SEASONAL VARIATION IN RESOURCE SELECTION OF JUVENILE MALE WHITE-TAILED DEER

by

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ABSTRACT

White-tailed deer (*Odocoileus virginianus*) have a significant impact on their habitat. Their populations have rapidly expanded in recent years due to increased accessibility to food resources. They are an important component of the ecosystems they inhabit, and are also a valuable part of human recreational activities, particularly hunting. Due to their large numbers, deer are causing significant losses in agricultural crops. Their role as both a predominant herbivore in the landscape and a prevalent aspect of human recreation makes them a crucial facet of modern wildlife management. When making management decisions, it is important to have information on the basic ecological processes of a species. Age class as well as gender can influence different behaviors in any species, therefore studying different demographic categories is necessary to gain a complete perspective of the ecology of a species. We studied the resource selection of six juvenile white-tailed bucks in an agricultural environment over the course of one year to determine which types of habitat the deer used during different seasons. We saw a trend towards using agricultural crop lands more than it was available during the growing season and a shift to forested and human-developed areas during the winter, however our small sample size makes the significance of those trends questionable.

Chapter 1

INTRODUCTION

Rapid human development of landscapes is providing generalist species with large areas of previously unavailable edge habitat. White-tailed deer (*Odocoileus virginianus*) is one such species. White-tailed deer tend to forage on the edges of clear-cut forests unless other desirable resources are present in the middle of the clear cut (Williamson and Hirth 1985). Increased access to agricultural resources enables greater incidence of individual survival in white-tailed deer populations. Deer populations frequently surpass carrying capacity and destroy agricultural crops, developed human landscapes and forested habitats (Colligan et al 2011, Conover 1997). The damage deer cause to agricultural habitats has been conservatively valued at 100 million dollars annually throughout North America (Conover 1997). In addition to the environmental consequences of white-tailed deer overabundance, increased deer numbers lead to greater frequencies of negative human-deer interactions (Rhoads et. al 2009).

Data about resource selection of white-tailed deer is an increasingly urgent component of wildlife management due to the feeding habits of large deer populations. Modern management of white-tailed deer in human-populated areas must incorporate data about seasonal resource selection shifts to better understand when and where deer are feeding during different times of the year. In agricultural areas, white-tailed deer diet is composed primarily of crops starting in June, and the availability of crops and other resources could influence resource selection (Colligan et. al 2011).

Additionally, white-tailed deer in an agricultural landscape use crops as a resource to compensate for the lack of natural forage provided by forests (Rouleau et. al 2002). White-tailed deer have seasonal shifts in resource selection corresponding to the changes in metabolic demands throughout the year, with males changing their home ranges between winter and summer (Beier and McCullough1990). However the seasonal home ranges of individual females have been shown to overlap (Rhoads et. al 2009).

While there are several studies pertaining to white-tailed deer resource selection, juvenile male white-tailed deer in the mid-Atlantic have not been extensively studied. Specifically, white-tailed deer movements and resource selection have been thoroughly examined in forested habitats, but information from largely agricultural and developed areas is limited. Climate, rather than agricultural resources, has played a significant role in seasonal home range determination for female white-tailed deer in Minnesota (Brinkman et. al 2005). However, data taken from one population of deer is not a good indication of other populations as white-tailed deer movements vary throughout their extensive range (Brinkman et. al 2005). Miller et al conducted a study examining female white-tailed deer resource selection in southern Delaware (2012), but their study did not include analyses of third order selection of males in the region (Johnson 1980).

The juvenile male age class overall is understudied, with most studies examining adult bucks in other regions of the country (Hellickson et al**.** 2008). Other studies examining white-tailed deer populations can also include predation as a factor that could influence resource selection and home range. The white-tailed deer population in southern Delaware does not have any natural predators besides humans and therefore have different influences on their foraging habits and resource selection. An individual's home range could be largely determined by forage abundance and could trend towards selecting habitats based on maximizing energy intake as opposed to minimizing potential exposure to predators (Masse 2009).

We captured and radio-collared six deer in Sussex County, Delaware in 2014 to examine resource selection and seasonal shifts. Our objectives were to determine the seasonal resource selection of the bucks. We found that there was a change in the resource selection that corresponded to the season.

Chapter 2

STUDY AREA

We conducted our study in Sussex County, Delaware. Sussex County consisted of 41% agricultural, 15% developed, and 44% natural areas (Miller 2012). The primary crops grown in the agricultural areas were corn, soybeans, and wheat (USDA 2012). From 1 December 2013 to 1 December 2014 the average temperature was 13.3°C (www.wunderground.com). Annual precipitation in Sussex County was an average of 112.0 centimeters (www.usa.com), and average annual snowfall was 31.9 centimeters (www.usa.com). A 2009 survey estimated the deer density to be 50.3 deer/square mile (www.dnrec.delaware.gov).

The total human population of Sussex County in 2014 was 206,649 (quickfacts.census.gov). Sussex County was open to public hunting and also offered a Severe Deer Damage Program provided by the state that allowed landowners to hunt antlerless deer causing damage to their property.

Chapter 3

METHODS

We captured deer in Sussex County, Delaware using baited drop nets from December 2013 to April 2014. We sedated all deer with an intramuscular injection of xylazine (0.5 mg/kg) and placed a blindfold over their eyes to reduce stress. Each deer received one numbered ear tag in each ear for future identification and we took body measurements including total length, neck diameter, chest girth and hind limb and shoulder length. We fitted males less than 1 year of age with an expandable GPS collar (Advanced Telemetry Systems, Isanti, MN). We reversed the sedation with an intramuscular injection of tolazoline (3.0mg/kg), and used an injection of vitamin E to counter any signs of capture myopathy. We monitored all deer until they left the capture site by their own power. All capture and handling techniques were approved by the University of Delaware Institutional Animal Care and Use Committee protocol number 1196. The GPS collars sent location data in the form of a coordinate point every twelve hours (0600 and 1800). We collected location data from the GPS collars from the time of capture until 31 December 2014. In this time, we caught and collared six male deer that contributed to our data.

To categorize the location data, we separated the twelve-month year into three seasons to delineate potential variation in resource selection. We categorized the year into a hunting season that lasted from 1 September to 31 January in accordance with the Sussex County hunting season (www.dnrec.delaware.gov), followed by a post-hunt season that lasted from 1 February to 31 May, and finally a summer season that spanned from 1 June to 31 August. We took the location data from the GPS collars that also included the date and time when the coordinate point was taken and filtered them according to the pre-defined seasons per deer, giving every deer between one and three separate data sets for the study year.

We collected data and generated home ranges for all six deer in the post hunt season. We had data from four deer in the summer season, and data from two deer during the hunt season. Using the coordinate data, we generated a 95% fixed kernel density home range estimate in R using the package 'adehabitatHR' and generated random points with the home range equal in number to GPS fixed locations using ArcMap 10.2. We buffered all points, both random and actual, by 30 m to account for position error. We extracted habitat data from the buffers and compared use vs. availability using a case-control logistic regression.

We calculated the probability of use and interpreted it from a use versus availability standpoint. We analyzed our data using a case control logistic regression that generated QICu values. Our SAS output created five models: agriculture, forested, wetland, developed and an overall model. The model with the lowest QICu indicated the clearest representation of the data. We calculated the change in QICu between the strongest model and all other models to determine if the other models were of similar representation. Models within two changes in QICu were similar. We weighted our ΔQICu values in order to determine the strength of a given model (Anderson et. al 2000).

Chapter 4

RESULTS

Of the six deer that we radio-collared, all six were active during the post hunt season and four were actively collecting data during the summer season. All deer had between one and three seasonal home ranges (Figure 1). During the post hunt season developed, forest and wetland land class categories were used more than they were available, and agriculture was used less than it was available (Table 1). In the summer season, agriculture was used more than it was available as were the developed and forest land class categories (Table 1). The agriculture model in the post hunt season was the clearest model overall with a percent change in use versus availability of -10.7, indicating that the deer used the agriculture land class less than it was available (Table 1). The agricultural model had a weight of 81.4% making it the strongest model (Table 2). There is a slight difference in the use versus availability for the post hunt season (Table 1). Developed, forest and wetland land class categories were all used slightly more than they were available (Table 1). The summer season did not have a significant difference between use and availability for any of the land class categories; therefore there was no best model for that season (Table 1, Table 2). The strongest model for the summer season was the wetland model with a weight of 36.4% (Table 1, Table 2).

While we included three seasons in our analysis: hunt, post-hunt and summer, we did not collect enough data for the hunt season to have adequate results. Out of our sample size of six deer, only two had data for the hunt season, with a total of 61 points between them.

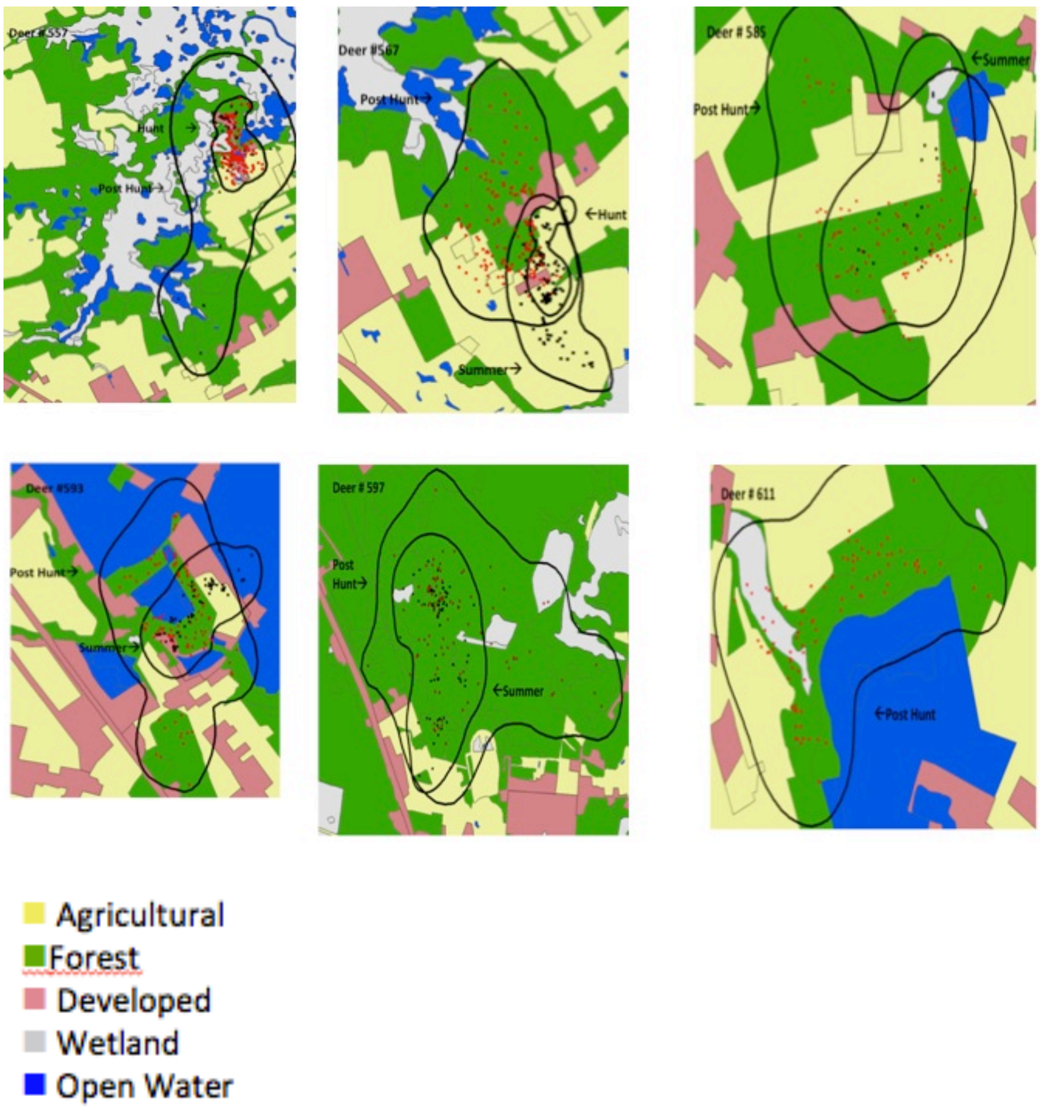
Table 1 Percent means and percent change of use versus availability for post hunt and summer seasons for 4 land class categories. Negative values in percent change indicate use was less than availability and positive percent change values indicate use was more than availability.

Post Hunt			
	Use(%)	Available (%)	Δ%
Agriculture	18.8	29.5	-10.7
Developed	12.3	9.7	2.6
Forest	36.6	30.2	6.4
Wetland	30.1	28.2	1.9
Summer			
Agriculture	48.5	42.3	6.2
Developed	5.7	4.8	0.9
Forest	16.4	15.6	0.8
Wetland	29.2	36.4	-7.2

Table 2 Resource selection results for post hunt and summer seasons using agriculture, developed, forest and wetland as models. The model set also includes a global model. QICu, ΔQICu and weighted QICu are included for every model.

Post Hunt				
Model	QICu	ΔQICu	Weight	K
Agriculture	2141.4917	0	0.814391032	2
Developed	2167.263	25.7713	2.06367E-06	2
Forest	2163.2027	21.711	1.57161E-05	2
Wetland	2168.5979	27.1062	1.05871E-06	2
Overall	2144.4495	2.9578	0.185590129	5
Summer				
Model	QICu	ΔQICu	Weight	K
Wetland	720.3478	0	0.36408281	2
Agriculture	721.3768	1.029	0.217648492	2
Developed	721.8483	1.5005	0.171937552	2
Forest	722.0333	1.6855	0.156746733	2
Overall	723.1522	2.8044	0.089584413	5

Figure 1 The seasonal home ranges of six juvenile male white-tailed deer with actual used locations within each home range. Home ranges are overlaid over the land use categories of Sussex County, DE. Points taken in the post hunt season are red circles, points from the summer season are black squares, and points from the hunt season are black triangles.



Chapter 5

DISCUSSION

We observed a slight shift in the seasonal resource selection of white-tailed deer over the course of a year. The differences between use and availability are slight, and because of this are not congruent with the findings of previous studies (Beier and McCullough1990, Brinkman et. al 2005, Miller 2012). The data show that deer used agriculture less than it was available during the post hunt season which does correlate to other studies that found that deer do not shift their resource use to agricultural lands until the growing season (Colligan et. al 2011). We observed a small amount of overlap between the seasonal home ranges for each deer that has been found in previous studies and could be indicative of a small seasonal shift in resource selection (Rhoads et. al 2009). Our findings could have not reflected a significant shift because of the lack of snow cover during the winter that gave the deer more access to resources that would have otherwise been unavailable during certain times of the year.

The use of forest and developed habitats during the post hunt season also indicates that deer shift their habitat usage to areas that have more resources according to the time of year. Shrubs and forbs planted in developed areas would be an appealing food source for the deer during the winter when there are limited agricultural resources. Similarly, forest resources such as bark, leaves and hard mast as well as shelter were available to the deer during the winter and could also explain the high use percentages during the post hunt season that contained the winter within its parameters.

The shift to use outweighing availability for the agricultural land class for our summer season reflects the food resources that are important to white-tailed deer, however our summer season was an anomaly because of the small difference between use versus availability. Typically, the difference between use and availability is greater and more significant (Latham 2015, Miller 2012).

Our small sample size and the high amount of variation individual deer introduced into the data contributed to our summer season failing to follow the typical results. The individual deer had too much influence on the data, therefore, one out of the four deer present in the summer season could have skewed the data by behaving atypically. The individual home ranges of each deer reveal that some deer, such as deer number 567 and deer number 585 used the agricultural land class during the summer season as expected. However, other deer such as deer number 597 had little use of the agricultural land class during the summer season. Deer number 611 only had data points in the post hunt season, which could have also contributed to the skewed data.

Our data does indicate use versus availability trends, however due to the limited sample size those trends may not be significant. Additionally, the results were heavily influenced by individual data that could have skewed results. Based on our data, we did determine that there was a slight shift toward agricultural lands during the growing season. The deer continued to use the developed and forest land class categories throughout all of the seasons, which could be because of the large amounts of land that are considered. All of the deer had seasonal home ranges that overlapped, meaning that they did not change their entire range with the seasons, but rather expanded or shifted their ranges to accommodate for the increased resources provided by agricultural lands in the summer.

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