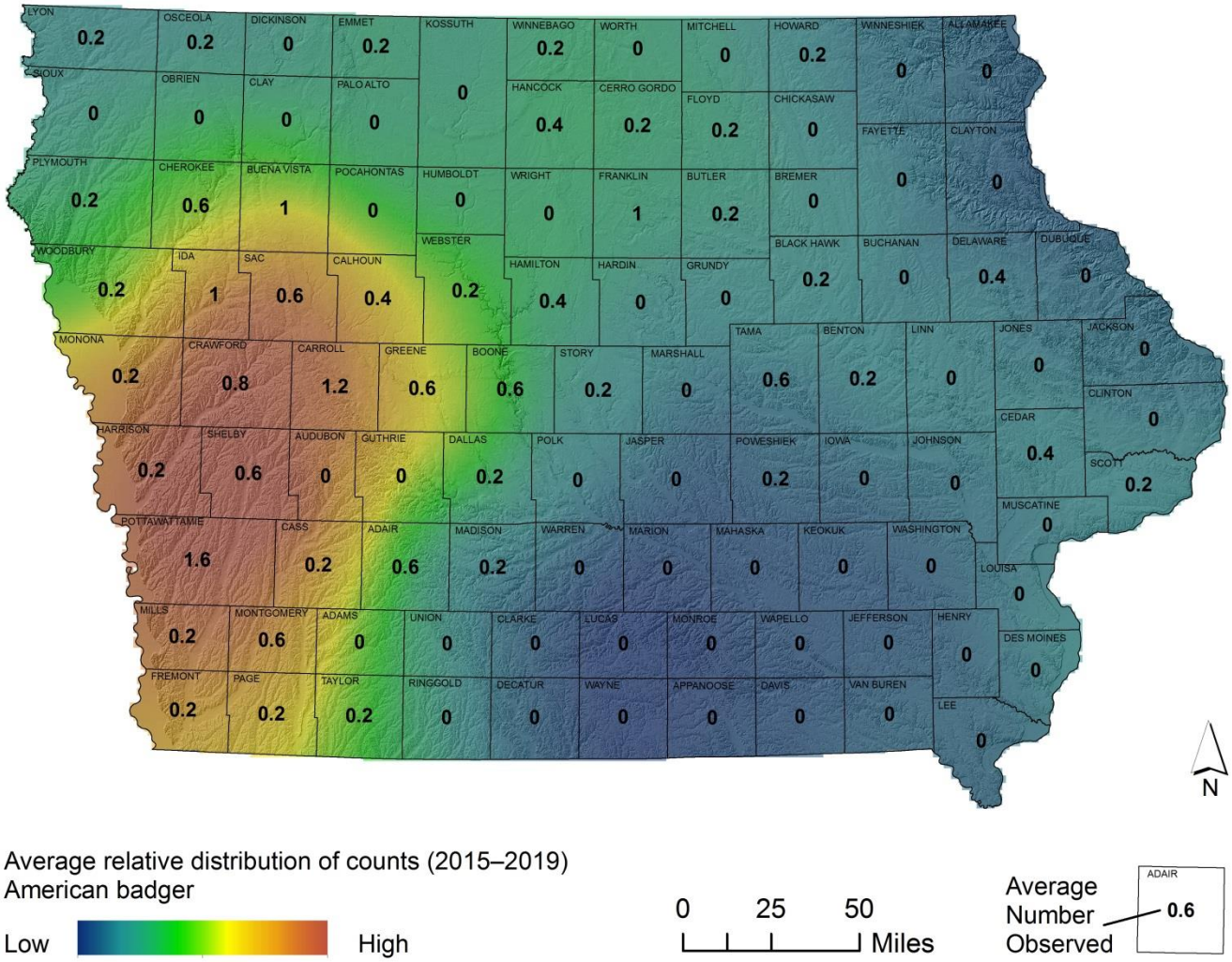


Figure 12. Relative distribution of average spring spotlight observations for American badger during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

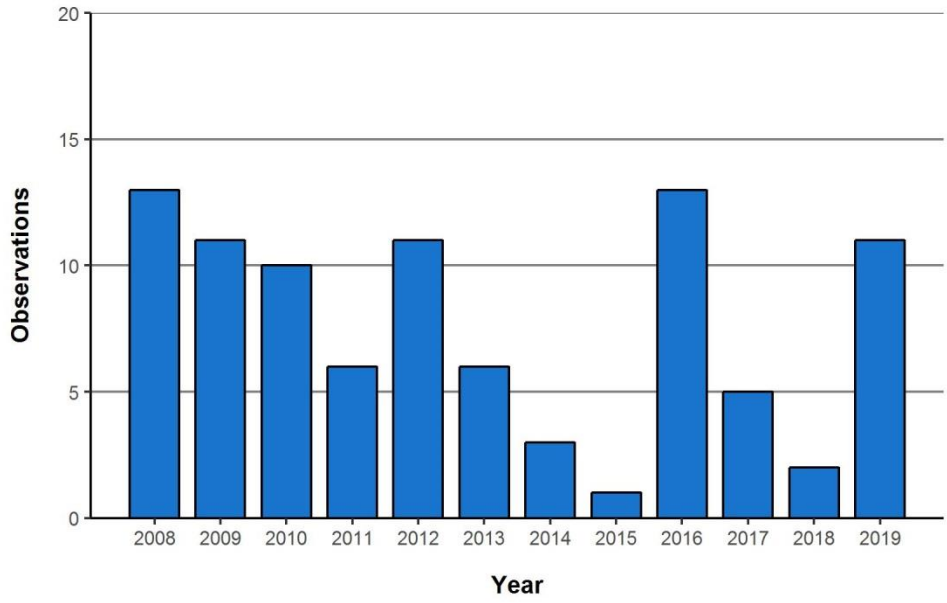


Figure 13. Total American mink observations by year during the Iowa Spring Spotlight Survey, 2008–present.

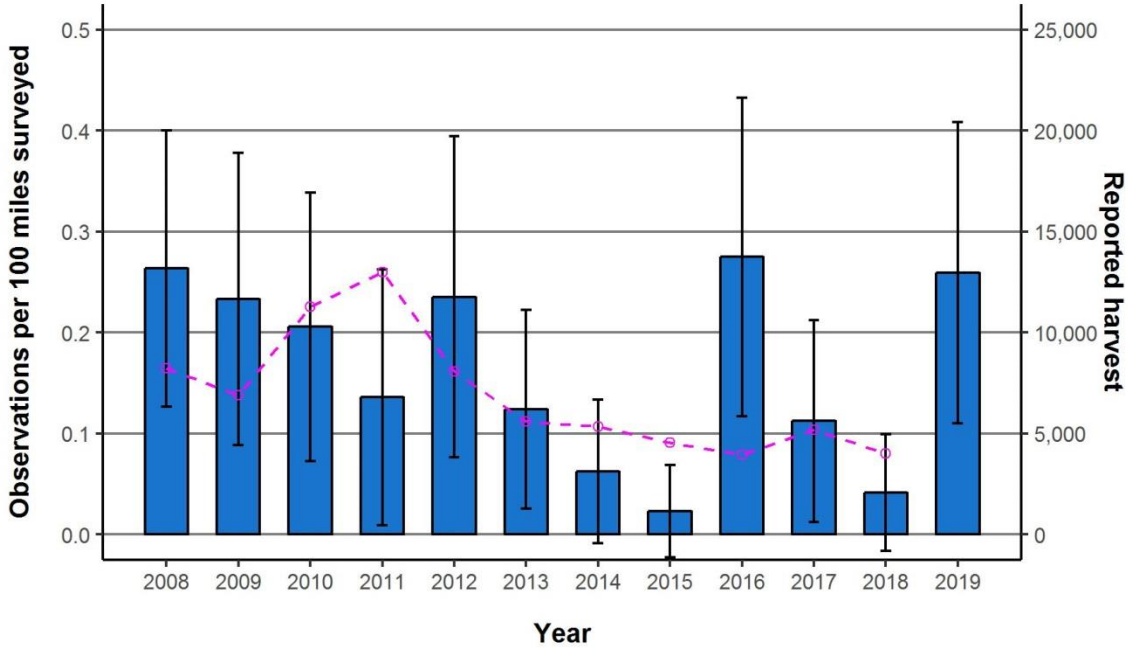


Figure 14. Average American mink observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide harvest.

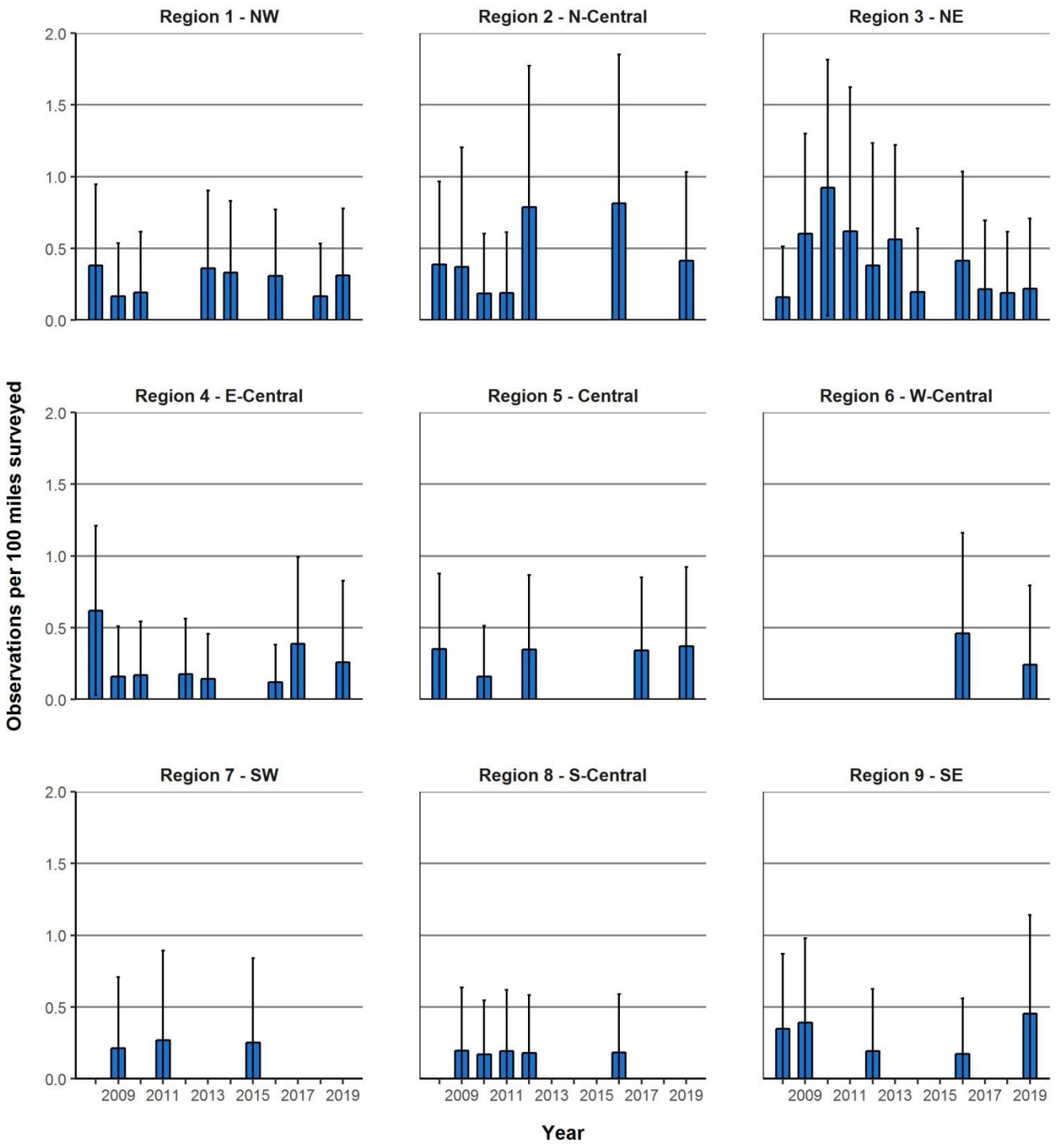


Figure 15. Average American mink observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

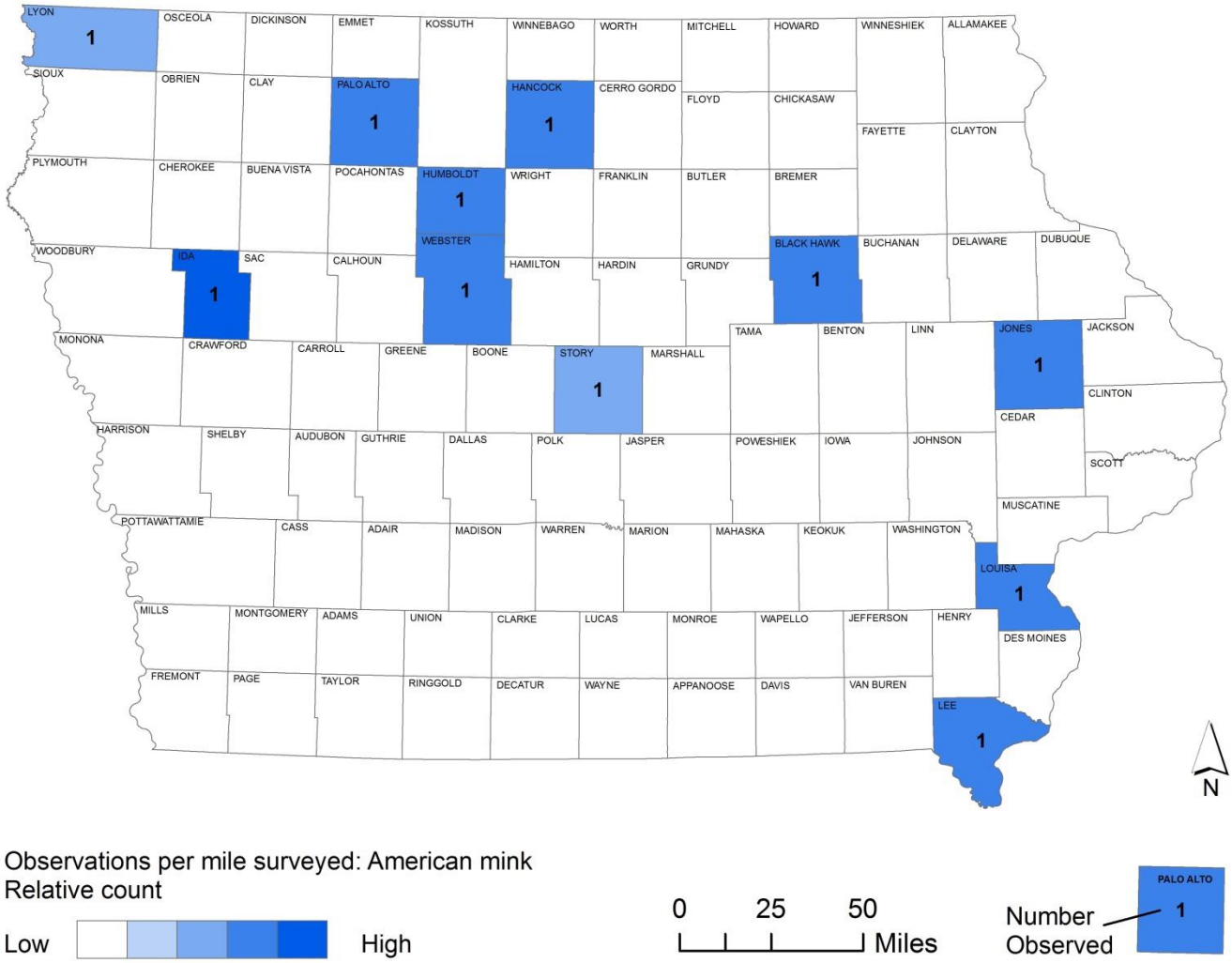


Figure 16. Total number of American mink observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

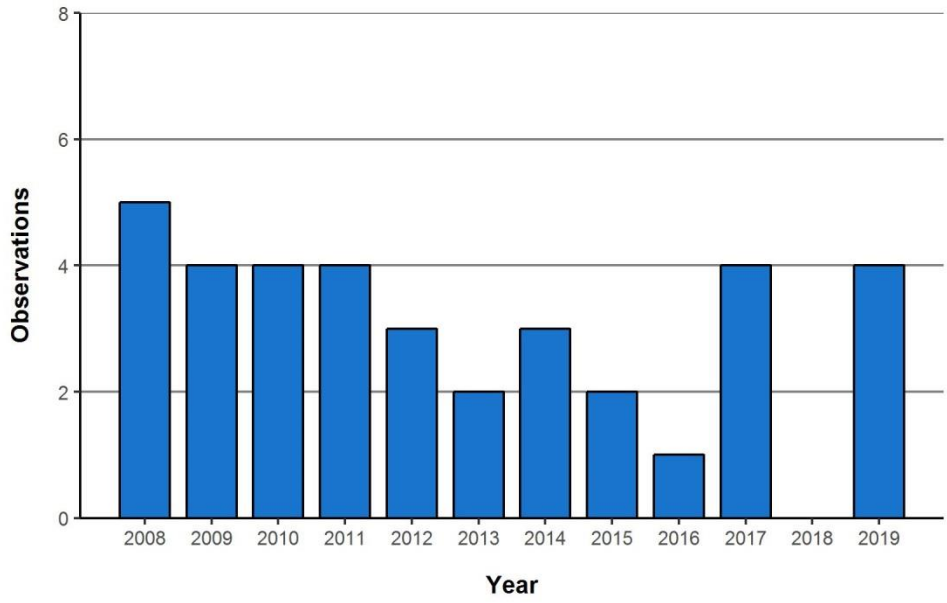


Figure 17. Total bobcat observations by year during the Iowa Spring Spotlight Survey, 2008–present.

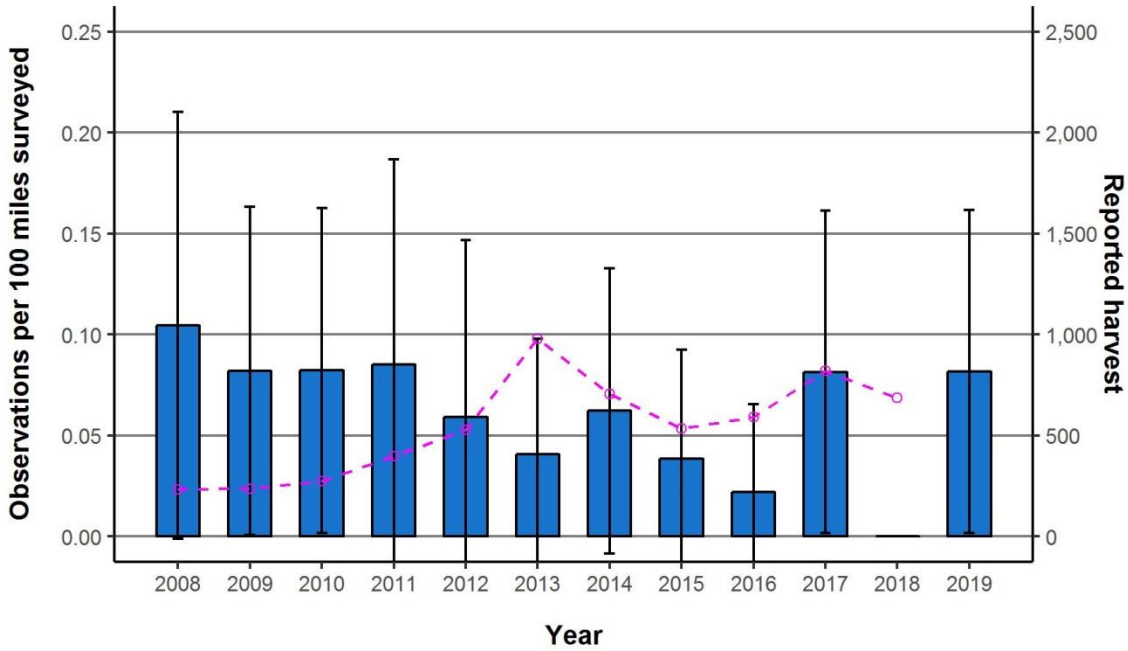


Figure 18. Average bobcat observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide harvest.

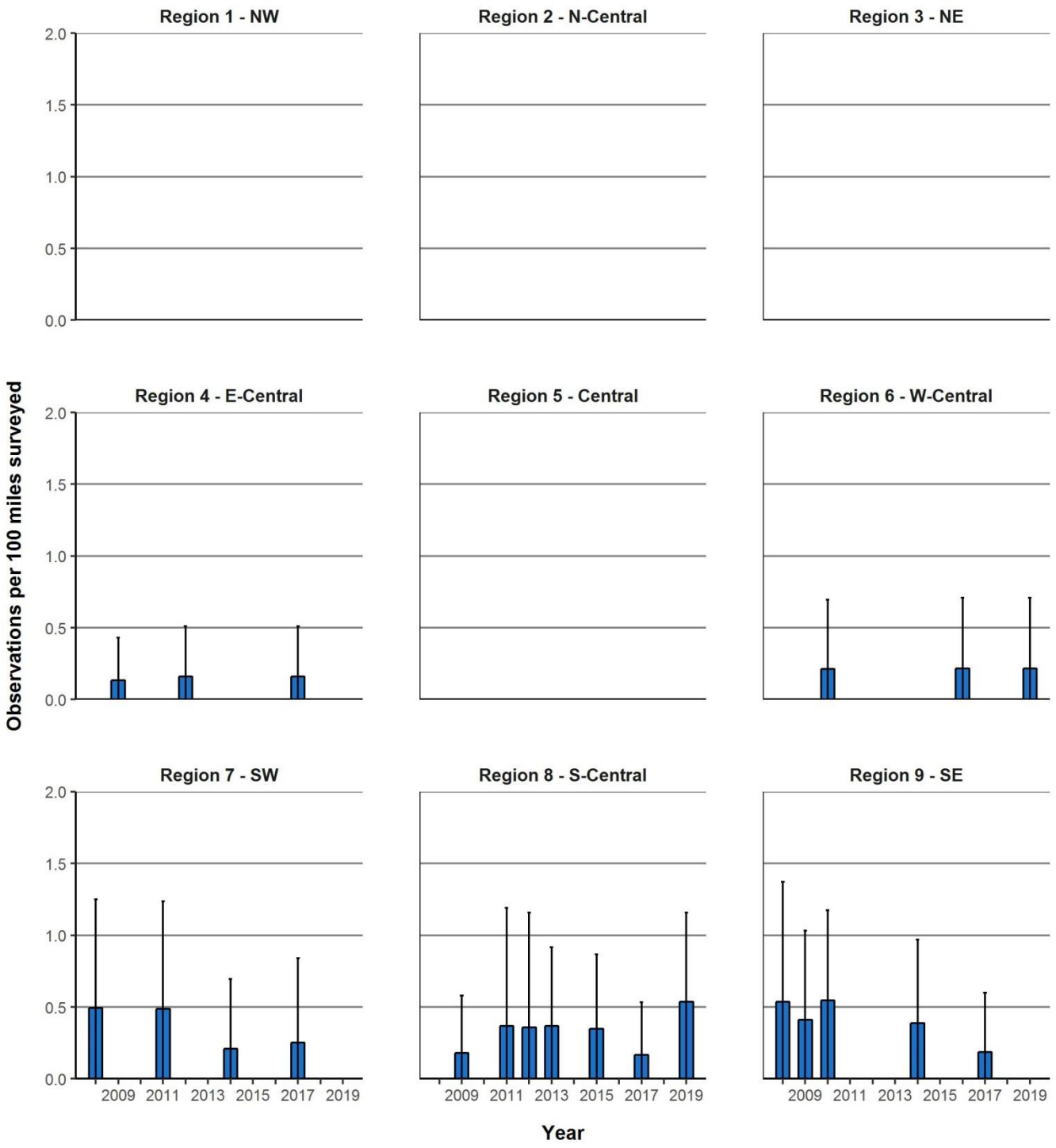


Figure 19. Average bobcat observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

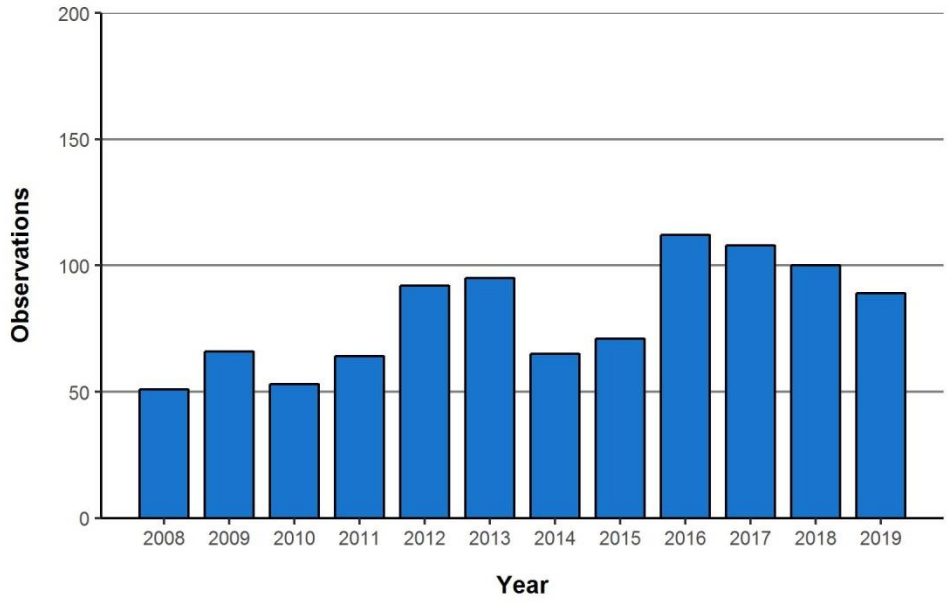


Figure 20. Total coyote observations by year during the Iowa Spring Spotlight Survey, 2008–present.

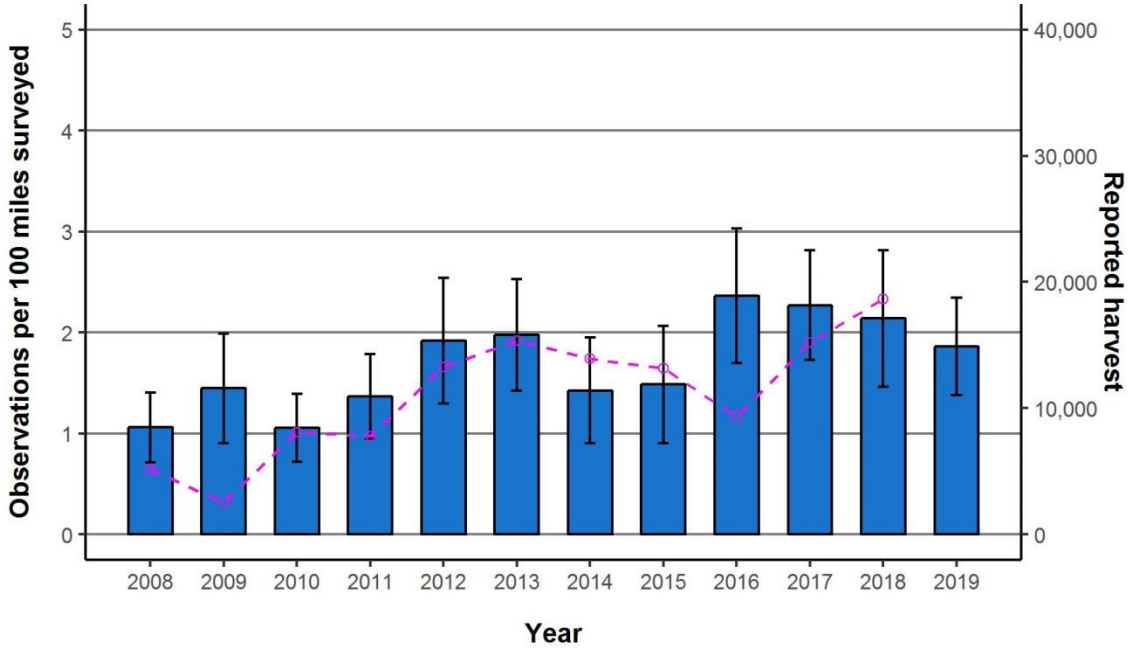


Figure 21. Average coyote observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide harvest.

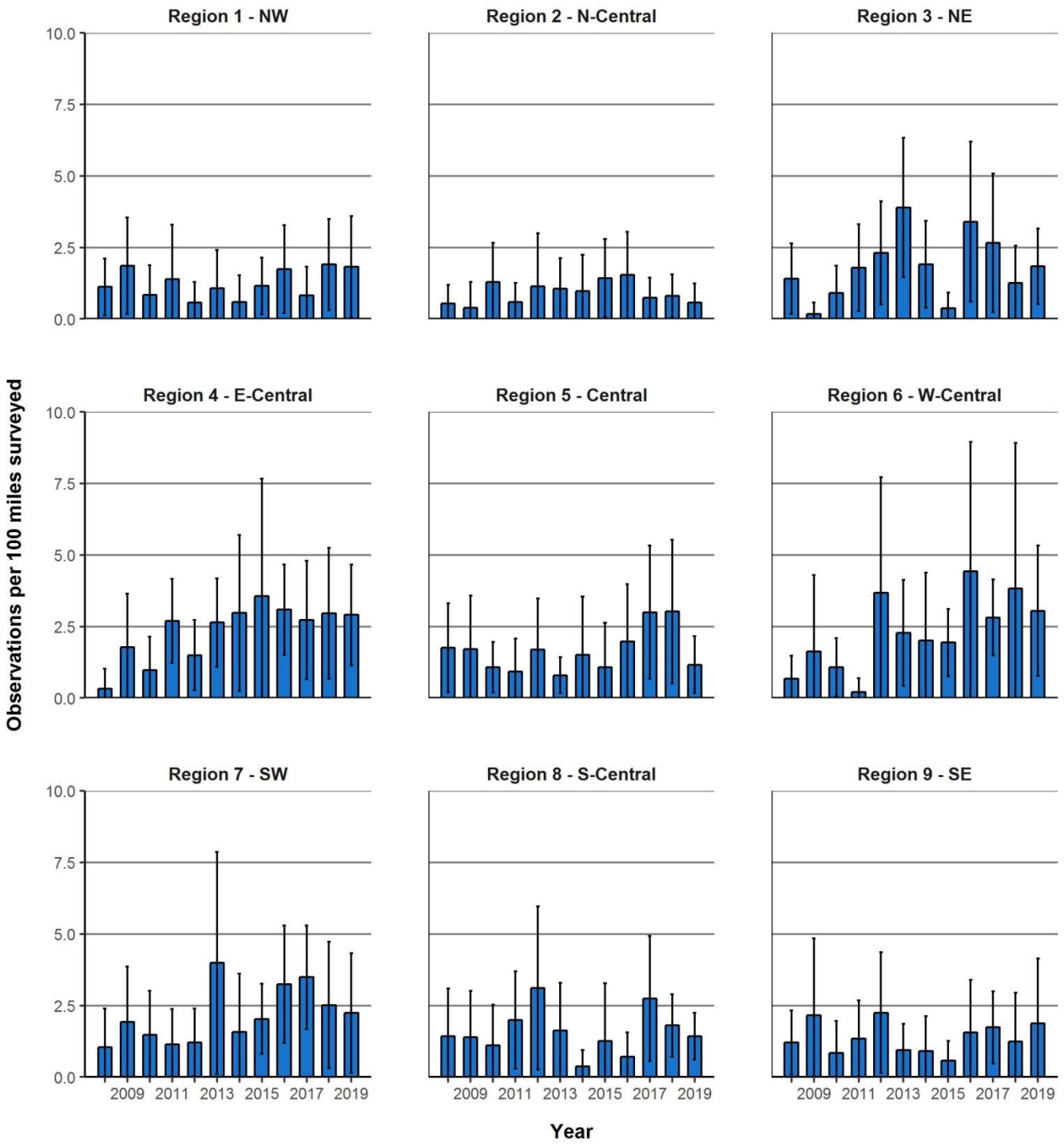


Figure 22. Average coyote observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

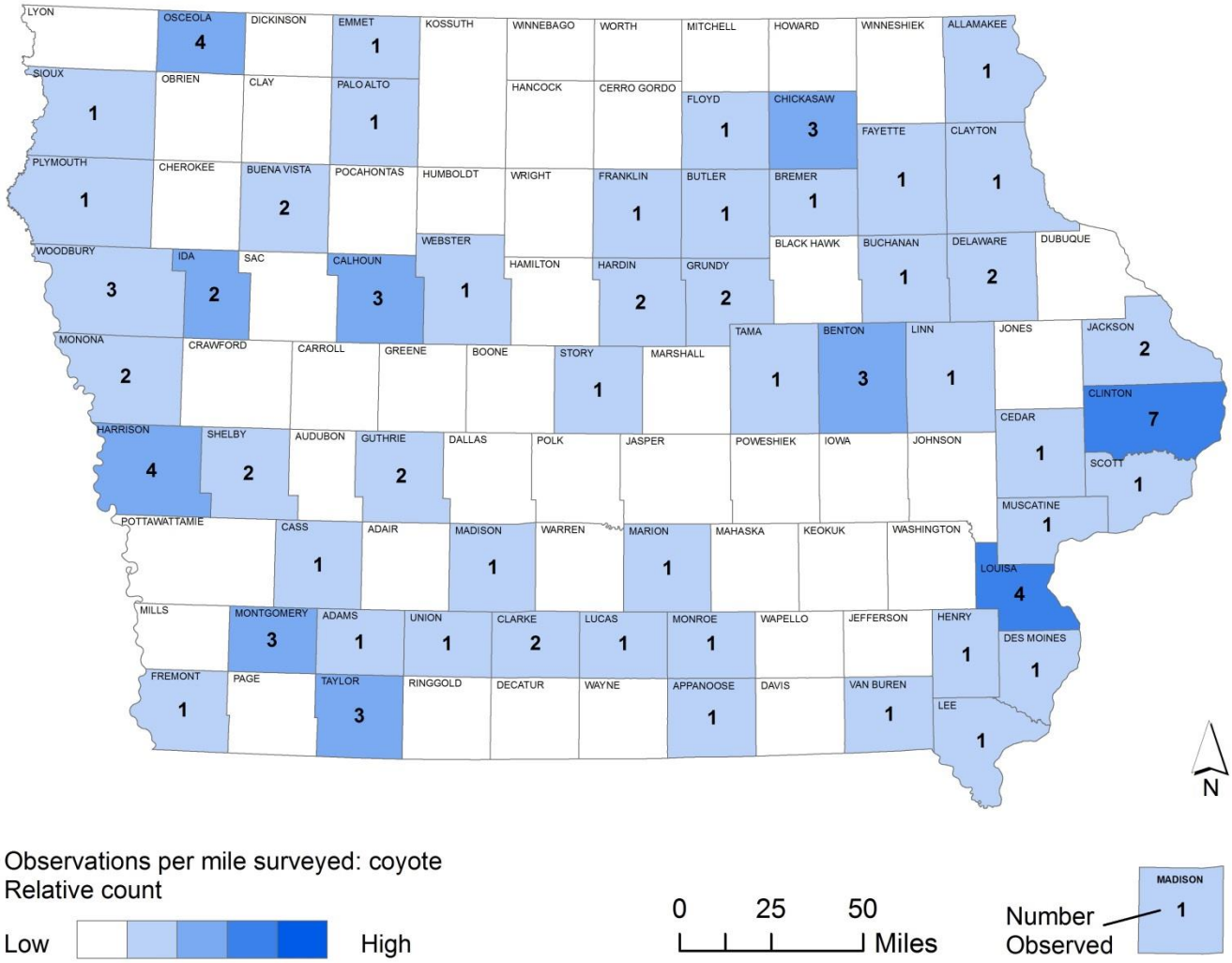


Figure 23. Total number of coyote observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

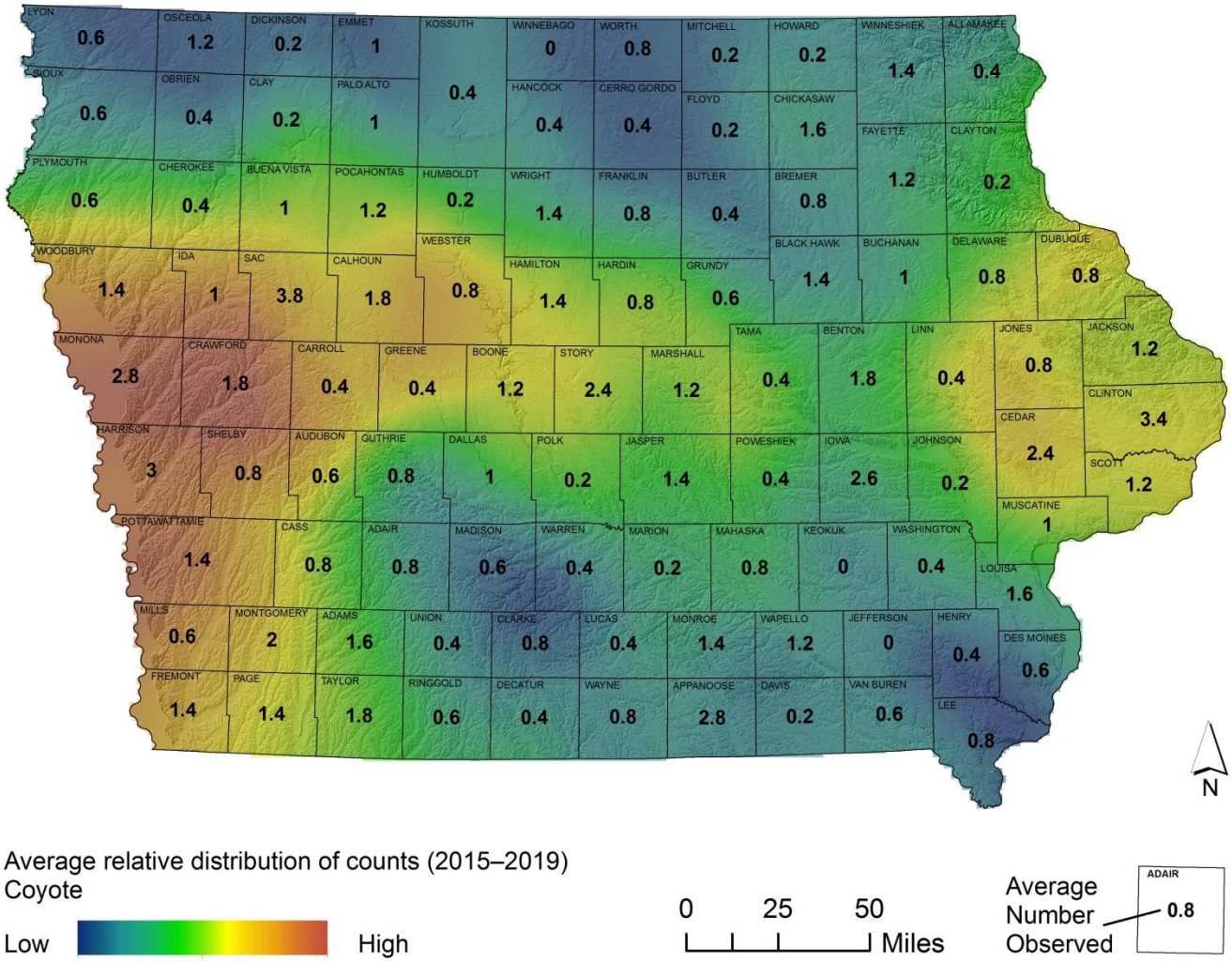


Figure 24. Relative distribution of average spring spotlight observations for coyote during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

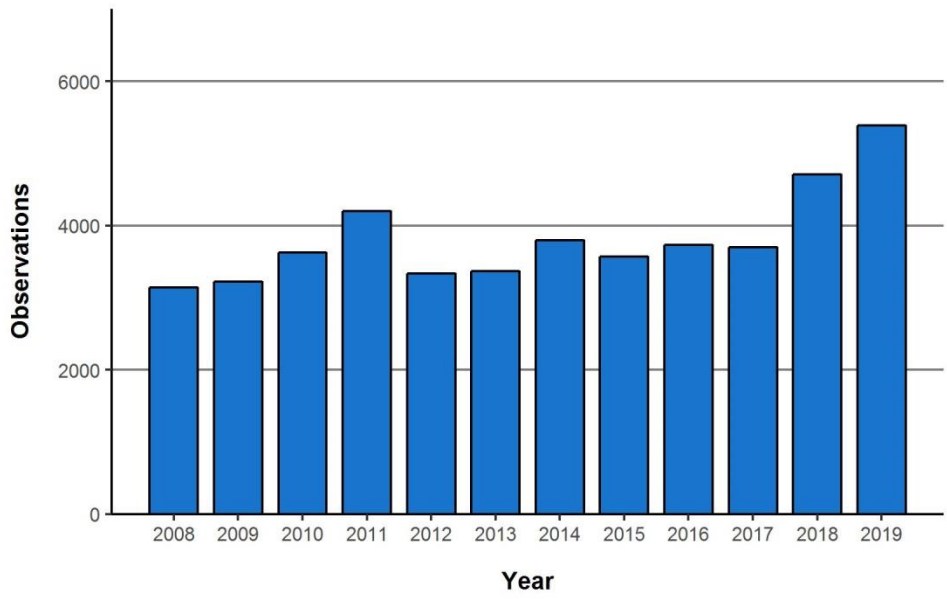


Figure 25. Total Northern raccoon observations by year during the Iowa Spring Spotlight Survey, 2008–present.

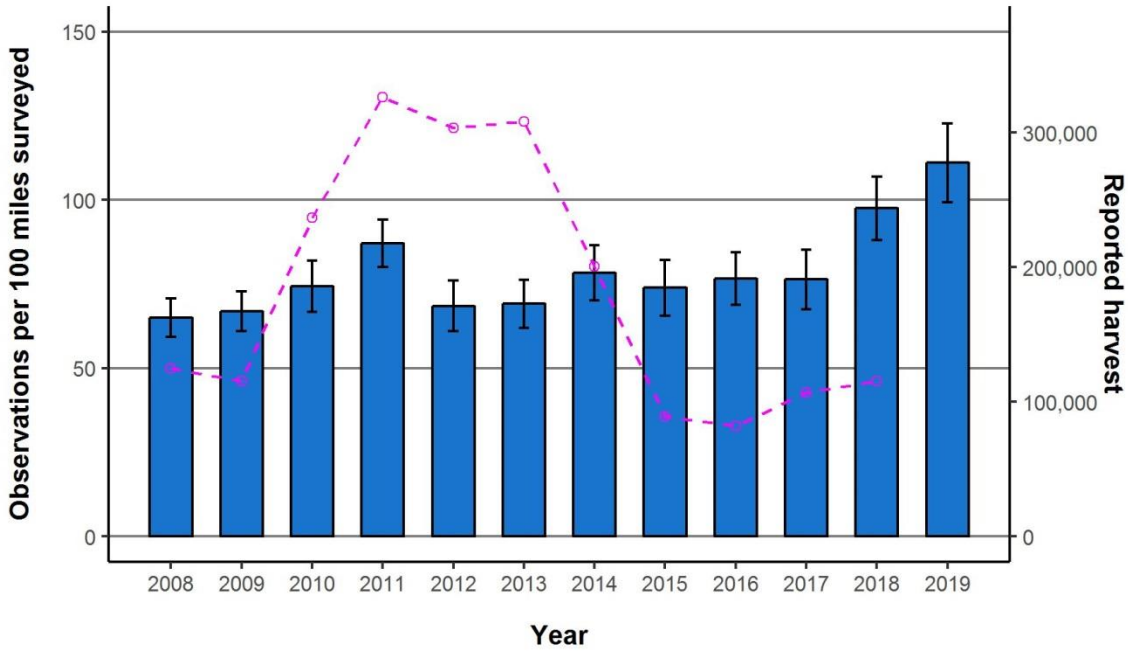


Figure 26. Average Northern raccoon observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide harvest.

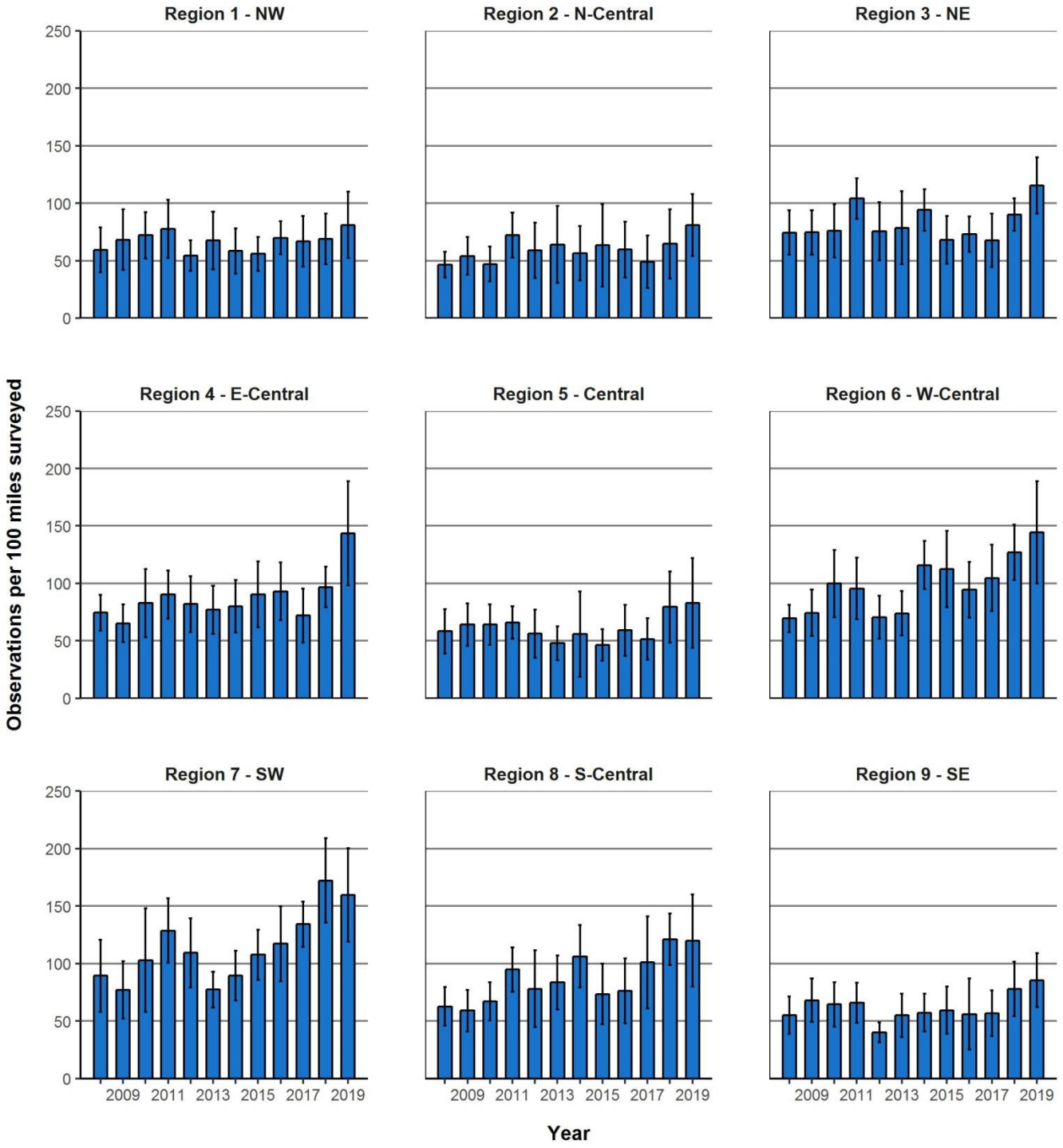


Figure 27. Average Northern raccoon observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

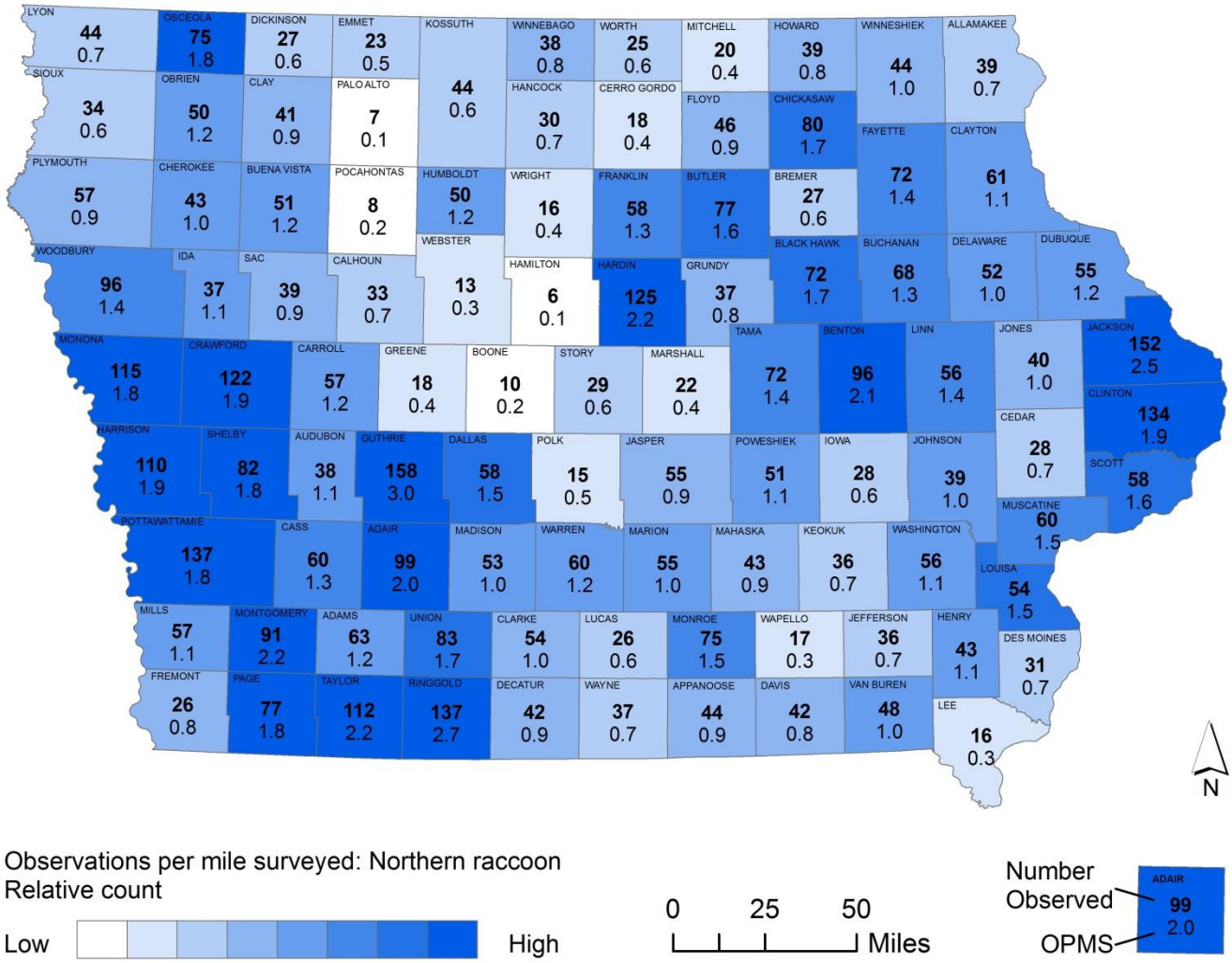


Figure 28. Total number of Northern raccoon observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

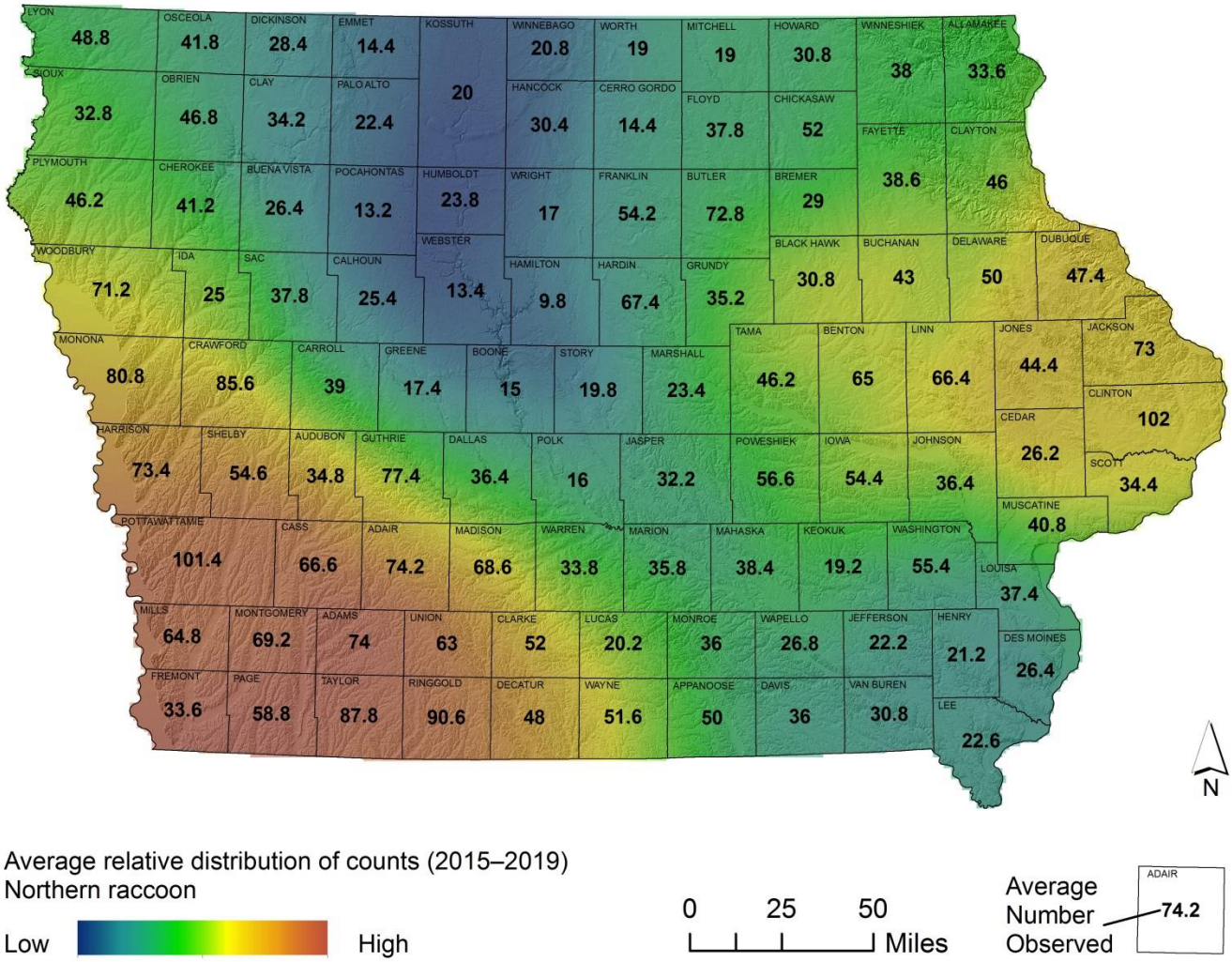


Figure 29. Relative distribution of average spring spotlight observations for Northern raccoon during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

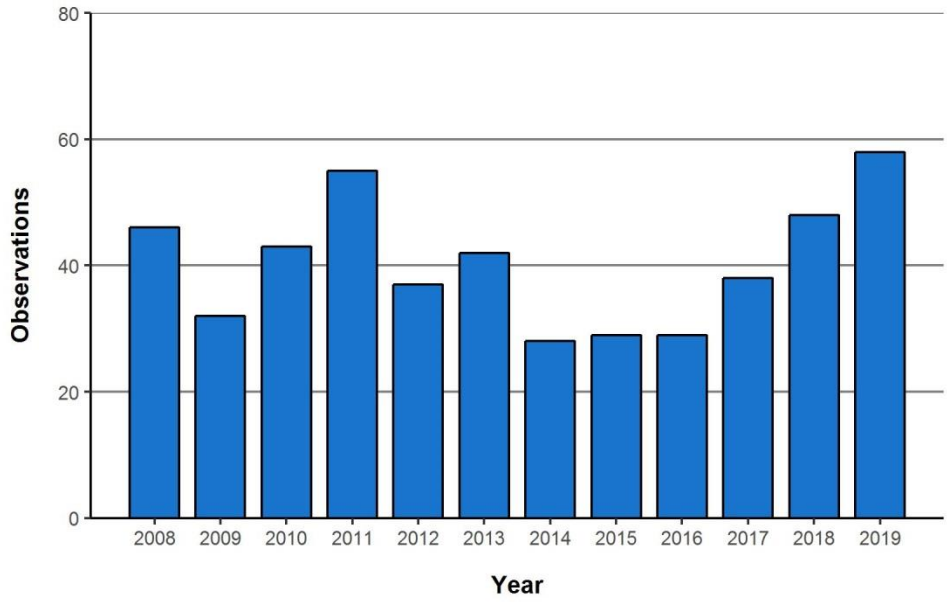


Figure 30. Total red fox observations by year during the Iowa Spring Spotlight Survey, 2008–present.

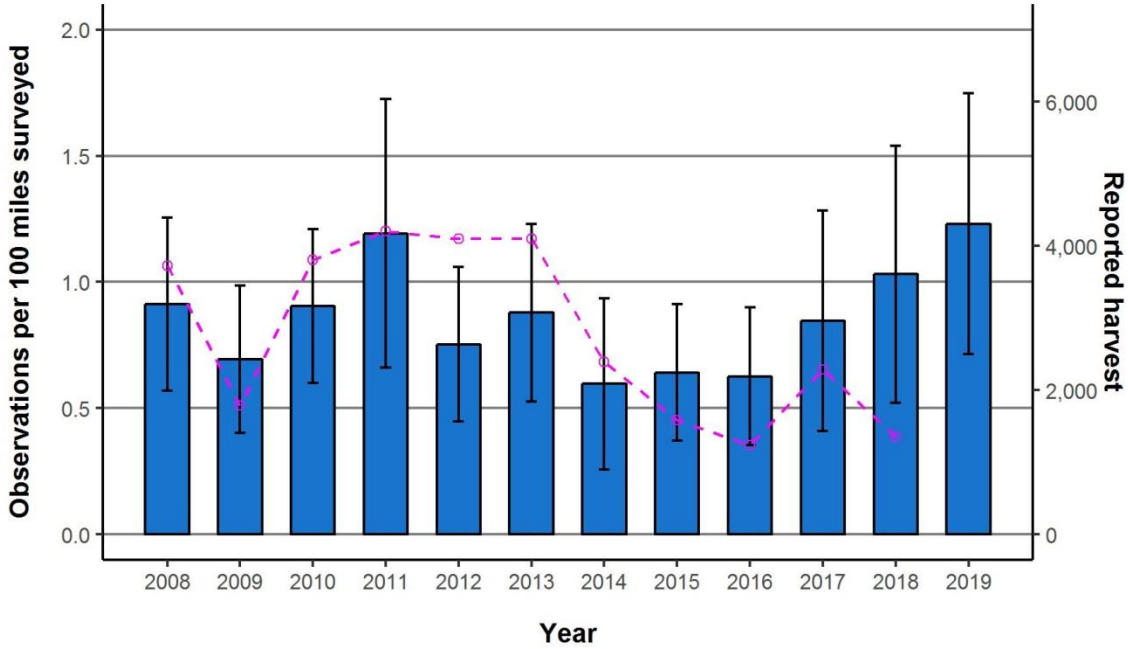


Figure 31. Average red fox observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide harvest.

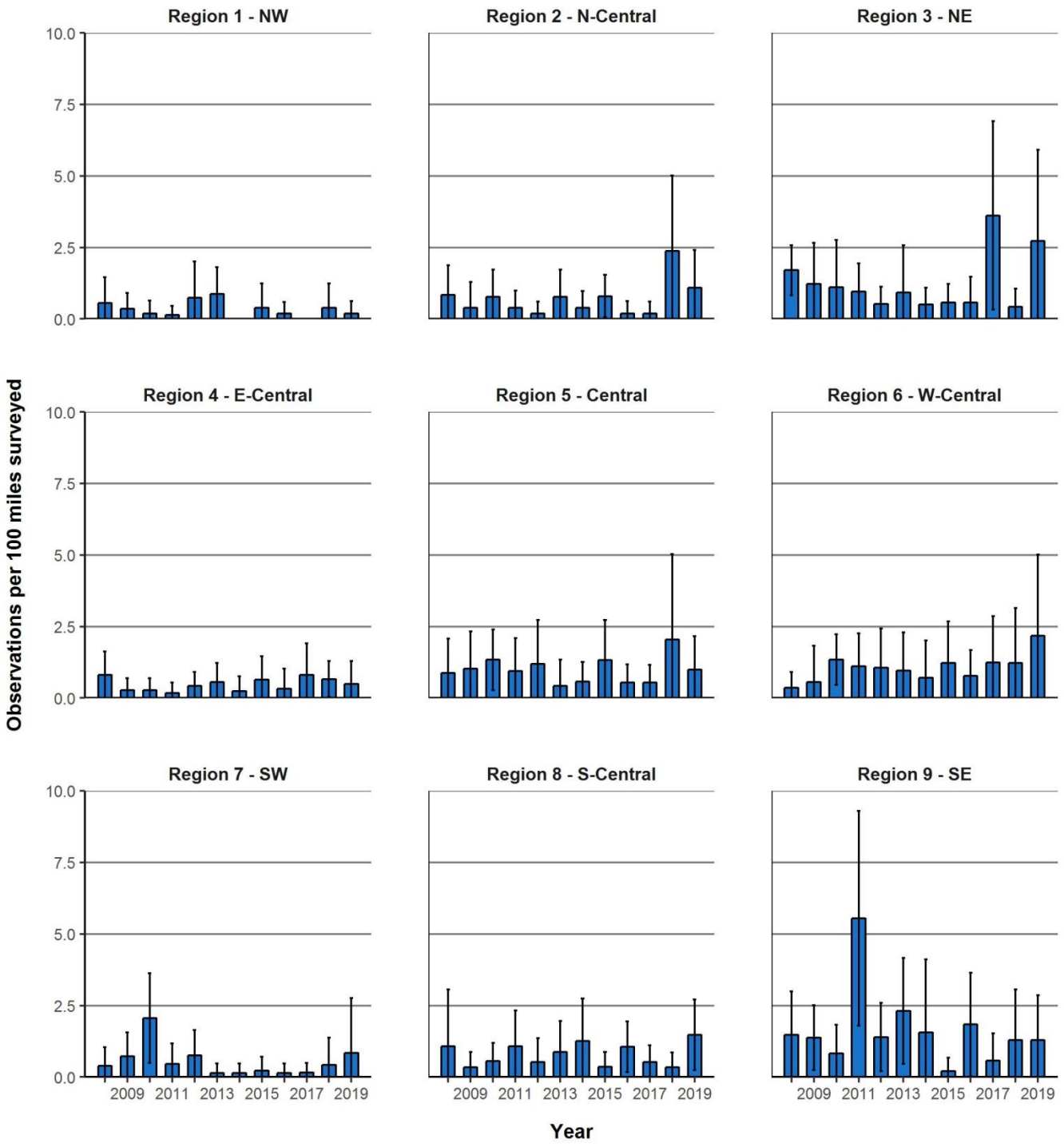


Figure 32. Average red fox observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Red fox includes observations listed as "fox" due to the rarity of gray fox in the state.

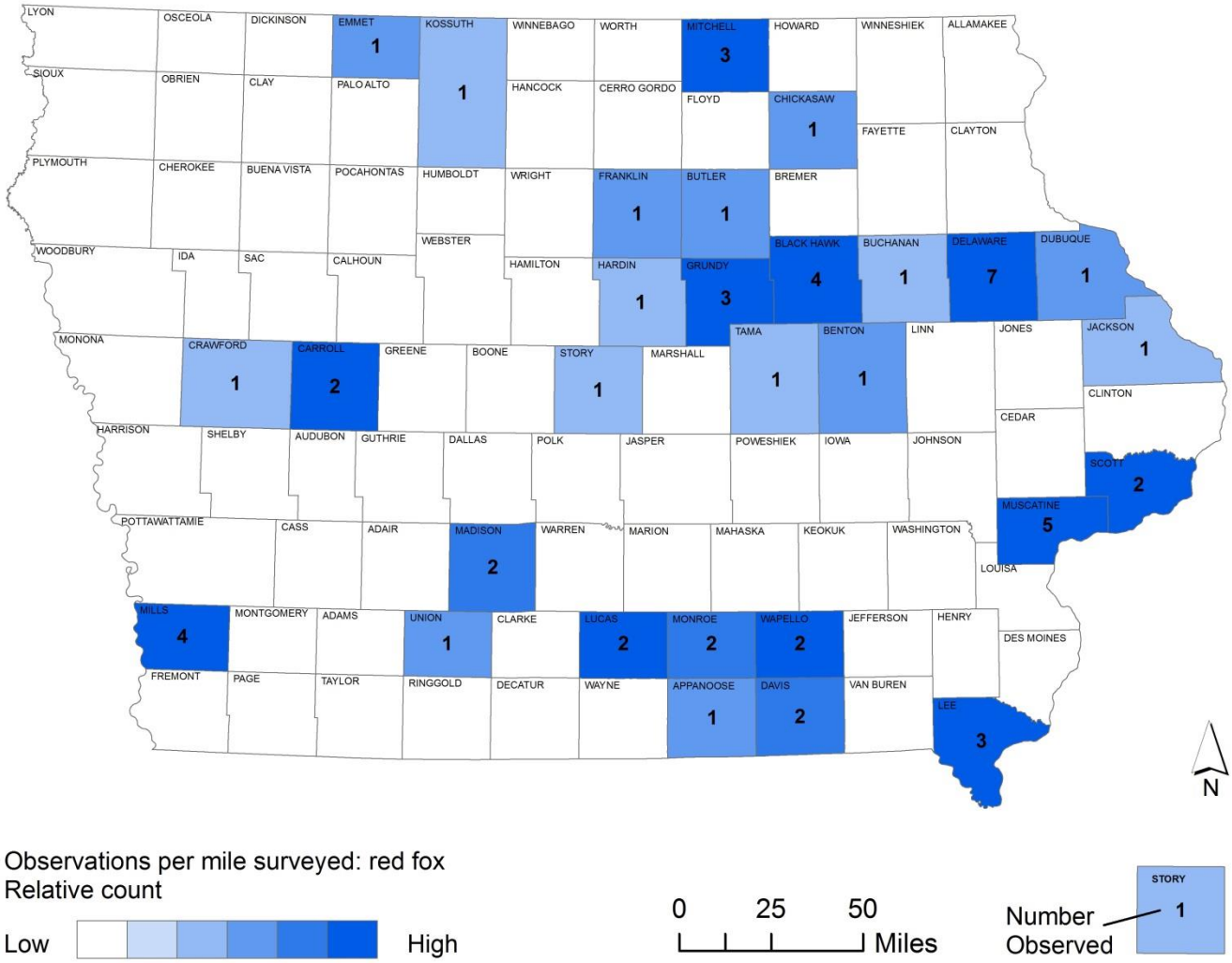


Figure 33. Total number of red fox observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

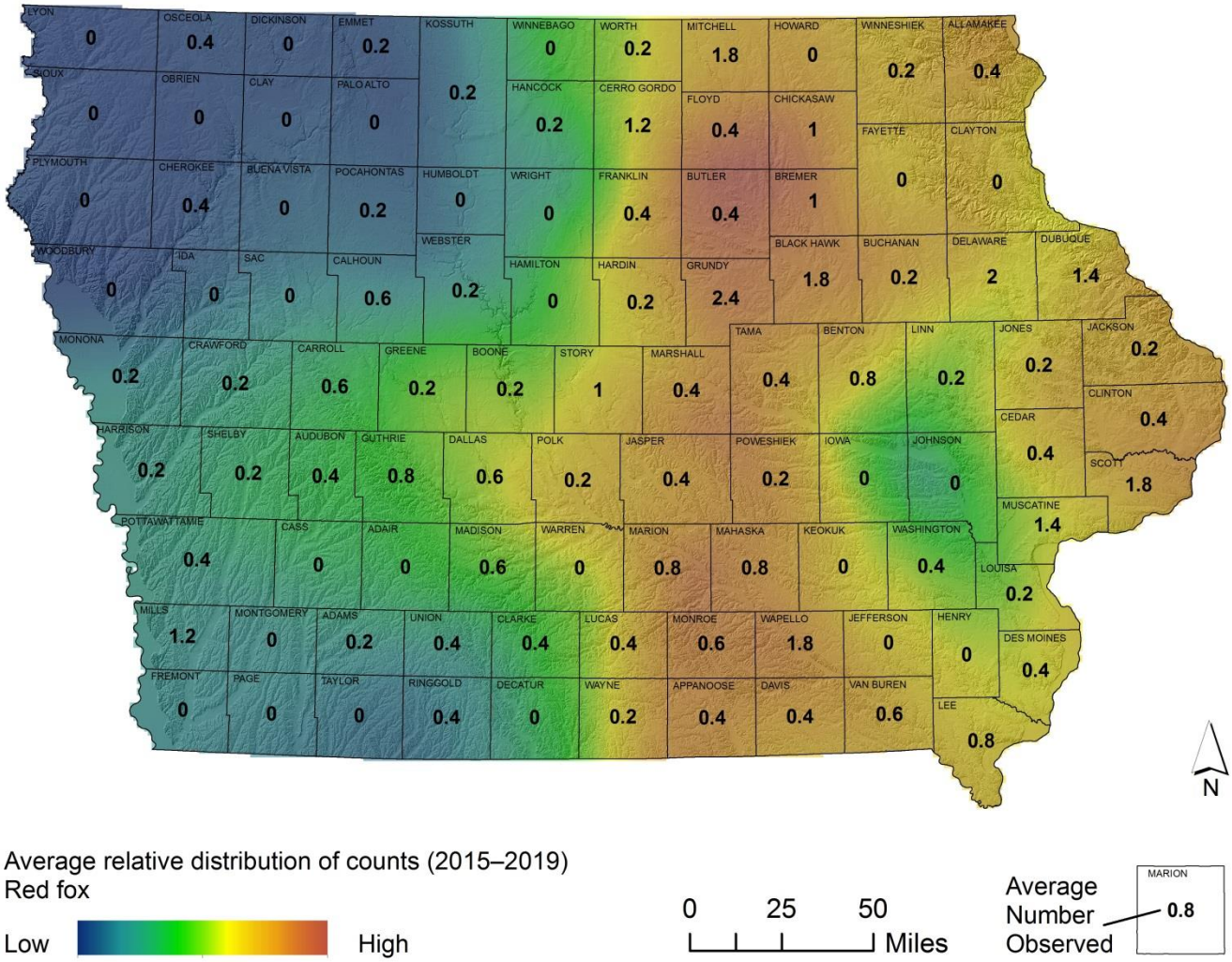


Figure 34. Relative distribution of average spring spotlight observations for red fox during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

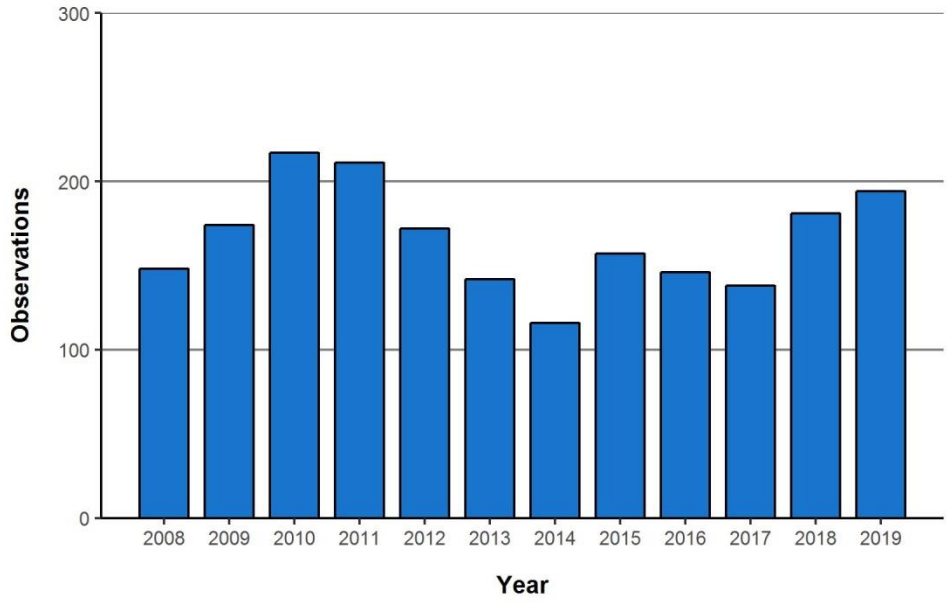


Figure 35. Total skunk observations by year during the Iowa Spring Spotlight Survey, 2008–present.

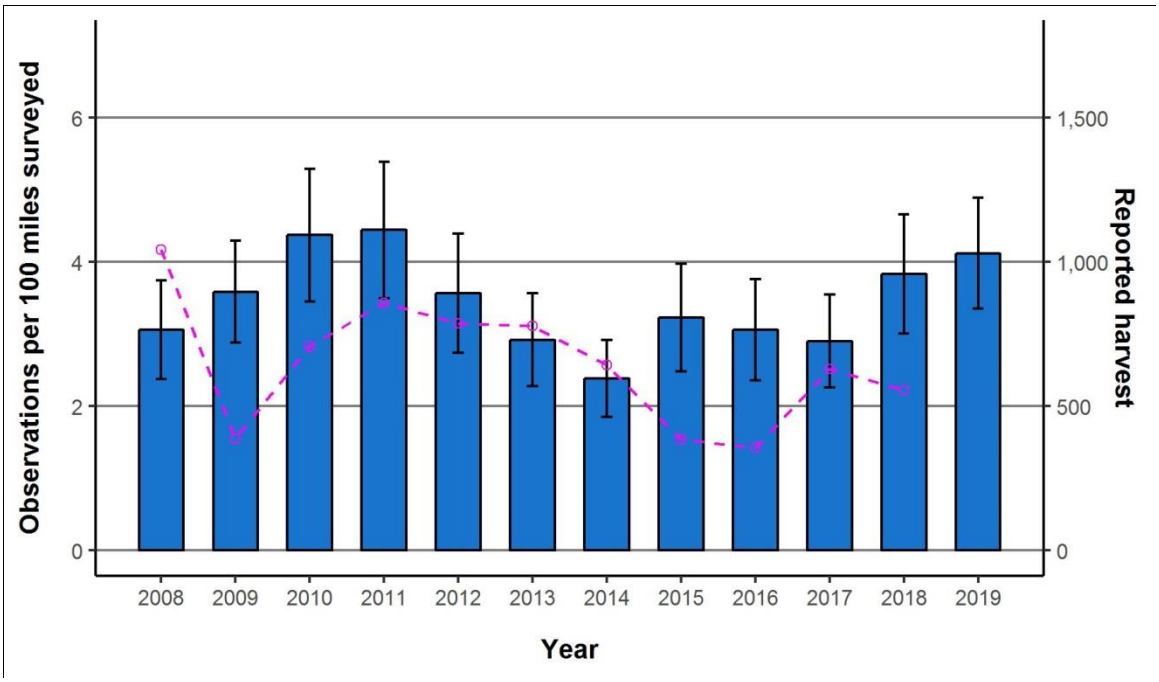


Figure 36. Average skunk observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Skunk includes all observations recorded as “striped skunk” and “skunk” and likely includes none or few spotted skunk observations due to the rarity of the species in the state. Dashed line indicates the reported statewide harvest.

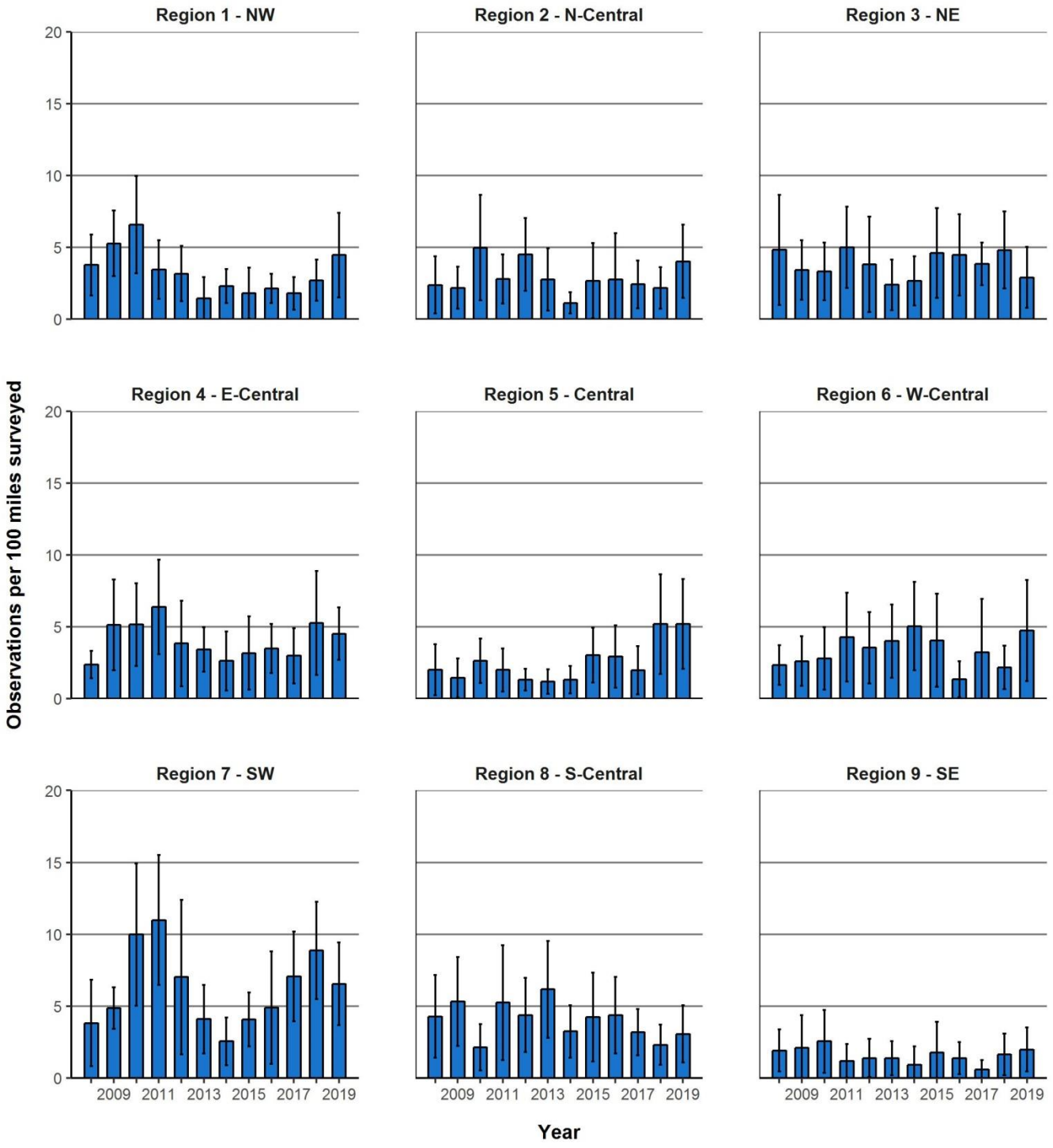


Figure 37. Average skunk observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Skunk includes all observations recorded as "striped skunk" and "skunk" and likely includes none or few spotted skunk observations due to the rarity of the species in the state.

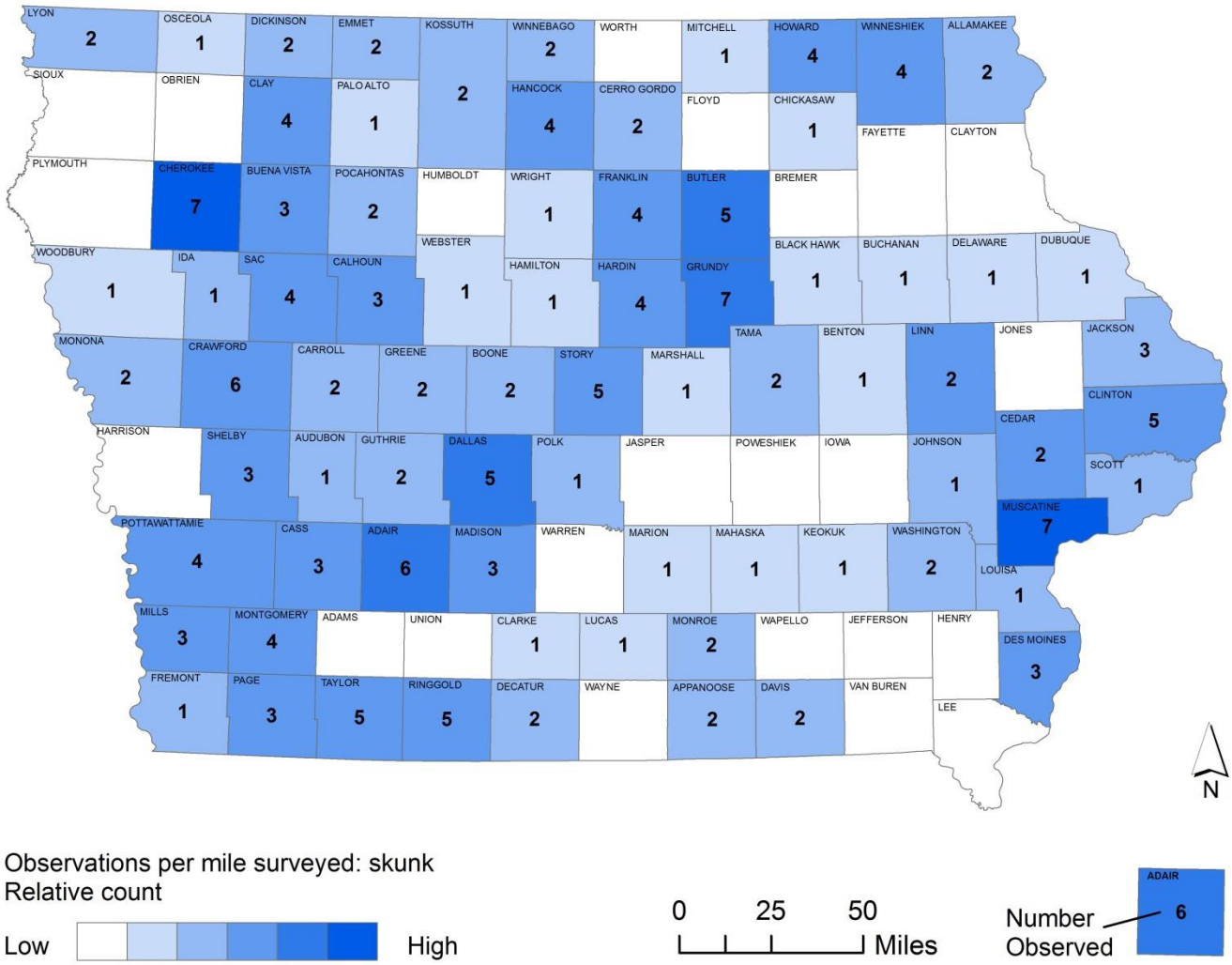


Figure 38. Total number of skunk observations per county. Color shading indicates the number of observations per mile surveyed (OPMS). Skunk includes all observations recorded as “striped skunk” and “skunk” and likely includes none or few spotted skunk observations due to the rarity of the species in the state.

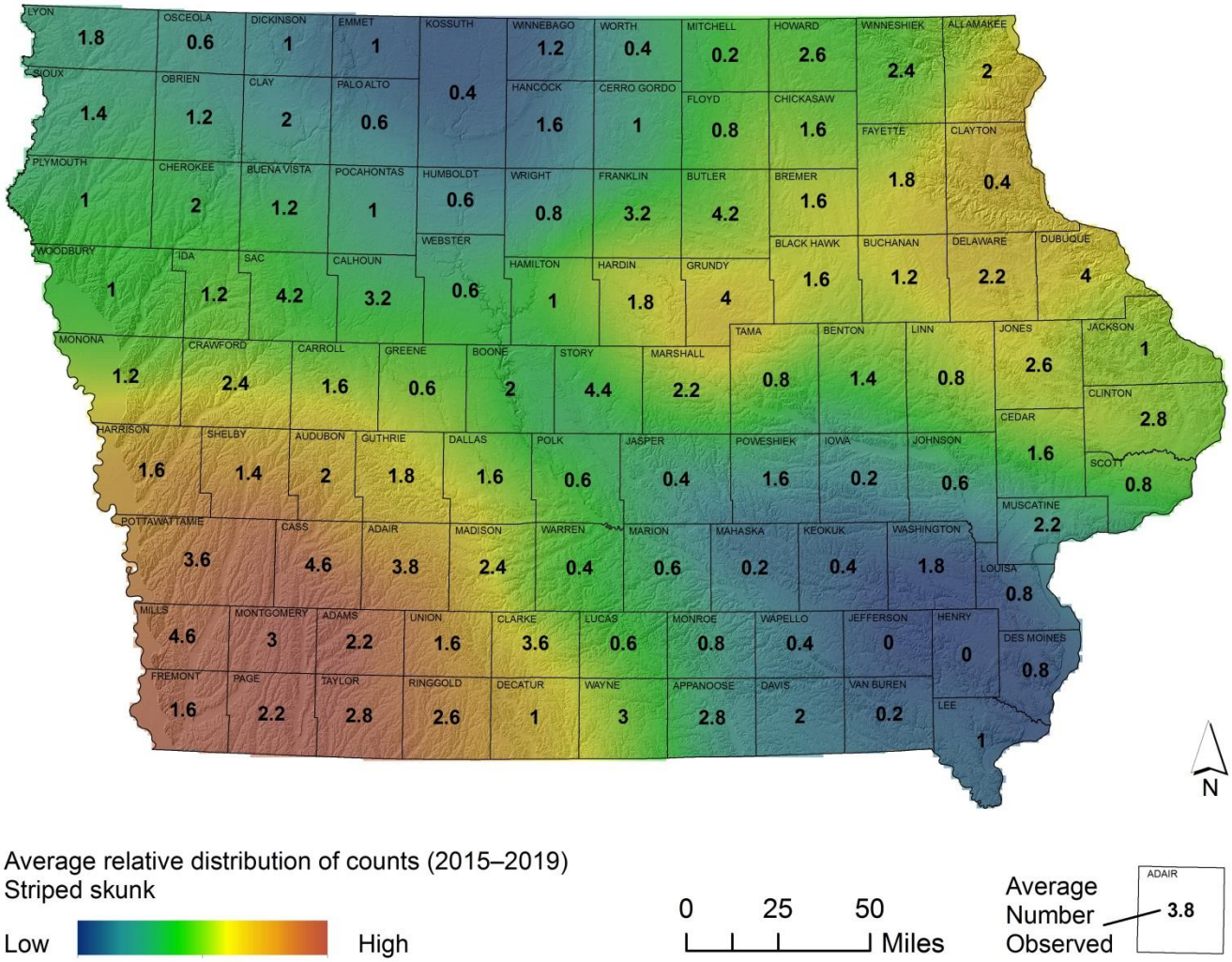


Figure 39. Relative distribution of average spring spotlight observations for skunk during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties). Skunk includes all observations recorded as “striped skunk” and “skunk” and likely includes none or few spotted skunk observations due to the rarity of the species in the state.

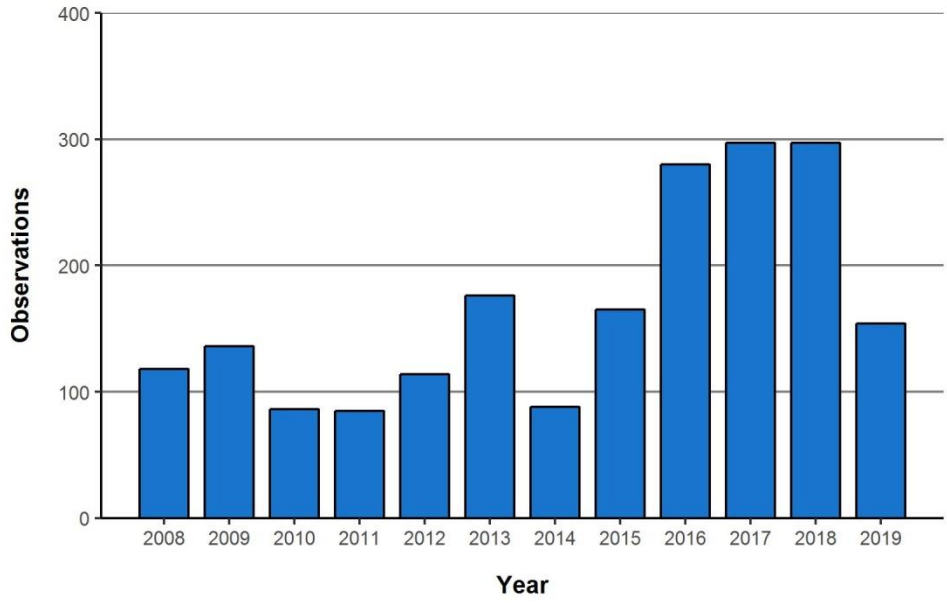


Figure 40. Total Virginia opossum observations by year during the Iowa Spring Spotlight Survey, 2008–present.

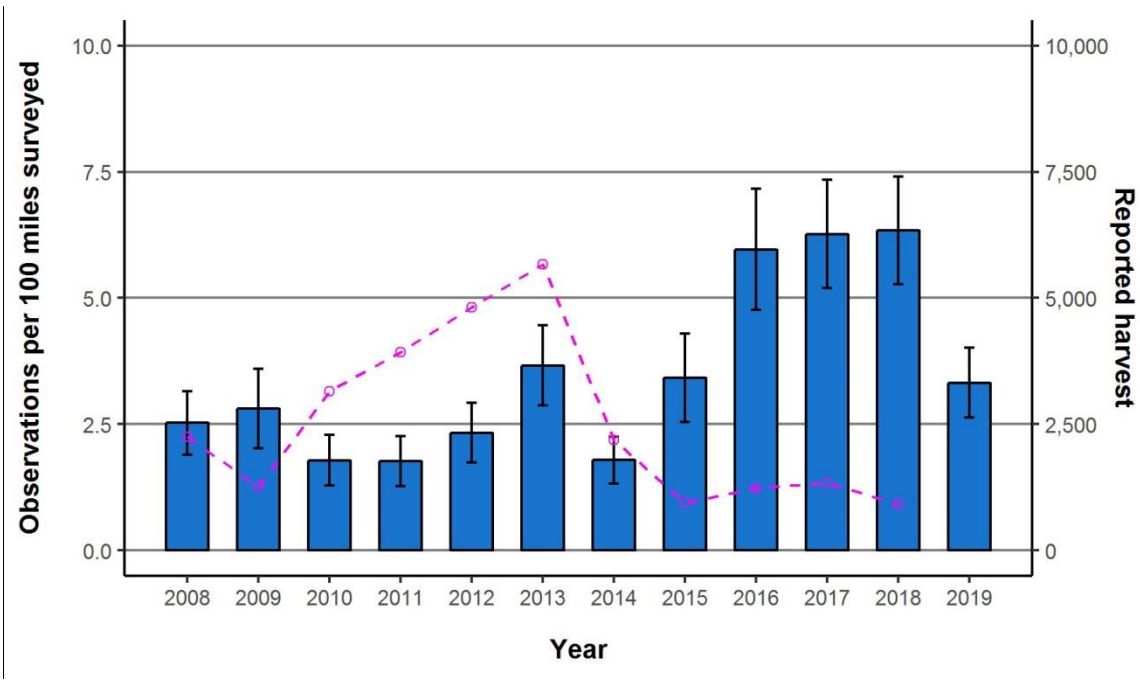


Figure 41. Average Virginia opossum observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Dashed line indicates the reported statewide harvest.

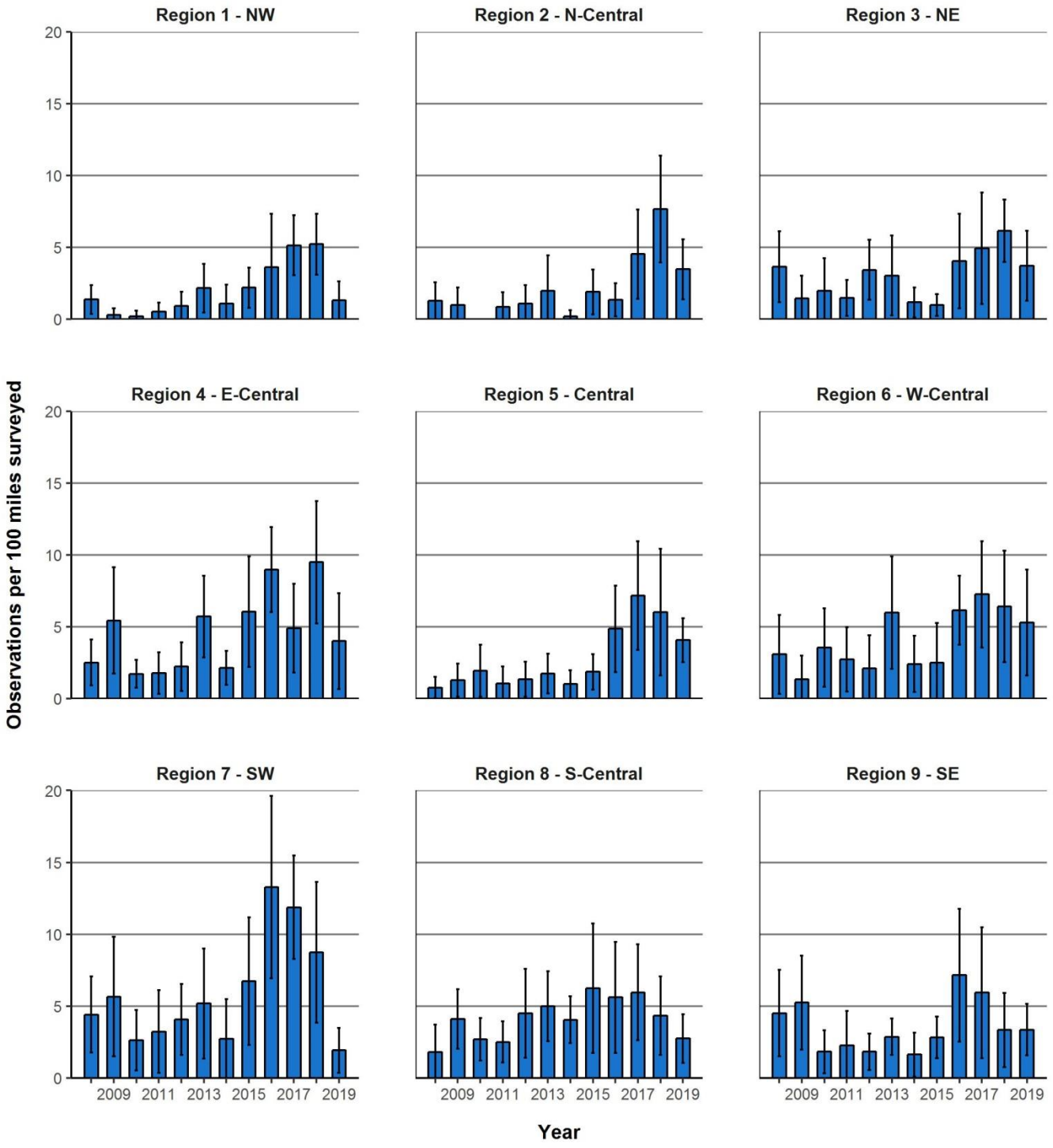


Figure 42 Average Virginia opossum observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

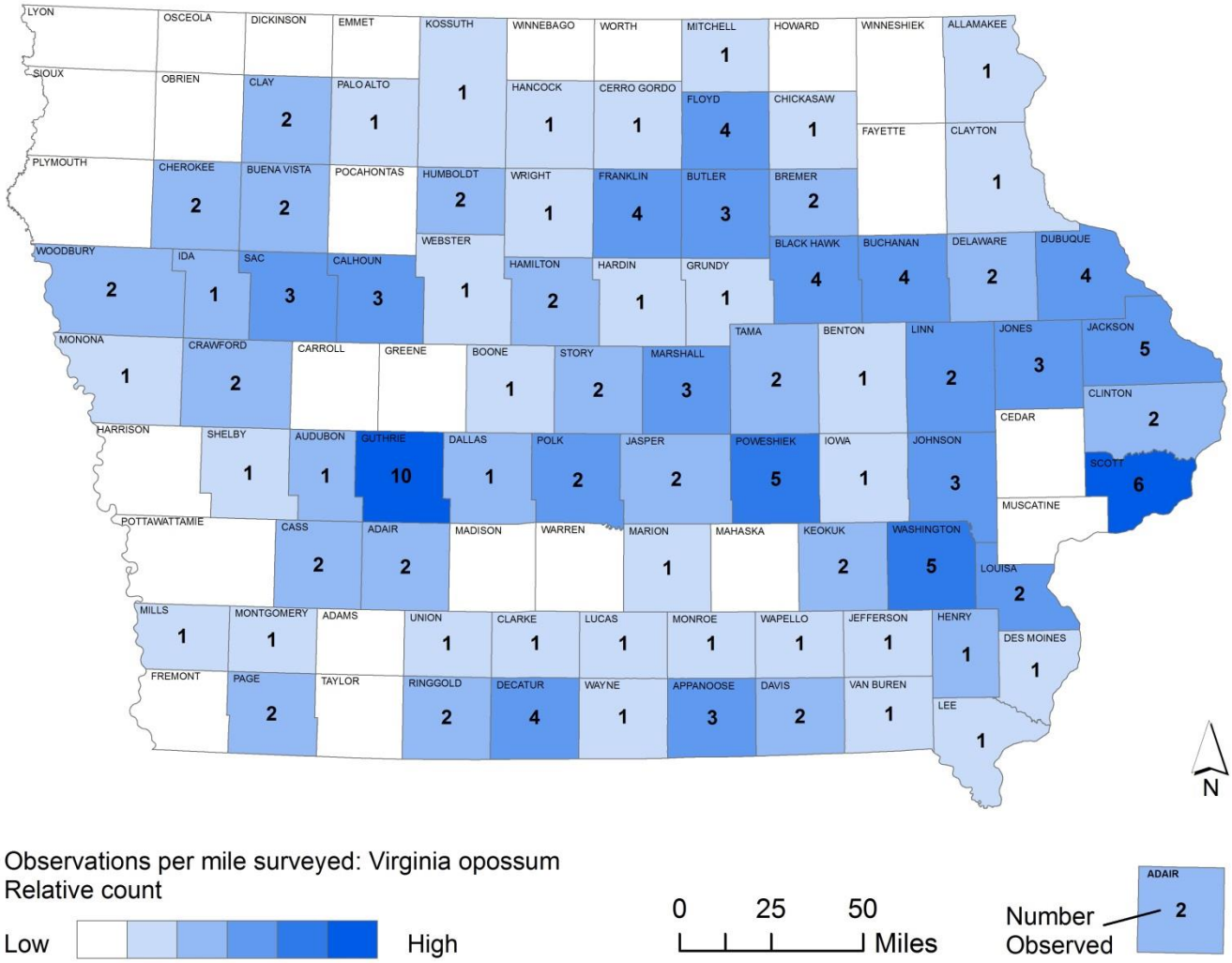


Figure 43. Total number of Virginia opossum observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

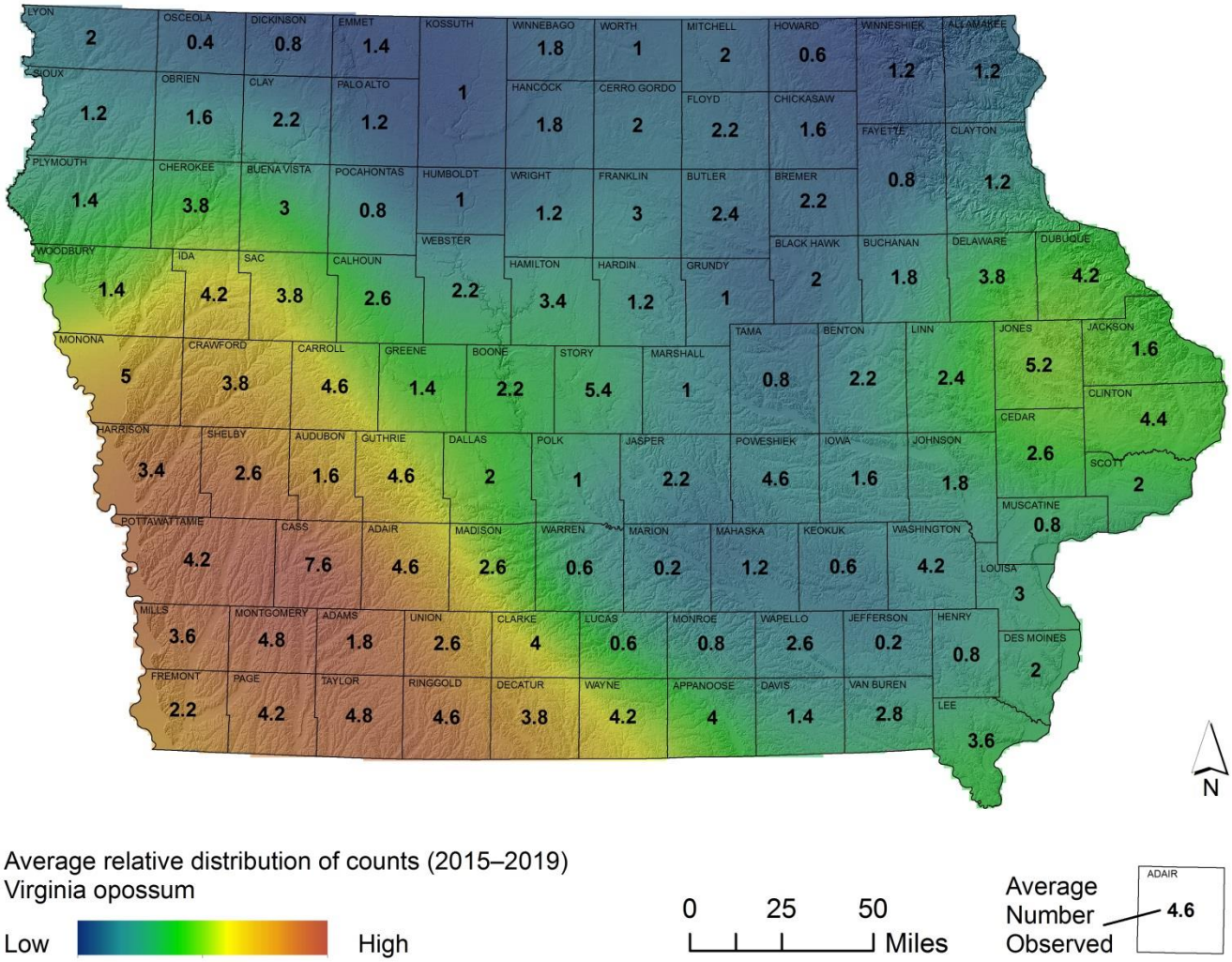


Figure 44. Relative distribution of average spring spotlight observations for Virginia opossum during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

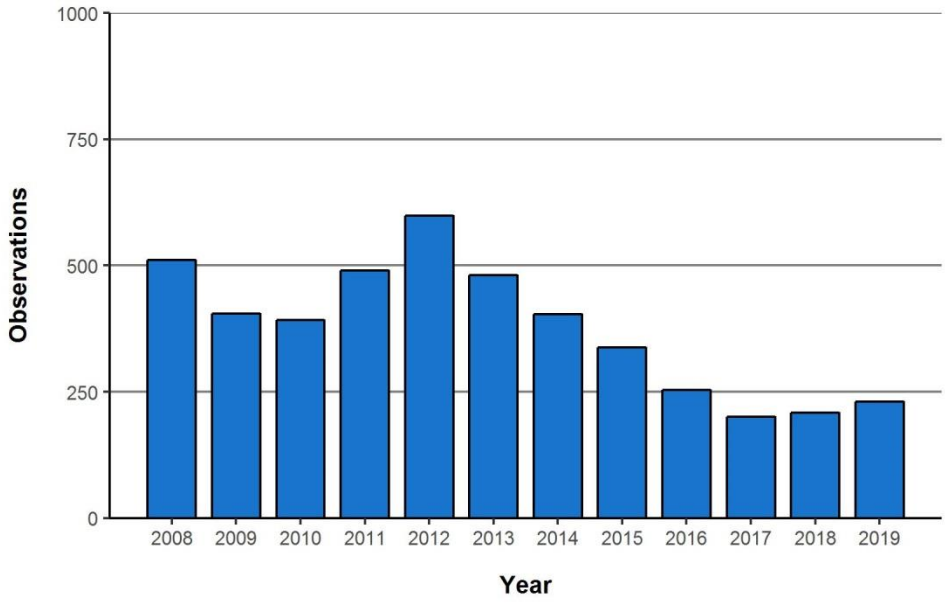


Figure 45. Total house cat observations by year during the Iowa Spring Spotlight Survey, 2008–present.

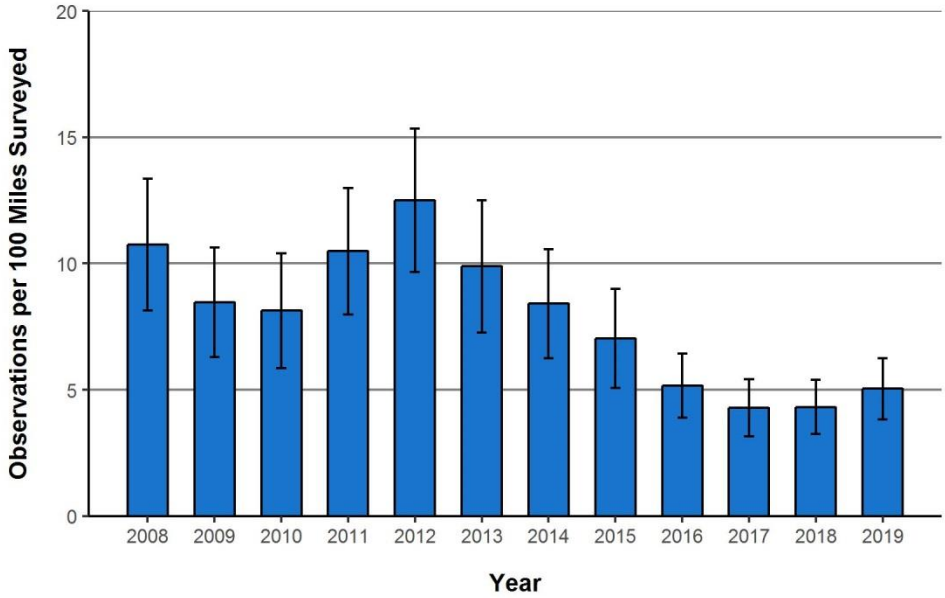


Figure 46. Average house cat observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2008–present. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages.

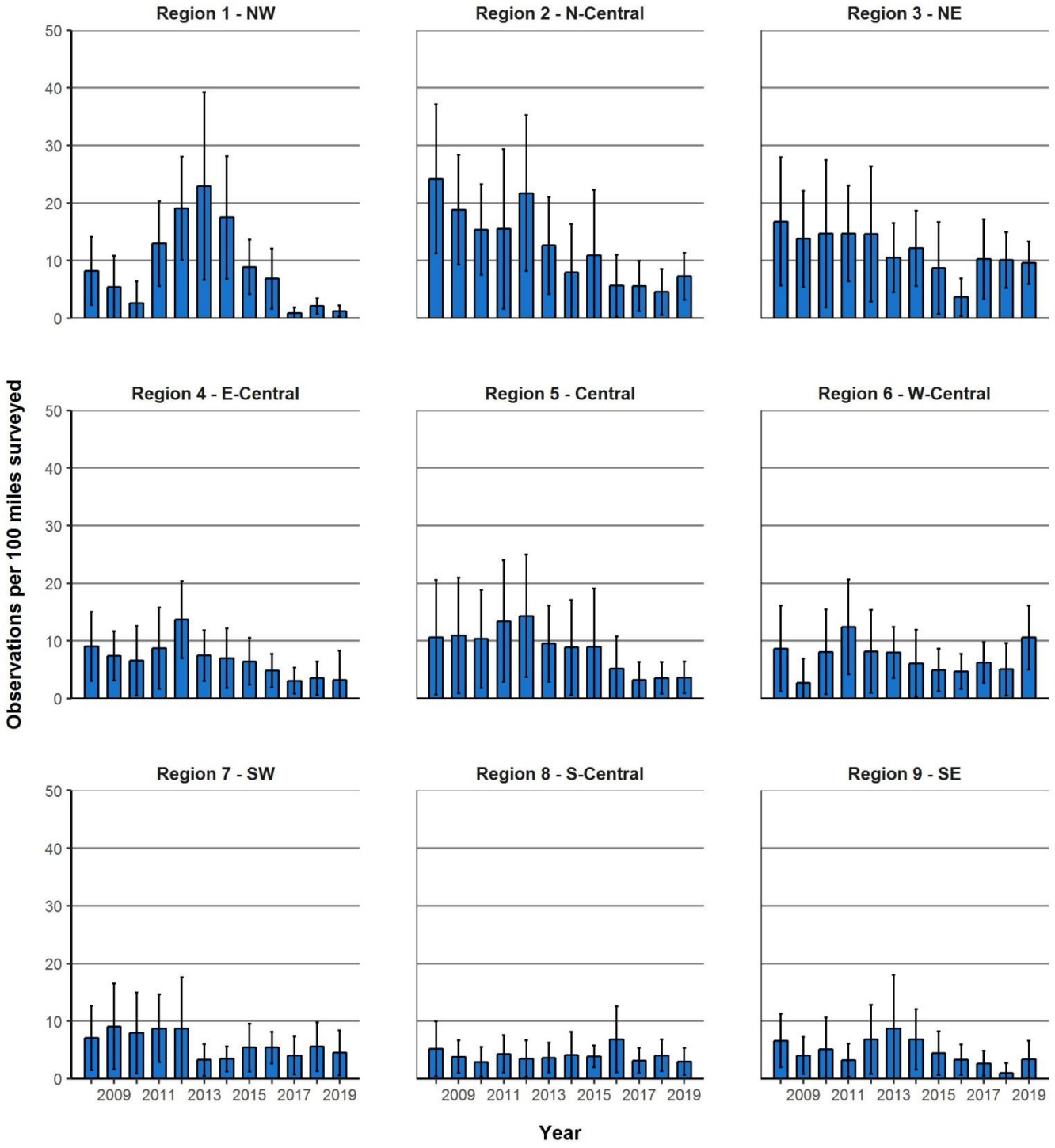


Figure 47. Average house cat observations per 100 miles surveyed during the Iowa Spring Spotlight Survey for each of the nine Iowa Department of Natural Resources management regions. Observations were standardized by 100 miles surveyed to account for regions in which counties were not surveyed or transect lengths changed due to annual variation in survey conditions. Error bars represent 95% confidence intervals around the averages. Observations were recorded for cats not within close proximity to human residences.

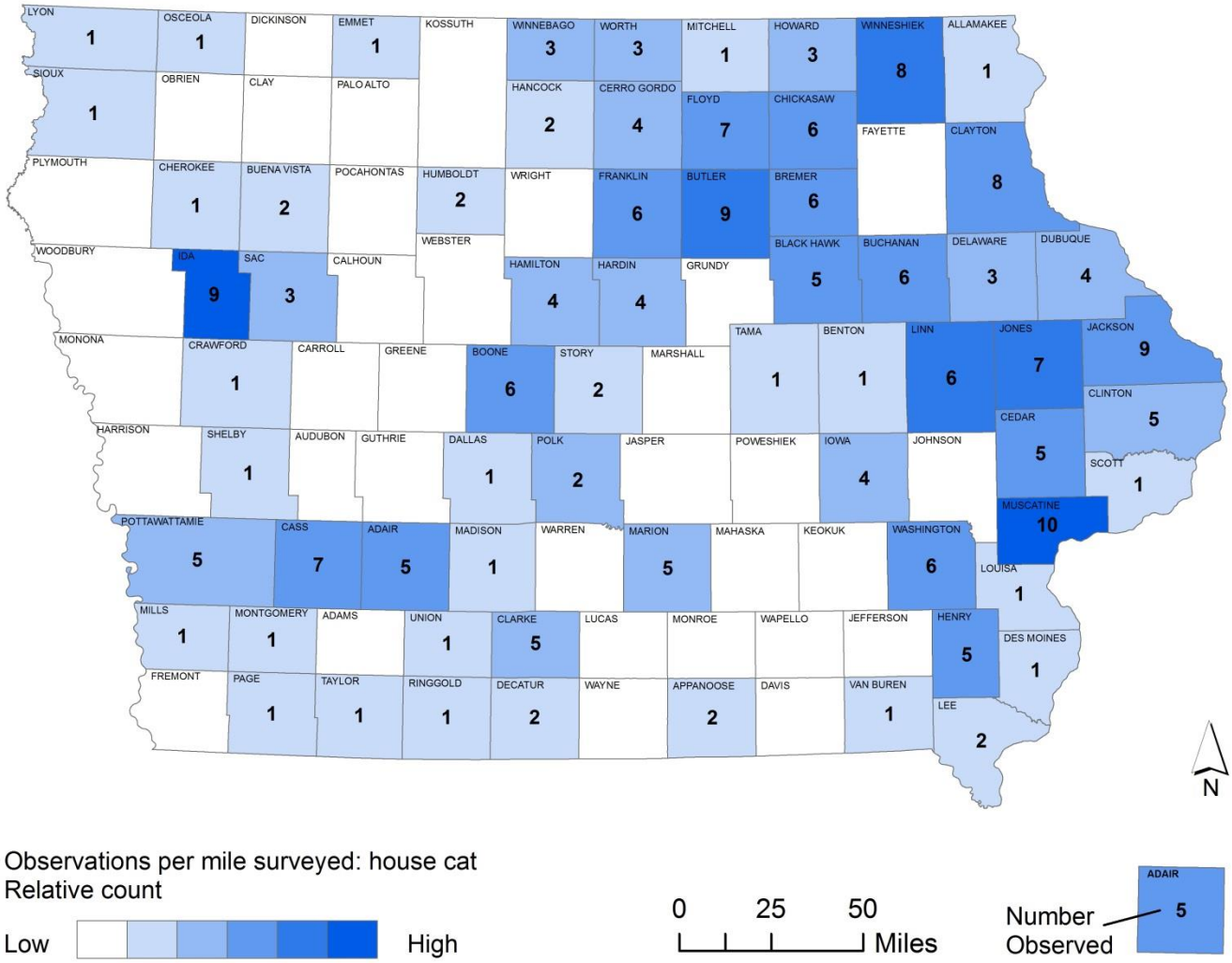


Figure 48. Total number of house cat observations per county. Color shading indicates the number of observations per mile surveyed (OPMS).

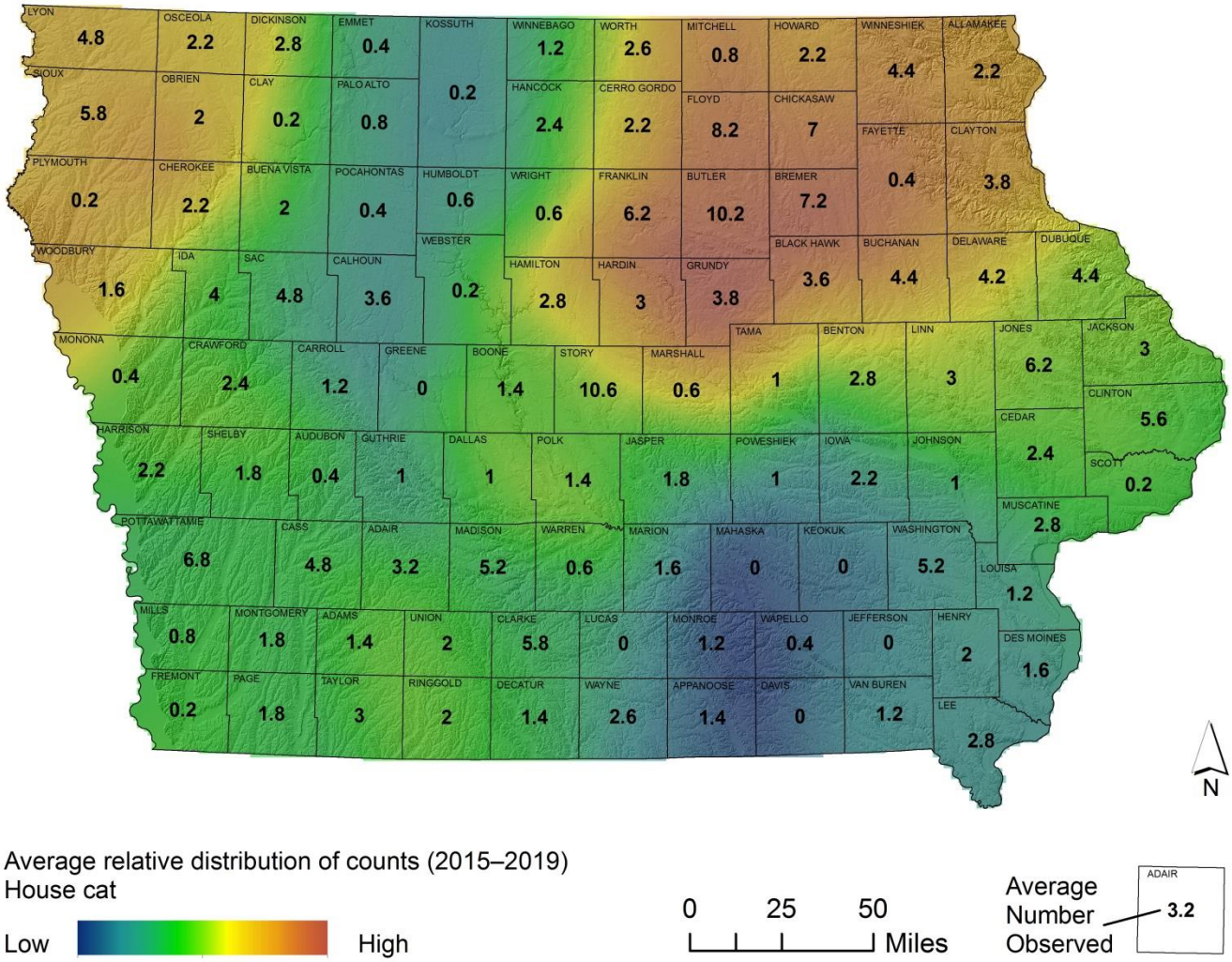
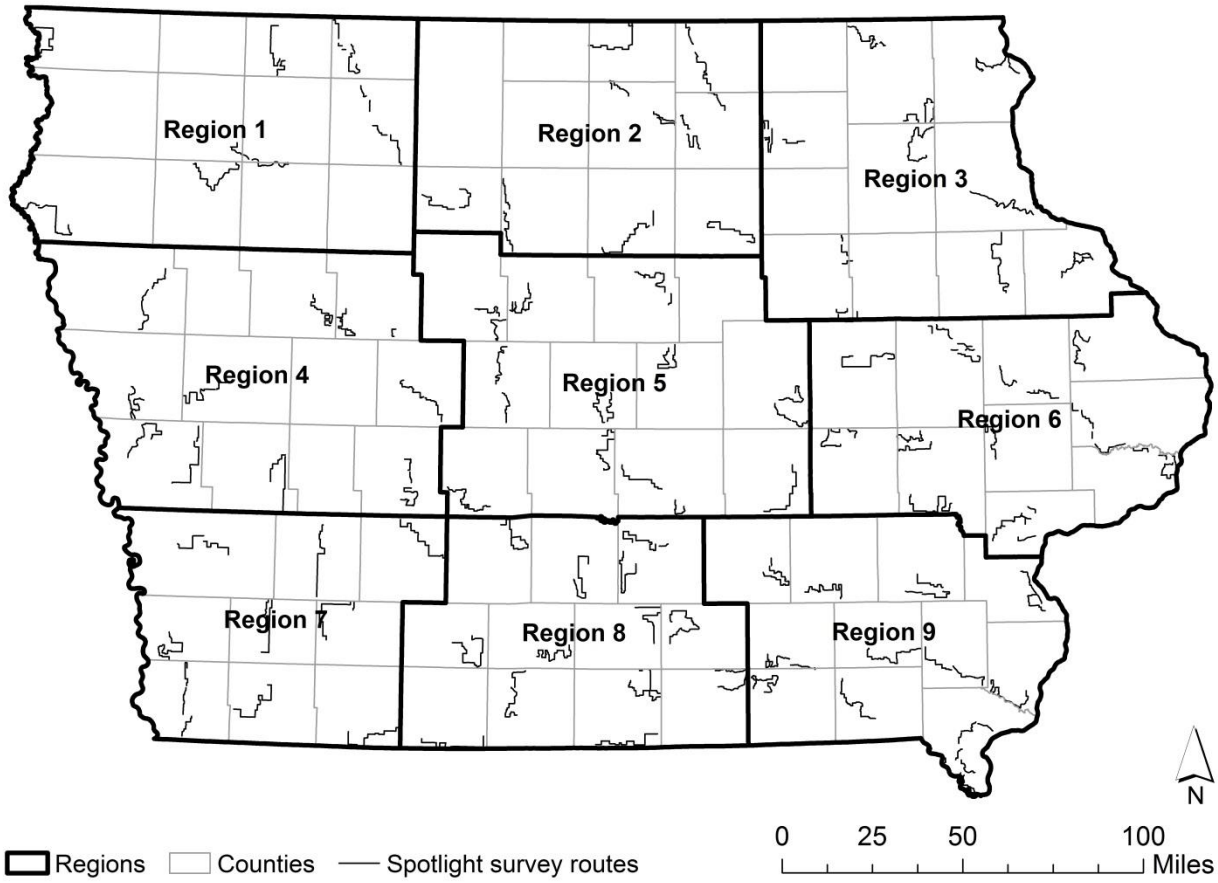


Figure 49. Relative distribution of average spring spotlight observations for house cat during the past 5 years. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

APPENDICES

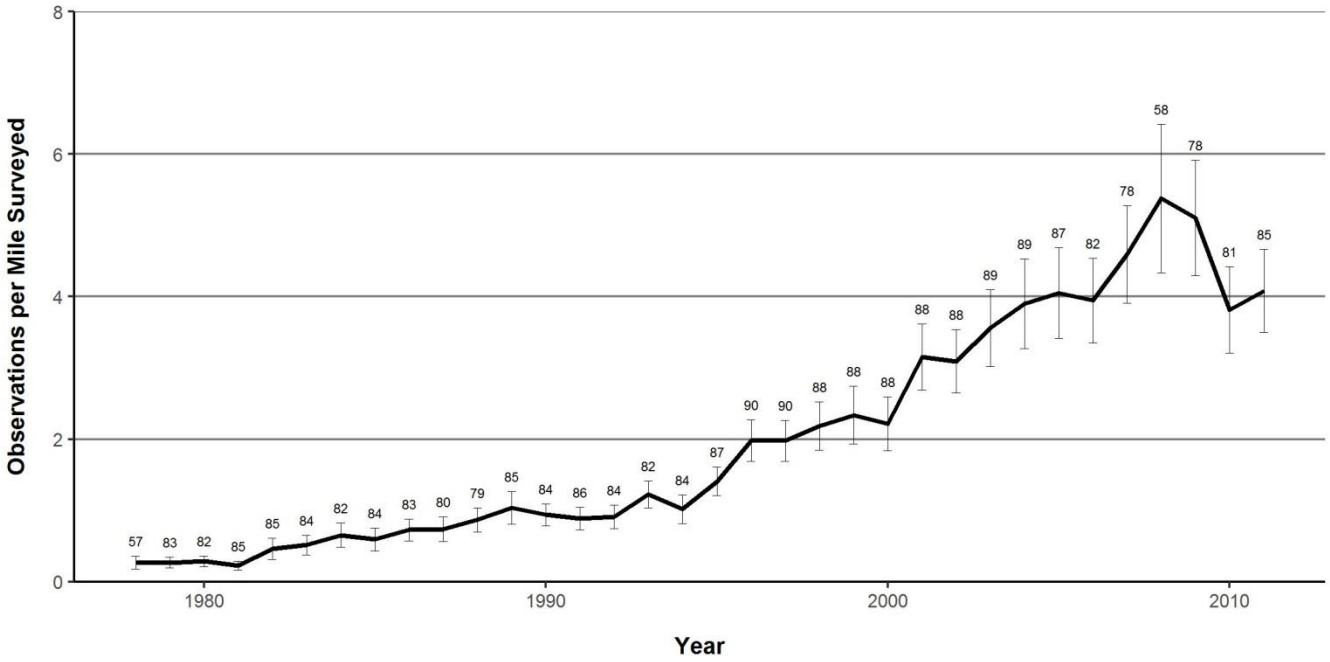
IOWA SPRING SPOTLIGHT SURVEY RESULTS FOR WHITE-TAILED DEER AND NORTHERN RACCOON, 1978–2011

APPENDIX A



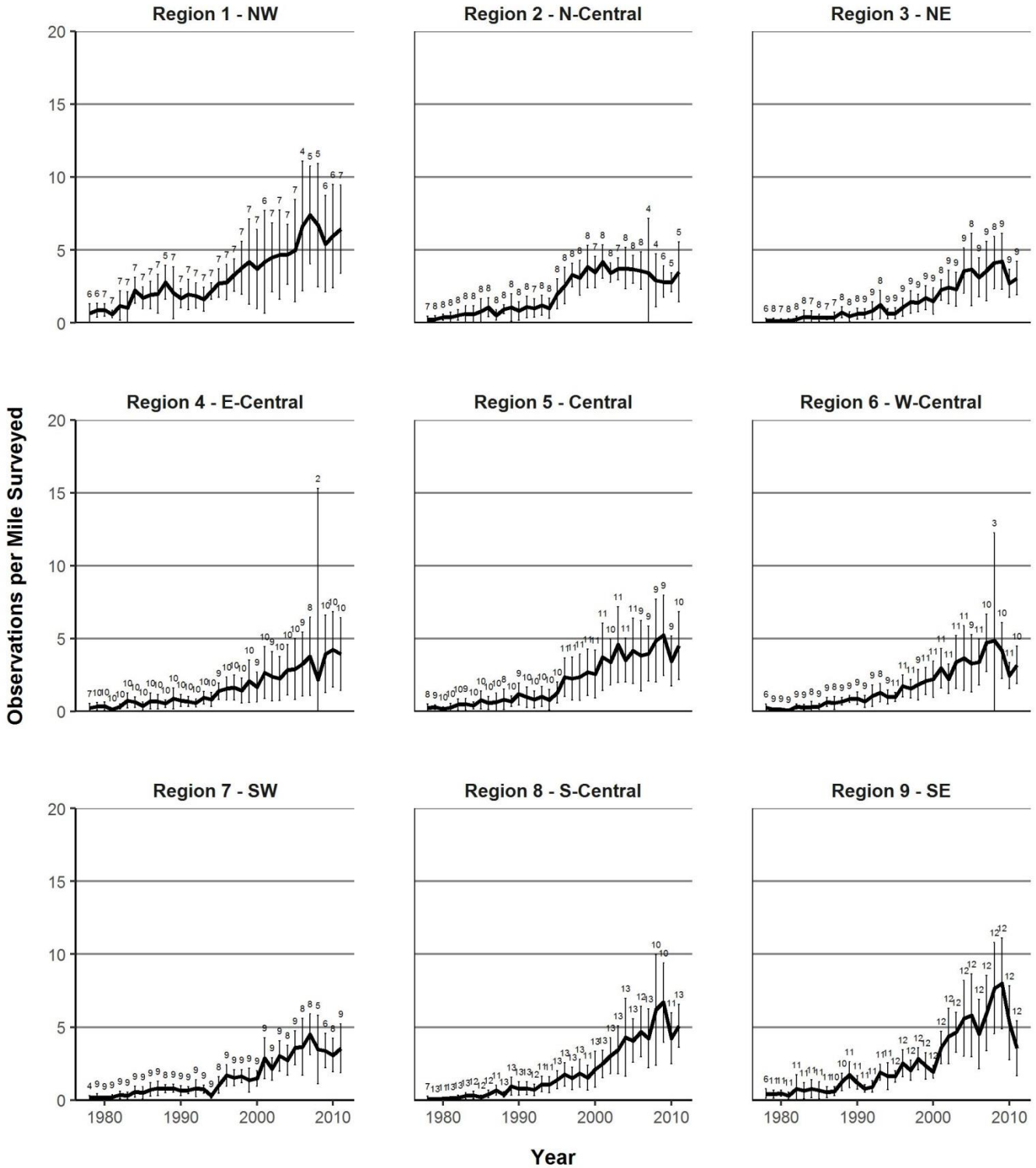
Appendix A. Regions used for summarizing Spring Spotlight Survey observations in Iowa and historical Spring Spotlight Survey routes sampled from 1978–2011.

APPENDIX B



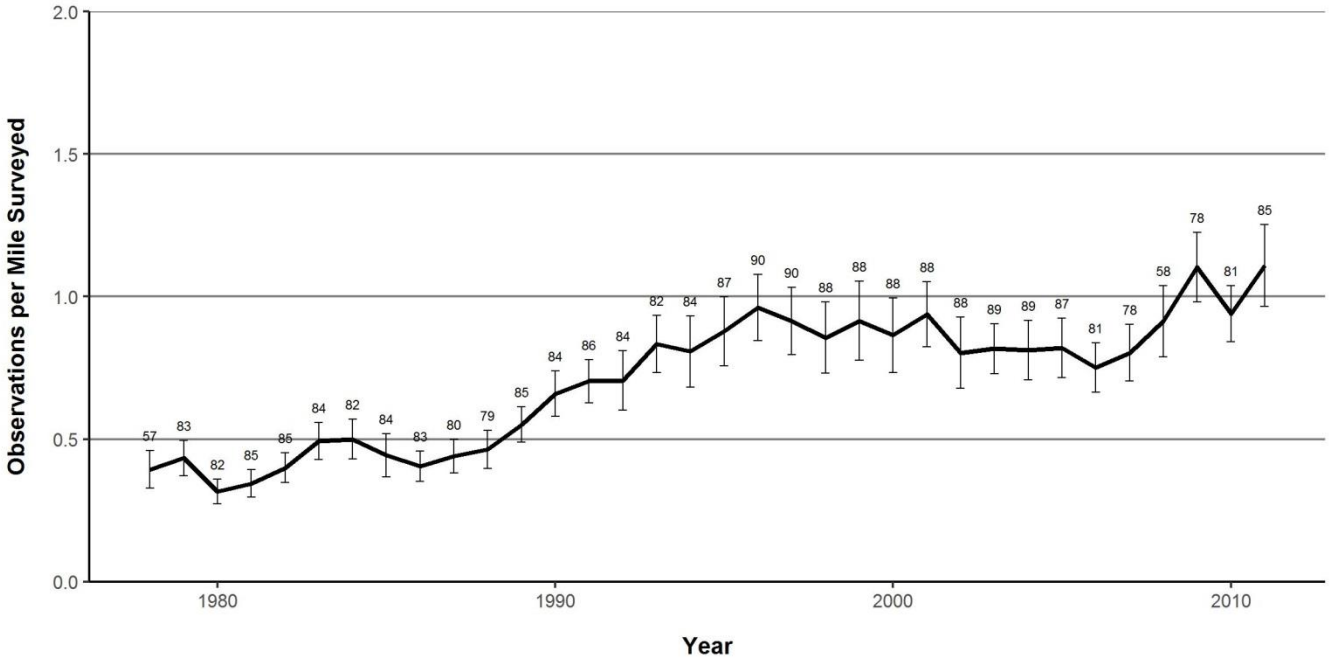
Appendix B. Statewide average white-tailed deer observations per mile surveyed during the Iowa Spring Spotlight Survey, 1978–2011. Observations were standardized by mile surveyed to account for regions in which counties were not surveyed. Error bars represent 95% confidence intervals around the averages. Numbers above error bars indicate the number of transects surveyed each year.

APPENDIX C



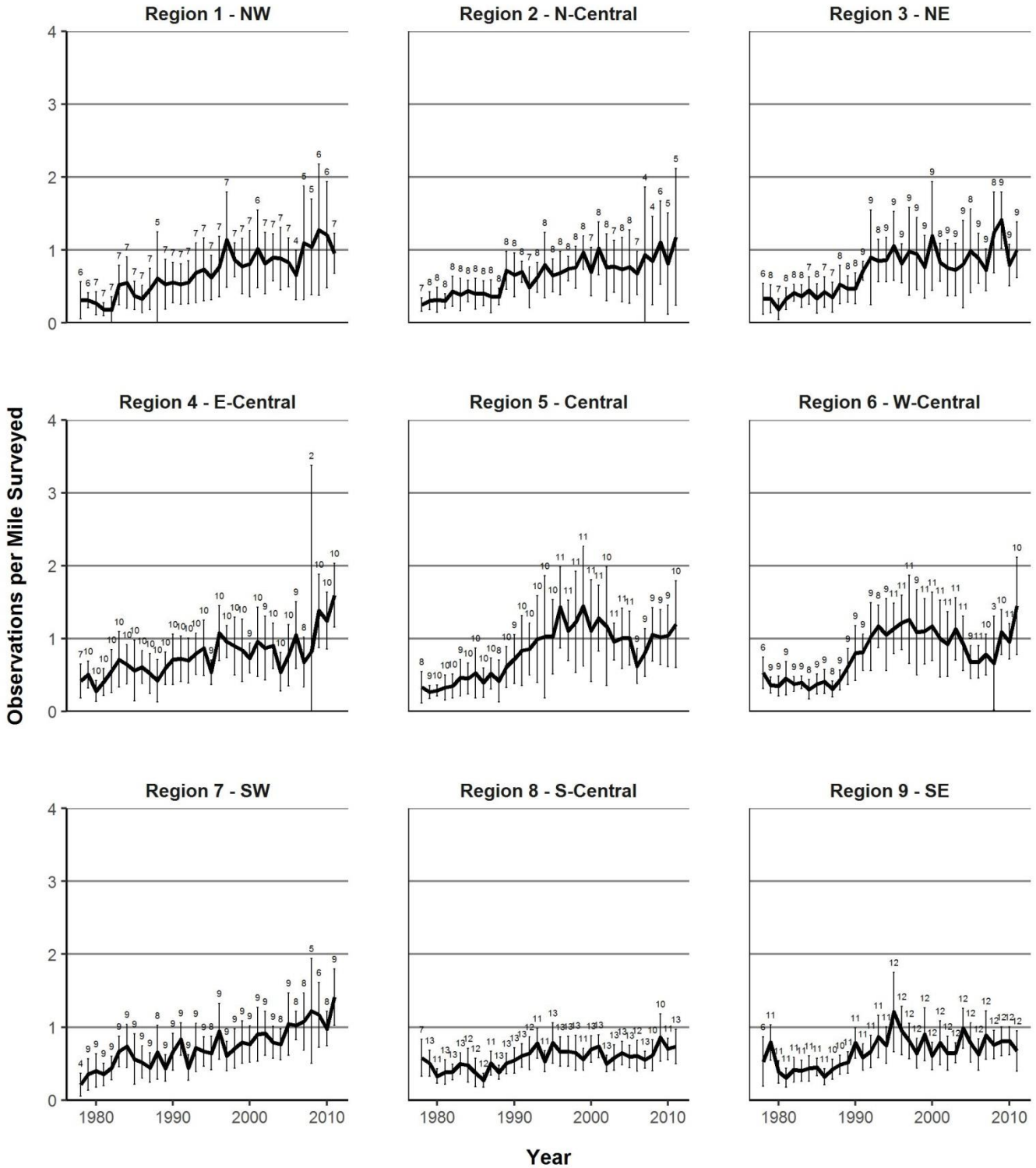
Appendix C. Average white-tailed deer observations per mile surveyed during the Iowa Spring Spotlight Survey, 1978–2011. Observations were standardized by mile surveyed to account for regions in which counties were not surveyed. Error bars represent 95% confidence intervals around the averages. Numbers above error bars indicate the number of transects surveyed each year. Note, surveys were conducted linearly along forested habitats and not standardized by amount of available habitat in each region; thus, cross-regional comparisons should be considered with caution as data represents the relative change in species abundance within each region.

APPENDIX D



Appendix D. Average Northern raccoon observations per mile surveyed during the Iowa Spring Spotlight Survey, 1978–2011. Observations were standardized by mile surveyed to account for variable number of transects surveyed each year. Error bars represent 95% confidence intervals around the averages. Numbers above error bars indicate the number of transects surveyed each year.

APPENDIX E



Appendix E. Average Northern raccoon observations per mile surveyed during the Iowa Spring Spotlight Survey, 1978–2011. Observations were standardized by mile surveyed to account for regions in which counties were not surveyed. Error bars represent 95% confidence intervals around the averages. Numbers above error bars indicate the number of transects surveyed each year. Note, surveys were conducted linearly along forested habitats and not standardized by amount of available habitat in each region; thus, cross-regional comparisons should be considered with caution as data represents the relative change in species abundance within each region.