

Social Grouping of White-tailed Deer in Shenandoah National Park, Virginia

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Abstract: During 1982, 3,095 social groups of white-tailed deer (*Odocoileus virginianus*) were observed in Shenandoah National Park, Virginia. Both time of day (dawn, day, dusk, and night) and season of the year (spring, fawning, summer, breeding, and winter) had a significant effect on total deer/group and numbers of adults, adult females, and adult males. Group size was largest at dusk (mean 2.7, range of 1 to 28), and slightly smaller at night (2.4, 1 to 21), at dawn (2.3, 1 to 10), and during the day (2.3, 1 to 13). Seasonally, group size was largest in winter (mean 3.4, range of 1 to 28), noticeably smaller during breeding (2.5, 1 to 13) and spring (2.4, 1 to 9), and smaller still during late summer (2.0, 1 to 10) and fawning (1.7, 1 to 9). Time of day did not significantly affect occurrence of doe, buck, and mixed groups, but season did, with doe groups occurring most frequently (90% of all observations) and buck groups least frequently (4%) in winter than during any other season. Single adult females were most common (27% of all observations), followed by 1 adult female with 1 fawn (13%), a single adult male (7%), 2 adult does (6%), and 2 does with 1 fawn (6%). At least 1 adult was present in 93% of all social groups. Adult does exhibited a moderately high degree of mutual tolerance at all times of year except the fawning season.

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In Shenandoah National Park, Virginia, white-tailed deer are abundant, highly visible, and are a highly valued resource by park visitors. As part of a comprehensive study of deer ecology in Shenandoah we determined social group composition by sex and age throughout 1982. We thank the National

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Methods

Shenandoah National Park extends for 170 km along the Blue Ridge Mountains between Waynesboro and Front Royal, Virginia, and varies in width from 2 to 14 km. The Skyline Drive traverses the entire length of the Park, running along or near the top of the Blue Ridge. Campgrounds, picnic areas, and wayside stores are associated with the drive. Open grass is common along the roadway and waysides, and moderately open mixed hardwood forest is common in the vicinity of campgrounds and picnic areas. This hardwood forest is predominately oak (*Quercus* spp.), hickory (*Carya* spp.), and yellow poplar (*Liriodendron tulipifera*), with occurrences of shrubs such as redflag (*Symphocarpus orbiculatus*), mountain laurel (*Kalmia latifolia*), spice bush (*Lindera benzoin*), witch hazel (*Hamamelis virginiana*), and blueberry (*Vaccinium* spp.) in the understory.

Throughout 1982 an average of 6 person-days/week were spent in the field to monitor social groups of deer in the park. For each group of deer observed, the number of adult bucks, adult does, yearlings, and fawns was noted. Only complete, undisturbed observations of social groups are presented here. All observations were made from a truck along Skyline Drive or on foot along trails directly adjacent to the drive, and at waysides or campgrounds associated with the drive. Most observations were made within 2 study areas at Piney River and Loft Mountain (Fig. 1) and the remaining observations were made along the Skyline Drive between the 2 study areas. Time of day and seasonal affects on social group composition were analysed. Dawn, day, dusk, and night (Hawkins and Klimstra 1970, Michael 1970) were considered for time of day, while fawning, breeding, spring green-up, and the intervening summer and winter periods were considered for seasons. Observations began in January 1982. The first flush of leaves (on about 24 Apr. 82) was chosen as the start of spring. Fawning season began with the first sighting of new-born fawns on 23 May 1982, and ended 2 months later when fawns had become capable of traveling regularly with their dams (Halls 1978). This date was estimated at 1 August 82 and was considered to be the beginning of summer. Summer ended when consistent sightings of fresh rubs and scrapes occurred around 11 October 1982, considered as the beginning of breeding season. Observations continued until 31 December 1982.

Two analyses of variance highlighted differences in mean social group composition, and in occurrence of doe, buck, and mixed groups (Hirth 1977) by time of day and season of the year. Yearlings and fawns were not included in variance tests because 2 cohorts were present in 1982 observations; ani-

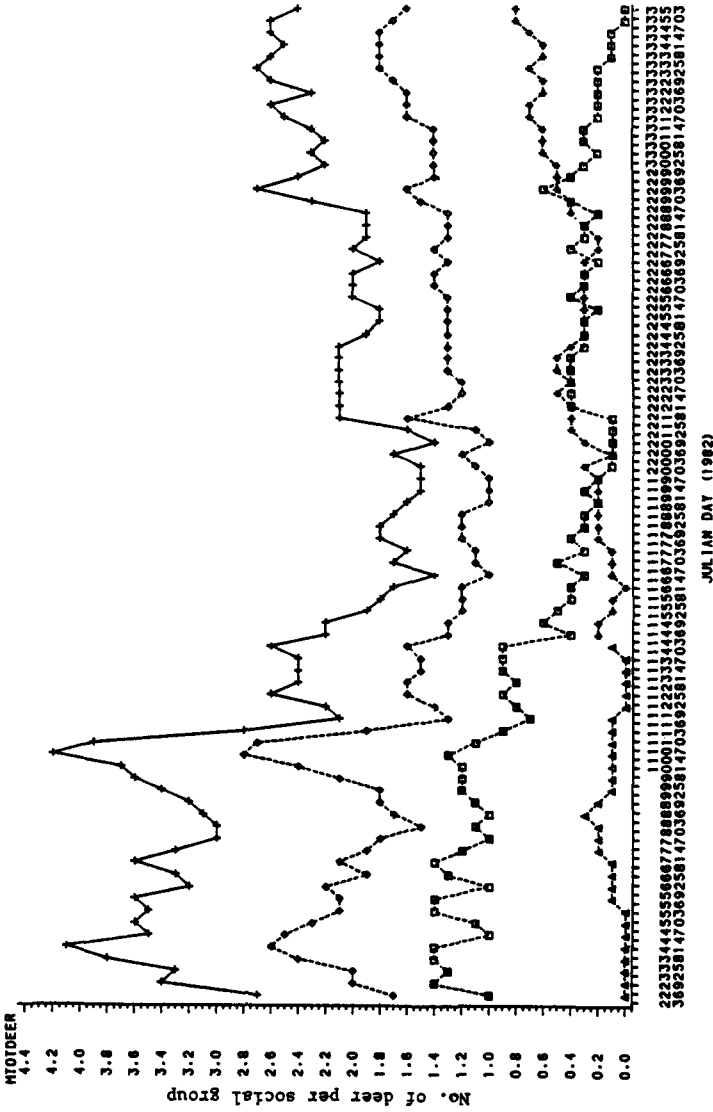


Figure 1. Running mean for white-tailed deer social group composition in Shenandoah National Park, Virginia, during 1982. The average number of total deer per social group (— + —), fawns of 1980 (--- ◊ ---), fawns of 1981 (--- △ ---), fawns of 1982 (--- * ---) are shown for 10 Julian day periods over increments of 4 Julian days. A minimum of 50 observations was used for each of the averages shown.

mals counted as yearlings and fawns (born in 1980 and 1981, respectively) during winter and spring of 1982 were tallied as adults and yearlings, respectively, after the first new fawns appeared in May of 1982. Equality of variances was tested with an F-max test (Sokal and Rohlf 1969). Fawn-to-doe ratios and the frequency of occurrence of specific social combinations of deer were calculated and were used to make inferences about population condition.

Results

Throughout 1982, 7,397 deer were observed in 3,095 social groups. Group size ranged from 1 to 28 deer with a mean of 2.4; adults constituted the majority of all social groups, and doe groups were observed more frequently than buck groups (Table 1, Fig. 1).

Variances across time of day and season for occurrence of adult females, adults, and total deer per social group were not homogeneous ($P < 0.01$). Variances were homogeneous for occurrences of adult bucks ($P > 0.05$). The range in numbers of adult females, adults, and total deer over time of day and season (Table 2) is an indication of the unequal variances. The number of adult bucks in social groups ranged only from 0–4 over all observations throughout the year (Tables 1, 2; Fig. 2). These analyses assume independence of observations, but it is certain that some deer were observed on more than 1 occasion. This problem was addressed by Hirth (1977) and we followed his example of not counting the same social group twice in 1 day if we could recognize it. Because assumptions were violated, we considered values of $P < 0.01$ to be significant, as did Hirth (1977).

Time of day was recorded for 3,029 social groups, and this variable significantly affected total group size ($P < 0.002$), number of adults ($P < 0.002$), number of adult males ($P < 0.006$) and number of adult females ($P < 0.01$) per social group. Largest groups occurred at dusk, with smaller and nearly equal-sized groups occurring at night, at dawn, and during the day (Table 2). Season also had a significant effect on total group size and number of adults, adult males, and adult females per social group ($P < 0.001$ in all cases). Social groups were largest during winter, smaller during spring and breeding seasons, still smaller during summer, and smallest during fawning season (Table 2). Time of day did not significantly affect the percentage of doe, buck, and mixed groups observed ($P > 0.6$); doe groups composed 75% to 80% of all observations across time of day, buck groups ranged from 9% to 13%, and mixed groups ranged from 3% to 6% (Fig. 3). Seasons, however, did significantly affect group occurrence ($P < 0.01$); doe groups were observed more frequently and buck groups less frequently in winter than in any other season (Fig. 4). The time of day and season interaction had a significant affect on total group size, adults, and adult females per social group

Table 1. Mean occurrence of adult, adult male, and adult female white-tailed deer in 3,095 social groups, and in doe, buck, and mixed groups during 1982 in Shenandoah National Park, Virginia.

Group ^a	N	%	Total deer			Adult			Adult male			Adult female		
			\bar{x}	SE	Range	\bar{x}	SE	Range	\bar{x}	SE	Range	\bar{x}	SE	Range
All	3,095	100.0	2.39	0.03	1-28	1.53	0.02	0-20	0.18	0.01	0-4	1.35	0.02	0-16
Doe	2,448	79.0	2.45	0.03	0-20	1.58	0.02	1-12				1.58	0.02	1-12
Buck	289	9.0	1.27	0.03	1-3	1.22	0.03	1-3	1.22	0.03	1-3			
Mixed	154	5.0	4.39	0.34	2-28	3.41	0.22	2-20	1.31	0.05	1-4	2.10	0.19	0-16

^a Yearlings and fawns are not included because 2 cohorts were observed during 1982: deer tallied as fawns in early 1982 were later tallied as yearlings after new-born fawns appeared in May.

Table 2. Mean occurrence of adult, adult male, and adult female white-tailed deer in social groups at different times of day and seasons of the year during 1982 in Shenandoah National Park, Virginia. Mean occurrence of yearlings and fawns are presented for seasons.^a

Time of day, or season	N	Total deer			Adults			Adult male			Adult female			Yearling			Fawn		
		\bar{x}	SE	Range	\bar{x}	SE ^b	Range	\bar{x}	SE	Range	\bar{x}	SE	Range	\bar{x}	SE	Range	\bar{x}	SE	Range
Dawn ^c	730	2.3	0.1	1-10	1.5	—	0-7	0.2	—	0-3	1.3	—	0-7	—	—	—	—	—	—
Day	1,282	2.3	0.1	1-13	1.5	—	0-8	0.2	—	0-4	1.3	—	0-7	—	—	—	—	—	—
Dusk ^d	665	2.7	0.1	1-28	1.7	—	0-20	0.2	—	0-4	1.5	—	0-16	—	—	—	—	—	—
Night	352	2.4	0.1	1-21	1.6	—	0-14	0.2	—	0-3	1.4	—	0-12	—	—	—	—	—	—
Wintere	656	3.4	0.1	1-28	2.0	0.1	0-20	0.1	—	0-4	1.9	0.1	0-16	0.1	—	0-3	1.2	0.1	0-8
Spring ^f	214	2.4	0.1	1-9	1.5	0.1	0-6	0.1	—	0-3	1.4	0.1	0-6	0.1	—	0-4	0.9	0.1	0-4
Fawnings	510	1.7	0.1	1-9	1.1	0.1	0-7	0.1	—	0-4	1.0	0.1	0-6	0.3	0.1	0-4	0.2	—	0-2
Summer ^h	916	2.0	0.1	1-10	1.3	0.1	0-7	0.2	—	0-4	1.1	0.1	0-7	0.3	—	0-4	0.4	—	0-4
Breeding ⁱ	799	2.5	0.1	1-13	1.6	0.1	0-9	0.2	—	0-4	1.4	0.1	0-9	0.2	—	0-3	0.6	—	0-4

^a Yearlings and fawns are not presented for time of day because 2 cohorts were observed during 1982: deer tallied as yearlings and fawns, respectively, in winter and spring seasons were tallied as yearlings and adults, respectively, after new-born fawns appeared in May of 1982 (fawning season).

^b Standard errors (SE) of less than 0.05 are not shown.

^c Dawn = \pm 90 minutes of sunrise.

^d Dusk = \pm 90 minutes of sunset.

^e Winter = 1 Jan 82-23 Apr 82.

^f Spring = 24 Apr 82-22 May 82.

^g Fawning = 23 May 82-1 Aug 82.

^h Summer = 2 Aug 82-10 Oct 82.

ⁱ Breeding = 11 Oct 82-31 Dec 82.

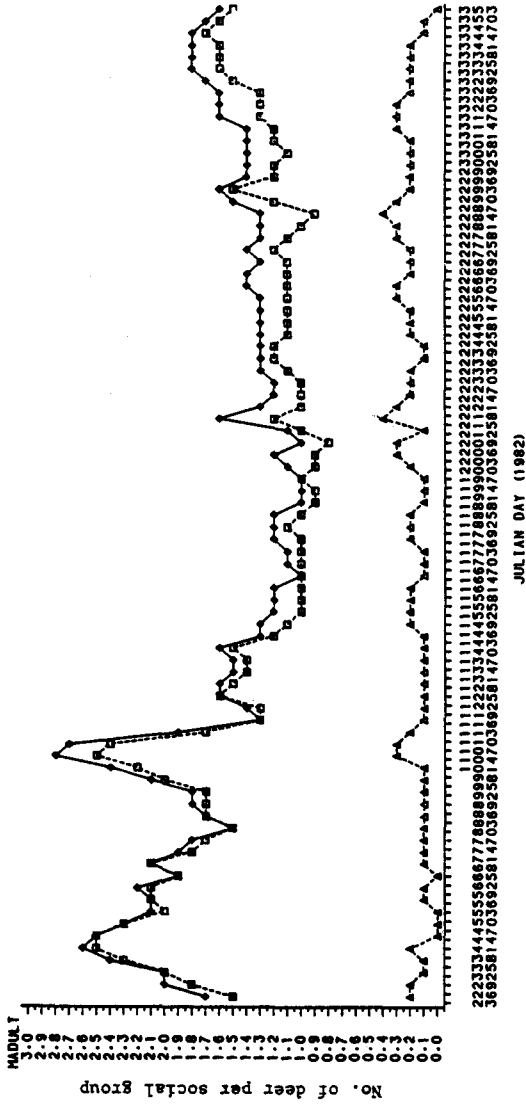


Figure 2. Running mean for adult white-tailed deer in social groups in Shenandoah National Park, Virginia, during 1982. The average number of adults per social group (—◇—), adult females (---□---), and adult males (---△---) are shown for 10 Julian day periods over increments of 4 Julian days. A minimum of 50 observations were used for each of the averages shown.

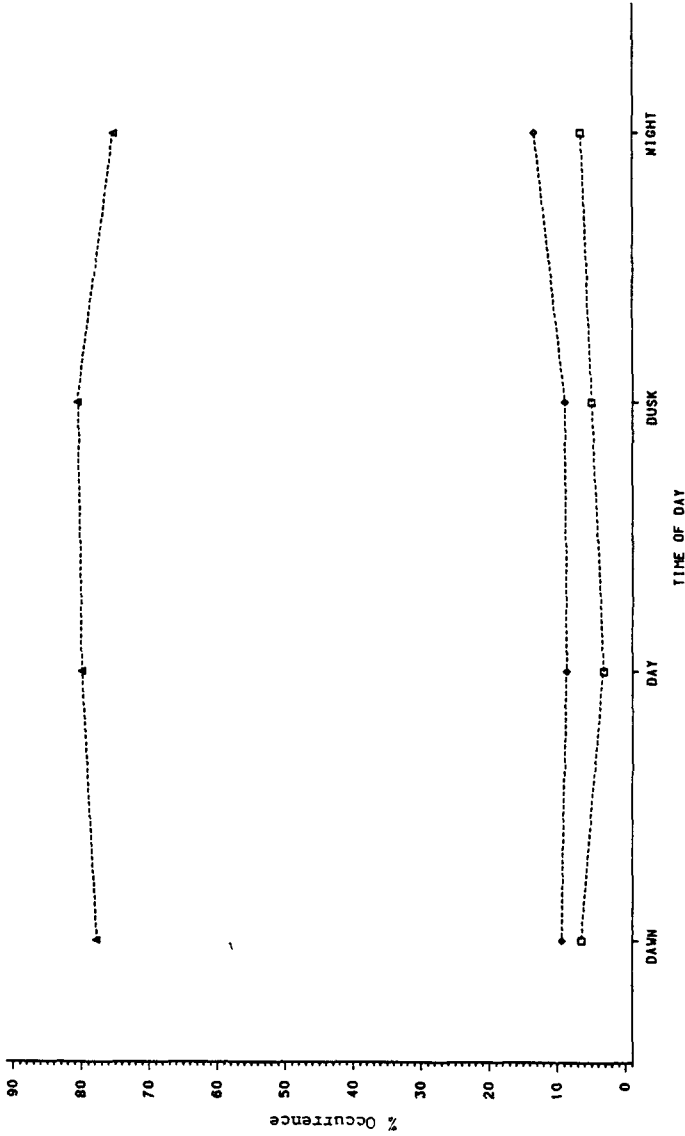


Figure 3. Percent occurrence of doe (Δ), buck (\diamond), and mixed (\square) social groups of white-tailed deer in Shenandoah National Park, Virginia, at dawn, day, dusk, and at night during 1982.

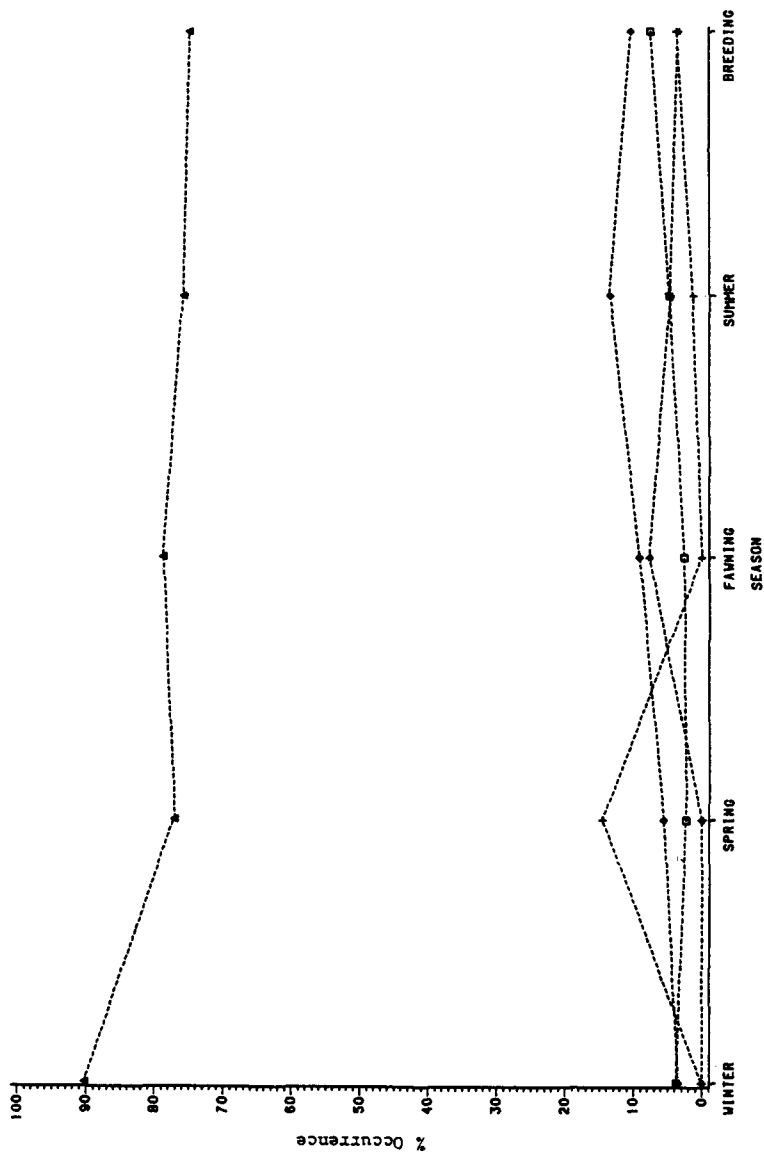


Figure 4. Percent occurrence of doe (Δ), buck (\diamond), mixed (\square), yearling (*), and fawn (+) social groups of white-tailed deer in Shenandoah National Park, Virginia, during winter, spring, fawning, summer, and breeding seasons of 1982.

($P < 0.001$), but only a marginal affect on adult males ($P = 0.04$) (Figs. 5, 6). Adult does constituted the greatest part of social groups at night during winter, spring, and fawning seasons, but were most abundant at dawn during summer and at dusk during the breeding season. The interaction did not significantly affect occurrences of doe, buck, and mixed groups ($P > 0.10$).

There were 142 different social combinations observed, but only 19 of the combinations each accounted for 1% or more of all observations (Table 3). The first 6 of these combinations are groups of 1, 2, or 3 deer, and they accounted for more than 60% of all observations. Their order of occurrence did not vary across time of day, but did vary with season; 1 doe with 1 fawn, and 2 does accompanied by a single fawn were seen least during fawning and summer seasons, relative to the other combinations, while a single doe was seen most often during this same time. At least 1 fawn was present in 25% of observations considered in Table 3, and yearlings were present in 18% of these observations. Fawns and yearlings were seen commonly in the same social group with 1 or more adult does, and this likely represents matriarchal associations of 3 and possibly 4 generations. Such associations were noted by Hawkins and Klimstra (1970). Adult females were observed far more often than any other age and sex of deer; they were present in 82% of observations

Table 3. Occurrence of social combinations of white-tailed deer in Shenandoah National Park, Virginia, during 1982.^a

Sex and age combination ^b	N	%	Cumulative %
1D	839	27.1	27.1
1D, 1F	398	12.9	40.0
1B	225	7.3	47.3
2D, 1F	173	5.6	52.9
2D	172	5.6	58.5
1D, 1Y	149	4.8	63.3
1D, 2Y	100	3.2	66.5
1F	98	3.2	69.7
1Y	81	2.6	72.3
2D, 2Y	73	2.4	74.7
3D, 2Y	59	1.9	76.6
1B, 1D	53	1.7	78.3
2B	44	1.4	79.7
3D	44	1.4	81.1
3D, 1Y	36	1.2	82.3
2D, 1F	36	1.2	83.5
1D, 1Y, 1F	36	1.2	84.7
4D, 2Y	31	1.0	85.7
1D, 2F	30	1.0	86.7

^a A total of 3,095 observations were made during 1982, and 142 different combinations were seen. Only those combinations which comprise 1% or more of all observations are presented here. The resulting 19 combinations in this table account for 86.7% of all observations (2,737 sightings of social groups).

^b D = adult doe, B = adult buck, Y = yearling, F = fawn.

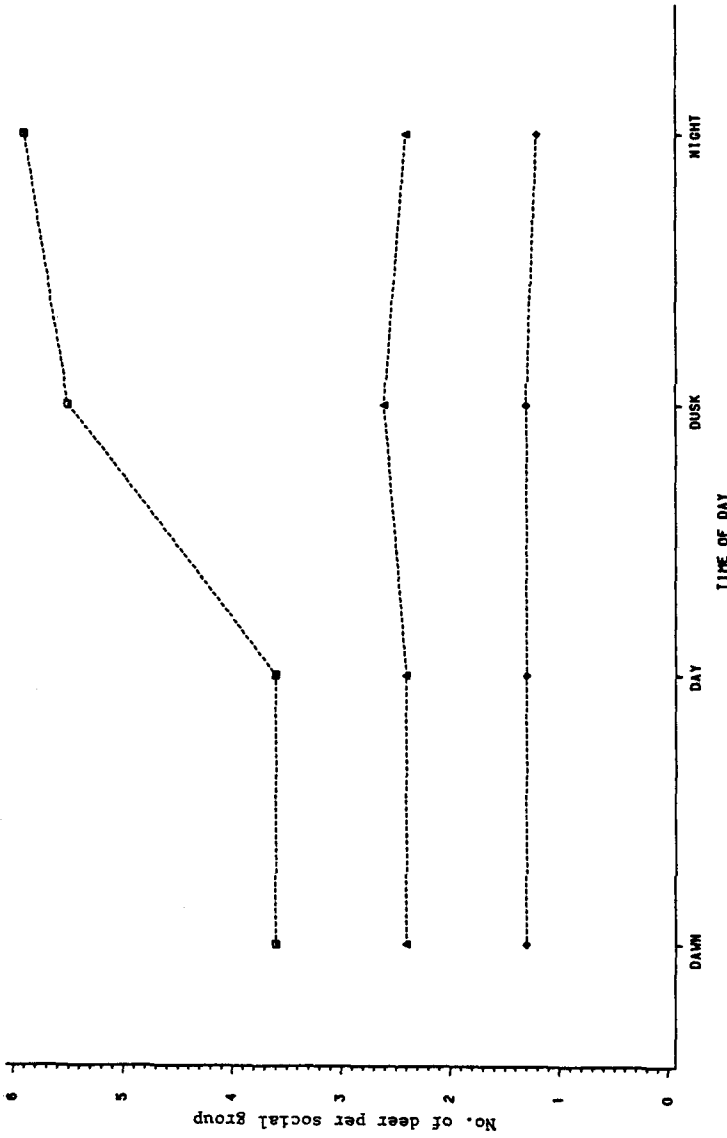


Figure 5. Average number of white-tailed deer in doe (Δ), buck (◇), and mixed (□) social groups in Shenandoah National Park, Virginia, at dawn, day, dusk, and at night during 1982.

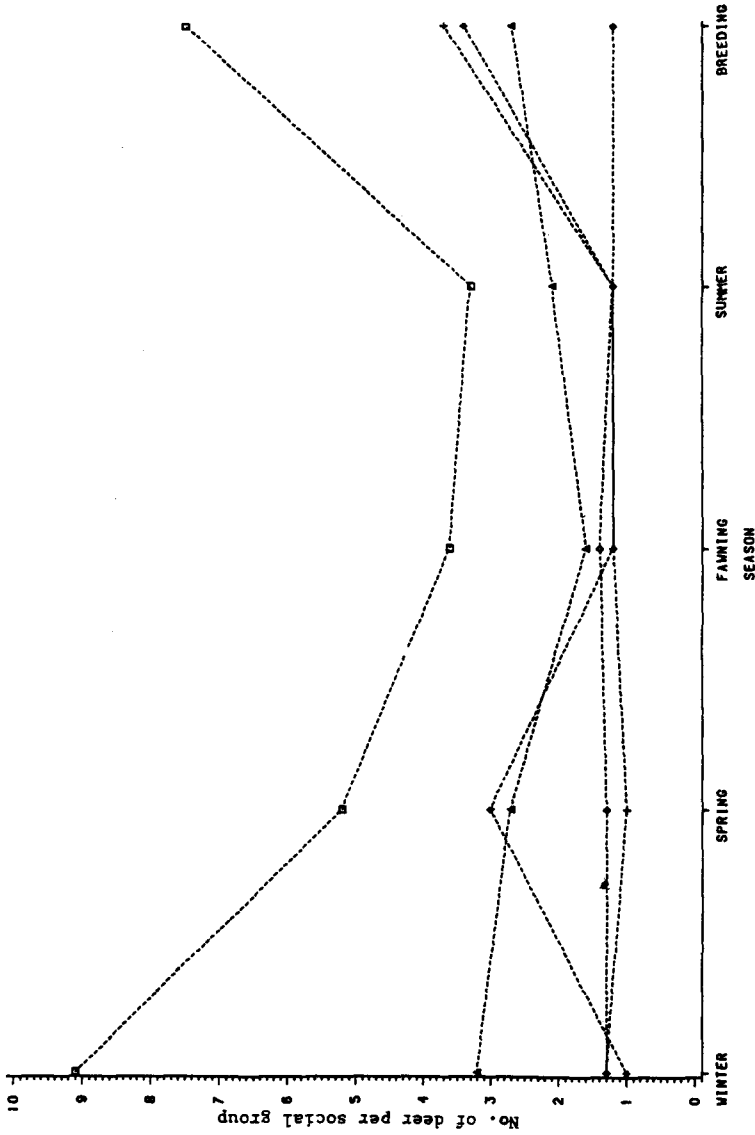


Figure 6. Average number of white-tailed deer in doe (Δ), buck (◇), mixed (□), yearling (*), and fawn (+) social groups in Shenandoah National Park, Virginia, during winter, spring, fawning, summer, and breeding seasons of 1982.

across seasons, and in 79% of observations across times of day (Table 2). Adult males are not as likely to be observed as adult females (Connolly 1981a), and in the present study, mean number of adult males/social group was never greater than 0.2 (Table 2). The size of buck groups was essentially constant across time of day and season of the year, but these groups constituted a greater percentage of observations during summer, breeding, and at night than during other seasons and times of day (Figs. 3, 4).

During fawning season of 1982, 428 social groups were observed which contained 1 or more adult does. Thirteen percent of these does were seen in social groups with newborn fawns and there were 100 fawns/100 does in these groups. During the course of this study we marked 28 adult females with colored collars, and these does produced an average of 120 fawns/100 does 1 to 2 weeks after parturition (Scanlon and Vaughan, unpubl. data). These ratios are low relative to general expectations for white-tailed deer were 180 and 120 fawns/100 does are produced on good and bad range respectively (Halls 1978).

Discussion

To interpret results from the present study, it is helpful to consider Hirth's (1977) study of social organization in 2 non-hunted populations of white-tailed deer in relation to habitat; 1 population was associated primarily with intermediate to dense cover and less with open range in Michigan, and the other population was associated mainly with intermediately open and open range and less with dense cover in Texas. For open areas, Hirth found average group sizes of 1.92 in Michigan and 4.28 in Texas, and attributed this difference primarily to behavioral adaptation for predator avoidance and secondarily to optimization of feeding strategy. Hirth felt that open areas at the Michigan study area may not have been large enough, from an evolutionary stand point, to favor the formation of large self-protecting groups. Rather, small groups could disperse into moderate or dense cover to avoid predators. In Shenandoah, moderate cover is readily available along Skyline Drive where mean group size was 2.39. In wooded areas of Shenandoah removed from Skyline Drive, observations of 110 social groups had a mean size of 2.19.

Hirth (1977) found adult females extremely intolerant of one another in Michigan (<6% of social groups contained more than 1 adult female during fawning, summer, and breeding seasons, 22% in late winter), and moderately tolerant in Texas (50% to 75% of social groups with 2 or more adult does except during fawning season). In Shenandoah, 2 or more adult females were present in 32% of all observations, with a low of 10.6% during fawning, 21.1% in summer, 36.1% during breeding, 36.8% in spring, and a high of 49.9% during winter. The percentage of social groups containing 1 or

more adults of either sex was 62% in Michigan, 91% in Texas (Hirth 1977), and 93% in Shenandoah.

Social group size in Shenandoah more closely resembled that of Hirth's (1977) Michigan population than his Texas population in terms of mean number of deer/group, and numbers of deer in doe, buck, and mixed groups. Other aspects of social organization in Shenandoah seemed intermediate between Hirth's Michigan and Texas populations; adults were observed in roughly the same percentage of social groups in Shenandoah and in Texas, and adult females in the Park were more like those in Texas than in Michigan in terms of mutual tolerance. Hawkins and Klimstra (1970) reported close associations of older does in a non-hunted population in Illinois, and felt that most of these associations were between siblings. The association of adult females in Shenandoah may also be of siblings, and the tameness of these does is indicated by consistent sightings of newborn fawns which occurred 2 to 8 weeks sooner than in studies by Hawkins and Klimstra (1970), Hirth (1977), and Nelson and Mech (1981). It may be that the man-made and artificially maintained open areas in Shenandoah, combined with the lack of hunting and limited natural predation on adults, allows prolonged association of adult does and/or their offspring, relative to the dispersal of family groups which normally occurs when a doe's offspring are 1 to 3 years old (Halls 1978).

The largest groups of deer (up to 28) were seen feeding together at dusk along grassy areas of Skyline Drive in late winter (Table 2). Deer seemed to join and leave these large, non-permanent groups at random. Similar observations were made by Hawkins and Klimstra (1970). White-tailed deer tend to form matriarchal groups around 1 or more mature females, but adult does will often separate themselves socially and spatially during fawning season (Hawkins and Klimstra 1970, Bartush and Lewis 1978, Nelson and Mech 1981), and this likely accounted for the marked decline in mean group size between spring and fawning seasons (Table 2).

Even though the number of adult males was probably underestimated in our observations, it seemed that the deer population in Shenandoah National Park contained an abundance of adult females, that these females had a relatively low reproductive rate, and that fawns which lived for more than 2 months had a high survival rate. It is likely that matriarchal groups with members of 2 or 3 generations were common, and that associations of 4 generations occur. Mutual tolerance among adult females appeared to be moderate.

The social grouping of deer in Shenandoah indicates something about population condition, although we do not have a measure of recuperative ability from environmental stress (Hanks 1981). We do know that in hunted white-tailed populations life expectancy is 3 to 6 years (Halls 1978), and we know from necropsy reports of car-killed deer that adult females in Shenandoah reach 10 years of age or more (Scanlon and Vaughan, unpubl. data). It is possible that the large population of deer in the Park is of an older

age structure and is less fecund than hunted white-tailed populations and, accordingly, might not have the same resilient capacity for recovery from environmental stress as would a population with younger individuals and a higher reproductive rate. The moderately high degree of mutual tolerance among adult females and the early sightings of does with newborn fawns indicates an uncharacteristic tameness for these white-tailed deer. Visitors to Shenandoah National Park who value seeing these deer, may not be observing the same social structure of deer which existed before the park was established.

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