MINNESOTA WOLF POPULATION UPDATE 2014

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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 ~10-year intervals (1978, 1988, 1997), then at ~ 5-year intervals thereafter (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 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 5 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. They estimated the wolf population at 2,211 (90% CI = 1,652 – 2,641), a 24% decline compared to the 2007-08 survey. The decline since 2007 was attributed to reduced prey populations, a record number of wolves removed for depredation control in 2012, and a public harvest that removed 413 wolves in the 2 months just prior to mid-winter pack counts that were conducted as part of the 2012-13 survey.

Because a post-harvest population is always temporarily reduced to a level below that which would otherwise have occurred in the absence of harvest, Erb and Sampson (2013) noted that the 2007-08 population estimate was more directly comparable to the pre-hunt wolf population in 2012-13, a comparison which indicated the wolf population had likely declined by 10% between 2007 and pre-hunt 2012. Although many natural and anthropogenic factors influence wildlife populations annually, assessment of any long-term population effects of a public harvest requires population estimates in subsequent years when post-hunt estimates could be directly compared.

As a result of changes in wolf management, it was deemed desirable to increase the frequency of population surveys to better inform decisions regarding wolf harvest and management. Although a more comprehensive evaluation of wolf monitoring methods and optimal survey frequency continues, short-term plans are to estimate population size on an annual basis using methods similar to past surveys. This update summarizes the results of the 2013-14 winter survey.

METHODS

The methodology used to estimate wolf population size in Minnesota requires 3 primary pieces of information: 1) an estimate of the number of square kilometers 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, average territory size changes at intermediate timescales, with average mid-winter pack size potentially fluctuating to the greatest degree on an annual basis. As such, for the 2013-14 survey we assumed that occupied range had remained unchanged from that estimated during the 2012-13 survey (i.e., 70,579 km^2; Erb and Sampson 2013).

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. Two wolves were also captured with the use of live-restraining neck snares. Captured wolves were typically immobilized using a mixture of either Ketamine:Xylazine or Telazol:Xylazine. After various project-specific wolf samples and measurements were obtained, an antibiotic and the antagonist Yohimbine 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 from 3-6 locations per day, while wolves fitted with VHF-only radio-collars were relocated at approximately 7-10 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 ~ 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.

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=18; mean number of radiolocations = 30), we multiplied each estimated territory size by 1.37 as in the past. For packs with > 100 radiolocations (n = 22; mean number of radiolocations = 806), territories were assumed fully delineated and 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 some cases (n = 6 packs) where visual observations were insufficient, we relied on estimates of pack size based on tracks observed in the snow within the pack territory. If snow-track counts produced uncertain estimates (e.g., 4 – 5 wolves), we used the lower estimate. Overall, most counts are assumed to represent minimum known mid-winter pack size.

The estimated number of packs within occupied wolf range is calculated 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.

RESULTS AND DISCUSSION

Pack and Territory Size

We obtained territory and winter pack size data from 37 radio-marked wolf packs (Figure 1). Three 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, collared pack territories represented ~ 9% of occupied wolf range.

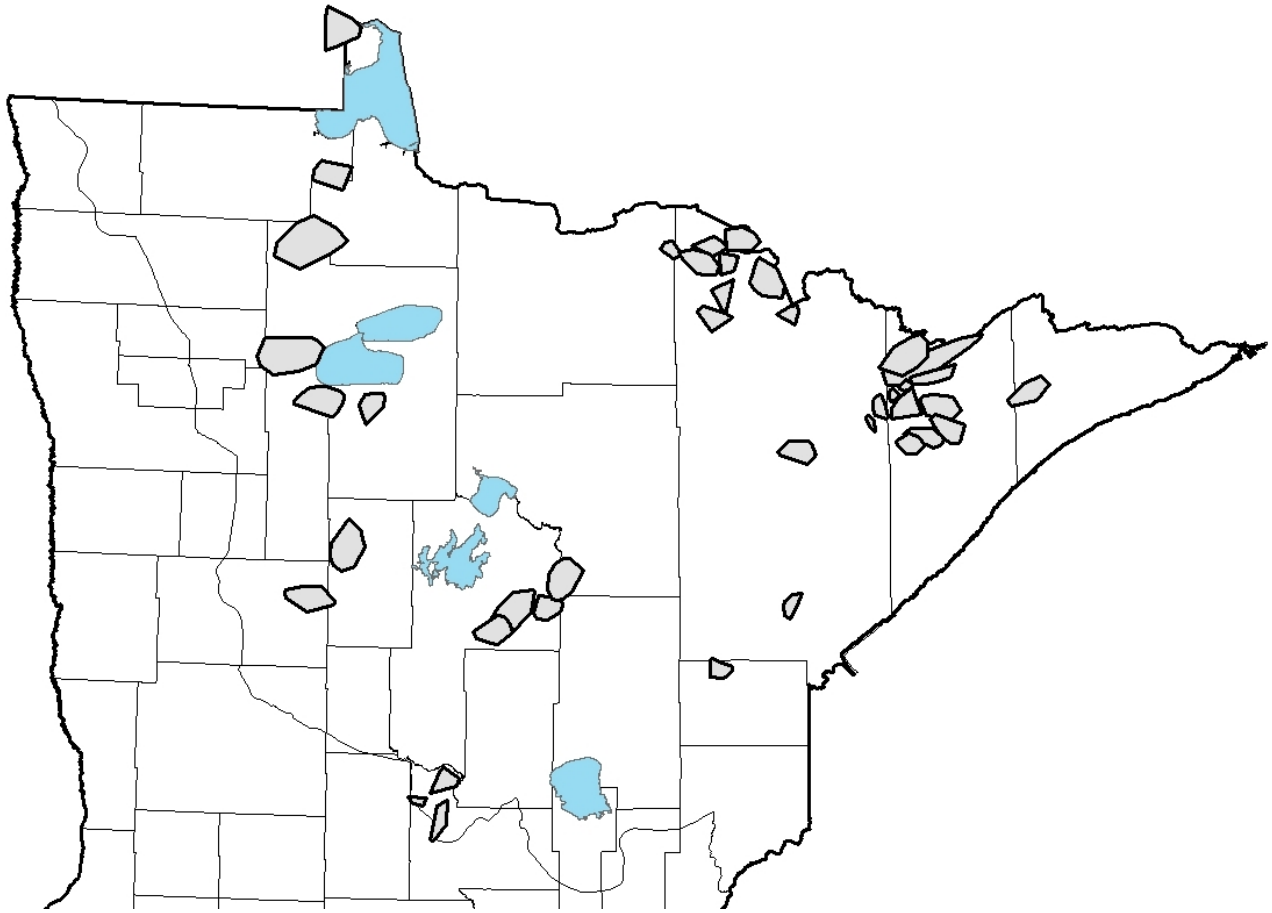

Figure 1. Location of radio-marked wolf packs during the 2013/14 survey.

A land cover comparison using the 2006 National Land Cover Database suggests that land cover within territories of radio-marked packs used in the survey was reasonably representative of land cover throughout the entirety of occupied wolf range in Minnesota. However, for the top 5 cover types, representing ~ 82% of occupied range, results indicate territories of collared wolf packs included more mixed and conifer forest and herbaceous wetlands, and less woody wetlands than expected from overall wolf range (Table 1). Using spring 2013 deer density data (Grund 2013) for deer hunting permit areas, weighted by number of wolf packs in a permit area, we estimate an average of ~ 8.3 deer/mi^2 in territories of radio-marked packs at the beginning of the biological year in which the survey was conducted. In comparison, 2013 spring deer density for the entire forest zone of Minnesota, a close approximation of wolf range, was ~10.8 deer/mi^2 in spring 2013. Collectively, we believe that 'conditions' within marked pack territories were a reasonable representation of overall wolf range, but acknowledge some potential bias with respect to land cover types and deer density.

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	33.088	27.273
Deciduous Forest	23.824	23.527
Emergent Herbaceous Wetlands	9.674	11.472
Mixed Forest	7.649	9.011
Evergreen Forest	7.318	10.341
Open Water	5.390	8.231
Shrub/Scrub	3.848	4.293
Pasture/Hay	3.473	1.706
Cultivated Crops	2.892	1.560
Developed, Open Space	1.604	1.221
Grassland/Herbaceous	0.884	1.213
Developed, Low Intensity	0.191	0.084
Barren Land (Rock/Sand/Clay)	0.120	0.053
Developed, Medium Intensity	0.034	0.009
Developed, High Intensity	0.014	0.005

[a] Land cover data derived from the 2006 National Land Cover Database

After applying the territory scaling factors, average estimated territory size for radio-marked packs during the 2013-14 survey was 150.04 km^2 (range = 21 – 477 km^2). Following a decline in average territory size from 1988 – 2003, likely attributable to increasing prey populations and increasing competition among established wolf packs, average territory sizes over the past 10 years (4 surveys) have not exhibited any notable trends (Figure 2).

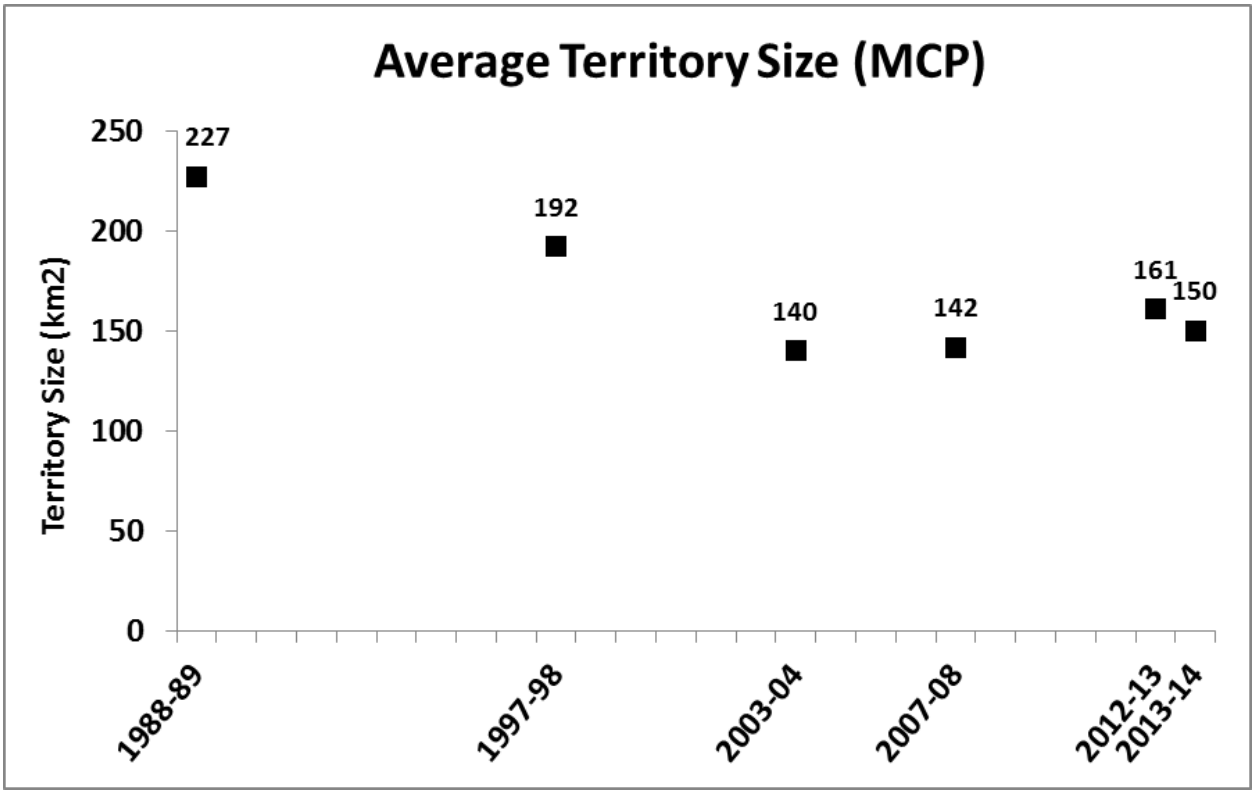

Figure 2. Average scaled territory size for radio-marked wolf packs in Minnesota from 1988 – 2014.

Average pack size appeared to have declined at an increasing rate from 1988 to 2012. However, average pack size during winter 2013-14 was ~4.4 (range = 2 – 11), essentially unchanged from last winter (Figure 3).

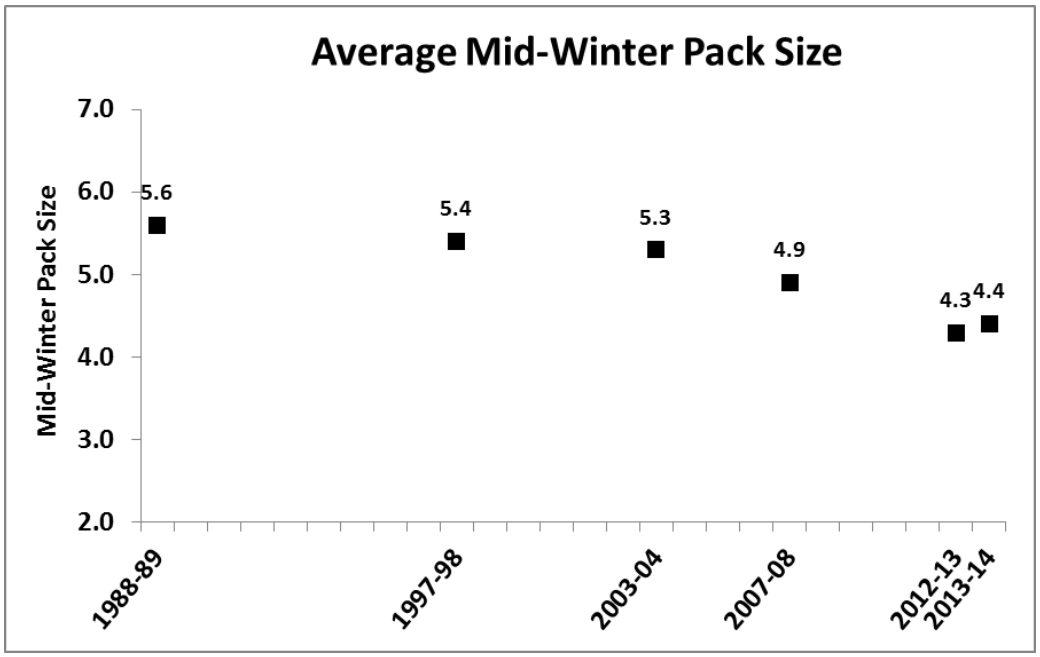

Figure 3. Average mid-winter pack size for radio-marked wolf packs in Minnesota from 1988 – 2014.

Wolf Numbers

Given the average territory size of 150 km^2 and assuming occupied range unchanged since last year (70,579 km^2; Erb and Sampson 2013), we estimate a total of 470 wolf packs in Minnesota. 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).

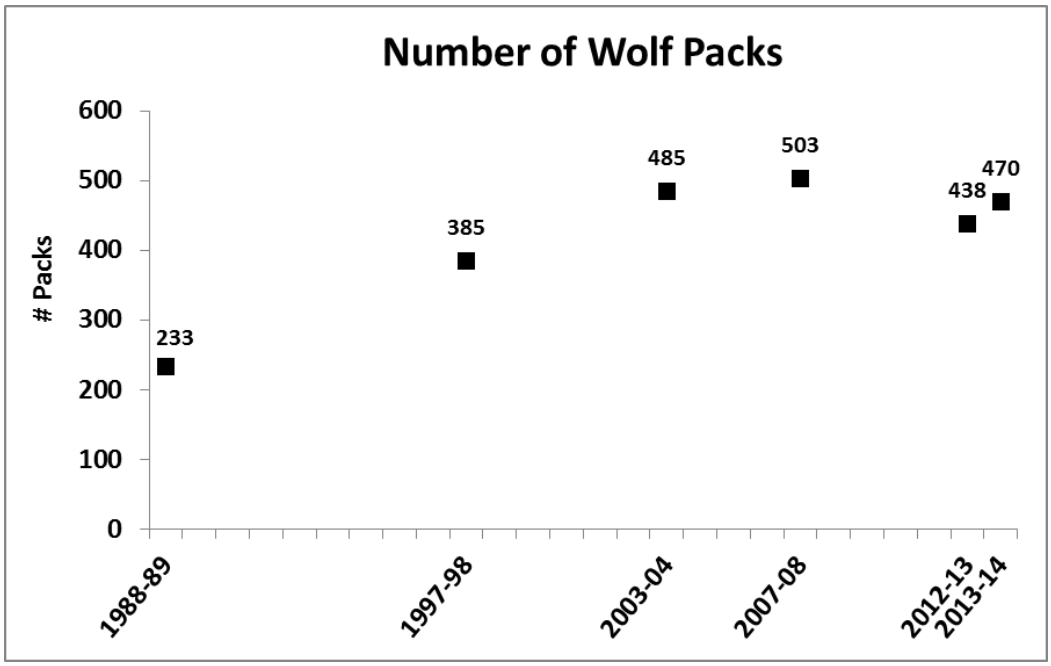

Figure 4. Estimated number of wolf packs in Minnesota at periodic intervals from 1988 – 2014.

After accounting for the assumed 15% lone wolves in the population, we estimate the 2013-14 mid-winter wolf population at 2,423 wolves, or 3.4 wolves per 100 km^2 of occupied range. The 90% confidence interval was approximately +/- 500 wolves, specifically 1,935 - 2,947. Given the substantial overlap with the 2012 confidence interval, we conclude there was no statistically significant change in the wolf population over the past year.

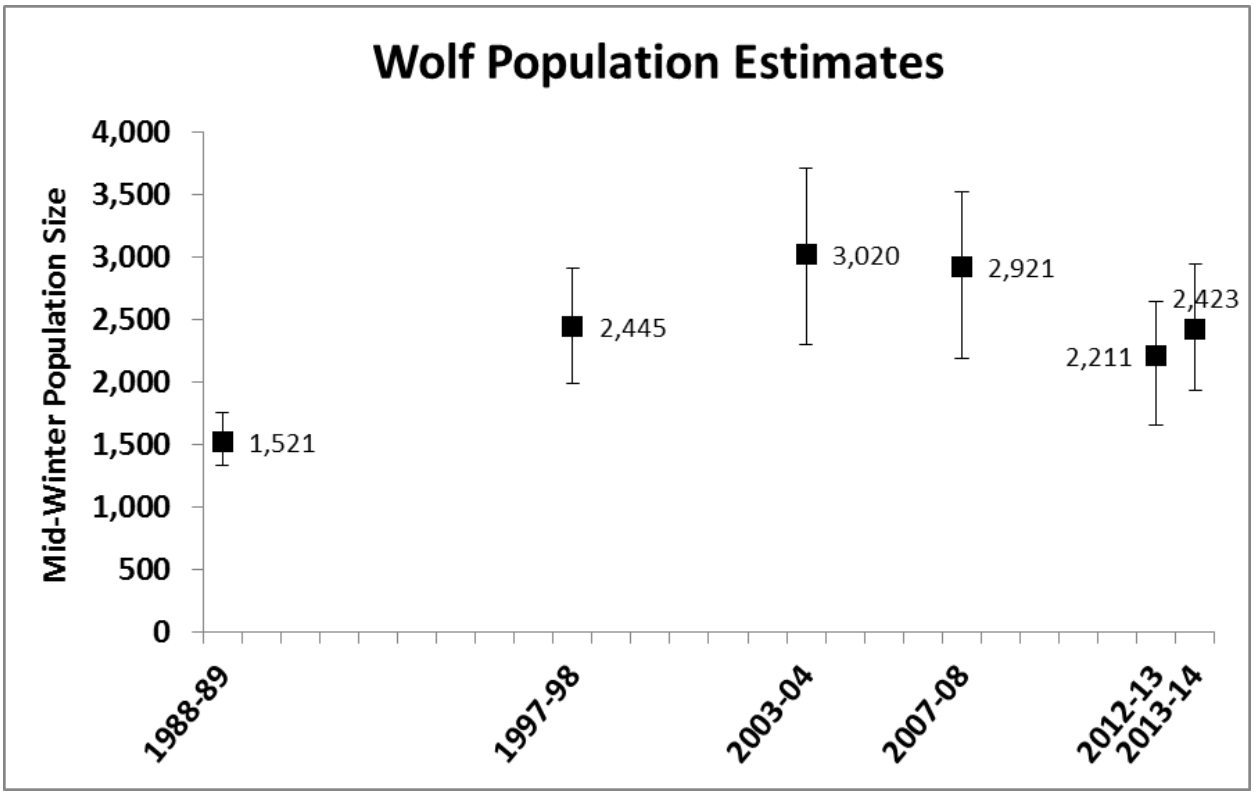

Figure 5. Wolf population estimates from periodic standardized surveys in Minnesota 1988 – 2014.

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