2023 MINNESOTA SPRUCE GROUSE SURVEY

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SUMMARY OF FINDINGS

The Minnesota Department of Natural Resources (MNDNR) initiated a spring (March-May) spruce grouse (*Canachites canadensis*) survey in 2018 with the help of dozens of cooperators and citizen volunteers. The survey is composed of 319 road-based sites organized into 67 routes with 4-5 sites/route. Observers walk a circular transect and record grouse pellets within 1 m of the transect. During 2018-2021, we used replicate surveys to quantify variation in the pellet detection process. Beginning in 2022, we conducted single-effort surveys (i.e., each site was surveyed once). Participants surveyed an average of 288 (90%) sites/year (range: 240 to 314 sites). However, due to the pandemic and occasional accessibility issues, only 55% of sites were surveyed every year. Spruce grouse pellets were detected at an average of 30% of sites (range: 26 to 36) during initial visits. However, data from replicate surveys indicated that 57–66% of survey sites classified as "unused" in initial surveys may have had spruce grouse pellets present but they were missed (overlooked) or not available for detection (e.g., buried in the snow). Fortunately, the detection process appears to be relatively consistent over time. Therefore, although naïve site use is a biased estimate of true site use, it should serve as a reasonable monitoring metric in this case; especially given our monitoring goal is to be able to detect a relatively large decrease over a 10-yr interval. Observers counted an average of 16.6 spruce-grouse pellet groups (single pellets or roost piles) at "used" sites during 2018-2023, but it varied greatly among sites and years (range: 1 to 212 pellet groups). The mean conditional pellet count in 2023 (14.2 pellets/used site) increased slightly compared to 2022 (12.6), whereas the proportion of used sites (33%) and used routes (62%) decreased slightly compared to 2022 (36% and 64%, respectively). A trend analysis did not find evidence of a statistically significant change (slope coefficient) in rangewide mean pellet counts (adjusted for zero-inflation) during 2018-2023. Conversely, at the ecosection level, count indices (unadjusted for probability of detection) suggest a possible decrease in the Minnesota Drift and Lake Plains, which is the southern part of spruce grouse range in Minnesota. However, we have relatively few routes (10) and survey sites (44) in this ecosection and the counts are dominated by zeros, which makes inference challenging. Overall, the spruce grouse population appears to be reasonably stable in terms of our monitoring metrics and spatial extent (except possibly in the extreme southern part of their range in Minnesota).

INTRODUCTION

Spruce grouse, *Canachites canadensis*, are a conifer-dependent gamebird in Minnesota and are expected to experience a range contraction due to climate change-induced habitat loss (Scheller and Mladenoff 2005, Prasad et al. 2007, Iverson et al. 2008). Thus, spruce grouse will likely have a more limited distribution in the southern portions of their range, which includes the Great Lakes region, in the future. Minnesota is unique among the Great Lakes states in that it still permits spruce grouse hunting, although they are a Species of Greatest Conservation Need because they are vulnerable to decline (Minnesota Department of Natural Resources, MNDNR 2015). The spruce grouse is considered a Species of Special Concern in Michigan (Michigan DNR 2005) and was listed as threatened in Wisconsin in 1997 (Wisconsin DNR 2004). Yet, the only data the MNDNR collected on spruce grouse before 2018 was estimated total harvest as part of the annual Small Game Harvest Mail Survey (Dexter 2016). Estimated total harvest of spruce grouse has been 7,000–19,000 birds/year since 2010 (Davros and Dexter 2020). However, variation in spruce grouse harvest among years may be more reflective of the number of ruffed grouse (*Bonasa umbellus*) hunters; thus these harvest data cannot be used as a population index for spruce grouse (Gregg et al. 2004).

During 2014–2017, we developed survey methodology to provide an index of the spruce grouse population (Roy et al. 2014, 2015, 2016, 2017, 2020). We evaluated an auditory survey using playback of female cantus calls (Roy et al. 2020), which is the most common approach to survey spruce grouse (Fritz 1979, Boag and McKinnon 1982, Schroeder and Boag 1989, Whitcomb et al. 1996, Lycke et al. 2011), and also evaluated a fecal pellet survey (Roy et al. 2020) as a means to monitor the population. Fecal pellets are easily detected in late winter/early spring as the snow pack dissipates and pellets that have been deposited and frozen during winter become visible on the snow surface, indicating spruce grouse use of forest stands. The pellet survey was more efficient and had higher detection rates than the auditory survey. We also found road effects to be negligible in high-use cover types (e.g., jack pine (*Pinus banksiana*) and black spruce (*Picea mariana*)). Thus, we designed a monitoring program based on a survey of sites centered on road-based points (hereafter, survey “sites”) in spruce grouse cover types dispersed across their range in Minnesota.

In 2018, MNDNR launched the annual spruce grouse pellet survey with the cooperation of biologists from the Chippewa National Forest, Grand Portage Band of Lake Superior Chippewa, Leech Lake Band of Ojibwe, Minnesota Department of Natural Resources, Red Lake Band of Chippewa Indians, Superior National Forest, 1854 Treaty Authority, Vermilion Community College, and dozens of citizen volunteers. This survey is expected to be able to detect meaningful changes in the population over a 10-year period (i.e., >15% decline) and is intended to provide population information (i.e., status and distribution) that can be used to guide management decisions. In addition to collecting data on spruce grouse, we also count pellets from ruffed grouse (*Bonasa umbellus*) and snowshoe hares (*Lepus americanus*), and report simple count-based monitoring metrics for these species.

METHODS

The pellet survey is comprised of 319 sites (waypoints) organized into 67 routes with 4-5 road-based sites per route spaced >400 m apart (Figure 1). Each route has >1 point with >30% black spruce or jack pine habitat. For the operational survey, sites are visited once during Mar-May, although we did conduct some revisit surveys during 2018-2021 to better understand the observation and detection process. Observers use a Global Positioning System (GPS) to walk a circular transect with a 100-m radius (i.e., 628-m length) centered on roadside sampling points. Observers record single grouse pellets and roost piles <1 m on either side of transects. Multiple pellets within a 30-cm diameter circle are considered a “roost” for the purpose of this survey. This standardization of the method is necessary because spruce grouse often roost in trees during winter and pellets fall to the ground in poorly defined roost piles. Ruffed grouse pellets are distinguished from spruce grouse pellets on the basis of length, thickness, uric acid wash, and color. Ruffed grouse pellets tend to be shorter, thicker, and usually have a uric acid wash, whereas spruce grouse pellets are longer, thinner, and infrequently have a uric acid wash.

Spruce grouse pellets are also darker green in color when spruce grouse are consuming conifer needles (during winter), but color changes depend on diet; spruce grouse pellets can have a similar color to ruffed grouse pellets later in the spring. At each site observers also record covariate data on major disturbances; access issues; the proportion of the 628-m transect that is located in spruce grouse cover types; days since last snow fall; whether snow cover is complete, partial, or gone; and survey conditions on a scale of 0-10, with 10 being the best conditions to detect pellets. Ruffed grouse pellets are recorded in a similar manner to spruce grouse pellets, whereas snowshoe hare pellets are recorded in ordinal categories (0, 1-4, 5-11, 12-25, 25+).

For the operational survey, we compute 3 annual count metrics for spruce grouse, ruffed grouse, and snowshoe hare: 1) proportion of waypoints surveyed where at least 1 pellet was detected (index of site use), 2) mean conditional pellet count (index of pellet abundance at used sites), and 3) proportion of routes surveyed where at least 1 pellet was detected (route-level index). We computed 85% confidence intervals (CIs) for these monitoring metrics by generating 500 bootstrap samples (with replacement using "route" as the sampling unit) for each monitoring metric and year, and then extracted the 0.075 and 0.925 quantiles of the bootstrapped estimates. The bootstrap was conducted using the R Programming Language (R Core Team 2023; R version 4.3.1 (2023-06-16 ucrt)). Although useful for big-picture monitoring, annual and spatial differences in these count indices could be influenced by annual and spatial variation in the detection process. The recommended approach is to use some type of formal population estimator (e.g., mark-recapture, distance sampling, double sampling, revisit surveys, sightability model) to account for the imperfect observation process. We used revisit surveys and occupancy modeling during 2018-2021 to better understand the observation and detection process in spruce-grouse pellet surveys (see Roy et al. 2017), but maintaining this level of survey effort was not feasible (money or staff time) for the long-term operational survey. As a compromise, we used the information from our occupancy models to construct a zero-inflated mixture model based on single-visit surveys, which attempts to adjust for the extra zeros in our count data (due to probability of detection <1). More specifically, we fit a hurdle model (Feng 2021) to our single-visit count data, which is a special type of mixture model where the binary detection/non-detection data are modeled separately from the truncated count data (positive counts only), and then brought back together to generate a predicted mean count that is adjusted for zero-inflation and, in our case, overdispersion. The latter was necessary because the distribution of our spruce-grouse pellet counts is dominated by small counts, but there are some very large counts in the extreme right tail of the distribution. The binary part of our H hurdle model contained a fixed effect for survey conditions (scale of 1-10) and a random effect for survey route (which also reflects observer effects because they tend to survey the same routes each year). The truncated count part of our model contained fixed effects for time (t = 1, 2, 3, . . . n years) and random effects for year, route, and a temporal trend within each route (i.e., a random-slopes model where we allowed the intercept and temporal trend to vary by route). We used this model structure to examine whether there was evidence of a temporal trend in the mean annual spruce grouse pellet count while adjusting for zero-inflation and annual variation in the sampling process (due to mean survey conditions and random year effects). We also accounted for our overdispersed count data by using the "truncated_nbinom2" family function in the glmmTMB R package (Brooks et al. 2017) to fit our hurdle model.

RESULTS AND DISCUSSION

Spruce Grouse

In 2023, 61 of 67 routes and 282 of 319 sites were surveyed by cooperating biologists (76% of surveys) and citizen volunteers (24% of surveys) between 2 March and 9 June (Table 1). Observers detected spruce grouse pellets at 94 (33%) sites in 2023, compared to an average of 30% of sites during initial visits in 2018-2022 (Figure 2). At the route level, spruce grouse pellets were detected on 38 routes (62%) in 2023 (Figure 3). Observers detected an average of 14.2 (range: 1–141) spruce grouse pellets (singles + roost piles) at used sites in 2023, compared to an average of 17.1 (annual range: 12.6-22) during initial visits in 2018-2022 (Figure 4). After adjusting for zero-inflation and overdispersion, we did not find evidence of a temporal trend (positive or negative) in mean spruce grouse pellet counts (log of estimated slope = -0.009; 85% CI: -0.154 to 0.136; Figure 5). Assuming pellet abundance is a good index of spruce grouse abundance, then the range-wide spruce grouse population in Minnesota appears to have been relatively stable during the 2018-2023 monitoring period (Figure 5). However, there are some indications that spruce grouse abundance in the Minnesota Drift & Lake Plains ecosection may have declined (see Figure 2, 3, and 4). Conversely, there has not been any large, obvious changes in the spatial distribution of spruce grouse pellet detections over time (Figure 6). We have relatively few routes (n = 10) and sites (n = 44) in the Minnesota Drift & Lake Plains region because it is at the southern edge of the spruce grouse range. Thus, power to detect a meaningful population change may be low for this subset of the population and it would be difficult to increase sample sizes given the paucity of good spruce grouse habitat in this area (which results in mostly zeros for pellet counts).

Ruffed Grouse and Snowshoe Hare

We detected ruffed grouse pellets (singles + roost piles) at 197 (70%) sites in 2023 (Table 1, Figure 2 and 3), with a mean count of 8.8 (range: 1-64) pellets per used site (Figure 4). Observers detected pellets of both spruce grouse and ruffed grouse at 69 sites (24%), whereas we failed to detect pellets of either species at 60 sites (21%).

We detected snowshoe hare pellets at 240 (85%) sites in 2023 (Table 1, Figure 2 and 3). Most (38%) pellet counts were in the 25+ count bin (Figure 4). Observers detected pellets of both spruce grouse and snowshoe hares at 82 sites (29%). Pellets of all 3 species were detected at 61 sites (22%).

ACKNOWLEDGEMENTS

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Table 1. Spruce grouse (SPGR) routes and sites surveyed in 3 Ecological Classification Sections (ECS) in northern Minnesota in 2023 by Department of Natural Resources (DNR) staff, cooperators, and volunteers, and the proportion of sites where observers detected spruce grouse, ruffed grouse (RUGR), and/or snowshoe hare (SNHA) pellets (singles and roosts or multiples per used site) during initial visits.

Cooperator	ECS Section[1]	Routes	Sites	SPGR	RUGR	SNHA
Aurora SNF[2]	212N	3	15	0.00	0.73	0.86
Baudette DNR	212M	4	19	0.21	0.84	0.89
Bemidji DNR	212N	1	5	0.00	0.60	0.40
Chippewa National Forest	212N	4	19	0.00	0.53	0.63
Cook SNF	212L	4	20	0.05	0.25	0.85
Duluth DNR	212L	2	9	0.11	0.78	0.89
Ely SNF	212L	5	22	0.55	0.91	0.82
Grand Marais DNR[3]	212L	3	12	0.50	0.83	1.00
Grand Marais SNF	212L	3	14	0.50	0.57	0.86
Grand Portage Reservation	212L	3	15	0.00	0.53	0.93
Grand Rapids DNR	212L	1	4	0.25	1.00	1.00
International Falls DNR	212M	2	9	0.56	0.67	0.89
Orr DNR	212L	4	18	0.33	0.83	0.89
Red Lake Reservation	212N	3	13	0.38	0.46	0.69
Red Lake WMA[4]	212M	5	25	0.24	0.64	1.00
1854 Treaty Authority	212L	2	7	0.86	1.00	1.00
Tofte SNF	212L	6	29	0.69	0.90	0.83
Two Harbors DNR	212L	3	13	0.08	0.85	1.00
Tower DNR	212L	3	14	0.93	0.57	0.71
Not surveyed		6	37	---	---	---
Total		61	282	0.33	0.70	0.85

[1]212L = Northern Superior Uplands, 212M = Northerrn Minnesota and Ontario Peatlands, 212N = Northern Minnesota Drift and Lake Plains
[2]SNF = Superior National Forest
[3]Grand Marias DNR Office has been moved to the Two Harbors DNR Office, but routes remain separated based on their geographic location.
[4]WMA = Wildlife Management Area

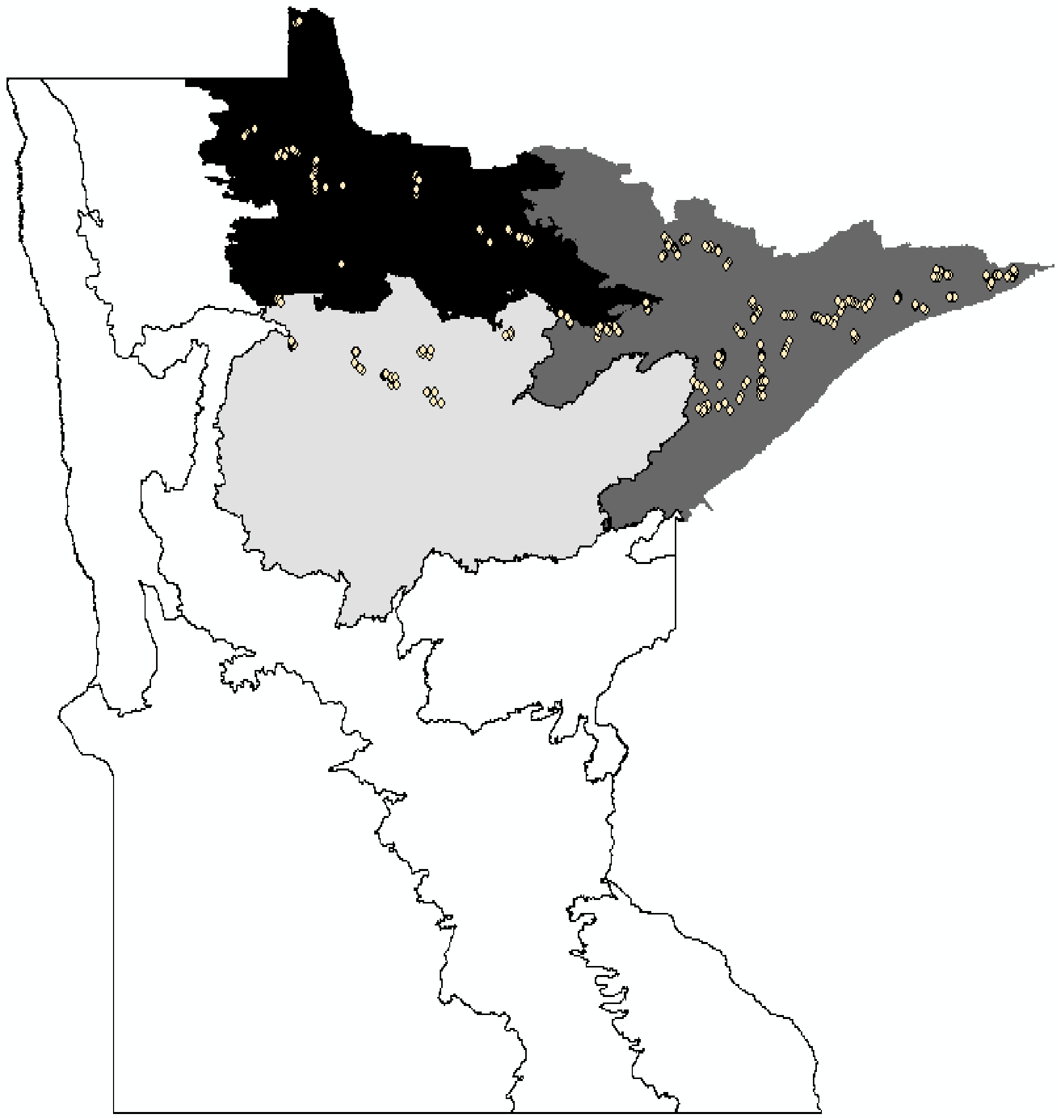

Figure 1. Distribution of sampling sites in northern Minnesota during 2018-2023. Ecological Classification System sections included the Northern Minnesota and Ontario Peatlands (n = 17 routes and 85 sites) in the northwest, the Northern Superior Uplands (n = 40 routes and 190 sites) in the east, and the Northern Minnesota Drift and Lake Plains (n = 10 routes and 44 sites) in the southcentral survey region.

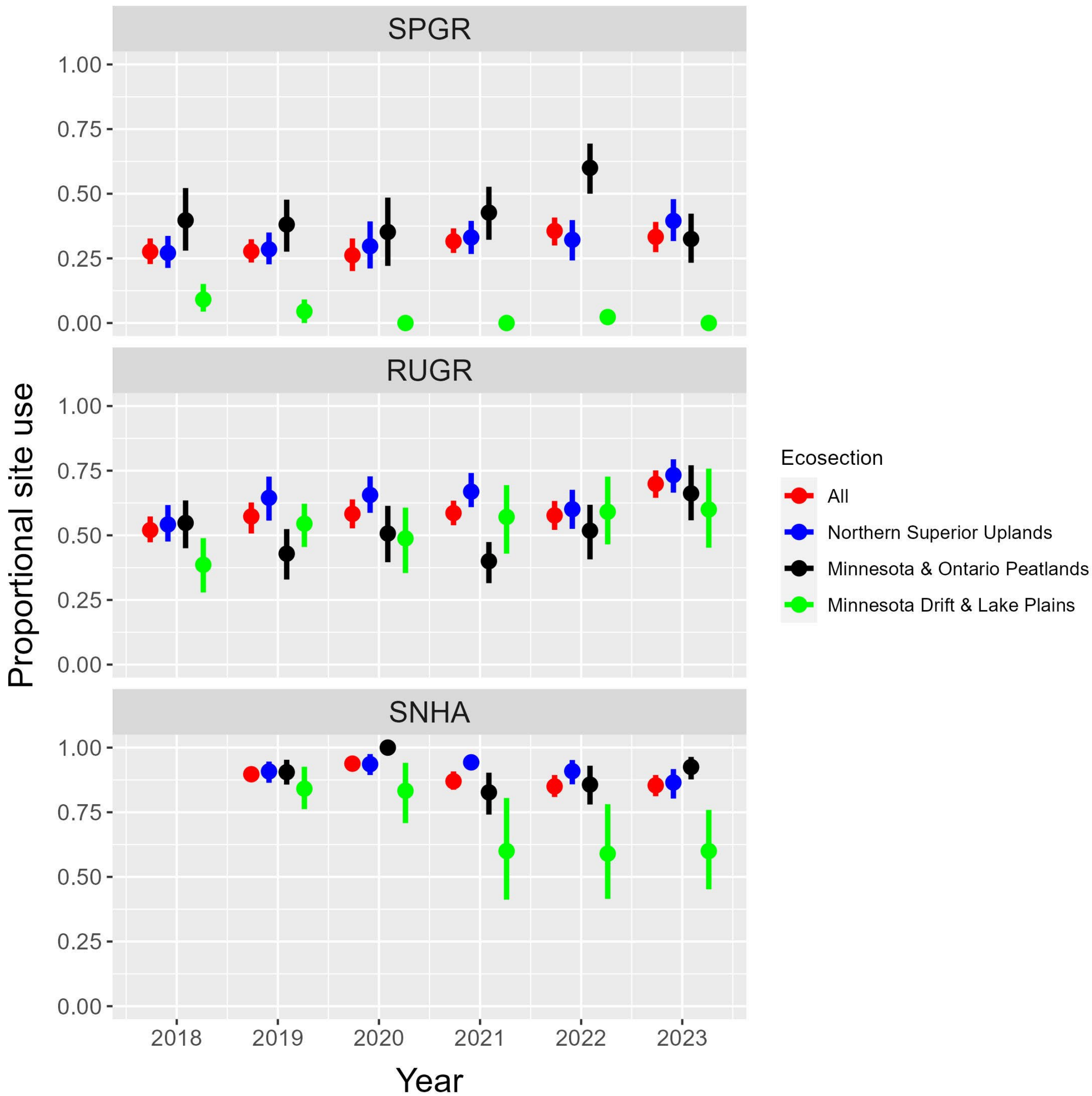

Figure 2. Index of site use in northern Minnesota during 2018-2023 based the proportion of sites surveyed where at least 1 pellet was detected for spruce grouse (SPGR), ruffed grouse (RUGR), or snowshoe hare (SNHA). Error bars are bootstrapped 85% confidence intervals.

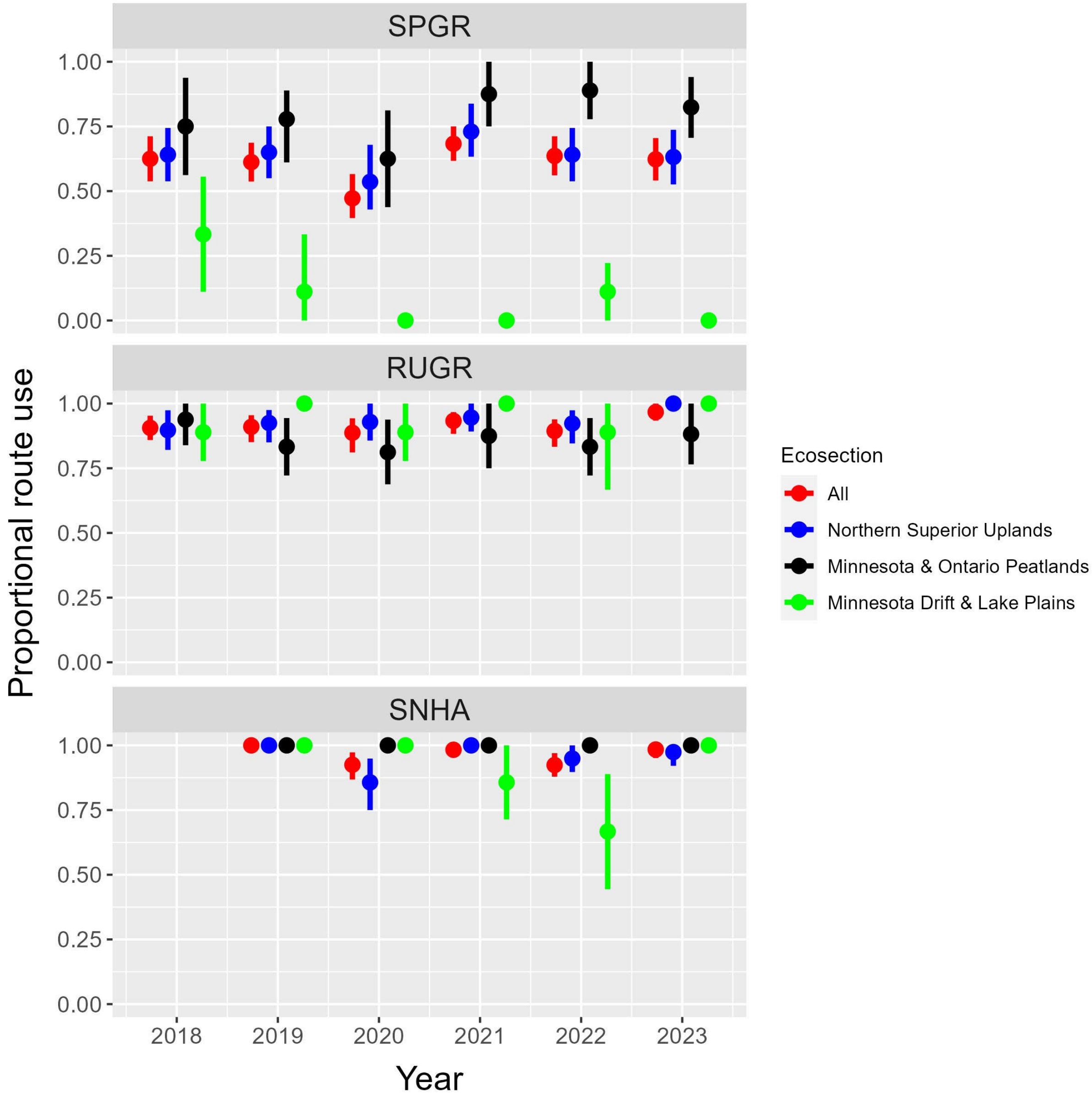

Figure 3. Index of route use in northern Minnesota during 2018-2023 based the proportion of routes surveyed where at least 1 pellet was detected for spruce grouse (SPGR), ruffed grouse (RUGR), or snowshoe hare (SNHA). Error bars are bootstrapped 85% confidence intervals.

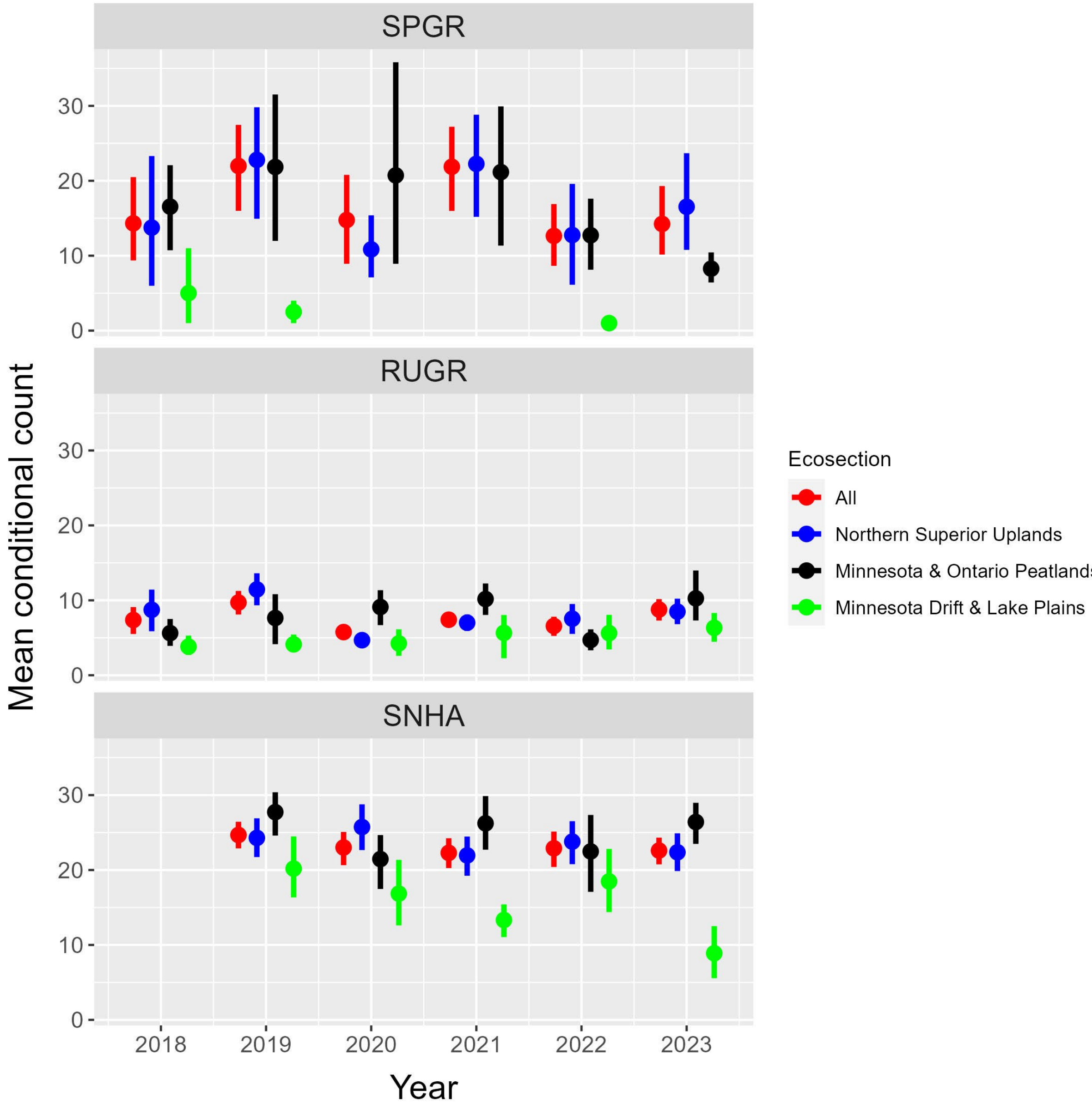

Figure 4. Index of pellet abundance at used sites for spruce grouse (SPGR), ruffed grouse (RUGR), and snowshoe hare (SNHA) in northern Minnesota during 2018-2023. Error bars are bootstrapped 85% confidence intervals.

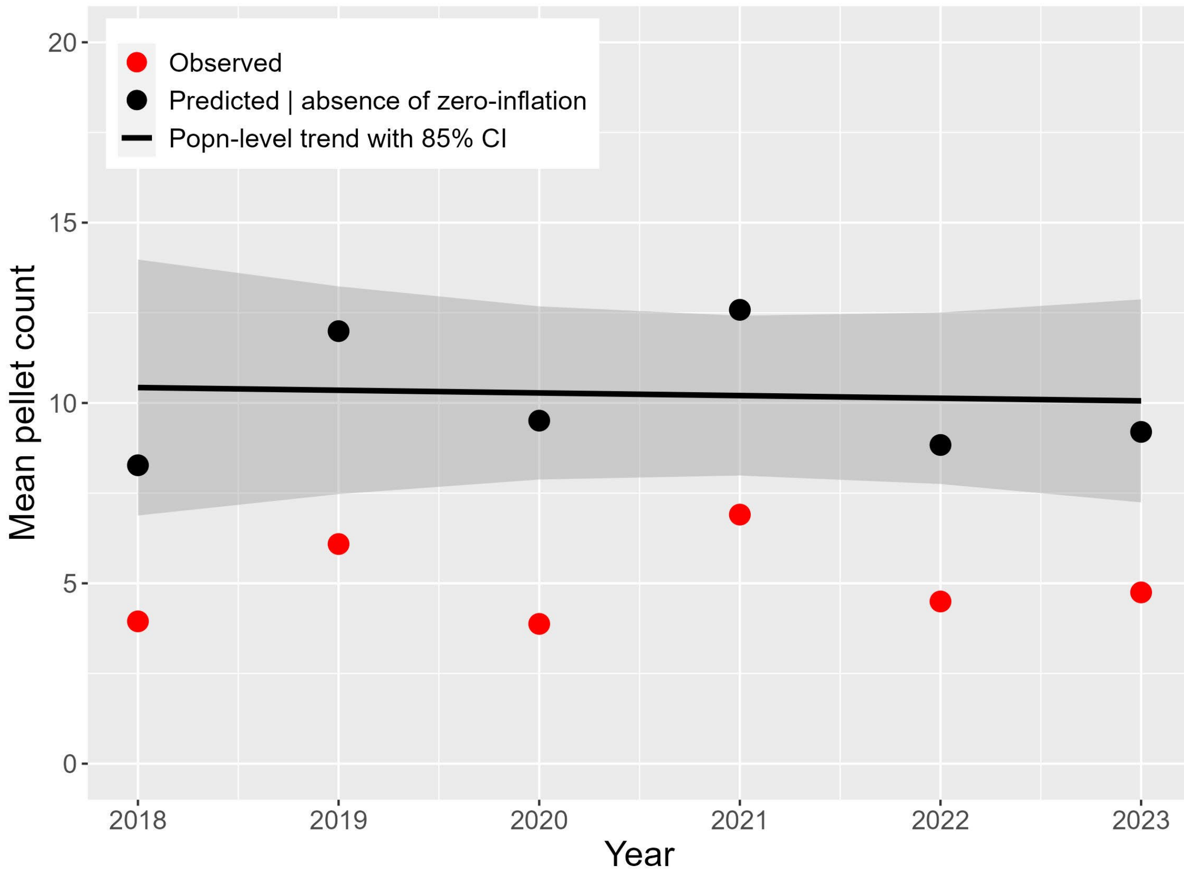

Figure 5. Predicted mean spruce grouse pellet counts in northern Minnesota during 2018-2023 and the estimated temporal population-level (popn-level) trend with 85% confidence intervals (CI) from a hurdle mixture model that adjusts for zero-inflation and overdispersion.

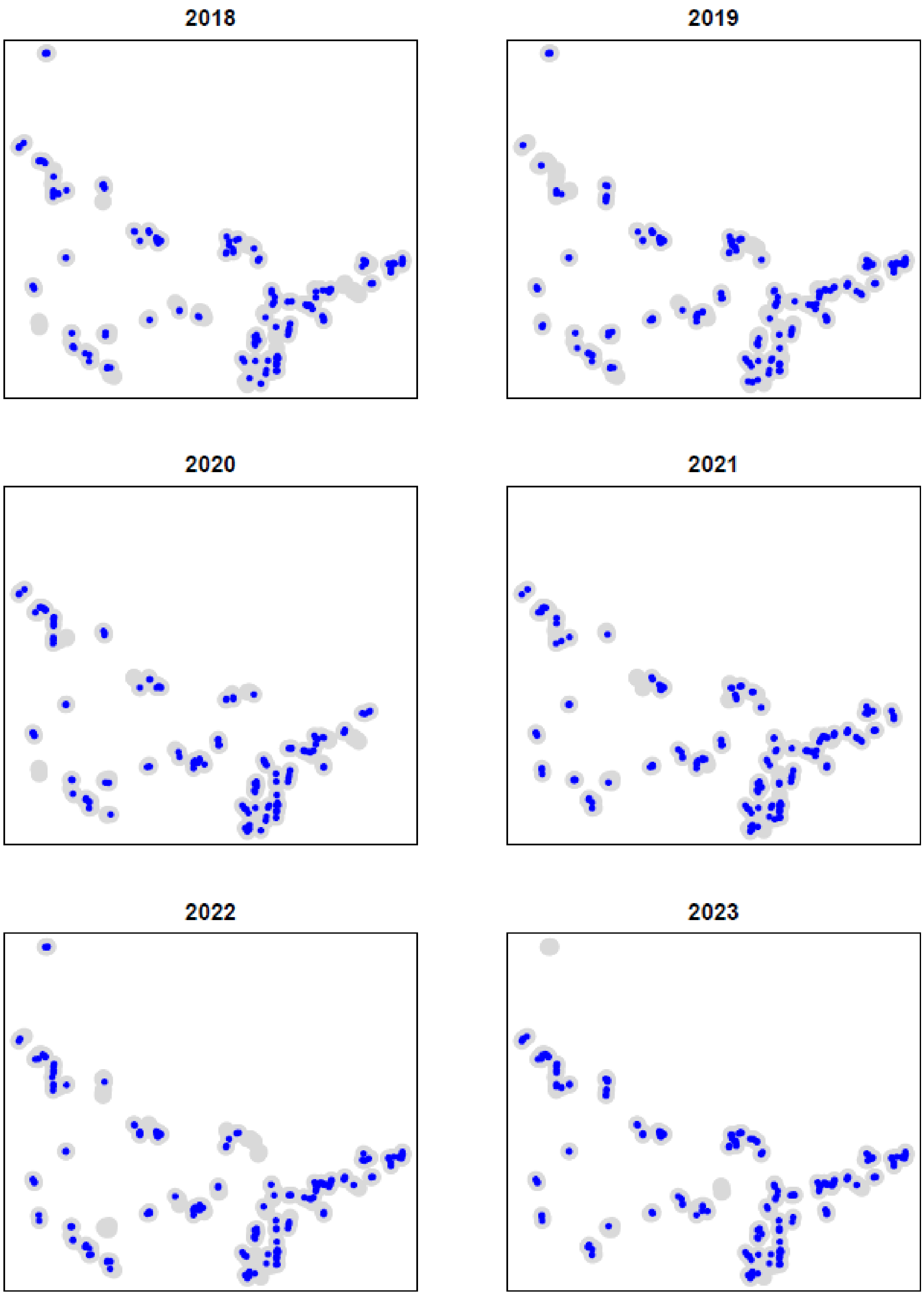

Figure 6. Spatial distribution of sampling effort and spruce grouse pellet detections by year in northern Minnesota during 2018-2023.