MONITORING POPULATION TRENDS OF WHITE-TAILED DEER IN MINNESOTA – 2024

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INTRODUCTION

Hunting is the primary method used to manage white-tailed deer (*Odocoileus virginianus*) populations in Minnesota. Minnesota Department of Natural Resources (MNDNR) sets annual hunting regulations to adjust deer harvest to meet management goals. MNDNR wildlife researchers conduct simulation modeling of deer populations to explore the impacts of various hunting regulations on populations, to understand historical deer herd dynamics, and to predict relative population sizes. To aid in decision-making, MNDNR Biologists consider output from population modeling along with deer harvest metrics, hunter success rates, surveys of hunter and landowner satisfaction with deer populations, and deer population goals set through a public process. This report summarizes the structure and parameters of the simulation model and provides a description of recent trends in modeled density estimates and harvest recommendations.

METHODS

Prior to 2020, we modeled deer populations at the deer permit area (DPA) level. However, with over 130 DPAs, this was a major annual undertaking that limited the time the modeler could devote to each modeling unit, including exploring the sensitivity of the model in each case. Furthermore, we typically lacked empirical data on population vital rates (other than harvest) at the DPA scale and it would be cost-prohibitive to collect such data. Conversely, collecting annual or periodic population data over larger modeling units might be feasible. Therefore, beginning in 2020, we consolidated DPAs into deer modeling units (DMUs; Figure 1). DMUs are generally consistent with goal-setting blocks (GSBs), except some DMUs may contain less than the full set of DPAs within a GSB if there were major boundary changes in the last 5 years (which makes it difficult to interpret harvest data and population trends).

We recognize that annual regulatory decisions still occur at the DPA level and we need to link DMU-level modeling results to DPA-level decision making. Therefore, we used the annual proportional buck harvest in each DPA to convert DMU population estimates to DPA-level density estimates, which we acknowledge is a simplification of factors that can influence variation in deer densities among DPAs and years. Thus, we advise caution when interpreting annual DPA-level estimates of absolute density and, in turn, encourage assessing the overall population trend.

Model Structure

We used the spring of the initial year before reproduction occurred as the starting period for each multi-year simulation (Figure 2). We specified an initial population density (see Modeling Procedures section). The model then converted the initial population density into a total population size by multiplying the density by the total land area of the DMU. We set the proportion of adult deer by age- and sex-class in the initial population (adult females mean = 0.45 [SD = 0.02], adult males mean = 0.20 [SD = 0.02]). We allocated the remaining proportion approximately equally (with some small variation for primary sex ratio) to young-of-year (YOY) males and females.

Within each annual cycle, we applied age-specific fecundity rates to females to estimate reproduction. We subjected all age- and sex-classes to spring/summer mortality, and the result was the pre-hunt fall population. We also subtracted hunter-harvested deer from the pre-hunt population. We estimated winter mortality rates by age-class relative to winter severity, and we then applied winter mortality rates to the post-hunt population. The remaining population represented the starting population size for the next stage of the simulation. We assumed that the effects of immigration and emigration on a population within a DMU were equal.

Reproduction

We used fecundity rates from a range of values reported for Iowa, Minnesota, and Wisconsin (Iowa DNR unpublished data, Fuller 1990, McCaffery et al. 1998, DelGiudice et al. 2007, Dunbar 2007, Grund 2011, Storm 2014, Storm 2015, Dittrich 2016). We partitioned fecundity rates by 2 age-classes of breeding females (i.e., <1 year old [YOY] when bred and ≥1 year old [adult] when bred) and allowed rates to vary by 3 ecogeographic zones (northeast, farmland and transition areas, and southeast) that reflected relative differences in climate and habitat quality. We estimated fecundity rates to be lowest in the northeast (YOYs, mean = 0.06 [SD = 0.005]; adults, mean = 1.55 [SD = 0.001]), moderate in the farmland and transition zone (YOYs, mean = 0.07 [SD = 0.017]; adults, mean = 1.71 [SD = 0.022]), and greatest in the southeast (YOYs, mean = 0.13 [SD = 0.029]; adults, mean = 1.81 [SD = 0.055]). Sex ratio of fawns at birth in most deer populations is approximately 50:50 but may vary annually (Ditchkoff 2011). Therefore, we allowed the proportion of male fawns at birth to vary uniformly between 0.48-0.52.

Spring/Summer Survival

We used estimates reported in the primary literature for deer in Minnesota, from research currently being conducted in southern Minnesota, and populations in similar habitats for fawn spring/summer survival (Wisconsin DNR unpublished data, Huegel et al. 1985, Nelson and Mech 1986a, Nelson and Woolf 1987, Kunkel and Mech 1994, Brinkman et al. 2004, Vreeland et al. 2004, Rohm et al. 2007, Hiller et al. 2008, Carstensen et al. 2009, Warbington et al. 2017). We used spring/summer survival rates ranging from 0.50-0.70 to assess the impact of fawn survival on the overall population trend.

Spring/summer survival rates reported in the primary literature for adult deer ≥1 year old were relatively high and similar for both sexes (DeYoung 2011). We used a range of values that varied stochastically (female: 0.94-0.97 [SD = 0.011], male: 0.92-0.98 [SD = 0.015]). These estimates overlapped values reported in the literature for Minnesota and populations in similar habitats (Nelson and Mech 1986a, Fuller 1990, Van Deelen et al. 1997, Whitlaw et al. 1998, Brinkman et al. 2004, Grund and Woolf 2004, Grund 2011, Grovenburg et al. 2011) and were adjusted using information from recently completed research from northeastern and southeastern Minnesota.

Fall Harvest and Recovery Rates

Hunter harvest represents the greatest source of mortality for deer populations in most DPAs in Minnesota during the fall (Fuller 1990, DelGiudice et al. 2006, Grovenburg et al. 2011). We obtained harvest data from the MNDNR Electronic Licensing System. Hunters were required to register deer within 48 hours after harvest, indicate in which DPA the deer was harvested, and classify the deer as adult male, adult female, fawn male, or fawn female. We pooled harvest data for the archery, firearms, and muzzleloader seasons, special hunts, and harvest reported by Native American Tribes within DPAs.

We recognized that some deer were not registered during the hunting season or they were harvested illegally (Dusek et al. 1992, Rupp et al. 2000), wounded and not recovered (Nixon et al. 2001), or died from other non-hunting causes (e.g., deer-vehicle collision, Norton 2015). We applied a mean multiplier of 1.05 (SD = 0.002) to the numerical harvest to account for non-registered deer that died during the hunting season. Because we expect the true multiplier to be greater than 1.05, density estimates are conservative, but resulting population trends will likely be similar when different multipliers are used based on the modeling procedures.

Winter Survival

Winter severity, particularly snow depth, increases deer mortality risk via starvation and predation, with fawns being more susceptible than adults (Nelson and Mech 1986b, DelGiudice et al. 2002, Norton 2015). Subsequently, Minnesota Information Technology (MNIT) Services/MNDNR staff calculate an annual winter severity index (WSI) in each DPA based on snow depth and minimum daily temperatures. From 1 November through 31 May, 1 point was added to the WSI for each day with snow depths $\geq$15 in (38.1 cm). One point was also added to the WSI for each day when temperatures were $\leq 0^0$ F (-17.8^0 C). Therefore, the WSI accumulated 0, 1, or 2 points every day in each DPA. We estimated winter survival rates relative to winter severity based on studies conducted in Minnesota (Nelson and Mech 1986a, DelGiudice et al. 2002, Brinkman et al. 2004, Grund and Woolf 2004, DelGiudice et al. 2006, Grovenburg et al. 2011, Grund 2011). These studies reported survival rates similar to those observed in other deer populations in northern latitudes (Van Deelen et al. 1997, Whitlaw et al. 1998, DePerno et al. 2000, Dumont et al. 2000, Norton 2015).

For adult deer, we set mean winter survival at 0.95 when WSI≤25. When WSI>25, we used an equation to calculate survival to account for increased winter severity based on previous research in Minnesota. For fawns, we set the mean winter survival rate at 0.85 when WSI≤60. When WSI was above 60 and less than 100, we applied the same equation used to calculate adult survival. However, we subtracted an additional mortality rate of 0.05 to represent lower survival of fawns versus adults. For more severe winters (100≤WSI≤240), we adjusted the equation to represent increased mortality reported for fawns in field studies. When WSI exceeded 240, we set fawn survival at 0.033.

Modeling Procedures

Simulation models can be sensitive to the parameter for initial population size (e.g., Grund 2014). Therefore, we used density estimates from last year's models as starting points for this year's models. However, we explored alternative starting values in cases where the simulated population was growing or declining at an unrealistic rate (e.g., due to adding new harvest data and, possibly, removing harvest data that are now outside the modeling window). This can lead to some discrepancies with previously reported model estimates, which is not an ideal situation. However, it reflects an important limitation of simulation models. Thus, we advise caution when interpreting estimates of absolute density (vs. population trends).

We ran model simulations for 5 years (2019-2024) with the final population estimate occurring pre-fawning for the spring following the most recent deer hunting season (i.e., spring 2024). We performed all simulations with the R programming language (ver. 3.6.2, R Core Team 2019) and used 500 Monte Carlo simulations until we determined the most reasonable set of starting parameters. We then used 5,000 simulations for the final model run.

RESULTS

Deer Population Trends and Management Recommendations

Although we derived the model parameters from studies of deer in Minnesota or from studies from states that have similar habitats and environmental conditions, uncertainty is inherent in modeling wild deer populations. Our modeling allowed input parameters to vary stochastically to represent natural variation that occurs in wild populations, and model outputs included measures of uncertainty reflecting variation among model simulations. However, for ease of interpretation, we present mean pre-fawn deer densities. We conducted simulation modeling for 23 DMUs (Table 1) and derived subsequent density estimates in 105 of 129 DPAs in Minnesota to estimate deer densities before reproduction during spring 2024 (Table 2; Figure 3). We used a combination of three metrics (modeled density estimates, the number of bucks harvested in each DPA, and hunter success) to evaluate whether a DPA was above, at, or below goal. For simplicity, we did not consider changes in the number of antlerless tags allocated for a lottery designation when interpreting designation changes from 2023 to 2024. We only assessed antlerless opportunities based on if DPAs completely changed a designation (e.g., moving from a Lottery designation to a Bucks Only or Either Sex designation).

Management designations in 2024 were mostly consistent in DPAs compared to 2023 even though the winters of 2023 and 2024 were mild. The number of DPAs recommending the Bucks Only designation slightly increased in 2024 (n = 11) compared to 2023 (n = 9) while there were slight decreases in the number of DPAs with the Three-Deer Limit with Early Antlerless (one less DPA), Three-Deer Limit (two fewer DPAs), and Two-Deer Limit (one less DPA) designations. All three ecogeographic zones observed some DPAs below goal (farmland zone, n = 13; farmland-forest transition zone, n = 12; northeastern forest region, n = 30). Liberal antlerless seasons will be required again in 2023 to effectively manage deer populations in DPAs with average and above average productivity while more conservative strategies will be required for those units below goal.

In terms of management intensity, the 2024 designations did not afford more antlerless deer harvest opportunities to hunters versus the 2023 season (not including changes in number of antlerless tags available for Lottery designations). About 9% of DPA designations afford less antlerless harvest opportunity in 2024 compared to 2023, while a majority (~91%) of designations provide the same antlerless opportunity as 2023.

Farmland Zone

We produced density estimates for 30 of 36 total farmland zone DPAs. Of the 36 DPAs in the farmland zone, 16 were at goal, 13 were below goal, and 7 were above goal. Designations aimed to stabilize or increase deer densities are most prevalent in 2024 (Either Sex, n = 7; Lottery, n = 18), while more liberal designations were less common (Three-deer Limit with Early Antlerless, n = 1; Three-deer Limit, n = 5; Two-deer Limit, n = 5). We attempt to maintain consistent regulations across years whenever possible to improve model performance.

Farmland-Forest Transition Zone

Deer populations in the farmland-forest transition zone are highly productive due to excellent habitat and generally milder winters compared to the forest zone. Historical harvests and modeled population trends suggested that Antlerless Permit Lottery designations were not sufficient to stabilize deer numbers in most transition zone DPAs as evidenced by few DPAs with Antlerless Permit Lottery recommendations. We produced density estimates for 40 of the 48 farmland-forest transition zone DPAs. Of the 48 DPAs in the farmland-forest transition zone, 19 were at goal, 12 were below goal, and 17 were above goal based. We selected management designations to decrease densities for DPAs above goal while attempting to maintain consistent regulations across years whenever possible to improve model performance. For the 2024 season designations, Bucks Only was used in 1 DPA, Antlerless Permit Lottery was used for 2 DPAs, Either Sex for 5 DPAs, and a Two-deer Limit designation was used for 13 DPAs. In 20 DPAs, a Three-deer Limit designation was necessary to continue reducing deer densities toward goal level, 13 of which have additional antlerless seasons. In the metro area (DPA 701) and the chronic wasting disease management zone (DPAs 605, 643, 645, 646, 647, 648, and 649), a Five Deer Limit with an Early Antlerless season will be available during the legal hunting seasons.

Forest Zone

Many deer populations in the forest zone with adequate habitat have recovered from the severe winter of 2013-14. However, the recent severe winters of 2021-22 and 2022-23 continued to decrease deer densities in some DPAs. Even though the winter of 2023-24 was mild, populations will likely require multiple mild winters to fully recover. We produced density estimates for 35 of 44 forest zone DPAs. Of the 44 DPAs in the forest zone, 10 were at goal, 30 were below goal, 1 was above goal, and goals were paused in 3 DPAs due to the detection of CWD. We selected management designations to increase densities for DPAs below goal while attempting to maintain consistent regulations across years whenever possible to improve model performance. For 2024 season designations, Bucks Only was used in 10 DPAs, Antlerless Permit Lottery in 21 DPAs, Either Sex in 8 DPAs, a Two-deer Limit designation in 4 DPAs, and a Three-deer Limit designation in 1 DPA.

Abridged Descriptions of Deer Hunting Season Designations

Bucks Only. <u>All</u> hunters, including youth and archery hunters, are restricted to harvesting only legal bucks. No antlerless deer may be harvested; limited exceptions for hunters ≥84 years of age or persons in veterans' homes. The bag limit is **one** deer.

Antlerless Permit Lottery. A hunter may apply for authorization to harvest one either-sex deer during either the firearm or muzzleloader season. Archery hunters can take a deer of either sex. Under this scenario, archers, youth, and disabled hunters can kill a deer of either sex. The bag limit is **one** deer.

Either Sex. The initial license is either-sex and bonus permits cannot be used. There is no antlerless permit lottery application and all hunters potentially could harvest an antlerless deer, regardless of season. The bag limit is **one** deer.

Two-deer Limit. The initial license is either-sex and a maximum of **two** deer (one buck) can be taken using any combination of licenses and permits.

Three-deer Limit. The initial license is either-sex and the maximum of **three** deer (one buck) can be taken using any combination of licenses and permits.

Five-deer Limit. The initial license is either-sex and the maximum of five deer (one buck, except the Southeast 600-series) can be taken using any combination of licenses and permits.

***Early Antlerless.** A hunter could harvest **three additional** deer in these permit areas during the early antlerless season (e.g., the annual limit in an intensive permit area with an early antlerless season would be eight deer).

LITERATURE CITED

Brinkman, T. J., J. A. Jenks, C. S. DePerno, B. S. Haroldson, and R. G. Osborn. 2004. Survival of white-tailed deer in an intensively farmed region of Minnesota. Wildlife Society Bulletin 32:1-7.

Carstensen, M., G. D. DelGiudice, B. A. Sampson, and D. W. Kuehn. 2009. Survival, birth characteristics, and cause-specific mortality of white-tailed deer neonates. Journal of Wildlife Management 73:175-183.

DelGiudice, G. D., M. R. Riggs, P. Joly, and W. Pan. 2002. Winter severity, survival, and cause-specific mortality of female white-tailed deer in north-central Minnesota. Journal of Wildlife Management 66:698-717.

DelGiudice, G. D., J. Fieberg, M. R. Riggs, M. Carstensen Powell, and W. Pan. 2006. A long-term age-specific survival analysis of female white-tailed deer. Journal of Wildlife Management 70:1556-1568.

DelGiudice, G. D., M. S. Lenarz, and M. Carstensen Powell. 2007. Age-specific fertility and fecundity in northern free-ranging white-tailed deer: evidence for reproductive senescence? Journal of Mammalogy 88:427-435.

DePerno, C. S., J. A. Jenks, S. L. Griffin, and L. A. Rice. 2000. Female survival rates in a declining white-tailed deer population. Wildlife Society Bulletin 28:1030-1037.

DeYoung, C. A. 2011. Population dynamics. Pages 147-180 *in* D. G. Hewitt, editor. Biology and management of white-tailed deer. CRC, Boca Raton, Florida, USA.

Ditchkoff, S. S. 2011. Anatomy and physiology. Pages 43-73 *in* D. G. Hewitt, editor. Biology and management of white-tailed deer. CRC, Boca Raton, Florida, USA.

Dittrich, J. 2016. Deer Reproduction and nutritional condition in Wisconsin. Project W 160-P performance report. Bureau of Science Services, Wisconsin Department of Natural Resources, Madison, Wisconsin, USA. 8 pp.

Dumont, A., M. Crete, J. Ouellet, J. Huot, and J. Lamoureux. 2000. Population dynamics of northern white-tailed deer during mild winters: evidence of regulation by food competition. Canadian Journal of Zoology 78:764-776.

Dunbar, E. 2007. Fetus survey data of white-tailed deer in the farmland/transition zone of Minnesota - 2007. Pages 29-34 *in* M. H. Dexter, editor. Status of wildlife populations, fall 2007. Division of Fish and Wildlife, Minnesota Department of Natural Resources, St. Paul, Minnesota. 302 pp.

Dusek, G. L., A. K. Wood, and S. T. Stewart. 1992. Spatial and temporal patterns of mortality among female white-tailed deer. Journal of Wildlife Management 56:645-650.

Fuller, T. K. 1990. Dynamics of a declining white-tailed deer population in north-central Minnesota. Wildlife Monographs 110.

Grovenburg, T. W., C. N. Jacques, C. S. DePerno, R. W. Klaver, and J. A. Jenks. 2011. Female white-tailed deer survival across ecoregions in Minnesota and South Dakota. American Midland Naturalist 165:426-435.

Grund, M. D., and A. Woolf. 2004. Development and evaluation of an accounting model for estimating deer population sizes. Ecological Modelling 180:345-357.

Grund, M. D. 2011. Survival analysis and computer simulations of lethal and contraceptive management strategies for urban deer. Human-Wildlife Interactions 5:23-31.

Grund, M. D. 2014. Monitoring population trends of white-tailed deer in Minnesota-2014. Pages 18-28 *in* M. H. Dexter, editor. Status of wildlife populations, fall 2014. Unpublished report. Division of Fish and Wildlife, Minnesota Department of Natural Resources, St. Paul, Minnesota. 328 pp.

Huegel, C. N., R. B. Dahlgren, and H. L. Gladfelter. 1985. Mortality of white-tailed deer fawns in south-central Iowa. Journal of Wildlife Management 49:377-380.

Hiller, T. L., H. Campa, S. Winterstein, and B. A. Rudolph. 2008. Survival and space use of fawn white-tailed deer in southern Michigan. American Midland Naturalist 159:403-412.

Kunkel, K. E., and L. D. Mech. 1994. Wolf and bear predation on white-tailed deer fawns in northeastern Minnesota. Canadian Journal of Zoology 72:1557-1565.

McCaffery, K. R., J. E. Ashbrenner, and R. E. Rolley. 1998. Deer reproduction in Wisconsin. Transactions of the Wisconsin Academy of Sciences, Art, and Letters 86:249-261.

Nelson, M. E., and L. D. Mech. 1986a. Mortality of white-tailed deer in northeastern Minnesota. Journal of Wildlife Management 50:691-698.

Nelson, M. E., and L. D. Mech. 1986b. Relationship between snow depth and gray wolf predation on white-tailed deer. Journal of Wildlife Management 50:471-474.

Nelson, T. A., and A. Woolf. 1987. Mortality of white-tailed deer fawns in southern Illinois. Journal of Wildlife Management 51:326-329.

Nixon, C. M., L. P. Hansen, P. A. Brewer, J. E. Chelsvig, T. L. Esker, D. Etter, J. B. Sullivan, R. G. Koerkenmeier, and P. C. Mankin. 2001. Survival of white-tailed deer in intensively farmed areas of Illinois. Canadian Journal of Zoology 79:581-588.

Norton, A. S. 2015. Integration of harvest and time-to-event data used to estimate demographic parameters for white-tailed deer. Dissertation, University of Wisconsin – Madison, Madison, Wisconsin, USA.

R Core Team. 2019. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. <http://www.R-project.org/>.

Rohm, J. H., C. K. Nielson, and A. Woolf. 2007. Survival of white-tailed deer fawns in southern Illinois. Journal of Wildlife Management 71:851-860.

Rupp, S. P., W. B. Ballard, and M. C. Wallace. 2000. A nationwide evaluation of deer hunter harvest survey techniques. Wildlife Society Bulletin 28:570-578.

Storm, D. 2014. Deer Reproduction and nutritional condition in Wisconsin. Project W 160-P performance report. Bureau of Science Services, Wisconsin Department of Natural Resources, Madison, Wisconsin, USA. 6 pp.

Storm, D. 2015. Deer Reproduction and nutritional condition in Wisconsin. Project W 160-P performance report. Bureau of Science Services, Wisconsin Department of Natural Resources, Madison, Wisconsin, USA. 6 pp.

Van Deelen, T. R., H. Campa, J. B. Haufler, and P. D. Thompson. 1997. Mortality patterns of white-tailed deer in Michigan's upper Peninsula. Journal of Wildlife Management 61:903-910.

Vreeland, J. K., D. R. Diefenbach, and B. D. Wallingford. 2004. Survival rates, mortality rates, and habitats of Pennsylvania white-tailed deer fawns. Wildlife Society Bulletin 32:542-553.

Warbington, W. H., T. R. Van Deelen, A. S. Norton, J. L. Stenglein, D. J. Storm, and K. J. Martin. 2017. Cause-specific neonatal mortality of white-tailed deer in Wisconsin, USA. Journal of Wildlife Management 81:824-833.

Whitlaw, H. A., W. B. Ballard, D. L. Sabine, S. J. Young, R. A. Jenkins, and G. J. Forbes. 1998. Survival and cause-specific mortality rates of adult white-tailed deer in New Brunswick. Journal of Wildlife Management 62:1335-134.

Table 1. Estimated mean pre-fawn deer densities (deer/mi²) for deer modeling units (DMUs) derived from population model simulations in Minnesota, 2019-2024.

Deer Modeling Unit	Land Area (mi²)	Pre-fawn Deer Density					
		2019	2020	2021	2022	2023	2024
1	1,470	7 (2.0)	8 (2.3)	9 (2.9)	10 (3.4)	10 (3.5)	12 (4.2)
2	2,026	13 (2.5)	14 (3.0)	15 (3.7)	14 (4.0)	14 (4.2)	15 (5.0)
3	1,384	5 (1.0)	5 (1.1)	6 (1.3)	6 (1.3)	6 (1.4)	7 (1.6)
4	3,249	3 (0.7)	3 (0.7)	3 (0.8)	3 (0.8)	3 (0.7)	3 (0.9)
5	2,779	2 (0.5)	2 (0.5)	2 (0.6)	2 (0.5)	2 (0.5)	2 (0.5)
6	3,750	12 (2.7)	13 (3.2)	14 (3.9)	14 (4.4)	14 (4.8)	16 (5.8)
7	3,932	15 (3.0)	14 (3.4)	14 (4.1)	13 (4.4)	12 (4.8)	13 (5.6)
8	3,573	9 (1.8)	8 (1.9)	9 (2.3)	8 (2.4)	8 (2.4)	8 (2.8)
9	3,466	12 (0.8)	11 (0.9)	10 (1.0)	9 (1.1)	7 (1.1)	7 (1.3)
10	3,520	30 (6.0)	31 (7.2)	33 (8.7)	34 (9.9)	33 (10.6)	36 (12.5)
11	2,334	24 (1.5)	22 (1.9)	20 (2.3)	17 (2.6)	15 (2.9)	13 (3.5)
12	3,331	27 (5.3)	31 (7.2)	35 (9.6)	38 (11.9)	42 (14.2)	50 (18.4)
13	2,550	6 (1.1)	7 (1.4)	8 (1.7)	9 (2.0)	10 (2.3)	11 (2.7)
14	1,456	21 (4.9)	24 (6.1)	27 (7.5)	28 (8.7)	29 (9.6)	32 (11.4)
15	3,647	27 (5.4)	32 (7.5)	36 (10.0)	42 (12.8)	46 (15.7)	55 (20.3)
16	546	14 (2.9)	16 (3.6)	18 (4.4)	19 (5.2)	20 (5.8)	23 (6.9)
17	840	7 (1.1)	8 (1.4)	9 (1.7)	11 (2.1)	12 (2.3)	14 (2.8)
18	2,822	8 (0.9)	8 (1.1)	8 (1.4)	8 (1.6)	8 (1.8)	8 (2.2)
19	2,102	5 (1.0)	5 (1.2)	6 (1.5)	6 (1.8)	6 (2.0)	7 (2.4)
20	4,314	8 (2.5)	9 (3.1)	11 (3.8)	13 (4.5)	14 (5.3)	17 (6.3)
21	4,274	7 (1.5)	8 (1.9)	9 (2.4)	9 (2.9)	10 (3.5)	12 (4.3)
22	1,042	26 (5.7)	29 (7.2)	31 (9.0)	34 (10.9)	38 (13.1)	42 (15.9)
23	1,677	31 (5.7)	32 (7.1)	34 (8.8)	36 (10.7)	38 (13.0)	42 (15.9)

Table 2. Estimated mean pre-fawn deer densities (deer/mi^2) for deer permit areas based on population model simulations in Minnesota deer management units, 2019-2024.

Deer Permit Area	Land Area (mi^2)	Pre-fawn Deer Density					
		2019	2020	2021	2022	2023	2024
101	496	11 (2.1)	11 (2.4)	11 (2.8)	12 (3.3)	10 (3.2)	12 (4.0)
[a]104	1,414	-	-	-	-	-	-
[a]105	1,199	-	-	-	-	-	-
[a]107	472	-	-	-	-	-	-
[a]109	1,182	-	-	-	-	-	-
110	529	13 (2.6)	13 (3.3)	13 (3.8)	13 (4.4)	14 (5.3)	15 (6.6)
111	1,384	5 (1.0)	5 (1.1)	6 (1.4)	6 (1.4)	6 (1.4)	7 (1.7)
[a]114	123	-	-	-	-	-	-
117	936	0 (0.1)	0 (0.1)	0 (0.1)	0 (0.1)	0 (0.1)	0 (0.1)
118	1,239	4 (0.7)	3 (0.8)	4 (0.9)	3 (0.8)	3 (0.8)	4 (1.0)
119	782	4 (0.7)	3 (0.7)	3 (0.8)	4 (0.9)	3 (0.8)	4 (1.0)
126	942	4 (1.1)	4 (1.1)	5 (1.4)	4 (1.1)	3 (0.9)	4 (1.1)
130	747	2 (0.4)	2 (0.4)	2 (0.4)	2 (0.4)	1 (0.4)	2 (0.4)
131	901	2 (0.4)	1 (0.3)	1 (0.2)	1 (0.4)	1 (0.3)	1 (0.3)
132	481	4 (0.8)	3 (0.7)	4 (0.9)	4 (1.0)	4 (1.0)	4 (1.1)
133	352	8 (0.5)	8 (0.6)	7 (0.7)	6 (0.7)	5 (0.7)	5 (0.9)
[b]152	60	-	16 (3.7)	18 (4.7)	17 (5.0)	18 (5.8)	25 (8.7)
[b]155	499	-	22 (5.1)	20 (5.4)	20 (6.0)	22 (7.3)	22 (7.7)
156	819	12 (0.8)	11 (0.8)	10 (0.9)	10 (1.1)	7 (1.0)	7 (1.2)
157	888	.	34 (7.8)	40 (10.5)	42 (12.3)	42 (13.6)	46 (16.0)
159	571	16 (1.0)	14 (1.1)	15 (1.5)	13 (1.6)	10 (1.5)	11 (1.9)
[a]169	939	-	-	-	-	-	-
[a]171	740	-	-	-	-	-	-
[b]172	688	-	24 (5.5)	22 (5.8)	26 (7.8)	24 (7.8)	24 (8.5)
[a]173	471	-	-	-	-	-	-
176	917	7 (1.5)	6 (1.5)	7 (1.9)	6 (1.7)	5 (1.6)	5 (1.8)
177	491	10 (2.0)	9 (2.1)	9 (2.4)	8 (2.3)	7 (2.4)	9 (3.1)
178	1,192	8 (1.7)	8 (1.9)	9 (2.5)	8 (2.5)	8 (2.5)	8 (2.8)
181	629	12 (0.8)	9 (0.7)	8 (0.8)	6 (0.8)	6 (0.8)	5 (0.9)
182	278	15 (1.0)	13 (1.0)	14 (1.3)	12 (1.4)	10 (1.4)	10 (1.8)
183	664	13 (0.8)	12 (0.9)	11 (1.1)	10 (1.2)	8 (1.1)	8 (1.4)
197	973	11 (2.2)	10 (2.3)	9 (2.5)	9 (2.8)	9 (3.0)	11 (3.7)
199	153	6 (0.4)	6 (0.4)	5 (0.5)	4 (0.5)	4 (0.6)	4 (0.6)
201	161	11 (2.1)	10 (2.2)	10 (2.4)	10 (2.9)	8 (2.5)	9 (3.1)
203	118	8 (1.9)	5 (1.3)	7 (2.0)	8 (2.6)	5 (1.6)	8 (2.8)
208	378	10 (2.3)	10 (2.6)	12 (3.6)	13 (4.0)	13 (4.5)	13 (4.7)

[a]Indicates deer permit area was not included in DMU population model.
[b]Deer density was not estimated in 2019.

Table 2. Continued

Deer Permit Area	Land Area (mi²)	Pre-fawn Deer Density					
		2019	2020	2021	2022	2023	2024
209	639	14 (3.2)	16 (4.0)	16 (4.6)	18 (5.6)	17 (5.6)	21 (7.5)
210	615	11 (2.2)	11 (2.8)	13 (3.8)	11 (3.9)	11 (4.2)	12 (5.2)
213	1,059	26 (5.2)	31 (7.2)	34 (9.5)	36 (11.3)	39 (13.3)	48 (17.4)
214	553	26 (1.6)	26 (2.2)	25 (2.9)	20 (3.0)	18 (3.6)	16 (4.2)
215	701	27 (5.3)	29 (6.9)	36 (9.8)	40 (12.3)	48 (16.3)	58 (21.0)
218	884	25 (5.7)	27 (6.9)	31 (8.6)	32 (10.0)	33 (11.1)	39 (13.8)
219	391	21 (4.2)	25 (5.9)	27 (7.5)	30 (9.3)	36 (12.4)	41 (14.9)
221	643	27 (5.4)	32 (7.6)	37 (10.2)	43 (13.1)	44 (14.9)	52 (19.1)
222	413	29 (5.7)	35 (8.1)	39 (10.8)	47 (14.5)	50 (16.8)	58 (21.2)
223	377	26 (5.1)	31 (7.2)	35 (9.7)	38 (11.6)	46 (15.6)	54 (20.0)
224	46	28 (5.5)	35 (8.2)	34 (9.5)	39 (12.1)	45 (15.4)	55 (20.0)
225	618	34 (6.6)	37 (8.8)	44 (12.0)	49 (15.2)	54 (18.4)	66 (24.2)
227	471	31 (6.2)	37 (8.7)	43 (11.9)	50 (15.5)	57 (19.4)	70 (25.7)
229	285	15 (2.9)	17 (4.0)	19 (5.2)	20 (6.2)	25 (8.4)	32 (11.8)
[b]230	454	-	8 (1.9)	8 (2.2)	9 (2.9)	10 (3.4)	10 (3.9)
[b]232	377	-	10 (2.5)	11 (3.0)	11 (3.5)	14 (4.7)	16 (6.1)
[b]233	384	-	9 (2.2)	10 (2.7)	11 (3.3)	12 (4.0)	12 (4.4)
234	636	7 (2.2)	9 (2.8)	9 (3.2)	12 (4.1)	10 (3.9)	12 (4.4)
235	35	24 (4.7)	33 (7.7)	39 (10.8)	47 (14.4)	42 (14.4)	51 (18.8)
236	368	27 (5.4)	31 (7.3)	35 (9.7)	41 (12.7)	47 (16.1)	57 (20.8)
[b]237	608	-	-	-	-	-	-
238	95	18 (5.4)	21 (6.8)	24 (8.5)	25 (8.9)	23 (8.4)	34 (12.7)
239	928	23 (4.5)	25 (5.9)	27 (7.5)	30 (9.4)	32 (10.8)	39 (14.1)
240	643	35 (6.9)	40 (9.4)	45 (12.3)	51 (15.9)	54 (18.2)	63 (23.2)
241	997	28 (1.7)	26 (2.2)	23 (2.5)	19 (3.0)	16 (3.2)	14 (3.8)
246	784	18 (1.1)	16 (1.4)	14 (1.6)	13 (2.0)	11 (2.2)	11 (2.9)
[b]248	216	-	38 (8.6)	42 (11.1)	42 (12.4)	35 (11.3)	42 (14.6)
[b]249	496	-	40 (9.3)	43 (11.5)	40 (11.8)	39 (12.8)	43 (15.0)
250	712	11 (3.3)	11 (3.7)	13 (4.6)	15 (5.2)	17 (6.3)	18 (7.0)
251	55	10 (2.1)	8 (2.1)	9 (2.8)	10 (3.6)	10 (3.7)	9 (3.7)
252	716	9 (2.8)	12 (3.8)	13 (4.4)	14 (4.9)	17 (6.4)	21 (7.8)
[b]253	974	-	6 (1.4)	6 (1.7)	7 (2.1)	8 (2.6)	8 (3.1)
[b]254	924	-	8 (1.9)	9 (2.5)	10 (3.0)	10 (3.5)	12 (4.3)
[b]255	388	-	9 (2.2)	9 (2.6)	11 (3.5)	11 (3.7)	14 (5.0)
256	654	12 (2.7)	12 (3.0)	14 (3.9)	14 (4.2)	14 (4.8)	15 (5.4)
257	412	16 (3.6)	18 (4.7)	19 (5.5)	20 (6.2)	20 (6.9)	23 (8.3)
258	343	21 (4.2)	21 (5.2)	22 (6.5)	18 (6.3)	16 (6.4)	19 (8.0)
259	489	17 (3.5)	16 (4.1)	16 (4.6)	16 (5.7)	16 (6.0)	16 (7.0)

[a]Indicates deer permit area was not included in DMU population model.
[b]Deer density was not estimated in 2019.

Table 2. Continued

Deer Permit Area	Land Area (mi²)	Pre-fawn Deer Density 2019	2020	2021	2022	2023	2024
[a]260	1,055	-	-	-	-	-	-
262	677	8 (2.1)	9 (2.6)	10 (3.3)	11 (3.6)	12 (4.3)	13 (4.7)
[a]263	706	-	-	-	-	-	-
264	669	16 (3.0)	16 (3.6)	18 (4.6)	17 (4.8)	17 (5.2)	18 (6.3)
265	494	16 (3.6)	17 (4.4)	19 (5.4)	18 (5.8)	20 (6.7)	21 (7.5)
266	617	11 (2.4)	11 (2.8)	12 (3.4)	11 (3.6)	12 (4.0)	15 (5.2)
267	472	9 (1.8)	10 (2.2)	12 (2.9)	10 (2.7)	10 (3.1)	10 (3.6)
268	228	18 (3.5)	23 (5.1)	22 (5.5)	22 (6.1)	22 (6.7)	21 (7.2)
269	650	7 (1.3)	8 (1.7)	9 (2.0)	10 (2.2)	10 (2.4)	13 (3.0)
270	736	5 (0.9)	6 (1.2)	7 (1.5)	7 (1.5)	7 (1.7)	7 (1.7)
271	632	6 (1.2)	7 (1.4)	9 (1.9)	10 (2.3)	11 (2.7)	13 (3.1)
272	532	6 (1.0)	7 (1.4)	8 (1.6)	10 (2.3)	10 (2.4)	14 (3.4)
273	572	16 (3.7)	19 (4.8)	20 (5.7)	22 (6.7)	22 (7.2)	22 (7.7)
274	355	5 (0.6)	6 (0.9)	7 (1.2)	7 (1.4)	6 (1.5)	6 (1.7)
[a]275	957	-	-	-	-	-	-
[a]277	1,058	-	-	-	-	-	-
278	402	9 (1.1)	9 (1.3)	9 (1.6)	9 (1.8)	8 (2.0)	8 (2.3)
279	344	5 (1.0)	6 (1.3)	5 (1.4)	7 (2.0)	7 (2.3)	8 (2.9)
280	674	7 (2.0)	7 (2.2)	9 (3.1)	10 (3.8)	11 (4.1)	13 (4.8)
281	605	8 (0.9)	8 (1.1)	8 (1.5)	9 (1.8)	8 (2.0)	8 (2.3)
[a]282	1,126	-	-	-	-	-	-
[a]283	337	-	-	-	-	-	-
284	840	7 (1.1)	8 (1.4)	9 (1.7)	11 (2.0)	12 (2.3)	14 (2.8)
285	546	14 (2.9)	16 (3.6)	18 (4.4)	19 (5.2)	20 (5.8)	23 (6.9)
286	447	5 (1.0)	6 (1.4)	6 (1.7)	7 (2.0)	7 (2.4)	8 (2.9)
287	47	10 (2.0)	7 (1.7)	9 (2.6)	7 (2.3)	6 (2.5)	12 (5.2)
288	624	6 (1.1)	6 (1.2)	6 (1.7)	6 (1.9)	6 (2.0)	7 (2.6)
289	816	5 (1.5)	6 (2.0)	7 (2.3)	8 (2.9)	10 (3.6)	12 (4.6)
290	661	6 (0.7)	6 (0.9)	6 (1.1)	7 (1.4)	7 (1.6)	6 (1.8)
291	799	8 (1.0)	8 (1.2)	8 (1.4)	8 (1.6)	8 (1.9)	9 (2.5)
[a]292	362	-	-	-	-	-	-
[a]293	278	-	-	-	-	-	-
294	687	5 (0.9)	5 (1.1)	5 (1.2)	5 (1.4)	5 (1.7)	5 (1.8)
[a]295	959	-	-	-	-	-	-
296	665	9 (2.9)	11 (3.6)	14 (4.7)	17 (6.0)	20 (7.3)	23 (8.7)
297	438	6 (1.4)	6 (1.4)	5 (1.4)	6 (2.0)	6 (2.0)	6 (2.1)
298	619	8 (1.6)	8 (1.9)	7 (2.1)	7 (2.5)	6 (2.2)	7 (2.9)
[b]299	387	-	11 (2.8)	12 (3.4)	12 (3.8)	14 (4.9)	15 (5.7)

[a]Indicates deer permit area was not included in DMU population model.
[b]Deer density was not estimated in 2019.

Table 2. Continued

Deer Permit Area	Land Area (mi2)	Pre-fawn Deer Density					
		2019	2020	2021	2022	2023	2024
[a]338	316	-	-	-	-	-	-
[b]341	608	-	31 (7.7)	38 (11.0)	41 (13.0)	45 (15.8)	50 (18.8)
342	350	26 (4.6)	23 (5.1)	30 (7.8)	31 (9.4)	36 (12.3)	39 (14.7)
[b]604	673	-	34 (7.9)	35 (9.3)	34 (10.1)	33 (10.6)	38 (13.2)
[a]605	1,192	-	-	-	-	-	-
[a]643	663	-	-	-	-	-	-
644	190	25 (4.5)	28 (6.1)	26 (6.9)	29 (8.8)	34 (11.4)	37 (14.2)
645	326	22 (4.0)	24 (5.1)	25 (6.5)	27 (8.0)	28 (9.6)	30 (11.6)
646	319	47 (8.5)	47 (10.2)	45 (11.7)	46 (13.9)	51 (17.4)	51 (19.6)
[b]647	434	-	26 (6.4)	22 (6.2)	25 (8.0)	28 (9.6)	31 (11.8)
[a]648	332	-	-	-	-	-	-
649	492	33 (5.9)	36 (7.9)	38 (9.8)	40 (11.9)	40 (13.5)	46 (17.5)
[b]655	386	-	6 (1.4)	8 (2.1)	8 (2.6)	8 (2.7)	9 (3.4)
661	793	6 (1.8)	7 (2.1)	8 (2.5)	9 (3.1)	8 (2.8)	10 (3.8)
[a]679	1,024	-	-	-	-	-	-
684	1,235	19 (3.8)	16 (3.9)	16 (4.6)	14 (4.8)	14 (5.2)	13 (5.7)
[a]701	1,324	-	-	-	-	-	-

[a]Indicates deer permit area was not included in DMU population model.
[b]Deer density was not estimated in 2019.

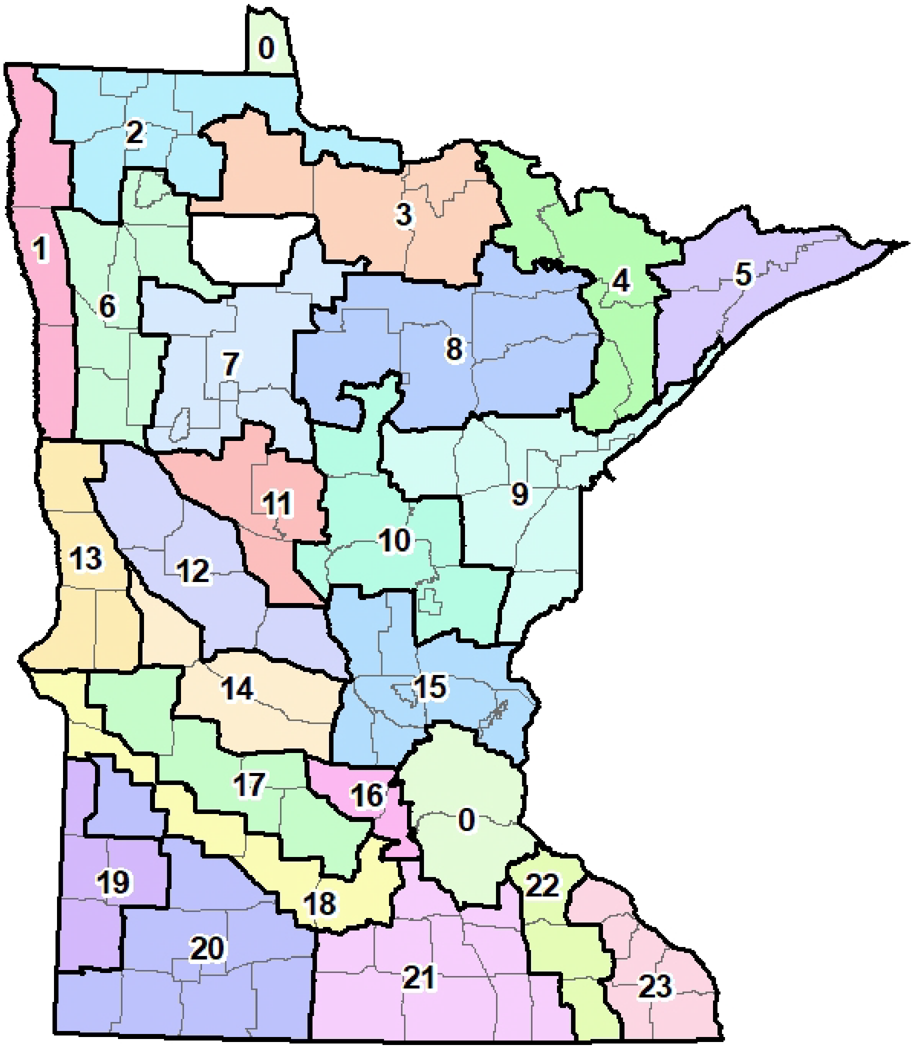


Figure 1. Deer permit areas aggregated into deer modeling units (DMUs; 1 through 23) in Minnesota. Areas not shaded or labeled 0 were not included in aggregated units.

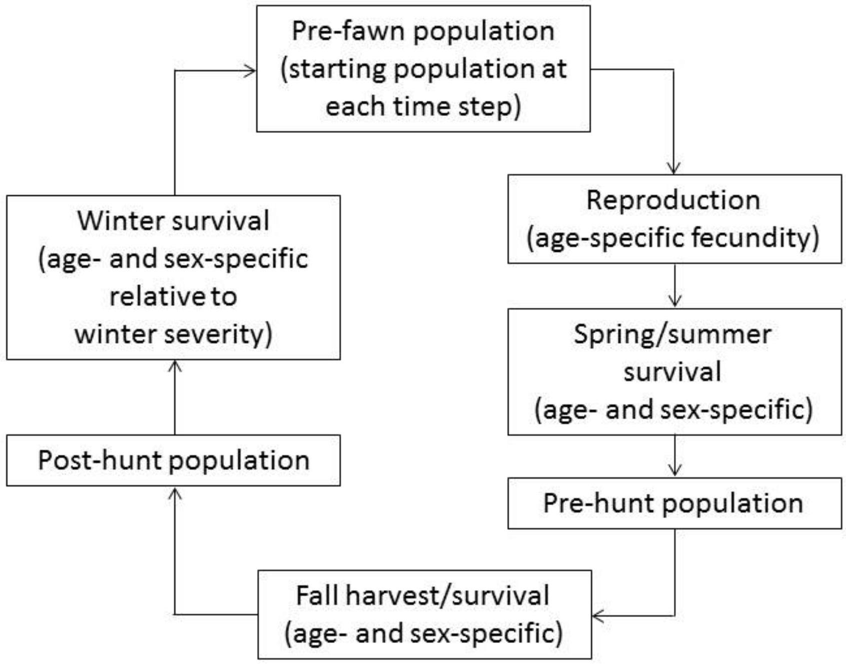
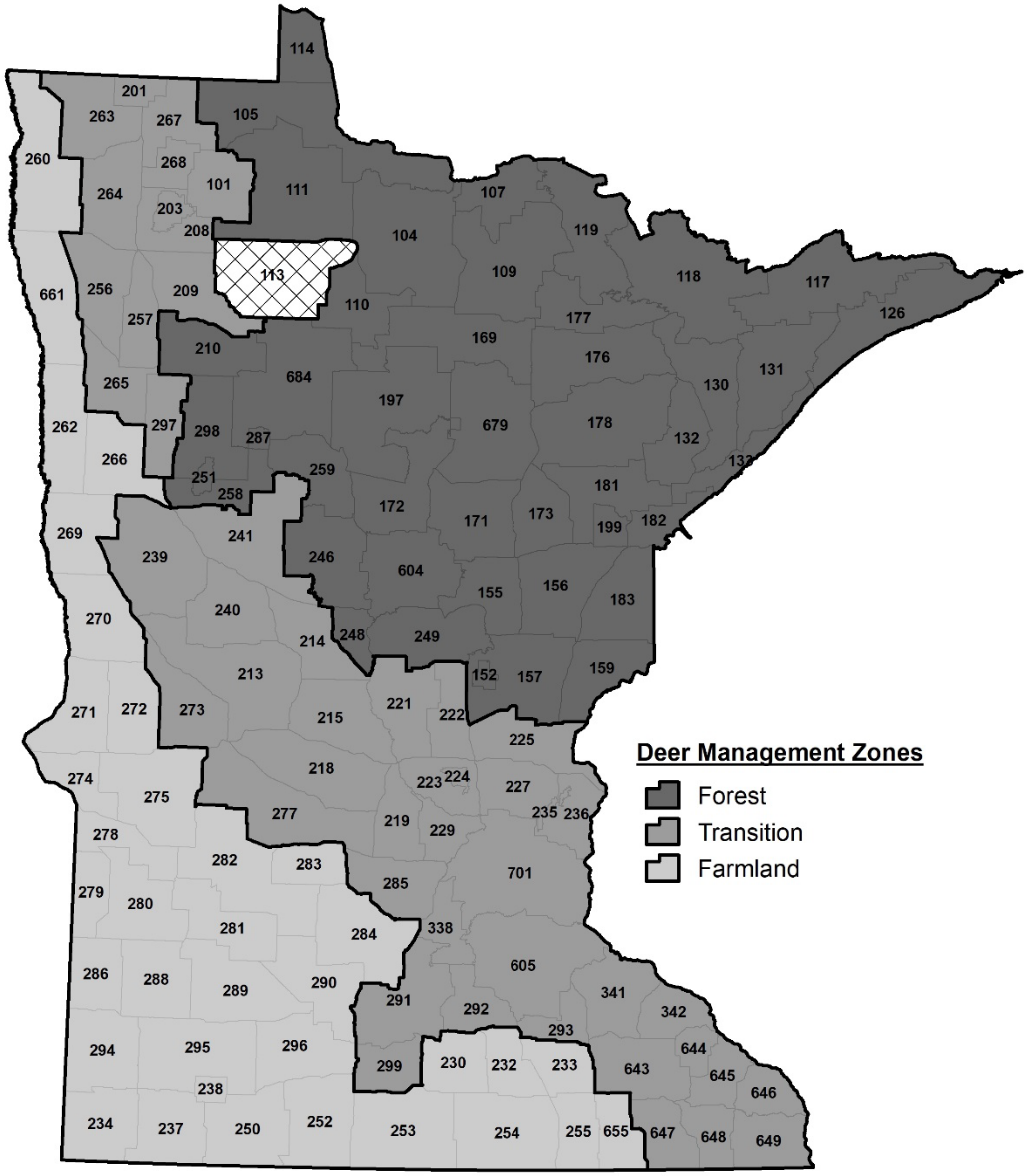


Figure 2. Model structure for simulations of white-tailed deer populations in Minnesota.



Political Boundaries Source: Minnesota DNR Quick Layers
Prepared by: Minnesota DNR Farmland Wildlife Populations & Research Group

Figure 3. Deer permit areas (DPAs) in Minnesota and deer management zones used to describe deer population and harvest trends, 2024. DPAs were assigned to forest, transition, or farmland zones based on historical land cover and current woody cover. Generally, forested DPAs were composed of >60% woody cover, transition DPAs were composed of 6%-50% woody cover, and farmland DPAs were composed of <5% woody cover.