SEASONAL CHANGES IN DEFECATION RATES OF FREE-RANGING WHITE-TAILED DEER

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Abstract: Defecation rates of 7 free-ranging female white-tailed deer (*Odocoileus virginianus*) were studied in a coniferous-deciduous forest in northeastern Minnesota. Defecation rates averaged 22.3, 27.0, 34.4, and 51.9 pellet groups/day during January–April, May–June, July–August, and September–December, respectively. Average defecation rate between autumn leaf-fall (15 Oct) and spring snowmelt (30 Apr) was 34 pellet groups/day. The same deer, when penned, defecated from 11 to 14 times/day. There was an average of 68.7 pellets/group.

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Counts of fecal pellet groups are used to estimate deer numbers and habitat use (Bennett et al. 1940, Neff 1968, Ryel 1971). Pellet groups deposited by white-tailed deer since autumn leaf-fall are usually counted in spring (Ryel 1971). Counts may be used directly to estimate year-to-year population trends or may be divided by pellet groups/deer/day to estimate deer numbers or deer-days of habitat use (Neff 1968). Defecation rates applied to white-tailed deer are based on 2 winter studies of penned white-tailed deer fed selected browse species in Michigan (Eberhardt and Van Etten 1956, Van Etten 1959), a study of penned white-tailed deer fed a commercial ration in Texas (Rollins et al. 1984), and studies of confined mule deer (*O. hemionus*) in western habitats (Neff 1968).

Additional defecation rate information is needed because defecation rates may change seasonally with diet and metabolism, defecation rates for penned deer on artificial diets may differ from those of wild deer, and defecation rates may differ between species or within a species in different habitats (Ryel 1971). Also, information is needed for late fall, which is commonly included in pellet group counts but for which little defecation rate data are available for any North American deer (Ryel 1971).

Studies of tame free-ranging deer ingesting natural forage were conducted in the Superior National Forest in northeastern Minnesota (47°48′N, 91°45′W) from 1977 through 1980. My objective is to report seasonal changes in the number of pellet groups deposited/day, based on direct observation of the tame, free-ranging deer.

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STUDY AREA

The study area was the composite home range of 7 white-tailed deer (3 km²). Habitat was primarily mixed coniferous-deciduous forest on gently rolling terrain interrupted by occasional granite outcrops. More than 60% of the study area was upland forest dominated by mature 2nd growth quaking (*Populus tremuloides*) and bigtooth (*P. grandidentata*) aspen, paper birch (*Betula papyrifera*), white (*Picea glauca*) and black (*P. mariana*) spruce, and balsam fir (*Abies balsamea*) with scattered veteran red (*Pinus resinosa*), white (*P. strobus*), and jack (*P. banksiana*) pines and small openings. Red and jack pine plantations made up 10% of the area, and 30% was a variety of riparian habitats, lowland conifer stands (black spruce, tamarack larch [*Larix laricina*], balsam fir, and eastern arborvitae [*Thuja occidentalis*]), lowland black ash (*Fraxinus nigra*) stands, clearcut upland and lowland areas, and scattered openings from old homesteads. Altitude was 434–460 m. Temperatures during defecation studies were −35 to +30 C. Snow was present from November to April each year.

In or near the study area summer deer densities were <3 deer/km² (Floyd et al. 1979). Winter densities were somewhat higher due to a yearly influx of deer into a traditional wintering area (Nelson and Mech 1984) that included a portion of the study animals' range.

METHODS

Seven radio-collared whitetail does were studied as yearlings and 2-year-olds between 14 June 1978 and 12 September 1980. They were

Table 1. Seasonal differences in number of fecal pellet groups deposited by 7 free-ranging female white-tailed deer in mixed coniferous-deciduous forests in northeastern Minnesota, June 1978–September 1980. (During any particular season, only 3–6 different deer were represented.)

Period	Defecations/day			Probability of no difference from previous period		Major foods
	$\bar{x}$	Range	N[a]	P	t	
Jan–Apr	22.3	14–31	11	<0.001[b]	10.88	Woody browse, lichens
May–Jun	27.0	21–33	8	NS	1.59	New leaves and forbs
Jul–Aug	34.4	19–45	16	<0.05	2.44	Mature leaves and forbs
Sep–Dec	51.9	40–66	13	<0.001	6.04	Overmature leaves and forbs, evergreen ground plants, mushrooms, lichens, woody browse

[a] Sample periods averaging 25.5 hours each (range = 19–34 hours).
[b] Previous period is Sep–Dec.

obtained at 2 game farms in northern Minnesota at <1 day of age. All deer were bottle-fed, radiocollared and released as fawns. They established activity centers of 2–3 km² near the release site but occasionally travelled several kilometers outside those ranges. As yearlings they only consumed natural forage except during portions of November deer hunting seasons when some of the deer were confined in a wooded 2-ha pen and fed supplemental commercial feed, and defecation studies were suspended. The deer accepted the close presence of people throughout the study (Rogers 1981, 1982).

To determine defecation rates, researchers observed ≥2 deer/month except in November. Observers took shifts of 6–14 hours each and remained with the deer for 19–34 hours ($\bar{x}$ = 25.2 hours). When a new observer joined them, bedded deer commonly remained bedded, but active deer usually paused briefly to lick the researcher before resuming other activities. The observer usually remained within 4 m of the deer to record activities, food consumption, and defecations. Deer were observed with the aid of flashlights at night.

For comparison with defecation data from free-ranging deer, 2 individuals were placed in their familiar 2-ha forested pen in March 1979 and observed for 24 hours each. Supplemental commercial food was provided because previous foraging had reduced the habitat quality in the pen. Defecation data from the penned deer are analyzed and reported separately.

Pellet groups deposited by the free-ranging deer during the 19–34-hour observation periods were adjusted to a 24-hour basis; i.e., 24 × pellet groups/hour. Fractions resulting from this adjustment were retained for calculations but rounded for presentation in the text. Statistical comparisons were made for 4 periods with differing food availabilities: winter (Jan–Apr), spring (May–Jun), summer (Jul–Aug), and fall (Sep–Dec). I used t-tests to compare means of pellet groups.

RESULTS AND DISCUSSION

The number of pellet groups deposited/day differed significantly between seasons, except between winter and spring greenup (Table 1). The average defecation rate increased >100% between spring and fall each year and then declined to low levels in late winter. Food intake followed a similar but less extreme cycle in captive deer studied by Thompson et al. (1973); intake of commercial ration was 85% higher in October than in March. If the deer in this study followed a similar feeding pattern, much of the seasonal change in defecation rates may be explained. Remaining differences may be due to seasonal differences in dietary fiber content. Moderate but increasing amounts of fiber may have added increasing bulk to the feces between spring and fall as the diet changed from succulent young leaves and forbs in spring to mature vegetation in summer to coarser items in fall after leaf-fall (Table 1) (Ammann et al. 1973). In winter, woody browse may have increased dietary fiber to the point that intake and passage rate were reduced even beyond that dictated by reduced metabolic demands (Van Soest 1982:276–293, Reed 1983).

Defecation rates of the free-ranging deer in the present study were higher in all seasons than has been reported for penned white-tailed or mule deer (Neff 1968). Winter defecation rates of penned white-tailed deer in 2 studies in Michigan averaged 12.0 and 13.2 pellet groups/day (range = 11.5–17.9), depending at least

partly upon forage quality (Eberhardt and Van Etten 1956, Van Etten 1959). Penned white-tailed deer eating commercial ration and alfalfa in Texas defecated an average of 19.6 pellet groups/day (Rollins et al. 1984). Similarly low defecation rates (11 and 14 pellet groups/day) were observed in the present study when the deer were confined in the 2-ha pen in March. These low rates occurred despite supplemental feeding with commercial food, which reportedly increases defecation rates (Smith 1964).

The lower defecation rates observed for penned deer compared with those of free-ranging deer may be due in part to lower quality and variety of deer forage in pens than on natural range. In my study preferred browse in the pen was reduced by previous browsing, and the lower quality and variety of the remaining forage may have led to reduced consumption. Reduced intake is common for other ruminants on poor quality diets (Madsen 1939, Hale et al. 1962, Halls 1970). Variety is important in deer diets to avoid excessive amounts of any one of the many secondary plant compounds that inhibit digestion (Nagy et al. 1964, Longhurst et al. 1968, Freeland and Janzen 1974, Levin 1976) and to obtain a variety of elements that aid in digestion of other plants deficient in those elements (Ullrey et al. 1971, Church 1977, Hanson and Jones 1977:254–256, McCullough 1979, VanGilder et al. 1982). Dahlberg and Guettinger (1956) found that captive deer maintained weight better on a variety of 2nd-choice woody browse species than on a diet of eastern arborvitae, a 1st-choice winter food. Thus, lower defecation rates might be expected in pens where browse diversity is not sufficient to stimulate maximum consumption and optimum digestion.

The high defecation rates of the tame free-ranging deer, compared to those reported from previous studies, were not due to lower fecal amounts/defecation. Twenty-six pellet groups from study individuals averaged 68.7 pellets/group (range = 30–96 pellets), which is similar to the average of 69.0 pellets/group reported for 15 penned female deer in Michigan (Ryel 1971:49). The average 68.7 pellets/group was not different (t = 1.94, 305 df, $P > 0.1$) from the average of 81.1 pellets/group (range = 10–210 pellets/group, N = 281 groups) for wild deer in and near the study area. Moreover, the wild sample probably contained pellet groups from adult bucks which may produce more pellets/group than females do. A pen containing an adult buck and 2 does in Michigan averaged 94.6 pellets/group (Ryel 1971:49).

Because defecation rates of the free-ranging deer differed greatly with season and diet in northeastern Minnesota, regional calibration of defecation rates may be necessary if pellet group counts are to be used other than for determining population trends. In habitat similar to the study area, the commonly used rate of 13 pellet groups/day overestimates deer numbers if a high portion of the pellet groups persist until spring and are counted. The 7 females in this study averaged 34 pellet groups/day between 15 October (when leaf-fall is essentially complete) and 31 April (when snowmelt is sufficiently complete for counting pellet groups). Bucks may differ; penned bucks reduce food intake for up to 60 days during the fall rut but may defecate more frequently than females in winter (Ryel 1971:44, 49).

Additional studies of defecation rates of free-ranging deer are needed to determine sex- and age-related differences and to determine regional variation. Where winters are less severe and winter foods are of higher quality than in northeastern Minnesota, seasonal variation may be less pronounced than in this study.

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