MINNESOTA WOLF POPULATION UPDATE 2020

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INTRODUCTION

Since the late 1970's, Minnesota has monitored its statewide wolf population using an approach that combines attributes of territory mapping with an *ad hoc* approach to determine the total area of the state occupied by wolf packs. The methods employed have changed only slightly during this time. Initially, surveys were conducted at approximately 10-year intervals (1978, 1988, 1997), thereafter at approximately 5-year intervals (2003, 2007, 2012). Results indicated a geographically and numerically expanding population through the 1997-98 survey, with little geographic expansion from 1998 to 2007 (Erb and DonCarlos 2009). These results were generally consistent with separate wolf population trend indicators (annual scent station survey, winter track survey, and number of verified depredations) in Minnesota.

In 2012, wolves in the Western Great Lakes Distinct Population Segment were removed as a listed species under the federal Endangered Species Act. The de-listing coincided with the normally scheduled (every 5th year) wolf survey as well as survey timeline specifications in the Minnesota Wolf Management Plan (i.e., first and fifth year after delisting; Minnesota Department of Natural Resources 2001). The 2012-13 survey (Erb and Sampson 2013) concluded that overall wolf range had expanded along its south and west edge, but with only minor change in the total amount of land occupied by wolf packs; similar patterns were found 5 years later as part of the winter 2017-18 survey (Erb et al. 2018).

After federal de-listing in 2012, wolf harvest seasons were established and population surveys have been conducted annually to better inform annual management decisions. In the first three winters after de-listing, wolf population point estimates varied from approximately 2,200 to 2,400 (Erb et al. 2014). In December 2014, following the third consecutive wolf harvest season, wolves in Minnesota were returned to the list of federally threatened species as a result of a court ruling. Since that time, wolf surveys have continued on an annual basis. Herein we provide an update of population status from the 2019-20 winter survey.

METHODS

The methodology used to estimate wolf population size in Minnesota utilizes three primary pieces of information: 1) an estimate of the total area of land occupied by wolf packs; 2) an estimate of average wolf pack territory size; and 3) an estimate of average mid-winter pack size. It is likely that occupied range changes on a comparatively slow timescale compared to fluctuations in average territory and pack size. As such, occupied range is estimated only once every 5 years, with the last being during winter 2017-18; we assume that occupied range has remained unchanged (i.e., 73,972 km^2; Erb et al. 2018) and use that in our population calculations for winter 2019-20.

To radio-collar wolves, we and various collaborators captured wolves using foothold traps (LPC # 4, LPC #4 EZ Grip, or LPC #7 EZ Grip) approved as part of research conducted under the Association of Fish and Wildlife Agencies Best Management Practices for trapping program. Some wolves are also captured with the use of live-restraining neck snares (Gese et al. 2019), and a few by helicopter dart-gun. Wolves were typically immobilized using a mixture of either Ketamine:Xylazine or

Telazol:Xylazine. After various project-specific wolf samples and measurements were obtained, the antagonist Yohimbine and an antibiotic were typically administered to all animals prior to release. Various models of radio-collars were deployed depending on study area and collar availability. Most GPS radio-collars were programmed to take 3-6 locations per day, and wolves fitted with VHF-only radio-collars were relocated at approximately 7- to 10-day intervals throughout the year, or in some cases, primarily from early winter through spring.

To estimate average territory size, we delineated territories of radio-collared packs using minimum convex polygons (MCP) for consistency with previous surveys. Prior to delineating wolf pack territories, we removed 'outlier' radiolocations using the following guidelines, though subjective deviations were made in some cases as deemed biologically appropriate: 1) for wolves with approximately weekly VHF radiolocations only, locations > 5 km from other locations were excluded as extraterritorial forays (Fuller 1989); 2) for GPS collared wolves with temporally fine-scale movement information, we removed obvious movement paths if the animal did not travel to that area on multiple occasions and if use of the path would have resulted in inclusion of obviously unused areas in the MCP; and 3) for consistency with the way in which the data is used (i.e., to estimate number of packs), points that result in notable overlap with adjacent territories are removed.

In past surveys where all or the majority of territories were delineated using VHF radiolocations, raw territory sizes were increased 37% to account for the average amount of interstitial space between delineated wolf pack territories, as estimated from several Minnesota studies (Fuller et al. 1992:50) where the number of radiolocations per pack typically averaged 30-60. Interstitial spaces are a combination of small voids created by landscape geometry and wolf behavior, but can also be an artifact of territory underestimation when there are comparatively sparse radiolocations. Hence, for packs with < 100 radiolocations (n = 9; mean number of radiolocations = 21), we multiplied each estimated territory size by 1.37 as in the past. For packs with > 100 radiolocations (n = 35; mean number of radiolocations = 2,904), territories were assumed to be fully delineated and were not re-scaled.

To estimate average mid-winter pack size, radio-marked wolves were repeatedly located via aircraft during winter to obtain visual counts of pack size. In cases where visual observations were insufficient, we also rely on any estimates of pack size based on tracks observed in the snow and trail camera images from within the pack's territory. If any reported count produced uncertain estimates (e.g., 4 to 5 wolves), we used the lower estimate. Overall, counts are assumed to represent minimum known mid-winter pack size.

The estimated number of packs within occupied wolf range is computed by dividing the area of occupied range by average scaled territory size. The estimated number of packs is then multiplied by average mid-winter pack size to produce an estimate of pack-associated wolves, which is then divided by 0.85 to account for an estimated 15% lone wolves in the population (Fuller et al. 1992:46, Fuller et al. 2003:170). Specifically,

N = ((km^2 of occupied range/mean scaled territory size)*mean pack size)/0.85.

Using the accelerated bias-corrected method (Manly 1997), the population size confidence interval (90%) was generated from 9,999 bootstrapped re-samples of the pack and territory size data and does not incorporate uncertainty in estimates of occupied range or percent lone wolves. For purposes of discussion, we base our informal assessments of significant differences in results across years on visual comparison of the degree of confidence interval overlap (Cumming and Finch 2005).

RESULTS AND DISCUSSION

Pack and Territory Size

We obtained data on 48 packs that were monitored during all or part of the survey period (April 2019 to April 2020). We obtained territory and winter pack size data from 31 radio-marked wolf packs

(Figure 1). Thirteen additional wolf packs had adequate radiolocation data to delineate territories, but we were unable to obtain mid-winter pack counts, and we obtained pack counts on 4 packs for which there was insufficient data to delineate a territory.

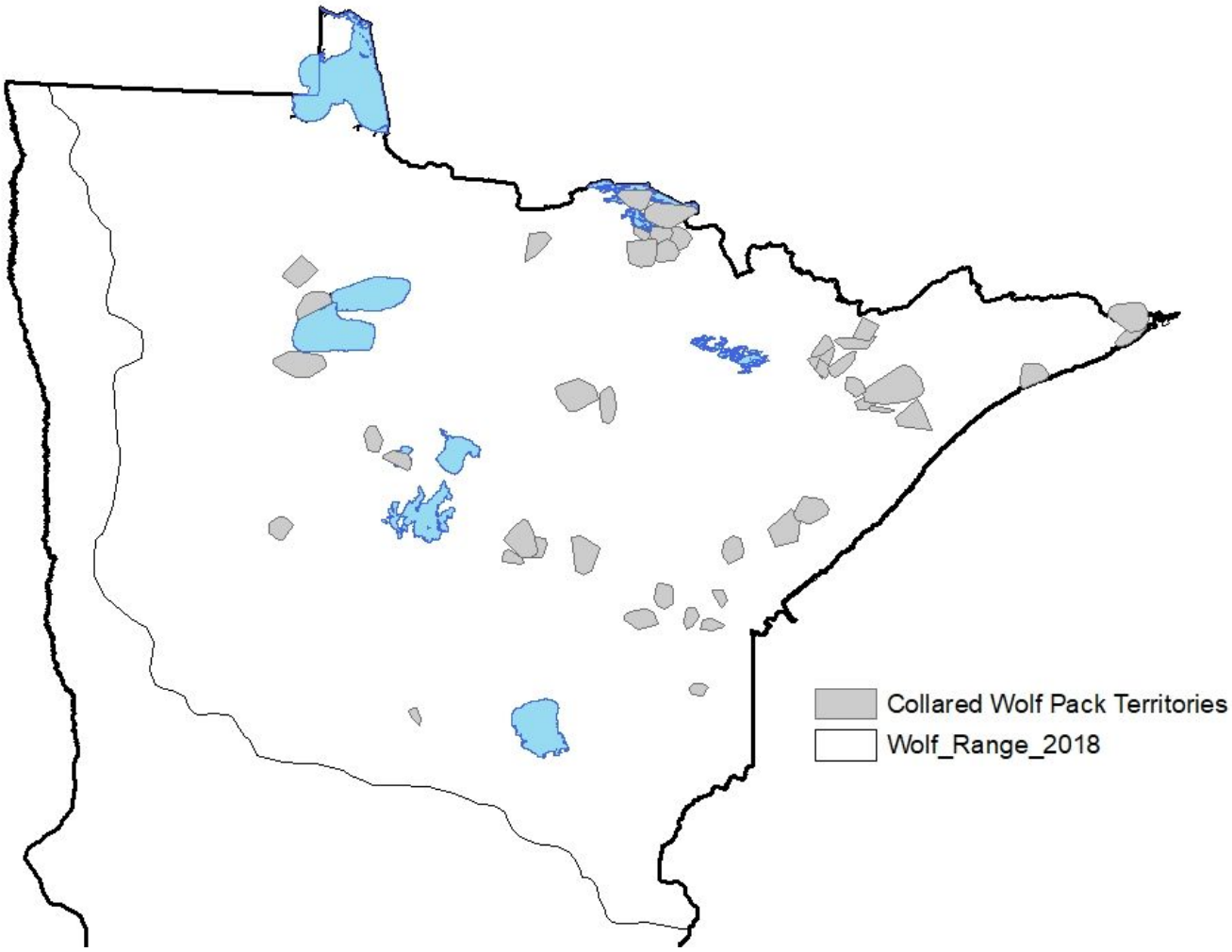

Figure 1. Location of radio-marked wolf packs during the 2019-20 survey.

A land cover comparison using the 2011 National Land Cover Database suggests that the location of collared packs this winter led to some under-representation of cover types classified as woody wetlands (Table 1), likely a result of under-sampling of packs in portions of northwest MN around Red Lake where territories tend to be larger. There was also under-representation of cover types classified as pasture-hay-grassland (Table 1), likely a result of fewer collared packs in our south and southwest study areas where territories tend to be closer to, or smaller than, the statewide average. Using spring 2019 deer density data (MNDNR, unpublished data) for deer hunting permit areas, weighted by number of radio-collared wolf packs in a permit area, we estimate an average of approximately 9.2 deer/mi^2 (pre-fawn) in territories of radio-marked packs during spring 2019. In comparison, 2019 spring deer density for the entirety of occupied wolf range (weighted by permit area) in Minnesota was approximately 13 deer/mi^2.

Table 1. Comparison of land cover[a] in territories of radio-collared wolf packs with land cover in all of occupied wolf range in Minnesota.

	Overall Occupied Wolf range	Radio-collared Wolf Territories
Land Cover Category	% Area	% Area
Woody Wetlands	32.6	31.5
Deciduous Forest	23.6	21.4
Emergent Herbaceous Wetlands	9.9	5.3
Mixed Forest	7.2	11.2
Evergreen Forest	7.0	12.7
Open Water	5.4	6.4
Shrub/Scrub	4.5	6.8
Pasture/Hay/Grassland/Crops	7.7	2.9
Developed, All	2.2	1.8

[a] Land cover data derived from the 2011 National Land Cover Database

The point estimate for average territory size in winter 2019-20 declined 21% from the previous winter. This represents a marginally significant decline and the lowest point estimate for average territory size since surveys began (Figure 2). After applying the territory scaling factors, average estimated territory size for radio-marked packs during the 2019-20 survey was 117 km^2 (range = 33 – 378 km^2).

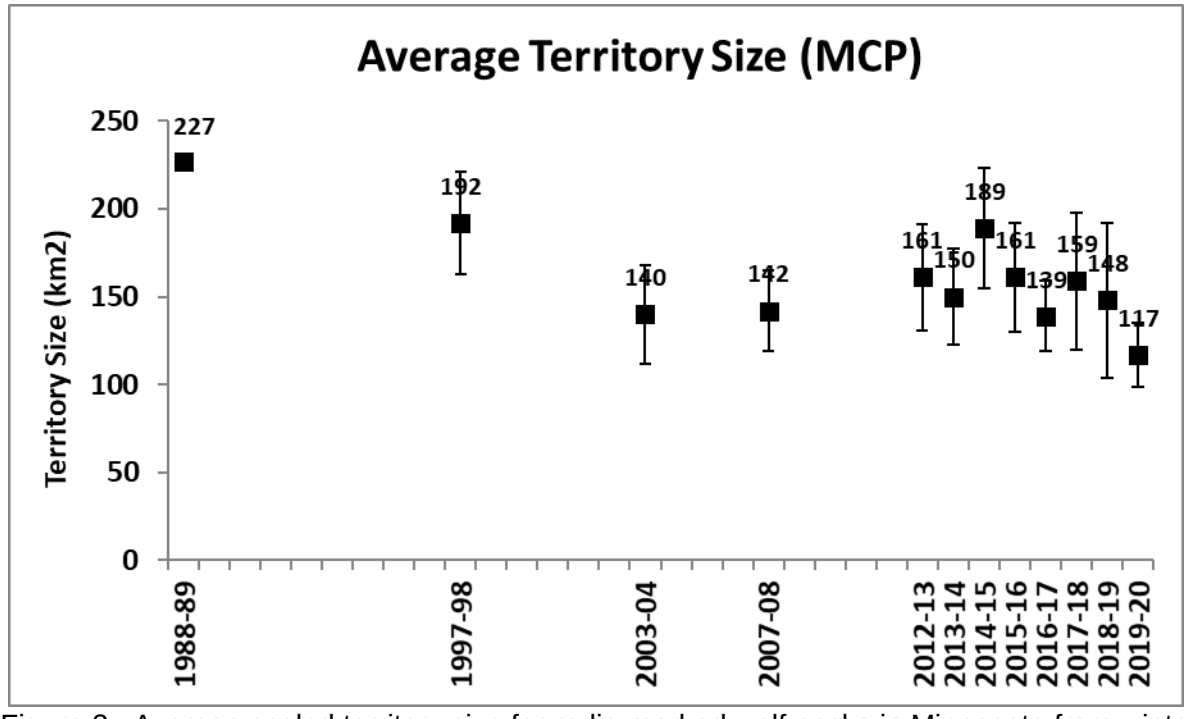

Figure 2. Average scaled territory size for radio-marked wolf packs in Minnesota from winter 1988-89 to 2019-20.

The point estimate for average winter pack size also declined by 21%, a significant decline and the lowest average pack size since surveys began. Average winter pack size in 2019-20 was estimated to be 3.6 (range = 2 – 7, Figure 3).

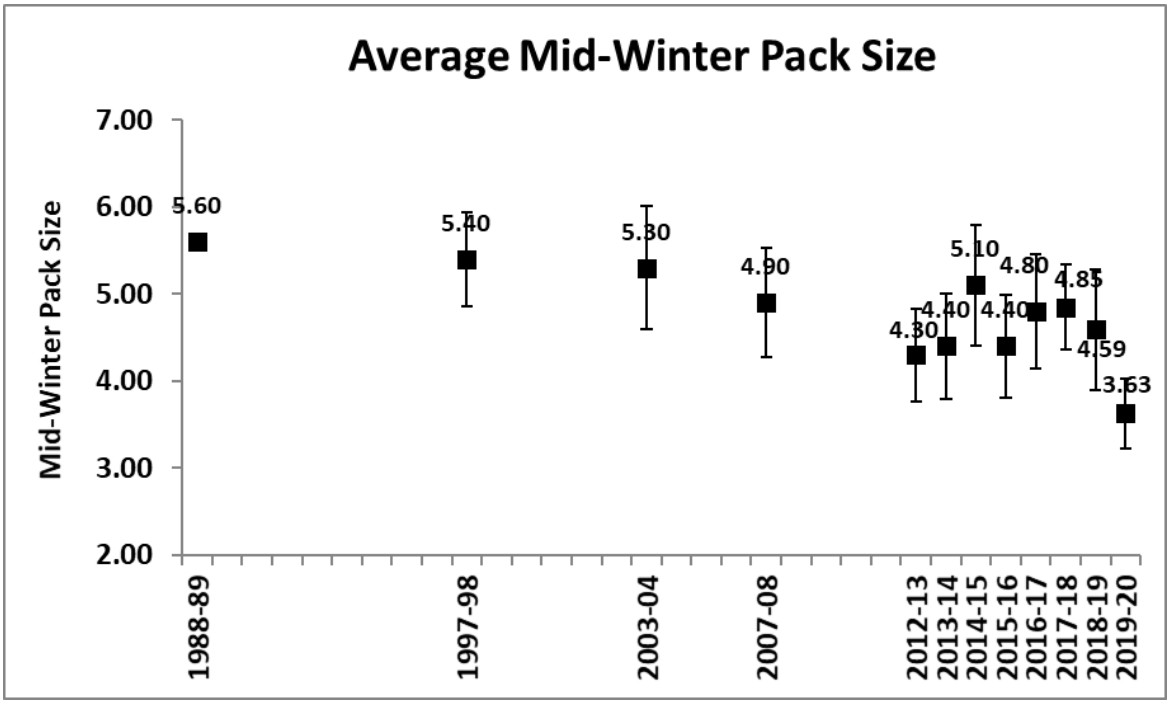

Figure 3. Average mid-winter pack size for radio-marked wolf packs in Minnesota from winter 1988-89 to 2019-20.

Wolf Numbers

Given an average territory size of 117 km^2 and assuming occupied range has not changed since the 2017-18 survey (73,972 km^2; Erb et al. 2018), we estimated a total of 631 wolf packs in Minnesota during winter 2019-20. Although also influenced by the estimated amount of occupied range, trends in the estimated number of packs are inversely correlated with trends in estimated territory size (i.e., for a given amount of occupied range, increases in average territory size yield lower estimates of the number of packs within the state).

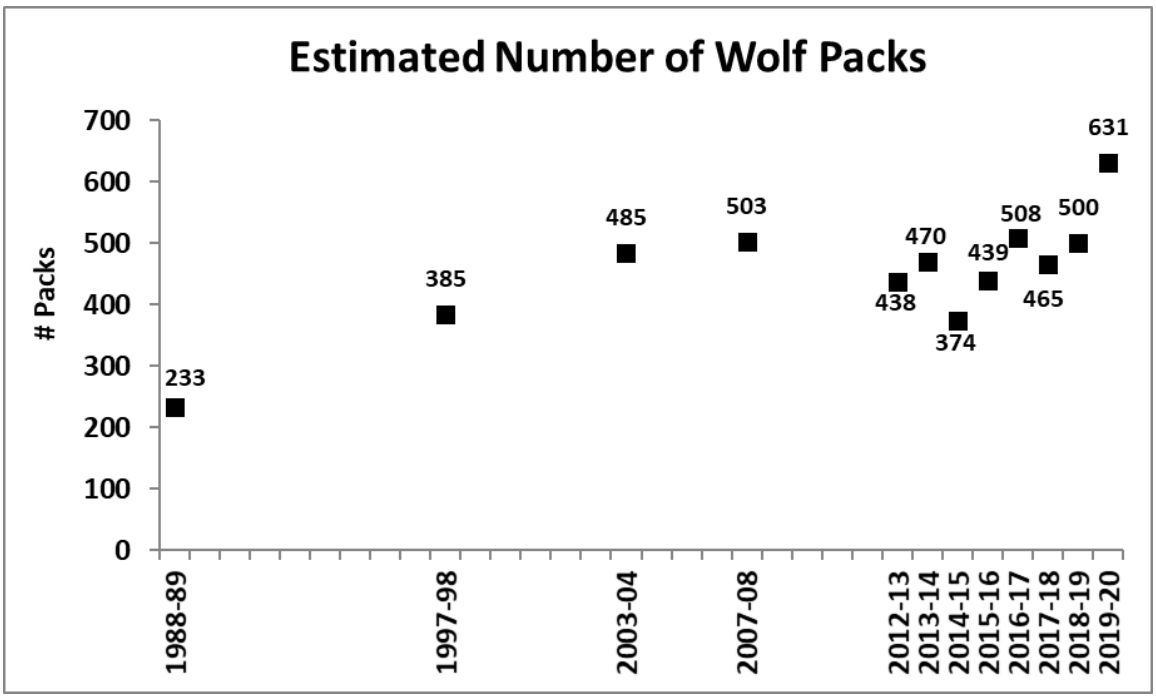

Figure 4. Estimated number of wolf packs in Minnesota at periodic intervals from winter 1988-89 to 2019-20.

After accounting for the assumed 15% lone wolves in the population, we estimated the 2019-20 mid-winter wolf population at 2,696 wolves, or 3.64 wolves per 100 km^2 of occupied range. The 90% confidence interval was approximately +/- 500 wolves, specifically 2,244 to 3,252. Given the nearly complete overlap with the 2019-20 confidence interval, we conclude that the 2019-20 statewide wolf population size was unchanged from the previous winter, but with results suggesting more but smaller packs.

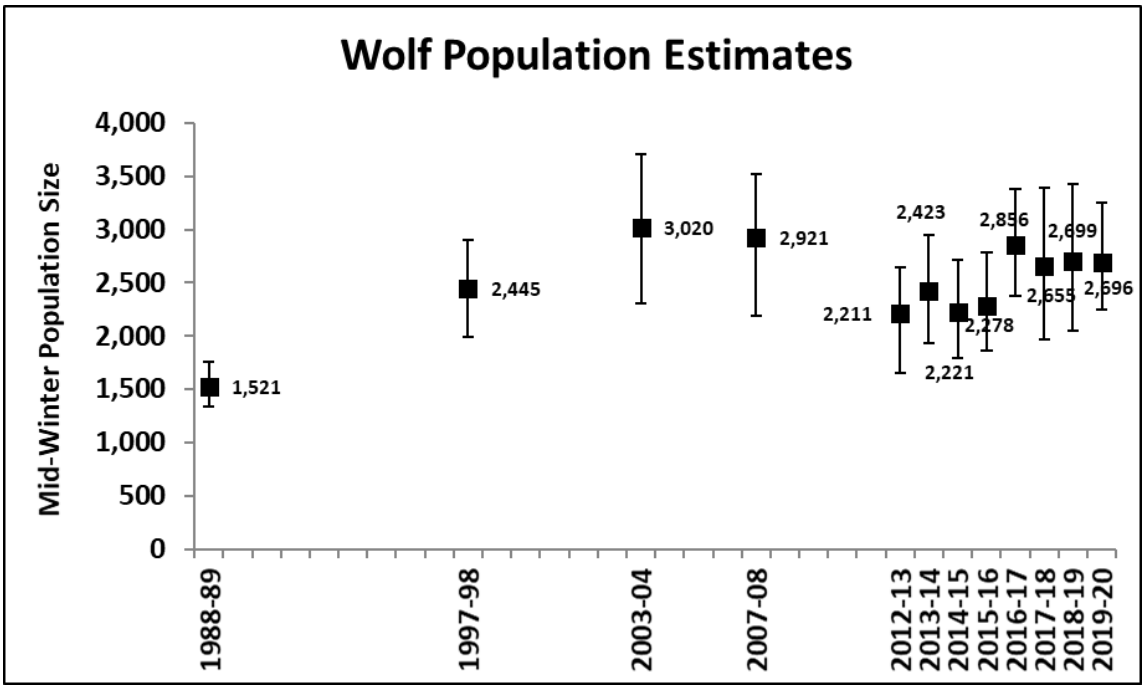

Figure 5. Wolf population estimates from periodic standardized surveys in Minnesota from winter 1988-89 to 2019-20.

From spring 2018 to spring 2019, overall average deer density within wolf range remained stable. Over the past 8 years, the trend in winter wolf population size has been positively correlated with average deer density within wolf range the preceding spring (Figure 6).

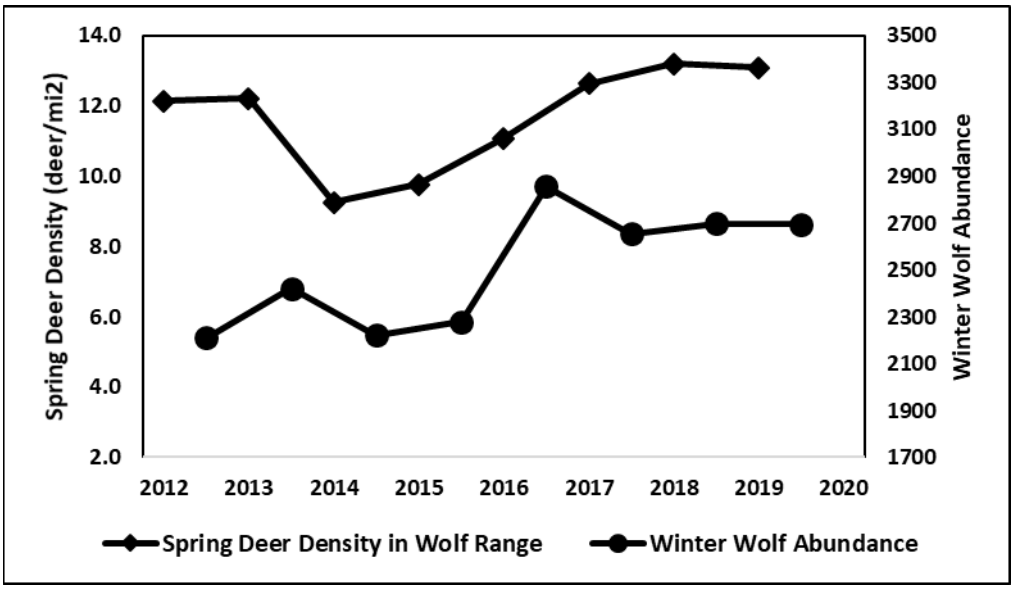

Figure 6. Comparison of estimated spring (pre-fawn) deer density and winter wolf abundance in Minnesota, 2012-2019.

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