Iowa Spring Spotlight Survey: 2023 Summary

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ABSTRACT The Iowa Department of Natural Resources conducts nocturnal spotlight surveys from mid-March to mid-May, annually. Spotlight surveys are conducted in all 99 Iowa counties and total ~4,780 mi ($\bar{x}$ = ~50 mi/county) of surveyed rural roads. In 2023, a total of 21,895 wildlife observations were recorded, with white-tailed deer (*n* = 15,550), raccoon (*n* = 5,526), opossum (*n* = 249), striped skunk (*n* = 246), and house cat (*n* = 122) most frequently observed. Counts increased for red fox, decreased for deer, badgers, mink, and raccoon, and were relatively stable for coyote, opossum, striped skunk, and house cat.

INTRODUCTION

Data capable of estimating wildlife abundance are often difficult, expensive, and time consuming to collect, particularly for rare or elusive species, or species that exist across large geographic areas. Standardized sampling methods, however, may provide consistent indices of populations over time. Reliable indices are important for understanding population trends and the factors affecting populations, 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 wildlife managers a cost-effective and easily implemented option to sample wildlife populations (SDDGFP 1950; Anderson 1959). Spotlight counts have been used to produce indices for species such as opossum (*Didelphis virginiana*; Gehrt et al. 2006), 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).

In 1978, the Iowa Department of Natural Resources (Iowa 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. In general, from 1978–1990, 85 spotlight routes were surveyed across the state, and from 1991–1995, 5 additional routes were added (Appendix A). This survey specifically targeted forested areas in an agriculturally dominated landscape, and given the close association between raccoon (Pedler et al. 1997, Beasley et al. 2007) and deer (Volk et al. 2007, Walter et al. 2009) populations and forest cover, statewide counts may have been biased (McShea et al. 2011). Regardless, the trends resulting from this survey provided key insight into these growing populations since the 1970s (Appendix B–E).

In 2006, a new survey was developed to address deficiencies in the original design. Rather than using survey routes perpendicular to forest cover, routes were oriented longitudinally in an east–west direction to achieve a representative sample of the land cover types across the state. Several species were added to the survey, including badger (*Taxidea taxus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray (*Urocyon cinereoargenteus*) and red fox, mink (*Mustela vison*), opossum, river otter (*Lontra canadensis*), and striped (*Mephitis mephitis*) and spotted skunk (*Spilogale putorius*). The new method 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 survey routes were adopted in all 99 Iowa counties. The new survey design results in relatively large counts of deer, raccoon, opossum, striped skunk, coyote, and red fox. Observations of other species (e.g., gray fox, bobcat, river otter, mink), however, are more variable because of the secretive nature, low density, or low visibility of animals. Thus, a low count of these species does not necessarily imply low population abundance.

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

STUDY AREA

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

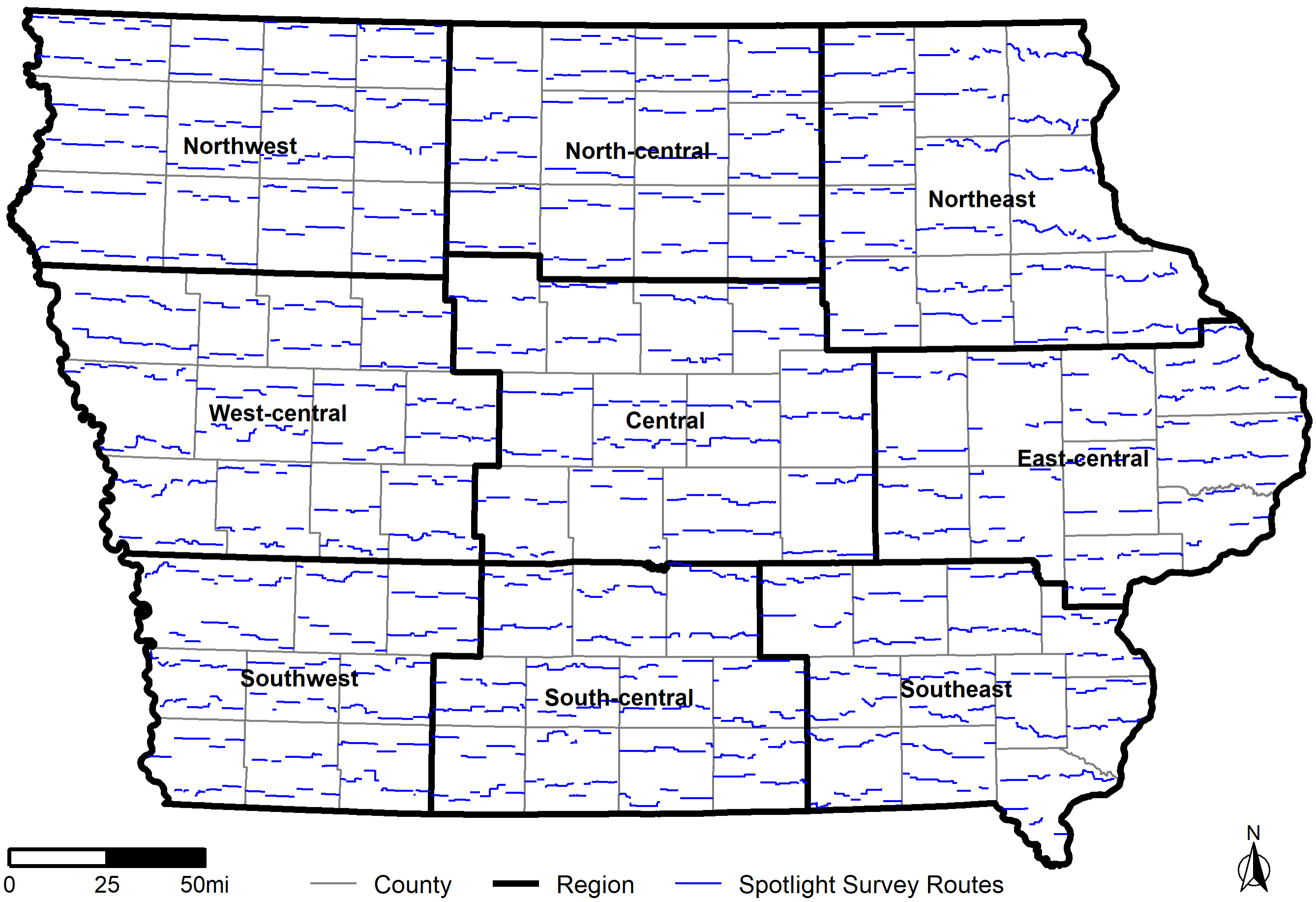

Figure 1. Spring Spotlight Survey routes (*n* = 199) in each county of Iowa and 9 regions of the state used for summarizing spotlight count data.

Table 1. Survey year, number of miles surveyed, and total number of animals observed for select species during the Spring Spotlight Survey in Iowa, 2006-present.

Year	Miles	Deer	Badger	Bobcat	Coyote	Mink	Opossum	Raccoon	Red fox	Skunk	House cat
2006[a]	4,317	9,279	9	4	56	9	136	2,417	41	133	15
2007	4,795	11,284	23	2	49	6	164	2,817	32	144	383
2008	4,793	13,329	22	5	51	13	118	3,143	46	148	511
2009	4,784	12,935	15	4	66	11	136	3,219	32	174	405
2010	4,787	10,888	16	4	53	10	86	3,621	43	217	392
2011	4,780	11,054	9	4	64	6	85	4,197	55	211	490
2012	4,788	9,322	9	3	92	11	114	3,282	37	171	599
2013	4,785	13,053	15	2	94	6	172	3,347	42	140	479
2014	4,800	11,401	12	3	65	3	88	3,793	28	116	391
2015	4,790	12,354	12	2	71	1	165	3,569	29	157	338
2016	4,799	12,522	16	1	110	13	273	3,672	27	144	252
2017	4,793	13,017	16	4	108	5	297	3,695	38	138	200
2018	4,790	15,102	18	0	99	2	295	4,683	46	181	209
2019	4,772	16,490	28	4	89	11	154	5,390	58	194	230
2020	4,781	15,746	26	8	86	8	179	4,454	24	173	161
2021	4,781	13,765	27	6	103	8	142	5,284	47	169	118
2022	4,783	17,103	27	4	119	7	268	6,486	48	270	143
2023	4,752	15,550	19	3	104	3	249	5,526	54	246	122

[a]In 2006, species other than white-tailed deer and northern raccoon, particularly house cat, were not recorded in all counties and species counts may not be comparable to subsequent years.

METHODS

The Spring Spotlight Survey is conducted each year, usually after snow-melt and before spring green-up 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 east–west driving routes, one across the north half and one across the south half of each county (except Kossuth County which has 3 routes; n = 199). Routes follow along rural unpaved roads totaling ~4,780 mi statewide ($\bar{x}$= 24.0 mi/route, 13.0–41.9 mi; SD=4.3 mi) and are sampled once each spring. Surveys begin 1 hour after sunset and are conducted at speeds ≤20 mi/hr. Surveys are conducted by 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 and location of animals was recorded at the observer location 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 deer density across the state. Beginning in 2019, observations were recorded digitally (e.g., smart phones, tablets) in a geospatial database (ArcGIS Field Maps; Environmental Systems Research Institute, Redlands, CA) which allowed for collection of more precise wildlife locations and increased survey efficiency.

We summarized long-term trends for spotlight counts across 9 regions of Iowa (Fig. 1) and statewide for the most commonly observed species each year. We standardized counts as the number of animals observed per 100 miles surveyed to account for annual differences in the number of miles surveyed (e.g., road closures). Because animal counts may vary annually, we further estimated the 5-year average relative distribution of counts to contextualize annual observations with recent trends and to map the relative distribution of species across the state. We interpolated the average distribution of counts for the most recent 5 years using inverse distance weighting (IDW; function gstat in Program R 4.2.2; R Core Team 2019) and 9 nearest neighbors. To determine the IDW power used to weight nearest neighbors for each species, we iteratively tested power values from 0.2–5.0 in 0.2 increments and estimated the root mean square error (RMSE) for each IDW estimate. We selected the power value from the IDW estimate with the lowest RMSE for producing the final IDW map. We further averaged the final IDW map using a focal analysis (function focal in Program R) and a 29.8-mi moving window to produce a smoother and more readily interpretable trend surface across Iowa.

RESULTS

In 2023, 4,752 mi of rural roads were surveyed across all 99 Iowa counties, with the exception of the Jasper county south route, which was not surveyed. A total of 21,895 animals were reported, marking a decrease of 1,439 animals (11%) compared with 2022 (n = 24,491). On average, 23 animals (n = 7–39; 2006–2022) are observed on Jasper south, which accounts for only 0.08% of the decreased count in 2023. Thus, observations for all regularly reported species decreased, except for red fox which increased 12.5% (Table 1; Fig. 2–39). Three otters, two weasels, and one woodchuck were also reported, whereas no jackrabbits or gray fox were reported.

A total of 15,550 deer were observed in 2023 and was consistent with counts since 2018 (Fig. 2). Deer were observed at a rate of 3.3 deer/mi statewide, with the highest numbers across south-central Iowa (Fig. 4). Deer counts were similar or decreased in all regions except east-central Iowa. Long-term deer observations have been relatively stable to increasing in all regions, except the southwest and south-central regions where counts have declined the past 5 years.

Raccoon observations (n = 5,526) decreased 14.8% compared with 2022 but remained above their long-term average ($\bar{x}$ = 4,033; Fig. 24; Table 1). All regions of the state recorded decreased raccoon counts from 2022, except the northeast region (Fig 26). The statewide trend has increased by 6.8% (238 animals per year) since 2017 (R^2 = 0.60, P = 0.04; Fig. 24).

Badger (Fig. 7–10), coyote (Fig. 13–16), skunk (Fig. 32–35), and opossum (Fig. 20–23) observations decreased 30%, 13%, 9%, and 7%, respectively. Badger observations were stable the previous four years, with most observations occurring in the western one-third of the state ($\bar{x}$ = 18). Coyote observations have been relatively stable since 2016 and fluctuated around 2 animals per 100 miles surveyed ($\bar{x}$ = 82). Despite a slight decrease in counts, opossum (n = 249; $\bar{x}$ = 173) and skunk (n = 246; $\bar{x}$ = 174) observations were similar to their counts in 2022 and above their long-term averages.

Overall, the total count for red fox (n = 54; $\bar{x}$ = 40; Fig. 28–31) increased 12.5% compared with last year, although there was no geographic pattern to changes across regions: increased counts in the northeast, central, southwest, and south-central regions and decreased counts in the northwest, east-central, and southeast regions.

Bobcat observations (n = 3; $\bar{x}$ = 3.5) were near their long-term average and generally low for this species (Fig. 11–12). Mink observations reached a 5-year low in 2023 (n = 3; $\bar{x}$ = 7.4), although counts have general fluctuated every 3 or 4 years (Fig. 17–19).

DISCUSSION

The statewide deer count increased in 2017 but has remained relatively stable with minor fluctuations during the past 6 years. Regionally, deer counts were stable or slightly increasing in all regions of the state, except in the southwest and south-central regions where counts have steadily decreased the past 5 years (Fig 4.). Despite decreasing counts in south-central Iowa, the region maintains some of the highest deer densities in Iowa (Fig. 5).

Raccoon observations have remained relatively high during the past 5 years and in 2023 exceeded an average of 1 raccoon per mile for the fourth time in the past 5 years. Increased raccoon counts coincide with low raccoon pelt values in international fur markets and reduced harvest during the past eight years (Evelsizer 2022). It is likely statewide populations will remain high pending an increase in pelt values and local populations will fluctuate with mechanisms such as disease in the coming years.

Spotlight observations for red fox are challenging to collect due to their small size and evasive behavior (Ruette et al. 2003), and as a result, some inherent variability exists in spotlight counts (Kaminski et al. 2021). Although counts regularly fluctuate, red fox counts have remained stable during the past three years.

Badger observations declined 30% in 2023 but remained near a 5-year high compared with the previous decade. The number of badgers observed is positively related to the number of precipitation events ≥1 inch in the 28 days prior to surveys and humidity during survey nights (R^2 = 0.57, $P \leq 0.001$; Appendix F). March and April were unseasonably dry months (Glisan 2023*a*), and although badger observations vary based on many coinciding factors, dry spring conditions likely reduced detectability of badgers in 2023. Regardless, most badger observations occur in western Iowa where models indicate the majority of suitable habitat exists in the state (Iowa DNR, unpublished data). Spotlight counts in northwest and southwest Iowa have fluctuated over time, whereas counts in east-central Iowa have steadily increased since the early 2010s.

Coyote observations remained above 2 individuals per 100 miles surveyed for the third year in a row. Long-term growth appears evident in the north-central, west-central, and southwest regions, with counts fluctuating but stable in other regions. Reported coyote harvest decreased 305% in 2021 (from 15,087 to 3,724) but it is unclear if this represents a true decrease in harvest or whether harvesters chose not to sell pelts into fur markets due to a 50% drop in average pelt values. It is possible that higher spotlight counts during the past 3 years are a result of low harvests and indicative of population growth. Ultimately, canids are difficult to survey using spotlighting and coyote observations are likely highly variable according to factors such as nighttime humidity, terrain, and road-avoidance behavior. Although weather variability has a moderately high capacity to predict annual counts for coyote (R^2 = 0.70, $P \leq 0.001$; Appendix F), archery hunter observations likely provide a more reliable annual index and indicated relatively stable populations in all regions of the state (Harms et al. 2021).

Opossum counts remained high in 2023 likely as a result of above average winter temperatures in January and February (Glisan 2023*b*, Glisan 2023*c*). Opossums are sensitive to winter temperatures (Gillette 1980, Gehrt et al. 2006) and spring spotlight counts for opossum are negatively correlated with winter weather severity in Iowa (r = -0.60; Boustead et al. 2015). Opossum populations have the ability to rebound quickly following severe winters because females can produce two litters per year consisting of a large number of young (up to 13 joeys/litter; Gipson and Kamler 2001). February 2014, 2019, and 2021 all ranked within the top 16 coldest February's in recorded history and opossum counts subsequently declined 49%, 48%, and 21%, respectively, in the following springs (Glisan 2019, Glisan 2021*a*, Hillaker 2014). Alternatively, opossum counts increased 65% and 16% in 2016 and 2020, respectively, following warmer than normal winters. Overall, reported harvest for opossums has been at near all-time lows during the past 6 years; therefore, statewide population trends will likely be driven by winter severity, among other non-harvest related factors, in the coming years.

Skunk observations remained near a 2-year high and relatively evenly distributed across the state, except in the southeast region where counts are typically lower. Spotlight counts for skunks tend to fluctuate every 3–10 years similar to archery hunter observations (Harms et al. 2021). Spotlight surveys for skunks (as well as mustelids; e.g., badger, mink, weasel) are challenging because spotlighting is most effective for species that are readily detectable by eye shine (e.g., deer, raccoon). Skunks are rarely identified by eye shine and must be close to the observer for detection (Gehrt et al. 2006). Regardless, spotlighting likely works well for striped skunks in Iowa because of their tendency to be viewed in open areas at night, slower movements, and their distinct black and white markings. Therefore, this survey provides an independent and consistent indices for skunks and is an important component of furbearer management in the state.

The spotlight survey provides one of the only indices for mink in Iowa and indicates that counts typically fluctuate every 3–4 years. Mink observations have declined for 5 consecutive years and an increased count may be anticipated next year if previous observation patterns continue. Regionally, the most consistent mink observations occur in the northern one-third of the state and the east-central region. Mink observations are rare because surveys are not focused on riparian or wetland areas typical of mink use. Reliable population trends for mink are possible using spotlight observations; however, annual counts may be highly variable (Waller 2010) and are typically low for our survey ($\bar{x}$ = 7.4). Weather indices accounted for 32% of annual variability in mink observations (Appendix F), indicating that other environmental or population factors likely drive counts in Iowa.

Spotlight observations for bobcats are collected incidentally as spotlighting is less likely to detect forest obligates. However, the distribution of bobcat observations is consistent with other population indices in Iowa and suggests a population distributed primarily in the southern half of the state.

For this survey house cats are defined as free-ranging domestic cats located in rural areas unconfined and away from farmsteads and human developments (e.g., feral cats). Observations for house cats have declined 80% since 2012. A similar pattern was observed for archery 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 declining cat populations is likely beneficial 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. When paired with long-term harvest and other survey data, the development of population abundance or growth models may be possible and provide more robust metrics for evaluating populations in the future.

ACKNOWLEDGMENTS

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 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. J. M. Coffey compiled and maintained data for many years of the survey.

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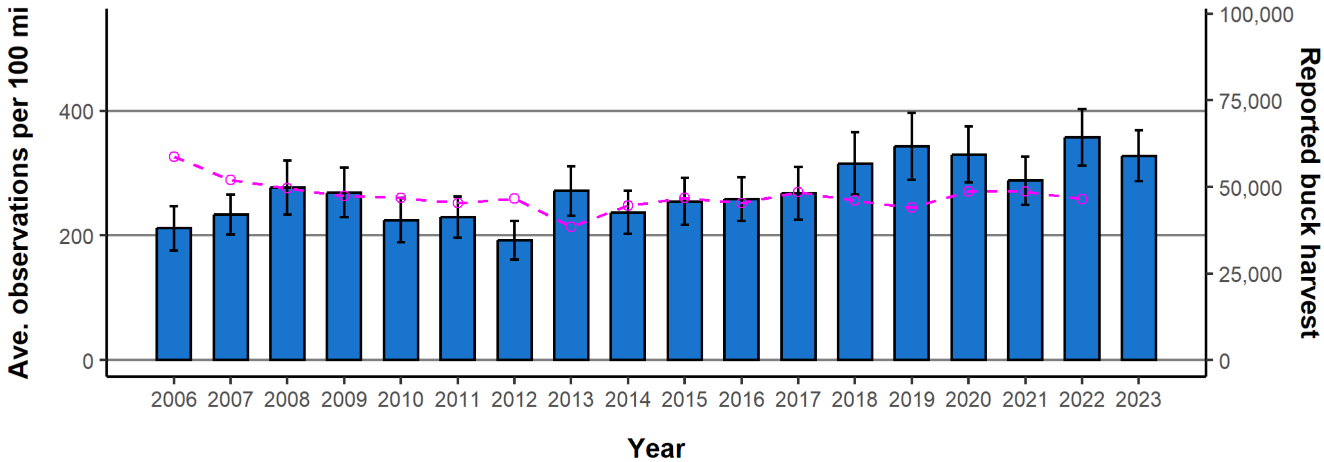


Figure 2. Average white-tailed deer observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide buck deer harvest.

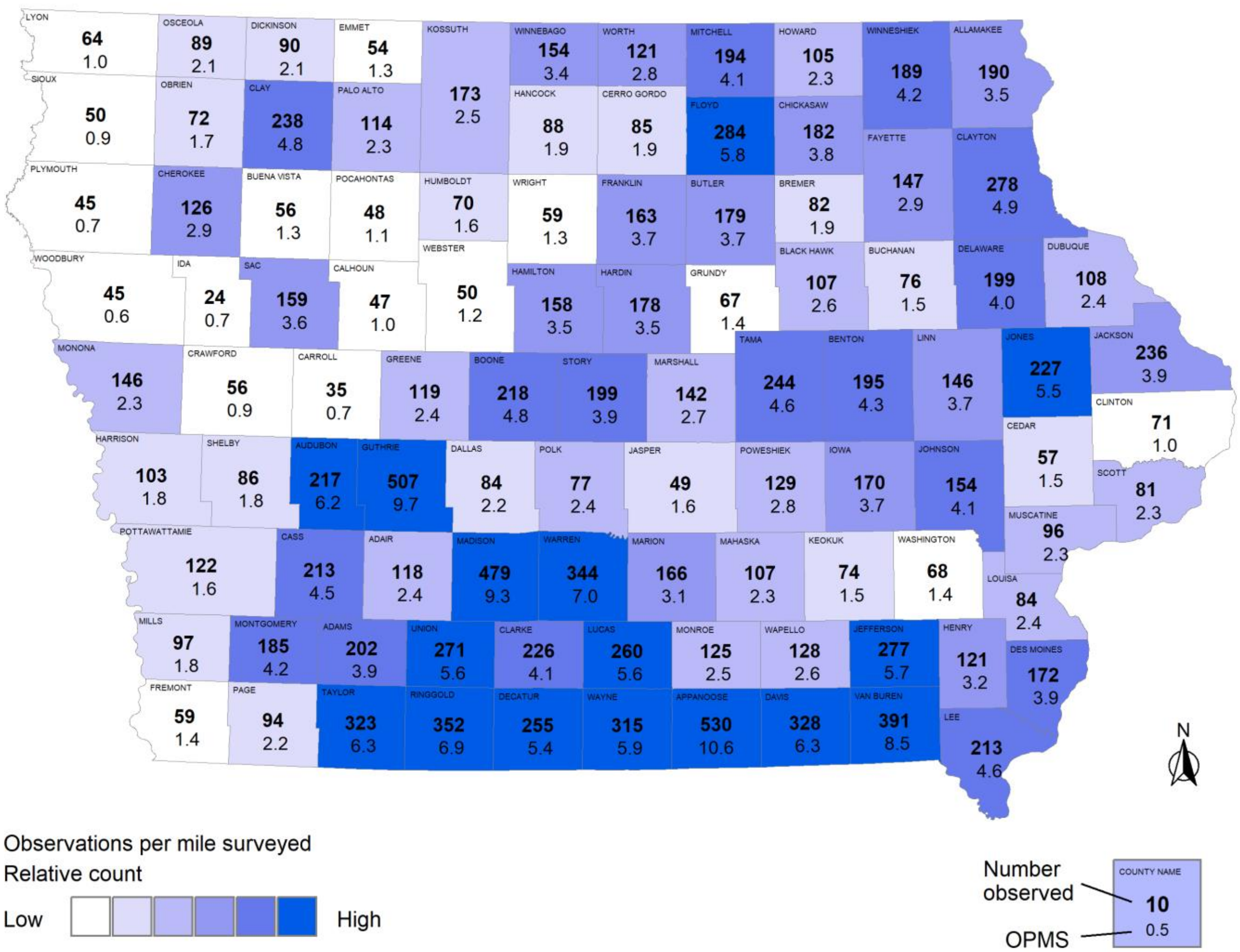


Figure 3. Total number of white-tailed deer observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS).

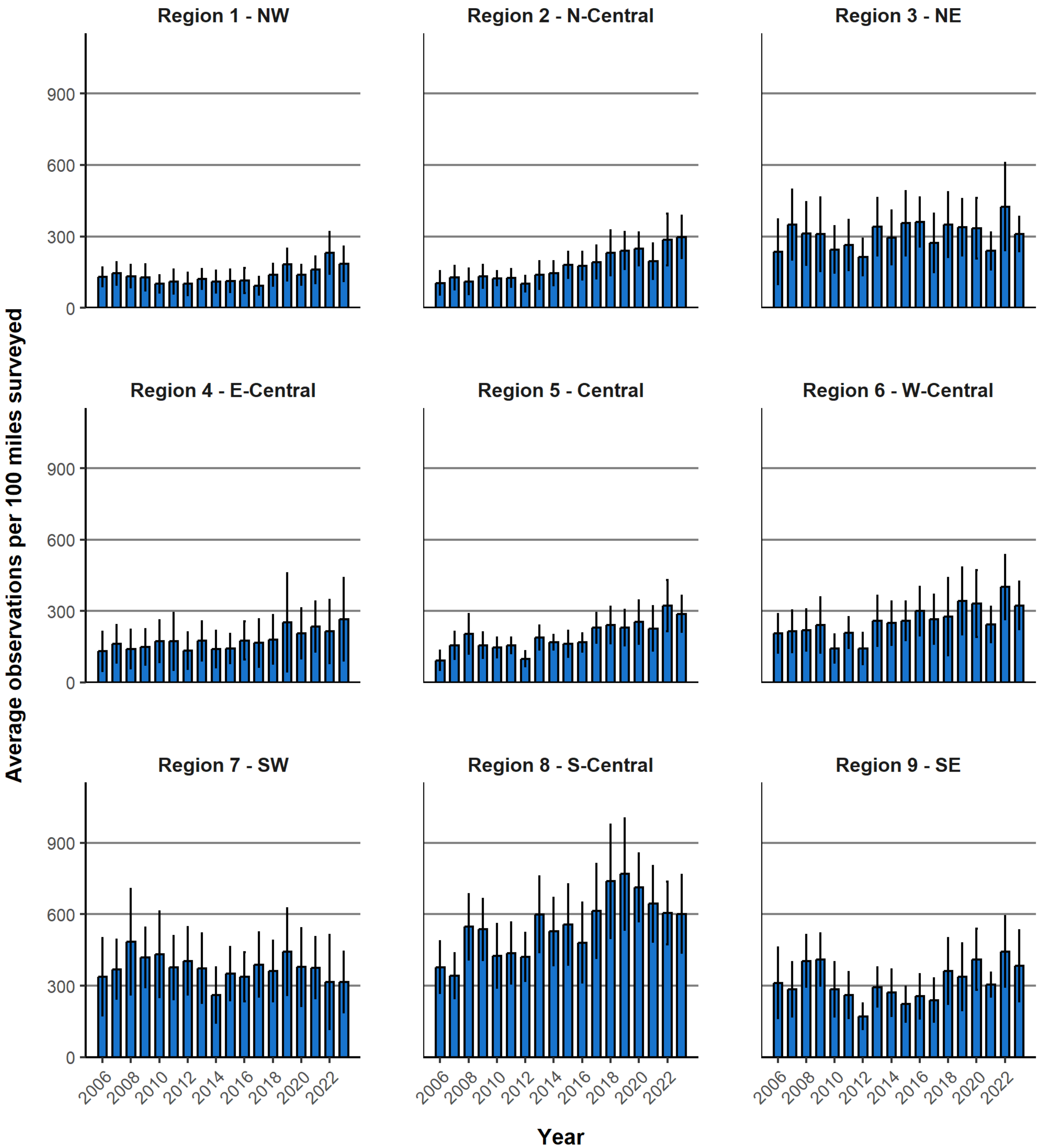


Figure 4. Average white-tailed deer observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006– 2023. Error bars indicate 95% confidence intervals.

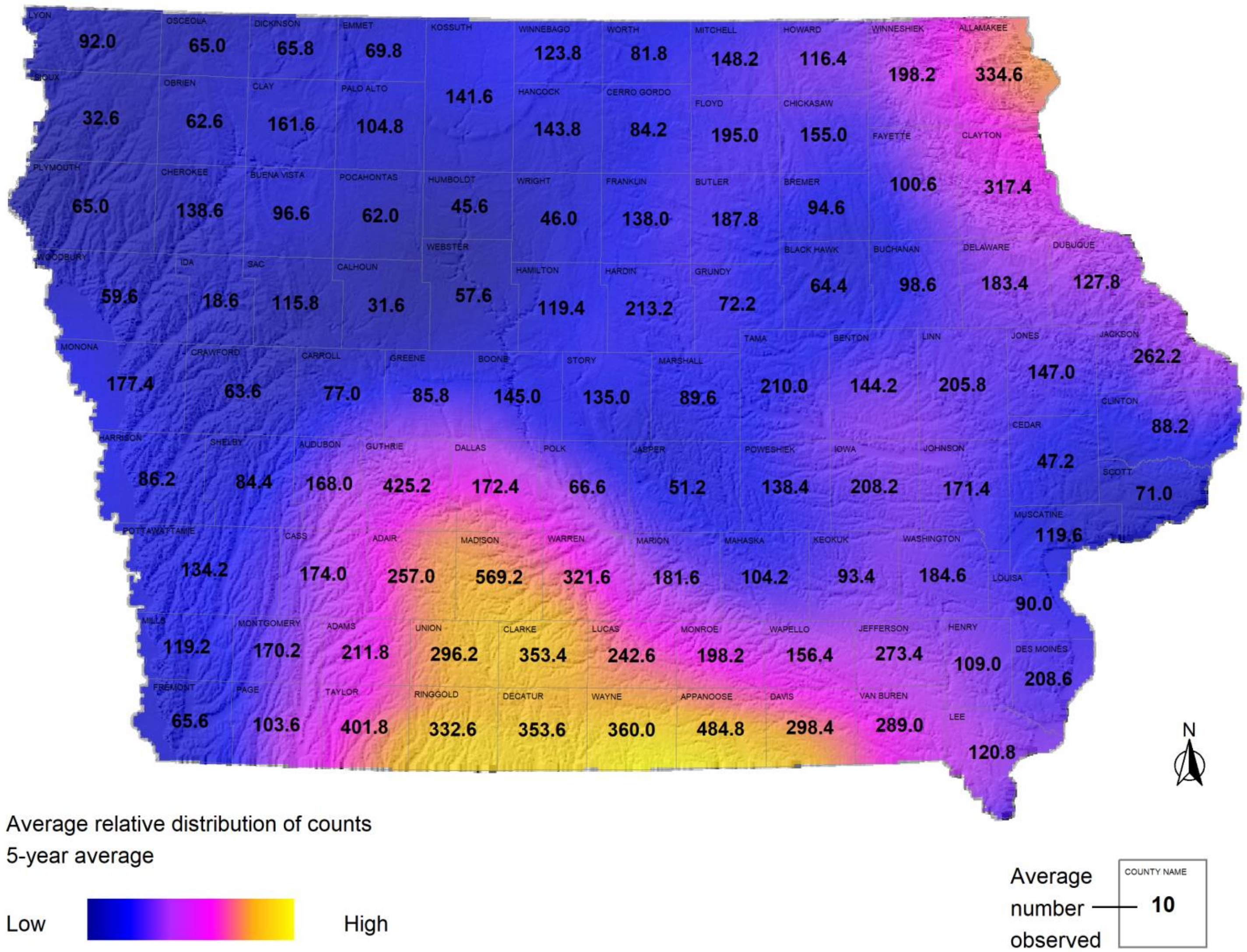


Figure 5. Average relative distribution of spring spotlight observations for white-tailed deer during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance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

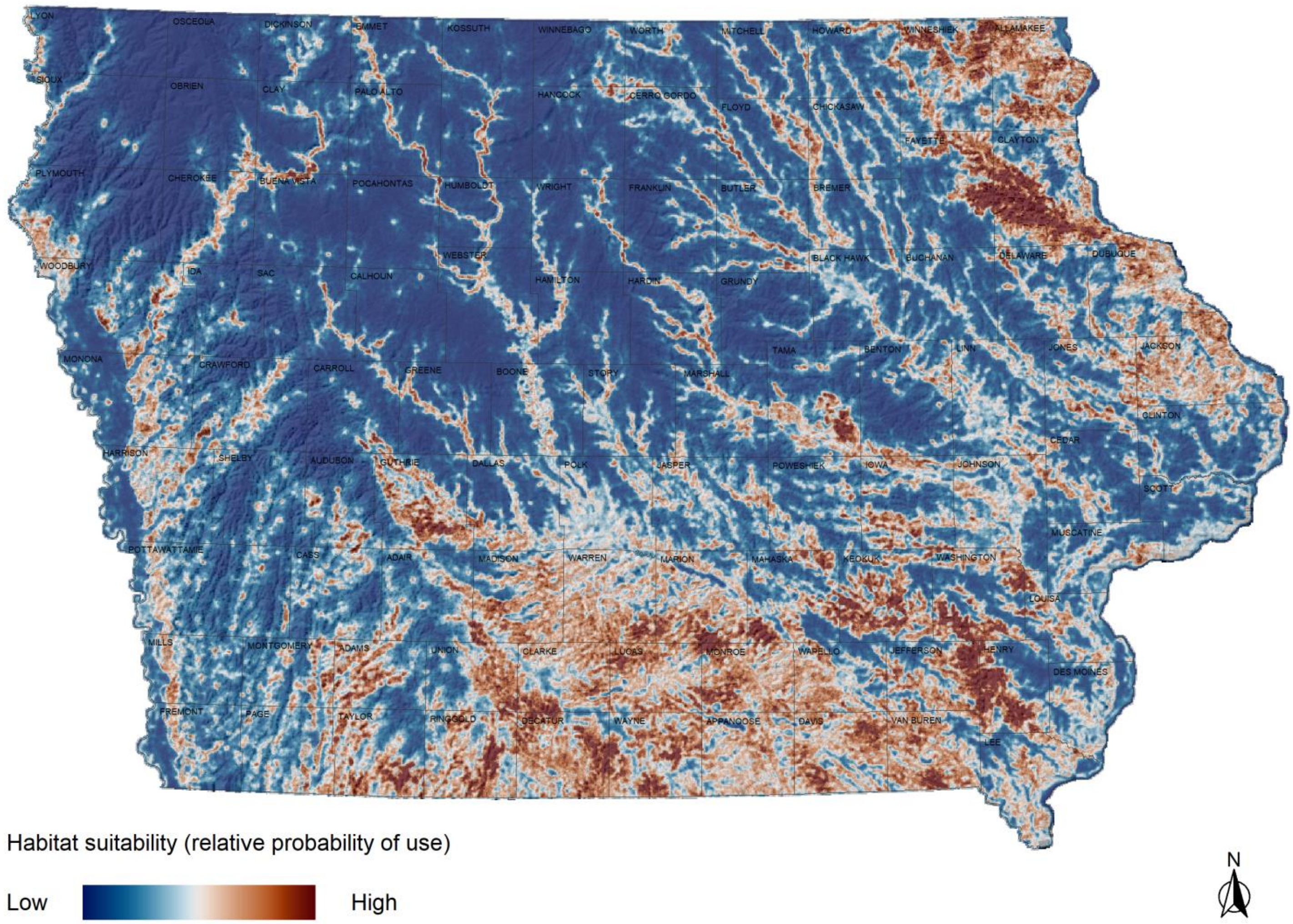


Figure 6. Habitat suitability (i.e., relative probability of use) for white-tailed deer in Iowa based on a resource selection function (RSF; see Kaminski et al. [2019] for details). The RSF model was predicted using spotlight observations for deer from 2012–2016 and the accuracy of the model was tested using 2017 observations (R^2 = 0.95). High values indicate areas of higher relative habitat quality for deer and low values indicate lower habitat quality.

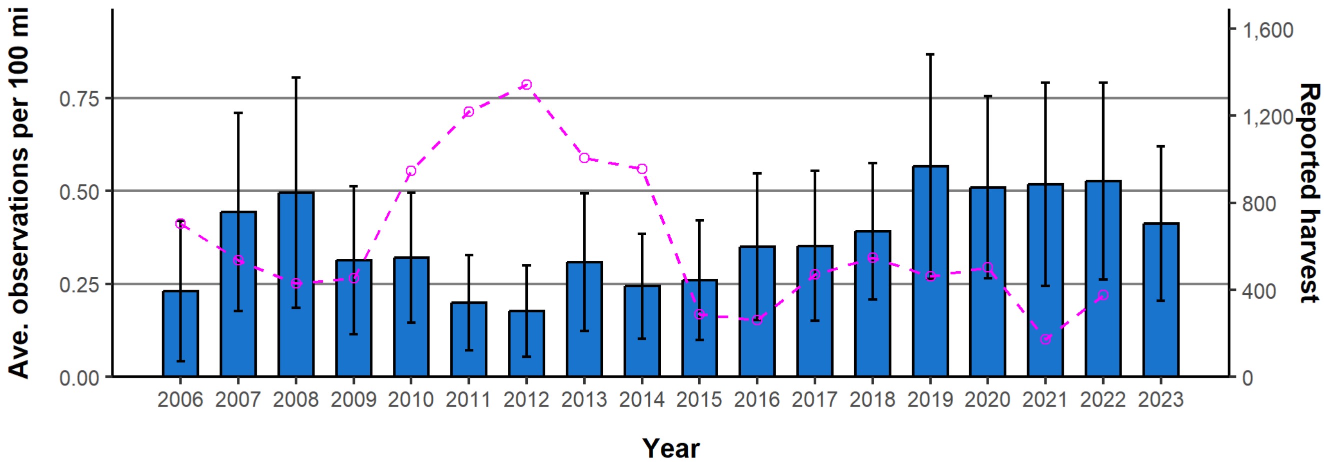


Figure 7. Average badger observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest

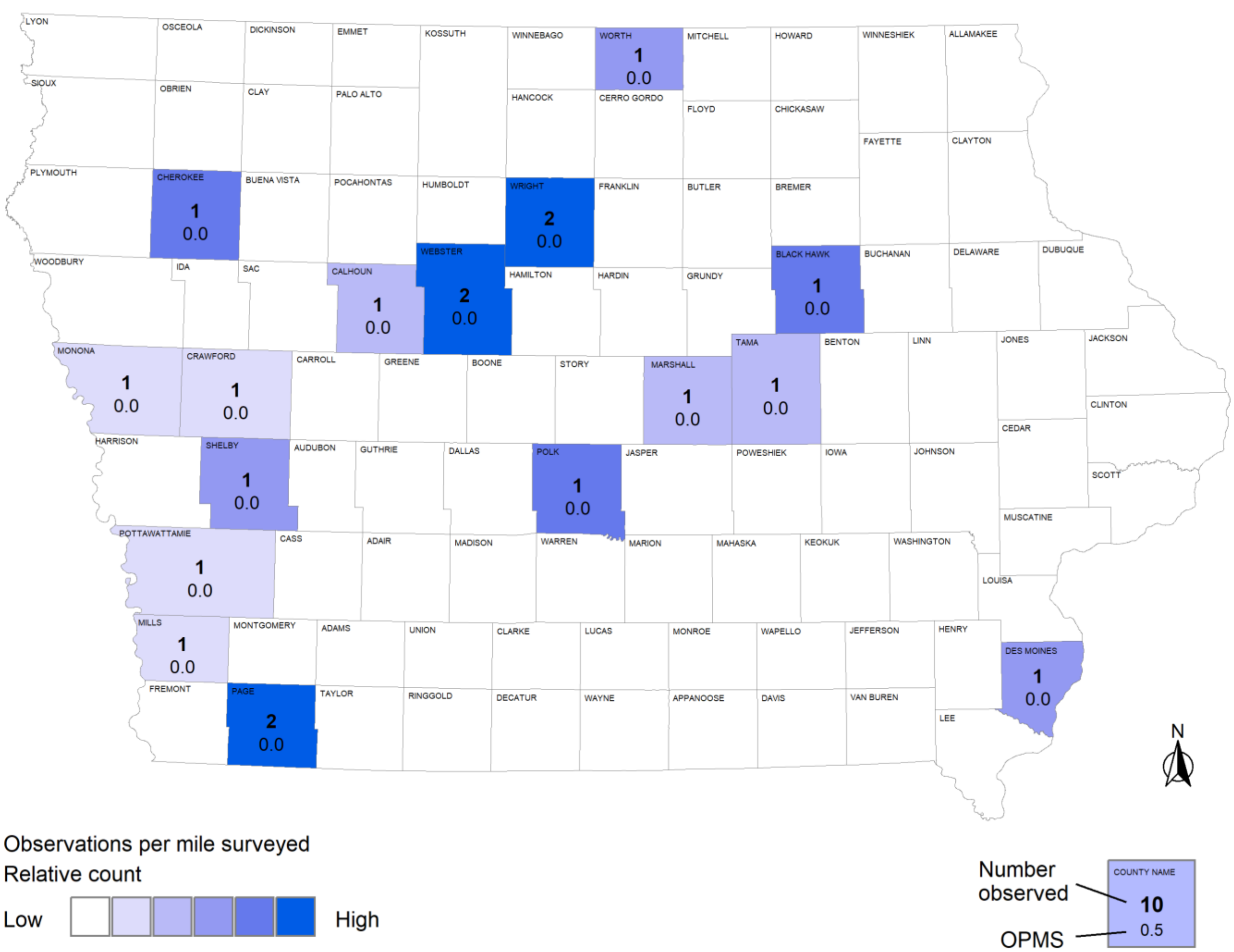


Figure 8. Total number of badger observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS).

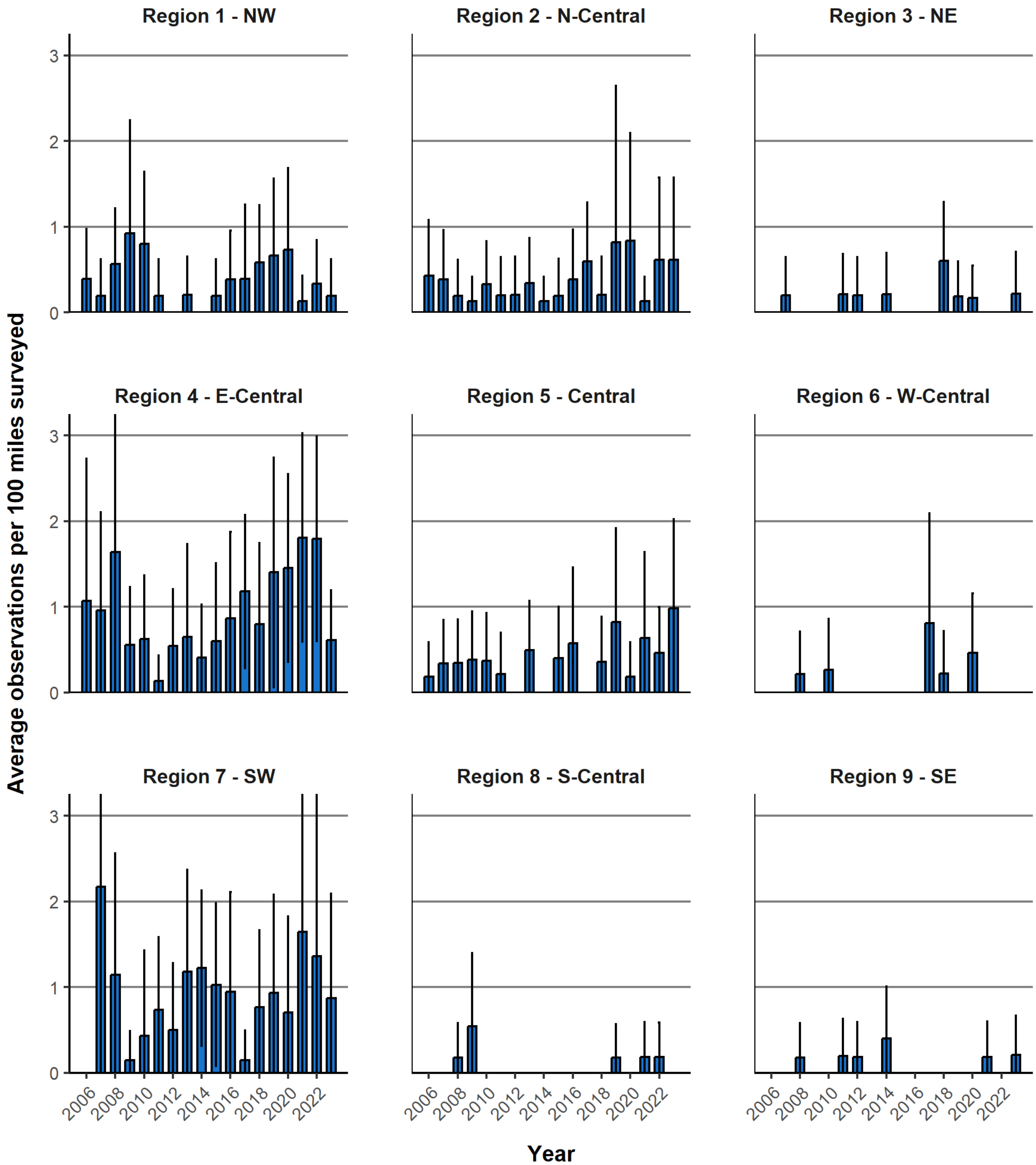


Figure 9. Average badger observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals.

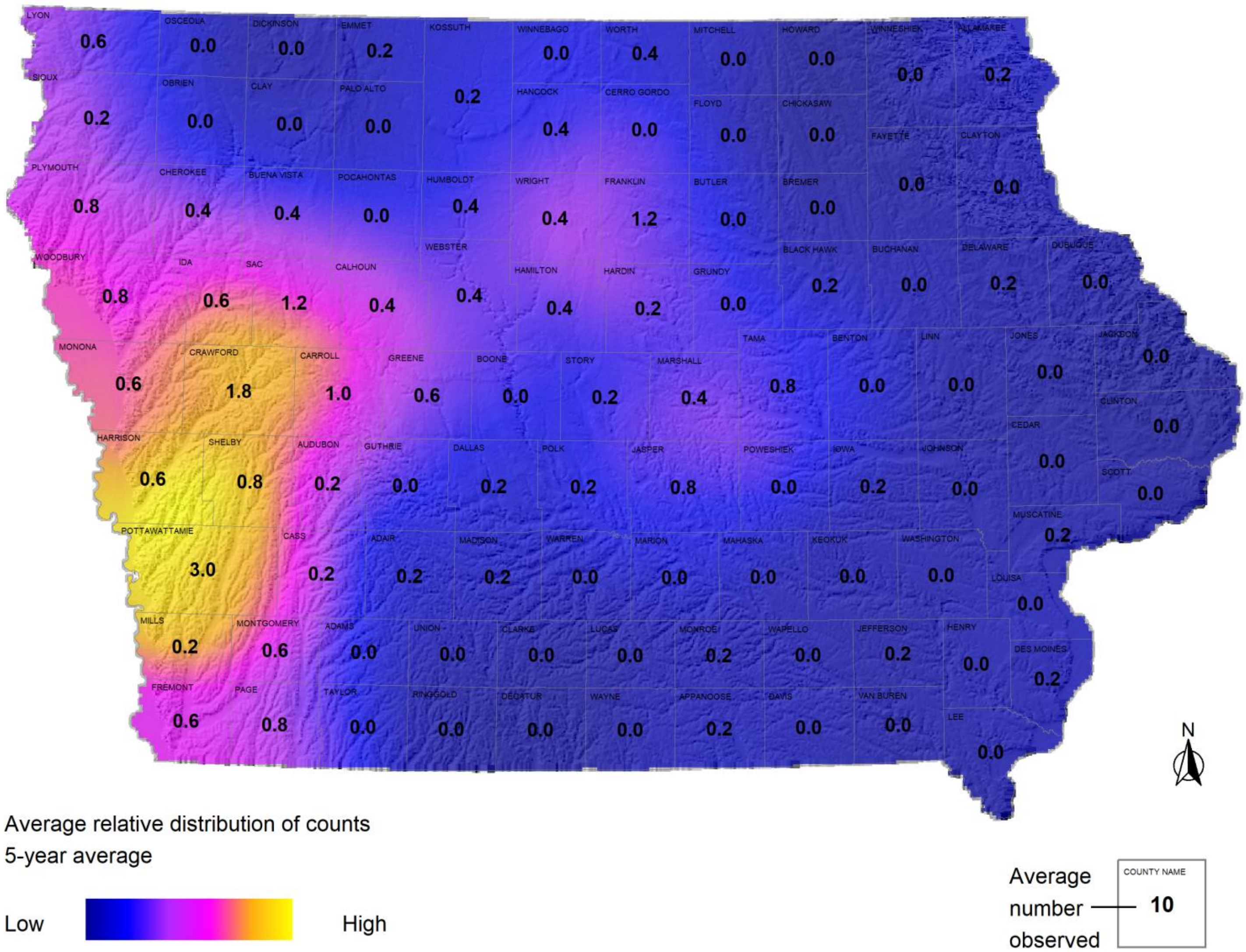


Figure 10. Average relative distribution of spring spotlight observations for badger during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

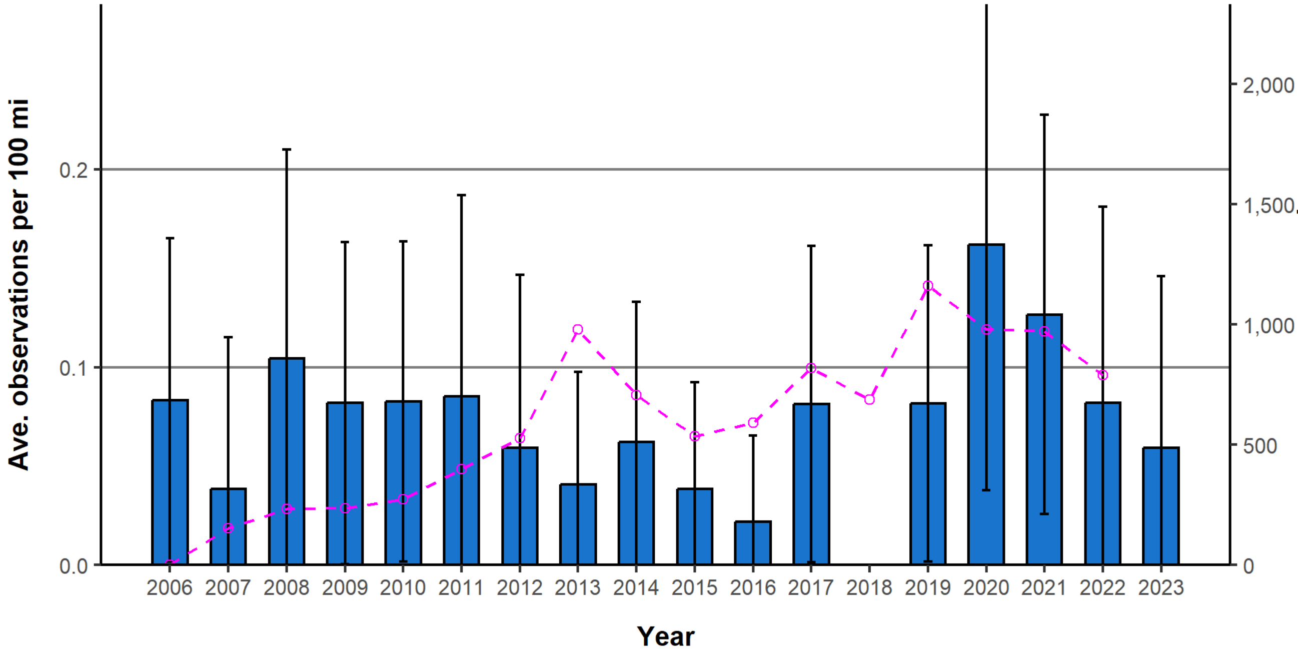


Figure 11. Average bobcat observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest.

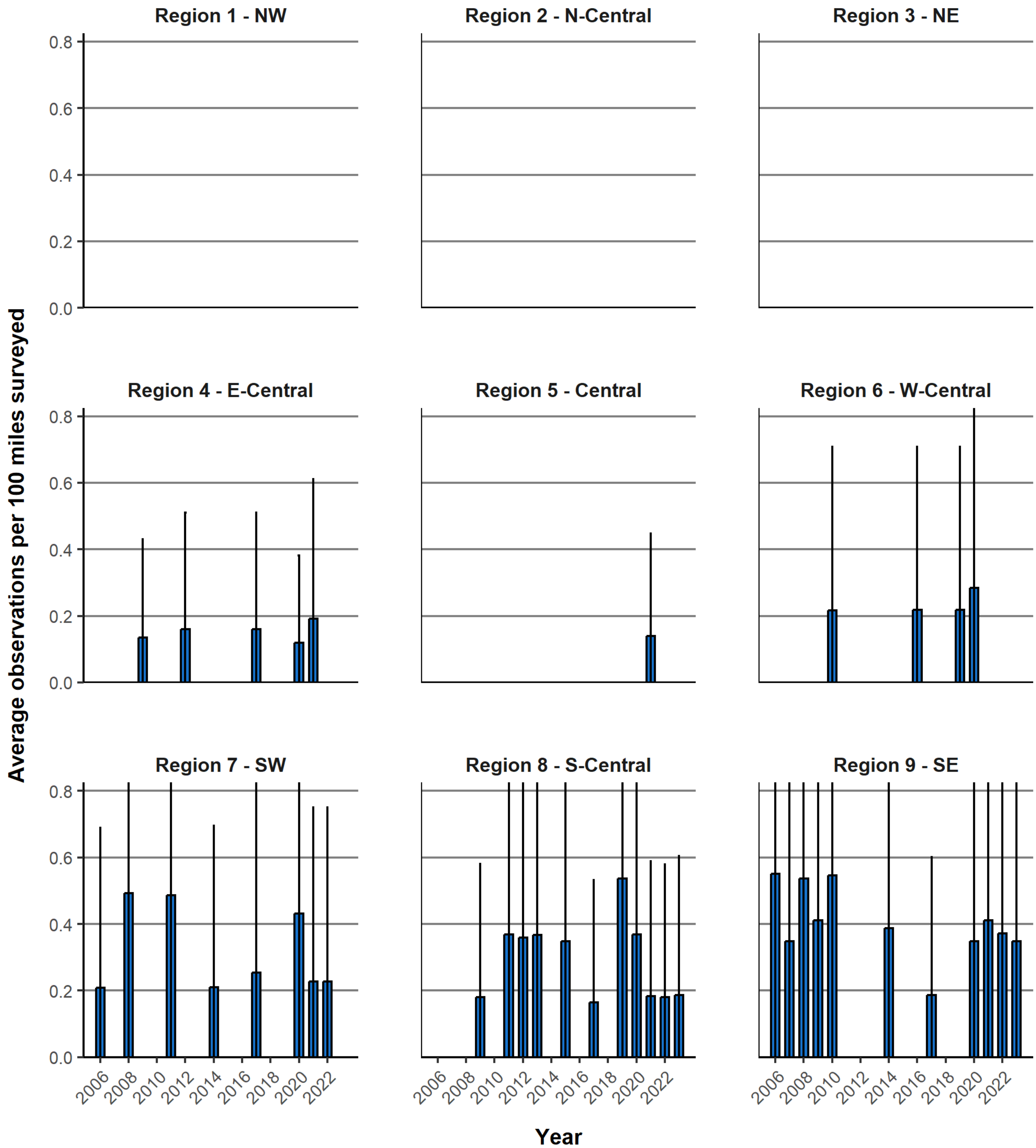


Figure 12. Average bobcat observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals.

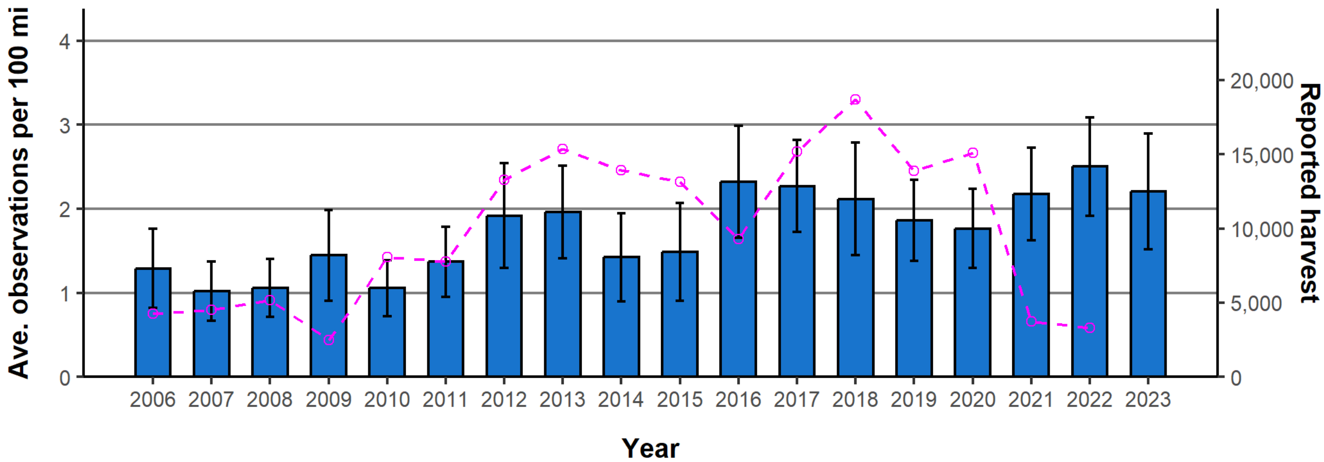


Figure 13. Average coyote observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest.

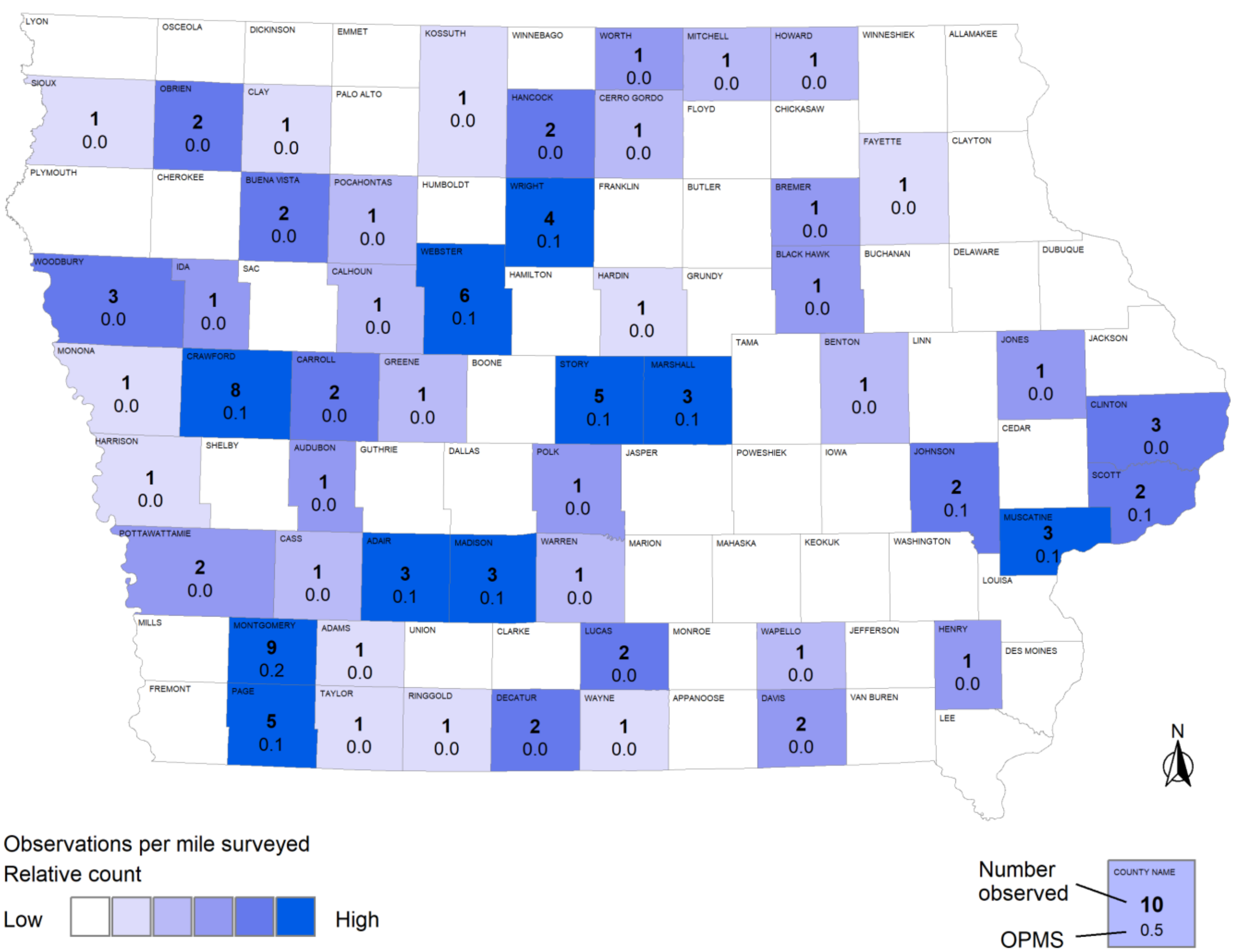


Figure 14. Total number of coyote observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS).

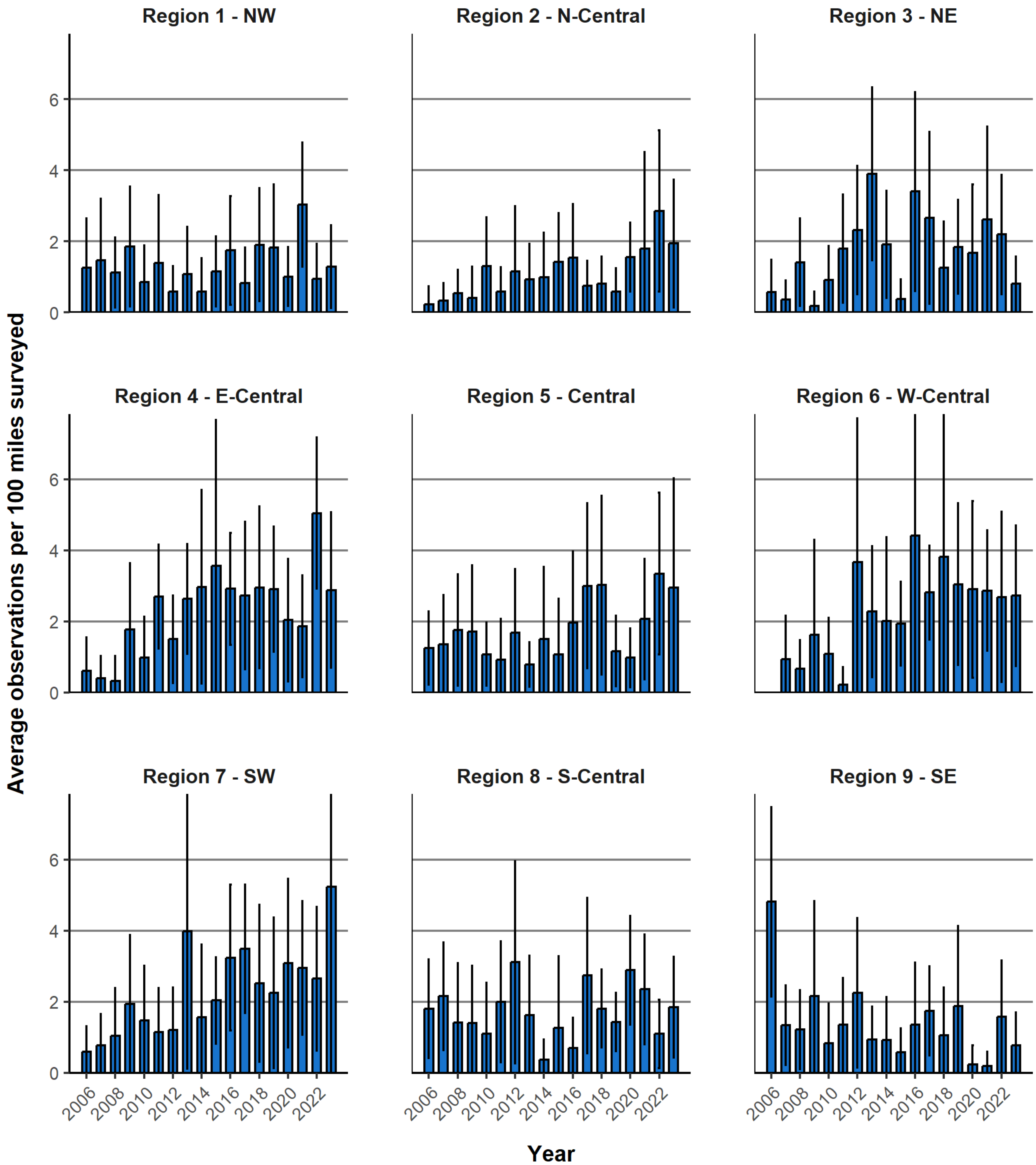


Figure 15. Average coyote observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals.

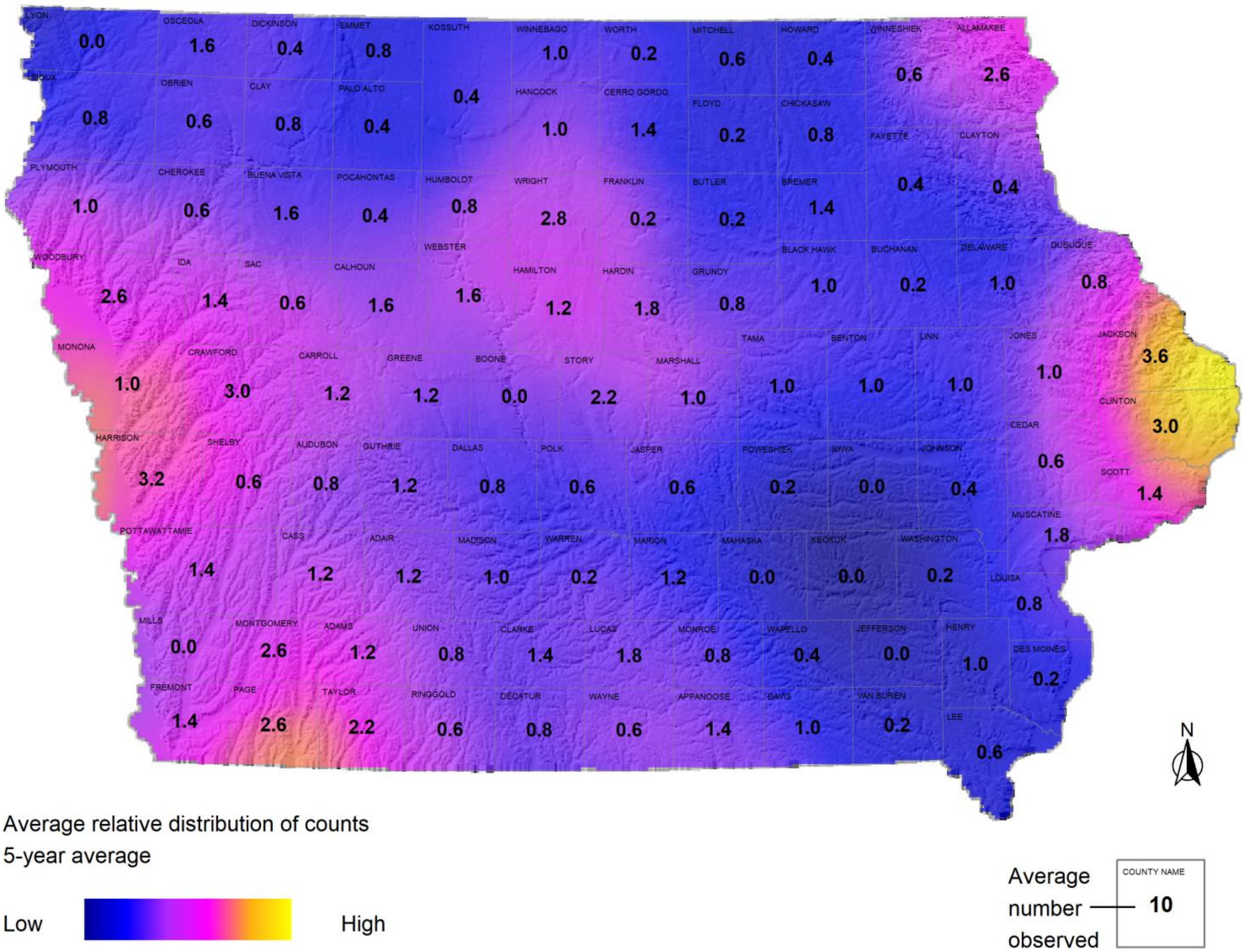


Figure 16. Average relative distribution of spring spotlight observations for coyote during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

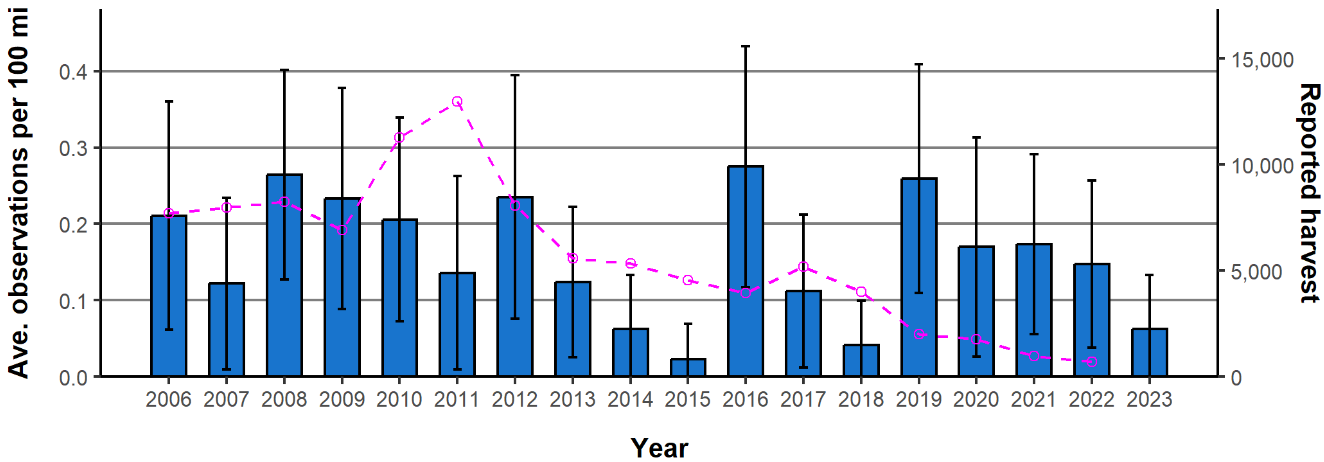


Figure 17. Average mink observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest.

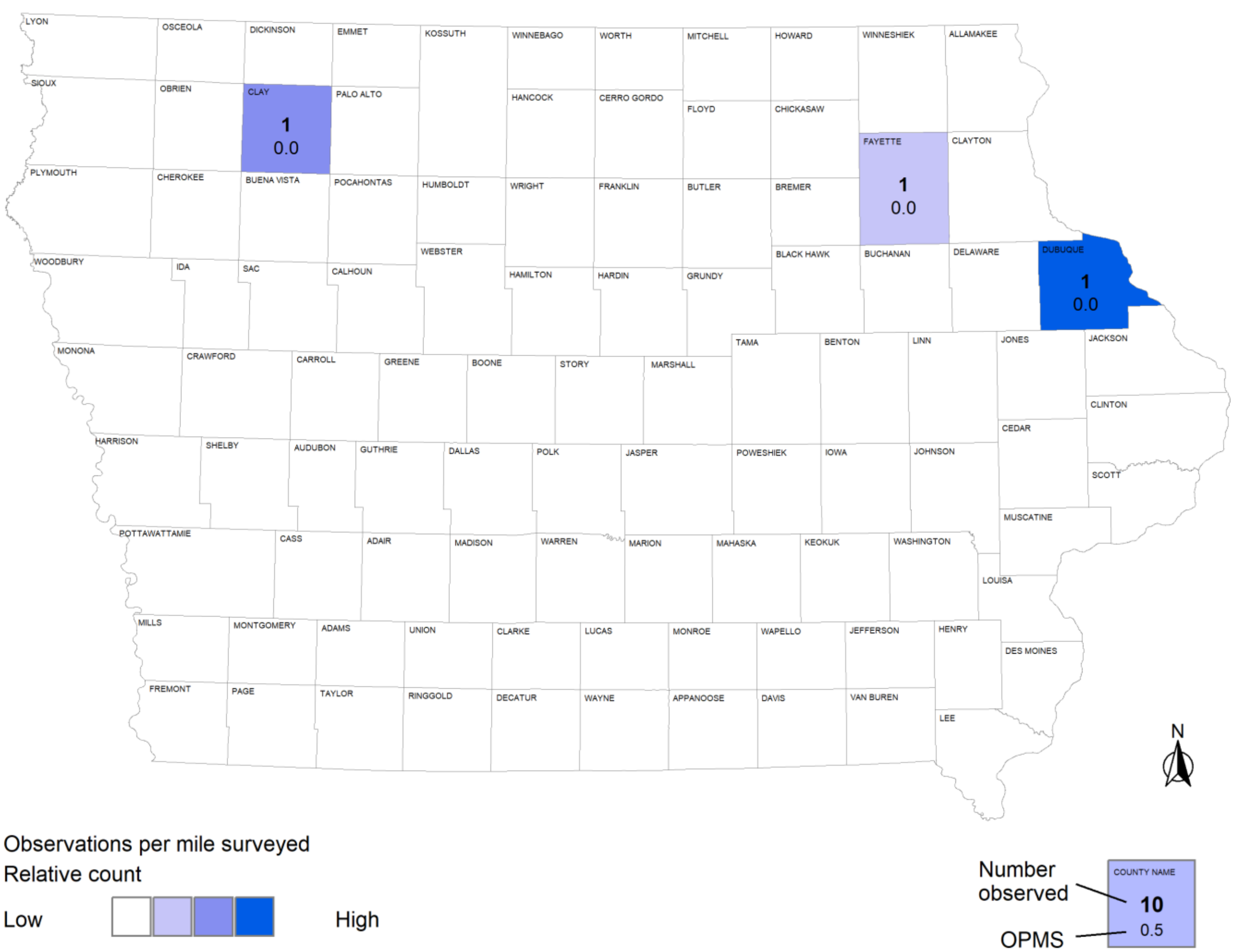


Figure 18. Total number of mink observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS).

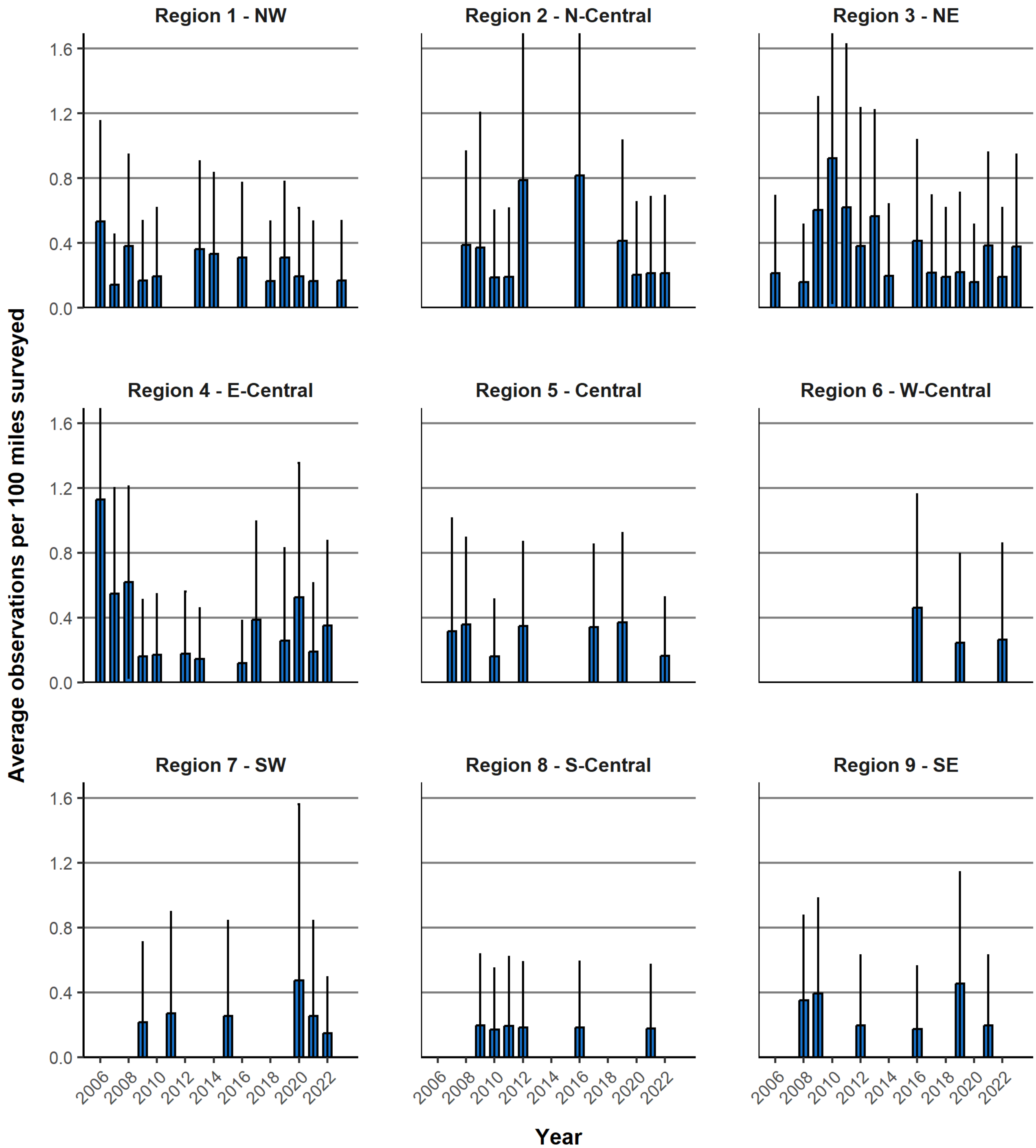


Figure 19. Average mink observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals.

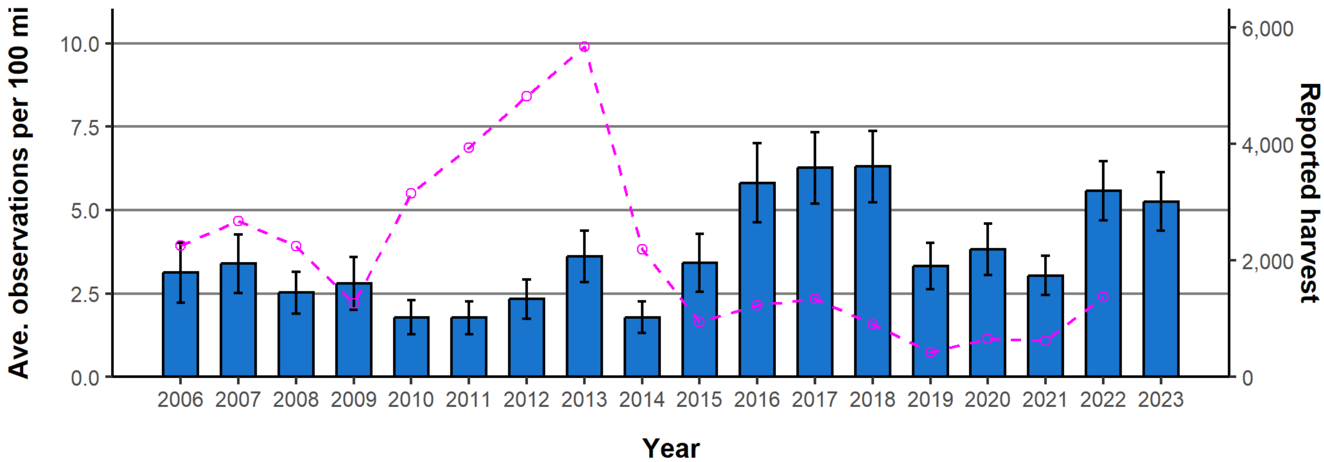


Figure 20. Average opossum observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest.

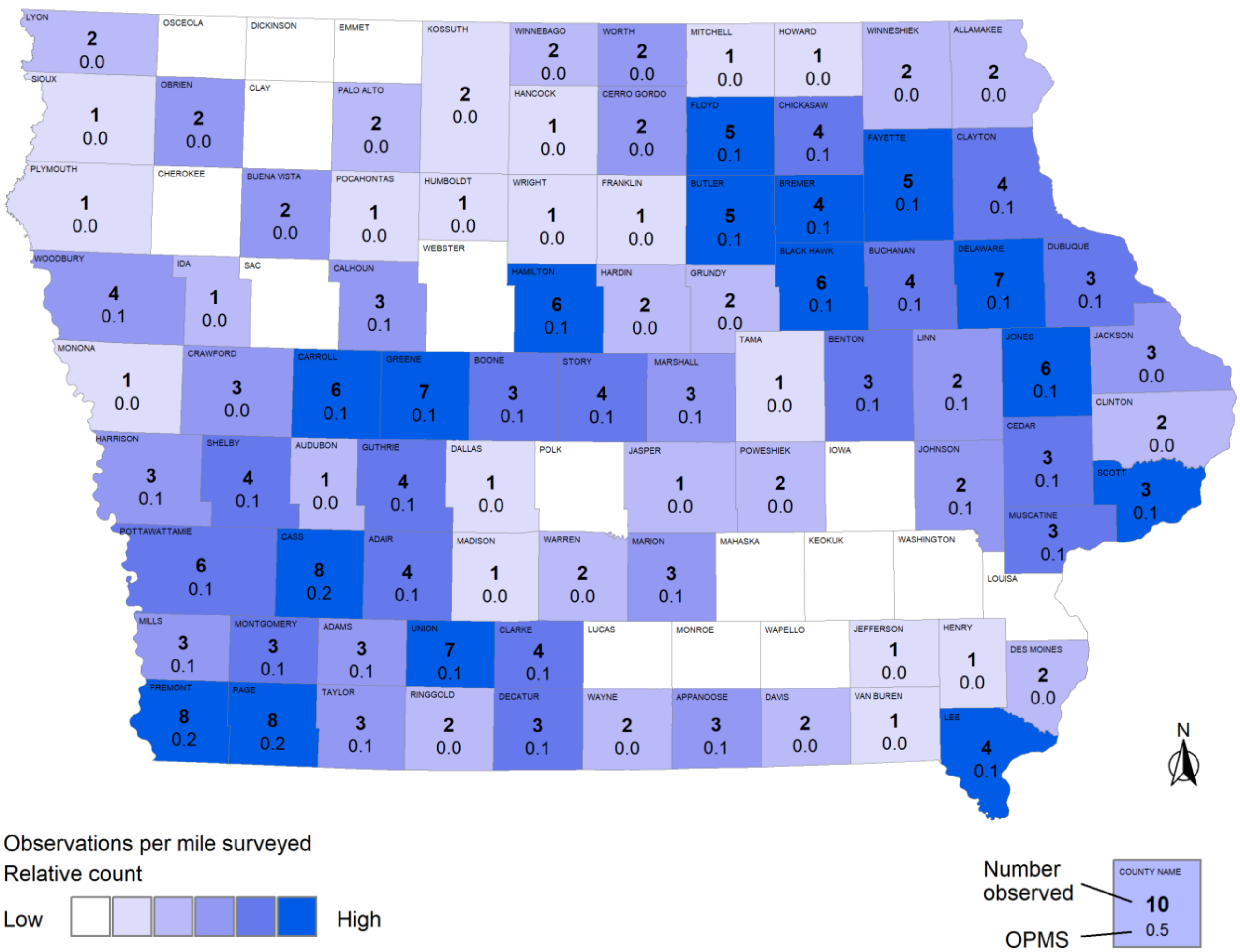


Figure 21. Total number of opossum observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS).

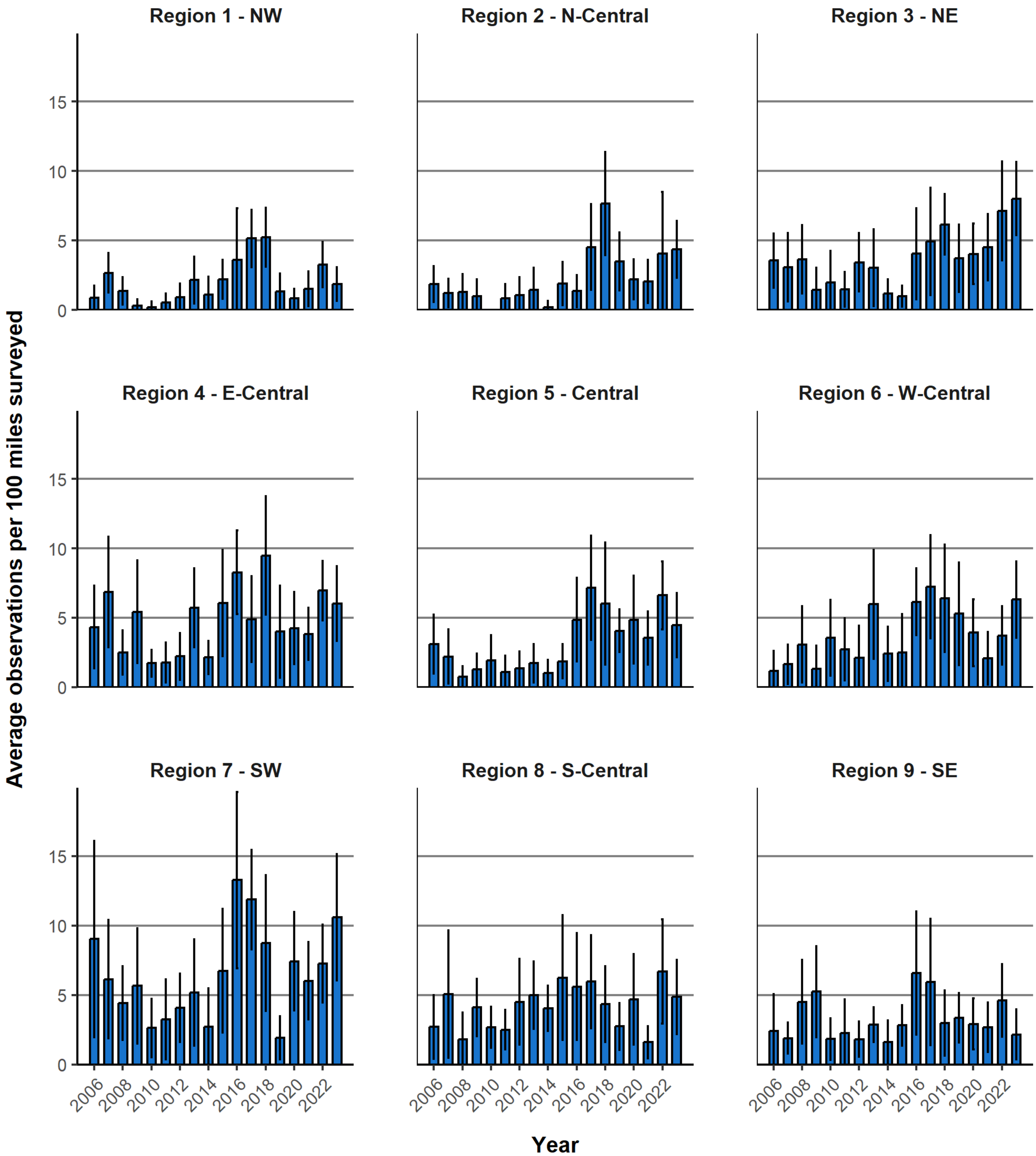


Figure 22. Average opossum observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals.

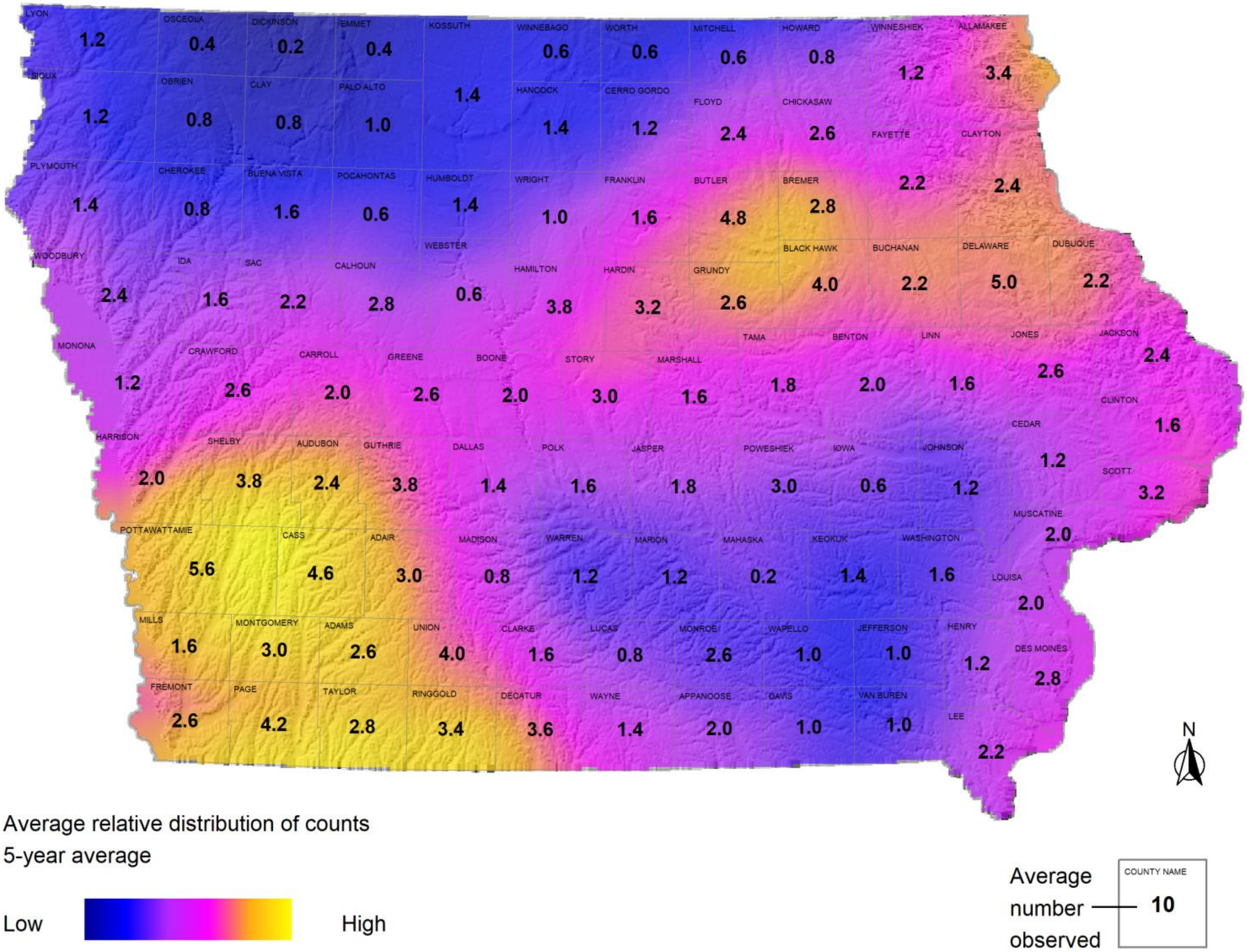


Figure 23. Average relative distribution of spring spotlight observations for opossum during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

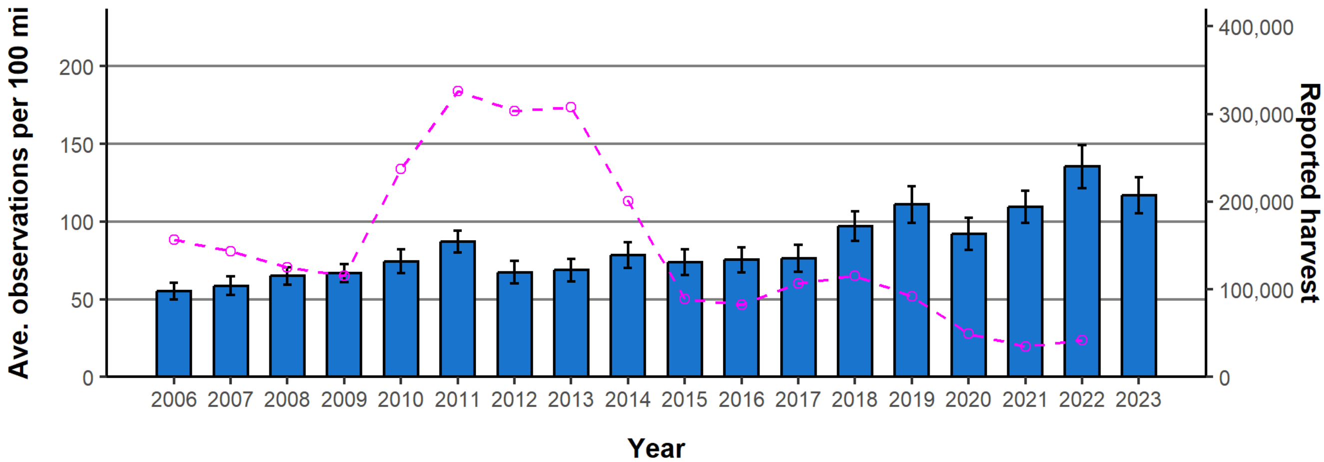


Figure 24. Average raccoon observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest.

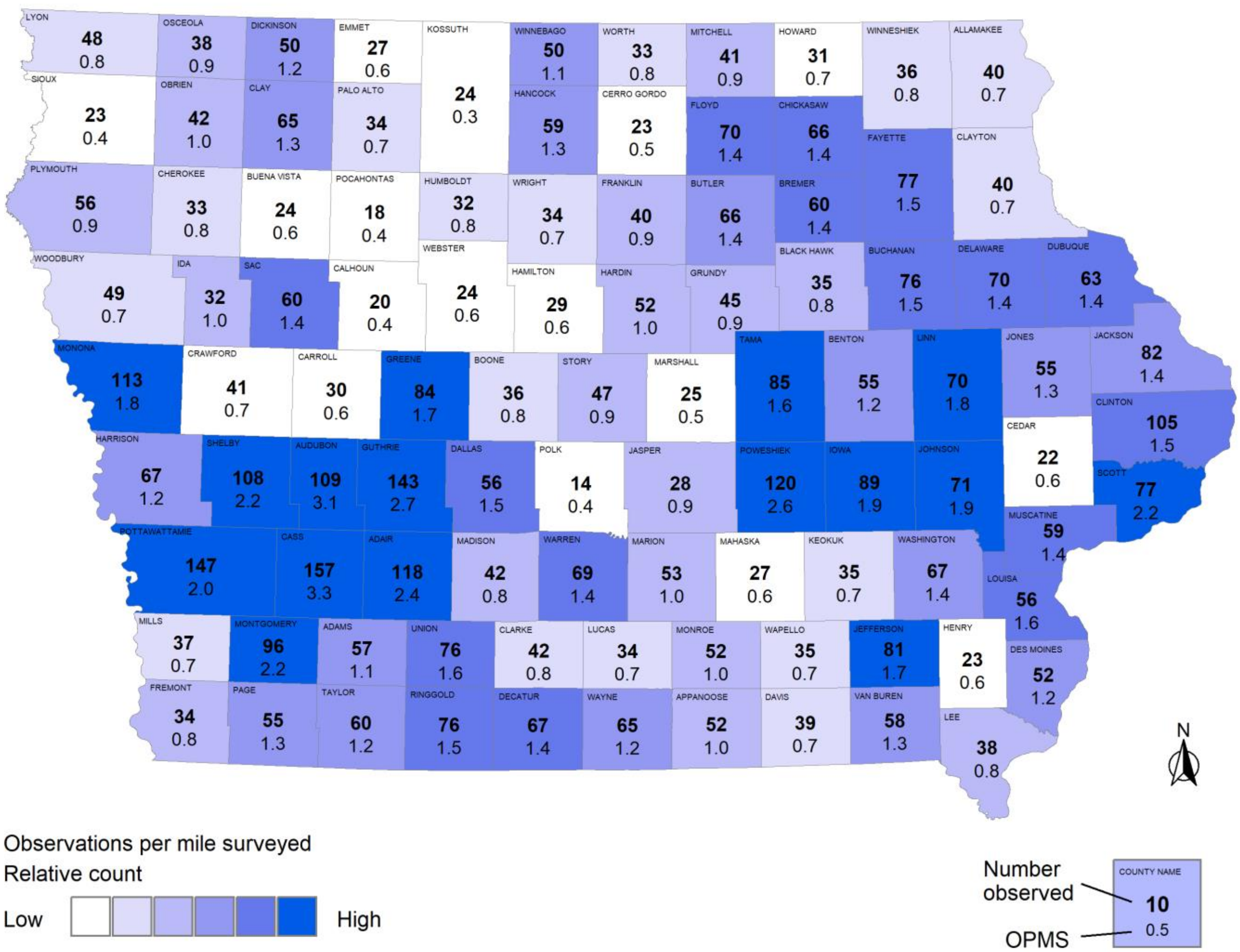


Figure 25. Total number of raccoon observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS).

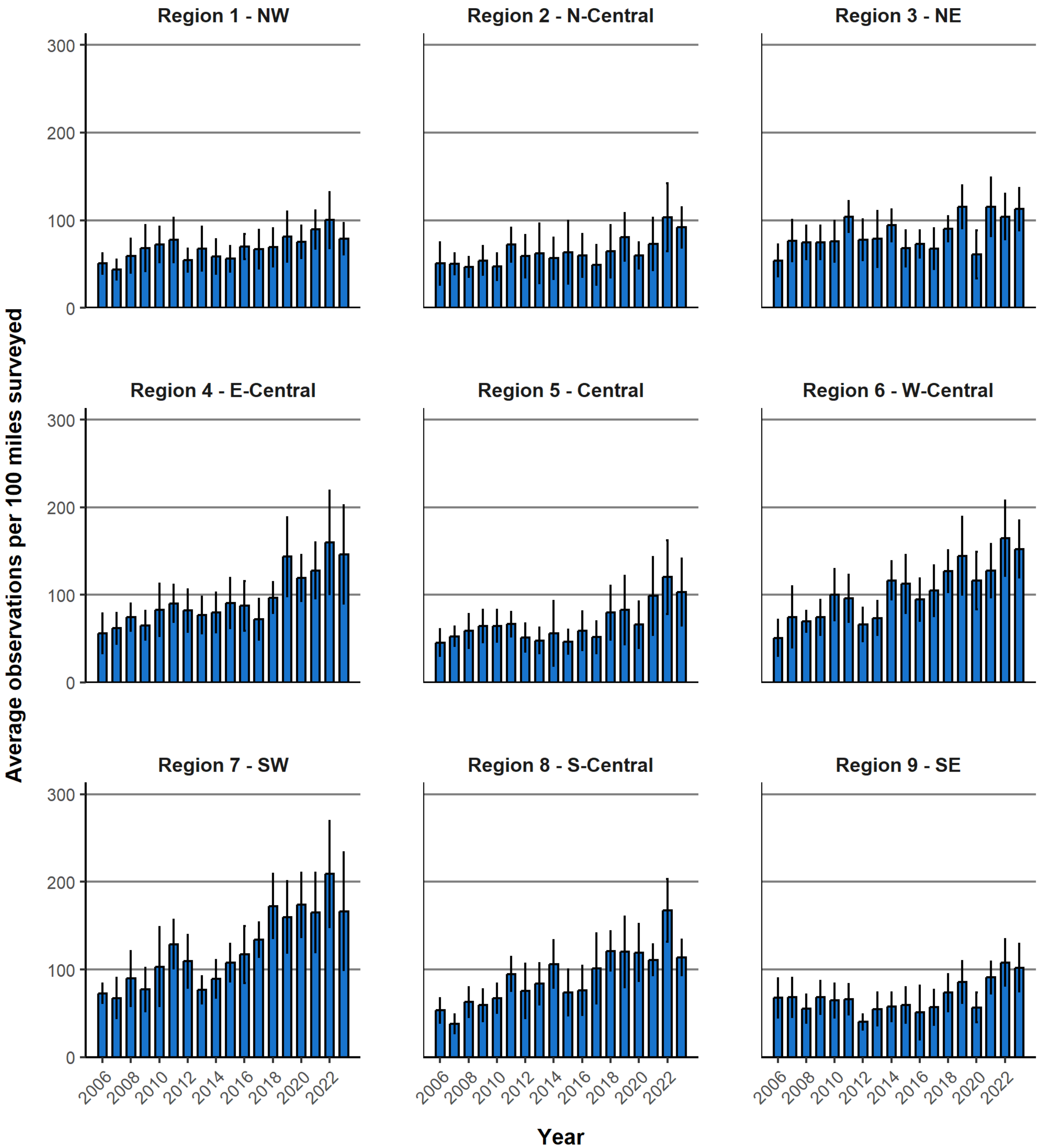


Figure 26. Average raccoon observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals.

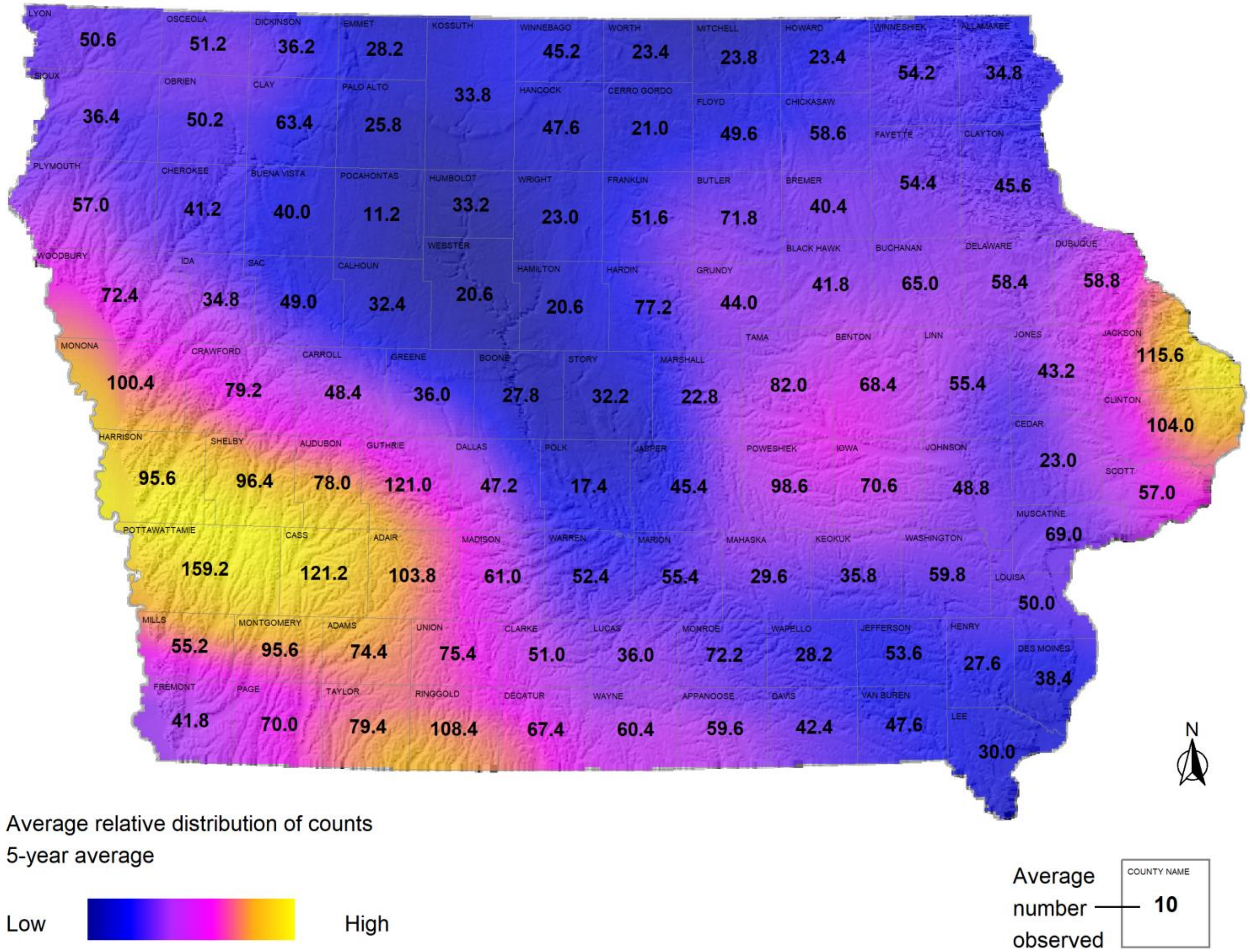


Figure 27. Average relative distribution of spring spotlight observations for raccoon during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

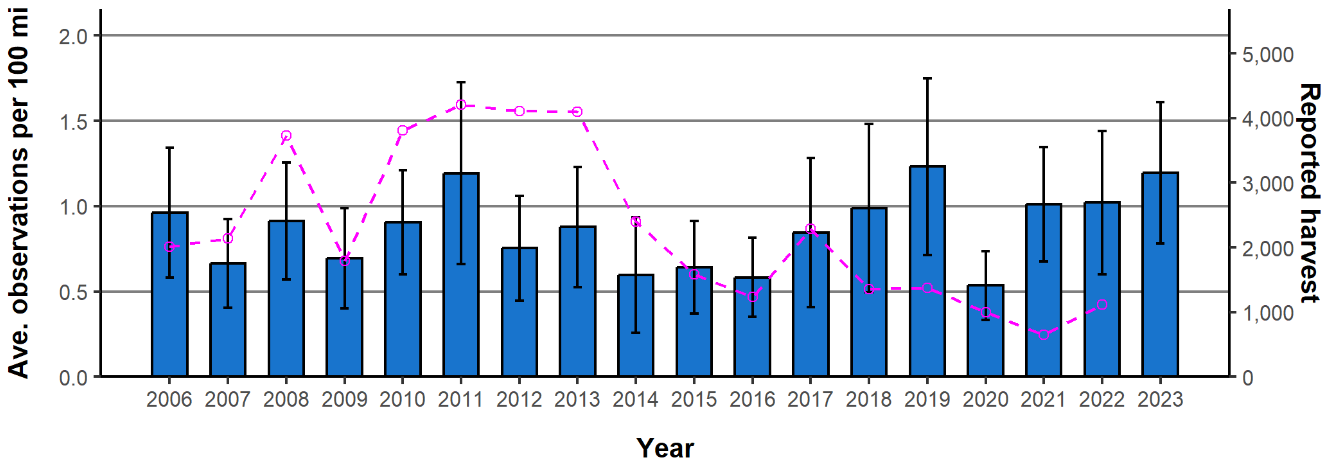


Figure 28. Average red fox observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest.

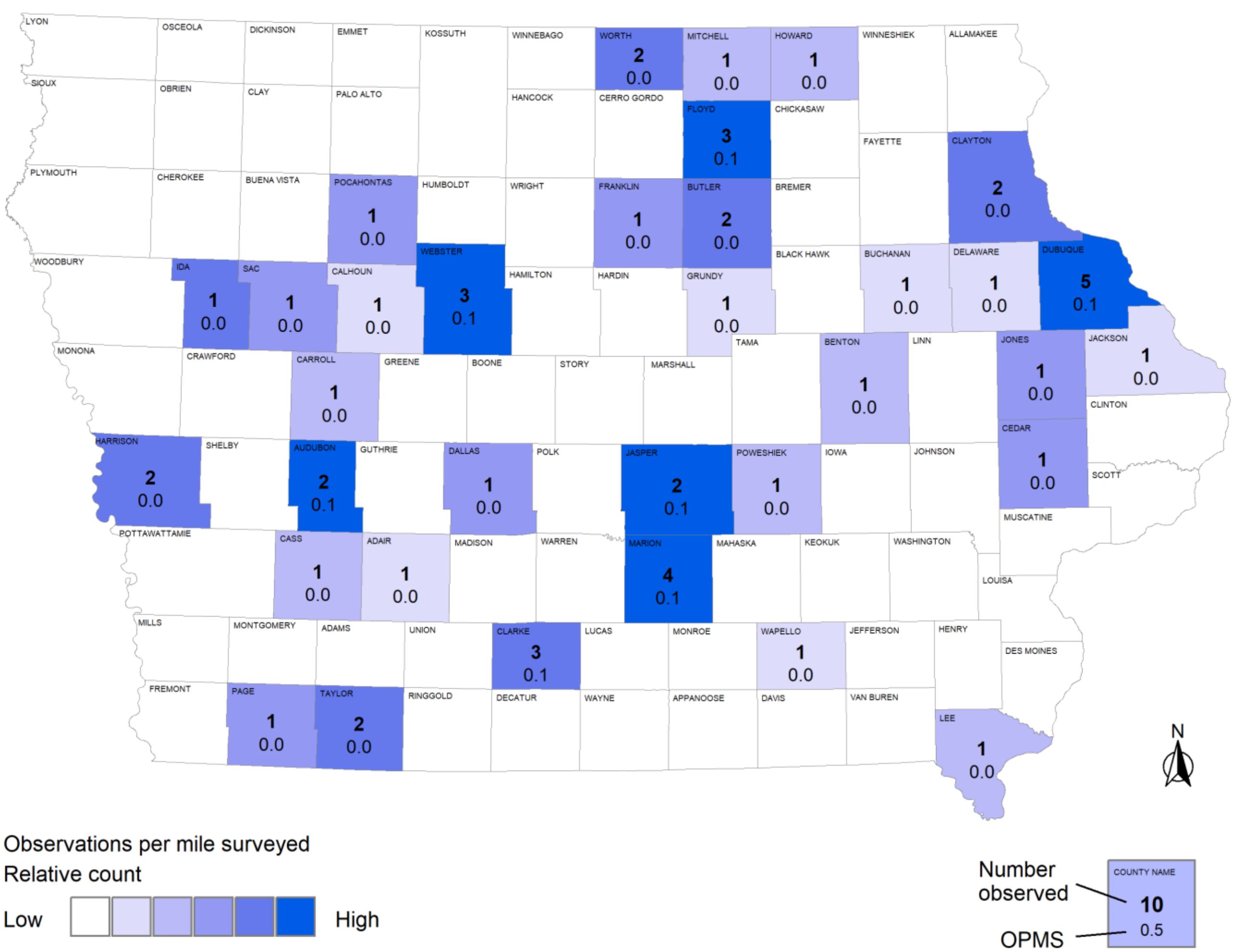


Figure 29. Total number of red fox observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS).

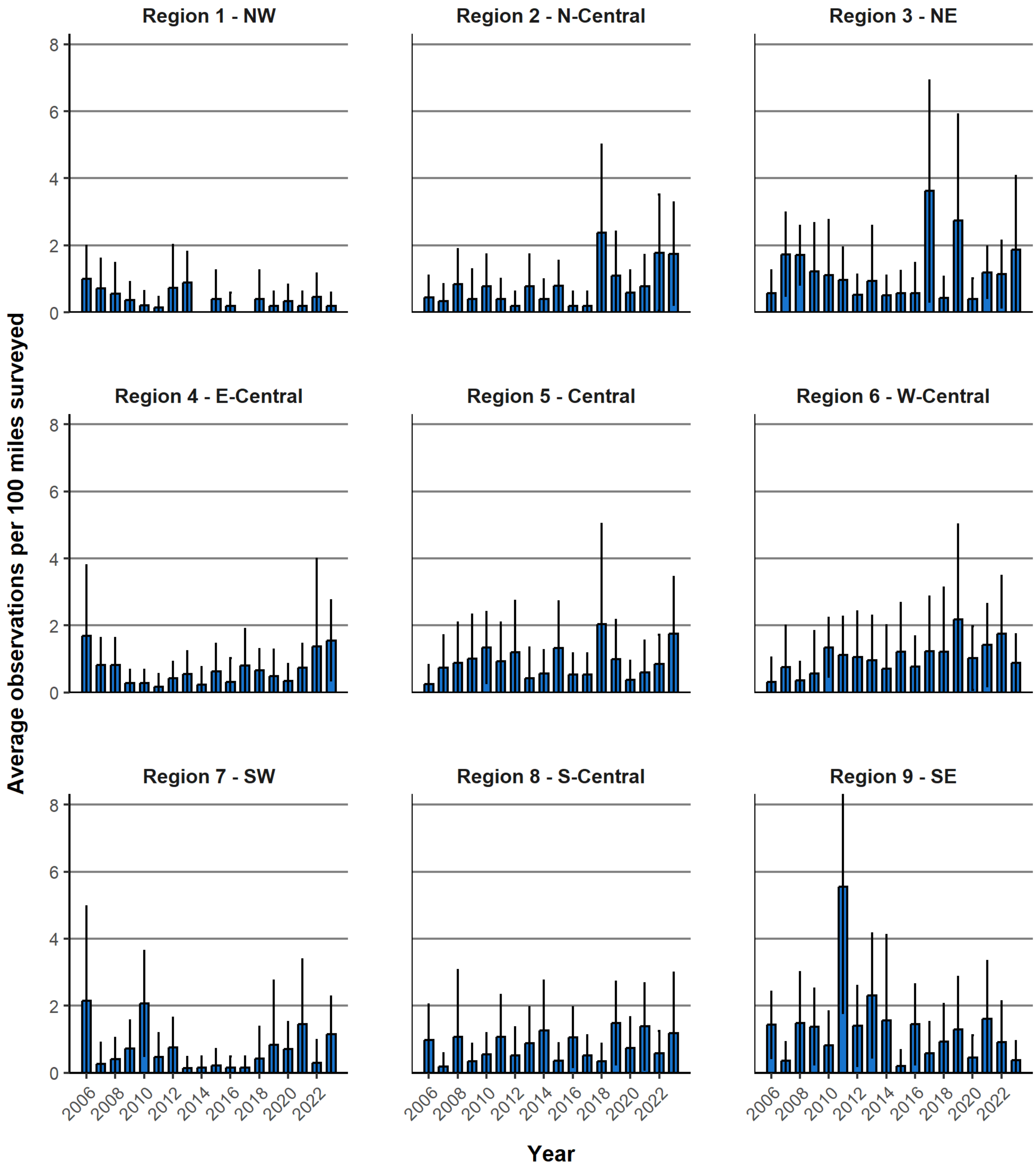


Figure 30. Average red fox observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals. Red fox includes observations listed as "fox" due to the rarity of gray fox in the state.

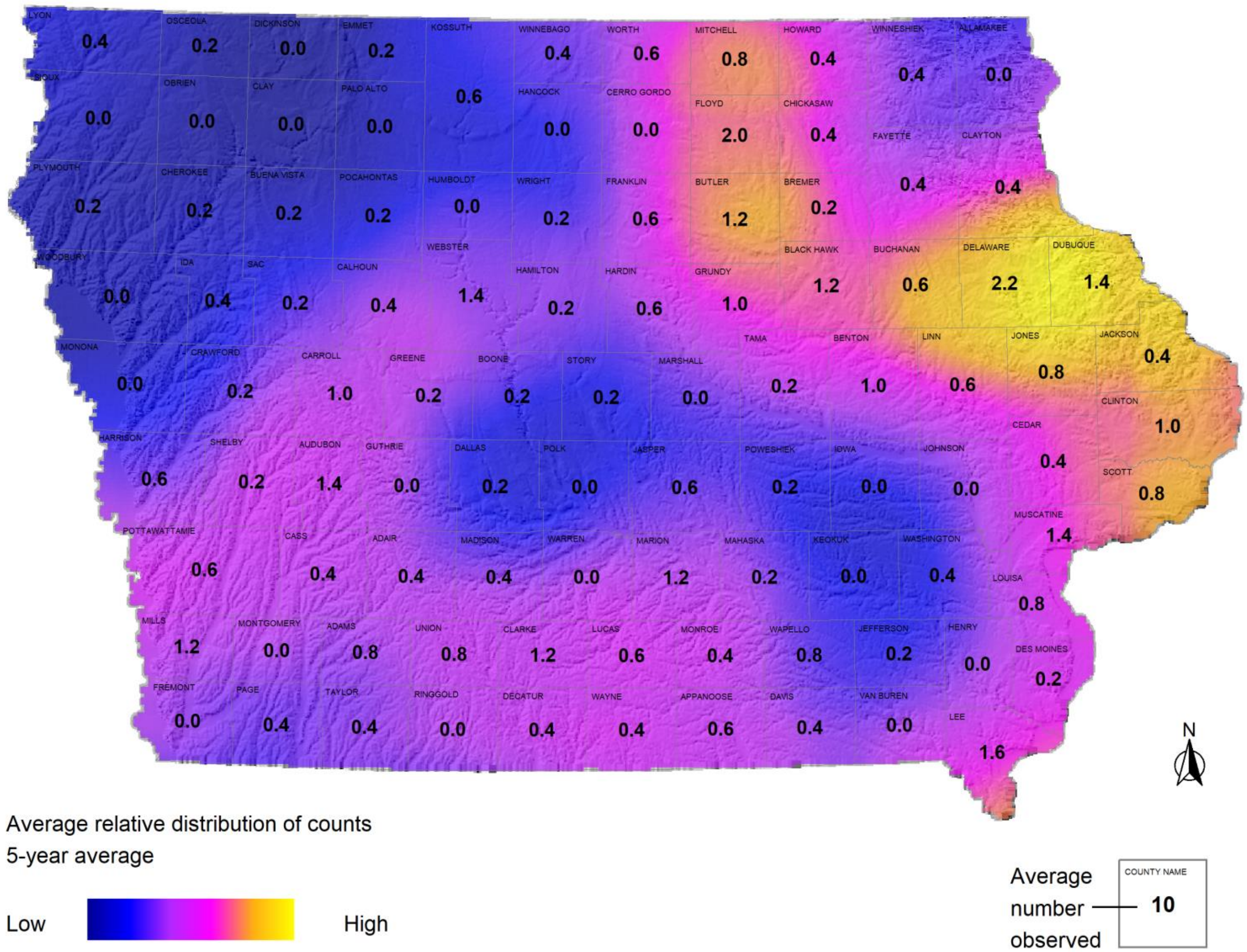


Figure 31. Average relative distribution of spring spotlight observations for red fox during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties).

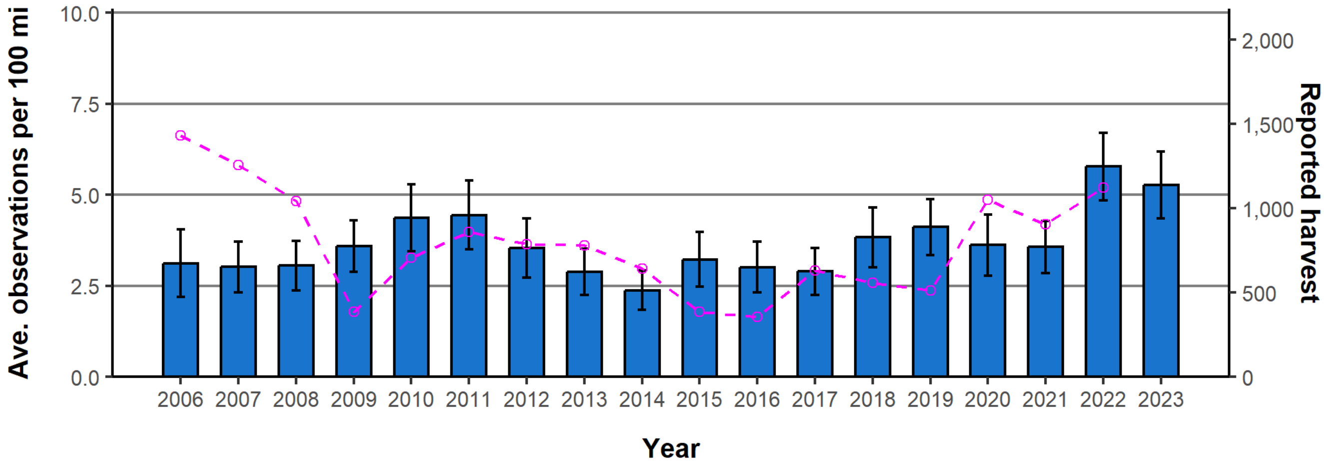


Figure 32. Average striped skunk observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Dashed line indicates the reported statewide harvest.

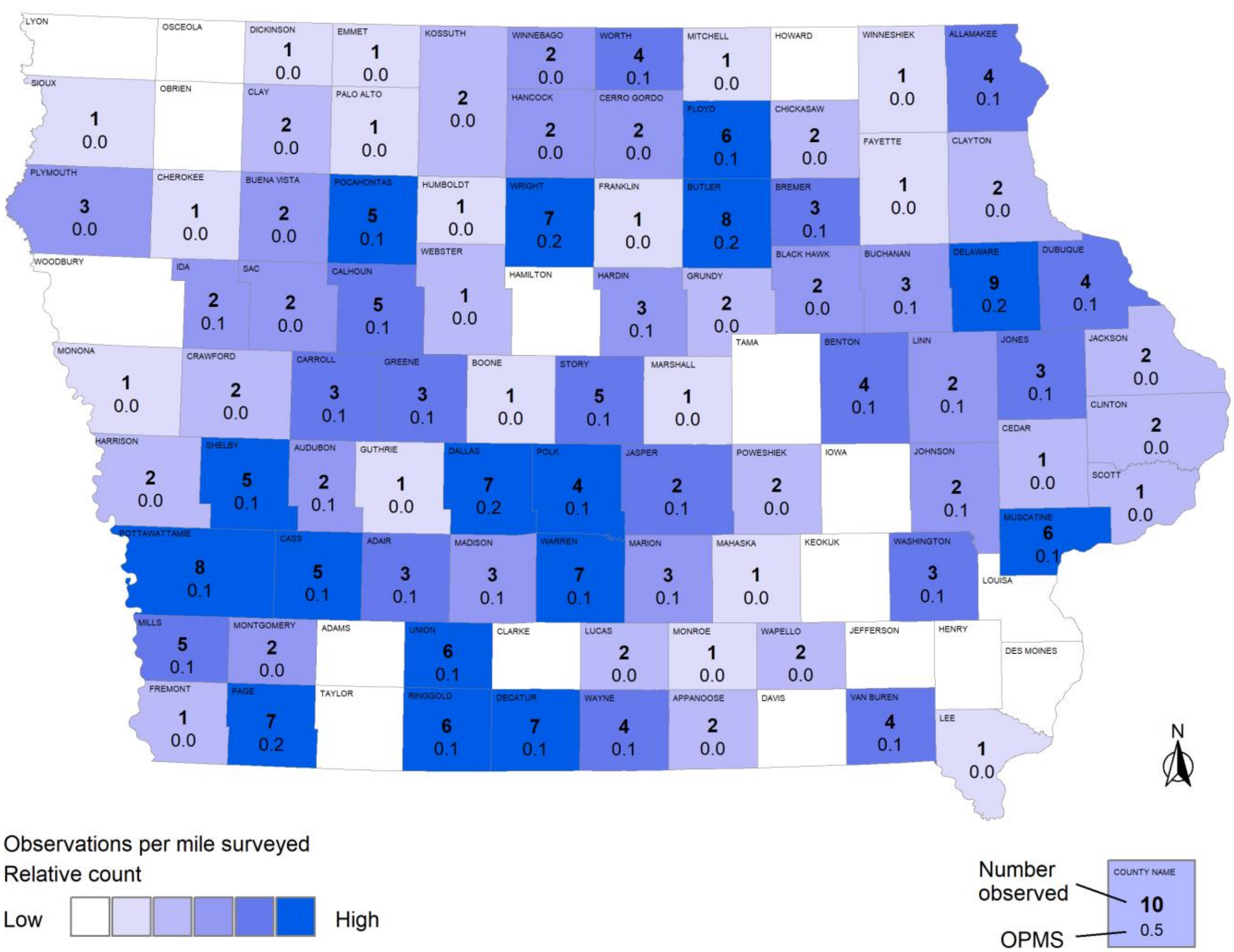


Figure 33. Total number of striped skunk observations per county during the Iowa Spring Spotlight Survey, 2023. Color shading indicates the number of animals counted per mile surveyed (OPMS). Counts likely include few or no spotted skunk.

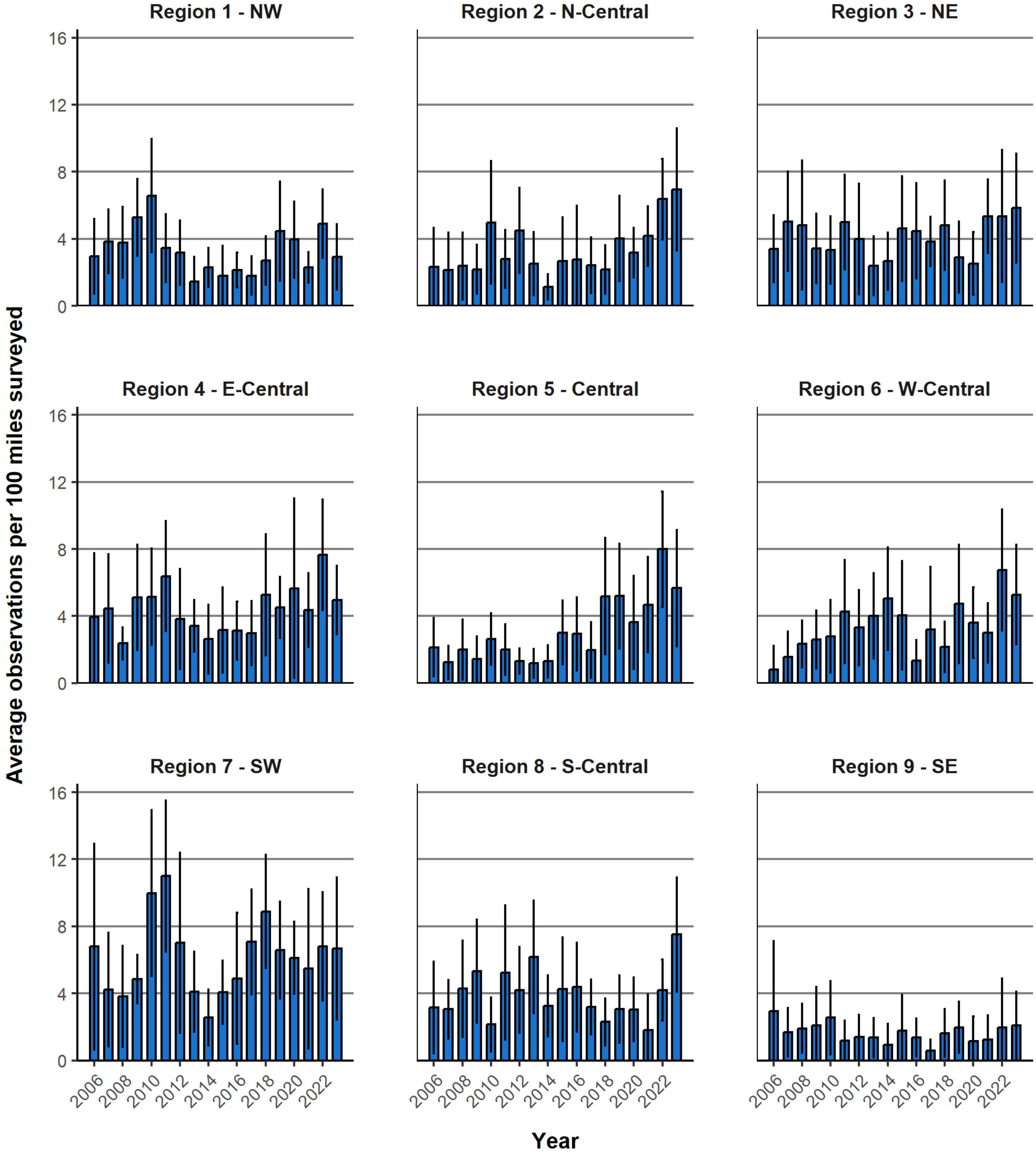


Figure 34. Average skunk observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals. Skunk includes all observations recorded as "striped skunk" and "skunk" and likely includes none or few spotted skunk observations due to the rarity of the species in the state.

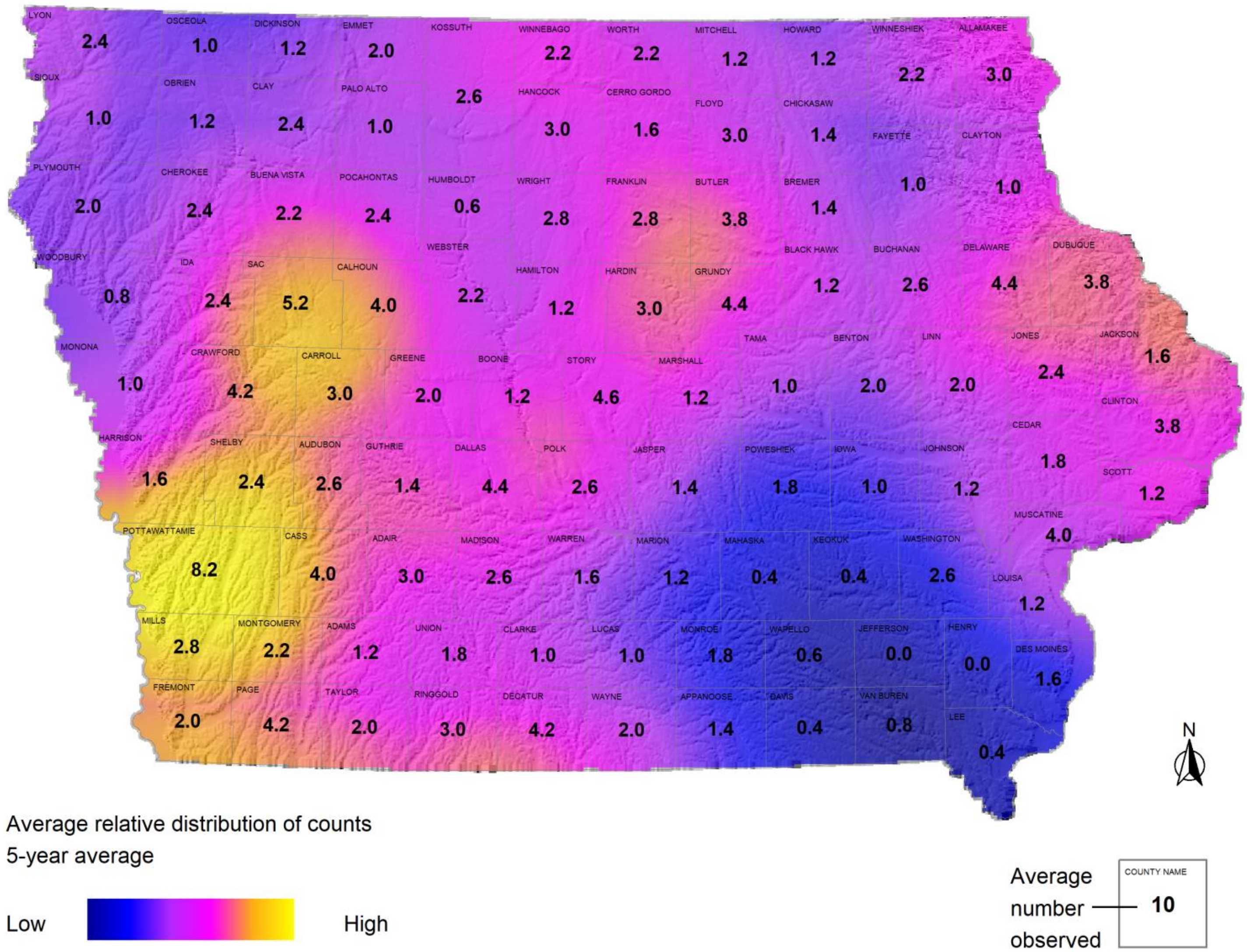


Figure 35. Average relative distribution of spring spotlight observations for skunk during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties). Counts likely include few or no spotted skunk observations due to their rarity in the state.

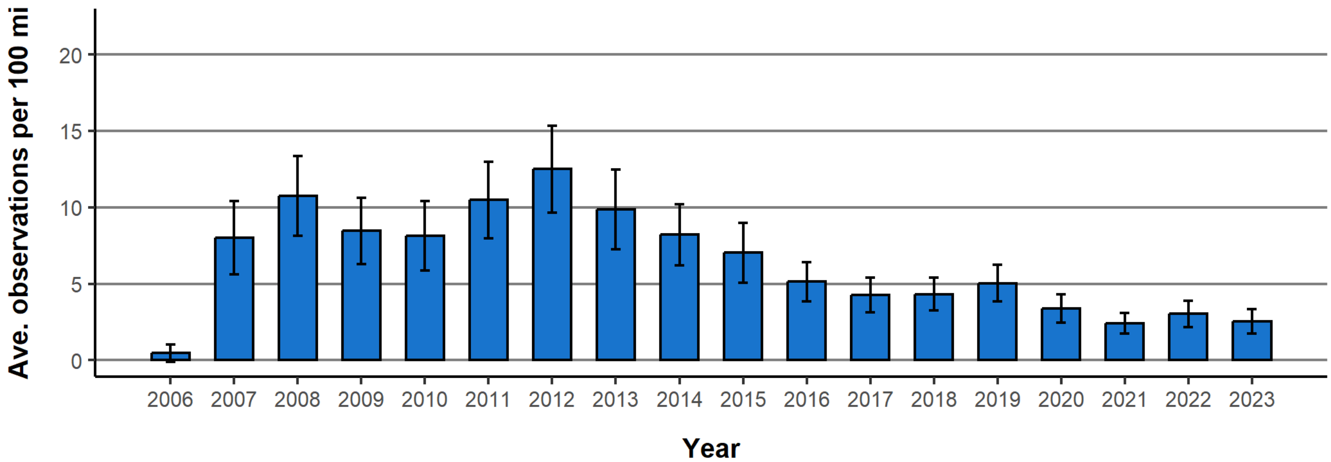


Figure 36. Average free-ranging house cat observations per 100 miles surveyed during the Iowa Spring Spotlight Survey, 2006–2023. Error bars indicate 95% confidence intervals. Observations were not recorded in most counties during 2006.

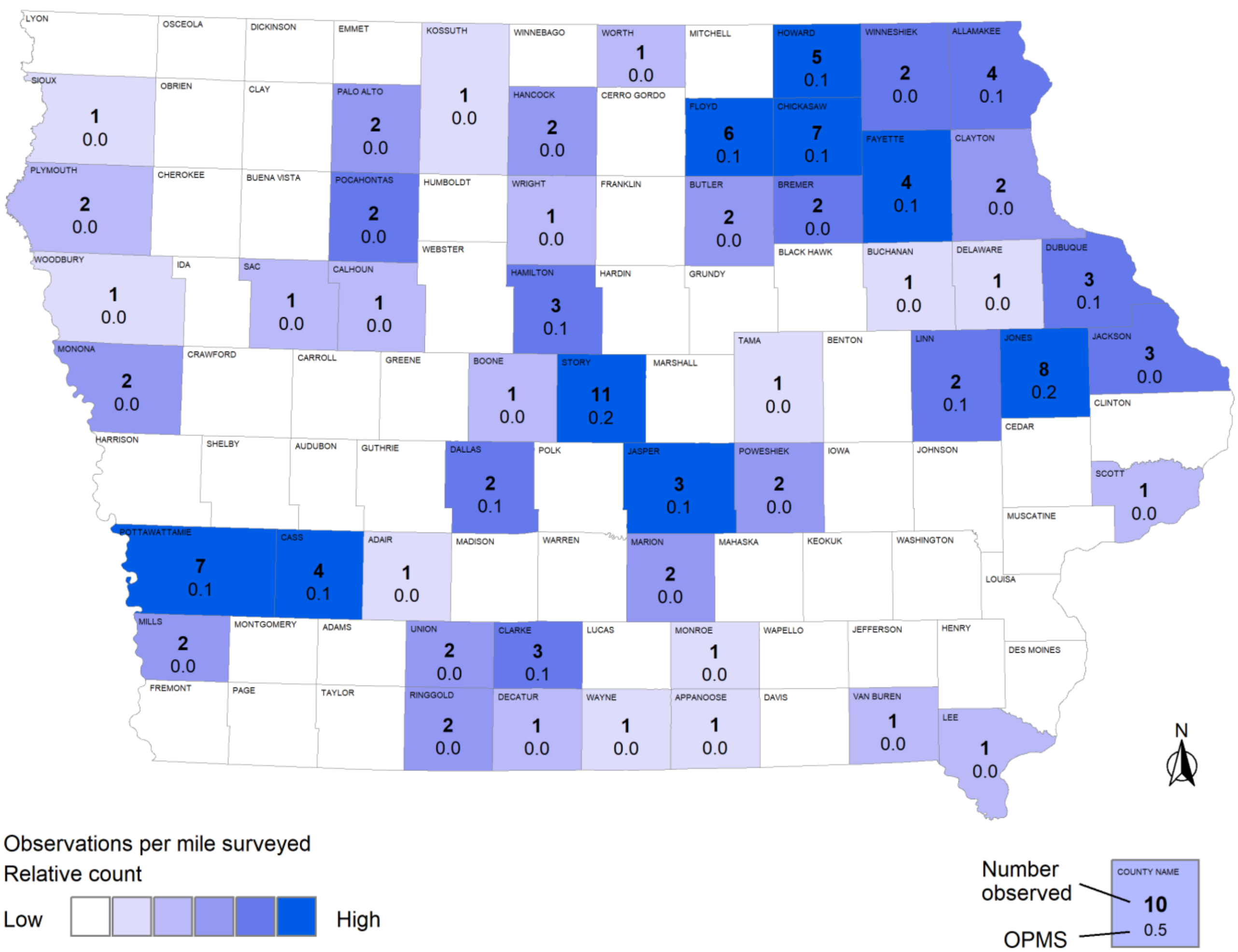


Figure 37. Total number of free-ranging house cat observations per county during the Iowa Spring Spotlight Survey, 2023. Cats located at farmsteads not included in counts. Color shading indicates the number counted per mile surveyed (OPMS).

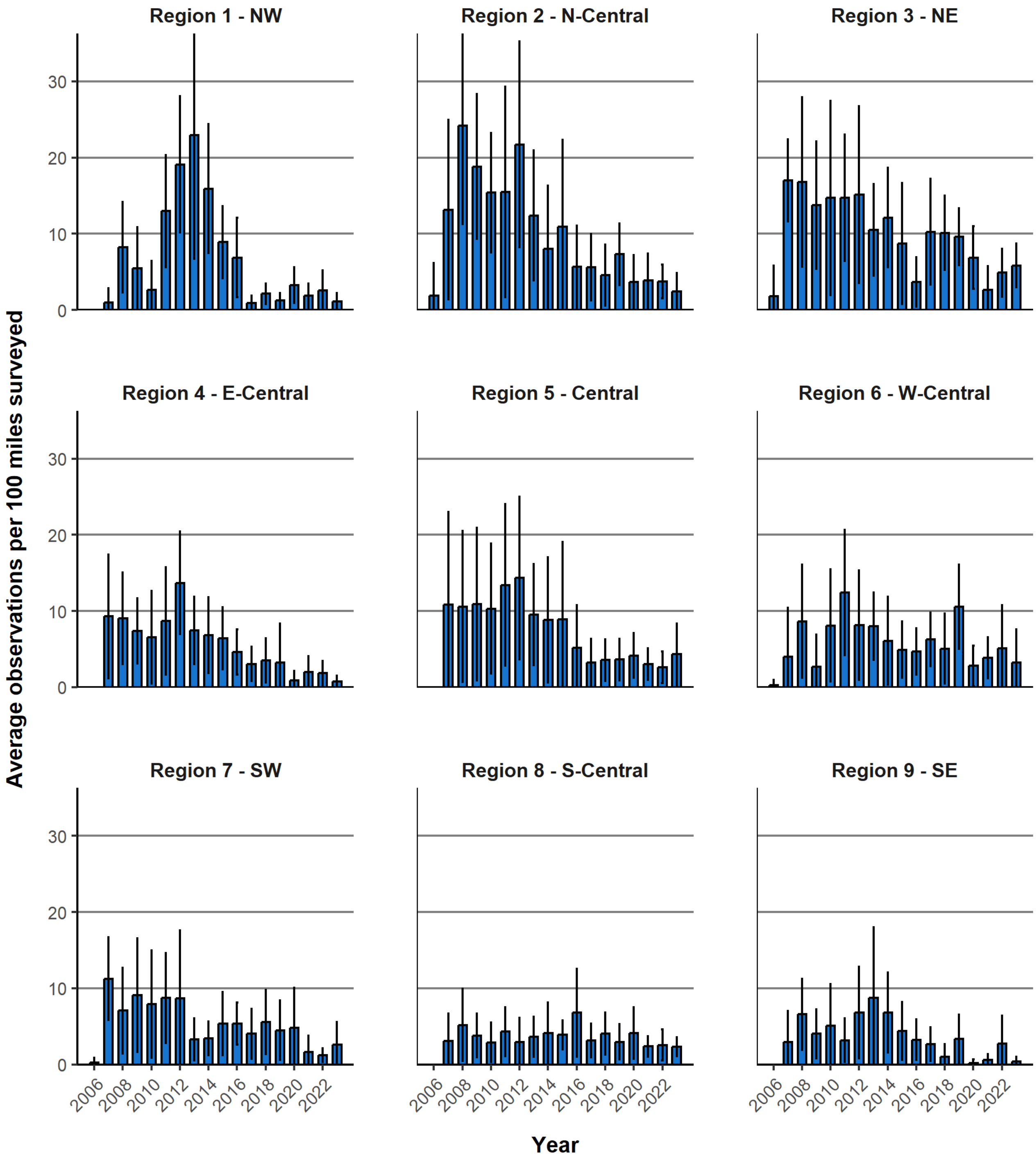


Figure 38. Average free-ranging house cat observations per 100 miles surveyed during the Spring Spotlight Survey for nine regions of Iowa, 2006–2023. Error bars indicate 95% confidence intervals. Cats located at farmsteads or human developments were not included in counts. Observations were not recorded in most counties during 2006.

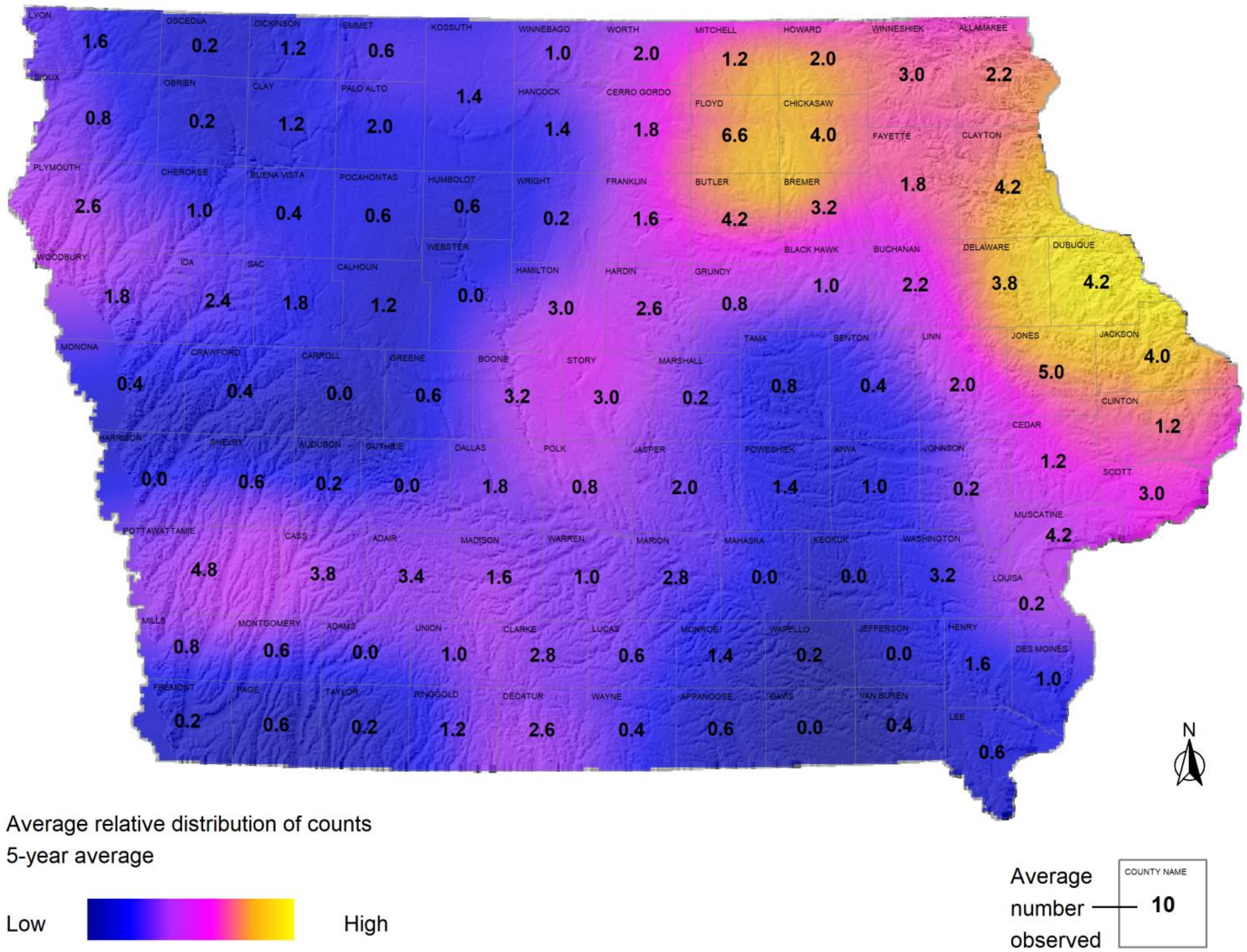
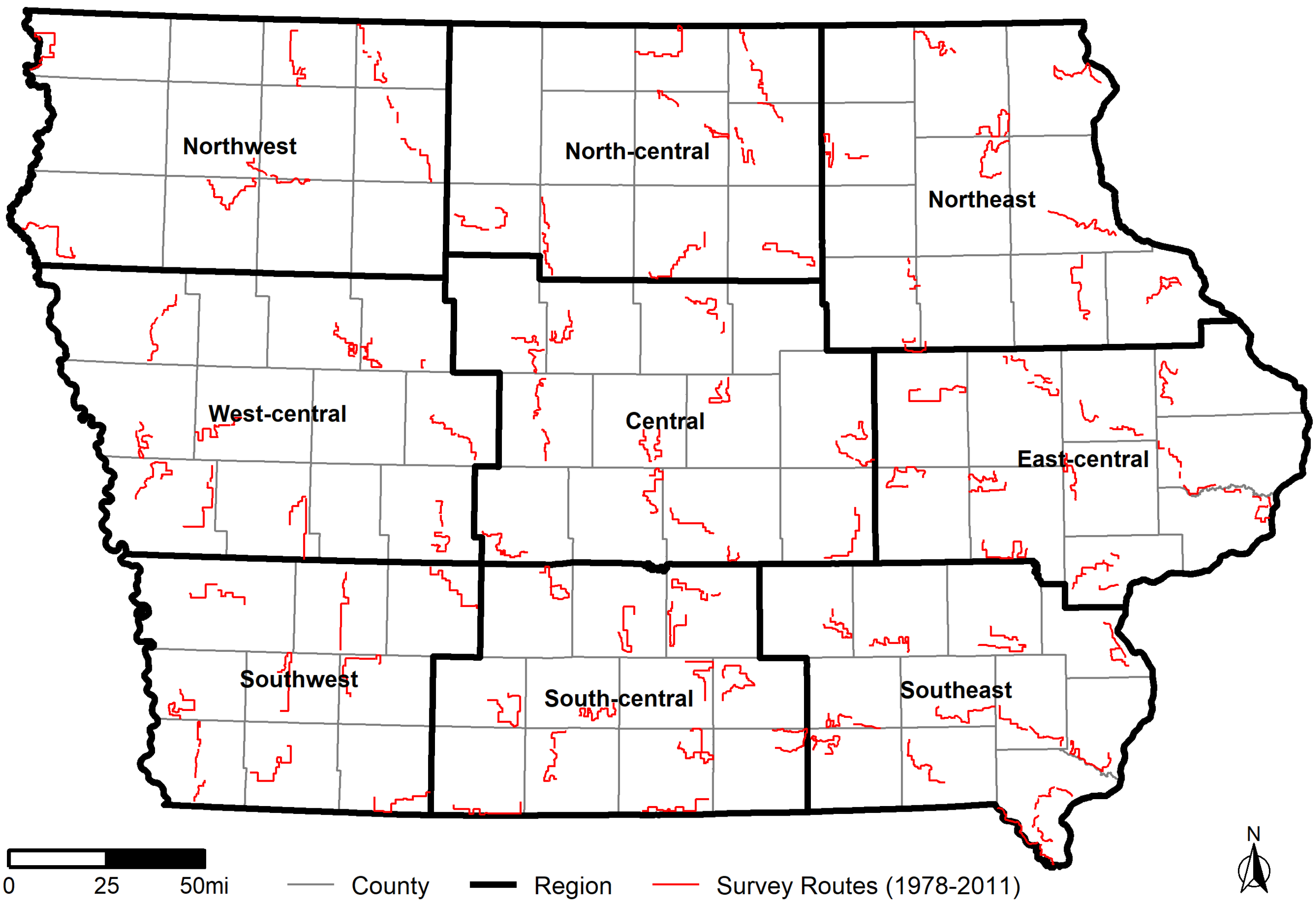


Figure 39. Average relative distribution of spring spotlight observations for house cat during the past 5 years in Iowa. The number of observations per county is relative to the highest and lowest number of observations across all counties during the survey and may not represent an over- or under-abundance of the species (i.e., high counts are considered high relative to those observed in all other counties). House cats located at farmsteads or human developments were not included in counts.

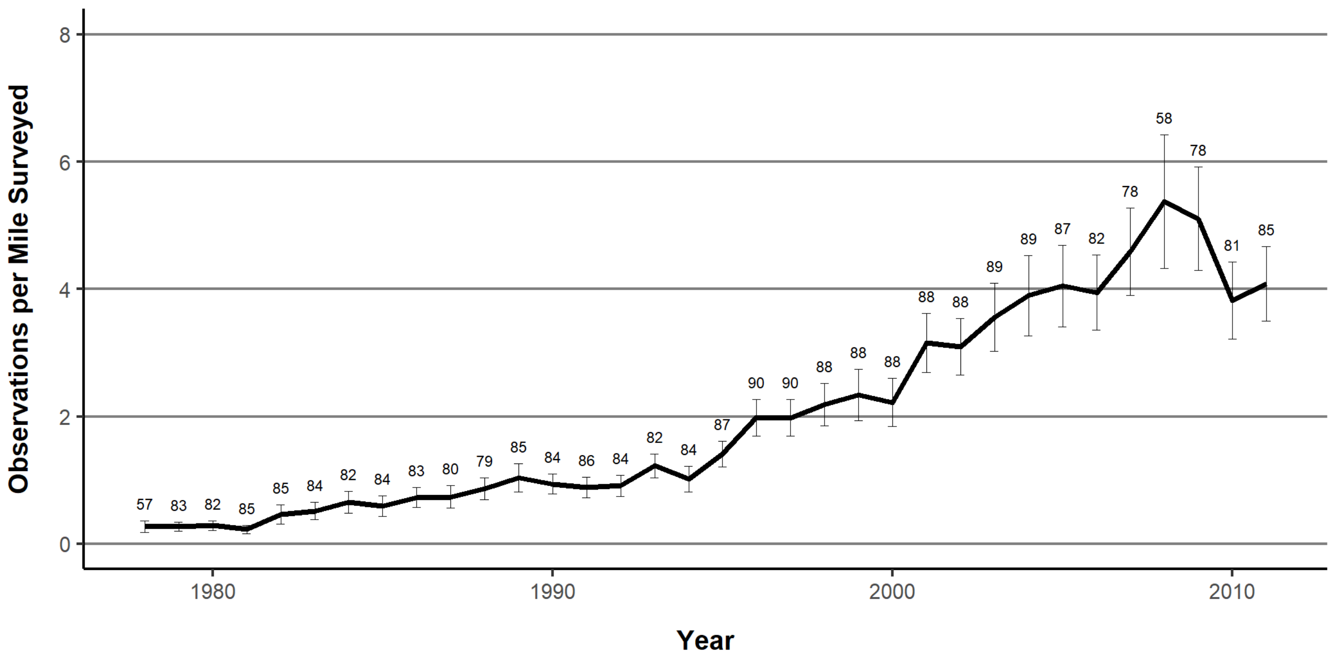
APPENDICES

APPENDIX A



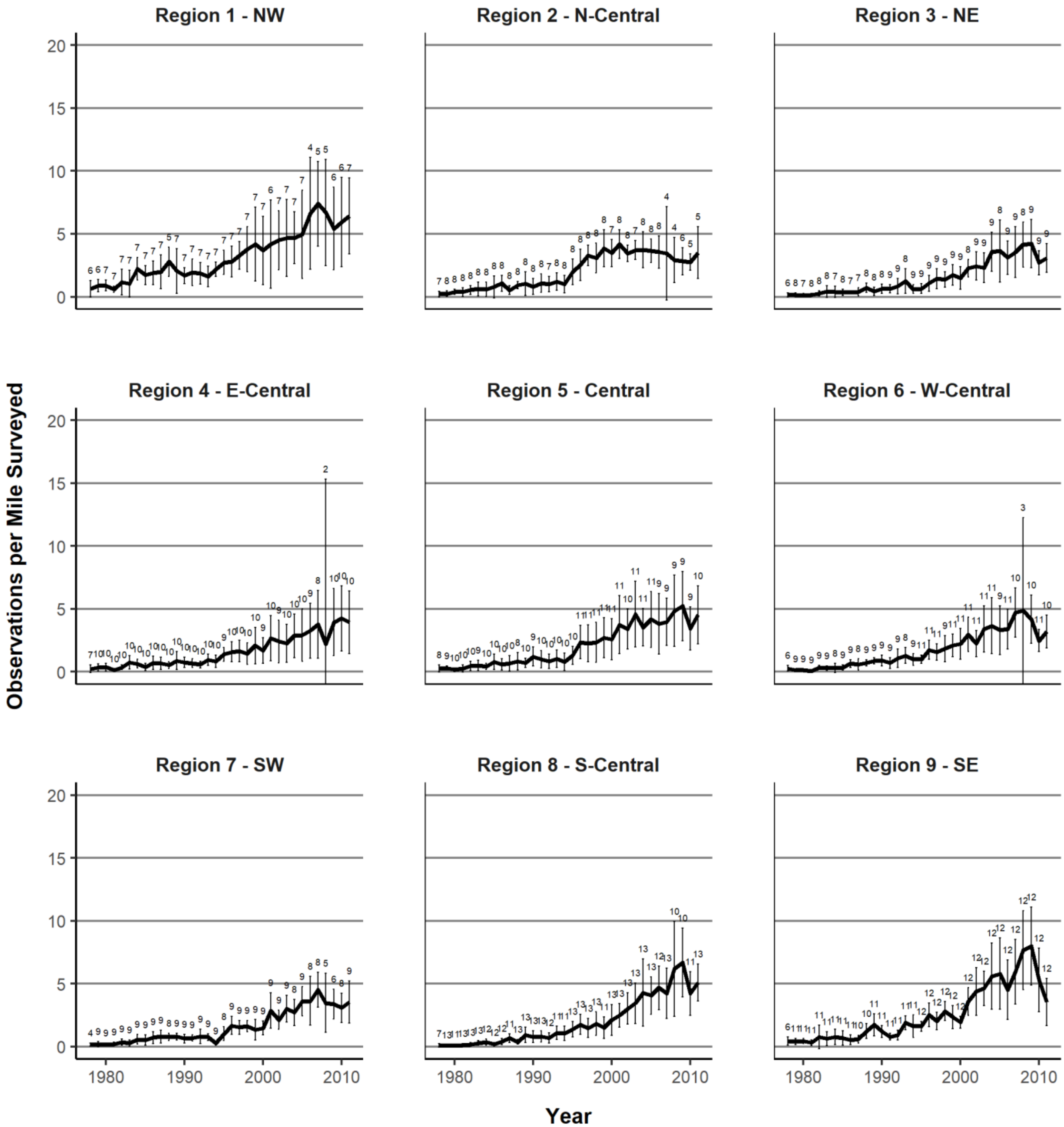
Appendix A. Regions used for summarizing Spring Spotlight Survey observations in Iowa and historical Spring Spotlight Survey routes sampled from 1978–2011.

APPENDIX B



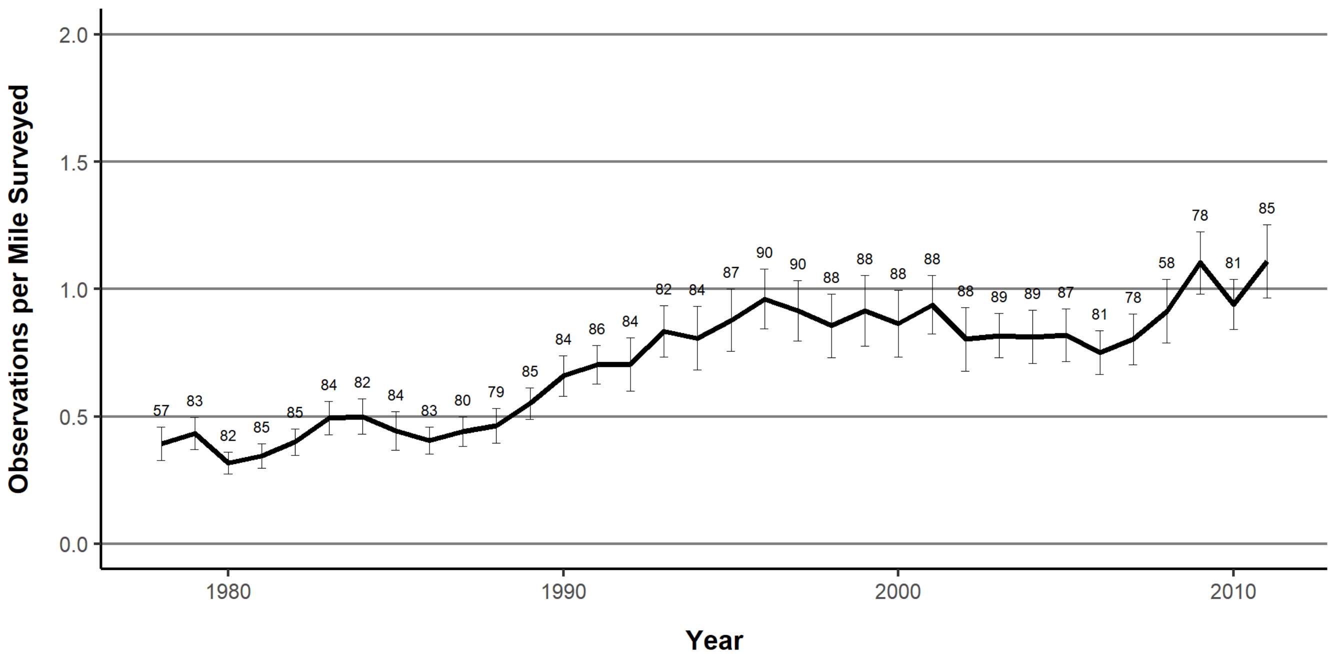
Appendix B. Statewide average white-tailed deer observations per mile surveyed during the Iowa Spring Spotlight Survey, 1978–2011. Observations were standardized by mile surveyed to account for regions in which counties were not surveyed. Error bars indicate 95% confidence intervals. Numbers above error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

APPENDIX C



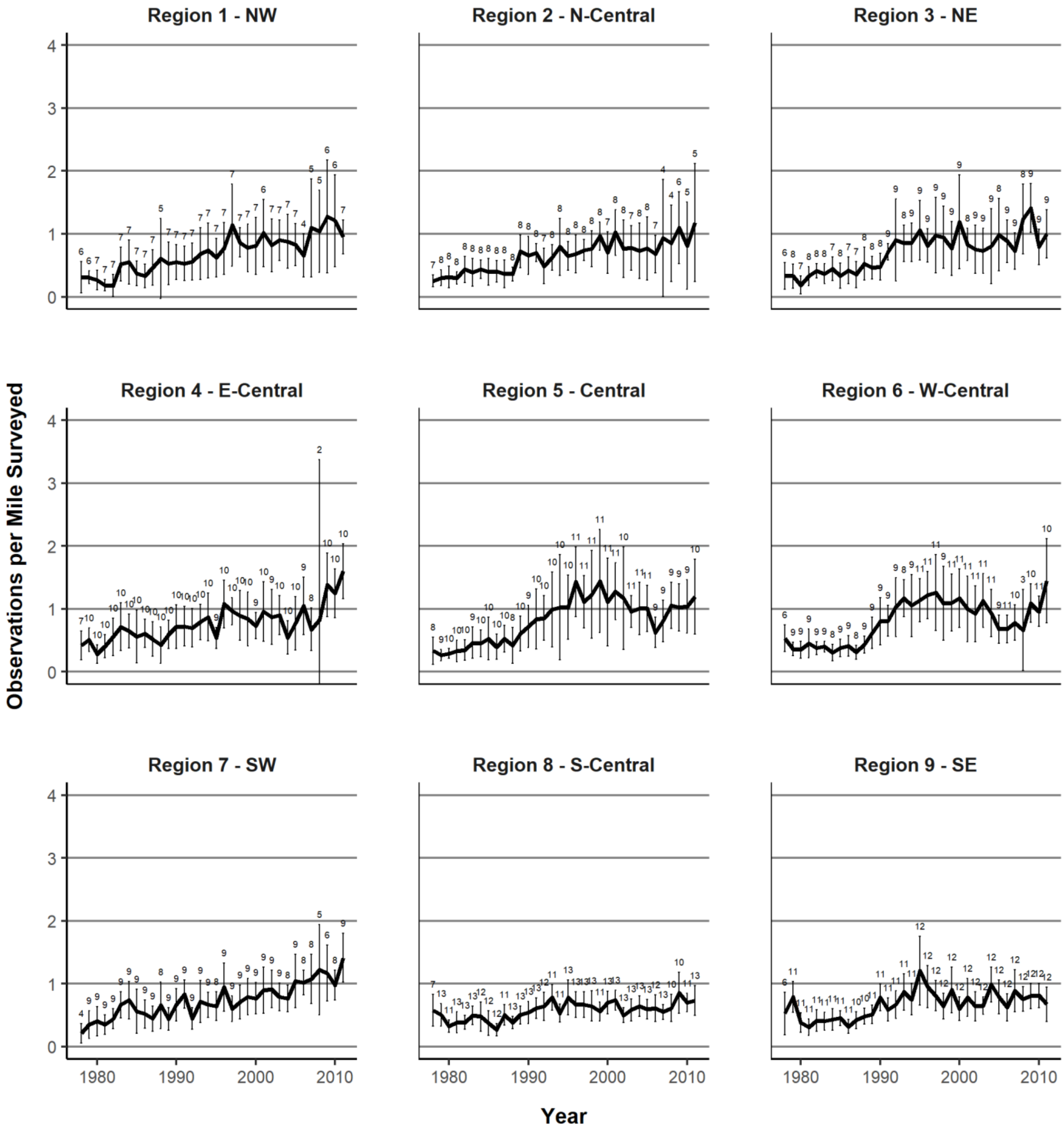
Appendix C. Average white-tailed deer observations per mile surveyed during the Iowa Spring Spotlight Survey, 1978–2011. Error bars indicate 95% confidence intervals. Numbers above error bars indicate the number of transects surveyed each year. Surveys were conducted parallel to forest cover and not standardized by the amount of available habitat in each region.

APPENDIX D



Appendix D. Average 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 indicate 95% confidence intervals. Numbers above error bars indicate the number of transects surveyed each year.

APPENDIX E



Appendix E. Average raccoon observations per mile surveyed during the Iowa Spring Spotlight Survey, 1978–2011. Error bars indicate 95% confidence intervals. Numbers above error bars indicate the number of transects surveyed each year. Surveys were conducted parallel to forest cover and not standardized by the amount of available habitat in each region.

APPENDIX F

Predicting species counts using weather variables for the Iowa Spring Spotlight Survey

Dan J. Kaminski, Iowa Department of Natural Resources

Introduction

Spring spotlight survey observations vary by environmental factors such as weather (e.g., humidity, temperature), landscape (e.g., land cover, terrain), and animal behavior. We estimated regression models to predict species counts using weather variables that potentially influence animal behavior and detection probability during the Iowa spring spotlight survey to help explain annual variability in counts.

Methods

We estimated multiple regression models for deer and 8 species of mesocarnivores, including badger, coyote, mink, opossum, raccoon, red fox, skunk, and house cat, using spring spotlight survey data from 2007–2022. We identified several environmental variables potentially capable of influencing animal behavior or detection probability and eliminated those that were highly correlated ($r \geq 0.60$). We selected six variables, including observations per mile in the previous year for each species (as an index of population abundance), total accumulated winter season severity index, average humidity and average temperature on survey nights, and the number of rain events ≥1 inch and average temperature in the 28 days prior to surveys. We log-transformed all predictor variables to better meet assumptions of normality. We evaluated negative binomial regression models for all species, but if theta approached infinity according to function glm.nb in Program R, we used a Poisson regression model to predict species counts. We tested the predictive capabilities of each model by estimating the relationship between observed and predicted counts for each species using linear regression. We estimated all models using Program R 4.2.2.

Results

Linear regression models indicated the relationships between predicted and observed counts for each species were significant, indicating weather variables explain in-part spring spotlight observations for each species and contributes to annual variability in species counts (R^2 = 0.28–0.70; Table 1; Figure 1).

Discussion

These models provide information on how weather influences species observations and demonstrate that some weather variables leading up to spring surveys and on survey nights are predictive of spring spotlight counts. Tested weather variables accounted for 28% (red fox) to 70% (coyote) of the variability in predicted counts and provided insight as to why observations may fluctuate across years. Additional work is necessary to test other environmental variables such as land cover (e.g., proportions of forest or grass cover), moon phase, or wind speed. Although these models were all significant, we view them as preliminary models given the extent of additional work that may be completed to improve predictions.

Table 1. Multiple regression models (negative binomial [Neg Bin] or Poisson) used to predict species counts for spring spotlight survey observations, 2007–2022, Iowa, USA. Predictor variables included log-transformed values for observations per mile in the previous year for each species (OPMPY), cumulative accumulated winter season severity index (AWSSI), average humidity (SurvHum) and average temperature (SurvTemp) on survey nights, number of precipitation events ≥1 inch in 28 days prior to surveys (Precip28d), and average daily temperature in the 28 days prior to surveys (Temp28d).

Species	Model	β_0	β_1 OPMPY	β_2 AWSSI	β_3 SurvHum	β_4 SurvTemp	β_5 Precip28d	β_6 Temp28d
Deer	Neg Bin	7.40	0.411	0.390	0.860	-0.598	0.194	-0.489
Badger	Poisson	-8.80	-0.053	0.264	2.805	0.011	-0.197	-0.595
Coyote	Neg Bin	13.71	0.364	-0.445	-0.999	-1.307	-0.232	-0.584
Mink	Neg Bin	0.66	0.056	0.108	0.842	0.094	0.145	0.689
Opossum	Neg Bin	15.30	-0.203	-0.823	0.943	-2.569	0.660	-1.304
Raccoon	Neg Bin	9.20	0.065	-0.036	0.236	-0.454	-0.043	-0.453
Red fox	Neg Bin	1.88	0.525	0.172	0.877	0.818	0.018	-0.016
Skunk	Neg Bin	8.34	0.434	-0.042	-0.973	-0.180	0.114	0.290
House cat	Neg Bin	-7.65	-0.457	0.668	0.074	2.271	-0.169	1.737

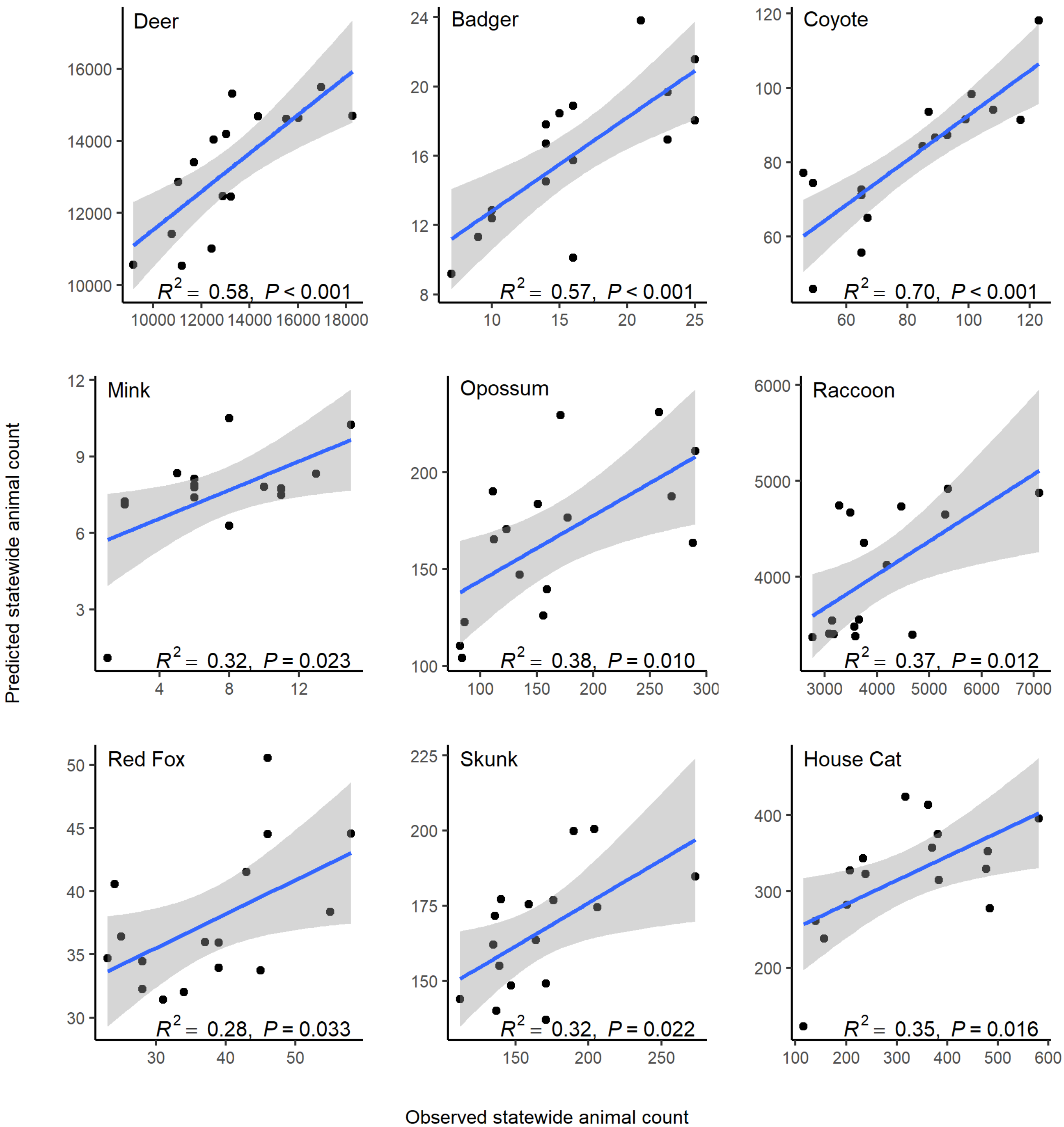


Figure 1. Relationship between observed and predicted spring spotlight survey counts for 9 wildlife species in Iowa, USA. Black points indicate species counts, blue lines indicate linear regression models, and grey ribbons indicate standard errors of the models. Predicted counts were estimated from spring spotlight survey counts, 2007–2022, using a negative binomial or Poisson regression model and 6 predictor variables, including log-transformed values for observations per mile in the previous year for each species, cumulative accumulated winter season severity index, average humidity and average temperature on survey nights, number of precipitation events ≥1 inch in the 28 days prior to surveys, and average daily temperature in the 28 days prior to surveys.