MINNESOTA WOLF POPULATION UPDATE 2017

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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 minimal change in the total amount of land occupied by wolf packs.

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. Herein we provide an update of population status from the 2016-17 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, since the 2012-13 survey we have assumed that occupied range has remained unchanged (i.e., 70,579 km^2; Erb and Sampson 2013) and tentatively plan to re-evaluate occupied range at 5-year intervals.

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. Twenty-five wolves have also been captured with the use of live-restraining neck snares, 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, while 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=7; mean number of radiolocations = 32), we multiplied each estimated territory size by 1.37 as in the past. For packs with > 100 radiolocations (n = 30; mean number of radiolocations = 2,013), 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,

$N = ((km^2 \text{ of occupied range}/\text{mean scaled territory size}) * \text{mean pack size})/0.85$.

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.

RESULTS AND DISCUSSION

Pack and Territory Size

A total of 39 packs were monitored during all or part of the survey period (April 2016 to April 2017). We obtained territory and winter pack size data from 30 radio-marked wolf packs (Figure 1). Seven 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 2 packs for which there was insufficient data to delineate a territory.

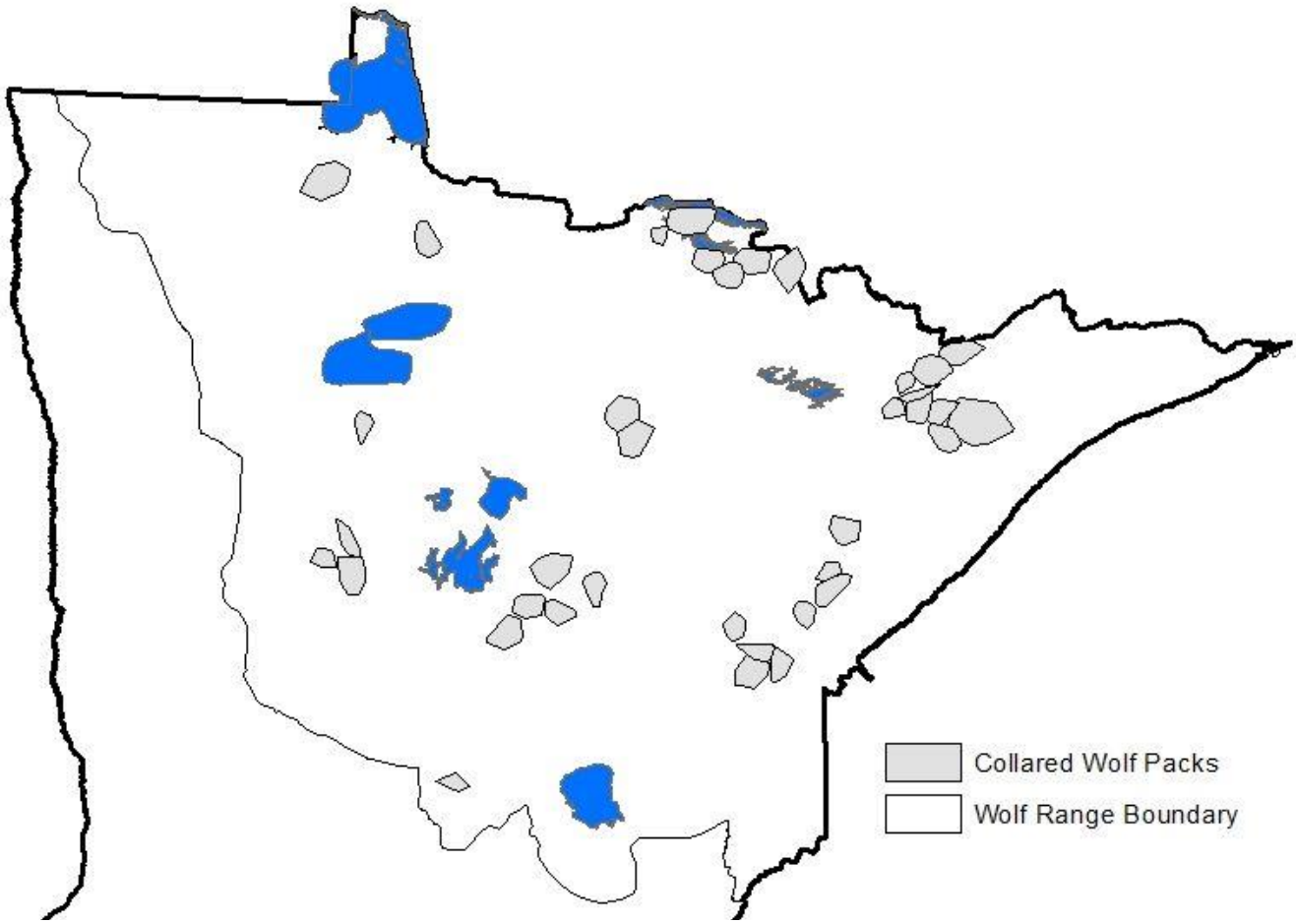

Figure 1. Location of radio-marked wolf packs during the 2016-17 survey.

Comparison of land cover type proportions within territories of collared packs with proportions throughout wolf range suggests that habitat within collared pack territories was representative of cover types throughout wolf range (Table 1; Chi-square $p = 0.7$; 8 df). Using spring 2016 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 11 deer/mi^2 (pre-fawn) in territories of radio-marked packs at the beginning of the biological year in which the survey was conducted. In comparison, 2016 spring deer density for the entirety of occupied wolf range (weighted by permit area) in Minnesota was approximately 12 deer/mi^2. Considering both cover type and deer density, we believe that key conditions within marked pack territories last winter sufficiently approximated conditions within overall wolf range.

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	29.0
Deciduous Forest	23.6	25.3
Emergent Herbaceous Wetlands	9.9	7.0
Mixed Forest	7.2	8.8
Evergreen Forest	7.0	11.5
Open Water	5.4	8.1
Shrub/Scrub	4.5	6.1
Pasture/Hay/Grassland/Crops	7.7	2.5
Developed, All	2.2	1.7

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

The point estimate for average territory size this winter declined 14% from last winter and was the lowest since surveys began. However, with the exception of comparison to the 2014-15 estimate, average territory size this winter was not significantly different from estimates obtained after 1998 (Figure 2). After applying the territory scaling factors, average estimated territory size for radio-marked packs during the 2016-17 survey was 139 km^2 (range = 53 – 437 km^2).

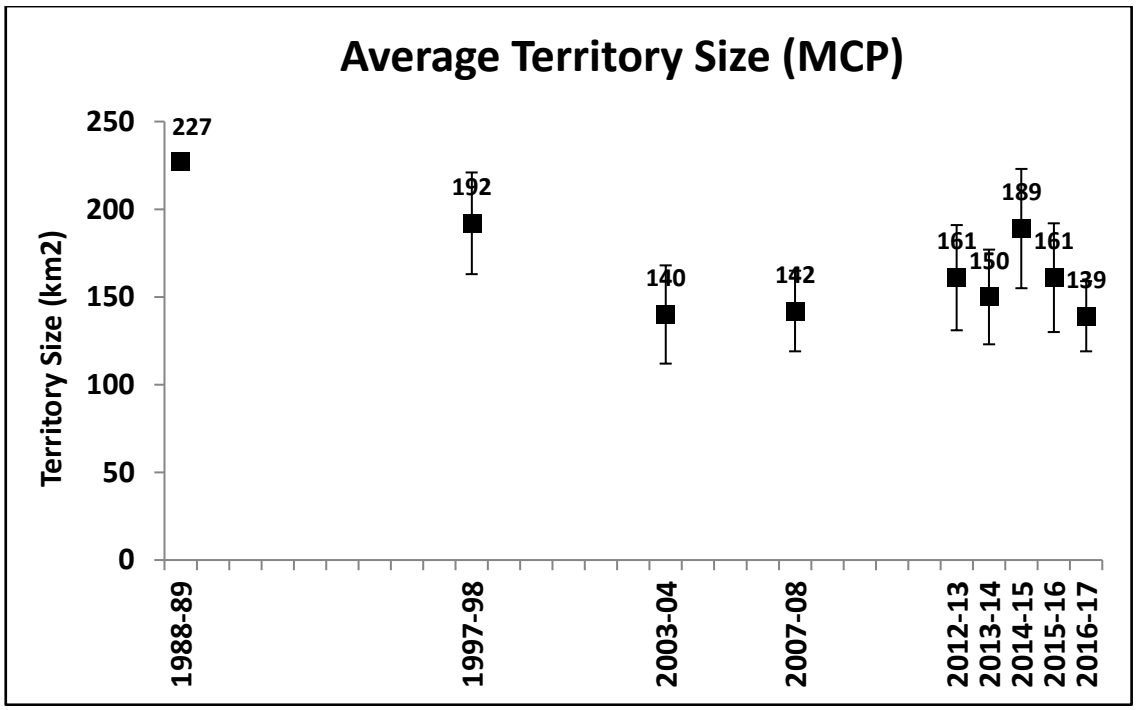

Figure 2. Average scaled territory size for radio-marked wolf packs in Minnesota from 1989 to 2017.

The point estimate for average winter pack size increased 9% from last winter, but the confidence interval widely overlaps those from the previous 5 surveys. Average winter pack size in 2016-17 was estimated to be 4.8 (range = 2 – 8, Figure 3).

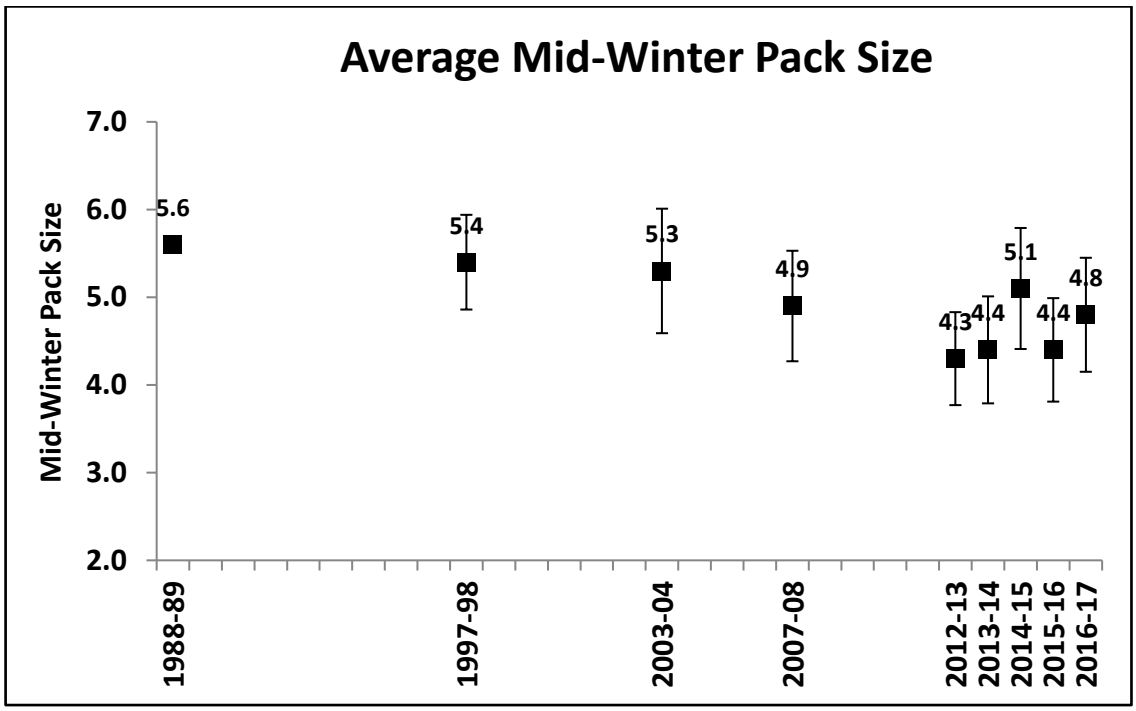

Figure 3. Average mid-winter pack size for radio-marked wolf packs in Minnesota from 1989 to 2017.

Wolf Numbers

Given an average territory size of approximately 139 km^2 and assuming occupied range has not changed since the 2012-13 survey (70,579 km^2; Erb and Sampson 2013), we estimated a total of 508 wolf packs in Minnesota during winter 2016-17. Although also influenced by the estimated amount of occupied range, trends in the estimated number of packs (Figure 4) are generally the inverse of trends in estimated territory size (Figure 2).

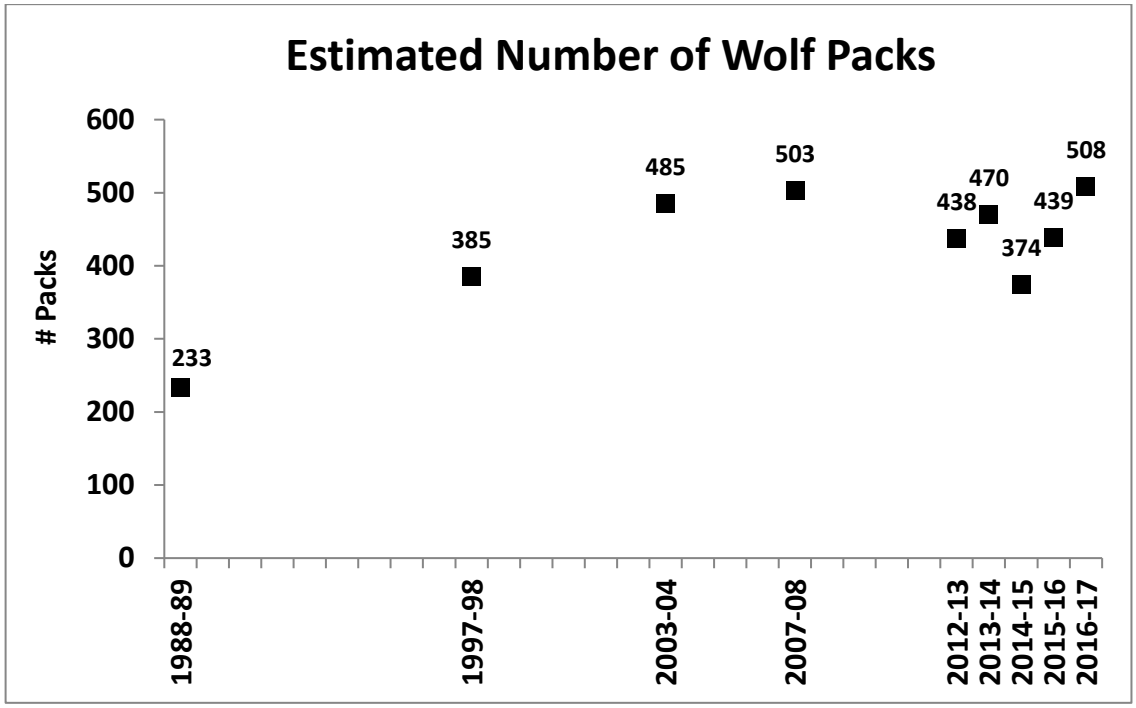

Figure 4. Estimated number of wolf packs in Minnesota at periodic intervals from 1989 to 2017.

After accounting for the assumed 15% lone wolves in the population, we estimated the 2016-17 mid-winter wolf population at 2,856 wolves, or 4.0 wolves per 100 km^2 of occupied range. The 90% confidence interval was approximately +/- 500 wolves, specifically 2,371 to 3,382. Comparison of point estimates from 2015-16 and 2016-17 suggests a 25% increase in the wolf population to levels similar to that estimated during the 2003 and 2007 surveys. Although there is some overlap with the 2015-16 confidence interval, a comparison of differences among the 2015-16 and 2016-17 bootstrap replicates results in 2016-17 population estimates being greater for 92% of the samples. We conclude that the 2016-17 statewide wolf population increased from the previous winter, consistent with expectations arising from a growing prey base over the past 2 years.

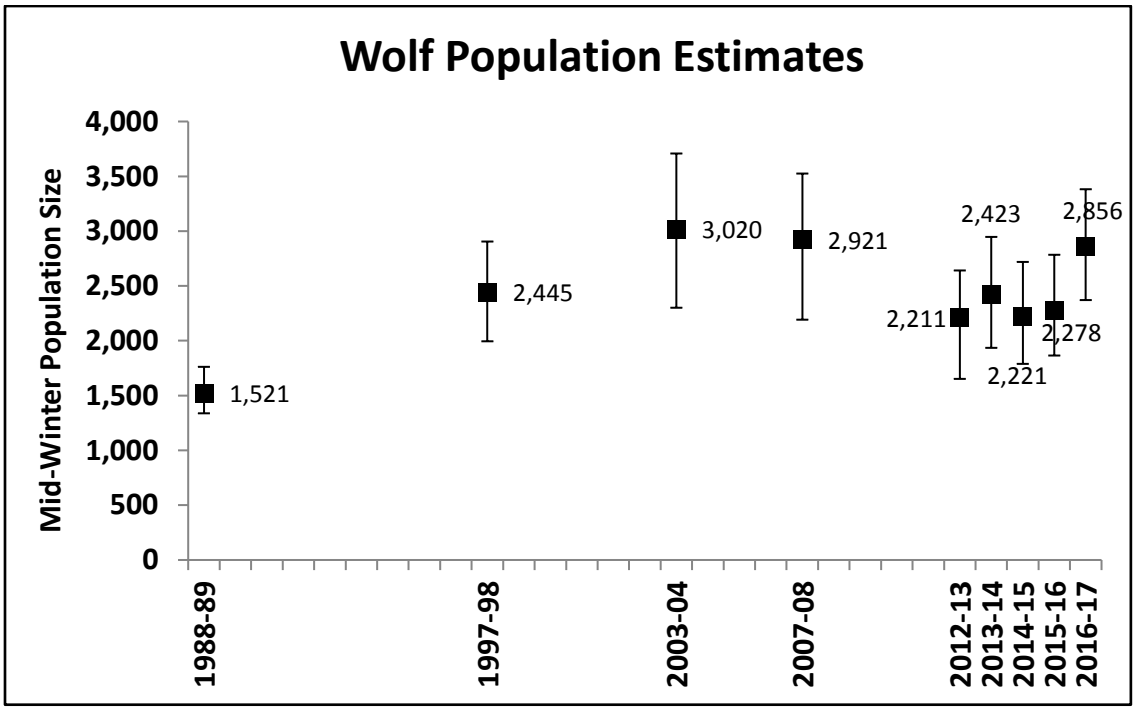

Figure 5. Wolf population estimates from periodic standardized surveys in Minnesota from 1989 to 2017.

From spring 2015 to spring 2016, deer density within wolf range is estimated to have increased approximately 22%, and the point estimate for mid-winter wolf density increased by approximately 25%. Over the past 5 years, wolf population estimates have been positively correlated with average deer density within wolf range (Figure 6).

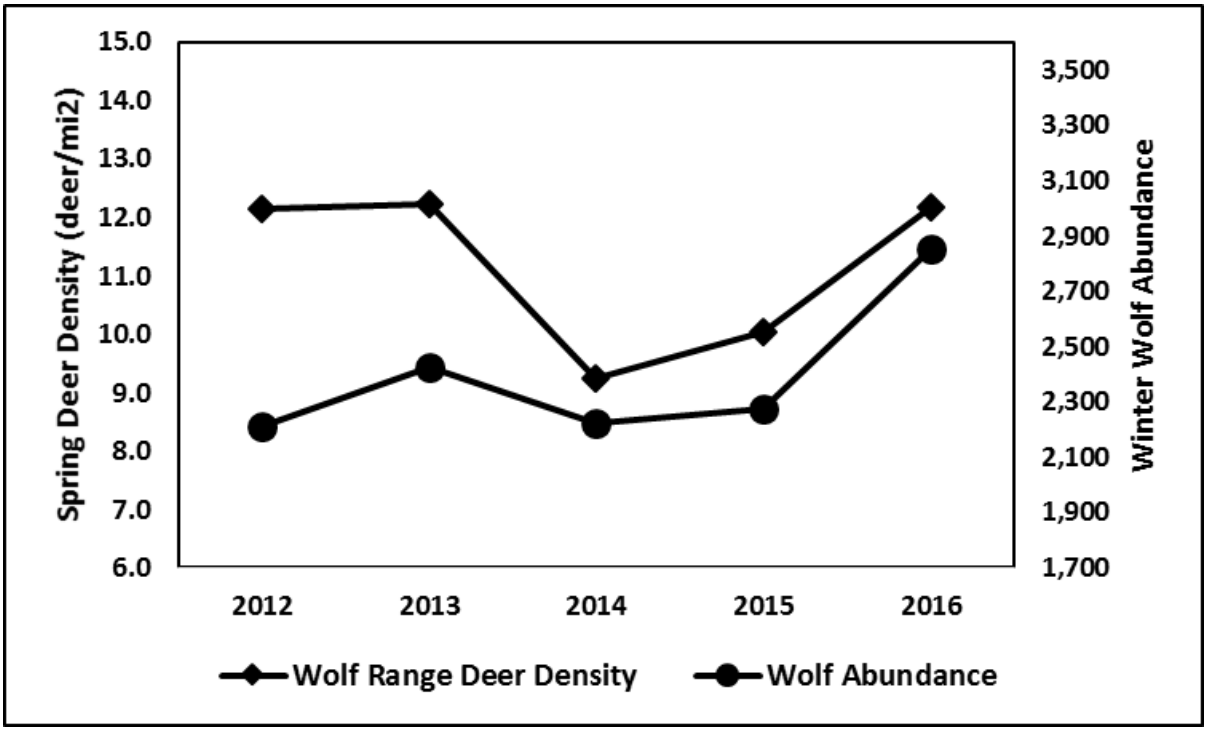

Figure 6. Comparison of estimated pre-fawn deer density and winter wolf abundance in Minnesota, 2012-2016.

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