Record High Wolf, *Canis lupus,* Pack Density

L. DAVID MECH[1,3] and SHAWN TRACY[2]

[1]Biological Resources Division, U.S. Geological Survey, Northern Prairie Wildlife Research Center, 8711 - 37th Street, SE, Jamestown, North Dakota 58401-7317 USA
[2]University of Minnesota, Department of Fisheries and Wildlife, 1980 Hodson Hall, St. Paul, Minnesota 55108 USA
[3]The Raptor Center, 1920 Fitch Avenue, University of Minnesota, St. Paul, Minnesota 55108 USA

Mech, L. David, and Shawn Tracy. 2004. Record high Wolf, *Canis lupus*, pack density. Canadian Field Naturalist 118(1): 127-129.

This report documents a year-around Wolf (*Canis lupus*) density of 18.2/100 km^2 and a summer density of 30.8/100 km^2, in a northeastern Minnesota Wolf pack. The previous record was a summer density of 14.1/100 km^2, for a Wolf pack on Vancouver Island, British Columbia, Canada.

Key Words: Wolf, *Canis lupus*, Minnesota, Superior National Forest, White-tailed Deer, *Odocoileus virginianus.*

Wolf (*Canis lupus*) densities are highly variable (Mech 1970), depending generally on prey biomass density (Keith 1983; Fuller 1989). Because prey biomass density is related inversely to latitude, Wolves tend to reach their highest densities at lower latitudes (Mech and Boitani 2003). The highest reported naturally occurring Wolf density is 14.1 Wolves/100 km^2 for a pack of nine Wolves on Vancouver Island (Scott and Shackleton 1982).

Herein we report on a Minnesota Wolf pack with a density higher for two years than the highest density reported elsewhere.

Study area

We studied the Farm Lake Wolf pack (FLP) that inhabited the Superior National Forest (SNF) of northeastern Minnesota where most of the Wolf's diet is White-tailed Deer (*Odocoileus virginianus)*. The Wolf packs in the SNF are spaced into territories (Mech 1973, 1986) and the FLP territory, 10.0 km east of Ely (48°N, 92°W), was surrounded by four or five other pack territories. The terrain, vegetation, and land use in the territory are typical of the surrounding region (Mech 1973). However, during winter, much of the territory encompasses part of the Garden Lake deer yard (Nelson and Mech 1981). Deer densities there in the late 1970s were estimated at 16-23 deer/km^2 (Nelson and Mech 1981), and the deer population in the general area has increased considerably since then (Mech and Nelson 2000).

Methods

Wolves were live-trapped, radio-tagged, aerially radio-tracked weekly when possible, and aerially observed with their packs during winter. Estimates of FLP territory size were made for summer (1 April–30 September), winter (1 October–31 March) and the entire year (1 April–31 March) from 1 October 1997 through 30 March 1999.

We used ArcView (copyrighted) GIS (ESRI Inc., Redlands, California) to estimate each period's territory area corresponding to the combination of all FLP radio-tagged Wolves. UTM coordinates of the FLP Wolf locations were imported into ArcView GIS and converted into point data. Minimum Convex Polygons (Mohr 1947) were then constructed using Animal Movement (Hooge and Eichenlaub 1997) extension to Arcview.

By using observation curve analysis we determined when a territory was defined (Odum and Kuenzler 1955). We subsampled period Wolf locations without replacement, increasing the number of samples (locations) with each subsample treatment, and calculated territory area from each subsample. Five repetitions of each subsample were performed to generate a corresponding mean territory area for each subsample. The mean areas were then plotted against number of locations in the subsample. We considered territories defined when there was ≤1% change in area (suggesting asymptotic behavior) as a result of the addition of one more sample.

We determined pack size through the winter aerial surveys. The greatest number of Wolves seen was considered the pack size. Vegetative cover prevented aerial surveys in summer. Pack sizes were divided by their territory size and then multiplied by 100 to give density in Wolves/100 km^2.

Results

We radio-tagged and tracked adult female Wolf 667 and male pup 673 (born in 1997) from 1 October 1997 through 30 March 1999 for this study (Table 1). A total of 127 Wolf locations were obtained, with one Wolf location defined as when one Wolf was at a point. If both Wolves were together, two locations were recorded. Observation curve analysis suggested that 30 locations were needed to accurately define the winter 1997-1998 FLP territory, 50 samples for the 1998-1999

TABLE 1. Background data for calculations of Wolf density in the Farm Lake Pack, northeastern Minnesota.

Period	Number of Locations	Number of Wolves	Area km^2	Density/100 km^2
1 October 1997 – 30 March 1998	39	4	22.88	17.5
1 April 1998 – 30 September 1998	44	–	19.50	30.8*
1 October 1998 – 30 March 1999	44	6	32.88	18.2
1 April 1998 – 30 March 1999	88	6	32.88	18.2

*Assuming only six Wolves, the number observed during the following winter.

territory, and 30 and 35 samples for the FLP summer and winter periods, respectively. In all these periods, these criteria were met (Table 1).

During winter 1997-1998, the FLP contained four members and used an estimated area of 22.88 km^2, a density of 17.5 Wolves/100 km^2. In winter 1998-1999, six FLP Wolves used an area of 32.88 km^2, a density of 18.2 Wolves/100 km^2, and in summer only 19.5 km^2 for a minimum density of 30.8 Wolves/100 km^2 (Table 1).

Discussion

The Wolf densities we found exceeded the highest previous record of 14.1 Wolves/100 km^2 for a Wolf pack on Vancouver Island (Scott and Shackleton 1982). Hebert et al. (1982), citing the Scott and Shackleton (1982) study, claimed a density of one Wolf per 6.3 km, or 15.9/100 km^2. However, Hebert et al. (1982) included a third pack not mentioned by Scott and Shackleton and presented no territory area data for this pack. Density estimates using radio-locations can be greatly influenced by the number and timing of locations. Our locations were evenly distributed throughout the year and met the observation curve test (Odum and Kuenzler 1955), even though the number of locations available were fewer than recommended by others (Fritts and Mech 1981; Bekoff and Mech 1984; Ballard et al. 1987). No doubt the much smaller size of our territory explains why fewer locations were needed to define it.

It is notable that the previous high record Wolf density (14.1 Wolves/100 km^2) was based only on summer locations during a relatively short period (11 April to 10 September). Furthermore, this period was before when most of the year's mortality occurs (Fuller et al. 2003). Thus the earlier density is not strictly comparable to either our year-around or winter densities.

The extraordinarily small FLP territory areas of 1997-1998 and 1998-1999 resulted in the highest documented Wolf density to date. This density was no doubt related to the high winter deer density in the area as well as to the relatively harsh winters during that period, with deep snow and extreme cold, that would have caused deer to concentrate with greater density. We know of no garbage dump or other regular source of food in this territory.

Even so, our highest Wolf density (30.8 Wolves/100 km^2) occurred in summer, and it was a minimum estimate because it was based on the pack size the following winter, after any mortality may have occurred. Thus the winter deer density at first seems irrelevant. However, possibly such a high deer density allowed the Wolves to add sufficient fat and to cache enough surplus food to help carry them through the summer. In any case, this study demonstrates the extreme density that Wolf densities can reach when prey is plentiful.

Acknowledgments

This study was supported by the Biological Resources Division of the U.S. Geological Survey and the U.S. Department of Agriculture North Central Forest Experiment Station.

Literature Cited

Ballard, W. B., J. S. Whitman, and **C. L. Gardner.** 1987. Ecology of an exploited Wolf population in south-central Alaska. Wildlife Monographs 98: 1-54.

Bekoff, M., and **L. D. Mech.** 1984. Simulation analyses of space use: Home range estimates, variability, and sample size. Behavior Research Methods and Instrumentation 16: 32-37.

Fritts, S. H., and **L. D. Mech.** 1981. Dynamics, movements, and feeding ecology of a newly protected Wolf population in northwestern Minnesota. Wildlife Monographs 80: 1-79.

Fuller, T. K. 1989. Population dynamics of Wolves in north-central Minnesota. Wildlife Monograph 105: 1-41.

Fuller, T. K., L. D. Mech, and **J. Fitts-Cochrane.** 2003. Population dynamics. Pages 161-191 *in* Wolves: Ecology, Behavior, and Conservation. *Edited by* L. D. Mech and L. Boitani. University of Chicago Press, Chicago, Illinois.

Hebert, D. M., J. Youds, R. Davies, H. Langin, D. Janz, and **G. W. Smith.** 1982. Preliminary investigations of the Vancouver Island Wolf (*Canis lupus crassodon*) prey relationships. Pages 54-70 *in* Wolves of the world. *Edited by* F. H. Harrington and P. C. Paquet. Noyes Publication, Park Ridge, New Jersey.

Hooge, P. N., and **B. Eichenlaub.** 1997. Animal movement extension to Arcview. Ver. 1.1. Alaska Biological Science Center, U.S. Geological Survey, Anchorage, Alaska, USA.

Keith, L. B. 1983. Population dynamics of Wolves. Pages 66-77 *in* Wolves in Canada and Alaska. *Edited by* L. N. Carbyn. Canadian Wildlife Service Report Series (45).

Mech, L. D. 1970. The Wolf: The ecology and behavior of an endangered species. Doubleday Publishing Company, New York.

Mech, L. D. 1973. Wolf numbers in the Superior National Forest of Minnesota. U.S. Department of Agriculture Forest Service Research Paper NC-97.
Mech, L. D. 1986. Wolf numbers and population trend in the Superior National Forest, 1967-1985. Research Paper NC-270. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota. 6 pages.
Mech, L. D., and **L. Boitani**. 2003. Social ecology. Pages 1-34 *in* Wolves: Ecology, Behavior, and Conservation. *Edited by* L. D. Mech and L. Boitani. University of Chicago Press, Chicago, Illinois.
Mech, L. D., and **M. E. Nelson**. 2000. Do Wolves affect white-tailed buck harvest in Minnesota? Journal of Wildlife Management 64: 129-136.
Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. American Midland Naturalist 37: 223-249.
Nelson, M. E., and **L. D. Mech.** 1981. Deer social organization and Wolf predation in northeastern Minnesota. Wildlife Monographs 77: 1-53.
Odum, E. P., and **E. J. Kuenzler.** 1955. Measurement of territory and home range size in birds. Auk 72: 128-137.
Scott, B. M. V., and **D. M. Shackelton**. 1982. A preliminary study of the social organization of the Vancouver Island Wolf (*Canis lupus crassodon*). Pages 12-41 *in* Wolves of the world. *Edited by* F. H. Harrington and P. C. Paquet. Noyes Publication, Park Ridge, New Jersey.

Received 25 August 2002
Accepted 3 June 2004

Extraordinary Size and Survival of American Black Duck, *Anas rubripes*, Broods

JERRY R. LONGCORE and DANIEL G. MCAULEY

United States Geological Survey, Patuxent Wildlife Research Center-Orono, 5768 South Annex A, Orono, Maine 04469-5768 USA

Longcore, Jerry R., and Daniel G. McAuley. 2004. Extraordinary size and survival of American Black Duck, *Anas rubripes*, broods. Canadian Field-Naturalist 118(1): 129-131.

Two female American Black Ducks (*Anas rubripes*) were initially observed during June 1982 with 20 Class Ib or 18-22 Class Ia-b ducklings in two wetlands in Hancock County, Cherryfield, Maine. Fifteen of 20 ducklings (75%) in one brood and 16 of 18-22 ducklings (72-89%) in the other brood survived to fledge. These large broods probably resulted from post-hatch brood amalgamation.

Key Words: American Black Duck, *Anas rubripes*, brood size, duckling survival, post-hatch brood amalgamation, Maine.

Exceptionally large broods of North American dabbling ducks (*Anas* spp.) that exceed average clutch size (8-10 eggs, Zammuto 1986) occur when females (1) lay extraordinarily large clutches, (2) lay eggs in nests of conspecifics ("pre-hatch brood amalgamation" (Pre-HBA), or brood parasitism; Eadie et al. 1988), or (3) hatch their own clutches and acquire the brood of another female ("post-hatch brood amalgamation" (Post-HBA); Eadie et al. 1988). Pre-HBA, which can be either inter- or intra-specific, and post-HBA occur infrequently in the Anatini; only 3 of 9 species of Anatini were reported by Eadie et al. (1988) for either type. Tufts (1986) in Nova Scotia reported brood amalgamation for three American Black Duck broods when he released orphaned ducklings near females with broods. Herein, we report two records of probable post-HBA resulting in two extremely large broods of wild American Black Ducks in Maine.

Study Area and Methods

We observed the two broods in two Beaver (*Castor canadensis*) flowages (Snake Flowage, 44º37'N, 68º06'; BFA Flowage, 44º 39'N, 68º07'W) that were 20 km northwest of Cherryfield, Maine, in township T10 SD, a forested area that has negligible acid-neutralizing capacity and low nutrients in wetlands (Norton 1980). We obtained morphometric and water chemistry characteristics of wetlands by methods of McAuley and Longcore (1988). We mapped and classified (Cowardin et al. 1979) both wetlands, and we sampled invertebrates in one (Snake Flowage), as part of related fieldwork (J. R. Longcore, unpublished data). All observations of broods followed the survey protocol of Longcore and Ringelman (1980). Morning visits on wetlands began 0.5 hour before sunrise and lasted two hours; the 2-h evening visit ended ≥0.5 hour after sunset. Broods were always sought on both wetlands simultaneously, and observers scanned wetlands with binoculars (7×50) and spotting scopes (20-60×) from elevated (4-5 m high) platforms. We backdated brood age (Gollop and Marshall 1954*) to determine approximate dates that first eggs were laid.

Results

During 3 June – 12 July 1982. we observed two American Black Duck broods that were twice (20 and 18-22 ducklings) the size of average broods. Each brood was seen three times. Both broods were seen on the same wetland on the same day (8 June) by DGM. Both broods were observed on 12 July during the even-