The Pennsylvania State University

The Graduate School

College of Agricultural Sciences

HABITAT USE AND BEHAVIOR OF ROSE-BREASTED GROSBEAKS IN CENTRAL PENNSYLVANIA

A Thesis in

Wildlife and Fisheries Science

by

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Submitted in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science

May 2009

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ABSTRACT

Rose-breasted Grosbeak (*Pheucticus ludovicianus*) populations are declining overall but have increased in some areas within their range. There are conflicting descriptions of Rose-breasted Grosbeak habitat, and several studies assume they are mature forest birds. The Barrens Grouse Habitat Management Area (BGHMA) on State Gamelands 176, Centre County, Pennsylvania, provides a unique combination of habitat-age classes in small 1-ha plots, ranging in age from 7-8 to >70 years and arranged in 4-ha blocks in both cherry-maple (*Prunus serotina* and *Acer rubrum*) and mixed-aspen (*Populus* spp.) habitat types. The objective of this study was to determine Rose-breasted Grosbeak habitat use when given a wide range of habitat-age classes in a small area during the summers of 2007 and 2008. I compared abundance of Rose-breasted Grosbeaks in different habitat-age class plots at the BGHMA to establish habitat use. I also determined the proportion of time spent in, and frequency of, (four) behaviors of Rose-breasted Grosbeaks. Rose-breasted Grosbeaks consistently used the early successional 7-8 year old habitat over other age classes. Rose-breasted Grosbeaks in 7-8 year old habitat spent the greatest proportion of their time in paused behavior but engaged in a higher frequency of territorial behavior. My research indicates that Rose-breasted Grosbeaks likely are declining due to habitat succession, and that silvicultural practices that generate small openings should aid in the recovery of this species.

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ACKNOWLEDGMENTS

I thank my advisor, Richard Yahner, for his guidance and insight throughout my research and writing experience. I also thank my committee members Margaret Brittingham and Nancy Ostiguy for all of their input and suggestions, particularly to Nancy for her help with statistics. I especially appreciated comments on my writing from Megan Rogers. I am particularly grateful to the students from the Ag Leap program: Morgan Pfeiffer, Nicole O'Block, Lisa Monastero, Jess DiMarzio, Zachary Craig, Hilary Sullivan, Peter Bernstein, Sam Nau, and Molly Burbank; Kacey Dananay, my parents, George and Joanne Stewart; and my fiancé, Jim Allshouse for their many hours of help collecting vegetation data wading through brush in the August heat. Funding for this project came from the University Wastewater Management Committee, the Pennsylvania Agricultural Experiment Station, and a McKenna Stewardship Award.

INTRODUCTION

Rose-breasted Grosbeak (*Pheucticus ludovicianus*) populations in Pennsylvania have been declining at a rate of 1.4% per year since 1980, and are declining throughout their geographic range (Sauer et al. 2007). During the breeding season, Rose-breasted Grosbeaks (RBGR) range from a southern extremity of the Appalachian mountains, north throughout the Mid-Atlantic states, New England and into southern Canada and throughout the Midwestern states, ending in the eastern portions of North and South Dakota, Nebraska and Kansas (Sauer et al. 2007). Partners in Flight estimate the global population of RBGR to be approximately 4,600,000 (Rich et al. 2004), and now list RBGR as regional stewardship species of planning and responsibility in three of their bird conservation regions. Despite their decline in Pennsylvania and throughout their geographic range, RBGR populations at the Barrens Grouse Habitat Management Area (BGHMA) in central Pennsylvania have been increasing during the same time period (Yahner 1997, 2000, 2008) and RBGR are known to breed at the BGHMA (Schill 2007). The particular habitat characteristics of the BGHMA may shed light on the habitat required for RBGR success.

Habitat use by RBGR is controversial. For instance, Sibley (2003) describes the RBGR as a mature forest bird, whereas Audubon (Bull and Farrand 2004) labeled it as using edges and tall shrubby areas. Peterson (Peterson and Peterson 2002) describes the RBGR as using a wide range of deciduous habitats.

Studies evaluating the effects of silvicultural practices on bird populations seem to confirm the classification of RBGR as an edge or an early successional bird (Rodewald and Yahner 2001, Smith et al. 2006, Askins et al. 2007). When comparing old-growth forest sites to Breeding Bird Census and Breeding Bird Atlas data in Pennsylvania, Haney (1999) found that RBGR on the Appalachian plateau had a negative affinity to old-growth forest in comparison with the surrounding landscape. Rose-breasted Grosbeaks may show a preference for aspen (*Populus* spp.) dominated habitat (Erskine 1977), therefore I compared RBGR habitat use in aspen habitat to black cherry (*Prunus serotina*) and red maple (*Acer rubrum*) dominated habitat.

Habitat that is preferentially used does not guarantee success (Van Horne 1983, Smith et al. 2007), and nesting success does not necessarily differ between habitat that is used more than habitat that is used less (Friesen et al. 1999). If habitat use is not a strong indicator of nesting success, other factors negate the advantage that might be conveyed by residence in the used habitat. One way to determine what other factors may be involved is to evaluate behavior (Yahner and Mahan 2002). Measures of abundance and density do little to infer why one habitat is use more than another (Van Horne 1983). Anecdotal behavior of RBGR is well documented (Ivor 1944, Dunham 1966a, b, c); however, behavior has not been quantified in any way, nor has it been documented with regard to habitat. To my knowledge, there seem to be no prior accounts of estimating passerine time-budgets in the field. I speculate that determining frequency and proportion of time spent in various behaviors may make it possible to draw conclusions regarding why a particular habitat is favored.

The lack of study regarding passerine time-budgets is likely a reflection of the fact that field observation of bird behavior presents special problems. Because the instantaneous and scan sampling technique described by Altmann (1974) can provide a “snapshot” of group activity, it is often used to determine the percent of time spent in various activities. The advantage of this method is that, when samples are collected in a relatively short period of time, they resemble a simultaneous sample of all individuals, or a "snapshot," and therefore this method is better for speculating about the general behavior of a population. However, this method also relies on samples being taken at predetermined time intervals, and finding individuals at predetermined time intervals over a large area is difficult. Altmann also describes the focal-animal technique, in which an individual is followed as much as possible for a predetermined length of time and behaviors of interest, or all of that individuals behaviors, are recorded during that time. Because the focal-animal technique does not rely on data being taken at specific time intervals, it is better suited to field observation of passerines over large areas; but, it lacks the "snapshot" created by the instantaneous and scan sampling technique and is not as easily generalized to a population. In an effort to quantify behavior of RBGR in the field, I attempted to combine these two techniques.

In this study, my primary objective was to determine whether RBGR use a particular forest successional stage more than others, given three choices of habitat age class. Studies that indirectly address habitat-use use large study areas that often are widely spaced; thus, differences in landscape-level features cannot be ruled out (Probst et al. 1992, Hobson and Bayne 2000, Smith et al. 2007). By using small-scale (1-ha) adjacent plots with different successional stages of forest, I assumed that differences in habitat use are due entirely to features associated with the habitat-age class. My other objectives were to determine whether RBGR use either cherry-maple or mixed-aspen habitat types more, and whether there are differences in behavior among habitat-age classes and habitat types.

METHODS

Study Area.—The Barrens Grouse Habitat Management Area (BGHMA) is on State Game Lands 176, near State College, Pennsylvania (10 km away). The BGHMA and surrounding area were timbered several times; the most recent clear-cut occurred between 1908 and 1918 (Westerfeld 1939). The area also was mined for its iron ore deposits from before 1800 until 1909, and there was moderate residential use associated with the mines. Commercial and residential use of the area has declined since 1909 and ended in 1937.

In 1976, the Pennsylvania Game Commission began the BGHMA to produce ruffed grouse (*Bonasa umbellus*) habitat (Storm et al. 2003). The study area includes 1,120-ha and is split into a 576-ha untreated sector, with 4 transects, and an adjacent 544-ha treatment sector (Fig. 1), with 4 transects (Storm et al. 2003). Both the untreated and the treatment sectors contain mixed-oak and aspen habitat types, as designated by the Pennsylvania Game Commission when the BGHMA was initiated. However, since that time, the mixed-oak habitat type has regenerated with a dominant cover of black cherry and red maple, hereafter referred to as cherry-maple habitat type, based on basal area determined in my vegetation analysis.

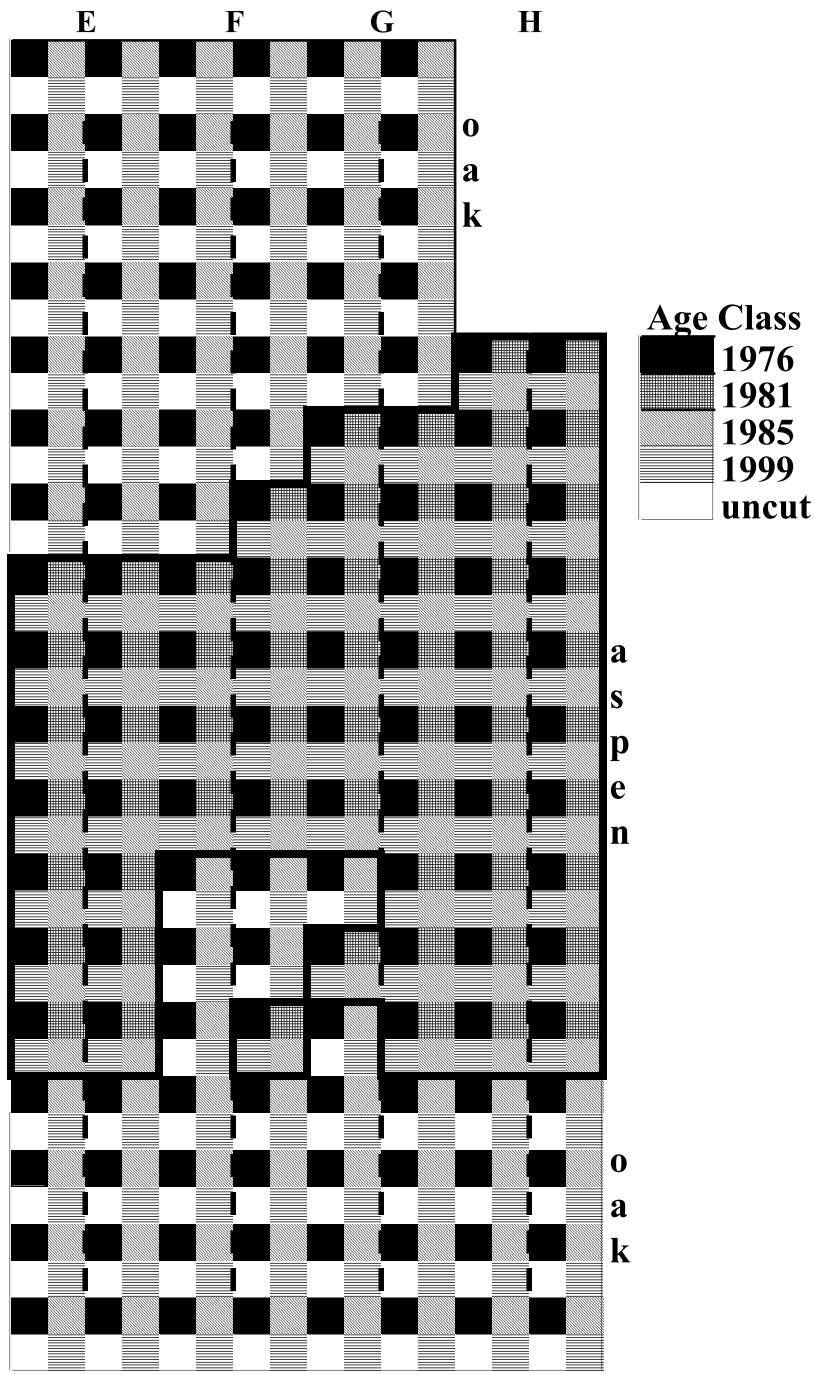

FIG 1. The 544-ha treatment sector at the Barrens Grouse Habitat Management Area at State Game Lands 176, near State College, Pennsylvania, summers 2007 and 2008. The age class of each 1-ha plot was determined by the first cutting year of that plot. The 1976 plots were cut in the winter of 1976-77, the 1981 plots in 1981-82, the 1985 plots were cut between 1985-1988, and the 1999 in 1999-2000.

The treatment sector consists of 4-ha blocks, each divided into four, 1-ha plots. One plot in each block is scheduled to be cut approximately every 10 years in the aspen habitat type and every 20 years in the cherry-maple (formerly oak) habitat type (Fig. 1). However, during the initial rotation period, the schedule was reduced to every 5 years for aspen and 10 years for cherry-maple. After 1986-88, cutting was delayed until 1999 to maintain greater size class diversity. The delay was 8 years and 4 years from the originally scheduled date in aspen and cherry-maple habitat types, respectively. Age structure on the treated sector ranges from approximately 100 years of age to approximately 8 years of age.

There are now five habitat-age classes at the BGHMA. The three corresponding habitat-age class plots are those that were cut in 1976, 1985, and 1999. Because I wanted to determine if RBGR preferentially used a particular habitat type, I only observed birds in the three habitat-age classes that corresponded in the cherry-maple and aspen habitat types.

Habitat Use.— I observed habitat use by Rose-breasted Grosbeaks (RBGR) on the treatment sector at the BGHMA along transects E, F, G, and H (Fig. 1), eight times each year (Svensson et al. 1970) from during summers 2007 and 2008. I began my surveys during the first week of May, approximately when RBGR had arrived at their breeding grounds at this latitude (Peterjohn and Rice 1991), and ended them when I encountered less than one bird per mean visit, roughly during the first week of July. Rose-breasted Grosbeaks are single-brooded (Wyatt and Francis 2002), and their young fledge at approximately the beginning of July at which time the adults become cryptic. I created a schedule for my surveys such that each transect was visited once every four days, but the order in which it was visited was randomized. I did not conduct surveys during thunderstorms, or during periods of heavy rain, but I did conduct surveys during periods of light or intermittent rain. I observed birds within 100 m perpendicular to the transects, corresponding with the depth of a 1-ha plot. Each transect was 3.22 km long, and I walked approximately 1.6 km/hr, allowing me to conduct my surveys during the first four hours after dawn when the birds were most active (Svensson et al. 1970).

In 2007, I also observed habitat use along transects on the untreated sector. Preliminary statistical analysis revealed a significant difference in habitat use between treated and untreated sectors; therefore, I did not include the untreated sector in my 2008 surveys. During 2007, I walked two transects each morning; in 2008, I walked one transect each morning. I did not walk two transects daily during 2008 because I found that behavioral observations required enough additional time that one transect took approximately three hours to cover. Because continuing on to a second transect during the same morning would mean making observations outside of the 4-hour window of peak activity, I opted to walk only one transect daily. Not making observations on the untreated sector during 2008 allowed me to make the daily reduction and still make 8 visits during the season. During both years, I only recorded the locations of vocalizing males, and in 2008 I recorded behavior of vocalizing males whenever possible.

Behavior.— I classified behavior into four categories: foraging, territorial, maintenance, and pause. Foraging included eating and searching for food (Dunham 1966a). Territorial behavior included singing, the “chink” vocalization, chasing, and mobbing (Dunham 1966b, c). Maintenance behaviors included bill-wiping, scratching, fluffing, preening, cleaning the feet, stretching, and any other hygiene or comfort-related behavior (Dunham 1966a). Paused behavior was any period of time where the bird ceased its previous activity and was not performing any other visible behavior (Yahner 1978). Although RBGR are known to breed in the 1999 habitat-age class (Schill 2007), I did not record breeding behavior, as such behavior is not often seen in males (Dunham 1966c). However, I did informally monitor approximately 10 nests to help determine the end of the breeding season.

Because I was unable to find any literature addressing observation of passerine time-budgets in the field, I adapted my methods from the focal-animal technique and instantaneous and scan technique described by Altmann (1974) using techniques described Mahan and Yahner (1999), who worked at the BGHMA, and techniques described by Bradley (1985). The focal-animal technique uses continuous time sampling (i.e., all behaviors within a time period are precisely recorded using a stopwatch), which can lead to discovery bias. Therefore, if I were able to find a vocalizing male, I waited for 1-minute before recording behavior in an effort to avoid discovery bias (Bradley 1985). I observed behavior of any vocalizing male that I was able to find without disruptive searching. I determined whether a search would be disruptive simply by observing whether I could quietly walk through the vegetation surrounding the approximate location of the RBGR.

I recorded behavior using a tape recorder with a small microphone attached to binoculars (Yahner 1978). I combined the focal-animal technique with the instantaneous and scan technique (Altmann 1974) by limiting every observation period to 5 minutes. By doing so, I attempted to merge the "snapshot" effect of the instantaneous and scan technique with the flexibility of the focal-animal technique. I recorded each behavior a bird performed until the RBGR was lost from sight or for a maximum of 5 minutes. Observation periods less than 30 seconds in length were excluded from analysis, as were observations of the bird clearly reacting to my presence. I transcribed the length of time each RBGR spent in a specified behavior from the recordings using a stopwatch. I also determined the frequency of behaviors within each observation period.

Vegetation analysis.—I quantified vegetation characteristics in the three habitat-age classes using the 0.04-ha circle method modified from James and Shugart (1970). I randomly selected five samples from each habitat age class for both the cherry-maple and aspen species classes (30 samples total, 15 each from cherry-maple and aspen), distributed on all four transects. Instead of using a specific tree with a nest as the center of my circles, I used the approximate center of chosen plots.

Statistical Analyses. — I used the relative abundance of vocalizing male RBGR in different habitat-age classes to determine which habitat-age class was being used the most. To separate individuals from the number of encounters, I assumed that a RBGR heard in the same plot on multiple occasions was one bird unless I heard two birds in the same plot at the same time. In other words, if I encountered a bird in the same plot more than once, it was only included once in the analysis. I took care not to count the same bird twice, and I assumed that birds did not travel among plots and that observations in different plots were independent because the mean size of RBGR territories is 0.77 ha and because RBGR usually exclude conspecifics from their territories (Dunham 1966c).

I pooled data from both years for my analyses and assumed that RBGR established new territories each year (Yunick 1996). I divided the pooled data by two to determine the means for each habitat type and habitat-age class individually, and I then used a chi-square goodness-of-fit test with equal distributions (based on the means rounded up to the nearest whole bird) to determine differences in use among habitat age classes. Because the number of plots sampled among age classes and habitat types were unequal, I used chi-square goodness of fit tests (Zar 1999) to determine that differences in number of plots sampled both among age classes and between habitat types was insignificant. I therefore did not transform the data to correct for sampling inequality. To test for interaction among habitat types and habitat-age classes, I used a single chi-square test of independence.

Based on the mean abundances between years for each habitat-age class and habitat type, I determined the approximate density of RBGR for each habitat-age class at the BGHMA. I divided the means for each habitat-age class and habitat type by the number of plots of that habitat-age class for each habitat type found along the transects. In the cherry-maple habitat type, there were 29 plots in the 1976 habitat-age class, 33 in the 1985 habitat-age class, and 33 in the 1999 habitat-age class. In the aspen habitat type, there were 32 plots in the 1976 habitat-age class, 28 in the 1985 habitat-age class, and 32 in the 1999 habitat-age class. I used the resulting density estimates of RBGR per ha of each habitat-age class to approximate the number of male RBGR in the three habitat-age classes on the entire treated sector at the BGHMA, not just the ones adjacent to the transects. Because the 1982 and the uncut (Fig. 1) were not included, the resulting abundance estimate likely under estimates the number of male RBGR at the BGHMA.

I was only able to record the behavior of a small number of birds ($n = 20$), and their distribution among the habitat-age classes was extremely uneven with 14 in the 1999 habitat age class, five in 1985 and one in 1976, which may have reflected abundance among habitat-age classes. Hence, I used only descriptive statistics to characterize the frequency (number of times per minute) of and proportion of time (Yahner 1978) spent in behaviors.

RESULTS

Habitat Use.—I recorded 145 individual male Rose-breasted Grosbeaks (RBGR) during summers of 2007 and 2008, with no difference in abundance between years (Table 1). Of those I encountered, 10 were in the 1976 habitat-age class, 35 were in the 1985 habitat-age class, and 100 were in the 1999 habitat-age class. Rose-breasted Grosbeaks used the 1999 habitat-age class the most, followed by the 1985 habitat-age class, then the 1976 habitat-age class (Table 2). During 2007, I observed 28 individual male RBGR on the untreated sector, compared to 75 individual male RBGR on the treatment sector at the Barrens Grouse Habitat Management Area (BGHMA; χ^2 goodness-of fit test: n = 103, df = 1, χ^2 = 21.4466, $P < 0.001$). Habitat use between cherry-maple and aspen habitat types did not differ (Table 2). There was no interaction among habitat age class and habitat type.

TABLE 1. Number of individual male Rose-breasted Grosbeaks observed in two habitat types and three habitat-age classes on the treatment area at the Barrens Grouse Habitat Management Area at State Game Lands 176, Centre County, Pennsylvania, USA, summers 2007 and 2008 combined. Habitat-age class is denoted by the first year the trees in an area were harvested.

Habitat type/year		**Habitat Age Class**		
	Total	**1976**	**1985**	**1999**
2007				
Cherry-maple	42	2	11	29
Aspen	33	6	8	19
2008				
Cherry-maple	34	1	8	25
Aspen	36	1	8	27
Both Years*				
Cherry-maple	76	3	19	54
Aspen	69	7	16	46

* Difference in abundance between years was insignificant: χ^2 Goodness of Fit test, n = 145, df = 1, $P = 0.678$

TABLE 2. Significance of χ^2 Goodness-of-Fit tests and χ^2 Test for Independence comparing habitat use in two habitat types and three habitat-age classes by the mean number (rounded up to the nearest whole bird) of male Rose-breasted Grosbeaks at the Barrens Grouse Habitat Management Area at State Game Lands 176, Centre County, Pennsylvania, USA, summers 2007 and 2008 combined.

Test ❐	***n***	**df**	χ^2	***P***
Habitat-age class	74	2	41.9459	<0.001
Cherry-maple vs. aspen, 1976	6*	1	0.666667	0.414
Cherry-maple vs. aspen, 1985	18	1	0.222222	0.637
Cherry-maple vs. aspen, 1999	50	1	0.32	0.572
Cherry-maple vs. aspen, combined	74	1	0.216216	0.642
χ^2 Test of Independence	*	2	0.996	0.608

* Two cells had an expected value less than 5.

I estimated abundance in all three habitat-age classes along the transects to be less than one male/ha (Table 3). Thus, the estimated abundance for each habitat-age class on the whole treatment area was also less than one (Table 3). Based on the density estimates, I calculated that the yearly abundance of male RBGR in the all of the 1976, 1985, and 1999 habitat-age classes (including those not sampled) at the BGHMA was approximately 155 adult birds. Given an approximate sex ratio of 1.3:1 males per female RBGR (Whittle 1938, Yunick 1996), I estimate there are approximately 120 adult female RBGR in the 1976, 1985, and 1999 habitat-age classes at the BGHMA, for a total abundance of approximately 275 adult RBGR.

TABLE 3. Estimated yearly abundance and density of male Rose-breasted Grosbeaks in three habitat-age classes and two habitat types on the treated sector at the Barrens Grouse Habitat Management Area at State Game Lands 176, Centre County, Pennsylvania, USA, based on mean abundance during summers 2007 and 2008 combined.

	Total	**1976**	**1985**	**1999**
MEAN ABUNDANCE				
Cherry-maple	38 (95)	1.5 (29)	9.5 (33)	27 (33)
Aspen	34.5 (92)	3.5 (32)	8 (28)	23 (32)
Total	72.5 (187)	5 (61)	17.5 (61)	50 (65)
DENSITY❖ (males/ha)				
Cherry-maple	0.4000	0.0517	0.2879	0.8182
Aspen	0.3750	0.1094	0.2857	0.7188
Total	0.3877	0.0820	0.2869	0.7692
EST. ABUNDANCE*				
Cherry-maple (76)	88	4	22	63
Aspen (60)	67	7	18	44
Total (136)	155	12	40	105

❖ density = mean number of males per habitat-age class ÷ (number of patches of habitat-age class adjacent to transect)

* estimated yearly abundance = density * (number of patches of habitat-age class on treatment sector), rounded up to the nearest whole bird

Behavior.—Rose-breasted Grosbeaks spent the greatest proportion of time in territorial behavior in 1976 and 1985 habitat-age classes (Table 4). They also spent a large proportion of time in territorial behavior in 1999 habitat-age class; however, a slightly greater proportion of their time was spent in paused behavior. Rose-breasted Grosbeaks engaged in territorial behavior at a greater frequency than any other behavior. However, lengths of bouts of RBGR behavior were longer for foraging than for any other behavior, and shortest for territorial behavior (Table 5).

TABLE 4. Mean frequency of (number of times per minute) and proportion of total time spent in four behaviors by male Rose-breasted Grosbeaks in three habitat-age classes at the Barrens Grouse Habitat Management Area, Centre County, Pennsylvania, USA, in summer 2008.

Behavior		**Habitat Age Class**		
		1976 (*n*=1)	1985 (*n*=5)	1999 (*n*=14)
Foraging				
	Frequency	0	0.679	0.867
	Proportion of time	0	0.199	0.104
Territorial				
	Frequency	6.457	6.395	4.779
	Proportion of time	0.57	0.48	0.293
Maintenance				
	Frequency	0.561	0.398	1.938
	Proportion of time	0.017	0.018	0.259
Pause				
	Frequency	5.895	3.762	3.773
	Proportion of time	0.413	0.303	0.344

* Because of small sample sizes (e.g., 1976 *n*=1), the mean does not estimate the population mean, but only that of the data collected. It is used here only as a descriptive measure of the data.

I observed that individual RBGR often alternated between territorial and paused behaviors, most often singing and pausing. Maintenance behavior also was alternated with pause, but was more often alternated with territorial behavior. Individuals that were engaged in foraging behavior tended to alternate between foraging and territorial behaviors, intermixed with an occasional maintenance behavior (often bill-wiping), and pause, with no pattern. Only one individual engaged in foraging bouts for the entire time that I followed it. Throughout that time, it alternated only between foraging and singing, only once performing a grooming behavior. Bouts of foraging behavior averaged longer than bouts of any other behavior (Table 5).

TABLE 5. Mean duration of bouts of four behaviors of individual male Rose-breasted Grosbeaks in three habitat-age classes at the Barrens Grouse Habitat Management Area, Centre County, Pennsylvania, USA, in summer 2008. Each row represents one individual.

		Mean duration of behavioral bout, in seconds, and (number of bouts) per individual			
Habitat Age Class	Individual*	Foraging	Territorial	Maintenance	Pause
1976	1	.	5.3 (23)	1.8 (2)	4.2 (21)
1985	2	18.7 (2)	0.7 (2)	.	.
	3	.	7.8 (4)	.	4.8 (2)
	4	6.4 (1)	4.1 (33)	1.6 (2)	5.5 (12)
	5	.	4.1 (16)	1.2 (1)	4.1 (15)
	6	.	4.5 (19)	4.2 (3)	5.4 (17)
1999	7	.	8.3 (11)	3.1 (8)	3.2 (7)
	8	9.5 (16)	4.8 (16)	5.1 (1)	.
	9	6.8 (3)	4.6 (18)	4.8 (4)	4.4 (6)
	10	3.3 (5)	4.5 (9)	.	4.1 (7)
	11	.	3.3 (11)	.	4.9 (10)
	12	.	5.5 (7)	11.2 (4)	6.4 (3)
	13	7.2 (2)	2.8 (7)	2.8 (3)	7.5 (7)
	14	.	2.4 (4)	.	5.9 (4)
	15	.	1.6 (34)	5.8 (31)	3.6 (16)
	16	.	4.1 (19)	6.6 (13)	4.1 (18)
	17	.	2.3 (3)	6.4 (6)	3.9 (3)
	18	9.1 (6)	1.6 (9)	11.7 (2)	5.7 (11)
	19	.	.	53.4 (1)●	.
	20	.	2.8 (4)	.	11.5 (4)
	Combined❖	8.71	3.95	5.10	5.25

* Individuals are numbered for clarity only. Numbers do not represent the order in which individuals were discovered.

● This is the only individual observed that performed only one behavior during observation.

❖ The maintenance value listed here excludes the outlier mentioned above, when the outlier value is included, the combined mean is 8.55 s.

Although I did not include breeding behavior as a category for analysis, I did see evidence of breeding. I saw females carrying nesting material on several occasions, and I monitored several nests informally, and saw two males incubating. In order to observe the nests after the foliage had completely leafed out, I had to get within at least 5 m to see the nest. The parent always reacted, so I was unable to record behavior of males on the nest. I did not see any of the male breeding behaviors described by Dunham (1966c), but

I did see males chasing females. I was unable to record the chases because they were too fast for me to follow in and out of the vegetation and ended before I could switch on the tape recorder. On one occasion, I came across a juvenile RBGR that was yet unable to fly. I approached it in order to identify it, and as soon as I got too close, I was mobbed with "chink" by a male RBGR that I presume to have been the father. I was able to record the incident, but I did not include it in analysis because the male was clearly reacting to my presence.

Vegetation Analysis.— Rose-breasted Grosbeaks did not respond to differences in tree species composition between cherry-maple and aspen habitat types. The dominant tree species in the aspen habitat type was bigtooth aspen (*Populus grandidentata*); the cherry-maple habitat type was dominated by black cherry (Table 6). The 1999 habitat age class was dominated by shrub cover (Table 6, Appendix); but a number of mature residual trees were left to grow, and those residual trees are now the dominant species; however, the shrub regeneration reflects the species with the highest relative density, not the dominant species by basal area. Because RBGR did not show a preference for either the cherry-maple or aspen habitat type, vegetation data (Table 6) were not tested for statistical differences.

TABLE 6. General vegetation characteristics and dominant tree species in three habitat-age classes and two habitat types at the Barrens Grouse Habitat Management Area.

		General Characteristics				Characteristics of dominant tree species			
Habitat-Age Class	Habitat type	Basal Area♦ (m^2/ha)	Canopy height (m)	% Canopy cover	Shrubs/ha*+	Dominant species	Basal Area (m^2/ha)	Relative Dominance❖	Relative Density❑
1976	Cherry-maple	29	16.10	82	5436	black cherry (*Prunus serotina*)	10.67	37	36
						red maple (*Acer rubrum*)	9.93	35	38
	Aspen	31	16.13	75	9390	bigtooth aspen (*Populus grandidentata*)	21.65	70	56
						black cherry	3.41	11	23
1985	Cherry-maple	15	12.65	87	31134	red maple	4.79	31	42
						red oak (*Quercus rubra*)	3.904	26	19
	Aspen	17	12.22	79	42995	bigtooth aspen	12.7	74	64
						black cherry	1.68	10	12
1999	Cherry-maple	1	4.5	63	32123	red oak↑	0.35	23	17
						black cherry↑	0.35	23	17
						white oak (*Quercus alba*)↑	0.35	23	17
						shagbark hickory (*Carya ovata*)↑	0.35	23	17
						red maple	0.1	7	33
	Aspen	2	4.14	69	79565	red oak↑	0.84	40	7
						bigtooth aspen	0.54	26	79

♦ Total basal area of all tree species observed

* In the 1999 habitat-age class, the area was visually dominated by shrubs <2.5cm DBH. The dominant shrub species in both cherry-maple and aspen habitat types reflected the species with the highest relative density, not the dominant species.

\+ Shrubs in the cherry-maple habitat type tended to be more branching, likely resulting in the discrepency between the habitat types in the number of actual stems.

↑ Only one of each of these were recorded, but their diameter limit made them dominant. The trees in the cherry-maple habitat type were all in the 23-53.5 cm DBH size class, and the red oak in the aspen habitat type was in the 53.5-68.5 cm DBH size class.

❖ Dominance = (total basal area of the species ÷ total basal area of all species)* 100

❑ Density = (number of trees of the species ÷ total number of trees of all species)* 100

DISCUSSION

Habitat Use.— Rose-breasted Grosbeaks (RBGR) tend to be classified either as mature forest birds or as early successional or edge species (Peterson and Peterson 2002, Sibley 2003, Bull and Farrand 2004). My findings and past research conducted at the Barrens Grouse Habitat Management Area (BGHMA) and nearby (Yahner 1993, 1997, Rohnke and Yahner 2008) are consistent with the classification of RBGR as an early succession or edge species; however, the presence of RBGR was not restricted to early successional habitat, indicating that my findings are congruent with those of Askins et al. (2007), and the better classification of RBGR is that of a shrubland or forest edge generalist rather than as a specialist.

The idea of RBGR as an early succession generalist is supported by anecdotal (Caswell 1889, Reed 1897, Gabrielson 1915) and specific (Smith et al. 2007) accounts of nesting at heights ranging from 1.5 to >11 m , as well as by their foraging habits (Holmes and Robinson 1981, Robinson and Holmes 1982). In addition, Smith et al. (2006) found higher densities of RBGR at sites that had been heavily timbered using diameter limit cuts than at unharvested reference sites where approximately 15% of the basal area had been removed. However, due to the habitat characteristics at the BGHMA, the presence of early succession may not entirely explain a preference by RBGR for the 1999 habitat-age class.

Because RBGR forage primarily by gleaning insects from leaves (Holmes and Robinson 1981, Robinson and Holmes 1982), early succession habitat next to forest edges may provide a good combination of nesting and foraging substrates for RBGR. Trees along edges tend to have more leaf area and deeper crowns than those in forest interiors (Brisson 2001, Mourelle et al. 2001, Sherich et al. 2007), providing more potential foraging substrate for RBGR. Edges also tend to be warmer than forest interior (Chen et al. 1993) and thus may have increased insect activity, which would provide more prey for RBGR; in addition, insect diversity near forest edges is greater than in open (field) habitat (Hradetzky and Kromp 1997). Residual trees left standing at the BGHMA were beginning to share more crown characteristics (e.g., lateral limb growth and more leaf area) with edge trees than with forest interior trees (personal observation). The small plot size of silvicultural treatments at the BGHMA also meant that the habitat-age class created in 1999 was closely surrounded by edge habitat. I often observed RBGR in residual trees, and they are known to utilize residual trees within harvested stands (Talbott and Yahner 2003).

Forest edge is an important part of the habitat classification of RBGR because their greater use of shrubland nesting substrate may lead to increased nest failure as a result of predation (Smith et al. 2007). However, RBGR nesting on forest edges have higher nesting success than those nesting in forest interior spaces, suggesting that edges provide good habitat (Friesen et al. 1999). The study areas used by Smith et al. (2007) ranged in area from 15 to 270 ha and were surrounded by fragmented agriculture; therefore, grosbeaks inhabiting these sites may not have had access to forest-edge habitat. Thus, amount of nesting substrate was maximized, whereas amount of foraging substrate was limited. The increased nest predation that occurred on nests observed by Smith et al. (2007), may have been caused by parents spending less time at the nest and more time foraging. Although more time spent on the nest does not guarantee a nest will succeed, in RBGR both sexes are known to aggressively harass objects perceived as a potential threat

(Ivor 1944, Dunham 1966b). Furthermore, when areas of clearcut, two-age management, and unharvested forest were compared, Rose-breasted Grosbeaks significantly were more abundant in areas of two-age management, followed by clearcut and unharvested (McDermott and Wood 2009). Two-age management creates a habitat similar to that of the habitat-age classes created in 1999 at the Barrens GHMA, where remnant mature trees are intermixed with early succession shrubland.

Even though evidence suggests that RBGR may use aspen habitat over other habitat types (Erskine 1977), I found no evidence of such at the BGHMA. Black cherry and red oak (*Quercus rubra*) were of secondary dominance in the aspen habitat type, which may account for their being no difference from the cherry-maple habitat type. Another consideration is that, because of the remnant trees left after cutting, both the cherry-maple and the aspen habitat types were dominated by red oak in the 1999 habitat-age class. The shrub layer, which created the canopy in the 1999 habitat-age class, was dominated by either maple or aspen depending on the habitat type. Further study will be required to determine the importance of the mature remnant trees vs. the shrub layer. Regardless, when considering the viability of small even-aged management in Pennsylvania, an important note is that habitat that was dominated by mixed oak (the cherry-maple habitat type) does not appear to regenerate with the same species dominance post-harvest (Fei et al. 2005).

The discrepancy over habitat use by RBGR can be primarily attributed to studies of the effects of forest fragmentation and forest age on avian populations (Hobson and Bayne 2000, Cumming and Diamond 2002). These studies excluded habitats young enough to attract RBGR. For example, the youngest stands Cumming and Diamond

(2002) evaluated were 50-years-old and the youngest stands evaluated by Hobson and Bayne (2000) were 21-years-old; neither study included early successional habitat. Whereas, the BGHMA had 8-year-old to approximately 70-year-old habitat available in a small enough area for a single bird to have access to any habitat-age class in that range. Cumming and Diamond (2002) and Hobson and Bayne (2000) likely found an increase in RBGR abundance in more mature forest because older tracts of forest tend to have more canopy openings where early succession can occur. Rose-breasted Grosbeaks likely increased in abundance as the availability of canopy openings increased. Therefore, because individual RBGR at the BGHMA had access to a range of habitat-age classes from early succession to mature forest, it is probably safe to conclude that RBGR do use early successional or edge habitat more than mature forest.

In studies where RBGR used more late successional habitat, even when early successional habitat was evaluated, the plot areas used were often quite large (Probst et al. 1992, Hagan et al. 1997). If RBGR require both shrubland and edge characteristics for their habitat, then the large plot areas used by the investigators may not have included an adequate mix of habitat. In addition, the density of early successional birds does not increase with clearcut area (Rudnicky and Hunter 1993, Krementz and Christie 2000, Askins et al. 2007), indicating that if the late successional habitat that was investigated by Probst et al. (1992) and Hagen et al. (1997) had enough canopy openings, it could have shown a higher relative abundance of RBGR than the early successional habitat they investigated. Thompson and Capen (1988) described Rose-breasted Grosbeaks as being associated with closed-canopy forests; however, their clearcut plots included an unspecified number of plots with purely herbaceous cover, which shares more characteristics with prairie than shrubland. There is no evidence associating RBGR with prairie habitat; therefore Thompson and Capen's results may have shown greater use of closed-canopy forest by RBGR because the early successional habitat they evaluated included prairie. My findings support the idea that RBGR might require both shrubland and edge habitat characteristics, based on the fact that the plots at the BGHMA were small enough (1-ha) and had enough remnant trees that they shared common characteristics with purely edge habitat and early successional habitat.

Perhaps the most influential, yet least researched, aspect of the RBGR habitat use discrepancy is reinforced by what people can observe most readily on their own. DeGraaf and Wentworth (1986) found that RBGR were found in areas with human housing more densely in old neighborhoods with 70-year-old trees. Because so much of the human population is likely more familiar with bird habits in their own back yards, observations made by DeGraaf and Wentworth probably support what people have noticed on their own, thus, the idea of RBGR as a bird preferring mature trees would become a common idea to the general public. Such an association might contribute to the idea that RBGR prefer mature forest but in fact better supports the edge hypothesis. Because neighborhood trees tend to be separated by houses, sidewalks and other structures, they receive more light from all angles and produce more lateral limbs, thus the architecture of trees in a neighborhood more closely resembles that of trees on edges and that of the residual trees left in the habitat-age class created in 1999 at the BGHMA.

Behavior.— My behavioral findings are insufficient to confirm the hypothesis that RBGR require both shrubland and edge habitat characteristics. Because almost three quarters of my data are from individuals observed in the habitat-age class created in

1999, and I observed only 20 individuals, it was not possible to draw statistically significant conclusions.

Although I attempted to avoid discovery bias by waiting 1-minute before beginning my recordings (Bradley 1985), I believe that by using vocalizing males as my discovery criterion, my data are biased toward territorial behavior, and under-represent foraging behavior. I observed that RBGR most often alternated between territorial (singing) and paused behaviors. Although not quantifiable in decibels, I noticed that RBGR seemed to sing softly while foraging, and were less cryptic while engaged in other behaviors. I may have encountered fewer foraging RBGR for the simple reason that I did not hear them. In support of the observation that RBGR sing more softly while foraging, Kroodsma (1974) noted that Rose-breasted Grosbeaks sang more softly when they were in close proximity to one another, and indicated that attack tendency was weaker during quiet song. I hypothesize that Rose-breasted Grosbeaks at the BGHMA may sing more softly while foraging in order to decrease the likelihood of attack from nearby conspecifics. By singing more softly while foraging, RBGR may seem less threatening to nearby conspecifics, and may be able to forage more efficiently. More obviously, singing softly would be less likely to startle prey than singing loudly.

Another second possibility is that, despite my efforts to be unobtrusive, I was observed by the RBGR, and the high frequency of territorial and paused behavior was the result. When I, or another animal, was perceived as a high-threat to an RBGR it was obvious, the bird either flushed or mobbed. On one occasion, I even observed an individual RBGR harassing a Red-tailed Hawk with the “chink” vocalization at a distance of about 10 m. Because I was most often about 30 m from an individual, I was most likely far enough away that I was not a high enough threat to merit mobbing behavior, or more direct aggression, but perhaps the individual sang more often than it typically would have in order to assert its presence. Individuals that observed me may have avoided engaging in behaviors other than territorial and pause in order to be more vigilant of me.

A third consideration is that the territorial behavior category was unnecessarily lumping behaviors. Because the category includes activities such as chasing, singing, "chink," and mobbing, which all are also associated with breeding, I find that the term "territorial" assumes intent, which cannot be inferred by observation. Lumping all of these behaviors into the territorial category may have masked male breeding behaviors. Chasing and singing are used to establish and defend a territory, but they are also used when showing interest in a female or for drawing a female in (Dunham 1966c). Mobbing and "chink" are both used for defending a nest or nestling, and "chink" is used for pair-bond formation and communication between the pair (Dunham 1966c). Despite the fact that males do sit on the nest (Ivor 1944), the proportion of time spent on the nest by females vs. males remains unknown, as well as whether either or both parents stay with the young after they fledge. I observed solitary fledged juveniles, as well as a group of juveniles with an adult male, but the male did not stay with the juveniles. Ivor (1944) described all of these behaviors but did not quantify them, and he indicated that the males were left by the females to handle the tail-end of the process.

For the sake of eliminating bias in the future, it is probably worthwhile to sacrifice the "snapshot" effects given by integrating the instantaneous and scan technique and use only the focal-animal technique. I think the best data could be acquired by using multiple field technicians to spot-map RBGR territories and then observe RBGR behavior in those territories using the focal-animal technique. Longer observation periods, though difficult, might allow an observer to follow a bird through more cryptic behaviors (such as foraging) from a period of more visible behavior, and breaking behavior down into more specific categories will provide more detailed information. However, it is also possible that RBGR spend very little time foraging if given optimal habitat; without an adequate comparison to behavior in sub-optimal habitat it is impossible to tell. Although behavioral data of passerines are difficult to gather, particularly in forested landscapes, quantifiable data will shed light on why nests fail or succeed in different situations, and why we observe greater use of particular habitats.

Because RBGR have shown population increases at the BGHMA (Yahner 1997, 2000, 2008) despite an overall decline in the state of Pennsylvania (Sauer et al. 2007), the BGHMA is an important local source of habitat for RBGR (Yahner 2003). Given that RBGR used early successional habitat more than other habitat-age classes available at the BGHMA, it seems likely that RBGR populations are declining partially as a result of habitat loss via forest succession throughout their breeding range (Brawn et al. 2001).

CONCLUSIONS

Rose-breasted Grosbeaks (RBGR) at the Barrens Grouse Habitat Management Area (BGHMA) used the 1999 habitat-age class more than the older two age classes, and did not show a difference in the use of cherry-maple and aspen habitat types. Discrepancies regarding RBGR habitat use most likely result from a combination of studies that did not evaluate early successional habitat, studies that used very large study areas that may have minimized foraging substrate, and common observation of RBGR in mature trees in suburban neighborhoods. I suggest the best habitat classification for RBGR is one of a shrubland or forest edge generalist. Early successional habitat is used by RBGR over other habitat types, and locations, such as the BGHMA, managed with the purpose of maintaining a diversity of successional stages will be important to maintaining RBGR populations.

In future studies, a combination of spot-mapping and focal-animal observation with the use of a blind may provide the best data, and behavioral categories should be carefully described and determined in order to avoid unnecessary lumping. Caution should be used when regarding my behavioral data, as it was only based on one breeding season, and I did not have enough data to evaluate possible changes in behavior from the start to the end of the breeding season. Future research regarding the habitat use of RBGR should focus on using behavior as a way to determine why RBGR use one habitat type more than another. An important part of such research will be to include a measure of nesting success to determine whether the population is succeeding. Quantitative data on RBGR behavior at the nest will fill gaps in the knowledge of RBGR breeding behavior, particularly male involvement. Despite the fact that bird behavior is difficult to observe in the field, valuable information can be gathered by doing so and will add to the body of knowledge regarding the habitat requirements of Rose-breasted Grosbeaks.

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APPENDIX.

APPENDIX. Locations, trees per ha and basal area of tree species present at the Barrens Grouse Habitat Management Area

		Trees/ha (basal area (m^2)/ha) by Species Class and habitat age class					
		Cherry-maple			Aspen		
Common Name	Scientific Name	1976	1985	1999	1976	1985	1999
red maple	*Acer rubrum*	450 (9.93)	331 (4.79)	10 (>0.09)	89 (1.19)	84 (0.84)	.
pignut hickory	*Carya glabra*	.	10 (0.69)	.	.	.	.
shagbark hickory	*Carya ovata*	.	15 (0.25)	5 (0.35)	.	.	.
mockernut hickory	*Carya tomentosa*	5 (0.15)	15 (>0.29)	.	.	.	.
pitch pine	*Pinus rigida*	.	.	.	.	.	5 (0.35)
bigtooth aspen	*Populus grandidentata*	15 (0.64)	.	.	583 (21.65)	677 (12.70)	54 (0.54)
quaking aspen	*Populus tremuloides*	.	.	.	.	74 (0.84)	.
black cherry	*Prunus serotina*	425 (10.67)	84 (2.32)	5 (0.35)	242 (3.41)	128 (1.68)	.
white oak	*Quercus alba*	30 (0.59)	84 (1.43)	5 (0.35)	25 (0.64)	84 (1.04)	5 (0.35)
chestnut oak	*Quercus monana*	99 (3.16)	89 (1.48)	.	.	.	.
pin oak	*Quercus palustris*	5 (0.15)	.	.	.	10 (>0.09)	.
black oak	*Quercus vetulina*	.	.	.	10 (>0.39)	.	.
red oak	*Quercus rubra*	133 (3.21)	153 (>3.90)	5 (0.35)	99 (3.46)	5 (0.05)	5 (0.84)
sassafrass	*Sassafras albidum*	25 (0.25)	5 (0.05)	.	.	.	.