The Effect of Seasonal Change on the Group Size, Group Composition, and Activity Budget of White-Tailed Deer, *Odocoileus virginianus*[1]

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ABSTRACT. **A free-ranging population of white-tailed deer (*Odocoileus virginianus*) located at the Miami University Ecology Research Center near Oxford, OH, was examined from October 1993 to February 1994 to determine seasonal changes in group size, group composition (number of males, females, and offspring), and behavior (feeding, locomotion, alert, and other behaviors). Observations took place at dusk in open pasture from a deer blind. Data were collected utilizing both scan samples and 60 second focal animal samples recorded on video. A significant increase in group size was found from fall to winter. No difference in group composition was found between seasons. Seasonal differences in behavior were found for all age/sex classes with an increase in feeding and a decrease in locomotion during the winter.**

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INTRODUCTION

Because of changing land use practices and growing human populations, the need for research concerning the ecology and management of deer has been increasing every year (LaGory 1979). In this respect, group size and behavior in relation to environmental conditions have comprised an important area of ungulate study. One way to quantify the numerous environmental changes that affect behavior throughout the year is to examine how behavior changes with the seasons. Seasonal divisions take several parameters into account, including phenological and climatological factors. In some African ungulates, group sizes vary temporally with seasonal variation in rainfall and consequently plant productivity (Estes 1974, Jarman 1974). Buschaus (1989) found mean group size of male, female, and mixed groups of fallow deer (*Dama dama dama*) varied over time, with total group size decreasing as the rut approached. In addition, several studies on white-tailed deer have noted increases in group size in the winter (LaGory 1978, Hawkins and Klimstra 1970, Payne 1995).

In several deer species, group composition has been found to change seasonally. Buschaus (1989) found that the number of solitary male fallow deer increased during the rut. Red deer (*Cervus elaphus*) group composition also varies seasonally, especially near the calving season when the maternal groups break up and the pregnant does separate to bear their young. Also at this time, the young stags leave the hind groups and join the older stag groups (Darling 1964). Several studies have also associated seasonal changes in white-tailed deer group composition with the onset of breeding (McCullough 1979, LaGory 1984, Payne 1995).

Seasonal changes in behavior have also been noted in red deer (Darling 1964), roe deer (*Capreolus capreolus*) (Turner 1979), white-tailed deer (LaGory 1984), mule deer (*Odocoileus hemionus californicus*) (Koutnik 1981), and fallow deer (Buschaus 1989). Male mule deer increase their aggressive behavior before the breeding season, while females show more agonistic interactions during the parturition season (Koutnik 1981). Male fallow deer also alter their behavior during the months of the rut, with an increase in aggressive and reproductive interactions and a decrease in maintenance activities (Buschaus 1989). In a white-tailed deer population in Georgia, LaGory (1984) found no age/sex class difference at any time of year, except for alert behavior (head raised above horizontal; no movement). During the summer and autumn, fawns spent more of their time alert and had more alert bouts than did adult bucks and does.

As the deer population continues to increase in Ohio (Stoll, pers. comm.), studies of how deer populations and behavior are affected by environmental factors are extremely important. Numerous studies in the Ohio Valley have examined the effect of habitat on deer behavior (LaGory 1978, LaGory 1979, LaGory et al 1985), but detailed seasonal studies are lacking (Rose and Harder 1985). The current study examined seasonal changes in group size, group composition, and the overall activity budget of white-tailed deer in open field habitat.

MATERIALS AND METHODS

This study was conducted at the Miami University Ecology Research Center near Oxford, OH (Butler County) from October 1993 to February 1994. The 50 ac study area encompassed open field habitat and was edged by forest to the south and west, goldenrod fields (*Solidago canadensis*) to the east, and an early successional stage field to the north. October and November were considered fall, while December, January, and February were considered winter (Rose and Harder 1985). General weather conditions were noted.

Observations were made at least two times a week (except for one week during severe weather) and began approximately one hour before dusk. Data were recorded from a deer blind with the aid of 8 x 40 binoculars and a Sony Video Camera Recorder.

Scan sampling and focal animal sampling (Altmann 1974) were the two methods of observation employed. In each scan sample, the age/sex class and behavior (listed below) of each individual in the group was recorded, providing information on group size, group

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composition, and an instantaneous sample of the group's activity. Focal animal samples were collected between scan samples. An individual within range was randomly selected and videotaped for 60 seconds. Video recordings were later reviewed on order to obtain the mean time spent in each behavior for each age/sex class.

Scan samples were taken at the first sighting of a group and then focal animal sampling was conducted until either each member of the group was sampled, the group left the study area, or visibility precluded further surveillance. After focal sampling, scan samples were taken again every minute until another group entered the study area or it was too dark to film but the deer were still visible through binoculars.

The size of the group was counted even if group composition could not be determined. For both group size and composition, solitary individuals were considered a group of one for statistical purposes. Groups were considered as solitary individuals or collections of individuals that moved together. If group size or composition changed during the observation period, the final subgroups were used in the analysis (LaGory 1978). Four group compositions were observed including: 1) does (solitary or groups), 2) bucks (solitary or groups), 3) doe-fawn, and 4) mixed (any combination of bucks and does, fawns present or absent).

Behaviors were grouped into four categories as follows (modified from Strickler-Shaw, pers. comm.):

1) Feeding: Included grazing (biting of herbaceous plants, usually with head below the withers), browsing (biting leaves and/or bark from woody plants), and food searching (walking with the head below the withers).
2) Locomotion: Included walking (moving forward with the head held at or below the withers) and running (any forward movement faster than a walk).
3) Alert: Head raised above the withers, ears erect, and the body rigid.
4) Other: Included reproductive behaviors such as chasing, following, or mounting, and grooming (itching, licking, or biting fur), urinating, play, sparring, and marking.

Seasonal changes in group size were determined using a one factor ANOVA. In order to detect any difference in group composition and frequency of behavior (from scan sampling) between seasons, a chi-square test of independence was utilized. A Bonferoni Z-test was then used to determine exactly which behaviors were significantly different between fall and winter. All age/sex classes were analyzed separately in the prior analysis of behavior. The data obtained from the focal animal sampling were analyzed using a MANOVA to determine how the season affected the behavior of each age/sex class. This test also allowed detection of any interaction present between season and age/sex class.

RESULTS

Group Size and Composition

A total of 59 groups were observed in the fall and 50 groups were observed in the winter. Group size ranged from 1-10 in the fall (X = 2.81, S.D. = 1.69) and 1-17 (X = 4.24, S.D. = 3.38) in the winter. Analysis of variance revealed a significant difference in group size between seasons ($F = 8.138$, $df = 1$, $p = 0.0052$), with larger groups occurring in the winter.

For both seasons the most common group composition was the doe-fawn group, while the mixed group was least common. Solitary fawns were not observed. No significant difference in group composition was found between seasons ($\chi^2 = 3.12$, $df = 3$, $p = 0.3732$).

Behavior – Scan Sample

Feeding was the most common behavior for all age/sex classes in both seasons with the exception of bucks in the fall (Fig. 1). Bucks spent an equal amount of time feeding and in locomotion in the fall. A significant difference in activity budget was found between seasons for does ($\chi^2 = 28.75$, $df = 3$, $p = 0.0001$), fawns ($\chi^2 = 13.78$, $df = 3$, $p = 0.0032$), and bucks ($\chi^2 = 8.20$, $df = 3$, $p = 0.0419$). All age/sex classes exhibited a significant increase in feeding ($p < .05$) and decrease in locomotion ($p < .05$) from fall to winter. The frequency of alert behavior did

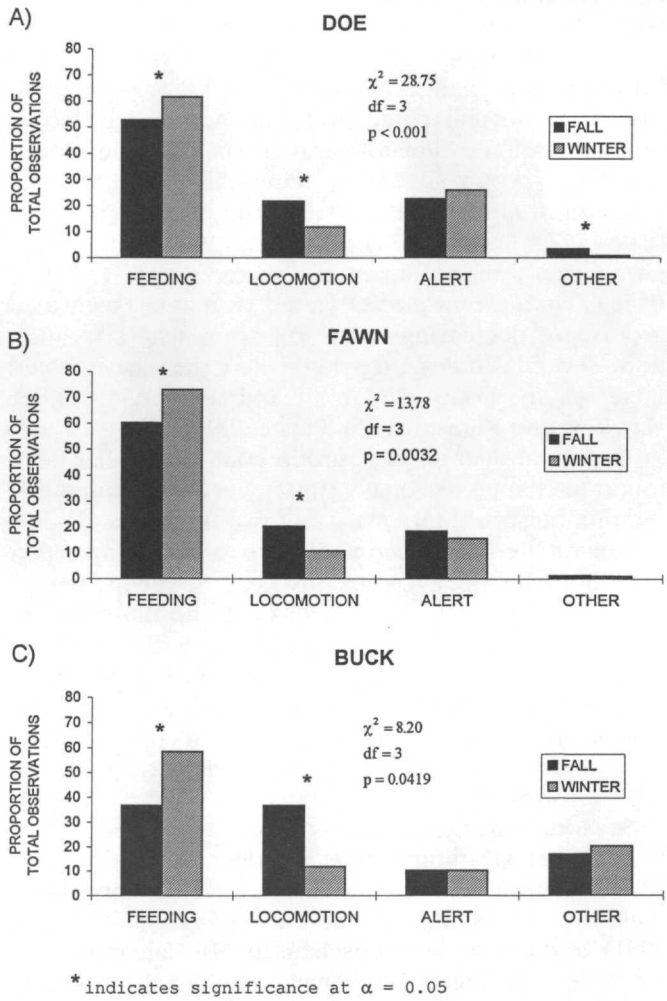

FIGURE 1. The proportion of total scan sample observations per behavior type compared between seasons for a) does, b) fawns, and c) bucks at the Miami University Ecology Research Center near Oxford, OH, from October 1993 to February 1994.

not differ significantly between seasons for any age/sex class ($p > .05$). No seasonal difference in other behaviors was noted for fawns ($p > .05$) and bucks ($p > .05$), although a significant decrease in other behaviors was found for does ($p < .05$).

Behavior – Focal Sample

Results of the MANOVA indicated no significant interaction between the two independent variables of season and age/sex class ($F[8,146] = 1.06$, $p = 0.3930$). However, a significant effect of season on proportion of time spent exhibiting a certain behavior was found ($F[4,73] = 3.35$, $p = 0.0142$). Feeding was significantly affected by a change of season ($F = 6.58$, $df = 1$, $p = 0.0123$). All age/sex classes spent a larger proportion of time feeding in the winter than in the fall. Season also had a significant effect on locomotion ($F = 10.73$, $df = 1$, $p = 0.0016$), with all age/sex classes decreasing the proportion of time walking or running in the winter. No significant difference between seasons was found for alert ($F = 12.67$, $df = 1$, $p = 0.8125$) and other behaviors ($F = 1.93$, $df = 1$, $p = 0.1683$).

Although weather conditions were noted, snow cover was the only quantifiable parameter recorded. Out of the 64 total observation days, snow covered the ground 7% of the time in the fall and 30% of the time in the winter.

DISCUSSION

Group Size and Composition

This study provided evidence that group size in a population of white-tailed deer increased from fall to winter. These results are similar to those of other studies of white-tailed deer. LaGory (1978) found very similar group sizes in a nearby population of white-tailed deer near Liberty, IN (Fall: $X = 2.50$, Winter: $X = 4.12$). LaGory (1978, 1984) also found a significant increase in group size from fall to winter and suggested larger groups allowed for less vigilant behavior and greater feeding time for each individual. This hypothesis, however, was not confirmed by the present study as the frequency of alert behavior did not differ between seasons. The observed change in group size may have been due to the breeding season, which, in Ohio, occurs from October to February with the peak usually the last week in November (Roseberry and Klimstra 1970). During this time the number of solitary individuals, especially males, increases (Hawkins and Klimstra 1970, Hirth 1977). After the breeding season, groups tend to reform as fawns and then yearlings begin to accompany does with increasing frequency (Hirth 1977).

Group size and composition are also affected by seasonal migrations. Migratory deer of several species often occupy a more limited area in their winter range than in their summer range, thus forcing more individuals to group together. Dahlberg and Guettinger (1956) reported that white-tailed deer in Wisconsin occupied an aggregate of over 16 million acres during the spring-summer-fall range, but concentrated within an aggregate of 1.5 million acres during the winter. In cold temperatures and two or three days before snow, red deer group together and, if conditions are sufficiently poor, daily movement is restricted and socially separate groups aggregate (Darling 1964). Studies of seasonal changes and their effect on group size and composition are especially important in winter when energy demands are at their peak. When population density is high, cold winters can greatly influence reproduction and survival of red deer (Clutton-Brock et al 1982). This may also be true for white-tailed deer in Ohio as evidence of starvation-induced death during the winter has recently been reported (Culbertson and Stoll 1995).

The high number of doe-fawn groups found both in the fall and in the winter in the present study agrees with other studies that found this group classification to be the most common (Hawkins and Klimstra 1970, Hirth 1977, LaGory 1978). Several studies on group composition also reported seasonal variations. Hawkins and Klimstra (1970) and Hirth (1977) found that adult does and their older female offspring reassociate in the fall and winter. LaGory (1984) reported that seasonal variation in group types was apparent in forested habitats with more doe-fawn groups occurring in the autumn and fewer occurring in the spring and summer. He also found that groups containing both doe-fawn and buck groups were relatively uncommon except during the breeding season. It is hypothesized that in the non-breeding season, adult bucks separate in order to minimize competition with their offspring for high quality habitat (McCullough 1979). The lack of any change in group composition in the present study, however, may be related to the fact that the breeding season overlapped both seasons examined and only one year of observation was possible.

Behavior

The current study found an increase in feeding and a decrease in locomotion during the winter for white-tailed deer. Similar seasonal changes in behavior have been found in other species of deer. Darling (1964) found that in December and January, when there is little variation in temperatures, daily movement of red deer was restricted. In parts of May and June, when daily temperature fluctuations were larger, daily movement was increased over a greater range. Turner (1979) found an increase in feeding and a decrease in locomotion during the winter in roe deer. He hypothesized that in times of potential energetic stress, animals can either reduce costs or increase energy income. This hypothesis is supported by our data as deer decreased time spent in locomotion and increased feeding time in the winter.

Another consideration is that feeding time might increase as a result of reduced quality and availability of vegetation during the winter, requiring an increase in feeding time to maintain an equivalent nutrient-energy income (Turner 1978). Although the nutritional status of deer in Ohio is generally considered high (Stoll and Parker 1986), 14 deer were found dead at Salt Fork State Park in February 1995 and the primary cause of death was starvation and secondary parasite problems (Culbertson and Stoll 1995). In Indiana, LaGory et al (1985) also found that white-tailed deer forage less selectively in winter, suggesting that food availability and quality are

important factors affecting deer behavior at this time. In the present study, seasonal changes in food availability may have been an important factor affecting deer behavior as snow cover was present more often in the winter than in the fall. In addition, the increased costs of thermoregulation may raise energy demands (Moen 1973) and could be related to the observed changes in behavior.

Nudds (1980) summarized all of these considerations in his "energy-maximization" strategy. He suggested that deer are forced to maximize caloric return per unit of energy expended, again citing reduced food availability, quality, and digestibility and the increased energetic costs of winter as contributing factors. The changes in behavior observed in the present study support this hypothesis and suggest that seasonal environmental change is an important factor affecting deer behavior.

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