MINNESOTA WOLF POPULATION UPDATE 2016

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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. Hence, no public harvest season took place during winter 2015-16 and this report provides an update of population status approximately one year since the last public harvest.

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 are much more likely to be an artifact of territory underestimation when there are comparatively sparse radiolocations. Hence, for packs with < 100 radiolocations (n=8; mean number of radiolocations = 35), we multiplied each estimated territory size by 1.37 as in the past. For packs with > 100 radiolocations (n = 34; mean number of radiolocations = 2,107), 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 within the pack 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,

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

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

We obtained territory and winter pack size data from 37 radio-marked wolf packs (Figure 1). Five additional wolf packs had adequate radiolocation data to delineate territories, but we were unable to obtain mid-winter pack counts. Using scaled territory sizes for all packs combined, radio-collared pack territories represented approximately 10% of occupied wolf range.

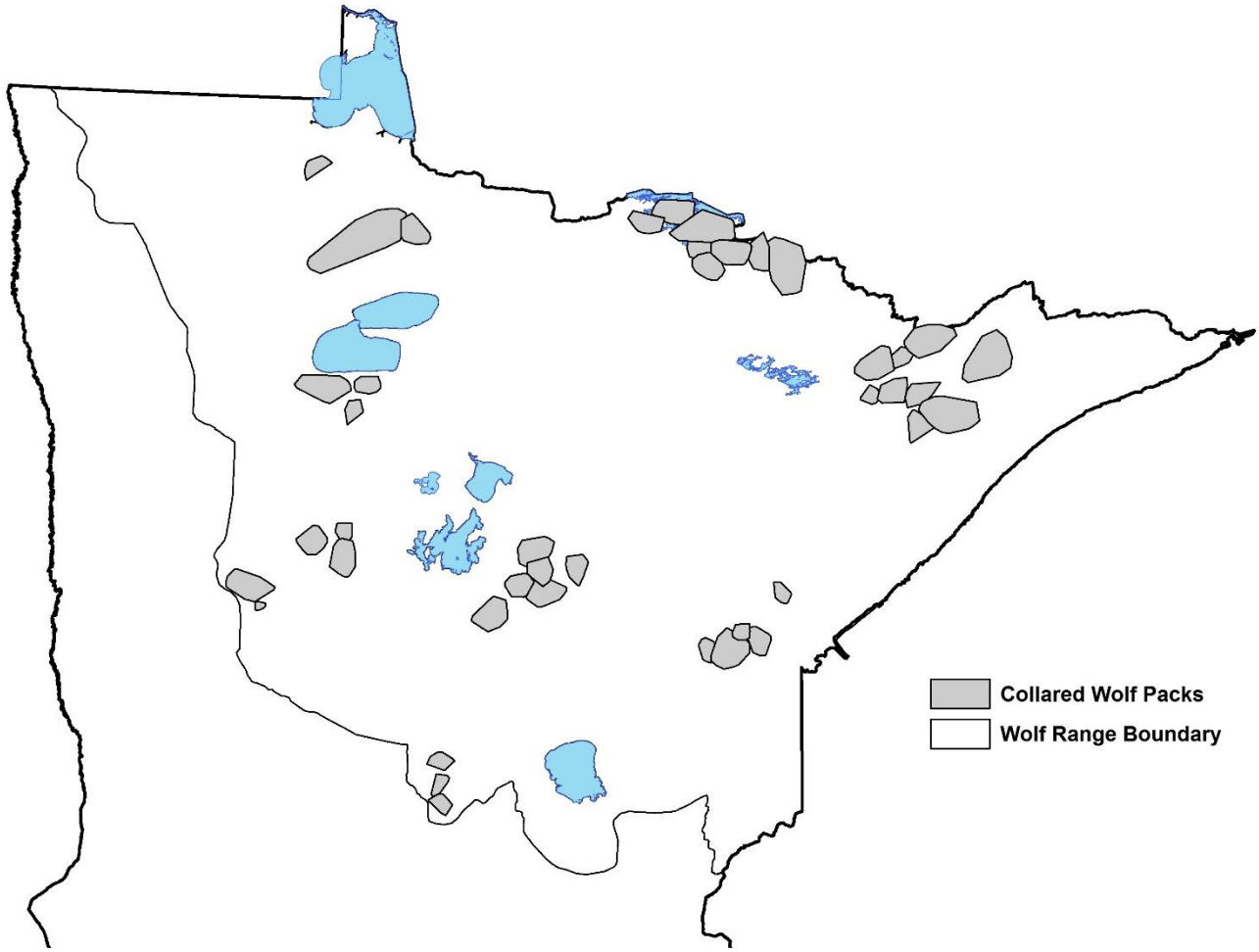

Figure 1. Location of radio-marked wolf packs during the 2015-16 survey.

Comparison of land cover type proportions within territories of collared packs with proportions throughout wolf range suggests differences (Table 1; Chi-square $p < 0.0001$; 8 df) consistent with collaring activities often occurring on forested public land with abundant lakes and less agriculture or human developments. Nevertheless, the 3 cover types contributing most to the significant difference account for less than 20% of overall wolf range. Using spring 2015 deer density data (MNDNR, unpublished data) for deer hunting permit areas, weighted by number of wolf packs in a permit area, we estimate an average of approximately 9.4 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, 2015 spring deer density for the entirety of occupied wolf range (weighted by permit area) in Minnesota was approximately 10.3 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	33	36
Deciduous Forest	24	33
Emergent Herbaceous Wetlands	10	5
Mixed Forest	7	3
Evergreen Forest	7	6
Open Water	5	14
Shrub/Scrub	4	1
Pasture/Hay/Grassland/Crops	8	1
Developed, All	2	1

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

After a marginally significant increase in territory size last year, territory size this winter was similar to the 2012-13 and 2013-14 averages (Figure 2). After applying the territory scaling factors, average estimated territory size for radio-marked packs during the 2015-16 survey was 161 km^2 (range = 15 – 666 km^2).

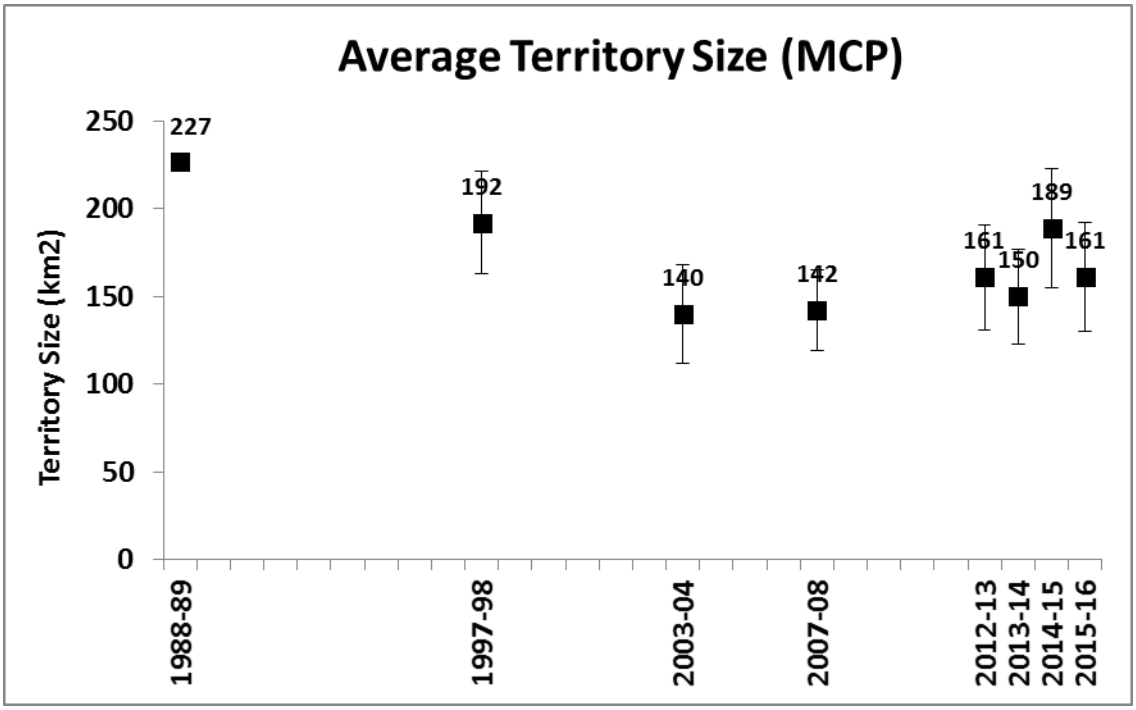

Figure 2. Average scaled territory size for radio-marked wolf packs in Minnesota from 1989 to 2016.

Similar to territory size, after a marginally significant increase in average pack size during winter 2014-15, average pack size in 2015-16 (4.4; range = 2 – 10, Figure 3) was similar to that observed during the 2012-13 and 2013-14 surveys.

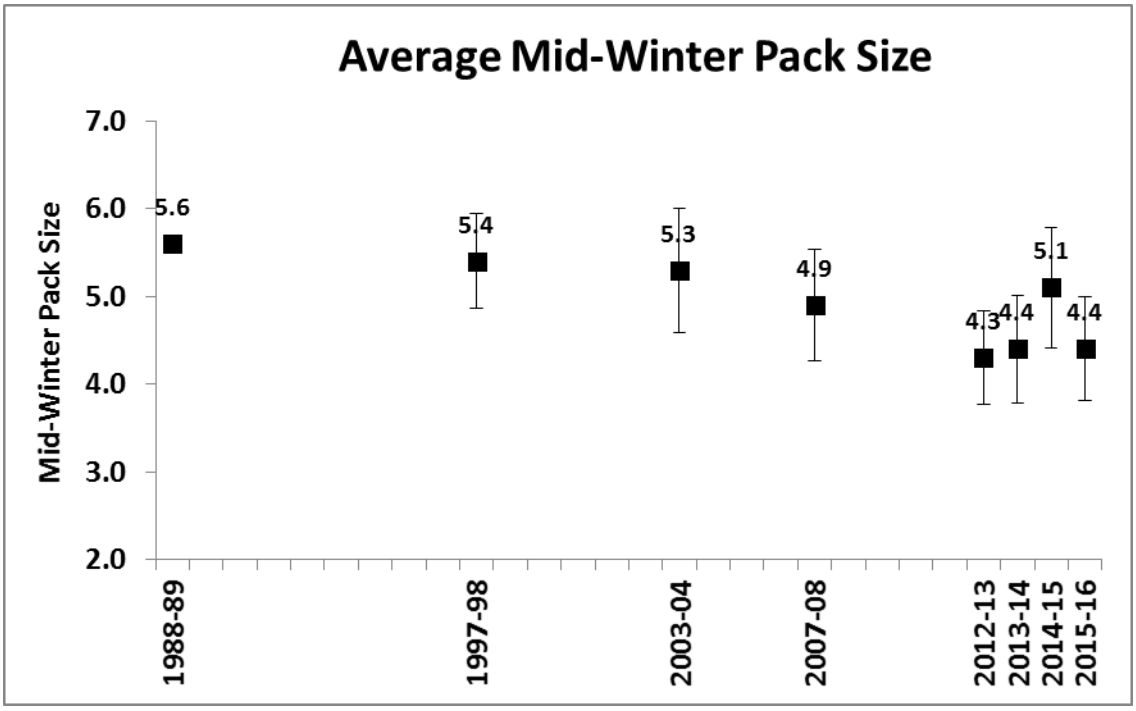

Figure 3. Average mid-winter pack size for radio-marked wolf packs in Minnesota from 1989 to 2016.

Wolf Numbers

Given an average territory size of approximately 161 km^2 and assuming occupied range has not changed since 2013 (70,579 km^2; Erb and Sampson 2013), we estimated a total of 439 wolf packs in Minnesota during winter 2015-16. 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).

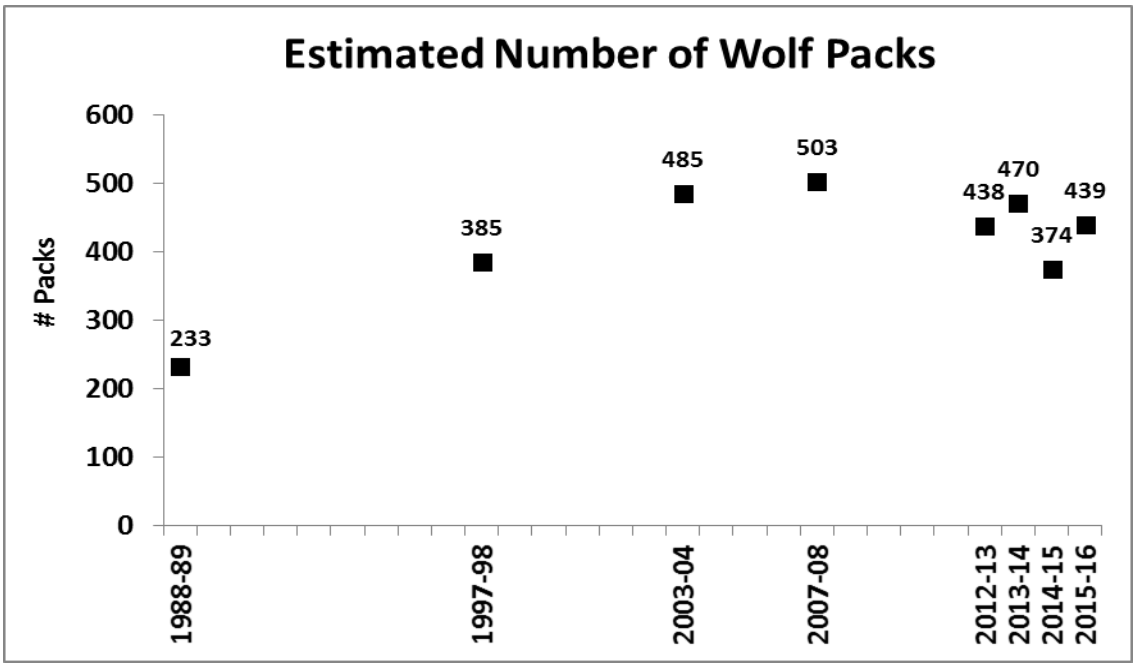

Figure 4. Estimated number of wolf packs in Minnesota at periodic intervals from 1989 to 2016.

After accounting for the assumed 15% lone wolves in the population, we estimated the 2015-16 mid-winter wolf population at 2,278 wolves, or 3.2 wolves per 100 km^2 of occupied range. The 90% confidence interval was approximately +/- 450 wolves, specifically 1,865 to 2,784. Given the very small changes in recent population estimates and substantial overlap in their confidence intervals, we conclude there has been no biologically or statistically significant change in the size of the statewide mid-winter wolf population over the past 4 years.

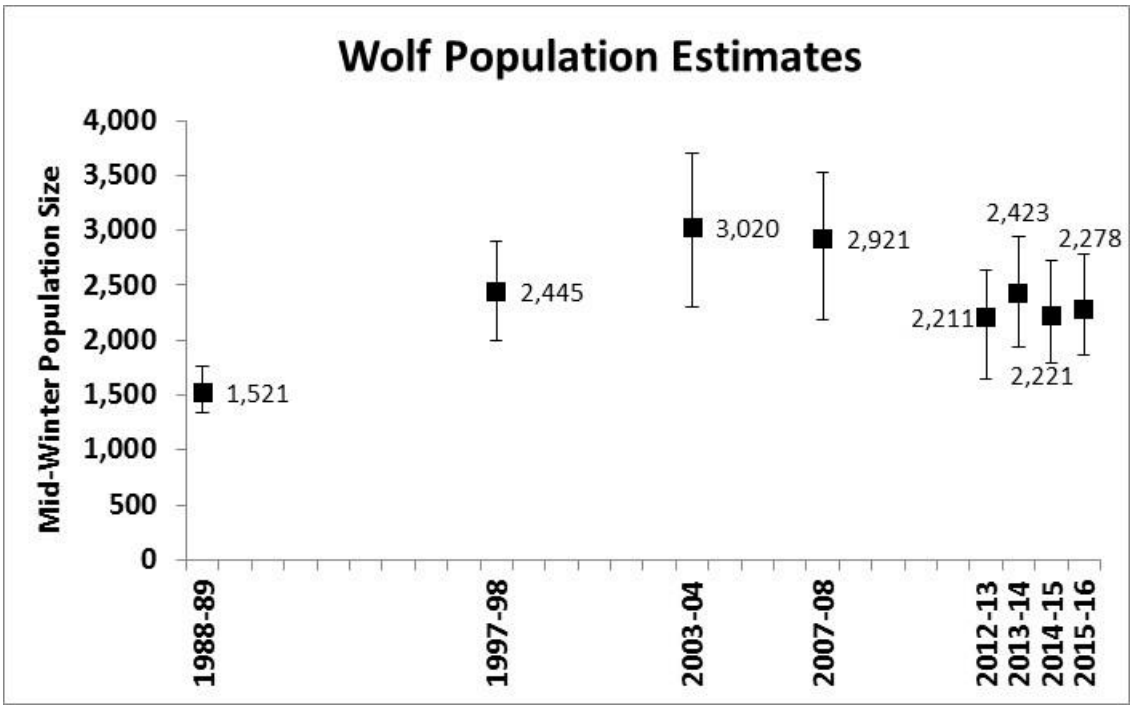

Figure 5. Wolf population estimates from periodic standardized surveys in Minnesota from 1989 to 2016.

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