



GEORGIA JOURNAL OF SCIENCE

Volume 62

2004

Number 2

CONTENTS

President's Comments and Report from the Academy Council
Cynthia S. Mayer 78

The Successful Use of Case Studies in Nutritional Biochemistry
C. Michele Davis 79

Bat Activity in Central Appalachian Wetlands
Karen E. Francl, W. Mark Ford, Steven B. Castleberry 87

Avian Response to Forest Management and Military Training Activities
at Fort Benning, Georgia
Lisa Duncan, John Dilustro, Beverly Collins 95

Description of the Georgia Academy of Science and Application 104



GAS President's Comments and Report from the Academy Council

As the newest Georgia Academy of Science President, I have been planning my direction of the Academy for the next year. After the successful and relaxing experience of our last annual meeting at Berry College, I experienced some major changes in life and moments of clarity. As a long-time member and leader within the Academy, I realize that it is a common place where we interact with colleagues and students in ways to conduct and report upon innovative research and instructional methodologies, as well as to form networks and friendships that can last a lifetime. In recent years, the Academy, like many other non-profit institutions, has seen a decline in its membership and general level of activity of the members that remain. My main goal for the upcoming year is to improve the general membership numbers and activity levels, but particularly among students, now that we have established a student membership category.

Last year, I was involved with developing a resolution regarding the teaching of evolution versus intelligent design theory that endorsed the stance of the AAAS, which can be viewed on our web site at www.gaacademy.org, under Useful Links. I intend to continue monitoring developments in this realm and I intend to continue working on another major development that began last year with a very interesting proposal to the Kellogg Foundation with Army Lester. Together, we worked on developing a plan that will establish an ongoing research opportunity to draw students into the Academy and foster local research projects across the state. You will see much more about this in the coming months.

I want to hear from any member who has ideas or projects that the council needs to address. Therefore, I invite you to call or e-mail me when you have a problem or concern or suggestion. I look forward to working with you this year.

Cynthia S. Mayer, President
Kennesaw State University
cmayer@kennesaw.edu

THE SUCCESSFUL USE OF CASE STUDIES IN NUTRITIONAL BIOCHEMISTRY

C. Michele Davis
Georgia Southern University
Statesboro, GA 30460-8064
mdavis@georgiasouthern.edu

ABSTRACT

The Department of Chemistry at Georgia Southern University provides foundation courses for nutrition majors in the Department of Health and Kinesiology. One foundation course is Nutritional Biochemistry – a one-semester course that focuses on the basic principles of biochemistry as they apply to human metabolic systems. The students gain familiarity with biological molecules such as proteins, fats, and carbohydrates, and they learn how the body metabolizes each of these molecules. Traditionally this course has been taught with a lecture-based format placing the students in a passive learning role. Recently, case studies have been incorporated as a supplement to these lectures allowing small student groups solve problems similar to the types of problems they will encounter in their chosen profession. This method motivates and engages students because they see relationships between complicated metabolic pathways and metabolic or nutritional disorders. The case study method has proved to be very successful in the Nutritional Biochemistry course at Georgia Southern University. The students were actively engaged in learning the material, and these exercises developed their analytical skills as well as writing skills.

Keywords: Biochemistry, Learning Aids, Nutrition

INTRODUCTION

The Department of Chemistry at Georgia Southern University (GSU) provides two foundation courses for nutrition majors in the Department of Health and Kinesiology, a General Organic and Biochemistry (CHEM 1140) followed by Nutritional Biochemistry (CHEM 2542). Nutritional Biochemistry is a one-semester course that focuses on the basic principles of biochemistry as they apply to human metabolic systems. The students gain familiarity with biological molecules such as proteins, fats, and carbohydrates, and they learn how the body metabolizes each of these molecules. In the past Nutritional Biochemistry has been taught in the traditional lecture/laboratory method. The students could recite many biochemical facts, draw the structures for many carbohydrates, amino acids, and fats as well as complicated metabolic pathways (including all the intermediates), but they often *could not* see a connection between these pathways and subsequent health problems. Making these types of connections is not just a problem at Georgia Southern University but has been acknowledged in other undergraduate biochemistry courses (1). Since it has been well documented that

case studies motivate students and allow them to make connections among many different concepts, case studies were incorporated into Nutritional Biochemistry as a supplement to traditional lectures (2).

The case study method has been used for years to teach law, business, and medicine with substantial success (1-4). In the past instructors of science have rarely used the case study method, but this fact has changed in the past two decades. Articles have been published in several journals in which instructors describe using case studies in general chemistry (5,6), environmental chemistry (7), molecular modeling and computational chemistry (8), biochemistry (9), and non-majors sciences courses (10). Cases are usually written as dilemmas that give a personal history of an individual, institution, or business faced with a problem that must be solved. The students must work through all the facts and analyze the problem. Then as a team they consider possible solutions. The goal of using the case study method is to teach students how the process of science works and the development of higher-order skills or learning while also teaching science content. This method holds great promise as a pedagogical technique for teaching science, especially for students who are “turned-off” by the traditional lecture format (5-10). Case studies humanize science while illustrating the scientific method. They develop students’ skills in speaking, writing, and analytical thinking. Students learn by doing instead of listening to a lecture or reading a textbook (5-10). Case studies make the concepts encountered in the lecture and in the textbook relevant since most are centered on problems that students will face in their future profession (11). For this course, case studies were chosen that deal with metabolic disorders, diseases that are the result of poor nutrition, or diseases that can be managed by a dietary change in conjunction with or in lieu of drugs.

BENEFITS OF CASE STUDIES

Description of Assignment

After covering the basic structure of biological molecules and intermediary metabolism, students embark on one of two case studies they will complete in a given semester. The class is divided up into small groups of 3-5 students and each group is assigned a different patient although all patients possess a common metabolic disorder. Each case is divided into two sections. The initial portion of each case study is an information gathering exercise; reference articles and websites are provided with a list of questions that investigate the metabolic problem, which is the focus of the case, as well as diets, supplements, or drugs that claim to treat the conditions and requires approximately 15-20 minutes of class time. The second portion of the assignment includes a discussion of the background research and then each group is given a patient who is suffering from the same metabolic condition they have researched and requires approximately 50 minutes of class time.

Section I:

- Professor presents case to entire class.
- Students divided up into groups and discuss their plans for dividing up the background research.
- Students are given 3-5 days to complete their individual research and

each team member receives a grade based on the value of his or her research.

Section II:

- Discussion of background research involving entire class.
- Each student group receives their patient and a list of questions from the patient.
- Each student group must answer all of the patient’s questions and formulate a nutritional plan as if they are a team of nutritionists the patient has contacted.
- To present their plan, each group writes a short paper (2-4 pages) in the form of a letter to the patient. Each team receives a grade for the paper and each member of the team receives the same grade.

EVALUATION

To evaluate the effectiveness of each case study, I presented students with a survey immediately after they completed each case. Surveys contained between 8-12 statements, and the students were asked whether they agreed, strongly agreed, disagreed, strongly disagreed, or were neutral to each statement as well as a section devoted to student comments.

Table I: Survey Response Results

	Strongly Agree	Agree	Disagree
My knowledge of the connection between nutrition and [specific metabolic disease] was increased by this activity.	85%	15%	
Our group was able to formulate a nutritional plan for our patient based on the information gathered earlier by our group.	70%	11%	19%
I would enjoy the opportunity to participate in another case study.	92%	8%	

Table II: Student Comments

I like the fact that we were able to apply what we have been learning in class to a “real life situation.”
I liked the fact that it was a real life simulation. It made my group want to work harder because we were acting as if we were really [a group of] nutritionists.
The case study was fun and interesting! We learned by talking to each other.
Finding out information together seemed realistic.

To further evaluate the effectiveness of this method, exam scores were examined. During the 2001 Spring semester, the Nutritional Biochemistry course was composed of 20 students, and no case studies were utilized that involved metabolic pathways. In contrast, the 2002 spring semester Nutritional Biochemistry course was composed of 26 students, and two case studies were presented that focused on metabolism and the connections between several metabolic pathways. Initially, final exams scores were examined since this exam is comprehensive and cumulative, including all metabolic pathways. When an increase was noticed in the section where case studies focusing on metabolism were used, the regular exam that focused mostly on metabolic pathways and their connections was also examined.

Table III: Comparison of Exam Scores

	2001 Spring Class	2002 Spring Class
Final Exam Averages	71 ± 2.31* %	76 ± 2.16* %
Final Exam Score Range	46% - 95%	55% - 94%
Exam #4 Averages	77 ± 2.31* %	80 ± 2.61* %
Test #4 Score Range	48% - 98%	61% - 98%

* 95% Confidence Limit.

A small but noticeable increase in performance is shown in Table 1 for the 2002 Spring Class (the section in which case studies that focused on these topics were employed). Other exam scores were examined to determine if the 2002 Spring Class performed better overall than the 2001 Spring Class, and no correlation was noted. The final averages for both classes were within two percentage points of each other.

CASE STUDY SOURCES

Writing case studies for one's courses is rewarding but can be very time consuming. Fortunately there are several books and websites that provide excellent cases for all disciplines, including biochemistry and nutrition. These sources usually include a case, a case solution, teaching notes, and integration techniques. For certain courses, minor modifications of these case studies may improve teaching effectiveness and student learning. Some of the most popular books and web sites are noted below:

Books

- Biochemistry: A Case-Oriented Approach* (12)
- Biochemistry: A Problems Approach* (13)
- Biochemical Reasoning* (14)
- Clinical Detective Stories: A Problem-Based Approach to Clinical Cases in Energy and Acid-Base Metabolism* (15)
- Learning Biochemistry: 100 New Case Oriented Problems* (16)
- Textbook of Biochemistry with Clinical Correlations* (17)

Web Sites

- National Center for Case Study Teaching in ScienceWeb (18)
- ChemCases: Case-Study General Chemistry Curriculum Supplements (19)
- University of Delaware PBL Clearinghouse (20)
- The Clearinghouse for Decision Case Education: Agriculture, Food, Natural Resources and the Environment (21)

DISCUSSION

The incorporation of case studies into the Nutritional Biochemistry curriculum at Georgia Southern University gave students the opportunity to learn in a more active environment. They gained knowledge of metabolic diseases and were able to make connections between the diseases and the metabolic pathways discussed in class. By working with their peers to solve the problem of their patient, the student teams learned by doing, not by listening to a lecture and memorizing specific points or structures!

The most popular case study in this course focused on Type II Diabetes (22) and a wide range of treatment options such as the Atkin's Diet, the herbal supplement Ephedra, and the American Heart Association's diet accompanied by exercise. The basic metabolic pathways of glycolysis, fatty acid metabolism, amino acid metabolism, and the Krebs cycle were revisited, but also signal transduction and insulin's role in glucose metabolism. When discussing the Atkins's Diet, the process of ketosis was reinforced, and students realized why the patient might be at an increased risk for kidney disease by looking back at the metabolic pathways of fats and proteins. The difference between thermogenesis and ketosis became very clear while discussing Ephedra as well as the fact that natural does not necessarily mean "good for you".

Additionally, these exercises allowed students to be creative. Almost every student team established their own nutritional firm name and approximately one-third of the teams came up with their own firm logo and used it to create personalized letterhead on which they wrote their patient letter. All students were actively engaged in solving the patient's problem, even the students who typically did not do well in the course. The only major criticism of this method by the students on both the case study evaluations and the end of the semester evaluations was the value of the case studies as a percentage of their final grade. In the past the combination of both case studies contributed to about 8-10% of their grade for the course. Several student comments indicated that the "amount of time and effort required to complete these case studies should have been worth more points". In the future, I plan to have the two case studies worth the same as one test grade, approximately 15-18% of their final grade.

The case study method has proved to be very successful in Nutritional Biochemistry. Not only are students actively engaged in learning, but they are also able to sort through a vast amount of information and make connections between this material and problems they might encounter in their future careers. These case studies allow students to be creative while developing their analytical and critical thinking skills as well as their ability to write and communicate.

APPENDIX I

A Sample Case Study
Adapted from Rubin, L. and Herreid, C.F.
Morgan: A Case for Diabetes
<http://ublib.buffalo.edu/libraries/projects/cases/diabetes/diabetes1.html> (accessed July 1, 2003)

Heather: A Native American Woman with Diabetes

Heather, a 27 year old Native American woman, was obese and led a sedentary lifestyle. She had heard of diabetes because one fourth of her tribe had this disease, but Heather had no family history of diabetes, heart disease, or other serious conditions; she never imagined she was at any risk. In the past few months, she had been experiencing unusual thirst, dizziness, blurred vision, and an awkward feeling of numbness in her right foot. She finally visited her family doctor on the advice of her parents. She was concerned but never suspected what she would hear.

After running several tests, Heather's doctor entered the room and said, "I'm sorry, Morgan, but the tests I've conducted unfortunately reveal that you have Type 2 diabetes. Your symptoms are exactly like those we see in many Native Americans. I understand this news is devastating for you, but I want to clarify that Type 2 diabetes is easily controllable through exercise, good nutrition, and weight loss."

"You mean if I lose weight I'll be OK?"

"Yes. If you are careful, weight loss will help manage your disease, and exercise will also help your condition. Please schedule an appointment with our nutritionist, Dr. Navarro. Losing weight will be easier for you, in my opinion, with the guidance of a professional. Come back in one month for a checkup, OK?"

The next day, she spoke of her condition to her family and friends and explained how weight loss was supposed to be an effective treatment. Her close friend Savannah suggested the Atkins' Diet. She told Heather the diet was fabulous because she could eat steak, chicken wings, and all the good stuff you enjoy and still lose weight.

"I don't know," said Morgan's brother, Alan. "There's a lot of argument about the Atkins' Diet. I think the best thing for you to do is exercise and stop eating all of junk food and sitting around the house."

Morgan sat silently, listening to the family debate and getting more confused. Finally, she asked her grandfather his opinion. He said nothing for a long moment and then, "Morgan, I think you should look to traditional herbal remedies for help. What Alan says is true. Exercise is good. But it is sometimes not enough. Our people have always looked to the natural medicine for cures. They will lift your spirits and energize you. Then you will lose weight and you will be healthy again."

"Do you mean I should take those herbs from the diet shop?"

"Yes. I hear they are safe and good. But you must take them like the medicine label says. It can't hurt to try them."

Activity I:

Research the general facts of diabetes. Your main objectives are the following:

1. Distinguish between Type 1 and Type 2 diabetes by comparing and contrasting their definitions, bodily effects, warning signs, target groups, and current treatments in a table.
2. Look up statistics to share concerning both types of diabetes.
3. Know the function of insulin and its involvement with diabetes.
4. Why does diabetes cause a great risk of cardiovascular disease?
5. How do blood triglycerides factor into this?
6. Is there a cure for diabetes?
7. What are some ways to control insulin resistance?

Activity II:

What should Morgan do? As a group, determine a recommendation for Morgan as your client.

1. Research the pros and cons of the Atkins' Diet.
2. Research health store supplements containing the herbs such as fat absorbers, appetite suppressors, and ephedra. What do major healthcare organizations say about it?
3. Learn about the possible effects of exercise to control weight.
4. Try to tie in aspects of each weight loss approach with the risks that Morgan now has with Type 2 diabetes. For example, should her risk for kidney disease and cardiovascular disease affect her choice?
5. Note if each approach stresses exercise or just dietary changes. What is the importance of exercise?

References

1. *Nature* 13 Dec. 2001. Seven review articles published on diabetes. *Nature* 414:782-827.
2. Diabetes Facts and Figures (American Diabetes Association) <http://www.diabetes.org>
3. National Institute of Diabetes & Digestive & Kidney Diseases <http://www.niddk.nih.gov>
4. Diabetes & Cardiovascular Disease <http://www.heartinfo.org/news2001/diabetes.083100.htm>

LITERATURE CITED

1. McNair MP and Hersum AC: "The Case Method at the Harvard Business School." New York: McGraw-Hill, 1954.
2. Barrows HS and Tamblyn RM: "Problem-Based Learning: An Approach to Medical Education." New York: Springer, 1980.
3. Christensen CR and Hansen AJ: "Teaching and the Case Method." Boston: Harvard Business School Publishing Division, 1987.
4. Herrid CF: Case Studies in Science: A Novel Method of Science Education. *J Coll Sci Teaching* 23: 349-355, 1994.

5. Brink CP, Goodney DE, Hudak NJ and Silverstein TP: A Novel Spiral Approach to Introductory Chemistry Using Case Studies of Chemistry in the Real World. *J Chem Educ* 72: 530-532, 1995.
6. Challen PR and Brazdil LC: Case Studies as a Basis for Discussion Method Teaching in Introductory Chemistry Courses. *Chem Educ* 1: 1-5, 1996.
7. Cheng VKW: An Environmental Chemistry Curriculum Using Case Studies. *J Chem Educ* 72: 525-527, 1995.
8. Ringan NS and Grayson L: Molecular Modeling in the Undergraduate Chemistry Curriculum: The Use of beta-Lactams as a Case Study. *J Chem Educ* 71: 856-859, 1994.
9. Cornely K: Use of Case Studies in an Undergraduate Biochemistry Course. *J Chem Ed* 78: 624-626, 1998.
10. Doherty MP: A Lively and Surprising Toxicology Case Study. *J Chem Educ* 71: 860, 1994.
11. Herrid CF: The Maiden and the Witch: The Crippling Undergraduate Experience. *J Coll Sci Teaching* 31: 87-88, 2001.
12. Montgomery R, Conway TW and Spector A: "Biochemistry: A Case-Oriented Approach." St. Louis: Mosby, 1990.
13. Wood WB, Wilson JH, Benbow RM and Hood LE: "Biochemistry: A Problems Approach." Menola Park, CA: W. A. Benjamin, Inc, 1974.
14. Keridge D and Tipton KF: "Biochemical Reasoning." Menola Park, CA: W. A. Benjamin, Inc, 1971.
15. Halperin ML and Rolleston FS: "Clinical Detective Stories: A Problem-Based Approach to Clinical Cases in Energy and Acid Base Metabolism." London: Portland, 1993.
16. Ludue-a RF: "Learning Biochemistry: 100 New Case Oriented Problems." New York: Wiley-Liss, 1995.
17. Devlin TM: "Textbook of Biochemistry with Clinical Correlations." New York: Wiley-Liss, 1992.
18. National Center for Case Study Teaching in ScienceWeb. <http://ublib.buffalo.edu/libraries/projects/cases/case.html> (accessed July 1, 2003).
19. ChemCases: Case-Study General Chemistry Curriculum Supplements. <http://science.kennesaw.edu/~mhermes/> (accessed July 1, 2003).
20. University of Delaware PBL Clearinghouse. <https://www.mis4.udel.edu/Pbl/> (accessed July 1, 2003, requires registration).
21. The Clearinghouse for Decision Case Education: Agriculture, Food, Natural Resources and the Environment University of Delaware PBL Clearinghouse. <http://www.decisioncase.edu/> (accessed July 1, 2003).
22. Rubin L and Herreid CF: Morgan: A Case for Diabetes. <http://ublib.buffalo.edu/libraries/projects/cases/diabetes/diabetes1.html> (accessed July 1, 2003).

RESEARCH NOTE

BAT ACTIVITY IN CENTRAL APPALACHIAN WETLANDS

Karen E. Francl*
Warnell School of Forest Resources
University of Georgia
Athens, GA 30602-2152
francl.1.@nd.edu

W. Mark Ford
USDA Forest Service Timber and Watershed Laboratory
Parsons, WV 26287
mford@fs.fed.us

Steven B. Castleberry
Warnell School of Forest Resources
University of Georgia
Athens, GA 30602-2152
scastle@smokey.forestry.uga.edu

* Current address: Department of Biological Sciences
University of Notre Dame
Notre Dame, IN 46556

ABSTRACT

We conducted acoustical bat surveys at 14 high-elevation wetlands in West Virginia, using the Anabat II detection system. In two survey periods (June and August 2002), we recorded seven bat species. Little brown bats (*Myotis lucifugus*) dominated the surveys, constituting 73.6% of all identifiable calls. Big Run Bog, which contains a 2-ha beaver pond with the most structurally "open" habitat in our study, accounted for 71.8% of all identifiable calls, nearly all identified as little brown bats. Observations of note were one Indiana bat (*M. sodalis*), an endangered species that is present but locally rare, recorded at Big Run Bog, and the evening bat (*Nycticeius humeralis*) at North Bog, considered an accidental migrant in the region. Although the importance of these mountain wetlands to regional bat communities is not fully understood, our surveys indicate that beaver-impacted wetlands appear to provide suitable foraging habitat for some bat species, including rare species in the region.

Key Words: Anabat, bat survey, West Virginia, wetlands

INTRODUCTION

Many insectivorous bats in North America preferentially forage over riparian areas and open water bodies, due to insect abundance and ease of foraging in a

less cluttered micro-environment (1, 2, 3). Indeed, bat abundance is positively related to the presence of such lacustrine and riverine habitats (4). Because of the high prey density combined with water's acoustic properties that make echolocation function more efficiently, it is not surprising that greatest bat activity is typically recorded over non-turbulent lacustrine sites (3, 5, 6, 7, 8). Nonetheless, few surveys or foraging studies have investigated the importance of freshwater palustrine areas for bat communities (7, 8).

Within the central Appalachians of West Virginia, nine of the 11 regularly-occurring bat species roost in forested habitats (snags or trees; 9). In the heavily forested central Appalachians, permanently open habitats are uncommon (10). However, palustrine, open-canopied sites are locally abundant in Randolph and Tucker counties, and often contain small ephemeral ponds or slower, first-order streams that may be optimal for foraging (11). It is not uncommon for bats to roost in nearby forests and commute to open foraging sites, such as these wetlands (12).

Bat studies have been conducted in nearby managed forests, including the Fernow Experimental Forest (Tucker County; 13), the Monongahela National Forest (Pendleton, Pocahontas, Randolph, and Tucker counties), and the Mead Westvaco Ecosystem Research Forest (Randolph County; 10, 14, 15). During these studies nine species of bats were recorded, including the federally listed Indiana bat (*Myotis sodalis*). Although the Allegheny Highlands may fall within the Indiana bat's maternity range, the species is locally uncommon in the summer months except for the presence of males in close proximity (< 10 km) to a few minor hibernacula caves in the region (14). Nearly all Indiana bats were detected while foraging in forested riparian areas or captured near their hibernacula (10, 13).

Despite these studies in the region's forests, no surveys have investigated bat use of palustrine areas. Given the lack of palustrine surveys, our goal was to provide baseline data for activity of all bat species in these wetlands, and to document the presence of rare or uncommon bat species foraging in semi-aquatic habitats.

METHODS

We performed acoustical surveys of bats at 14 high elevation wetlands in Tucker and Randolph counties, West Virginia in the summer of 2002 (Table I). These sites are part of a larger wetland characterization study by Francl et al. (11) and are generally open bog- or fen-like habitats dominated by low-lying mosses, grasses, and sedges, or patchy shrub-scrub vegetation. Site elevations ranged from 918-1111 m, and wetland size varied from 0.08-30 ha (Table I).

Table I. Locality information for 14 wetland sites in West Virginia, surveyed for bats in 2002.

Site Name	Code	County (WV)	Latitude (North)	Longitude (West)	Elevation (m)	Area (ha)
Canaan Valley State Park, Abe Run Trail	ABER	Tucker	39° 00.930'	79° 27.800'	960	3.0
Canaan Valley NWR, Beall Tract	BEAL	Tucker	39° 04.273'	79° 24.776'	954	1.2
Big Run Bog	BIGR	Tucker	39° 07.017'	79° 34.554'	982	15.0
Condon Run	COND	Randolph	38° 56.540'	79° 40.000'	918	3.0
Canaan Valley NWR, Herz Tract	HERZ	Tucker	39° 02.268'	79° 25.358'	983	10.0
Canaan Loop, Main Rd.	MAIN	Tucker	39° 04.371'	79° 28.363'	1111	30.0
Moore Run	MOOR	Randolph	39° 00.072'	79° 39.623'	991	2.0
Canaan Loop, North Rd.	NORT	Tucker	39° 04.140'	79° 29.059'	1076	15.0
Canaan Loop, Powerline	POWR	Tucker	39° 04.959'	79° 27.784'	1099	0.08
Canaan Loop, Red Run	REDR	Tucker	39° 04.125'	79° 29.455'	1085	0.4
Canaan Loop, Trail 101	TRL1	Tucker	39° 05.197'	79° 28.896'	1038	0.4
Canaan Loop, Trail 109/108	TRL2	Tucker	39° 04.823'	79° 28.847'	1067	0.2
Canaan Loop, Trail 109/701	TRL3	Tucker	39° 04.466'	79° 29.487'	1085	1.3
Yellow Creek	YELL	Randolph	38° 57.742'	79° 40.600'	952	2.5

We actively surveyed bats using the Anabat system, which consisted of an Anabat II detector, Zero Crossings Analysis Interface Module (ZCAIM), and laptop computer (Titley Electronics, Ballina, New South Wales, Australia; 16). Surveys of 2-4 sites per night were performed over four nights, from 2100 until 0130 each evening. One stationary observer recorded calls for 20 minutes at each site in June and August 2002 with active monitoring to maximize quality and quantity of bat calls (17, 18). Survey points within wetlands were chosen to be least obstructed by vegetation, so that detection area was maximized, and clutter mini-

mized (19). Temperature, humidity, and wind speed also were recorded.

Recorded echolocation calls were filtered prior to analysis (20) and identified to species using Anabot 4.7j and Analyze 2.3 software (21, 22). Additionally, we utilized a key to bat calls of West Virginia, based on frequency, curvature, and slope characteristics (M.A. Menzel, West Virginia University, unpublished data). Calls with < 3 individual call pulses were not deemed identifiable (18). Because bat detectors do not distinguish among individual calls, we did not use the data to estimate abundance; rather, we noted species presence and relative activity levels among sites (7).

RESULTS

We recorded 177 calls at 14 sites during two survey periods on 4 sampling nights. Of these calls, 154 were identifiable to genus, and 153 to species. Seven species were identified in these surveys (Figure 1). Little brown bats constituted the majority (131 calls; 73.6%) of identifiable calls, 111 of them recorded at a single site, Big Run Bog. Many feeding buzzes were recorded, indicating active foraging at this site. Little brown bats also were detected at the greatest number of sites (eleven). The remaining six species were recorded 10 times or less across all sites.

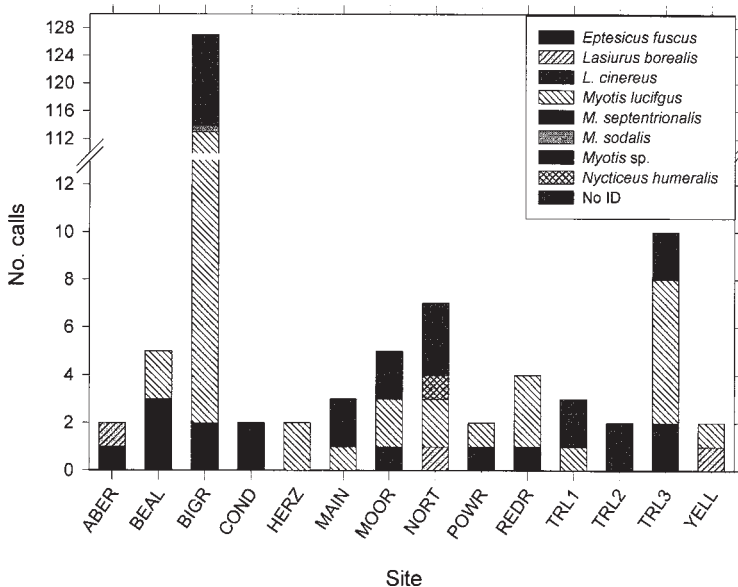


Figure 1. Total number of Anabat calls identified per species in June and August 2002 bat surveys at 14 wetlands in West Virginia. Site codes listed in Table I.

DISCUSSION

Previous research indicated that bat abundance is positively related to presence of lacustrine and riverine habitats (4). Studies of preferred habitats in Maine showed that bats appear to avoid wetlands lacking ponds (7). Our study of palustrine habitats in the central Appalachians concurs with this research, recording minimal bat use at all sites. The exception is Big Run Bog, which contains a permanent 2-ha beaver pond (tannin-rich water, maximum depth > 1 m), above which the bats were actively foraging. We predict that the prey abundance was greatest at this site, and that echolocation ability was efficient over this calm water (23). At the remaining palustrine sites, the lack of open water and cool, acidic conditions did not likely provide an abundance of prey items for bats. It is likely that, given the regional climate conditions, bats may spend more time foraging at lower elevations, where temperatures are slightly higher and invertebrates might be more active. However, lower activity levels at these wetlands do not negate their ecological value; indeed, bat species richness across all sites was relatively high and the presence of several uncommon species emphasizes the value of such palustrine habitats.

Of note is the one Indiana bat identified at Big Run Bog. Because their call is similar to the abundant little brown bats in the area and their ability to produce echolocation signatures are similar to Indiana bats, positive identification is not without the chance of error. However, it is not unreasonable to believe this species is present at the site, because Indiana bats are monitored around Big Springs Cave at the Fernow Experimental Forest, ca. 16 km (10 mi) from Big Run Bog (13). Big Springs Cave is a known winter hibernaculum of approximately 200 of the species, and areas within 8 km (ca. 5 mi) are considered part of the male bats' home ranges in the summer (13).

We also recorded an evening bat (*Nycticeius humeralis*) during our August survey. This bat is not typically found in mountainous regions in the Mid-Atlantic or Southeast, and is probably an accidental migrant in the area (9; M.A. Menzel, West Virginia University, unpublished data; Craig Stihler, West Virginia Department of Natural Resources, personal communication).

We acknowledge several limitations in this study and suggest modifications for future surveying work. First, we suspect the number of calls recorded was lower than expected due to suboptimal weather conditions. The June surveying period was hindered by rainstorms three of four nights, and surveys were performed just prior to the rain events (humidity 61-98%). During the August surveying period, the temperature dropped below 10°C (50°F) during half of the surveys. It is likely that bat foraging activity was affected by these conditions, because insect biomass and abundance typically declines with cooler ambient air and water temperatures (3, 24). We suggest that evenings with warmer, less humid conditions be chosen for survey dates. We also recommend that more surveys be performed at each site in order to assess true community composition. Perhaps calculations of a species accumulation curve might help us obtain an acceptable level of completeness (25).

Secondly, we acknowledge the limitations of Anabat surveys. As opposed to mist-netting, species identification can be problematic (26). Calls can be variable

within species and useful data, e.g., gender and age ratios, absolute abundance, are not available (17, 27, 28). However, mist-netting is labor-intensive and less effective than Anabat in detecting some bat species (29). Additionally, if the goal is to assess bat species richness, active Anabat monitoring is a time-efficient and effective monitoring strategy (18) if coupled with mist-netting to minimize the biases of each surveying technique and maximize species detection.

The full importance of these mountain bogs and fens to regional bat communities is not known. However, based on our surveys, beaver-impacted wetlands such as Big Run Bog appear to provide suitable foraging habitat for some bat species. We recognize that open areas, like these wetlands, amidst heavily forested habitats are important to big brown bats (*Eptesicus fuscus*), little brown bats (*Myotis lucifugus*), hoary bats (*Lasiurus cinereus*), and possibly eastern pipistrelles (*Pipistrellus subflavus*; 10, 30).

ACKNOWLEDGMENTS

The USDA Forest Service Northeastern Research Station and the D.B. Warnell School of Forest Resources at the University of Georgia provided funding and equipment necessary to conduct this research. We especially thank R. Kotecki for assistance with the August 2002 bat surveys.

LITERATURE CITED

1. Brigham RM and Fenton MB: Convergence in foraging strategies by two morphologically and phylogenetically distinct nocturnal aerial insectivores. *J Zoo* 223: 475-489, 1991.
2. Krusic RA, Yamasaki M, Neefus CD and Pekins PJ: Bat habitat use in White Mountain National Forest. *J Wildl Manag* 60: 625-631, 1996.
3. Grindal SD, Morissette JL and Brigham RM: Concentration of bat activity in riparian habitats over an elevational gradient. *Can J Zoo* 77: 972-977, 1999.
4. Walsh AL and Harris S: Factors determining the abundance of vespertilinoid bats in Britain: geographical, land class, and local habitat relationships. *J Appl Ecol* 33: 513-529, 1996.
5. Fenton MB, Merriam HG and Holroyd GL: Bats of Kootenay, Glacier, and Mount Revelstroke national parks in Canada: identification by echolocation calls, distribution, and biology. *Can J Zoo* 61: 2503-2508, 1983.
6. Barclay RMR and Brigham RE: Constraints on optimal foraging: a field test of prey discrimination by echolocating insectivorous bats. *Anim Behav* 48: 1013-1021, 1994.
7. Zimmerman GS and Glanz: Habitat use by bat in eastern Maine. *J Wildl Manag* 64: 1032-1040, 2000.
8. Ellis AM, Patton LL and Castleberry SB: Bat activity in upland and riparian habitats in the Georgia Piedmont. *Proc Ann Conf Southeastern Fish and Wildl Agencies*, in press.
9. Webster WD, Patnell JF and Biggs, Jr. WC: Mammals of the Carolinas, Virginia, and Maryland. Chapel Hill: University of North Carolina, 255 pp, 1985.

10. Owen SF, Menzel MA, Ford WM, Edwards JW, Menzel JM, Chapman BR, Wood PB and Miller KV: Bat activity in managed and unmanaged forest and riparian zones in the Allegheny Mountains. *Northern J Appl Forestry*, in press.
11. Francl KE, Ford WM and Castleberry SB: Characterization of high elevation central Appalachian wetlands, Characterization of high elevation central Appalachian wetlands. Gen. Tech. Rep. NE-XXX. Parsons, WV: USDA Forest Service, Northeastern Experimental Research Station, 57 pp, in press.
12. Grindal SD and Brigham RM: Impacts of forest harvesting on habitat use by foraging insectivorous bats at different spatial scales. *Ecoscience* 6: 25-34, 1999.
13. Adams MB, Edwards P, Evans T, Ford WM, Kochenderfer J, Rodrigue J, Schuler T and Wood F: Biological Assessment for threatened, endangered, and sensitive species on the Fernow Experimental Forest, Tucker County, West Virginia. Parsons, West Virginia: USDA Forest Service Northeastern Research Station, 2000.
14. Owen SF, Menzel MA, Ford WM, Chapman BR, Miller KV, Edwards JW and Wood PB: First summer record of a female Indiana bat, *Myotis sodalis*, in West Virginia. *J Elisha Mitchell Scientific Soc* 117: 132-134, 2001.
15. Menzel MA, Owen SF, Ford WM, Chapman BR, Miller KV, Edwards JW and Wood PB: Roost tree selection by maternity colonies of northern long-eared bats (*Myotis septentrionalis*) in an industrial forest of the central Appalachian Mountains. *For Ecol Manag* 155: 107-114, 2002.
16. Corben C. Anabat. Version 6.2d. Computer software. IBM, 1999.
17. O'Farrell MJ, Miller BW and Gannon WL: Qualitative identification of free-flying bats using the Anabat detector. *J Mammal* 80: 11-23, 1999.
18. Johnson JB, Menzel MA, Edwards JW and Ford WM: A quantitative comparison between two acoustical bat survey techniques. *Wildl Soc Bull* 30: 931-936, 2002.
19. Johnson JB: Spatial and predictive foraging models for gray bats in north-west Georgia and a comparison of two acoustical bat survey techniques. M.S. thesis, University of West Virginia, Morgantown, 2002.
20. Britzke ER and Murray KL: A quantitative method of selection of identifiable search-phase calls using the Anabat system. *Bat Res News* 41: 33-36, 2000.
21. Corben C. Analoook Version 4.7j. Computer software, IBM, 1999.
22. Jolly S: Analyze Version 2.3. Computer software. IBM, 1999.
23. von Frecknell B and Barclay RMR: Bat activity over calm and turbulent water. *Can J Zoo* 65: 219-222, 1987.
24. Barclay RMR: long- versus short-range foraging strategies of hoary (*Lasiurus cinereus*) and silver-haired (*Lasionycteris noctivagans*) bats and the consequences for prey selection. *Can J Zoo* 63: 2507-2515, 1985.

25. Moreno CE and Halffter G: Assessing the completeness of bat biodiversity inventories using species accumulation curves. *J Appl Ecol* 37: 149-158, 2000.
26. Barclay RMR: Bats are not birds - a cautionary note on using echolocation calls to identify bats: a comment. *J Mammal* 80: 290-296, 1999.
27. Obriest MK: Flexible bat echolocation: the influence of individual, habitat and conspecifics on sonar signal design. *Behav Ecol Sociobiol* 36: 207-216, 1995.
28. Hayes JP: Temporal variation in activity of bats and the design of echolocation-monitoring studies. *J Mammal* 78: 514-524, 1997.
29. O'Farrell MJ and Gannon WL: A comparison of acoustic versus capture techniques for the inventory of bats. *J Mammal* 80: 24-30, 1999.
30. Owen SF: Impacts of timber harvest in the central Appalachians hardwood region on bat foraging and roosting behavior. M.S. thesis, University of Georgia, Athens, 2000.

AVIAN RESPONSE TO FOREST MANAGEMENT AND MILITARY TRAINING ACTIVITIES AT FORT BENNING, GEORGIA

Lisa Duncan*, John Dilustro, and Beverly Collins
Savannah River Ecology Laboratory
P.O. Drawer E
Aiken, SC 29802

*Corresponding author (duncan@srel.edu)

ABSTRACT

Evaluating intensity and effects of land use disturbance is difficult, especially in sites with multiple land use. We conducted point counts to determine if abundance of bird species could be used to assess military training and forestry management practices at Fort Benning, Georgia. We evaluated heavy and light use sites in the 1st growing season after prescribed fire and in the 3rd growing season post-fire. Results focus on species common to early successional habitats and pine-grasslands and on forest species and habitat generalists. In the 3rd growing season post-fire, Indigo buntings (*Passerina cyanea*) and northern bobwhites (*Colinus virginianus*) were more abundant in recently burned heavy use sites than in light use sites. Conversely, red-eyed vireos (*Vireo olivaceus*) were more abundant in light use sites in the 3rd growing season post-fire than in recently burned, heavy use sites. Further study could help determine if these species are indicators of disturbance.

INTRODUCTION

Land management on military installations must provide adequate provision for support of the military training mission. In addition, on many installations in the southeast, land management is driven by a mandate to protect and improve habitat for the endangered red-cockaded woodpecker (*Picoides borealis*; RCW). Management prescriptions under the recovery plan for RCW include prescribed burning on a short burn rotation, uneven age timber management, and understory hardwood reductions (1). The combined effects of military training and forestry practices create a complicated disturbance regime on the landscape. Military installations and other public lands with multiple land use need reliable measures of land-use disturbance effects on ecosystem composition, structure, and dynamics to responsibly implement and monitor their complex management plans.

Response to disturbance, or to the habitat patches and edge effects created by that disturbance, has been documented for many bird species. Early successional species such as brown-headed cowbirds (*Molothrus ater*) and yellow-breasted chats (*Icteria virens*) might be expected to occur more frequently in areas heavily disturbed by military training or by forestry practices that create forest openings and increase edge (2, 3). Several species, including Bachman's sparrow (*Aimophila aestivalis*), northern bobwhite, eastern wood-pewee (*Contopus virens*), and indigo bunting respond favorably to RCW management practices such as prescribed

burning and hardwood understory reduction (4, 5, 6, 7, 8). Alternatively, frequent prescribed burning, timber harvest, and hardwood reduction may negatively impact some species, including tufted titmouse (*Baeolophus bicolor*) (9), ovenbird (*Seiurus aurocapillus*), red-eyed vireo (10), and black-and-white warbler (*Mniotilta varia*; 5). Canterbury et al. (11) examined the effects of forest disturbance in the southeastern U.S. on four functional groups based on habitat assemblages (shrubland, forest-edge, habitat generalist, and mature forest) and found that shrubland (e.g., yellow-breasted chat, common yellowthroat [*Geothlypis trichas*], eastern towhee [*Pipilo erythrophthalmus*], and indigo bunting) and mature-forest (e.g., pine warbler [*Dendroica pinus*], red-eyed vireo, wood thrush [*Hylocichla mustelina*], and hooded warbler [*Wilsonia citrina*]) assemblages were most commonly correlated with disturbance measures (canopy cover and tree basal area). All four commonly occurring species in the shrubland assemblage decreased with increasing canopy cover and all four in the mature-forest assemblage increased with increasing canopy cover.

The research reported here was conducted in upland mixed pine-hardwood forest stands. These stands are part of a larger study at Fort Benning, Georgia of the ecological effects of disturbances imposed by land use and management practices on upland forests. All sites were assigned *a priori* to a 'heavier' or 'lighter' military training use category based on known history of military training in that area. Site disturbance was further evaluated using a survey of vegetation and disturbance features. Our objective was to conduct short-term point counts in stands with known disturbance and vegetation patterns to determine if abundance of selected bird species might, in turn, be an indicator of disturbance. We focused on two groups of birds based on habitat preferences. One group includes associates of early successional and pine-grassland habitats. The other group includes habitat generalists and species associated with forests. This approach may provide land managers with useful measures of land-use disturbance and information on the implications of forestry management and military training on bird populations, including neotropical migrant species, which are a particular concern.

MATERIALS AND METHODS

Fort Benning is a 73,533 ha U.S. Army installation located on the Coastal Plain-Piedmont Fall Line in west-central Georgia and eastern Alabama. In association with management prescriptions for the red-cockaded woodpecker, upland managed forests at Fort Benning are thinned on a nine-year cycle and prescribe-burned, typically on a three-year cycle.

We selected 16 of the 32 upland forest stands being studied by our research team at Fort Benning. All were burned in 2000 and half were burned again prior to the 2002 growing season, when our research was conducted. The eight stands burned only in 2000 were in their third post-burn growing season. Half of these stands are located in 'heavier' (H) military use compartments open to mechanized training (tracked vehicles) and half are in 'lighter' (L) use compartments supporting only dismounted infantry training (foot traffic) off the roads and trails. The combinations of military training (H, L) and prescribed fire (sites burned in

2002 = 1st growing season post-fire, sites burned only in 2000 = 3rd growing season post-fire) produced four land-management categories: 1st growing season post-fire, heavy use (1H); 1st growing season post-fire, light use (1L); 3rd growing season post-fire, heavy use (3H); and 3rd growing season post-fire, light use (3L).

In 2000, 25 vegetation sampling points were established in a 100 m x 100 m plot in each stand. Tree density (dbh > 10 cm) was measured in 2000 and groundlayer vegetation (< 1.4 m height) was measured in 2002 as described by Dilustro et al. (12). Sapling density was surveyed in 2000 by recording each shrub or tree sapling (> 1.4 m height, dbh 1 to 10 cm) that intercepted a 10 m transect at each sampling point. In 2001, hemispherical canopy photographs were taken at each of the vegetation sampling points in each plot using a Nikon Coolpix 950 with a FC-E8 fisheye lens converter. Gap Light Analyzer (GLA) imaging software was used with these photographs to estimate canopy cover (13).

To confirm the heavier vs. lighter military use categories correctly reflected level of disturbance, and to evaluate disturbance features that might influence avian species, we conducted a survey of disturbance features along two 300 m transects that bisected each 100 m x 100 m plot. Features associated with forestry, military use, and natural disturbance, including roads, tank trails, gullies, and canopy openings, were assessed by line-intercept along each transect (12).

The vegetation and disturbance survey results include 6 additional stands (2 additional stands in 3H and 3L land use categories and 1 additional stand in 1H and 1L categories). These stands were included because point counts had to be relocated (see next paragraph) or because at least one count from the selected stand fell within another nearby stand.

Point counts were conducted at the center of each 100 m x 100 m plot and 50 m from both ends of each disturbance survey transect (5 points/plot; 20 points/land use category). Because of windy conditions, only three point counts could be conducted in one 3H stand (18 points total/3H). Locations were modified if the land use category was not met (e.g., the area had not burned) or if the area did not meet the study criteria (e.g., was a hardwood slope forest). Three points were moved to the center of 100 m x 100 m plots in other nearby stands that had the same land use (included in the vegetation and disturbance survey results). Points were located at least 200 m apart and most were \geq 250 m. We surveyed each point for 10 minutes, typically between sunrise and 10:00 h, during May 2002. Occurrence of each individual seen or heard was recorded by species in concentric distance bands of < 25 m, 25-50 m, and > 50 m (14). Because birds were detected most often beyond the 50 m band and sample size was small (20 points/land use category) we did not limit our analysis to birds detected only within a fixed-radius of 50 m. An effort was made to not record individuals believed to have been recorded in other counts; however, some of the species can be heard from greater than the 250 m that typically separated our counts (e.g., northern bobwhite and indigo bunting), likely causing some repeated counts of individuals (15). Ideally, sample size would have been larger; however, we needed to minimize time and personnel. We chose to use these constraints,

which could likely mimic management constraints, to look at results from this level of effort.

Results focus on seven resident or neotropical migratory species associated with open pine-grasslands or early successional habitats and on seven resident or neotropical migratory forest and habitat generalist species common to Fort Benning (Table I). We compared abundance among land use categories for 1) individual species, 2) combined species abundance or early successional and pine-grassland species (brown-headed cowbird abundance was not used in this analysis because of its very low occurrence in our study), and 3) combined species abundance of forest species and habitat generalists. Analysis of variance was used to test differences among the four land use categories for species abundance and habitat variables. Tukey's standardized range test was used to compare means among land use categories. A one-way ANOVA was used to test differences in disturbance (m of line "disturbed" per 600 m transect sampled) between heavy and light use categories.

Table I. Mean (SE) abundance (mean detections/point/land use category) of selected avian species in recently burned heavy use (1H) and light use (1L) and 3rd growing season post-fire heavy use (3H) and light use (3L) land use categories at Fort Benning, Georgia, May 2002.

	Land Use Category			
	1H	1L	3H	3L
Early successional or pine-grassland species				
Bachman's Sparrow (<i>Aimophila aestivalis</i>)	0.50 (0.15)	0.50 (0.19)	0.33 (0.14)	0.35 (0.20)
Brown-headed Cowbird (<i>Molothrus ater</i>)	0.20 (0.12)	0	0	0.15 (0.08)
Eastern Towhee (<i>Pipilo erythrophthalmus</i>)	0.50 (0.14)	0.45 (0.14)	0.61 (0.16)	0.55 (0.14)
Indigo Bunting (<i>Paserina cyanea</i>)	1.50 ^a (0.27)	0.95 ^{ab} (0.21)	1.11 ^{ab} (0.24)	0.65 ^b (0.18)
Northern Bobwhite (<i>Colinus virginianus</i>)	0.35 ^a (0.35)	0.85 ^{ab} (0.25)	0.78 ^{ab} (0.21)	0.25 ^b (0.10)
Prairie Warbler (<i>Dendroica discolor</i>)	1.05 (0.29)	0.95 (0.23)	0.94 (0.21)	1.10 (0.22)
Yellow-breasted Chat (<i>Icteria virens</i>)	0.25 (0.12)	0.50 (0.15)	0.33 (0.14)	0.60 (0.13)
Species combined*	5.15 (0.50)	4.20 (0.75)	4.11 (0.62)	3.50 (0.52)

Forest species or habitat generalists

Carolina Wren (<i>Thryothorus ludovicianus</i>)	0.70 ^{ab} (0.16)	0.80 ^{ab} (0.19)	0.44 ^b (0.12)	1.25 ^a (0.20)
Great-crested Flycatcher (<i>Myiarchus crinitus</i>)	0.65 (0.13)	0.55 (0.11)	0.78 (0.15)	0.55 (0.14)
Northern Cardinal (<i>Cardinalis cardinalis</i>)	1.30 (0.28)	0.80 (0.20)	1.33 (0.21)	1.15 (0.23)
Pine Warbler (<i>Dendroica pinus</i>)	0.75 (0.23)	0.75 (0.18)	0.78 (0.19)	0.65 (0.15)
Red-eyed Vireo (<i>Vireo olivaceus</i>)	0.35 ^b (0.13)	0.45 ^{ab} (0.15)	0.33 ^b (0.11)	0.90 ^a (0.18)
Summer Tanager (<i>Piranga rubra</i>)	0.55 (0.14)	0.35 (0.11)	0.44 (0.12)	0.45 (0.11)
Tufted Titmouse (<i>Baeolophus bicolor</i>)	0.45 (0.15)	0.35 (0.11)	0.83 (0.15)	0.80 (0.20)
Species combined	4.75 ^{ab} (0.44)	4.05 ^b (0.48)	4.94 ^{ab} (0.37)	5.75 ^a (0.39)

Abundance means with the same letter and without a letter do not differ significantly ($P > 0.10$).

*Does not include brown-headed cowbird abundance.

RESULTS

Groundlayer vegetation differed among the land use categories. Percent ground cover (all species combined) was greater in 1H and lower in 1L than in other categories (Table II). Relative cover of forbs, legumes, and grasses was greatest in recently burned sites with heavier military training (1H; Table II). Shrubs and trees had higher relative abundance in sites with lighter military training and last burned in 2000 (3L; Table II). Although canopy level vegetation (tree density and canopy closure) did not differ significantly among the land use categories; within-site variation was high in all land use categories.

Table II. Mean (SE) habitat measurements in recently burned heavy use (1H) and light use (1L) and 3rd growing season post-fire heavy use (3H) and light use (3L) land use categories at Fort Benning, Georgia.

Parameter	1H	1L	3H	3L
Tree density (no./ha)	262 (41)	360 (75)	310 (38)	467 (93)
Pine density (no./ha)	188 (34)	181 (17)	207 (45)	292 (60)
Hardwood density (no./ha)	74 (45)	179 (87)	102 (31)	175 (40)
% Canopy closure	64 (1.5)	69 (4.1)	68 (0.84)	70 (1.5)
% Relative sapling density	46 (16)	127 (57)	138 (22)	112 (41)
% Ground cover	78 ^a (3.1)	55 ^c (3.2)	69 ^b (3.1)	67 ^b (2.9)
% Forb	21 ^a (1.3)	15 ^b (1.6)	13 ^b (1.1)	8 ^c (0.7)
% Legume	8 ^a (0.8)	6 ^b (0.6)	2 ^c (0.3)	2 ^c (0.3)
% Grass	21 ^a (1.8)	19 ^{ab} (1.7)	14 ^b (1.6)	6 ^c (0.6)
% Shrub	9 ^{bc} (1.1)	5 ^c (0.8)	10 ^b (1.4)	17 ^a (1.4)
% Tree species	12 ^b (1.3)	5 ^c (0.6)	16 ^b (1.6)	23 ^a (1.5)
% Vine	6 ^b (0.9)	4 ^b (0.7)	12 ^a (1.5)	10 ^a (1.4)
% Dead or woody debris	2 (0.3)	2 (0.4)	1 (0.2)	1 (0.3)

Abundance means within a row with the same letter and without a letter do not differ significantly ($P > 0.05$).

Clearcuts, remnant roads, remnant trails, skidder trails, and gullies were the most common disturbance features observed in the disturbance survey of these sites (Table III). Sites designated as heavy land use (1H and 3H) did have significantly greater disturbance than those designated light land use ($P = 0.0011$). Remnant roads, remnant trails, and gullies were common in light use sites and remnant roads, skidder trails, tank trails, and gullies were common in heavy use sites. Clearcuts were present in all land use categories but relative abundance of clearcuts was highest in 1H sites.

Table III. Mean disturbance (m of line “disturbed” per 600 m sampled; SE), % clearcut disturbance (m clearcut/total m disturbed \times 100), and other common disturbance features in recently burned heavy use (1H) and light use (1L) and 3rd growing season post-fire heavy use (3H) and light use (3L) land use categories at Fort Benning, Georgia.

Category	Disturbance (m)	% Clearcut	Other Common Features
1H	199.53 (28.83)	33	Skidder trails, remnant roads, gullies
1L	96.76 (28.89)	21	Remnant roads, gullies, remnant trails
3H	191.21 (32.92)	20	Remnant roads, tank trails, gullies
3L	94.68 (17.69)	18	Gullies, remnant roads, remnant trails

Abundance of two bird species in the early successional and pine-grassland group and of two birds in the forest species and habitat generalists group differed among the land-use categories (Table I). Both indigo bunting and northern bobwhite abundance differed only between land use extremes; and both were more abundant in recently burned, heavy use sites (1H) than in light use sites burned in 2000 (3L; Table I). Carolina wrens were more abundant in 3L sites than in heavy use sites burned in 2000 (3H), but there were no differences among other land use categories. Red-eyed vireos were more abundant in 3L sites than in heavy use sites (3H and 1H; Table I). When we combined species abundances based on similar habitat preference (early successional and pine-grassland species or forest and habitat generalist species), we found that each group occurred most often at opposite land use extremes. Early successional and pine-grassland species were most abundant in 1H, while forest species and habitat generalists were most abundant in 3L. However, differences in early successional and pine-grassland species abundance were not significant, and forest species and habitat generalists were only significantly more abundant in 3L than in 1L (Table I).

DISCUSSION

Some combination of past or present military training, forestry practices, or agricultural practices impacts all the upland forest stands considered in this study. Our disturbance survey revealed a gradient of disturbance among sites within and among each land use category studied. Vegetation parameters, including tree, shrub, and ground cover density, reflect these disturbance patterns. Canopy cover was lowest and ground cover was highest in recently burned sites with heavier military training (1H sites). As previously stated, our objective was to determine whether abundances of early successional and pine-grassland birds or forest species and habitat generalists would reflect these disturbance gradients and vegetation patterns.

Abundances of individual species differed most often between land use category extremes. Early successional indigo buntings and northern bobwhites were more abundant in 1H than in 3L stands. These species have been shown to benefit from ground cover response to open tree canopies (4, 5). Cram et al. (8) found that northern bobwhites occurred most frequently in unburned, thinned pine-grassland stands and in thinned stands in the third growing season following fire. Wilson et al. (5) found that indigo bunting densities also peak three years after fire. In our study, abundances of both species were higher in recently burned stands (1H) than in stands in the third post-fire growing season (3L). Stands in the 1H category had lower tree densities and more ground cover than 3L stands.

In contrast to the early succession and pine grassland species, forest-dwelling red-eyed vireos were more abundant in 3L than in 1H. Red-eyed vireos typically are associated with hardwood forests, but will utilize older pine stands (16). This species can be negatively affected by timber harvesting but may still commonly occur in thinned or clearcut stands (10, 17). In our study, red-eyed vireo abundance was greater in stands with highest tree density (3L) than in those with lowest tree density (1H). Carolina wrens were less common in 3H sites but abundance only differed significantly from 3L. Red-eyed vireos showed a similar response in sites in their third growing season post-fire.

Our study revealed other notable patterns of species abundances among the land use categories. Brown-headed cowbirds were not common in any category possibly because they may prefer areas disturbed by agricultural practices or residential and recreational human activities as opposed to disturbed patches created from logging (or, in this case logging and military) practices within forested areas (18). Tufted titmice occurred less often in recently burned sites (1H and 1L) than at sites in the third season post-fire (3H and 3L). These birds have been suggested as potential indicators of fire exclusion (9).

Although disturbance likely influences occurrence of birds over the Fort Benning landscape, abundance of the focal species in our study may not be the most suitable indicator of current land use. These species may not discriminate finely over a landscape and region that reflects a long history of natural disturbances and intensive land use. However, our limited study did reveal some individual species responses to land use disturbance. Further, examining the abundance of groups of species that use similar habitats (such as early successional and pine-grassland species) may be useful in defining disturbed habitats. Our results suggest a more intensive study of avian abundance across Fort Benning, that better defined distribution and population patterns, would reveal that early successional and pine-grassland species are positively affected by management practices; conversely, forest species and habitat generalists may utilize less disturbed areas.

ACKNOWLEDGMENTS

We thank Nicole White and Maggie Johnston for field assistance. Hugh Westbury has been instrumental in project operation on the Fort Benning site. Hal Balbach provided useful comments on the manuscript. This research was supported by the Strategic Environmental Research and Development Program (SERDP), funded by the Departments of Defense, Energy, and the EPA as part of the SERDP Ecosystem Management Project (SEMP) CS-1114E. Manuscript preparation was supported by Financial Assistance Award Number DE-FC09-96SR18546 between the U.S. Department of Energy and the University of Georgia.

REFERENCES

1. U.S. Fish and Wildlife Service: Recovery plan for the red-cockaded woodpecker (*Picoides borealis*): second revision. U.S. Fish and Wildlife Service, Atlanta, GA. 296 pp, 2003.
2. Askins RA: Population trends in grassland, shrubland, and forest birds in eastern North America. *Curr Ornithol* 11: 1-34, 1993.
3. Donovan TM, Jones PW, Annand EM and Thompson FR III: Variation in local-scale edge effects: mechanisms and landscape context. *Ecology* 78: 2064-2075, 1997.
4. Block WM, Finch DM and Brennan LA: Single-species versus multiple-species approaches for management. In *Ecology and Management of Neotropical Migratory Birds* (Martin and Finch, Eds). Oxford University Press, New York, NY. p461-476, 1995.

5. Wilson CW, Masters RE and Bukenhofer GA: Breeding bird response to pine-grassland community restoration for red-cockaded woodpeckers. *J Wildl Manage* 59: 56-67, 1995.
6. Plentovich S, Tucker JW, Holler NR and Hill GE: Enhancing Bachman's sparrow habitat via management of red-cockaded woodpeckers. *J Wildl Manage* 62: 347-354, 1998.
7. White DH, Chapman BR, Brunjes JH IV, Raftovich RV Jr and Seginak JT: Abundance and reproduction of songbirds in burned and unburned pine forests of the Georgia Piedmont. *J Field Ornithol* 70: 414-424, 1999.
8. Cram DS, Masters RE, Guthery FS, Engle DM and Montague WG: Northern bobwhite population and habitat response to pine-grassland restoration. *J Wildl Manage* 66: 1031-1039, 2002.
9. Provencher L, Gobris NM, Brennan LA, Gordon DR and Hardesty JL: Breeding bird response to midstory hardwood reduction in Florida sandhill longleaf pine forests. *J Wildl Manage* 66: 641-661, 2002.
10. Baker MD and Lacki MJ: Short-term changes in bird communities in response to silvicultural prescriptions. *For Ecol Manage* 96: 27-36, 1997.
11. Canterbury GE, Martin TE, Petit DR, Petit LJ and Bradford DF: Bird communities and habitat as ecological indicators of forest condition in regional monitoring. *Conserv Biol* 14: 544-558, 2000.
12. Dilustro JJ, Collins BS, Duncan LK and Sharitz RR: Soil texture, land-use intensity, and vegetation of Fort Benning upland forest sites. *J Torrey Bot Soc* 129: 289-297, 2002.
13. Frazer GW, Canham CD and Lertzman KP: Gap Light Analyzer (GLA): Imaging software to extract canopy structure and gap light transmission indices from true-color fisheye photographs. Simon Fraser University, Burnaby, British Columbia, and the Institute of Ecosystems Studies, Millbrook, New York, Copyright © 1999.
14. Ralph CJ, Geupel GR, Pyle P, Martin TE and DeSante DF: Handbook of field methods for monitoring landbirds. USDA Forest Service Gen Tech Rep PSW-GTR-144, 41pp, 1993.
15. Wolf AT, Howe RW and Davis GJ: Detectability of forest birds from stationary points in Northern Wisconsin. In *Monitoring bird populations by point counts* (Ralph, Sauer, and Droege, Eds). USDA Forest Service Gen Tech Rep PSW-GTR-149. p19-23, 1995.
16. Turner JC, Gerwin JA and Lancia RA: Influences of hardwood stand area and adjacency on breeding birds in an intensively managed pine landscape. *For Sci* 48: 323-330, 2002.
17. Thompson FR III, Dijk WD, Kulowiec TG and Hamilton DA: Breeding bird populations in Missouri Ozark forests with and without clearcutting. *J Wildl Manage* 56: 23-30, 1992.
18. Coker DR and Capen DE: Landscape-level habitat use by brown-headed cowbirds in Vermont. *J Wildl Manage* 59: 631-637, 1995.

THE GEORGIA ACADEMY OF SCIENCE

Affiliated with the American Association for the Advancement of Science

The Georgia Academy of Science is composed of "Residents and non-residents of Georgia who are engaged in scientific work, or who are interested in the development of science." The purpose of the Academy of "the promotion of interests of science, particularly in Georgia."

The Georgia Academy of Science was organized in 1922 and incorporated as a non-profit organization in 1953. Originally, eligibility for membership in the Academy was "definite achievement in some branch of scientific activity," and the number of members was set at fifty. This number gradually increased to ninety-five by 1934, and in 1937 the numerical limitation was removed. For several years the Academy affairs were administered by Fellows, but today this class of membership is honorary only, and all members who are residents of Georgia are equally eligible for Academy offices. Currently the membership of the Georgia Academy of Science is approximately 450, composed of men and women from all scientific disciplines and interest, located throughout the state of Georgia. In addition to direct membership in the Academy, affiliation of scientific societies with the Academy is also possible. At present the Georgia Junior Academy of Science and the Georgia Genetics Society are affiliated with the Academy, and have representatives on the Council, which is the governing body of the Academy.

The primary activities of the Academy are centered around the Journal, the Annual Meeting and the Georgia Junior Academy of Science. The Georgia Journal of Science is a recognized scientific publication, and is to be found in libraries throughout the United States and in many foreign countries. The Journal is published four times each year, the April issue being devoted to the abstracts of papers presented at the Annual Meeting.

The Annual Meeting of the Academy presents an opportunity for scientists and others interested in the development of science to meet, visit, and deliver scientific papers. Members of the Academy belong to Sections representing various fields of scientific endeavor the Annual Meeting is primarily oriented towards the programs of these Sections. In order to fulfill the growing requirement for interdisciplinary conferences one session of the Annual Meeting is devoted to a joint program in which the entire Academy participates.

The Georgia Junior Academy is composed of high school and middle school students organized into science clubs under the guidance of a Director and his (or her) staff, appointed by the President of the Georgia Academy of Science. The Georgia Junior Academy of Science supports a number of activities designed to promote scientific inquiry on the part of students. These activities include: (1) a state-wide Scientific Problem-Solving Bowl, (2) regional and state Science Bowl competitions, (3) regional and state Science Olympiad competitions, and (4) original research projects presented at the American Junior Academy annual meeting. In addition, the Georgia Junior Academy of Science sponsors a Fall Leadership Conference and a Spring Conference to give all members opportunities to explore areas of scientific inquiry in regional settings, and is heavily involved with regional and state science fairs. Active participation by businesses, industrial organizations, and colleges and universities in Georgia contribute significantly to the work of the Junior Academy.

Membership in the Georgia Academy of Science supports the activities described above: the publication of the Journal, the Annual Meeting and the Junior Academy with its State District Science Fairs. Members of the Academy benefit from the opportunities to associate with their colleagues, to present scientific papers and introduce their students at the Annual Meeting, the receipt of and opportunity to publish in the Journal, and participation in the one state-wide interdisciplinary organization in Georgia devoted solely to the promotion of the interests of science.

GEORGIA ACADEMY OF SCIENCE MEMBERSHIP RECORD

For our records and for mailing purposes, please print the following information:

Name _____

Position _____

School or Organization _____

E-mail Address _____

Mailing Address (no more than three lines) _____

_____ Zip _____

Degrees with dates and institutions: _____

Special Scientific interests: _____

Memberships in other scientific organizations: _____

Section of Academy preferred (only one): I. Biological Sciences; II. Chemistry; III. Earth and Atmospheric Sciences; IV. Physics, Mathematics, Engineering, and Computer Sciences; V. Biomedical Sciences; VI. Philosophy and History of Science; VII. Science Education; VIII. Anthropology.

Ways you would be willing to serve the Academy:

Printed Name

Date

Signature

Current dues are \$35.00 U.S. (\$50 International) for individuals and \$50.00 U.S. (\$65 International) for institutions per calendar year, payable at the time of submission of this form. Make check payable to Georgia Academy of Science.

**Return to: Dr. Hubert B. Kinser, Treasurer
Division of Natural Science and Mathematics
Dalton State College
Dalton, Georgia 30720**



106

NOTES



107

NOTES





NOTES

