2021 MINNESOTA SPRUCE GROUSE SURVEY

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SUMMARY OF FINDINGS

The Minnesota Department of Natural Resources (MNDNR) initiated the first annual spruce grouse (*Falcipennis canadensis)* survey in 2018 with the help of dozens of cooperators and citizen volunteers. Participants surveyed for spruce grouse pellets at 273 sites in 2018, 314 sites in 2019, 241 sites in 2020, and 285 sites in 2021. Spruce grouse pellets were detected in initial visits at 79 sites in 2018 (proportional use = 0.29; 95% confidence interval (CI): 0.24–0.34), 87 sites in 2019 (0.28; 95% CI: 0.24–0.34), 63 sites in 2020 (0.26; 95% CI: 0.24–0.29), and 90 sites in 2021 (0.32; 95% CI: 0.29–0.34). Participants counted a mean of 15.2 (95% CI: 8.8–21.6), 22.0 (95% CI: 14.7–29.3), 21.2 (95% CI: 14.5–27.9), and 21.9 (95% CI: 14.6–29.1) pellet groups at used sites in 2018, 2019, 2020, and 2021, respectively. Based on our updated Bayesian multi-season occupancy model, the estimated mean detection probability during initial visits was 0.34 (95% credible interval (CRI): 0.28–0.40) in 2018, 0.35 (95% CRI: 0.30–0.40) in 2019, 0.41 (95% CRI: 0.33–0.50) in 2020, and 0.43 (95% CRI: 0.37–0.50) in 2021. When adjusted for probability of detection, the estimated probability of site use was 0.76 (95% CRI: 0.66–0.85) in 2018, 0.77 (95% CRI: 0.69–0.86) in 2019, 0.69 (95% CRI: 0.57–0.81) in 2020, and 0.72 (95% CRI: 0.62–0.81) in 2021. We also found very little turnover in site use between years, e.g., the probability of a site changing status between years was 0.10 (95% CRI: 0.03–0.18) in 2018–2019, 0.11 (95% CRI: 0.02–0.22) in 2019–2020, and 0.22 (95% CRI: 0.12–0.32) in 2020–2021. Thus, based on the 4-year dataset, the spruce grouse population appeared to be stable (mean finite rate of change = 0.99 [range: 0.90 to 1.04], where a value of 1 denotes a stable population, >1 indicates an increasing population, and <1 indicates a decreasing population. This survey is expected to be able to detect meaningful changes in the population over a 10-year period (e.g., a ≥15% decline).

INTRODUCTION

Spruce grouse, *Falcipennis 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 10,000–27,000 birds/year since 2006 (Dexter 2016). 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 backsiana*) 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 (e.g., ≥15% decline) and is intended to provide population information (i.e., status and distribution) that can be used to make management decisions.

METHODS

The pellet survey is comprised of 67 survey routes with 4-5 road-based sites per route spaced ≥400 m apart. Each route has ≥1 point with ≥30% black spruce or jack pine habitat. 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 for detection of grouse pellets, including 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. Surveys are repeated up to 5 times at a subset of sites (where seasonal technicians and/or volunteers were available) to allow modeling of the detection process and to help determine whether repeat visits will be necessary to account for annual variation in the detection process.

Beginning in 2020, we standardized our Bayesian model structure (Kéry and Schaub 2012, Su and Yajima 2015) based on what we learned in 2018–2019. That is, we did not conduct an exhaustive variable-selection exercise in 2020 or 2021. Our model contained the following covariates for the initial occupancy state (in year 1): an indicator variable for the presence of jack pine and/or black spruce, the proportion of the transect that went through spruce grouse habitat (in year 1), and a random effect for the geographic clustering of sites into routes. For the observation process, we included covariates for survey conditions (1-10, with 10 being very good), visit, year, and a random effect for route. We did not attempt to use covariates to model transition probabilities, although we did allow them to vary annually. We computed 95% credible intervals (CRI) around parameter estimates.

RESULTS & DISCUSSION

In 2021, 60 of 67 routes (median 5 points per route, range: 4–5) were surveyed by 26 cooperating biologists, 24 citizen volunteers, and 2 seasonal technicians between 1 March and 24 May (Table 1, Figure 1). Spring 2021 was generally warm with less snow than in 2018 and 2019, and more similar to 2020. Observers detected spruce grouse pellets at 90 (32%) of 285 survey sites during the initial visit and at 48 additional sites in revisit surveys. On average 21.9 (range: 1–197) spruce grouse single pellets and roosts were detected in initial visits at used sites. Similarly, ruffed grouse pellets and roosts were detected at 167 (59%) sites in initial visits with a mean count of 7.4 (range: 1–48) pellets per used site. Observers detected pellets of both species at only 56 sites (20%) in 2021, whereas pellets of neither species were detected at 84 sites (29%). This is similar to concordance rates observed in 2019 (14% and 29%, respectively) and 2020 (16% and 32%, respectively).

The overall probability of spruce grouse site use, adjusted for imperfect detection, was 0.76 (95% CRI: 0.66–0.85) in 2018, 0.77 (95% CRI: 0.69–0.86) in 2019, 0.69 (95% CRI: 0.57–0.81) in 2020, and 0.72 (95% CRI: 0.62–0.81) in 2021 (Figure 2). We found little turnover in site use between years, e.g., the probability of a site changing status between years was 0.10 (95% CRI: 0.03–0.18) in 2018–2019, 0.11 (95% CRI: 0.02–0.22) in 2019–2020, and 0.22 (95% CRI: 0.12–0.32) in 2020–2021. When survey sites were grouped by ecological section, the Northern Minnesota and Ontario Peatlands had the highest probability of site use (mean annual estimate = 0.82), followed by the Northern Superior Uplands (0.74), and the Northern Minnesota Drift & Lake Plains (0.56). The estimated mean finite rate of population change, meaning the ratio of future to current population size, was 1.02 (95% CRI: 0.91–1.15) during 2018–2019, 0.90 (95% CRI: 0.75–1.02) during 2019–2020, and 1.04 (95% CRI: 0.87–1.27) during 2020-2021, indicating a stable population (Figure 3).

Our 2021 naïve estimate of spruce grouse use (the proportion of sites where $\geq$1 pellet was detected in the initial survey) was much lower (0.32) than our model-based estimate of site use (0.72) and was consistent with previous analyses. This difference is the result of imperfect detection (i.e., many of the sites classified as “unused” after the initial survey probably had pellets that were present but not detected). If the conditional probability (i.e., given a site was truly used) of detecting $\geq$1 pellet was close to 1, then a naïve estimate of site use based on a single-visit survey would be sufficient for monitoring spruce grouse populations and their distribution. However, if the mean conditional probability of detection is relatively low and the detection process varies greatly over space or time, then a naïve estimate of site use might be misleading. We estimated the mean probability of detection for a single-visit survey as 0.34 (95% CRI: 0.28–0.40) in 2018, 0.35 (95% CRI: 0.30–0.40) in 2019, 0.41 (95% CRI: 0.33–0.50) in 2020, and 0.43 (95% CRI: 0.37–0.50) in 2021. This means that 57–66% of survey sites classified as “unused” in the initial survey may have had spruce grouse pellets present but they were missed (overlooked) or not available for detection (e.g., buried in the snow). Conducting 2 follow-up surveys for a total of 3 visits improved the conditional probability of detection to 0.62–0.71, which allowed us to compute a better estimate of true site use. In other words, by finding additional pellets in subsequent visits (or not finding pellets at sites where they were detected previously), a correction factor can be applied to account for missed pellets and produce a more accurate estimate of true site use. Based on 4 years of data with repeat surveys, annual variation in the detection process appeared to be negligible (i.e., range = 0.34–0.43) relative to other sources of sampling variation. Thus, a single visit should be sufficient to monitor the population in future years of the survey.

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Table 1. Spruce grouse (SPGR) routes and sites surveyed in northern Minnesota in 2021 by staff, cooperators, and volunteers, and detections of SPGR and ruffed grouse (RUGR) pellets (singles and roosts per used site) during initial visits.

Cooperator Area	No. citizen volunteers	Routes	Sites surveyed	Proportion sites used by SPGR	Proportion sites used by RUGR
Aurora SNF[1]	1	3	15	0.20	1.00
Baudette DNR[2]	0	3	14	0.21	0.36
Bemidji DNR	0	2	10	0.00	0.80
Chippewa NF[3]	1	4	19	0.00	0.42
Cook SNF	0	4	20	0.25	0.60
Duluth DNR	5	2	9	0.33	0.67
Ely SNF	10	5	24	0.21	0.50
Grand Marais DNR[4]	2	3	12	0.17	0.75
Grand Marais SNF	0	3	14	0.36	0.86
Grand Rapids DNR	2	1	4	0.50	1.00
I Falls DNR	1	3	13	0.46	0.15
Leech Lake Res.	0	2	0	--	--
Orr DNR	1	4	18	0.44	0.39
Red Lake Res.	0	2	9	0.00	0.78
Red Lake WMA	1	5	25	0.48	0.32
1854 Treaty Authority	0	4	20	0.50	0.80
Tofte SNF	2	6	30	0.47	0.50
Two Harbors DNR	2	3	15	0.13	0.93
Tower DNR	1	3	14	0.71	0.50
Total		60	285	0.32	0.59
Not Surveyed		7	34	--	--

[1]SNF = Superior National Forest
[2]DNR = Minnesota Department of Natural Resources –Section of Wildlife
[3]Some volunteers worked in groups on the same route, and some volunteers did routes in >1 work area.
[4]Grand Marias DNR Office has been moved to the Two Harbors DNR Office, but routes remain separated based on their geographic location.

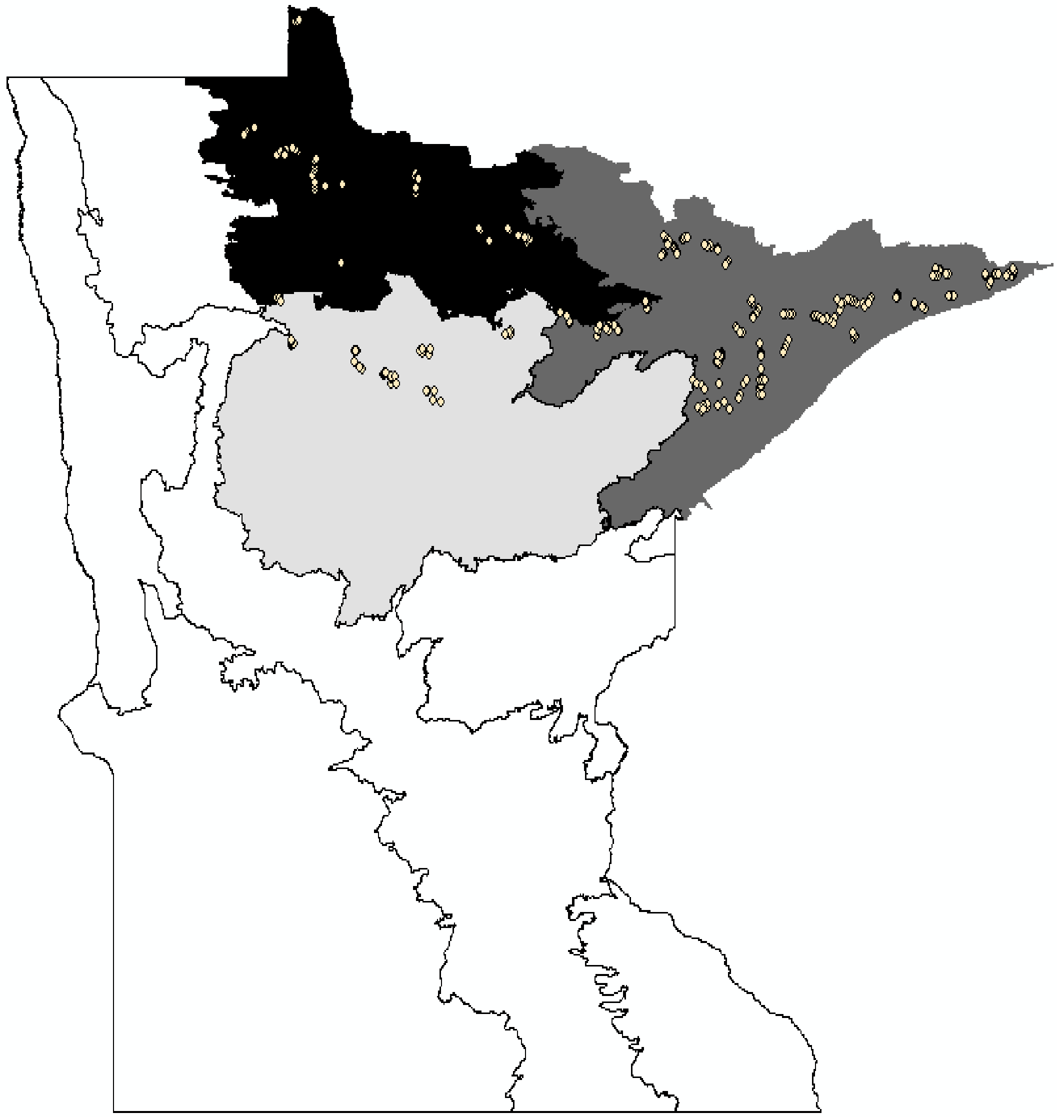

Figure 1. Distribution of sampling sites in northern Minnesota. Ecological Classification System sections included the Northern Minnesota and Ontario Peatlands (n = 85 sites) in the northwest, the Northern Superior Uplands (n = 188 sites) in the east, and the Northern Minnesota Drift and Lake Plains (n = 44 sites) in the southcentral survey region.

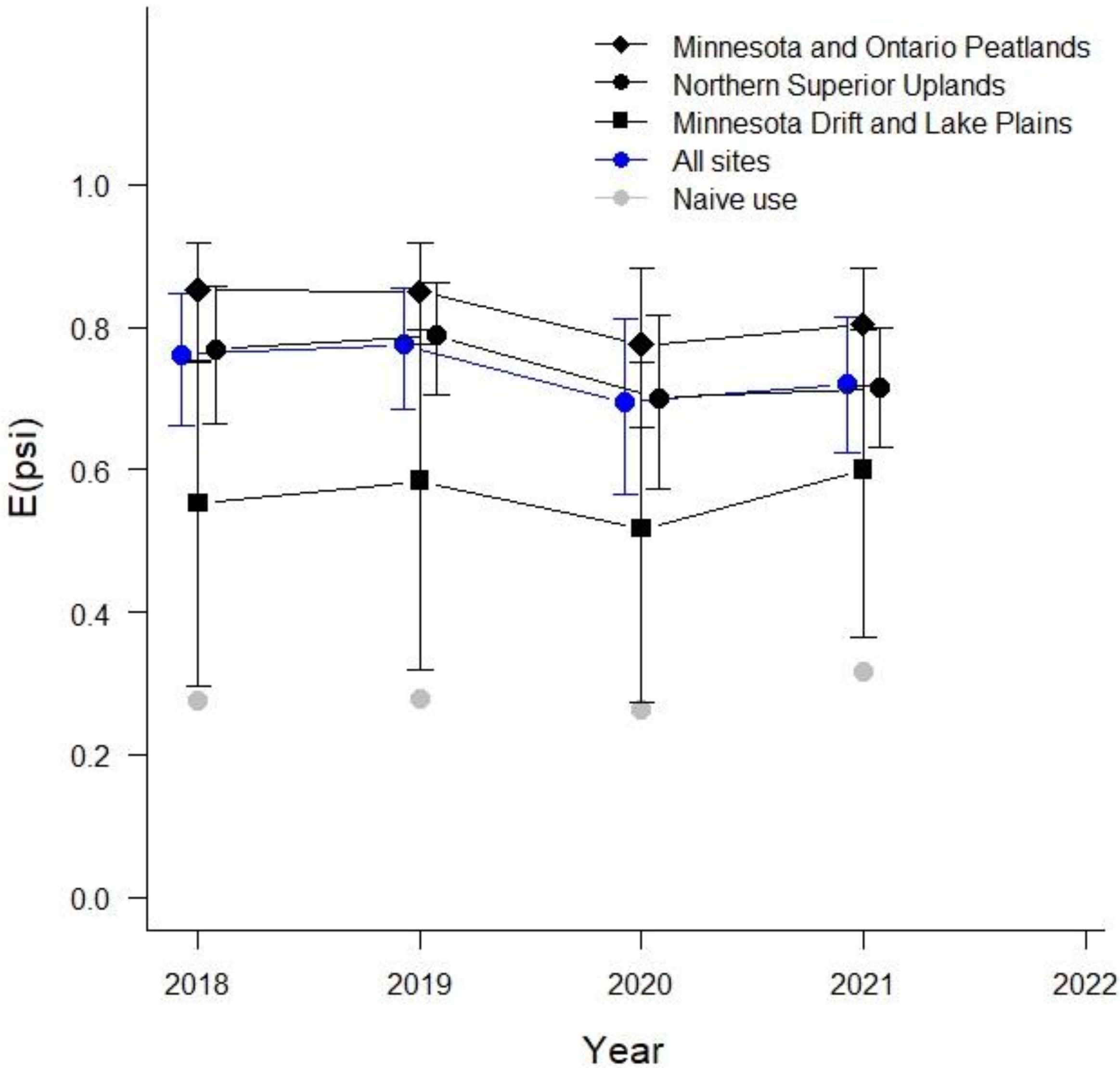

Figure 2. Estimated spruce grouse site use by Ecological Classification System section and across all sections in northern Minnesota during 2018–2021. Expected values are based on a hierarchical dynamic occupancy model and naive use is the proportion of sites where pellets were detected in the initial survey. Error bars denote 95% credible intervals.

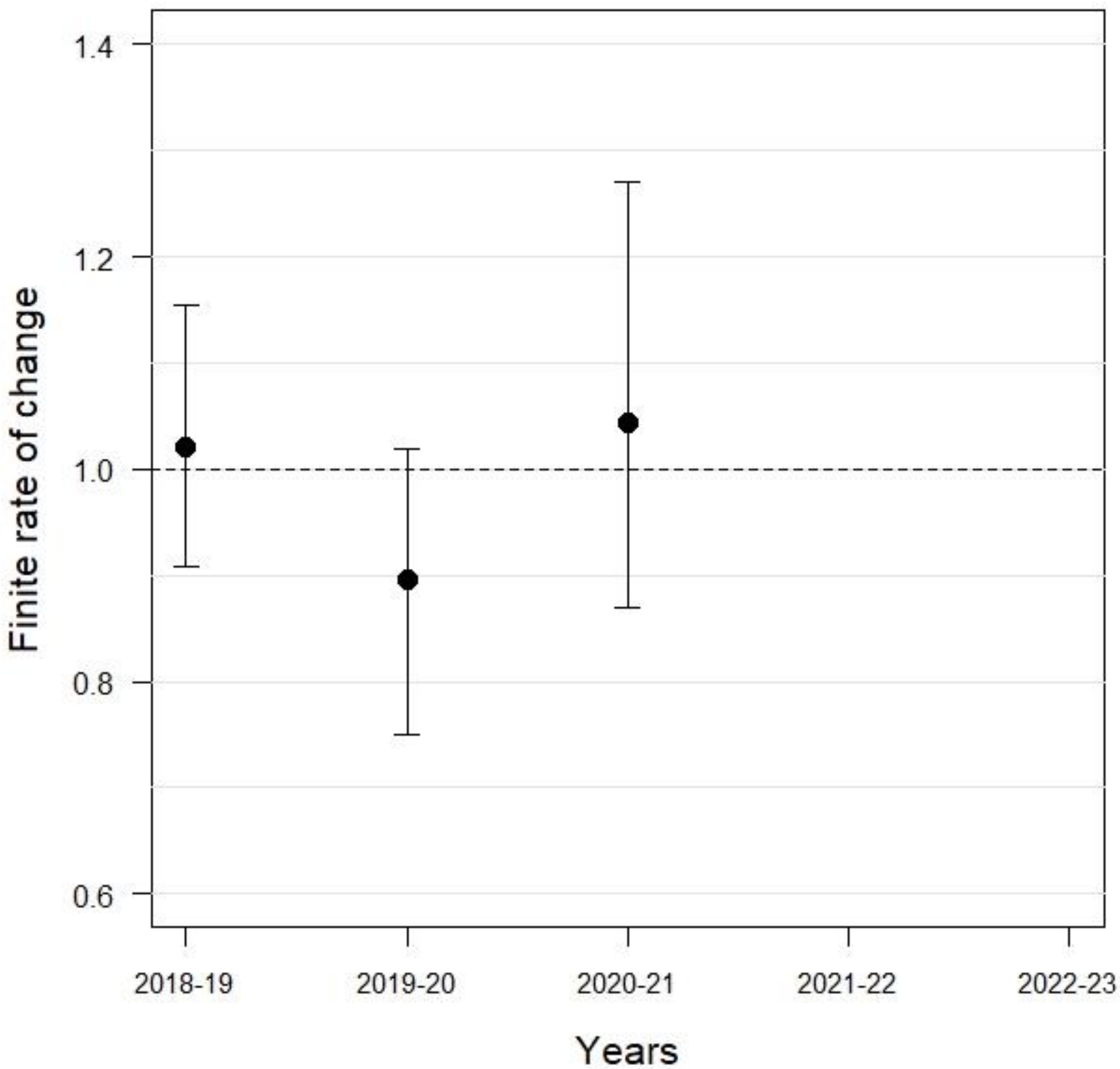

Figure 3. Estimated finite rate of change in site use by spruce grouse in northern Minnesota during 2018–2021 based on a hierarchical dynamic occupancy model. Values below the dashed line denote a decrease in site use between years, whereas values above the line indicate an increase in site use between years. Error bars denote 95% credible intervals.