Volume 74, Number 3

WVAS
West Virginia
ACADEMY of SCIENCE
Founded 1924

Proceedings of West Virginia Academy of Science

2002

CAMP DAWSON SYMPOSIUM
THE SEVENTY-SEVENTH
ANNUAL SESSION

WVAS
West Virginia
ACADEMY of SCIENCE
Founded 1924

Proceedings of the West Virginia Academy of Science 2002

Vol. 74 No. 3

CAMP DAWSON SYMPOSIUM
THE SEVENTY-SEVENTH ANNUAL SESSION

Morgantown, WV
April 20, 2002

Printed by
Ralston Press
Buckhannon, WV
February 2006

West Virginia Academy of Science, Inc.

The West Virginia Academy of Science was founded at Morgantown, November 28, 1924. The Academy was incorporated under the Code of West Virginia on May 9, 1959 as a "nonstock corporation, which is not organized for profit but for the advancement of learning and scientific knowledge."

Officers 2002

President	Roger Seeber, West Liberty
President-Elect	Ron Fortney, Morgantown
Past President	James Van Gundy, Elkins
Treasurer	Dewey Sanderson, Marshall
Assistant Treasurer	John R. Warner, Jr. Buckhannon
Secretary	Ralph Booth, Elkins
Proceedings Editor	Ron Canterbury, Concord
Associate Editor	Darla Wise, Concord
Former Editor	Ralph W. Taylor, Huntington
Chair of the WV Junior Academy of Science	Marcia Harrison, Huntington
Co-Chairs of the Annual Meeting	Jim Anderson and Ron Fortney, Morgantown

Dues Structure

Student	$7.50
Regular	$15.00
Contributing	$30.00
Sustaining	$60.00
Life	$150.00
Institutional	$200.00
Corporate	$200.00
Library subscription to proceedings	$25.00

Proceedings of the West Virginia Academy of Science
Camp Dawson Symposium 2002
Ron Canterbury, Editor
Darla Wise, Associate Editor

Published as a peer-reviewed journal at the West Virginia Academy of Science, Inc. Manuscripts for publication should be sent to the editor, Dr. John Warner, Box 129. West Virginia Wesleyan, Buckhannon, WV 26201. Manuscripts must be sent electronically (email or compact disk) in Microsoft WORD to **warner@wvwc.edu**. Three hardcopies should also be sent to the address above. Proofs, edited manuscripts, and all correspondence regarding papers for publication should be directed to the editor. For additional information, call (304) 472-1907. See also our web page at http://www.marshall.edu/wvas/public.html.

Application for membership in the Academy and dues should be sent to Robert Kreisberg, Box 76, West Liberty State College, West Liberty, WV, 26074. Changes of address should be sent to Dr. Kreisberg. Libraries or others wishing to purchase the Proceedings should direct requests to the editor. Correspondence concerning library exchanges should be directed to the Director of Libraries, West Virginia University, Morgantown, WV 26506.

Table of Contents

NATURAL RESOURCE MANAGEMENT ON THE CAMP DAWSON COLLECTIVE TRAINING AREA IN PRESTON COUNTY, WEST VIRGINIA

JOSEPH D. OSBOURNE*, JAMES T. ANDERSON, Wildlife and Fisheries Resources, Division of Forestry, West Virginia University, P.O. Box 6125, Morgantown, WV 26506-6125, USA. *Joe.Osbourne@mail.wvu.edu, LAURENCE B. WILLIAMS, and JEFFREY A. SIMCOE, The West Virginia Army National Guard, Natural Resources Office, CDCTA, Kingwood, WV 26537, USA.

ABSTRACT

The Sikes Act Improvement Act of 1997 included amendments to the 1960 Sikes Act mandating the creation of Integrated Natural Resource Management Plans (INRMPs) on all Department of Defense (DOD) installations. This symposium provided an overview and case study of the procedures and surveys conducted in developing the INRMP for the Camp Dawson Collective Training Area (CDCTA), a 1,655 ha West Virginia Army National Guard (WVARNG) training installation in Preston County, West Virginia. This article presents a description of the INRMP process and the natural resources program on the CDCTA.

INTRODUCTION

The DOD is the third largest land management agency in the United States, behind the Bureau of Land Management and the Forest Service, with over 12.1 million ha of land used for military training and operation (Hollingsworth 1999). Almost every ecosystem found in the United States is represented on DOD land, and these areas provide tremendous value as habitat for numerous threatened and endangered species. In addition, DOD installments provide a wealth of public goods and services including natural resources for consumption and recreational opportunities (United States Army Legal Service Agency [USALSA] 1998, Hollingsworth 1999, WVARNG 2001). The Sikes Act is the primary legislation governing the management of natural resources on DOD lands. Amendments to this Act in 1997 provided a mandate for sustained multiple-use management of natural resources on DOD lands through the creation of INRMPs at DOD installations (USALSA 1998, Hollingsworth 1999).

Camp Dawson is a National Guard post in Preston County, West Virginia primarily used for training and maneuver exercises in mountainous terrain. Prior to the initiation of the Camp Dawson Natural Resources Program, little was known about the natural resources on the base properties (WVARNG 2001). This symposium, conducted during the 77th Annual West Virginia Academy of Sciences meeting, presents the INRMP process at Camp Dawson as a case study of the establishment of a natural resources management program on a military instillation. Because no data were available on the floral and faunal communities at Camp Dawson, the following articles present the results of inventory surveys aimed at describing the biological communities that occur on the CDCTA. These data were used in creating the management goals and objectives of the Camp Dawson INRMP. This article provides descriptions of the natural resources program at Camp Dawson and the Camp Dawson INRMP process.

SITE DESCRIPTION

The CDCTA is a 1,655 ha military training post located in Preston County, West Virginia at 39° 25' north latitude and 79° 40' west longitude (WVARNG 2001, Osbourne 2002; Figure 1).

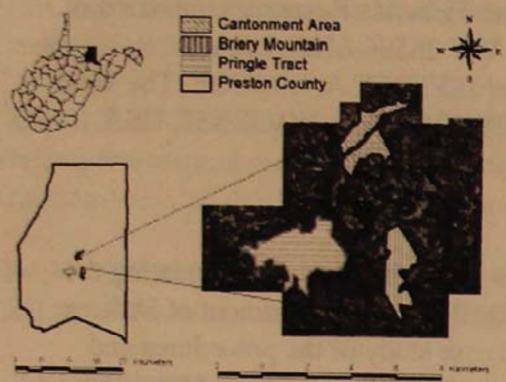

Figure 1. The Camp Dawson Collective Training Area in Preston County, West Virginia.

Preston County has a temperate climate with moderate winters, warm summers, and almost equal distribution of precipitation across seasons (Ruffner 1985, Garwood 1996). The mean temperature in Preston County is 8.8°C, and total annual precipitation is 137.0 cm (Garwood 1996). The elevation of the CDCTA ranges from 122 - 853 m above sea level (Table 1). The CDCTA is composed of three distinct, non-contiguous training areas (TAs): the Cantonment Area (378 ha), the Briery Mountain TA (423), and the Pringle Tract TA (854). Military training (i.e., land navigation, parachute drops, light infantry), public recreation, and timber harvesting are the primary uses of the CDCTA properties (WVARNG 2001).

The Cantonment area, located in the Dunkard Bottom floodplain of the Cheat River, is the main operating area for the WVARNG. The property is primarily covered by maintained lawns, office buildings, vehicle maintenance buildings, an armory, an abandoned manganese plant, firing ranges, and a paved airstrip (WVARNG 2001, Osbourne 2002). The eastern and western borders of the Cantonment area are steep, forested mountain slopes primarily composed of mixed mesophytic forest. The non-urbanized portions of the Cantonment Area floodplain are dominated by old field and successional floodplain forests (Vanderhorst 2001). There is a stocked fishing pond and several small wetland patches on the property (Lee et al. 2001). The primary soils on the property are silt and sandy loams (Bell 2001).

The Briery Mountain TA is located about 5 km south of the Cantonment Area. This property is owned and managed as a state wildlife management area by the Department of Public Safety and Military Affairs and the WVARNG in conjunction with the West Virginia Division of Natural Resources (WVARNG 2001). Second growth forest covers most of the Briery Mountain TA. A small area in the central portion of the TA is dominated by scrub-shrub habitat, and a small portion of the southern end of the property contains a limestone quarry that is used as a demolition training site (WVARNG 2001, Anderson et al. 2002a). The primary plant communities on the Briery Mountain TA are mixed montane hardwood forest and sub-xeric oak (*Quercus* spp.) forest (Vanderhorst 2001). The primary soils on the TA are loams, silt loams, and rubbly complexes (Bell 2001).

The Pringle Tract TA is located west of the Briery Mountain TA across the Cheat River. This tract is owned by Allegheny Wood Products, and the maneuver rights were leased to the WVARNG for 50 years in 1996. In exchange for the land use rights, Allegheny Wood Products was granted timber rights for the Cantonment and Briery Mountain TAs (WVARNG 2001, Osbourne 2002). The Pringle TA provides the greatest mix of land cover types of the 3 TAs with the primary vegetative cover types being mixed mesophytic forest of colluvial slopes, successional forests of low elevation plateaus, old field, pine plantation, and eastern hemlock (*Tsuga canadensis*) ravine (Vanderhorst 2001). The primary soils on the Pringle Tract TA are loams, silt loams, and rubbly complexes (Bell 2001).

CAMP DAWSON NATURAL RESOURCES PROGRAM

Military Mission

The mission of the Camp Dawson branch of the WVARNG is to provide realistic training opportunities for Army National Guard installments nationwide and any active components of the Air Force, Navy, and Marines that require rugged mountain terrain for training activities. The most common training that occurs on the CDCTA is company level tactical training (90-150 soldiers). These exercises include, but are not limited to, land navigation, bivouacking, small arms training, pyrotechnics, demolition, construction of fortification and defense positions, and special forces training (WVARNG 2001). The understood principle in natural resources management on military lands is that management should not hinder military activity, but the ecological impacts of military operations should be minimized or avoided whenever possible. This presents a complex management scenario requiring the cooperation of natural resource managers and military personnel.

Ecosystem Management

In 1994, the DOD adopted an ecosystem management approach on installations nationwide (DOD Instruction 4715.3). The Sikes Act amendments in 1997 emphasized this approach by requiring INRMPs on all DOD installations. The goal of ecosystem management on military lands is to incorporate protection and enhancement of ecosystem integrity into a multiple-use strategy that minimizes the ecological impacts of military training without interfering with the overall training mission (WVARNG 2001). An ecosystem management approach requires that goals and objectives be established regarding the management of natural resources within ecosystems on a site. A task of this magnitude requires many partnerships and on-site research to be initiated effectively. Because of the infancy of the CDCTA program, ecosystem plans have just recently been developed (Anderson et al. 2002a), but not yet implemented.

Program Establishment

Prior to 1999, the natural resources on the CDCTA were managed from the Charleston National Guard Bureau Office. The ecosystems of the CDCTA have been drastically altered by mining, agriculture, forestry, development, and military operations. In 1999, the WVARNG decided on-site management would be required to create an ecosystem management approach and initiate a natural resources program on the CDCTA. A Natural Resources Office was established with the responsibilities of managing floral, faunal, air, water, and cultural resources on the CDCTA properties (WVARNG 2001). The specific duties of the Natural Resources Office were to advise the WVARNG on the best ways to comply with federal and state environmental laws, create an acceptable INRMP for Camp Dawson, and adopt an ecosystem management approach integrating natural resource management and training activities. The establishment of an Integrated Training Area Management (ITAM) program was required to carry out the activities described in the INRMP. An ITAM coordinator is a liaison between military and natural resources personnel with the duties of coordinating military training activities and fulfillment of INRMP requirements.

The INRMP Process at Camp Dawson

The purpose of the INRMP is to guide natural resources management over a 5 year period consistent with installation mission requirements. This document is the primary vehicle for determining management activities and interpreting policy at the installation level. The first step in creating the INRMP at Camp Dawson was establishing a core team of individuals that would be involved in the process and identifying stakeholders that would be affected by or have input on components of the INRMP. The key stakeholders for the

CDCTA were identified as WVARNG master planning staff, state and federal agencies, West Virginia University, and Allegheny Wood Products.

The next step in the process was data gathering. The existing data on natural resources at Camp Dawson was minimal, and no data were available on the biological communities on the CDCTA. Collection of these data would have been nearly impossible without the cooperation of several stakeholders as contractors. Scientists from West Virginia University were contracted to conduct faunal and timber inventories and create wildlife and forest ecosystem management plans for the INRMP (Anderson et al. 2002*a*,*b*). The West Virginia Division of Natural Resources was hired to identify vegetative communities (Streets 2001, Vanderhorst 2001). Two federal agencies, the Natural Resources Conservation Service and the United States Army Corp of Engineers, were contracted to conduct soil (Bell 2001) and wetland surveys (Lee et al. 2001) on the TAs. In addition to natural resources data, information was gathered on historic, current, and proposed land alterations and military training activities.

Once data collection was complete and proposed actions were determined, an environmental assessment (EA) was conducted to evaluate the impact of the proposed actions. The National Environmental Policy Act of 1969 (NEPA; 42 USC 4321 *et seq.*) requires that an EA be conducted to identify and resolve environmental concerns with human activities at the earliest stage of project development (USALSA 1998, WVARNG 2001). The final step in creating the INRMP was to identify alternatives to proposed development and land use actions and explain the rationale for why the proposed actions were chosen over the alternatives. The INRMP is now a working guide for natural resource management on the CDCTA. Future projects and activities will be determined by the objectives and actions proposed in the INRMP.

Geographic Information Systems at Camp Dawson

A vital component to the establishment and development of the natural resources program at Camp Dawson is the use of Geographic Information Systems (GIS). The purpose of GIS is to capture, store, update, manipulate, analyze, and display geographically referenced data (Coombes et al. 1993). A GIS specialist was hired to the Camp Dawson natural resources staff in 2000 to assist with creation of maps and spatial analysis of geographic data for military training and natural resources. Training activities, bivouac sites, land navigation courses, and site mapping are all military uses for GIS.

The natural resources program on the CDCTA has relied on GIS at every stage of development. Determining the boundaries of the TAs and creating maps to use on site for planning level surveys was the initial incorporation of GIS into the INRMP process. Since then, GIS has been used to create maps of trapping locations, vegetative communities, soil types, sensitive areas, and many other natural resource components. In planning proposed actions for the INRMP, GIS was used to determine optimal locations for management activities and future monitoring efforts. The GIS component of the Camp Dawson Natural Resources Program is and will continue to be an integral part of ecosystem management and military training.

Since 1999, the Natural Resources Office staff at Camp Dawson has grown from one natural resources manager to include a GIS specialist, a wildlife biologist, and an ITAM coordinator. Carrying out the objectives of the INRMP will require the participation and cooperation of the natural resources staff and the military personnel on the base.

ACKNOWLEDGEMENTS

We thank W. P. Grantham and R. J. Michalow for providing comments on this manuscript. We thank the West Virginia

Academy of Sciences for allowing us to conduct this symposium. We also thank the West Virginia Army National Guard, the West Virginia University Research Corporation, and the West Virginia University Davis College of Agriculture, Forestry, and Consumer Sciences (McIntire-Stennis) for funding and logistical support. This is manuscript number 2908 of the West Virginia University Agricultural and Forestry Experiment Station.

LITERATURE CITED

Anderson, J. T., G. M. Forcey, J. D. Osbourne, and A. B. Spurgeon. 2002*a*. Wildlife management plan for the Camp Dawson Collective Training Area, Kingwood, West Virginia. Division of Forestry, West Virginia University, Morgantown, West Virginia, USA.

Anderson, J. T., G. M. Forcey, J. D. Osbourne, and A. B. Spurgeon. 2002b. Camp Dawson Collective Training Area Faunal Report. Division of Forestry, West Virginia University, Morgantown, West Virginia, USA.

Bell, J. W. 2001. Soil survey of Camp Dawson, Preston County, West Virginia. USDA Natural Resources Conservation Service, Moorefield, West Virginia, USA.

Coombes, M., C. Saunders, and S. Raybould. 1993. Critical problems in developing databases for upland areas: The potential value of GIS techniques. Journal of Environmental Management 39:271-280.

Forcey, G. M. 2002. An evaluation of double-observer point count techniques and avian habitat use on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Garwood, A. N., editor. 1996. Weather America: The latest detailed climatological data for over 4,000 places with rankings. Toucan Valley Publications, Milpitas, California, USA.

Hollingsworth, T. K. 1999. The Sikes Act Improvement Act of 1997: Examining the changes for the Department of Defense. The Air Force Law Review 46:109-153.

Lee, A. A., D. D. Evans, M. Bishop, T. Wilson, and M. Mauney. 2001. Delineation of wetlands and other regulated waters of Camp Dawson, WV. U. S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, Mississippi.

Osbourne, J. D. 2002. Effects of edge and coarse woody debris on small mammal communities in riparian and upland habitats in northern West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Ruffner, J. A. 1985. Climates of the states: National Oceanic and Atmospheric Administration narrative summaries, tables, and maps for each state with overview of state climatologist programs. Volume 2. National Oceanic and Atmospheric Administration, Gale Research Company, Washington, D. C., USA.

Spurgeon, A. B. 2002. Comparison of herpetofaunal species composition and response to edge on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Streets, B. P. 2001. Floristic inventory of Camp Dawson Army Training Site Preston County, West Virginia. West Virginia Division of Natural Resources, Elkins, West Virginia, USA.

United States Army Legal Service Agency (USALSA). 1998. USALSA Report. The Army Lawyer 1998:36-43.

Vanderhorst, J. 2001. Plant community classification and mapping of Camp Dawson Collective Training Area, Preston County, West Virginia. Nongame Wildlife and Natural Heritage Program, Wildlife Resources Section, Division of Natural Resources, Elkins, West Virginia, USA.

West Virginia Army National Guard (WVARNG). 2001. Integrated Natural Resources Management Plan. Camp Dawson, Preston County, West Virginia, USA.

Table 1. Physical and biological characteristics of the 3 tracts comprising the Camp Dawson Collective Training Area, Kingwood, West Virginia.

Characteristic	Tract: Briery	Cantonment	Pringle	Combined	Reference
Size (ha)	423	378	854	1,655	
Minimum Elevation (m)	579	122	396	122	
Maximum Elevation (m)	853	464	610	853	
Dominant Soil Series	Lily, Clymer	Gilpin, Udorthents	Gilpin, Fairpoint	Gilpin, Laidig, Fairpoint	Bell (2001)
No. Soil Series	15	14	15	25	Bell (2001)
Dominant Plant Community Type[a]	MMHF, SXOF	MMFCS, SFF	SFLEP, MMFCS	MMFCS,SFLEP, MMHF	Vanderhorst (2001)
No. Plant Community Types	8	13	8	17	Vanderhorst (2001)
Number of Streams	24	17	62	103	Lee et al. (2001)
Stream Length (km)	10.49	6.57	16.75	33.81	Lee et al. (2001)
Number of Wetlands	1	13	6	20	Lee et al. (2001)
Wetland Area (ha)	0.23	2.12	1.44	3.79	Lee et al. (2001)
Number of Ponds and Lakes	0	5	5	10	Lee et al. (2001)
Pond and Lake Area (ha)	0	2.89	0.51	3.4	Lee et al. (2001)
No. Plant Species	269	421	340	579	Streets (2001)
No. Mammal Species	24	30	40	40	Osbourne (2002)
No. Bird Species	61	78	69	103	Forcey (2002)
No. Reptile Species	3	3	6	9	Spurgeon (2002)
No. Amphibian Species	14	16	10	19	Spurgeon (2002)
No. Moth Species	105	148	156	235	Anderson et al. (2002*b*)
No. Fish Species	0	16	11	24	Anderson et al. (2002*b*)

[a]MMHF = Mixed Montane Hardwood Forest, SXOF = Sub-xeric Oak Forest, MMFCS = Mixed Mesophytic Forest of Colluvial Slopes, SFF = Successional Floodplain Forest, and SFLEP = Successional Forest of Low Elevation Plateaus.

THE IMPORTANCE AND USE OF WILDLIFE MANAGEMENT PLANS: AN EXAMPLE FROM THE CAMP DAWSON COLLECTIVE TRAINING AREA

JAMES T. ANDERSON*, GREG M. FORCEY, JOSEPH D. OSBOURNE, and AMY B. SPURGEON, Wildlife and Fisheries Resources, Division of Forestry, West Virginia University, P. O. Box 6125, Morgantown, WV 26506-6125, USA. *jander25@wvu.edu.

ABSTRACT

It is naive to think that management of wildlife habitat or populations is unnecessary. Drastic landscape-level alterations have substantially changed the potential carrying capacity for many species from historic times. Current problems including habitat loss and degradation, fragmentation of habitats, the spread of exotic floral and faunal species, pollution, and human disturbance among others, are all contributing to loss of species diversity and abundance. Wildlife management plans are essential for properly managing wildlife habitats, populations, and associated recreational activities. A management plan is a description of the short-term objectives and long-term goals that will be met by manipulation of habitat, wildlife populations, and people and how these objectives and goals will be reached. Historically, management plans have focused primarily on increasing abundance of game species and maximizing recreational opportunities associated with these species. Currently, management plans address threatened and endangered species and habitats, nongame species that are not classified as rare, overall biodiversity, and quality and abundance of game species populations. Wildlife management plans on Camp Dawson, an Army National Guard training facility in Preston County, West Virginia, have been developed for each of three primary training areas. Management objectives are targeted towards restoring native habitats; removing invasive, exotic species; protecting habitats for rare species; conserving and providing habitat for birds, small mammals, and herpetofauna; increasing the quality of white-tailed deer (*Odocoileus virginianus*) populations; increasing the abundance of ruffed grouse (*Bonasa umbellus*) and other game species; providing public recreational opportunities; and allowing for the military training mission. These plans are biologically feasible and should result in the maintenance and enhancement of wildlife populations and habitats on Camp Dawson.

INTRODUCTION

An Overview of Wildlife Management

To fully implement a quality wildlife management plan, fundamental wildlife management principles must be understood. Historically, wildlife managers took a restricted view of wildlife and focused primarily on game species of interest to hunters because revenue from hunting products and services provided the main funding source for program development and land acquisition. One of the earliest definitions was formulated by Leopold (1933), who defined game management as the art of making land produce sustained annual crops of wild game for recreational use. Alexander (1962) defined wildlife management as the art of producing sustained populations of wild vertebrates for man's convenience, pleasure, and use. Since the early days of the profession, the definitions have evolved to encompass more species, but still focus on humans as the end users of wildlife. As an example, Anderson (1999) defined wildlife management as the art and science of manipulating populations and habitats for animals and for human benefits. Similarly, Scalet et al. (1996) defined wildlife management as the art and science of manipulating the biota, habitat, and human users of a wildlife system to produce some desired end result. Bolen and Robinson (1999) emphasized the human component, defining wildlife management as the application of ecological knowledge to populations of vertebrate animals and their plant and animal associates in a manner that strikes a balance between the needs of these populations and the needs of people. Several approaches can be used to manage wildlife including preservation, conservation, and management (Anderson 1999).

In the past several decades, ecosystem management has come to the forefront as the paradigm for modern land management. Grumbie (1994) defined ecosystem management as the meshing of scientific knowledge of ecological relationships within a complex sociopolitical and values framework towards the general goal of protecting native ecosystem integrity over the long term. We define wildlife management in an ecosystem management context as the management of rare and common habitats and animal populations for multiple uses at multiple scales to achieve ecosystem integrity and sustainable use of available resources. Management in this approach must embrace human use and employ methods to preserve, conserve, enhance, restore, and manage species and habitats. As such, the historic and current definitions of wildlife management are integrated with ecosystem management to meet the needs of society.

A wildlife management plan is a required prerequisite for conducting most wildlife management activities. A wildlife management plan is designed to serve as guidance for the implementation of habitat and population manipulations that will increase, decrease, or sustain populations of wildlife and the quality or quantity of habitat. Management plans are objective-oriented and provide a description of the objectives that will be accomplished through the alteration of habitat, populations, and people and the ways these objectives will be attained (Ripley 1980, Anderson 1999). A properly prepared plan will direct the management objectives and reduce expenses and time (King 1974). Management plans are designed to serve as guidance only; as new information is obtained, changes to the plan should be implemented, as in an adaptive management approach (Nichols et al. 1995).

Management plans are usually designed to increase populations of specific wildlife species (featured species approach) or overall diversity. This is accomplished by providing and maintaining a proper and satisfactory environment (King 1974, Bolen and Robinson 1999). Wildlife species have three basic needs—food, water, and shelter. Many species also require specialized habitats for breeding, nesting, brood rearing, loafing, or escape cover. Most importantly these habitats must be interspersed or connected by travel lanes and within the animals' home range (Leopold 1933). Therefore, the spatial locations of management activities are as important as the types of actions themselves.

Wildlife management is particularly necessary in today's world. An increasing human population (Maurer 1996) is placing greater demands on the natural systems upon which wildlife depend. Alteration of the landscape has caused numerous species to suffer drastic declines in populations, become extirpated from particular areas, and even become extinct. Indeed, worldwide 11% of birds, 24% of amphibians, and 23% of mammals are threatened with extinction (IUCN 1996). Concomitantly, other species have increased their populations to the point where they have exceeded sociological and biological carrying capacities. For example, in some areas, white-tailed deer and Canada goose (*Branta canadensis*) populations have reached a level where they cause significant ecological degradation and human health concerns (Cummings et al. 1995, Stromayer and Warren 1997). Wildlife management is required to achieve a healthy, sustainable balance between human populations, wildlife resources, and ecosystem integrity.

Management Plan Components

Management plans should include most of the following components: cover page, acknowledgments, table of contents, study area description, human use of the area, inventory of wildlife populations, inventory of vegetative cover types and plant species, coordination of management objectives, wildlife management practices, monitoring and inventory, measuring success, budgets, and literature cited (Ripley 1980). An individual plan may include some or all of these components depending upon existing data and reports and the overall goals and objectives of the management plan.

The cover page consists of a descriptive title, list of authors and affiliations, the date prepared, and for whom it was prepared. The acknowledgments section should list and thank appropriately all of the people who assisted with the plan. This may include the landowner, funding sources, biologists from public agencies and nongovernmental organizations, and field technicians or volunteers that contributed to data collection, formulating recommendations, or reviewing the plan.

The study area description should include a summary of the physical and ecological setting of the area. Information on location, soils, historical land use, topography, climate, and vegetative cover types should be included as minimal components. Aerial photographs, soil maps, plat maps, cover type maps, and topographic maps should be included. The use of Geographic Information Systems (DeMers 2000) makes the preparation and manipulation of maps relatively easy to incorporate into management plans. Enough details should be provided so the reader can interpret the management practices in terms of what is happening on the ground. However, more importantly, this section should be adequately referenced so the reader can refer to the original documents to obtain more information on past land use practices and current conditions. Any information on current human use of an area, including land use, timbering practices, and recreational uses should be included. In most cases, this can be part of the study area description, but in certain situations, this may warrant a separate section.

Depending on the goals of the management plan, an inventory of wildlife populations should be conducted. The first consideration is which species or guilds are of concern for the plan. Management plans may have as their focus one or more game species, endangered or rare species, or overall biodiversity. Another consideration is the level of precision required for the plan. Plans aimed at a limited number of species should attempt to obtain accurate and precise population estimates for each species. Obtaining accurate population estimates for a diversity of species in most situations will be too expensive to justify. In these situations, a simple listing of presence or absence in combination with relative density estimates for certain species may be more appropriate. In any case, all previous studies and surveys on the area should be cited so the reader can obtain more details on species occurrence, distribution, and abundance. A variety of books and manuals should be consulted for details on how to inventory wildlife populations (e.g., Cooperrider et al. 1986, Davis 1990, Bookhout 1994, Heyer et al. 1994, Sutherland 1996, Wilson et al. 1996).

The majority of wildlife management deals with managing habitats rather than populations. Therefore, a detailed inventory and analysis of the vegetative communities and plant species that occur should be conducted in addition to the preparation of a cover type map, if these data do not already exist. Methods for sampling vegetative communities are found in Cain and Castro (1959), Mueller-Dombois and Ellenberg (1974), Causton (1988), Bonham (1989), and Higgins et al. (1994).

Management activities should be coordinated so different land management goals can be meshed into one plan. Existing plans or activities on a site should be consulted and integrated into a management plan. For example, if the area is a National Guard training facility, then wildlife management activities must be integrated with the military training mission.

The wildlife management practices section is the focal point of the plan. This section makes explicit recommendations on the types of activities that should be implemented concerning wildlife habitat and populations. The plan should include the type of activity, where and when it should be implemented, the intensity of the action (i.e., amount of area, number of structures, etc.), and how these management actions should be implemented. The management actions should be based on the best available data from scientific research articles and the results of previous management activities on the site. These actions should be adequately referenced and include diagrams, flow charts, and maps to ensure the best chance of success. Good overviews of management practices are found in Payne and Copes (1986), Payne (1992), Bookhout (1994), and Payne and Bryant (1998).

Adequate monitoring of the site should continue throughout the implementation phase of the proposed management action. A plan should be developed to monitor the response of both wildlife species and their habitat to the implemented activities. Additionally, goals should be set in terms of wildlife population densities, amount of habitat enhanced, productivity of individuals, or some other measure to determine if the management plan was successful in meeting the goals that were set.

A budget should be included that provides estimates of cost for implementing the management actions described. This will allow the landowner to better determine which activity can be implemented within a given year. Additionally, a detailed accounting of the costs associated with the preparation of the plan should be provided.

There are numerous examples of wildlife management plans that have been developed for state and federal natural resources properties, corporate lands, and private landowners. These plans are primarily in the gray literature but should be consulted for different models of management plans (e.g., Foster and Rauch 1998, Anderson et al. 2002*a*).

AN OVERVIEW OF THE CAMP DAWSON MANAGEMENT PLANS

Background

In 2002, wildlife management plans were developed for each of the three tracts comprising the Camp Dawson Collective Training Area (CDCTA), Kingwood, WV: Cantonment, Pringle, and Briery Mountain (Anderson et al. 2002*a*). The CDCTA, Kingwood, West Virginia is a military training facility operated by the West Virginia Army National Guard. Three tracts comprise the 1,655 ha base that is centered about 6 km east of Kingwood (39° 26' north latitude, 79° 40' west longitude). The plans were designed to serve as guidance only, but provided a detailed description of the activities and techniques that can be implemented on the area to manage wildlife populations and habitats. The rest of this paper provides a summary of some of those recommendations as a means of introducing the concept of wildlife management plans and wildlife management practices, and to showcase the plan for the CDCTA. To conserve space only selected practices and limited details are provided. However, the concepts presented can be implemented on almost any piece of property depending upon landowner objectives.

The objectives of the management plans were specific to the three particular tracts of the CDCTA, but some overriding themes prevailed. The main objectives of the CDCTA wildlife management plans were to:

1. Protect, restore, maintain, and manage populations of state rare plant and animal species or communities within the guidelines of ecosystem management, while still allowing for the overall training mission;
2. Manage game and nongame wildlife and fish species within the guidelines of

ecosystem management and the training mission; and

3. Conserve, maintain, restore, and manage forest, grassland, and wetland ecosystems to allow for long-term sustainability that provides for timber production, soil conservation, wildlife habitat, and the military training mission.

Management of Forest Lands

A large part of wildlife management in forested environments is timber management. We recommend a variety of silvicultural techniques for use on the CDCTA, including crop tree management and shelterwood cuts for oaks (*Quercus* spp.), single-tree and group-tree selection for maples (*Acer* spp.), and clearcuts for yellow poplar (*Liriodendron tulipifera*) (Payne and Copes 1986, Hunter 1990, Perkey and Wilkins 1990, Mannan et al. 1994, Anderson et al. 2002*a*). Existing hemlock (*Tsuga canadensis*) stands and bottomland hardwood areas should not be harvested. Additionally, white pine (*Pinus strobus*) or other evergreens should be planted on Briery Mountain, as this type of habitat currently is lacking but provides good cover for a number of species (Hunter 1990). The natural resources management staff will need to reconcile our suggested practices, which are aimed primarily at wildlife, with the suggested practices from foresters. However, most practices recommended are good for both timber and wildlife, and if properly implemented should result in good ecosystem management (R. R. Hicks, West Virginia University, personal communication). Management techniques such as the creation and retention of grape vines (*Vitis* spp.), brush piles, snags, den trees, and coarse woody debris should be implemented to benefit particular groups of wildlife in all forested cover types (Anderson et al. 2002*a*).

On all forested habitats, we recommend that 10-25% of grapevines be left uncut, rather than removed to improve timber production, because grapes provide important food for most songbirds, mammals, and game animals (Martin et al. 1951, Miller and Miller 1999). Creating brush piles provides necessary cover for various species of birds and small mammals. Ruffed grouse, wild turkeys (*Meleagris gallopavo*), many species of songbirds, striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), rabbits (*Sylvilagus* spp.), and eastern woodrats (*Neotoma floridana*) use brush piles as sources of cover (Payne and Bryant 1998). Brush piles should be located within 50 to 150 m (164 to 492 ft) of food sources and other types of cover such as hedgerows, clearings, woodland-field edge, and ponds. Slash and tops from tree harvesting combined with old logs and downed trees make excellent brush pile material. Piles should be about 1.5 to 2.5 m tall (4.9 to 8.2 ft), 4 to 10 m across (13 to 33 ft), and constructed with 10 to 30 cm (4 to 12 in) of ground clearance (Payne and Bryant 1998). Slash from previous or on-going forestry practices should be used to make brush piles opportunistically in edge habitats. Existing downed woody timber should be left in place and not removed for firewood or other purposes. Coarse woody debris provides important habitat for most herpetofauna and small mammals (Osbourne 2002), and also provides critical display habitat for drumming grouse.

Border cuts of trees should be conducted near all open grassy areas and in several other edge habitats (Anderson et al. 2002*a*). All trees taller than 3 m or larger than 7.5 cm diameter at breast height (DBH) should be cut in a border 10-15 m wide (Payne and Bryant 1998). This technique will provide the scrub-shrub habitat and edge diversity that is currently lacking on the property. These areas should be maintained on a 3-7 year rotation.

Snags provide critical habitat for cavity-nesting birds and small mammals (Davis 1983, Hunter 1990, Payne and Bryant 1998). Preserving existing snags and artificially creating new ones should be conducted within each of the forest cover types of the CDCTA. While uneven-aged management is more appropriate for snag management, existing snags also can be left standing with even-aged management practices. One way to artificially create snags is to girdle large trees (>30 cm DBH) (Payne and Bryant 1998); large snags typically are more valuable to wildlife than smaller ones. This practice is particularly applicable when releasing crop trees in oak cover types.

Artificial nesting boxes should be constructed and placed on the CDCTA for cavity-nesting birds and mammals. These artificial cavities provide nesting and roosting structures in the absence of natural cavities. Nest boxes can benefit birds such as black-capped chickadee (*Poecile atricapilla*), tufted titmouse (*Baeolophus bicolor*), white-breasted nuthatch (*Sitta carolinensis*), great-crested flycatcher (*Myiarchus crinitus*), eastern screech-owl (*Otus asio*), and northern saw-whet owl (*Aegolius acadicus*) and mammals such as gray squirrel (*Sciurus carolinensis*), flying squirrels (*Glaucomys* spp.), and bats. Specific dimensions, number, and placement of boxes for target species is critical (Stokes 1990, Henderson 1992, Payne and Bryant 1998, Anderson et al. 2002*a*).

Management of Grassland and Scrub-shrub Habitats

Most of the grassland habitats on the CDCTA are reclaimed mine areas used frequently for military training activities. These areas also are important as habitat for a diversity of early successional wildlife species (Forcey 2002, Osbourne 2002, Spurgeon 2002). Many of these areas are strip mowed several times a year to control invasion by woody plants and keep vegetation levels low for maneuverability. This mowing regime should continue to maintain open grassy areas for eastern bluebirds (*Sialia sialis*) and other songbirds to forage. As much as possible, mowing should be avoided from April-July to allow nesting of breeding birds (Kie et al. 1996).

Some of the grasslands should be converted from cool-season exotics (i.e., meadow fescue [*Festuca pratensis*]) to cool-season natives (Anderson et al. 2002*a*). The site should be prepared by spraying in late summer with a non-selective, short persistence (i.e., 2-4 weeks) herbicide, such as Weedazole or Roundup, to kill most of the existing vegetation (Payne and Bryant 1998). Patches of native warm-season broomsedge (*Andropogon virginicus*) should not be sprayed, but maintained to provide spatial heterogeneity in the landscape. A month after spraying, the ground should be disked and prepared for planting. Soil should be tested to determine if fertilizer and/or lime is needed to promote good plant growth. A mixture of native grass seeds (e.g., *Poa* spp., *Festuca* spp.) of about 11 kg/ha (10 pounds/acre) should be seeded along with selected forbs (Anderson et al. 2002*a*). We recommend that seeds from the native species present on site be collected and used in the re-seeding effort. A cover crop of winter wheat or rye should be used in conjunction with the plantings. An area of 2 ha (5 acres) should be planted yearly until 50% of the area is completed. In addition to reducing soil erosion, the cover crop will serve as a temporary food source for deer, turkey, rabbits, and songbirds.

Much of the scrub-shrub habitat on the CDCTA is composed of exotic, invasive species such as autumn olive (*Elaeagnus umbellata*) and multiflora rose (*Rosa multiflora*), and native black locust (*Robinia pseudoacacia*). Black locust provides a valuable resource for nutrient-poor soil because it is a nitrogen fixing species, but the two former exotics are highly invasive and should be reduced and controlled so that native grassland species can be planted (Kie et al. 1996). Methods of removing unwanted vegetation are mechanical, chemical, biological, or prescribed burning (Payne and Copes 1986).

We recommend that mechanical and chemical control be conducted to spot-treat autumn olive and multiflora rose. Basal treatment with Tordon or a similar chemical may be most effective, but if there are concerns over using pesticides then mechanical control should be used (Payne and Bryant 1998). Following either chemical or mechanical control, a controlled burning program should be implemented to promote warm season grasses (Payne and Copes 1986, Vallentine 1989, Payne and Bryant 1998).

Indian grass (*Sorghastrum nutans*) and broom sedge already occur on site and may increase in aerial coverage following burning. The area should be burned from late fall through early spring on a 2 or 3 year rotation. Seeding can be conducted if response is not great enough after one or two controlled burns. A no-till seed drill can be used (available through the Natural Resources Conservation Service [NRCS]) to plant a mixture of big bluestem (*Andropogon gerardii*), Indian grass, and switch grass (*Panicum virgatum*) for the benefit of grassland associated wildlife (Anderson et al. 2002*a*). A workable mixture is 5.5 kg/ha (5 pounds/acre) (based on percent live seeds) switchgrass, 5.5 kg Indian grass, and 5.5 kg big bluestem per ha. A list of seed dealers and examples of types of native species to plant is found in Anderson et al. (2002*a*). Shrubs should naturally invade the area and should not be planted, particularly if the decision is made to keep burning as a management tool.

Management of Wetland and Riparian Areas

Management of water resources should primarily target the remediation of Acid Mine Drainage (AMD) in the streams. In particular, Pringle Run is heavily polluted and should be targeted for cleanup in cooperation with state agencies. Forested riparian corridors that currently exist along streams should be maintained because they are important as wildlife habitat and movement corridors (Brinson et al. 1981, Harris 1984, Hunter 1990).

Due to topographic constraints on much of the CDCTA, particularly Briery Mountain, large-scale wetland development is impractical. Briery Mountain will never be an important area for wetland wildlife, but small wetlands can be developed to increase herpetofaunal populations and provide terrestrial fauna with drinking water. The first priority should be to conserve and/or protect the few wetland areas that already occur (Lee et al. 2001) by not allowing any development on these sites. Military training activities should only be allowed in wetlands if they cannot otherwise be avoided.

Protection of riparian areas can primarily be achieved through the creation of buffer strips (Small and Johnson 1986). Small and Johnson (1986) recommend a strip 75 m (250 ft) wide with an undisturbed zone at least 25 m (80 ft) wide, adjacent to the water. No cutting should be permitted within 25 m of the water's edge, and any harvesting within the buffer strip should be careful not to reduce overall canopy cover of the stand to less than 70% (Small and Johnson 1986). Group selection cuts are recommended for the buffer strip because this technique provides openings large enough to allow regeneration, thus increasing vertical structure and browse, while not adversely affecting the amount of cover needed to maintain travel corridors. All snags within the riparian area should be maintained for wildlife (Scott et al. 1977, Davis 1983).

Species Management and Conclusions

Deer demographics should be studied so a Quality Deer Management program can be created (Miller and Marchinton 1995). This will result in fewer, healthier deer. Additionally, state listed rare species should be monitored at least every 5 years to ensure their populations are stable. Recommended monitoring regimes are found in Anderson et al. (2002*b*).

The above was a brief description of the types of activities that can be implemented within a wildlife management plan. The keys to all of these activities are conducting the management at the appropriate time and scale and getting expert advice on management strategies and existing resources. The plans for the CDCTA are biologically and technically feasible and should allow healthy wildlife populations to exist on the CDCTA, while at the same time allowing the property to fulfill its primary mission of training soldiers.

ACKNOWLEDGMENTS

This project was funded by the West Virginia Army National Guard, West Virginia University Research Corporation, and the West Virginia Agricultural and Forestry Experiment Station. We thank L. B Williams and G. A. Blackhurst, for providing us with this opportunity to assist in the management of Camp Dawson's wildlife. We thank S. L. Helon for assistance with compiling the management plan upon which this manuscript is based. This is scientific article number 2909 of the West Virginia University Agricultural and Forestry Experiment Station. Use of product names does not imply endorsement by West Virginia University.

LITERATURE CITED

Alexander, H. E. 1962. Changing concepts and needs in wildlife management. Proceedings Annual Conference Southeastern Association Game and Fish Commission 16:161-167.

Anderson, J. T., G. M. Forcey, J. D. Osbourne, and A. B. Spurgeon. 2002*a*. Wildlife management plans for the Camp Dawson Collective Training Area, Kingwood, West Virginia. West Virginia University, Morgantown, West Virginia, USA.

Anderson, J. T., G. M. Forcey, J. D. Osbourne, and A. B. Spurgeon. 2002*b*. Camp Dawson Collective Training Area Faunal Assessment. West Virginia University, Morgantown, West Virginia, USA.

Anderson, S. H. 1999. Managing our wildlife resources. Third edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Bolen, E. G., and W. L. Robinson. 1999. Wildlife ecology and management. Fourth edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Bonham, C. D. 1989. Measurements for terrestrial vegetation. John Wiley and Sons, New York, New York, USA.

Bookhout, T. A., editor. 1994. Research and management techniques for wildlife and habitats. The Wildlife Society, Bethesda, Maryland, USA.

Brinson, M. M., B. L. Swift, R. C. Plantico, and J. S. Barclay. 1981. Riparian ecosystems: their ecology and status. Eastern Energy and Land Use Team, United States Fish and Wildlife Service, Kearneysville, West Virginia, USA. FWS/OBS-81/17.

Cain, S. A., and G. M. deOliveira Castro. 1959. Manual of vegetation analysis. Harper and Brothers Publishing, New York, New York, USA.

Causton, D. R. 1988. An introduction to vegetation analysis: principles, practice, and interpretation. Unwin Mymann, London, UK.

Cooperrider, A. Y., R. J. Boyd, and H. R. Stuart, editors. 1986. Inventory and monitoring of wildlife habitat. U. S. Department of the Interior, Bureaus of Land Management Service Center, Denver, Colorado, USA.

Cummings, J. L., P. A. Pochop, and J. E. Davis, Jr. 1995. Evaluation of ReJex-IT AG-36 as a Canada goose grazing repellent. Journal of Wildlife Management 59:47-50.

Davis, D. E., editor. 1990. Handbook of census methods for terrestrial vertebrates. CRC Press, Boca Raton, Florida, USA.

Davis, J. W. 1983. Snags are for wildlife. Pages 4-9 *in* J. W.Davis, G. A. Goodwin, and R. A. Ockenfels, technical coordinators. Proceedings of the symposium on snag habitat management. US Forest Service General Technical Report RM-99.

DeMers, M. N. 2000. Fundamentals of geographic information systems. Second edition. John Wiley and Sons, New York, New York, USA.

Forcey, G. M. 2002. An evaluation of double-observer point count techniques and avian habitat use on the Camp Dawson

Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Foster, G. M., and S. Rauch. 1998. Wildlife management plan for Pleasant Creek Wildlife Management Area. West Virginia Division of Natural Resources, District 1, Fairmont, West Virginia, USA.

Grumbie, R. E. 1994. What is ecosystem management? Conservation Biology 8:27-38.

Harris, L. D. 1984. The fragmented forest. University of Chicago Press, Chicago, Illinois, USA. Henderson, C. L. 1992. Woodworking for wildlife: homes for birds and mammals. Minnesota Department of Natural Resources, St. Paul, Minnesota, USA.

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. 1994. Measuring and monitoring biological diversity: standard method for amphibians. Smithsonian Institution Press, Washington, D.C., USA.

Higgins, K. F., J. L. Oldemeyer, K. J. Jenkins, G. K. Clambey, and R. F. Harlow. 1994. Pages 567-591 *in* T. A. Bookhout, editor. Research and management techniques for wildlife and habitats. Fifth edition. The Wildlife Society, Bethesda, Maryland, USA.

Hunter, M. L. 1990. Wildlife, forests, and forestry: principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, New Jersey, USA.

IUCN. 1996. The 1996 IUCN red list of threatened animals. IUCN, Gland, Switzerland.

Kie, J. G., V. C. Bleich, A. L. Medina, J. D. Yoakum, and J. W. Thomas. 1996. Managing rangelands for wildlife. Pages 663-688 *in* T. A. Bookhout, editor. Research and Management Techniques for Wildlife and Habitats. The Wildlife Society, Bethesda, Maryland, USA.

King, R. T. 1974. The wildlife management plan. Pages 101-107 *in* J. A. Bailey, W. Elder, and J. D. McKinney, editors. Readings in wildlife conservation. The Wildlife Society, Washington, D.C., USA.

Lee, A. A., D. D. Evans, M. Bishop, T. Wilson, and M. Mauney. 2001. Delineation of wetlands and other regulated waters of Camp Dawson, WV. U. S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, Mississippi.

Leopold, A. 1933. Game management. Charles Scribner's Sons, New York, New York, USA.

Mannan, R. W., R. N. Conner, B. Marcot, and J. M. Peek. 1994. Managing forestlands for wildlife. Pages 689-721 *in* T. A. Bookhout, editor. Research and management techniques for wildlife and habitats. The Wildlife Society, Bethesda, Maryland, USA.

Martin, A. C., H. S. Zim, and A. L. Nelson. 1951. American wildlife and plants: a guide to wildlife food habits. Dover Publications, New York, New York, USA.

Maurer, B. A. 1996. Relating human population growth to the loss of biodiversity. Biodiversity Letters 3:1-5.

Miller, J. H., and K. V. Miller. 1999. Forest plants of the southeast and their wildlife uses. Southern Weed Science Society, Champaign, Illinois, USA.

Miller, K. V., and R. L. Marchinton, editors. 1995. Quality whitetails: the why and how of quality deer management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York, New York, USA.

Nichols, J. D., F. A. Johnson, and B. K. Williams. 1995. Managing North American waterfowl in the face of uncertainty. Annual Review of Ecology and Systematics 26:177-199.

Osbourne, J. D. 2002. Effects of edge and coarse woody debris on small mammal communities in riparian and upland habitats in northern West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Payne, N. F. 1992. Techniques for wildlife habitat management of wetlands. McGraw-Hill, New York, New York, USA.

Payne, N. F., and F. C. Bryant. 1998. Wildlife habitat management of forestlands, rangelands, and farmlands. Krieger Publishing Company, Malabar, Florida, USA.

Payne, N. F., and F. Copes, editors. 1986. Wildlife and fisheries habitat improvement handbook. United States Department of Agriculture, Forest Service.

Perkey, A. W., and B. L. Wilkins. 1990. Crop tree management in eastern hardwoods. NA-TP-19-93, United States Department of Agriculture, Forest Service, Morgantown, West Virginia, USA.

Ripley, T. H. 1980. Planning wildlife management investigations and projects. Pages 1-6 *in* S. D. Schemnitz, editor. Wildlife management techniques manual. Fourth edition. The Wildlife Society, Washington, D.C., USA.

Scalet, C. G., L. D. Flake, and D. W. Willis. 1996. Introduction to wildlife and fisheries: an integrated approach. W. H. Freeman and Company, New York, New York, USA.

Scott, V. E., K. E. Evans, D. R. Patton, and C. P. Stone. 1977. Cavity nesting birds of North American forests. USDA Forest Service Agricultural Handbook 511.

Small, M. F., and W. N. Johnson. 1986. Wildlife management in riparian habitats. *In* J. A. Bissonette, editor. Is good forestry good wildlife management? Maine Agricultural Experiment Station Miscellaneous Publication Number 689.

Spurgeon, A. B. 2002. Comparison of herpetofaunal species composition and response to edge on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Stokes, D. L. 1990. The complete birdhouse book. Little, Brown and Company, Boston, Massachusetts, USA.

Stromayer, K. A. K., and R. J. Warren. 1997. Are overabundant deer herds in the eastern United States creating alternate stable states in forest plant communities? Wildlife Society Bulletin 25:227-234.

Sutherland, W. J., editor. 1996. Ecological census techniques: a handbook. Cambridge University Press, Cambridge, UK.

Vallentine, J. F. 1989. Range development and improvement. Third Edition. Brigham Young University Press, Provo, Utah, USA.

Wilson, D. E., F. R. Cole, J. D. Nichols, and R. Rudran, editors. 1996. Measuring and monitoring biological diversity: standard methods for mammals. Smithsonian Institution Press, Washington, D.C., USA.

ECOLOGICAL COMMUNITY CLASSIFICATION AND MAPPING OF CAMP DAWSON COLLECTIVE TRAINING AREA, PRESTON COUNTY, WEST VIRGINIA

JIM VANDERHORST,* Wildlife Diversity Program (Natural Heritage Program) West Virginia Division of Natural Resources, Elkins, WV 26241 USA. *jimvanderhorst@wvdnr.gov

ABSTRACT

Ecological communities of the Camp Dawson Collective Training Area (including Camp Dawson proper, Volkstone, Briery Mountain, and Pringle tracts) were classified and mapped to assist natural resource planning for the base and provide data for the state's community classification and conservation databases. Classification was based on quantitative sampling of plots chosen to represent the range of ecological diversity within the study area. Data analyses included ordination and classification. Delineation of ecological communities was based on interpretation of high-resolution digital ortho-rectified aerial imagery. Geographic Information Systems (GIS) layers were produced for plot points and ecological community polygons. Fourteen ecological communities, including ten forest types and four herbaceous types, were classified, characterized, and mapped. These natural and semi-natural communities occupy approximately 84 percent of the study area, most of this forested. Community types with highest areal coverage include mixed mesophytic forests of colluvial slopes, successional forests of low elevation plateaus, and montane mixed hardwood forests. Less common natural types include mature and successional floodplain forests, hemlock ravines, transitional forests, subxeric oak forests, xeric oak/evergreen heath forests, herbaceous wetlands, and riverscour prairies. Semi-natural types include old fields (upland and bottomland types) and pine plantations.

INTRODUCTION

The mission of the West Virginia Natural Heritage Program is to inventory and maintain databases on the natural biological diversity of the state, including rare, threatened, and endangered animal and plant species, and rare and exemplary ecological communities. Ecological communities are assemblages of organisms (plants, animals, fungi, and microbes) that live together in a particular physical environment. Terrestrial ecological communities are classified based on vegetation but they serve as a "coarse filter" for conservation of diversity in all taxonomic kingdoms (Grossman et al. 1998). As part of its strategic plan to develop a vegetation classification for the state and document rare and exemplary types, the West Virginia Natural Heritage Program works in partnership with other government agencies and private organizations and individuals to conduct surveys on their lands. In 2000, we contracted with the West Virginia Army National Guard to classify and map the ecological communities of Camp Dawson Collective Training Area in Preston County, including Camp Dawson proper, Volkstone, Briery Mountain, and Pringle tracts.

METHODS

Seventy-six plots were sampled during the summer of 2000. Plots were subjectively located to be homogenous and representative of their stand and community type. Location coordinates for each plot were determined using a global positioning system (GPS). Most plots were 20x20 meter squares, but shape and size were appropriately altered to sample small patch and linear communities. Data recorded for each plot included location, environment (elevation, topographic position, slope, aspect, soil profile, moisture regime, drainage, soil pH, soil texture, and unvegetated ground cover), community physiognomy and structure, and floristic composition. Percentage cover was estimated for total cover in each vegetation stratum (tree canopy, tree subcanopy, tall shrub, short shrub, and herbaceous) and for each vascular plant species in each stratum. Diameter at breast height was measured for all woody species greater than 7 cm.

Data analysis utilized the Non-metric Multidimensional Scaling (NMS) and Two-Way Indicator Species Analysis (TWINSPAN) algorithms of PCOrd version 4 (McCune and Mefford 1999). Plots with forest physiognomy were analyzed as one set and plots with herbaceous or shrubland physiognomy were analyzed as a separate set. NMS, an ordination technique, was used to determine plot similarity and clustering in species space and to graphically relate these patterns to environmental factors. TWINSPAN, a classification technique, was used to produce ordered tables of species by plots. The final classification was derived from the TWINSPAN tables with judicious reordering of some plots based on presence or absence of selected dominant or indicator species. A map of ecological communities was produced using ESRI ArcView GIS software. Plot points were projected on background coverages of high resolution digital ortho-rectified aerial imagery and additional GIS layers. Two sets of aerial imagery were used, a true color set flown in March 2000 and a color infra-red set flown in October 2000. The true color imagery was useful for distinguishing evergreen and early leaf-out herbaceous vegetation, while the infra-red imagery was most useful for distinguishing stand physiognomy and structure. Additional GIS layers utilized to interpret vegetation were a digitized geological map (based on West Virginia Geological and Economic Survey 1968), a digital raster graph of the USGS Kingwood 7.5' topographic map, and hypsography produced by the aerial photo contractor. Polygons of ecological communities were delineated subjectively based on extrapolation of aerial photography signatures of the classified plots, interpretation of topographic factors (elevation and aspect), and field observations.

RESULTS AND DISCUSSION

Figure 1 is an NMS ordination graph that illustrates the strong relationship between landform and plant species composition of forest communities in the study area. Plots with similar species composition are placed close together on the graph. Landform is a mappable categorical variable that integrates environmental factors including microclimate, soils, and disturbance regimes. The most significant quantitative environmental variable explaining the forest ordination is elevation (Figure 2). Although precipitation generally increases with elevation in the Allegheny Mountains (Stephenson 1993), the relationship between soil moisture and elevation is more complex. In the study area the soils developed on residual geologic strata at higher elevations are more xeric compared to those formed on colluvium and alluvium at lower elevations. Thus the more mesophytic forests are found at lower elevations. Figure 3 shows an overlay of the classified forest communities on the ordination graph. The importance of landform and elevation are reflected in the descriptive names chosen for the communities.

Fourteen ecological communities were classified, characterized, and mapped. These include ten forest communities and four herbaceous communities. An additional eleven mapping units were identified for areas not occupied by natural or semi-natural vegetation, including aquatic features. Approximately 84 percent of the study area is occupied by the classified ecological communities and approximately 96 percent of this area is forested. The predominant forest types are mixed mesophytic forests of colluvial slopes, successional forests of low elevation plateaus, and mixed montane hardwood forests. Mixed mesophytic forests of colluvial slopes occur in all tracts, but are most abundant on the gorge slopes of the Camp Dawson, Volkstone, and Pringle tracts. Successional forests of low elevation plateaus are abundant only on the Pringle tract, and mixed montane hardwood forests are restricted to the Briery Mountain tract. Figures 4-6 are examples of ecological community mapping of small areas in each tract that illustrate some of the characteristic vegetation patterns in the study area.

Although no rare community types were found, the riparian communities and mixed mesophytic forests were identified as conservation priorities. Floodplain forests are communities with originally limited areal coverage in West Virginia that have been mostly converted or degraded by agriculture, transportation, housing, and commercial development. In addition to their biological value, they serve to attenuate the effects of catastrophic floods. The mature floodplain forests (Figure 4) on the Volkstone tract are not extensive but are a relatively high quality occurrence. The adjacent successional floodplain forests and bottomland old fields have potential for succession towards mature forests. The riverscour prairies are interesting communities that host a high diversity of native and exotic plant species adapted to frequent disturbance. Although no rare plants were found in this habitat at Camp Dawson, three rare species (*Marshallia grandiflora, Rosa blanda,* and *Scleria triglomerata*) are known from similar habitat upstream. These open habitats are threatened by the aggressively invasive *Polygonum cuspidatum* and other exotic weeds. The mixed mesophytic forests in the study area have high diversity and include populations of two species (*Heuchera alba, Juglans cinerea*) tracked by the Natural Heritage Program. They serve to stabilize easily eroded slopes and are under-represented on public lands in West Virginia, but are potentially threatened by logging and invasion by exotic species.

The following sections provide brief environmental and floristic descriptions for each of the 14 classified ecological communities. Dominant, characteristic, and diagnostic taxa are given for each stratum characterizing the community type. The most important native taxa are listed first in italics, followed by exotic taxa underlined. Nomenclature follows Harmon and Ford-Werntz (2002), which is in general concordance with Kartesz (1999). A total of 445 vascular plant taxa were identified in the plots.

Mature floodplain forest

Setting: stabilized terraces and levees along the Cheat River above the zone frequently scoured by high energy river flows, but subject to periodic over-bank flooding. **Canopy:** *Aesculus flava, Fagus grandifolia, Liriodendron tulipifera, Quercus rubra, Acer saccharum, Prunus serotina.* **Subcanopy:** *Aesculus flava, Carpinus caroliniana.* **Shrubs:** *Lindera benzoin,* Berberis thunbergii, Elaeagnus umbellata, Rosa multiflora. **Herbs:** *Ageratina altissima, Dryopteris intermedia, Elymus hystrix, Festuca subverticillata, Thelypteris noveboracensis, Eurybia divaricata, Leersia virginica, Parthenocissus quinquefolia, Polystichum acrostichoides, Polygonum virginianum, Sedum ternatum, Verbesina alternifolia, Viola striata,* Alliaria petiolata, Glechoma herderacea, Microstegium vimineum, Polygonum ceaspitosum.

Successional floodplain forests

Setting: stabilized terraces and levees along the Cheat River above the zone frequently scoured by high energy river flows, but subject to periodic over-bank flooding. These are young forests (about 40 years old or less). **Canopy:** *Robinia pseudoacacia* (dominant in youngest stands), *Carya cordiformis* (dominant in older stands), *Betula lenta, Carya ovata, Fraxinus americana, Prunus serotina, Ulmus rubra.* **Shrubs:** *Carpinus caroliniana, Crataegus* sp., Rosa multiflora. **Vines:** *Toxicodendron radicans.* **Herbs:** *Elymus virginicus, Leersia virginica, Polygonum virginianum, Verbesina alternifolia,* Glechoma hederacea, Duchesnea indica.

Mixed mesophytic forests of colluvial slopes

Setting: colluvial slopes of the Cheat River Gorge in the Camp Dawson, Pringle, and Volkstone tracts and colluvial slopes with limestone parent material at the south end of the Briery Mountain tract. **Canopy:** *Acer saccharum, Tilia americana, Aesculus flava, Fagus grandifolia, Liriodendron tulipifera, Quercus rubra, Acer rubrum, Betula lenta, Fraxinus americana, Ulmus rubra, Robinia pseudoacacia,* Ailanthus altissima. **Shrubs:** *Lindera benzoin.* **Herbs:** *Asarum canadense, Caulophyllum thalictroides, Laportea canadensis, Geranium maculatum, Hydrophyllum canadense, Sedum ternatum, Ageratina altissima, Arisaema triphyllum, Eurybia divaricata, Botrychium virginianum, Carex albursina, Actaea racemosa, Disporum lanuginosum, Dryopteris intermedia, Galium triflorum, Hepatica nobilis, Osmorhiza longistylis, Parthenocissus quinquefolia, Pilea pumila, Polystichum acrostichoides, Solidago flexicaulis, Stellaria pubera, Tiarella cordifolia, Trillium* spp. and *Viola* spp.

Hemlock ravines

Setting: alluvial terraces and lower slopes with northerly aspects along tributary streams in the Pringle, Volkstone, and Briery Mountain tracts. **Canopy:** *Tsuga canadensis, Fagus grandifolia, Liriodendron tulipifera, Betula lenta, Betula alleghaniensis, Magnolia acuminata, Prunus serotina, Quercus rubra.* **Shrubs:** *Rhododendron maximum* (dominant), *Ilex montana, Hamamelis virginiana, Lindera benzoin.* **Herbs:** *Dryopteris intermedia, Dennstaedtia punctilobula, Thelypteris noveboracensis, Arisaema triphyllum, Eurybia divaricata, Cardamine diphylla, Clintonia umbellulata, Dichanthelium lanuginosum, Trillium* spp., *Viola* spp.

Successional forests of low elevation plateaus

Setting: upland plateaus above the gorge slopes of the Pringle, Camp Dawson, and Volkstone tracts with elevations from 500 to 625 meters. These are even aged secondary forests. **Canopy:** *Liriodendron tulipifera, Prunus serotina, Acer rubrum, Acer saccharum, Fagus grandifolia* (on clay soils), *Robinia pseudoacacia* (in the youngest stands), *Betula lenta, Carya glabra, Carya ovata, Fraxinus americana, Magnolia acuminata, Quercus alba, Quercus rubra.* **Subcanopy:** *Aesculus flava, Cercis canadensis, Cornus florida, Crataegus* spp., *Fagus grandifolia, Magnolia acuminata.* **Shrubs:** *Sambucus canadensis, Cornus alternifolia, Hamamelis virginiana, Lindera benzoin, Viburnum acerifolium.* **Vines:** *Aristolochia macrophylla, Parthenocissus quinquefolia, Smilax rotundifolia, Toxicodendron radicans, Vitis aestivalis.* **Herbs:** *Ageratina altissima, Dioscorea quaternata, Diphasiastrum digitatum, Galium triflorum, Laportea canadensis, Maianthemum racemosum, Osmorhiza longistylis, Polystichum acrostichoides, Potentilla simplex, Solidago caesia, Viola* spp.

Pine plantations

Setting: "reclaimed" strip mines on the plateau of the Pringle tract. **Canopy:** *Pinus strobus, Pinus resinosa, Acer rubrum, Prunus serotina, Prunus pensylvanica, Robinia pseudoacacia.* **Subcanopy:** *Acer saccharum, Fraxinus americana, Ulmus rubra.* **Shrubs:** *Lindera benzoin,* Alnus glutinosa, Eleagnus umbellata, Rosa multiflora. **Herbs:** *Osmorhiza claytonii, Botrychium dissectum, Asplenium platyneuron, Geum canadense, Pilea pumila, Polygonum virginianum.*

Transitional forests of high elevation colluvial slopes

Setting: upper south facing colluvial slopes derived from acidic sandstone and shale at the south end of the Briery Mountain tract. **Canopy:** *Acer saccharum, Prunus serotina, Acer rubrum, Quercus rubra, Quercus velutina, Carya ovata, Fraxinus americana, Liriodendron tulipifera.* **Shrubs:** *Acer pensylvanicum, Smilax rotundifolia.* **Herbs:** *Ageratina altissima, Disporum lanuginosum, Polystichum acrostichoides, Uvularia perfoliata, Carex* *albursina*, *Festuca subverticillata*, *Galium triflorum*, *Pilea pumila*, *Polygonum virginianum*, *Sedum ternatum*.

Montane mixed hardwood forest

Setting: mesic aspects of the upper slopes of Briery Mountain with elevations from 585 to 860 meters. These forests were recently selectively cut. **Canopy:** *Acer rubrum*, *Prunus serotina*, *Quercus rubra*, *Liriodendron tulipifera*, *Acer saccharum*, *Betula lenta*, *Fraxinus americana*, *Magnolia acuminata*, *Quercus prinus*. **Shrubs:** *Acer pensylvanicum*, *Smilax rotundifolia*, *Castanea dentata*, *Amelanchier arborea*, *Hamamelis virginiana*, *Ilex montana*, *Rhododendron calendulaceum*. **Herbs:** *Dennstaedtia punctilobula*, *Arisaema triphyllum*, *Carex blanda*, *Carex debilis*, *Conopholis americana*, *Disporum lanuginosum*, *Dioscorea quaternata*, *Dryopteris intermedia*, *Lysimachia quadrifolia*, *Parthenocissus quinquefolia*, *Smilax herbacea*, *Thelypteris noveboracensis*, *Viola rotundifolia*.

Sub-xeric oak forest

Setting: dryer aspects of the upper slopes of Briery Mountain with elevations ranging from 652 to 829 meters. **Canopy:** *Acer rubrum*, *Quercus prinus*, *Quercus rubra*, *Quercus alba*, *Quercus coccinea*, *Liriodendron tulipifera*, *Prunus serotina*. **Subcanopy:** *Nyssa sylvatica*, *Sassafras albidum*. **Shrubs:** *Acer pensylvanicum*, *Smilax rotundifolia*, *Vaccinium pallidum*. **Herbs:** *Dennstaedtia punctilobula*, *Thelypteris noveboracensis*, *Lycopodium obscurum*, *Brachyelytrum erectum*, *Danthonia compressa*, *Dichanthelium* spp., *Monotropa uniflora*, *Medeola virginica*, *Lysimachia quadrifolia*.

Xeric oak/evergreen heath forest

Setting: one narrow band in the Briery Mountain tract. It is on a dry, rocky, convex upper slope with a west to southwest aspect. **Canopy:** *Quercus prinus*, *Quercus coccinea*, *Acer rubrum*, *Quercus alba*. **Subcanopy:** *Nyssa sylvatica*, *Castanea dentata*. **Shrubs:** *Kalmia latifolia*, *Vaccinium pallidum*, *Gaylussacia baccata*. **Herbs:** *Gaultheria procumbens*, *Cypripedium acaule*, *Medeola virginiana*, *Monotropa uniflora*, *Pteridium aquilinum*.

River scour prairies

Setting: sunny, cobble zones frequently scoured by high energy flooding along the Cheat River in the Camp Dawson and Volkstone tracts. **Scattered trees and shrubs:** *Platanus occidentalis*, *Catalpa speciosa*, *Alnus serrulata*, *Carpinus caroliniana*, *Cornus amomum*, *Physocarpus opulifolius*, *Salix caroliniana*, *Salix sericea*, Ligustrum vulgare, Lonicera japonica, Rosa multiflora. **Herbs:** *Andropogon gerardii*, *Panicum virgatum*, *Sorghastrum nutans*, *Dichanthelium clandestinum*, *Ambrosia artemisiifolia*, *Symphiotrichum praealtum*, *Eupatorium fistulosum*, *Eupatorium perfoliatum*, *Euphorbia corollata*, *Euthamia graminifolia*, *Oenothera biennis*, *Solanum carolinense*, *Solidago rugosa*, *Verbesina alternifolia*, Centaurea biebersteinii, Coronilla varia, Daucus carota, Galium mollugo, Hypericum perforatum, Leucanthemum vulgare, Linaria vulgaris, Melilotus officinalis, Plantago lanceolata, Polygonum cuspidatum (dominant in patches), Prunella vulgaris, Rumex acetosella, Trifolium repens.

Herbaceous wetlands

Setting: wet alluvial bottomlands in the Volkstone tract. **Scattered trees and shrubs:** *Robinia pseudoacacia*, *Salix nigra*, *Fraxinus pensylvanica*, *Cornus amomum*, Rosa multiflora. **Herbs:** *Leersia oryzoides*, *Phalaris arundinacea*, *Dichanthelium clandestinum*, *Elymus virginicus*, *Eupatorium fistulosum*, *Juncus effusus*, *Lobelia siphilitica*, *Lycopus virginicus*, *Mimulus ringens*, *Osmunda cinnamomea*, *Osmunda regalis*, *Scirpus atrovirens*, *Packera aurea*, *Vernonia noveboracensis*, *Viola cucullata*, Agrostis gigantea, Echinochloa crus-galli.

Bottomland old fields

Setting: abandoned farmlands in bottomlands of the Volkstone tract. **Scattered trees and shrubs:** *Crataegus* spp., *Fraxinus pensylvanica*, *Prunus serotina*, *Ulmus rubra*, *Rubus* spp., Rosa multiflora, Elaeagnus umbellata. **Vines:** *Toxicodendron radicans*. **Herbs:** *Verbesina alternifolia*, *Phalaris arundinacea*, *Boehmeria cylindrica*, *Dichanthelium clandestinum*, *Eupatorium fistulosum*, *Euthamia graminifolia*, *Geum canadense*, *Solidago rugosa*, *Teucrium canadense*, Duchesnea indica, Coronilla varia, Glechoma hederacea.

Old fields

Setting: reclaimed surface mines and abandoned farmlands on the plateau of Pringle tract and small areas on Briery Mountain and Camp Dawson tracts. **Scattered trees and shrubs:** *Crataegus* spp., *Prunus pensylvanica*, *Robinia pseudoacacia*, *Rhus hirta*, *Rubus* spp., *Sassafras albidum*, Elaeagnus umbellata (dominant in patches). **Herbs:** *Andropogon virginicus*, *Dichanthelium clandestinum*, *Sorghastrum nutans*, *Clinopodium vulgare*, *Potentilla simplex*, *Solidago canadensis*, *Anthoxanthum odoratum*, Arrhenatherum elatius, Dactylis glomerata, Holcus lanatus, Lolium perenne, Lolium pratense, Phleum pratense, Daucus carota, Hypericum perforatum, Leucanthemum vulgare, Lotus corniculata, Plantago lanceolata, Trifolium campestre, Trifolium pratense, Trifolium repens.

ACKNOWLEDGEMENTS

Brian Streets and Leah Ceperley provided botanical expertise, endured a rainy when not hot summer of plot sampling, and assisted with data entry when allowed to come inside. Assistance with GIS and GPS was provided by Joel Harrison. Sam Norris, Brian McDonald, and Walt Kordek reviewed the manuscript and contributed editorial comments. Office assistance was provided by Angela McWilliams, Janet Mullennex, Diane Cash, and Nanci Fregonara. Coordination and logistical assistance were provided by Ladd Williams. Aerial imagery was produced by EarthData International. This project was funded by the West Virginia Army National Guard.

LITERATURE CITED

Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume 1. The National Vegetation Classification System: development, status, and applications. The Nature Conservancy, Arlington, VA.

Harmon, P. J. and D. Ford-Werntz (eds.). 2002. Checklist and atlas of the vascular flora of West Virginia. Wildlife Diversity Program,WV Division of Natural Resources, Elkins, WV.

Kartesz, J. T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. in Kartesz, J. T. and C. A. Meacham. Synthesis of the North American flora, version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

McCune, B. and M. J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data, Version 4. MjM Software Design, Gleneden Beach, Oregon.

Stephenson, S. L. 1993. Upland forests of West Virginia. McClain Publishing Co., Parsons, WV.

West Virginia Geological and Economic Survey. 1968. Geologic Map of West Virginia. Morgantown, WV.

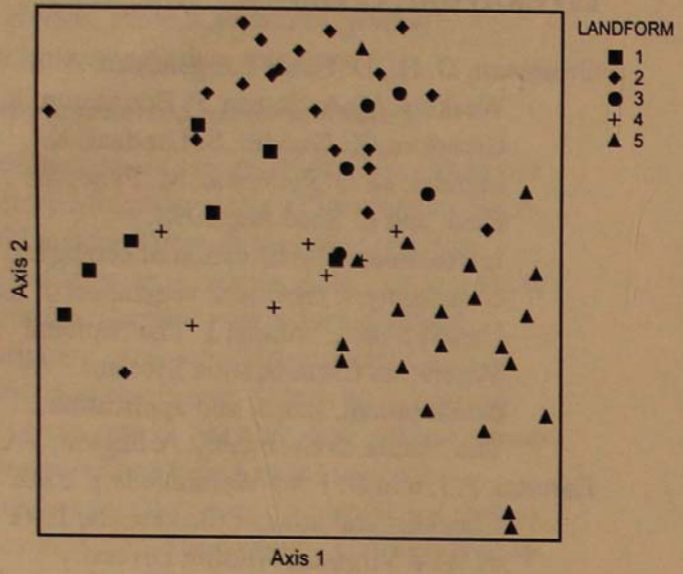

Figure 1. NMS ordination graph of forest plots in plant species space with overlay of landform. Symbols denote the landform category of each plot: 1) alluvial terrace, 2) colluvial gorge slope, 3) ravine, 4) plateau, and 5) mountain.

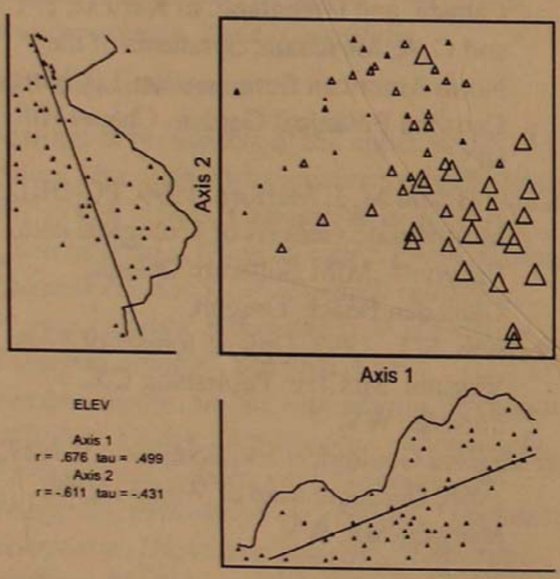

Figure 2. NMS ordination graph of forest plots in plant species space with overlay of elevation. The size of each triangle is proportional to the elevation of the plot. Side scatter plots show simple regression lines and envelope curves of elevation in relation to each axis. Statistics are Pearson's r and Kendall's tau.

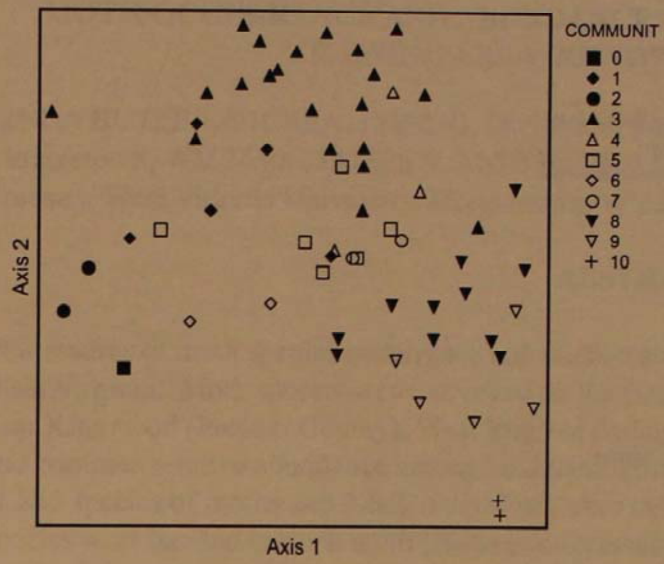

Figure 3. NMS ordination graph of forest plots in plant species space with overlay of community. Symbols denote the classified ecological community type for each plot: 0) Unclassified, 1) Mature floodplain forest, 2) Successional floodplain forest, 3) Mixed mesophytic forest of colluvial slopes, 4) Hemlock ravine, 5) Successional forest of low elevation plateaus, 6) Pine plantation, 7) Transitional forest of high elevation colluvial slopes, 8) Montane mixed hardwood forest, 9) Sub-xeric oak forest, and 10) Xeric oak/evergreen heath forest.

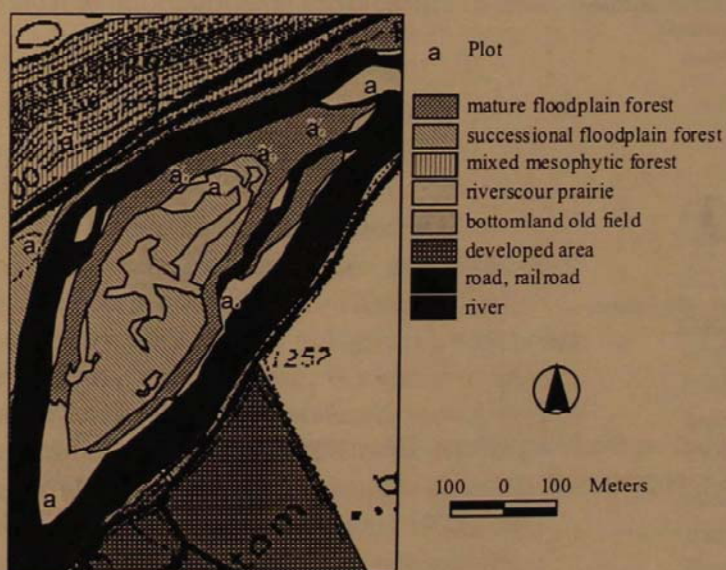

Figure 4. Ecological community mapping detail on the Volkstone and Camp Dawson Tracts. Basemap is an enlarged image of the USGS 7.5' Kingwood topographic map.

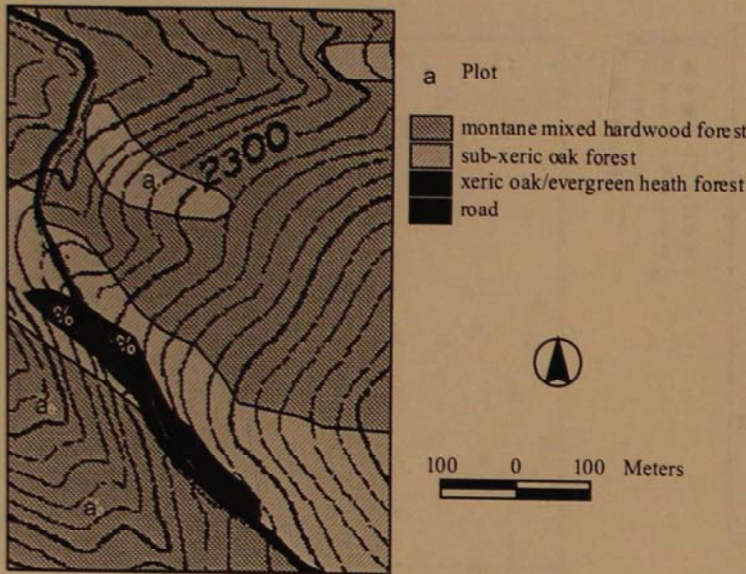

Figure 5. Ecological community mapping detail on the Briery Mountain tract. Basemap is an enlarged image of the USGS 7.5' Kingwood topographic map.

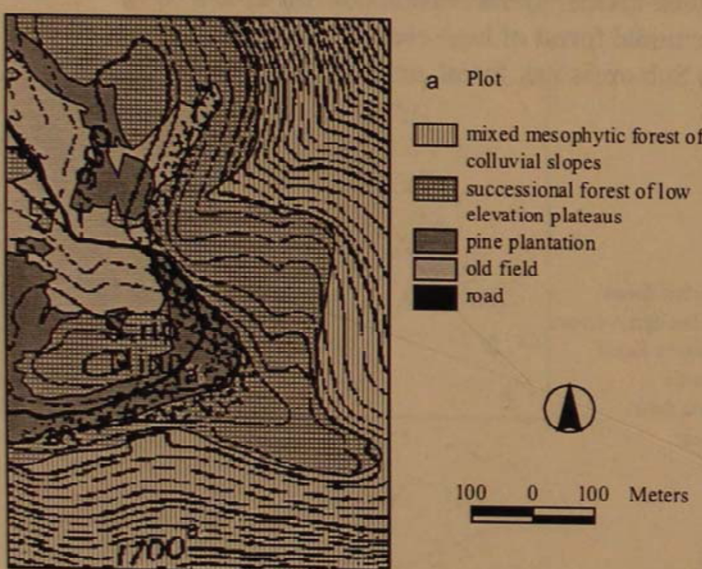

Figure 6. Ecological community mapping detail on the Pringle tract. Basemap is an enlarged image of the USGS 7.5' Kingwood topographic map.

MOTH OCCURRENCE AND ABUNDANCE ON THE CAMP DAWSON COLLECTIVE TRAINING AREA, KINGWOOD, WEST VIRGINIA

LINDA BUTLER, VICKI A. KONDO, Division of Plant and Soil Sciences, West Virginia University, Morgantown, WV 26506, JAMES T. ANDERSON,* Wildlife and Fisheries Resources, Division of Forestry, West Virginia University, Morgantown, WV 26506-6125 USA. *jander25@wvu.edu.

ABSTRACT

Few studies of moth species occurrence and relative abundance have been conducted in Preston County, West Virginia. Moth species were surveyed on the Camp Dawson Collective Training Area (CDCTA) near Kingwood (Preston County), West Virginia during 2000 and 2001 to determine species composition and compare relative abundance among land tracts (Briery Mountain, Pringle, and Cantonment). A total of 235 species of moths and 3,666 individuals were captured in 16 trap nights. The most common species were banded tussock moth (*Halysidota tessellaris*), unadorned carpet (*Hydrelia inornata*), lesser maple spanworm moth (*Itame pustularia*), and Eastern tent caterpillar (*Malacosoma americanum*). Total number of species captured was highest on Pringle (156), followed by the Cantonment (148), and Briery Mountain (104) tracts. Species richness was higher on Pringle ($\bar{x}$= 81.7 species/ trap-night; SE = 11.39) than on either Briery Mountain ($\bar{x}$= 44.3; SE = 10.17) or the Cantonment tract ($\bar{x}$= 36.9; SE = 4.22) ($P < 0.05$). Species diversity was similar among the three tracts of land ($P > 0.05$). Total number of moths captured per trap night was higher on Pringle than on either the Cantonment or Briery tracts ($P < 0.05$). Species composition varied among tracts and ranged from 52% to 56% community similarity. Differences in species richness and relative abundance were likely due to differences in habitat structure and quality (e.g., vegetation diversity, elevation, aspect) among the tracts. This study contributes valuable information on the presence of moth species in Preston County, West Virginia.

INTRODUCTION

In recent years, Lepidoptera have become increasingly important as bioindicators of environmental quality or change. Moths, especially, are a species rich group whose adults are relatively well known. A number of species are federally listed as threatened, endangered, or as species of concern. While a number of methods have been used to sample diversity and abundance of moths (Southwood 1978), no trapping method has proved as consistently successful as light trapping in capturing large numbers and great varieties of species of night flying Lepidoptera (Muirhead-Thompson 1991). Moths make up a high proportion of the catch of black light traps. The traps are robust sampling devices that are relatively inexpensive and can be left overnight unattended.

Baseline surveys for moths and other fauna are required on the CDCTA, Kingwood, West Virginia and other military installations under requirements of the Sikes Act (16 USC 670a et seq.), Army Regulation 200-3, and Department of Defense Instruction 4715.3. These surveys are designed to determine the occurrence of state and federally listed species and to form an overall species list so changes in diversity or richness due to military activities can be determined. The objectives of our study were to determine overall species occurrence, richness, diversity, and relative abundance of moths among the three main training areas of the CDCTA (Briery Mountain, Pringle, and Cantonment).

STUDY AREA

The study was conducted on the three tracts (Briery Mountain (423 ha), Pringle (854 ha), and Cantonment (378 ha) comprising the CDCTA in Preston County, West Virginia. Elevation on the base ranges from 122 to 853 m. Dominant vegetation (Vanderhorst 2001) and soil (Bell 2001) types vary by tract, but Gilpin, Laidig, and Fairpoint are the most abundant soil series. Several small palustrine emergent wetlands and intermittent streams occur on each tract (Lee et al. 2001). More detail on each tract is provided in Osbourne et al. (2002). Climate is classified as temperate, with moderate winters, warm summers (mean annual temperature is 8.8°C), and relatively equal distribution of precipitation across seasons (mean annual precipitation is 137 cm) (Ruffner 1985, Garwood 1996).

Moth traps on the Cantonment area were placed in interior sites of mixed mesophytic forests of colluvial slopes, and the edges of mature and successional floodplain forests (Vanderhorst 2001). On Briery Mountain the interior sites were mixed montane hardwood and sub-xeric oak forest and the edge samples were from sub-xeric oak stands (Vanderhorst 2001). Samples from Pringle tract were taken from the interior and edge portions of mixed mesophytic forests of colluvial slopes and successional forests of low elevation plateaus (Vanderhorst 2001). The edge habitats on the Cantonment and Pringle tracts were generally near a combination of old field or scrub-shrub habitat and mowed field. On Briery Mountain open habitats adjacent to forested plots were primarily maintained or mowed grasslands. Wetlands were near most sample sites on the Cantonment area, relatively near some of the sites on the Pringle tract, and were absent near sample points on the Briery Mountain tract.

METHODS

Moths were sampled on three nights in 2000 (27 July, 9 September, and 13 October 2000) and 2 nights in 2001 (23 May, 30 June) on each tract using a 12-volt battery-powered 8-watt black light trap with plexiglass baffles to increase capture rates (Ausden 1996). Light traps were set 3–5 m above the forest floor, kept on all night, and were situated so the light source could attract moths from a distance (Ausden 1996). One trap per tract for each sampling date was placed in randomly located edge and interior wooded areas 1 hour prior to sunset and samples were removed within 1 hour after sunrise the following morning. Light traps were set in different locations during each trapping bout. Samples were collected from each tract during the same night, and traps were removed in the same order that they were placed. Trap buckets were charged with No-Pest Strips (2,2–dichlorovinyl dimethyl phosphate) as a killing agent. Specimens were frozen for 3–8 months prior to identification and enumeration.

In 2000, the Cantonment area was divided into two separate tracts (Camp Dawson Proper and Volkstone) and each area was trapped with a separate light trap on each date. However, in 2001, the tracts were combined and only one light trap was deployed in the Cantonment area. Therefore, moth captures were standardized and presented as number per trap night for each tract and date. Moth densities (overall and abundant species), species richness, and Shannon Wiener species diversity (Magurran 1988) served as dependent variables and were compared among tracts (independent variable) using Kruskal-Wallis tests (Conover 1980) ($P < 0.05$). Community similarity was compared among tracts using the Sorenson Coefficient of Community Similarity (Magurran 1988).

RESULTS

Overall, 3,666 moths representing 235 species were captured on the CDCTA (Pringle 156, Cantonment 148, and Briery Mountain 104 species) (Table 1). The most common species sampled were the arctiid, banded tussock moth; the geometrids, unadorned carpet moth and lesser maple spanworm; and the lasiocampid, eastern tent caterpillar. For all moths, average species richness (no. species/trap-night) was higher on Pringle ($\bar{x}$ = 81.67, SE = 11.39) than on Briery Mountain ($\bar{x}$ = 44.33, SE = 10.17) and the Cantonment ($\bar{x}$= 36.86, SE = 4.22) tracts ($X^2_2 = 6.09, P = 0.047$). Species richness was similar between Briery Mountain and the Cantonment tract. Species diversity was similar among Briery Mountain ($\bar{x}$ = 1.26, SE = 0.11), Pringle ($\bar{x}$= 1.49, SE = 0.01), and the Cantonment ($\bar{x}$= 1.70, SE = 0.24) tract (X^2_2 = 2.89, $P = 0.024$). The percent community similarity coefficients were relatively low (Cantonment – Pringle 52.6%, Briery Mountain – Pringle 55.4%, Briery Mountain – Cantonment 56.3%) across the tracts.

Total moth abundance (no. moths/ trap-night) was higher on Pringle ($\bar{x}$= 728.33, SE = 210.19), than on either the Cantonment ($\bar{x}$= 127.43, SE = 25.19) or Briery Mountain ($\bar{x}$= 193.67, SE = 48.03) tracts, which were similar ($X^2_2 = 7.08, P = 0.029$). Abundance of banded tussock moths also was greater on Pringle ($\bar{x}$= 131.00, SE = 65.82), than on either the Cantonment ($\bar{x}$= 1.43, SE = 1.11) or Briery Mountain ($\bar{x}$= 8.33, SE = 4.41) tracts, which were similar ($X^2_2 = 6.00, P = 0.049$). Abundance of unadorned carpet moths (Briery Mountain: $\bar{x}$= 1.67, SE = 1.67; Pringle: $\bar{x}$= 36.33, SE = 20.25; Cantonment: $\bar{x}$ = 0.00, SE = 0.00; $X^2_2 = 5.57, P$ = 0.062), lesser maple spanworm moths (Briery Mountain: $\bar{x}$= 48.33, SE = 25.77; Pringle: $\bar{x}$= 46.33, SE = 23.68; Cantonment: $\bar{x}$= 0.14, SE = 0.14; $X^2_2 = 4.48, P = 0.106$), and eastern tent caterpillars (Briery Mountain $\bar{x}$ = 12.33, SE = 12.33; Pringle: $\bar{x}$= 2.14, SE = 2.14; Cantonment: $\bar{x}$= 47.33, SE = 28.34; $X^2_2 = 3.79, P = 0.150$) were not statistically different among the tracts.

DISCUSSION

During 2000 and 2001, multiple black light traps were operated for five nights, one night each in May, June, July, September, and October at three locations on the Camp Dawson Collective Training Area in Preston County. A total of 235 species of moths from 15 selected families were identified from the samples. No known species of concern were collected. The highest number of species was collected at Pringle, followed by the Cantonment tract, and Briery Mountain.

Richness and abundance of moths captured in black light traps depend on many factors. Weather, especially temperature and rainfall, and moon phase influence activity patterns and attraction of moths to traps (Butler et al. 1999). Other factors include the distance of attraction of particular moth species, how innately common or rare a species may be, the number of generations per year for a given species, the timing of light trap operation during the adult moth flight period, the number of traps operated, the placement of the traps themselves, the length of the sampling season, and the frequency of trap operation (Butler and Kondo 1991).

Light traps are a relative, not absolute, method of sampling (Southwood 1978). While there are difficulties in estimating moth populations from light trap data, light traps are excellent for survey purposes, and for comparing different locations. Moths generally are found near areas where they develop as larvae. Caterpillars, the larvae of moths, primarily feed on living vegetation; some species of larvae feed on dead vegetation and fungi. While some species of caterpillars are relatively specific on their host plants, others may feed on many different plants. There is a corresponding relationship between high richness of plant species and Lepidoptera species within study areas.

An earlier study of moth diversity was conducted at Coopers Rock State Forest on the border of Preston and Monongalia Counties. In that study, a 15–watt light trap was operated at one location in the forest interior once each week, from March through October for 3 years. Over that period, 400 species of moths representing 13 selected families were collected (Butler and Kondo 1991). Despite the much greater sampling intensity and higher number of captured species, several moth species in the current study were not captured in the Coopers Rock study. For example, the noctuid, large yellow underwing (*Noctua pronuba*) is a European species that made its way from Nova Scotia into our region in the late 1990s (Rings and Gilligan 1997). The cattail borer moth (*Bellura obliqua*) was only captured on the Cantonment area, likely associated with wetland vegetation. Feeble grass moth (*Amolita fessa*) larvae feed on grasses, *Papaipema nilita* larvae on burdock (*Arctium* spp.), and goldenrod stowaway (*Cirrhophanus triangulifer*) larvae on beggarticks (*Bidens* spp.). These three species of noctuids were captured only on the Cantonment and/or Pringle areas, not in the forests of Briery Mountain or Coopers Rock.

The high abundance of the four most common moths in the samples reflects the common presence of larval host plants, maples for lesser maple spanworm; black cherry (*Prunus serotina*) and other *Prunus* spp. for eastern tent caterpillar; and varied hardwood trees for banded tussock and unadorned carpet larvae. Even so, all lesser maple spanworm moths were captured on Briery and Pringle tracts only; and most unadorned carpet, eastern tent caterpillar, and banded tussock moths were captured on Pringle.

The highest number of species was captured on Pringle tract and the lowest number on Briery Mountain indicating differences in plant diversity and perhaps in distance the traps were visible for moth attraction, although the edge traps should be visible for longer distances. Woodland studies are known to be especially challenging because of shading and screening by vegetation (Waring 1989). Other factors such as weather should not have been an influence in this study as traps on all tracts were operated simultaneously. However, differences in microclimate are possible due to differences in elevation and aspect.

On the Camp Dawson Collective Training Area, 235 species of selected moths were captured using multiple traps on three tracts. Given that sampling occurred on only five nights, the moth species richness is high; 56 species of moths were represented by only one specimen, and 25 species were represented by only two specimens. To increase knowledge of the moth fauna at CDCTA, traps should be operated on more nights, ranging over more of the flight season for moths (March through November), and at more sites representing diverse habitats.

ACKNOWLEDGEMENTS

This project was funded by the West Virginia Army National Guard, West Virginia University Research Corporation, and the West Virginia Agricultural and Forestry Experiment Station. We thank L. B. Williams and G. A. Blackhurst, for providing us with this opportunity to assist in the management of Camp Dawson's fauna. We thank H. W. Weaver, G. M. Forcey, J. D. Osbourne, and D. A. Helon for assisting with fieldwork, S. L. Helon, for help in compiling data, and R. C. Whitmore for providing equipment. We thank H. W. Godwin and S. F. Hutchinson for reviewing this manuscript. This is scientific article number 2910 of the West Virginia University Agricultural and Forestry Experiment Station.

LITERATURE CITED

Ausden, M. 1996. Invertebrates. Pages 139-177 *in* W. J. Sutherland, editor. Ecological census techniques: a handbook. Cambridge University Press, Cambridge, UK.

Bell, J. W. 2001. Soil survey of Camp Dawson, Preston County, West Virginia. USDA Natural Resources Conservation Service, Moorefield, West Virginia, USA.

Butler, L. and V. Kondo. 1991. Macrolepidopterous moths collected by blacklight trap at Coopers Rock State Forest, West Virginia: a baseline study. West Virginia Agricultural Experiment Station Bulletin 705.

_____, _____, E. M. Barrows, and E. C. Townsend. 1999. Effects of weather

conditions and trap types on sampling for richness and abundance of forest macrolepidoptera. Environmental Entomology 28:795-811.
Conover, W. J. 1980. Practical nonparametric statistics. Second edition. John Wiley and Sons, New York, New York, USA.
Garwood, A. N. 1996. Weather America. Toucan Valley Publications, Milpitas, California, USA.
Lee, A. A., D. D. Evans, M. Bishop, T. Wilson, and M. Mauney. 2001. Delineation of wetlands and other regulated waters of Camp Dawson, WV. U. S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, Mississippi, USA.
Magurran, A. E. 1988. Ecological diversity and its measurement Princeton University Press, Princeton, New Jersey, USA.
Muirhead-Thompson, R. C. 1991. Trap responses of flying insects. The influence of trap design on capture efficiency. Academic Press, San Diego, California, USA.
Osbourne, J. D., J. T. Anderson, L. B. Williams, and J. A. Simcoe. 2002. Natural Resource Management on the Camp Dawson Collective Training Area in Preston County, West Virginia. Proceedings of the West Virginia Academy of Sciences 74:1-7.
Rings, R. W. and M. Gilligan. 1997. What is it doing here? The Ohio Lepidopterist 19:42-43.
Ruffner, J. A. 1985. Climates of the states: National Oceanic and Atmospheric Administration narrative summaries, tables, and maps for each state with overview of state climatologist programs. Volume 2. National Oceanic and Atmospheric Administration, Gale Research Company, Washington, D.C., USA.
Southwood, T. R. E. 1978. Ecological methods with particular reference to the study of insect populations. Second edition. John Wiley and Sons, New York, New York, USA.
Vanderhorst, J. 2001. Plant community classification and mapping of the Camp Dawson Collective Training Area, Preston County, West Virginia. West Virginia Division of Natural Resources, Elkins, West Virginia, USA.
Waring, P. 1989. Comparison of light-trap catches in deciduous and coniferous woodland habitats. Entomological Record 101:1-10.

Table 1. List of moth species occurring on the Camp Dawson Army Training Site, Kingwood, WV, 2000 and 2001.

Family	Common Name	Genus	Species	Total Number of Captures			
				Briery	Cantonment	Pringle	Total
Apatelodidae	Spotted apatelodes	*Apatelodes*	*torrefaeta*	0	2	0	2
Apatelodidae	The angel	*Olceclostera*	*angelica*	0	0	20	20
Arctiidae	Little white lichen moth	*Clemensia*	*albata*	1	7	0	8
Arctiidae	Pale lichen moth	*Crambidia*	*pallida*	1	8	2	11
Arctiidae	Delicate cycnia	*Cycnia*	*tenera*	0	1	0	1
Arctiidae	Milkweed tussock moth	*euchaetes*	*egle*	0	1	1	2
Arctiidae	Virgin tiger moth	*Grammia*	*virgo*	0	1	0	1
Arctiidae	Banded tussock moth	*Halysidota*	*tessellaris*	25	10	393	428
Arctiidae	Clymene moth	*Haploa*	*clymene*	0	0	1	1
Arctiidae	Colona Moth	*Haploa*	*colona*	0	0	10	10
Arctiidae	The neighbor	*Haploa*	*contigua*	0	4	0	4
Arctiidae	Leconte's Haploa	*Haploa*	*lecontei*	0	0	10	10
Arctiidae	Fall webworm moth	*Hyphantria*	*cunea*	0	1	0	1
Arctiidae	Painted lichen moth	*Hypoprepia*	*fucosa*	9	2	2	13
Arctiidae	Scarlet-winged lichen moth	*Hypoprepia*	*miniata*	1	1	1	3
Arctiidae	Hickory tussock moth	*Lophocampa*	*caryae*	1	4	0	5
Arctiidae	Isabella tiger moth	*Pyrrharctia*	*isabella*	0	1	1	2
Arctiidae	Agreeable tiger moth	*Spilosoma*	*congrua*	0	3	3	6
Arctiidae	Virginian tiger moth	*Spilosoma*	*virginica*	0	0	1	1
Ctenuchidae	Yellow-collared scape moth	*Cisseps*	*fulvicollis*	0	18	0	18
Drepanidae	Arched hooktip	*Drepana*	*arcuata*	4	3	2	9
Drepanidae	Rose hooktip	*oreta*	*rosea*	0	0	1	1
Geometridae	Brown-shaded gray	*Anacamptodes*	*defectania*	0	3	0	3
Geometridae	Pale-winged gray	*Anacamptodes*	*ephyraria*	1	9	0	10
Geometridae	American barred umber	*Anagoga*	*occiduaria*	1	0	1	2
Geometridae	Variable antepione	*Antepione*	*thisoaria*	6	1	2	9
Geometridae		*Anticlea*	*vasiliata*	0	1	0	1
Geometridae	Straw besma	*Besma*	*endropiaria*	3	0	10	13
Geometridae	Oak besma	*Besma*	*quercivorata*	1	2	0	3
Geometridae	Pepper-and-salt geometer	*Biston*	*betularia*	0	1	7	8
Geometridae	Yellow-dusted cream moth	*Cabera*	*erythemaria*	17	3	2	22

Table 1. Continued.

Family	Common Name	Genus	Species	Total Number of Captures			
				Briery	Cantonment	Pringle	Total
Geometridae	Cross-lined wave	*Calothysanis*	*amaturaria*	0	2	2	4
Geometridae	Pale beauty	*Campaea*	*perlata*	8	22	6	36
Geometridae	Scallop moth	*Cepphis*	*armataria*	0	0	1	1
Geometridae	Blackberry looper moth	*Chlorochlamys*	*chloroleucaria*	0	3	2	5
Geometridae	Barberry geometer	*Coryphista*	*meadii*	0	0	1	1
Geometridae	Sweetfern geometer	*Cyclophora*	*pendulinaria*	0	2	0	2
Geometridae	The bad-wing	*Dyspteris*	*abortivaria*	0	0	4	4
Geometridae		*Echlaena*	*pectinaria*	1	0	3	4
Geometridae	Dark-banded geometer	*Ecliptopera*	*atricolorata*	0	0	6	6
Geometridae	The small engrailed	*Ectropis*	*crepuscularia*	1	2	0	3
Geometridae	Maple spanworm moth	*Ennomos*	*magnaria*	0	0	1	1
Geometridae	Elm spanworm moth	*Ennomos*	*subsignaria*	0	0	4	4
Geometridae	Tulop-tree beauty	*Epimecis*	*hortaria*	1	1	12	14
Geometridae	The little beggar	*Eubaphe*	*mendica*	3	1	34	38
Geometridae	Obtuse euchlaena	*Euchlaena*	*obusaria*	0	1	0	1
Geometridae	Snowy geometer	*Eugonobapta*	*nivosaria*	14	5	77	96
Geometridae	Lesser grapevine looper moth	*Eulithis*	*diversilineata*	0	4	10	14
Geometridae	Sharp-angled carpet	*Euphyia*	*unangulata*	0	11	8	19
Geometridae	Hereford's eupithecia	*Eupithecia*	*matheri (herefordaria)*	4	4	6	14
Geometridae	Confused eusarca	*Eusarca*	*confusaria*	0	18	2	20
Geometridae	Curve-toothed geometer	*Eutrapela*	*clemataria*	0	0	9	9
Geometridae	Chickweed geometer	*Haematopis*	*grataria*	0	1	0	1
Geometridae	Three-patched bigwing	*Heterophleps*	*refusaria*	0	0	25	25
Geometridae	Three-spotted fillip	*Heterophleps*	*triguttaria*	0	1	4	5
Geometridae	Dark homochlodes	*Homochlodes*	*disconventa*	15	4	3	22
Geometridae	Unadorned carpet	*Hydrelia*	*inornata*	5	0	109	114
Geometridae	Ferguson's scallop shell	*Hydria*	*prunivorata*	12	2	19	33
Geometridae	One-spotted variant	*Hypagyrtis*	*unipunctata*	0	3	29	32
Geometridae	Bent-line gray	*Iridopsis*	*larvaria*	6	7	14	27
Geometridae	Lesser maple spanworm moth	*Itame*	*pustularia*	145	1	139	285
Geometridae	Barred itame	*Itame*	*subcessaria*	0	0	2	2
Geometridae	Yelllow-headed looper moth	*Lambdina*	*pellucidaria*	6	1	0	7
Geometridae	White spring moth	*Lomographa*	*vestaliata*	13	0	6	19
Geometridae	Common lytrosis	*Lytrosis*	*unitaria*	3	1	44	48
Geometridae	Canadian melanolopha	*Melanolophia*	*canadaria*	7	34	36	77

Table 1. Continued.

Family	Common Name	Genus	Species	Total Number of Captures			Total
				Briery	Cantonment	Pringle	
Geometridae	White-ribboned carpet	*Mesoleuca*	*ruficillata*	1	0	0	1
Geometridae	common metarranthis	*Metarranthis*	*hypochraria*	1	3	1	5
Geometridae	Horned spanworm moth	*Nematocampa*	*limbata*	18	3	64	85
Geometridae		*Nemoria*	*bistriaria*	25	2	2	29
Geometridae	Bent-line carpet	*Orthonama*	*centrostrigaria*	2	18	1	21
Geometridae	The gem	*Orthonama*	*obstipata*	2	3	2	7
Geometridae	Honest pero	*Pero*	*honestaria*	3	1	0	4
Geometridae		*Plagodis*	*fervidaria*	0	0	2	2
Geometridae	Straight-lined plagodis	*Plagodis*	*phlogosaria*	1	0	0	1
Geometridae	Lemon plagodis	*Plagodis*	*serinata*	7	4	0	11
Geometridae	Hollow-spotted plagodis	*Plagodis*	*alcoolaria*	4	0	0	4
Geometridae	Common tan wave	*Pleuroprucha*	*insulsaria*	1	3	1	5
Geometridae	Alien probole	*Probole*	*alienaria*	17	2	12	31
Geometridae	Friendly probole	*Probole*	*amicaria*	3	3	3	9
Geometridae	Large maple spanworm moth	*Prochoerudes*	*transversata*	4	15	16	35
Geometridae	Porcelain gray	*Protoboarmia*	*porcelaria*	0	0	6	6
Geometridae	Large lace-border	*Scopula*	*limboundata*	6	1	13	20
Geometridae	Kent's geometer	*Selenia*	*kentaria*	0	0	3	3
Geometridae	Promiscuous angle	*Semiothisa*	*aemulataria*	2	0	0	2
Geometridae	Hemlock angle	*Semiothisa*	*fissinotata*	3	0	3	6
Geometridae	Faint-spotted angle	*Semiothisa*	*ocellenata*	7	4	6	17
Geometridae	Four-spotted angle	*Semiothisa*	*quadrinotaria*	0	4	0	4
Geometridae	Sharp-lined yellow	*Sicya*	*macularia*	1	0	0	1
Geometridae	Shiny gray carpet	*Stamnodes*	*gibbicostata*	0	1	0	1
Geometridae	White slant-line	*Tetracis*	*cachexiata*	4	2	0	6
Geometridae	Yellow slant-line	*Tetracis*	*crocallata*	0	0	3	3
Geometridae	Shite-striped black	*Trichodezia*	*albovittata*	0	1	0	1
Geometridae	Crocus geometer	*Xanthotype*	*sospeta*	0	2	0	2
Geometridae	False crocus geometer	*Xanthotype*	*urticaria*	0	2	0	2
Lasiocampidae	Eastern tent caterpillar	*Malacosoma*	*americana*	37	15	142	194
Lasiocampidae	Forest tent caterpillar moth	*Malacosoma*	*disstria*	2	2	75	79
Lasiocampidae	Large tolype	*Tolype*	*velleda*	0	0	1	1
Lymantriidae	Sharp-lined tussock moth	*Dasychira*	*dorsipennata*	0	3	29	32
Lymantriidae	Streaked tussock moth	*Dasychira*	*obliguata*	1	4	3	8
Lymantriidae	Gypsy moth	*Lymantria*	*dispar*	1	1	0	2

Table 1. Continued.

Family	Common Name	Genus	Species	Total Number of Captures			Total
				Briery	Cantonment	Pringle	
Lymantriidae	White-marked tussock moth	*Orgyia*	*leucostigma*	1	3	6	10
Noctuidae	Greater red dart	*Abagrodis*	*alternata*	0	0	1	1
Noctuidae	Afflicted dagger moth	*Acronicta*	*afflicta*	0	0	1	1
Noctuidae	American dagger moth	*Acronicta*	*americana*	0	0	1	1
Noctuidae	Funerary dagger moth	*Acronicta*	*fragilis*	1	0	1	2
Noctuidae		*Acronicta*	*increta*	2	0	3	5
Noctuidae	Unmarked dagger moth	*Acronicta*	*inntata*	0	0	1	1
Noctuidae	Ovate dagger moth	*Acronicta*	*ovata*	2	0	1	3
Noctuidae	Retarded dagger moth	*Acronicta*	*retardata*	1	0	0	1
Noctuidae	Nondescript dagger moth	*Acronicta*	*spinigera*	0	0	1	1
Noctuidae	Delightful dagger moth	*Acronicta*	*vinnula*	0	0	3	3
Noctuidae	Ipsilon dart	*Agrotis*	*ipsilon*	0	1	0	1
Noctuidae	Venerable dart	*Agrotis*	*venerabilis*	0	2	0	2
Noctuidae	Unspotted looper moth	*Allagraphia*	*aerea*	0	1	0	1
Noctuidae	False underwing	*Allotria*	*elonymphia*	0	0	1	1
Noctuidae	Feeble grass moth	*Amolita*	*fessa*	0	3	0	3
Noctuidae	American ear moth	*Amphipoea*	*americana*	1	0	0	1
Noctuidae	American ear moth	*Amphipola*	*velata*	0	0	1	1
Noctuidae	Copper underwing	*Amphipyra*	*pyramidoides*	0	1	0	1
Noctuidae	Celery looper moth	*Anagrapha*	*falcifera*	1	2	0	3
Noctuidae	The slowpoke	*Anorthodes*	*tarda*	0	2	0	2
Noctuidae	Common looper moth	*Autographa*	*precationis*	1	3	0	4
Noctuidae	Sleeping baileya	*Baileya*	*dormitans*	0	0	5	5
Noctuidae	Eyed baileya	*Baileya*	*ophthalmica*	0	3	0	3
Noctuidae	White-blotched balsa	*Balsa*	*labecula*	1	0	5	6
Noctuidae	Cattail borer moth	*Bellura*	*obliqua*	0	1	0	1
Noctuidae	Bent-winged owlet	*Bleptina*	*caradrinalis*	0	3	1	4
Noctuidae	Large bomolocha	*Bomolocha*	*edictalis*	0	0	4	4
Noctuidae	Forage looper moth	*Caenurgina*	*erechtea*	0	55	0	55
Noctuidae	Silver-spotted fern moth	*Callopostria*	*cordata*	1	0	0	1
Noctuidae	Charming underwing	*Catocala*	*blandula*	0	0	2	2
Noctuidae	Ultronia underwing	*Catocola*	*ultronia*	0	0	1	1
Noctuidae	Tufted bird-dropping moth	*Cerma*	*cerintha*	0	0	6	6
Noctuidae	Formosa looper moth	*Chrysanympha*	*formosa*	0	0	1	1
Noctuidae	Morbid owlet	*Chytolita*	*morbidalis*	1	4	0	5

Table 1. Continued.

Family	Common Name	Genus	Species	Total Number of Captures			
				Briery	Cantonment	Pringle	Total
Noctuidae	Cloaked marvel	*Chytonix*	*palliatricula*	0	0	1	1
Noctuidae	Goldenrod stowaway	*Cirrhophanus*	*triangulifer*	0	1	0	1
Noctuidae	Closebanded yellowhorn	*Colocasia*	*propinquilinea*	0	0	1	1
Noctuidae	Variegated midget	*Elaphria*	*versicolor*	0	0	4	4
Noctuidae	Sloping sallow	*Epiglaea*	*decliva*	0	0	1	1
Noctuidae	Beautiful wood-nymph	*Eudryas*	*grata*	0	0	4	4
Noctuidae	Pearly wood-nymph	*Eudryas*	*unio*	0	2	0	2
Noctuidae	Two-spot dart	*Eueretagrotis*	*perattenta*	0	0	5	5
Noctuidae	Locust underwing	*Euparthenos*	*nubilis*	1	0	3	4
Noctuidae	American angle shades	*Euplexia*	*benesimilis*	5	4	13	22
Noctuidae		*Euxoa*	*scholastica*	1	2	0	3
Noctuidae	Wheat head armyworm moth	*Faronta*	*diffusa*	1	2	0	3
Noctuidae	Master's dart	*Feltia*	*herilis*	0	84	0	84
Noctuidae	Scurfy quaker	*Homorthodes*	*furfurata*	1	4	0	5
Noctuidae		*Hormisa*	*orciferalis*	0	3	0	3
Noctuidae	Sotted graylet	*Hyperstrotia*	*pervertens*	2	0	1	3
Noctuidae	Common idia	*Idia*	*aemula*	4	7	42	53
Noctuidae	American idia	*Idia*	*americalis*	1	4	4	9
Noctuidae	Glossy black idia	*idia*	*lubricalis*	0	8	13	21
Noctuidae	Rotund idia	*Idia*	*rotundalis*	9	9	12	30
Noctuidae	Smoky idia	*Idia*	*scobialis*	0	2	4	6
Noctuidae	Bristly cutworm moth	*Lacinipolia*	*renigera*	0	69	0	69
Noctuidae	Ambiguous moth	*Lascoria*	*ambigualis*	0	2	2	4
Noctuidae	False wainscot	*Leucania*	*pseudargyria*	0	0	2	2
Noctuidae	Green leuconycta	*Leuconycta*	*diphteroides*	0	0	2	2
Noctuidae	Pink-barred lithacodia	*Lithacodia*	*carneola*	0	4	7	11
Noctuidae	large mossy lithacodia	*Lithacodia*	*muscosula*	1	2	6	9
Noctuidae	black-dotted lithacodia	*Lithacodia*	*synochitis*	0	0	15	15
Noctuidae	Confused meganola	*Meganola*	*minuscula*	0	1	3	4
Noctuidae	Common fungus moth	*Metalectra*	*discalis*	0	1	0	1
Noctuidae	Confused woodgrain	*Morrisonia*	*confusa*	1	0	0.	1
Noctuidae	Bronzed cutworm moth	*Nephelodes*	*minians*	0	77	0	77
Noctuidae		*Noctua*	*pronuba*	1	1	1	3
Noctuidae	Common pinkband	*Ogdoconta*	*cinereola*	0	1	0	1
Noctuidae	Cynical quaker	*Orthodes*	*cynica*	2	3	25	30

Table 1. Continued.

Family	Common Name	Genus	Species	Total Number of Captures			
				Briery	Cantonment	Pringle	Total
Noctuidae	Faint-spotted palthis	*Palthis*	*asopialis*	0	15	14	29
Noctuidae	Decorated owlet	*Pangrapta*	*decoralis*	0	0	2	2
Noctuidae		*Papaipema*	*nelita*	0	1	4	5
Noctuidae		*Pappipema*	*baptisiae*	0	4	0	4
Noctuidae	Maple looper moth	*Parallelia*	*bistriaris*	0	1	0	1
Noctuidae	Variegated cutworm moth	*Peridroma*	*saucia*	0	1	0	1
Noctuidae	Black-banded owlet	*Phalaenophana*	*larentioides*	0	2	0	2
Noctuidae	Dark-banded owlet	*Phalaenophana*	*pyramusalis*	0	2	0	2
Noctuidae	Turbulent phosphila	*Phosphila*	*turbulenta*	0	1	0	1
Noctuidae	Green cloverworm moth	*Plathypena*	*scabra*	4	3	0	7
Noctuidae	Dusky groundling	*Platysenta*	*vecors*	2	6	10	18
Noctuidae	Disparaged arches	*Polia*	*detracta*	0	0	3	3
Noctuidae	Cloudy arches	*Polia*	*imbrifera*	1	0	3	4
Noctuidae	Fluid arches	*Polia*	*latex*	1	1	14	16
Noctuidae	Stormy arches	*Polia*	*nimbosa*	0	1	3	4
Noctuidae	The hebrew	*Polygrammate*	*hebraeicum*	2	1	1	4
Noctuidae	Brown-collared dart	*Protolampra*	*brunneicollis*	0	0	5	5
Noctuidae	Armyworm moth	*Pseudaletia*	*unipuncta*	1	7	1	9
Noctuidae	Small brown quaker	*Pseudorthodes*	*vecors*	0	0	4	4
Noctuidae		*Renia*	*factiosalis*	9	53	28	90
Noctuidae	The herald	*Scoliopteryx*	*libatrix*	0	1	0	1
Noctuidae	Henry's marsh moth	*Simyra*	*henrici*	0	1	0	1
Noctuidae	Six-spotted gray	*Spargaloma*	*sexpunctata*	0	2	0	2
Noctuidae	Greater black-letter dart	*Xestia*	*dolosa*	0	2	3	5
Noctuidae	Norman's dart	*Xestia*	*normaniana*	0	1	0	1
Noctuidae	Smith's dart	*Xestia*	*smithii*	0	20	0	20
Noctuidae	Colorful zale	*Zale*	*minerea*	1	0	0	1
Noctuidae	Early zanclognatha	*Zanclognatha*	*cruralis*	0	2	0	2
Noctuidae	Variable zanclognatha	*Zanclognatha*	*laevigata*	11	8	54	73
Noctuidae	Lettered zanclognatha	*Zanclognatha*	*lituralis*	1	5	12	18
Noctuidae	Wav-lined zanclognatha	*Zanclognatha*	*ochreipennis*	9	10	47	66
Noctuidae	Grayish zanclognatha	*Zanclognatha*	*pedipilalis*	0	0	4	4
Notodontidae	Angle-lined prominent	*Clostera*	*inclusa*	1	1	0	2
Notodontidae	Black-spotted prominent	*Dasylophia*	*anguina*	4	0	1	5
Notodontidae	Angus's datana	*Datana*	*angusii*	0	1	2	3

Table 1. Continued.

Family	Common Name	Genus	Species	Total Number of Captures			Total
				Briery	Cantonment	Pringle	
Notodontidae	Yellow-necked caterpillar moth	*Datana*	*ministra*	2	1	14	17
Notodontidae	Linden prominent	*Ellida*	*caniplaga*	0	0	9	9
Notodontidae	Wavy-lined heterocampa	*Heterocampa*	*biundata*	0	4	58	62
Notodontidae	Saddled prominent	*Heterocampa*	*guttivitta*	2	6	5	13
Notodontidae	White-blotched heterocampa	*Heterocampa*	*umbrata*	0	0	10	10
Notodontidae	Double-lined promnent	*Lochmaeus*	*bilineata*	0	2	3	5
Notodontidae	Variable oakleaf caterpillar moth	*Lochmaeus*	*manteo*	0	0	1	1
Notodontidae	White-dotted prominent	*Nadata*	*gibbosa*	4	0	36	40
Notodontidae	Red-washed prominent	*Oligocentria*	*semirufescens*	2	0	35	37
Notodontidae	Oval-based prominent	*Peridea*	*basitriens*	0	2	15	17
Notodontidae	Morning-glory prominent	*Schizura*	*ipomoeae*	1	1	6	8
Notodontidae	Black-blotched schizura	*Schizura*	*leptinoides*	0	0	3	3
Notodontidae		*Symmerista*	*canicosta*	1	0	20	21
Notodontidae		*Symmerista*	*leucitys*	0	0	16	16
Pyralidae	Grape leaffolder moth	*Desmia*	*funeralis*	2	4	27	33
Pyralidae		*Euzophera*	*ostricolorella*	1	0	0	1
Pyralidae	Basswood leafroller moth	*Pantographa*	*limata*	1	5	5	11
Saturniidae	Luna moth	*Actias*	*luna*	1	0	0	1
Saturniidae	Polyphemus moth	*Antheraea*	*polyphemus*	1	1	0	2
Saturniidae	Io moth	*Automeris*	*io*	1	2	1	4
Saturniidae	Rosy maple moth	*Dryocampa*	*rubicunda*	2	0	5	7
Saturniidae	Imperial moth	*Eacles*	*imperialis*	0	0	1	1
Sphingidae	Lettered sphinx	*Deidamia*	*inscripta*	0	6	0	6
Sphingidae	Walnut sphinx	*Laothoe*	*juglandis*	0	0	1	1
Sphingidae	Blinded sphinx	*Paonias*	*excaecatus*	2	1	9	12
Sphingidae	Small-eyed sphinx	*Paonias*	*myops*	0	0	1	1
Thyatiridae	Lettered habrosyne	*Habrosyne*	*scripta*	0	1	0	1
Thyatiridae	Tufted thyatirid	*Pseudothyatira*	*cymatophoroides*	0	0	1	1
Yponomeutidae	Ailanthus webworm moth	*Attera*	*punctella*	0	11	0	11

AN ASSESSMENT OF AVIAN FAUNA ON THE CAMP DAWSON COLLECTIVE TRAINING AREA, KINGWOOD, WEST VIRGINIA

GREG M. FORCEY and JAMES T. ANDERSON,* Wildlife and Fisheries Resources, Division of Forestry, West Virginia University, P. O. Box 6125, Morgantown, WV, 26506-6125, USA. *jander25@wvu.edu.

ABSTRACT

The United States Armed Forces has placed increased emphasis on the importance of natural resources on military lands as they have required faunal assessments to occur on all military installations by 2002. The objectives of this study were to inventory rare bird species, determine bird diversity, and evaluate avian habitat use on the Camp Dawson Collective Training Area (CDCTA), West Virginia. We studied three tracts of land at the CDCTA: Briery Mountain, the Cantonment Area, and the Pringle Tract. Point counts for birds were conducted using a double-observer approach on 100 point locations during 2000 and 137 points in 2001. Sixty-one, 78, and 69 species of birds were found on Briery Mountain, the Cantonment Area, and the Pringle Tract respectively. Six state rare bird species were detected on the CDCTA. Over half of the abundant bird species used in the analyses showed significant differences in abundance among the three tracts. In general, species preferring forested areas were most abundant on the Pringle Tract, those favoring early successional habitats with undergrowth were concentrated on Briery Mountain, and species commonly associated with developed areas were most frequent on the Cantonment Area. Management recommendations are to manage habitat appropriately for rare species and to continue long-term monitoring of avian wildlife. These suggestions will insure that the CDCTA continues to provide a safe harbor for rare species and maintain a high richness of avifauna.

INTRODUCTION

Native birds are extremely important in the United States and to scientists around the world. They have social, economic, political, aesthetic, and intrinsic values to people and to the environment (Meffe and Carroll 1997). Many popular American hobbies revolve around birds such as bird watching, bird feeding, and hunting. Kerlinger and Wiedner (1990) termed birdwatching as an economically significant sport. In the United States alone, there are an estimated 61 million birdwatchers with Canada and Great Britain having equally impressive densities (Gill 1995). The average birder in the United States spends $1,884 annually on expenses such as travel, optical equipment, and reference material (Kerlinger and Wiedner 1990). Overall, the amount of money spent by birders in 1990 within North America was more than $20 billion (Gill 1995).

Because of their importance, it is imperative that scientists inventory the health of current bird populations so that appropriate management decisions can be made. Often faunal assessments are conducted because of an observed or an *a priori* belief that a species or guild may be declining. Causes of the declines of many species are often human-induced and include factors such as habitat loss, introduction of exotics, the pet trade, environmental toxins, and extreme human predation (Gill 1995). One powerful incentive for surveying bird populations is the recent decline of neotropical migratory land birds. Reasons for the decline are thought to be linked to tropical deforestation, habitat fragmentation, Brown-headed Cowbird (*Molothrus ater*) parasitism, and the degradation of breeding grounds in the boreal forest (Ralph et al. 1995, Meffe and

Carroll 1997). The decline of these species has led the government and many private organizations to inventory existing populations of these birds so that long-term trends in abundance can be monitored (McLaren and Cadman 1999). Other reasons that scientists may conduct faunal assessments include determining the species composition and abundance of an area, evaluating habitat use by a species, or ascertaining the reproductive success of a species (Ralph and Scott 1981). Additionally, the Sikes Act (16 USC 670a et seq.), Army Regulation 200-3, and Department of Defense Instruction 4715.3 state that faunal surveys should be completed on military installations by 2002. The objectives for the bird surveys at the Camp Dawson Collective Training Area (CDCTA) were to:

1. Compile a list of bird species, including rare species that occur on the CDCTA,
2. Determine the abundance and distribution of birds on the CDCTA, and
3. Suggest management practices to preserve existing rare species on the CDCTA.

MATERIALS AND METHODS

Study area

The CDCTA is located in Preston County within the state of West Virginia. The installation contains 1,655 ha of land distributed among three tracts: Briery Mountain (423 ha), the Cantonment Area (378 ha), and the Pringle Tract (854 ha) (West Virginia Army National Guard 2001). Elevation on the CDCTA ranges from approximately 122 m on the Cantonment Area to 853 m on Briery Mountain (Anderson et al. 2002).

All three tracts of land are used for military training, although other types of land use vary among areas. Briery Mountain serves as a wildlife management area that is managed by both the West Virginia Division of Natural Resources and the West Virginia Army National Guard. The Cantonment Area contains many office buildings and housing facilities used by the army, as well as shooting ranges and an airport (West Virginia Army National Guard 2001).

Within each tract, points were stratified among major habitats and location (edge and interior) including forest, riparian areas, reclaimed mines, and developed areas. Forest edge habitats include wooded areas adjacent to grasslands, lawns, roads, or developed areas, as well as forest interior areas with large gaps in canopy coverage; forest interior locations were greater than 100 m from a clearing or edge; riparian edge habitats are adjacent to either standing or moving water adjoining grasslands, lawns, roads, or developed areas; riparian interior locations contain standing or moving water within forest interior habitats; reclaimed mine areas are currently in an early successional stage containing grassland and shrub vegetation; and developed habitats contain buildings created by humans. The number of points occurring within each habitat was allocated according to the amount of each habitat that occurred on a tract. Points also were stratified between interior and edge areas within a habitat. An edge is defined as the location where two distinct vegetative types or land uses come together (Yahner 1995). Points located within interior habitats were less than 100 m from an edge (Meffe and Carroll 1997).

The CDCTA lies on the boundary of two main soil types: the Gilpin-Rayne-Wharton and the Dekalb soil type (Bell 2001). Preston County occurs in the Allegheny Mountains in eastern West Virginia (Hall 1983). The majority of Preston County is forested with wooded areas covering about 57% of the county. The remaining areas consist primarily of agricultural areas, although most farms contain some forested areas (Vanderhorst 2001). The CDCTA has two main forest types that occur within its boundaries. Areas of high elevation contain a mix of Chestnut Oak (*Quercus prinus*), Scarlet Oak (*Q. coccinea*), and Black Oak (*Q. velutina*). Lower elevations contain a mix of Yellow-poplar (*Liriodendron tulipifera*), White Oak (*Q. alba*), and Red Oak (*Q. rubra*) (Strasbaugh and

Core 1978, Vanderhorst 2001). Society of American Foresters forest cover types occurring on the CDCTA include oak (types 44, 52, 53, 55, 110), maple (types 25, 27, 28, 60, 108) and yellow poplar (types 57, 58, 59, 60) (Eyre 1980).

West Virginia has moderately severe winter weather, with extreme conditions occurring in the mountainous areas of the east. Scattered showers and thunderstorms occur often in the summer months (National Oceanic and Atmospheric Administration 1985). Average yearly temperatures for Preston County are 3.5°C (Minimum) and 14.1°C (Maximum) (Garwood 1996). Average yearly precipitation for Preston County, West Virginia is 137 cm, and average yearly snowfall is 371.3 cm (Garwood 1996).

Point Count Sampling

Common and scientific names for birds were taken from the American Ornithologists' Union Check-list (American Ornithologists' Union 1998). Point locations for sampling birds were randomly established on the CDCTA in 2000 among the three tracts of land; 26 were placed on Briery Mountain, 29 on the Cantonment Area, and 45 on the Pringle Tract. In 2001, 37 additional points were placed in locations that were not adequately surveyed in 2000; 14 additional points were placed on Briery Mountain, three on the Cantonment Area, and 20 on the Pringle Tract. Point locations were placed along transects on each tract and were randomized by using a random numbers table (SAS Institute 1999) containing values from 1-50. Transect starting points were dictated by property boundaries on the CDCTA. The random number drawn for each point corresponds to the number of additional meters to walk beyond the minimum 250-m point spacing distance (Hamel et al. 1996). Points were placed on each area of the property until all areas were adequately covered. Point locations were marked with red flagging tape and recorded with a global positioning system.

Double-observer point counts were performed on the CDCTA during the spring and summer of 2000 and 2001 (Nichols et al. 2000). When conducting point counts with two observers, one is designated the primary observer and the other is the secondary observer. The primary observer is responsible for identifying and verbally communicating all birds he/she detects to the secondary observer. The secondary observer records this information along with birds that are not detected by the primary observer. Data collected in this manner allow a detection probability and estimated abundance to be calculated for each bird species. This is accomplished using the program DOBSERV (Nichols et al. 2000) in conjunction with the SURVIV code (White 1983). Abundance estimates generated from the double-observer method are likely to be more robust than those calculated from single-observer point counts (Nichols et al. 2000).

Avian surveys were conducted primarily during the breeding season, although some counts did occur early and late in the breeding season to evaluate potential migrant use of the CDCTA. Point locations were surveyed with the double-observer approach once during each season: between 2 June and 7 July in 2000 and between 22 May and 16 July in 2001. Unlimited-radius point count surveys were conducted from dawn to 1000 hours, for a duration of 10 minutes at each location (Hamel et al. 1996). To maximize the probability that bird detections would be independent between observers, surveyors spent the majority of the count duration facing in opposite directions. Additionally, observers intermittently directed their attention toward certain areas at times when no birds were detected. This further decreased the chance that surveyors would use each other's cues as a way to detect birds (Nichols et al. 2000).

A different second observer was used between 2000 and 2001. Both observers were trained in bird identification (both visual and aural) and distance estimation before starting point count surveys. Both observers had previous experience with visual and aural bird identification, so training served as a review and for learning any unfamiliar bird species.

Data Analysis

Bird species richness was determined using point count data as well as incidental bird sightings. Only double-observer point count data were used for bird abundance and diversity comparisons among tracts. A mean abundance per point was calculated for each bird species for each tract as well as an overall abundance across all tracts. The birds used in the abundance comparisons only included species that were observed 150 or more times ($n = 9$) over the 2-year survey period. Analysis of Variance (ANOVA) and Duncan's multiple range test (Cody and Smith 1997) were used to compare bird abundance among tracts on the CDCTA. Abundance comparisons were performed with year, tract, and the year by tract interaction serving as independent variables; the dependent variable was the mean abundance per point for each tract.

Sorensen's coefficients were used to evaluate the species composition similarity between tracts (Krebs 1999). Bird species diversity was compared among the three tracts of land using a Shannon index of diversity (calculated using natural logs) (Krebs 1999, Zar 1999) for each point for both 2000 and 2001. Analysis of variance was used to determine if significant differences in bird species diversity existed among tracts. Year, tract, and year by tract interaction were the independent variables and the Shannon diversity value for each point was the dependent variable. Normality of dependent variables was tested with stem-and-leaf and normal scores plots before performing ANOVA (Cody and Smith 1997). Plots showed diversity indices to be normally distributed.

RESULTS

One hundred and three species of birds were located on the CDCTA over the 2-year study period; 93 and 92 species were observed in 2000 and 2001 respectively (Appendix 1). In 2000, 52 species were observed on Briery Mountain, 69 species were found on the Cantonment Area, and 59 species were detected on the Pringle Tract. Similar numbers of species were found in 2001 with 54 species observed on Briery Mountain, 67 species on the Cantonment Area, and 61 species on the Pringle Tract. Across both years, 61 bird species were observed on Briery Mountain, 78 species on the Cantonment Area, and 69 species on the Pringle Tract.

Six state rare species were observed on the CDCTA over the 2000 and 2001 field seasons (West Virginia Division of Natural Resources 2000). Golden-winged warbler (*Vermivora chrysoptera*) ($n = 15$ birds observed across 2000 and 2001) and Cliff Swallow (*Petrochelidon pyrrhonota*) ($n = 3$) were observed during 2000 and 2001. Sharp-shinned Hawk (*Accipiter striatus*), Great Blue Heron (*Ardea herodias*) ($n = 4$), and Alder Flycatcher (*Empidonax alnorum*) ($n = 1$) were observed only in 2000, while the Yellow-bellied Sapsucker (*Sphyrapicus varius*) ($n = 1$) was only detected in 2001.

Additionally, several bird species observed on the CDCTA are among the top 20 West Virginia Birds for conservation priority (West Virginia Partners in Flight 2002). Some of the more uncommon species occurring on the CDCTA include Yellow-billed Cuckoo (*Coccyzus americanus*) ($n = 7$), Black-billed Cuckoo (*Coccyzus erythropthalmus*) ($n = 2$), Belted Kingfisher (*Ceryle alcyon*) ($n = 3$), Acadian Flycatcher (*Empidonax virescens*) ($n = 24$), Yellow-throated Vireo (*Vireo flavifrons*) ($n = 13$), Worm-eating Warbler (*Helmitheros vermivorus*) ($n = 11$), Blue-winged Warbler (*Vermivora pinus*) ($n = 6$), Cerulean Warbler (*Dendroica cerulea*) ($n = 26$), and Louisiana Waterthrush (*Seiurus motacilla*) ($n = 5$).

The tracts with the most similar species composition were the Pringle Tract and Briery Mountain with Sorensen's coefficients of 77.4% in 2000 and 73.0% in 2001. Species similarity between the Pringle and Cantonment Areas was less similar with Sorensen's coefficients of 67.2% in 2000 and 68.8% in 2001. The

Cantonment Area and Briery Mountain had the least similar species composition with Sorensen's coefficients of 57.0% in 2000 and 62.8% in 2001.

Shannon index calculations revealed no significant difference in bird diversity among tracts ($F_{2, 229} = 1.27$, $P = 0.20$) or between years ($F_{1, 229} = 1.80$, $P = 0.18$), and there was no interaction between years and tracts ($F_{2, 229} = 1.27$, $P = 0.28$). Mean diversity indices per point were 2.35 (SE = 0.041) on Briery Mountain, 2.30 (SE = 0.055) on the Cantonment Area, and 2.26 (SE = 0.034) on the Pringle Tract.

Six of the nine species analyzed varied in abundance among the tracts of land ($P < 0.05$) (Table 1). Red-eyed Vireos were significantly more abundant on the Pringle Tract than the Cantonment Area and Briery Mountain. Eastern Towhees were more abundant on Briery Mountain than the Cantonment Area and Pringle Tract. American Robins (*Turdus migratorius*) and European Starlings (*Sturnus vulgaris*) were more numerous on the Cantonment Area than Briery Mountain and the Pringle Tract. American Crows (*Corvus brachyrhynchos*) were more prevalent on the Cantonment Area and Pringle Tract than on Briery Mountain. Hooded Warbler (*Wilsonia citrina*) abundance was significantly different among all three tracts with Briery Mountain having the highest abundance followed by the Pringle Tract and the Cantonment Area. Indigo Bunting (*Passerina cyanea*), Wood Thrush (*Hylocichla mustelina*), and Common Yellowthroat (*Geothlypis trichas*) abundance did not differ among tracts (Table 1).

DISCUSSION

Given the variety of habitats that occur on the CDCTA, it is not surprising that a large number of bird species were found. Species richness was highest on the Cantonment Area, followed by the Pringle Tract, and Briery Mountain. The Cantonment Area has the greatest variety of habitats with forest, open, riparian, and developed areas, which explains the high bird diversity in this area. Vegetative types on the Pringle Tract are less diverse followed by Briery Mountain, which is primarily forest (Vanderhorst 2001). This association occurs because more vegetative types are present that can support many bird species with a variety of niches (Morrison et al. 1998).

While most of the birds discovered on the CDCTA are locally common breeders, six species of birds found on the CDCTA are uncommon to northeast West Virginia. The Sharp-shinned Hawk, Purple Martin (*Progne subis*), Yellow-bellied Sapsucker, Blue-winged Warbler (*Vermivora pinus*), Mourning Warbler (*Oporornis philadelphia*), and Dark-eyed Junco (*Junco hyemalis*) were not found in central Preston County during the West Virginia breeding bird atlas project (Buckelew and Hall 1994). Sharp-shinned Hawks, Yellow-bellied Sapsuckers, and Dark-eyed Juncos are relatively inconspicuous during the breeding season aside from their vocalizations, and could have been overlooked by atlas volunteers. The Purple Martin was only observed on one occasion and early in the season, so it is possible that the individual was a late migrant or was traveling from one location to another and was not breeding in the county. The Mourning Warbler observations were exclusively early in the breeding season and therefore were not likely breeding on the CDCTA. It is possible that Blue-winged Warblers are new breeders to Preston County. This species is relatively conspicuous during the early breeding season with its characteristic song, and therefore it is unlikely that atlas volunteers would have overlooked this species if it were present.

There also are several bird species that were found in central Preston County during the breeding bird atlas surveys but were not found during the faunal assessments at the CDCTA. These species include the following: Rock Dove (*Columba livia*), Great-horned Owl (*Bubo virginianus*), Common Nighthawk (*Chordeiles minor*), Northern Mockingbird (*Mimus polyglottos*), Grasshopper Sparrow (*Ammodramus savannarum*), and Eastern

Meadowlark (*Sturnella magna*). Rock Doves and Common Nighthawks commonly inhabit urban areas (Johnston 1992, Poulin et al. 1996) and were probably found in the nearby town of Kingwood during the atlas survey period. Suitable habitat does not exist on the CDCTA for either of these species. Great-horned Owls likely occur on the CDCTA, but were not recorded likely due to their nocturnal habits. Grasshopper Sparrows and Eastern Meadowlarks typically inhabit grasslands, old fields, and savannah, with Grasshopper Sparrows favoring locations with bare ground (Lanyon 1995, Vickery 1996). While this habitat is present on the Pringle Tract, the total area is small and it is often disturbed during the breeding season with military training activities. The most notable bird species absent on the CDCTA was the Northern Mockingbird. Northern Mockingbirds are a habitat generalist (with the exception of deep forest) and are primarily found in parkland and suburban habitats (Derrickson and Breitwisch 1992). Adequate habitat exists on the Cantonment Area and on the Pringle Tract for this species, so it is peculiar that the species was not detected over the 2-year study period. One possible explanation for its absence on the CDCTA is the general scarcity of the bird in the eastern counties of West Virginia, which are primarily mountainous and forested (Buckelew and Hall 1994).

Shannon diversity indices did not differ among Briery Mountain, the Cantonment Area, and the Pringle Tract. While there is habitat diversity in these areas, the presence of heterogeneous vegetation associations in all three areas (Vanderhorst 2001) may explain why one tract did not harbor more bird diversity than others. In addition, the geographic proximity of the three tracts to one another could have influenced the diversity similarity among the areas.

Bird species composition varied among the three tracts, most likely due to differences in vegetative composition. Optimal cover, as defined by breeding success, typically supports higher species abundance (Duguay et al. 2001, Weakland et al. 2002). On the CDCTA, species using areas of early successional forest or mature forest with understory such as the American Redstart, Chestnut-sided Warbler, and Veery (Moskoff 1995, Richardson and Brauning 1995, Sherry and Holmes 1997) were most concentrated on Briery Mountain. Bird species preferring developed and open areas such as the American Robin, European Starling, House Sparrow, and the Killdeer (Lowther and Cink 1992, Cabe 1993, Sallabanks and James 1999, Jackson and Jackson 2000) were most frequently detected on the Cantonment Area. Common inhabitants of brushy reclaimed mine areas such as Prairie Warblers, Yellow-breasted Chats, and Blue-winged Warblers (Ehrlich et al. 1988) were far more frequent on the Pringle Tract compared to the other areas. These data suggest that vegetative structure has a profound impact on bird species composition among the three tracts of land on the CDCTA.

Different cover types also may influence invertebrate biomass, which can affect avian nest success and potentially bird abundance (Duguay et al. 2000). Red-eyed Vireos are primarily a woodland species (Elphick et al. 2001) and favor deciduous forest and planted residential areas (Ehrlich et al. 1988). Forested areas on the Pringle Tract have a large quantity of this habitat, while the forested areas on Briery Mountain and the Cantonment area are more heavily fragmented. Eastern Towhees favor forest edge habitat (Bell and Whitmore 1997), which explains their prevalence on Briery Mountain relative to the other two tracts. American Robins and European Starlings prefer open developed areas for foraging and nesting (Cabe 1993, Sallabanks and James 1999), and therefore were more abundant on the Cantonment Area compared to the other tracts. American Crows are largely a habitat generalist (Elphick et al. 2001), although their abundance was not uniform over the three tracts. The high number of American Crows on the Cantonment Area and the Pringle Tract is likely because these areas have a mix of woodland and hedgerows, which the species favors (Brauning 1992). Hooded Warblers favor deciduous forest with undergrowth (Evans Ogden and Stutchbury 1994), which suggests why they were most abundant on Briery Mountain, followed by the Pringle Tract, and the Cantonment Area. Indigo Buntings, Wood Thrushes, and Common Yellowthroats all had similar abundance among the three tracts because these species typically inhabit either early successional (Indigo Bunting and Common Yellowthroat) (Payne 1992, Guzy and Ritchison 1999) or interior and edge deciduous forest (Wood Thrush) (Roth et al. 1996), which is present on all three tracts.

Many bird species recorded on the CDCTA have similar abundances compared to other areas of eastern West Virginia. Red-eyed Vireos were the most abundant species recorded on the CDCTA. Similarly, Weakland (2000) found Red-eyed Vireos to be extremely abundant on the Westvaco Wildlife and Ecosystem Research Forest (WWERF) in Randolph County, West Virginia. It also was found to be numerous on the Monongahela National Forest (MNF) in West Virginia (Duguay 1997). Wood Thrush and Hooded Warbler abundance on the CDCTA was similar to the MNF (Duguay 1997) and was much higher than what was observed on the WWERF (Weakland 2000). This may be attributable to the undergrowth present in many of the forested areas on the CDCTA and the MNF, which both species prefers (Evans Ogden and Stutchbury 1994, Roth et al. 1996). Species preferring higher elevation mixed coniferous/deciduous forest such as the Black-throated Green Warbler (Morse 1993) were found in greater numbers in the WWERF than on the MNF or the CDCTA as these areas consist primarily of deciduous forest (Duguay 1997, Weakland 2000). Species preferring open areas such as the Brown-headed Cowbird are not highly abundant anywhere in eastern West Virginia; however, abundance data for this species was similar between the MNF and the CDCTA (Duguay 1997). The species was almost nonexistent on the WWERF (Weakland 2000), which is likely due to the high elevation and extensive forest cover (Ehrlich et al. 1988); this type of habitat is absent on the WWERF.

All of the state rare bird species, as well as those of conservation priority on the West Virginia Partners in Flight List, which were discovered on the CDCTA breed in other locations in the state and are not federally endangered or threatened (Buckelew and Hall 1994, West Virginia Division of Natural Resources 2000, West Virginia Partners in Flight 2002). Management recommendations for bird species of conservation priority are to minimize or eliminate anthropogenic disturbance within the established buffer zones on the CDCTA during the bird species' breeding season. Buffer areas for rare bird species only include 5.5% of the total land area on the CDCTA, and therefore limiting human activity should have minimal impact on military training activities (Forcey 2002).

Additional management suggestions are to preserve or increase the amount of suitable breeding habitat for each rare bird species and those of conservation priority. Great Blue Herons and Belted Kingfishers would benefit from preserving existing riparian areas along the Cheat River and by cleaning up sources of acid mine drainage pollution. Sharp-shinned Hawks would profit from preserving the existing pine plantation area on the Pringle Tract, where the species was observed. Existing amounts of edge on the Pringle Tract also may benefit this species by increasing songbird prey abundance (Brauning 1992). Yellow-bellied Sapsucker breeding areas can be managed by maintaining existing areas of forest containing birch (*Betula* spp.), which they commonly use for nesting (Ehrlich et al. 1988). Management suggestions for the Alder Flycatcher, Blue-winged Warbler, and Golden-winged Warbler are to maintain existing areas of early successional shrub thickets occurring on reclaimed mine areas of the Pringle Tract as these locations contain habitat for both species (Ehrlich et al. 1988). Cliff Swallows benefit from human habitation because they often nest on human-built structures and prefer to forage in open areas (McWilliams and Brauning 2000). Active nest sites occurring on the Cantonment area should be monitored to increase the chance the species will nest successfully. Maintaining existing open areas on the Cantonment Area adjacent to the Cheat River also may benefit this species. Both cuckoo species and the Yellow-throated Vireo would benefit from management aimed at maintaining existing areas of open woodland with dense undergrowth (Rodewald and James 1996, Hughes 1999). Effective management for Acadian Flycatcher and Louisiana Waterthrushes would be to limit disturbance within wooded bottomlands adjacent to streams, which both species prefer (Ehrlich et al. 1988). Forested steep hillsides with dense shrub cover should be maintained for Worm-eating Warblers (Hanners and Patton 1998) and areas containing mature deciduous trees should be conserved for Cerulean Warblers (Hamel 2000).

Monitoring long-term bird population trends on the CDCTA also will benefit avian fauna, and identify trends in population growth or declines. A long-term bird monitoring program should include yearly surveys of breeding birds and winter residents across the CDCTA. Observers should be experienced with bird identification and should implement a standardized survey method to monitor bird species composition and abundance. Because point locations have already been established across the CDCTA (Forcey 2002), point counts are probably the most feasible technique investigators could use to achieve this objective.

A long-term bird monitoring program along with increasing the amount of existing habitat for rare bird species, and protecting established buffer zones are realistic and feasible goals that will benefit avian populations on the CDCTA. These management strategies are cost-effective and should have minimal impact on army training activities (Anderson et al. 2002). Thus natural resource managers will be able to implement beneficial management strategies for birds while not inhibiting army training activities on the CDCTA.

ACKNOWLEDGEMENTS

We thank F. K. Ammer and L. E. Reber for serving as field assistants during this study. We are grateful for assistance, advice, and suggestions on this research from P. Bohall Wood, L. B. Williams, G. E. Seidel, R.C. Whitmore, and D. Mitchell. We also thank the following organizations for providing funding toward this study: West Virginia Army National Guard, the West Virginia University Research Corporation, and the West Virginia University Davis College of Agriculture, Forestry, and Consumer Sciences (McIntire-Stennis). This is manuscript number 2911 of the West Virginia University Agricultural and Forestry Experiment Station.

LITERATURE CITED

American Ornithologists' Union. 1998. Check-list of North American Birds. Seventh edition. Allen Press, Lawrence, Kansas, USA.

Anderson, J. T., G. M. Forcey, J. D. Osbourne, and A. B. Spurgeon. 2002. Wildlife management plans for the Camp Dawson Collective Training Area, Kingwood, West Virginia. West Virginia University, Morgantown, West Virginia, USA.

Bell, J. L., and R. C. Whitmore. 1997. Eastern towhee numbers increase following defoliation by gypsy moths. Auk 114:708-716.

Bell, J. W. 2001. Soil survey of Camp Dawson, Preston County, West Virginia. United States Department of Agriculture, Natural Resources Conservation Service, Moorefield, West Virginia, USA.

Brauning, D. W., editor. 1992. Atlas of breeding birds in Pennsylvania. University of Pittsburgh Press, Pittsburgh, Pennsylvania, USA.

Buckelew, A. R. Jr., and G. A. Hall. 1994. The West Virginia breeding bird atlas. University of Pittsburgh Press, Pittsburgh, Pennsylvania, USA.

Cabe, P. R. 1993. European Starling (*Sturnus vulgaris*). Number 48 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Cody, R. P., and J. K. Smith. 1997. Applied statistics and the SAS programming language. Fourth edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Derrickson, K. C., and R. Breitwisch. 1992. Northern Mockingbird (*Mimus polyglottos*). No. 7 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Duguay, J. P. 1997. Influence of two-age clearcut timber management practices on songbird abundance, nest success, and invertebrate biomass in West Virginia. Dissertation, West Virginia University, Morgantown, West Virginia, USA.

———, P. B. Wood, and G. W. Miller. 2000. Effects of timber harvests on invertebrate biomass and avian nest success. Wildlife Society Bulletin 28:1123-1131.

———, ———, and J. V. Nichols. 2001. Songbird abundance and avian nest survival rates in forest fragmented by different silvicultural treatments. Conservation Biology 15:1405-1415.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The birder's handbook: a field guide to the natural history of North American birds . Simon and Schuster, New York, New York, USA.

Elphick, C., J. B. Dunning, Jr, and D. A. Sibley. 2001. The Sibley guide to bird life and behavior. Chanticleer Press, New York, New York, USA.

Evans Ogden, L. J., and B. J. Stutchbury. 1994. Hooded Warbler (*Wilsonia citrina*). No. 110 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Eyre, F.H. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington D.C., USA.

Forcey, G. M. 2002. An evaluation of double-observer point count techniques and avian habitat use on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Garwood, A. N. 1996. Weather America. Toucan Valley Publications, Milpitas, California, USA.

Gill, F. B. 1995. Ornithology. Second edition. W. H. Freeman and Company. New York, New York, USA.

Guzy, M. J., and G. Ritchison. 1999. Common Yellowthroat (*Geothlypis trichas*). No. 448 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Hall, G. A. 1983. West Virginia bird distribution and ecology. Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA.

Hamel, P. B. 2000. Cerulean Warbler (*Dendroica cerulea*). No. 511 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

———, W. P. Smith, D. J. Twedt, J. R. Woehr, E. Morris, R. B. Hamilton, and R. J. Cooper. 1996. A land manager's guide to point counts of birds in the southeast. USDA Forest Service General Technical Report SO-120.

Hanners, L. A., and S. R. Patton. 1998. Worm-eating Warbler (*Helmitheros vermivorus*). No. 367 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Hughes, J. M. 1999. Yellow-billed Cuckoo (*Coccyzus americanus*). No. 418 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Jackson, B. J. S, and J. A. Jackson. 2000. Killdeer (*Charadrius vociferus*). No. 517 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Johnston, R. F. 1992. Rock Dove (*Columba livia*). No. 13 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Kerlinger, P., and D. Wiedner. 1990 . Economics of birding: A national survey of active birders. American Birds 44:209-213.

Krebs, C. J. 1999. Ecological methodology. Second edition. Addison Wesley Longman, Menlo Park, California, USA.

Lanyon, W. E. 1995. Eastern Meadowlark (*Sturnella magna*). No. 160 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Lowther, P. E., and C. L. Cink. 1992. House Sparrow (*Passer domesticus*). No. 12 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

McLaren, M. A, and M. D. Cadman. 1999. Can novice volunteers provide credible data for bird surveys requiring song identification? Journal of Field Ornithology 70:481-490.

McWilliams, G. M., and D. W. Brauning. 2000. The birds of Pennsylvania. Cornell University Press, Ithaca, New York, USA.

Meffe, G. K., and C. R. Carroll. 1997. Principles of conservation biology. Sinauer Associates, Sunderland, Massachusetts, USA.

Morrison, M. L., B. G. Marcot, and R. W. Mannan. 1998. Wildlife-habitat relationships: concepts and applications. University of Wisconsin Press, Madison, Wisconsin, USA.

Morse, D. H. 1993. Black-throated Green Warbler (*Dendroica virens*). No. 55 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

Moskoff, W. 1995. Veery (*Catharus fuscescens*). No. 142 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.

National Oceanic and Atmospheric Administration. 1985. Climates of the states. Third edition. Gale Resources, Detroit, Michigan, USA.

Nichols, J. D., J. E. Hines, J. R. Sauer, F. W. Fallon, F. E. Fallon, and P. J. Heglund. 2000. A double-observer approach for estimating detection probability and

abundance from point counts. Auk 117:393-408.
Payne, R. B. 1992. Indigo Bunting (*Passerina cyanea*). No. 4 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
Poulin, R. G., S. D. Grindal, and R. M. Brigham. 1996. Common Nighthawk (*Chordeiles minor*). No. 213 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
Ralph, C. J.—, and J. M. Scott, editors. 1981. Estimating numbers of terrestrial birds. Studies in Avian Biology 6.
———, J. R. Sauer, and S. Droege, editors. 1995. Monitoring bird populations by point counts. USDA Forest Service General Technical Report PSW-GTR-149.
Richardson, M., and D. W. Brauning. 1995. Chestnut-sided Warbler (*Dendroica pensylvanica*). No. 190 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
Rodewald, P. G., and R. D. James. 1996. Yellow-throated Vireo (*Vireo flavifrons*). No. 247 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
Roth, R. R., M. S. Johnson, and T. J. Underwood. 1996. Wood Thrush (*Hylocichla mustelina*). No. 246 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
Sallabanks, R., and F. C. James. 1999. American Robin (*Turdus migratorius*). No. 462 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
SAS Institute. 1999. SAS Online Doc, version 8. SAS Institute, Cary, North Carolina, USA.
Sherry, T. W., and R. T. Holmes. 1997. American Redstart (*Setophaga ruticilla*). No. 277 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
Strasbaugh, P. D. and E. L. Core. 1978. Flora of West Virginia. Second edition. Seneca books, Morgantown, West Virginia, USA.
Vanderhorst, J. 2001. Plant community classification and mapping of the Camp Dawson Collective Training Area, Preston County, West Virginia. West Virginia Division of Natural Resources, Elkins, West Virginia, USA.
Vickery, P. D. 1996. Grasshopper Sparrow (*Ammodramus savannarum*). No. 239 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C., USA.
Weakland, C. A. 2000. Effects of diameter-limit and two-age timber harvesting on songbird populations on an industrial forest in central West Virginia. Dissertation, West Virginia University, Morgantown, West Virginia, USA.
———, P. B. Wood, and W. M. Ford. 2002. Responses of songbirds to diameter-limit cutting in the central Appalachians of

West Virginia, USA. Forest Ecology and Management 155:115-129.

West Virginia Army National Guard. 2001. Final integrated natural resources management plan and environmental assessment. West Virginia Army National Guard, West Virginia, USA.

West Virginia Division of Natural Resources. 2000. Rare Species List: Vertebrates. http://www.state.wv.us/dnr/wvwildlife/vertebrates.pdf

West Virginia Partners in Flight. 2002. Top 20 bird species for conservation priority. Elkins, West Virginia, 26241. http://www.tracwv.org/wvneo.htm

White, G. C. 1983. Numerical estimation of survival rates from band-recovery and biotelemetry data. Journal of Wildlife Management 47:716-728.

Yahner, R. H. 1995. Eastern deciduous forest: ecology and wildlife conservation. University of Minnesota Press, Minneapolis, Minnesota, USA.

Zar, J. H. 1999. Biostatistical Analysis. Fourth edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Table 1. Mean abundance per point (±SE) of bird species with more than 150 observations across all tracts of land in 2000-2001 at the Camp Dawson Collective Training Area, Kingwood, West Virginia[a].

	Briery Mountain		Cantonment Area		Pringle Tract			
Species	Mean	SE	Mean	SE	Mean	SE	$F_{2,231}$	*P*-value
Red-eyed Vireo[b]	1.33A	0.115	1.11A	0.122	1.88B	0.101	15.53	0.0001
Eastern Towhee	1.85A	0.147	0.80B	0.140	1.18B	0.123	13.76	0.0001
Indigo Bunting	1.24A	0.163	1.08A	0.124	0.97A	0.091	1.19	0.3062
Wood Thrush	0.91A	0.098	0.72A	0.110	0.73A	0.075	1.45	0.2356
American Robin	0.43A	0.092	2.23B	0.450	0.06A	0.027	29.40	0.0001
American Crow	0.35A	0.076	0.84B	0.157	0.82B	0.088	5.72	0.0038
Hooded Warbler	1.05A	0.117	0.05B	0.036	0.78C	0.085	26.18	0.0001
European Starling	0.00A	0.000	2.55B	0.657	0.00A	0.000	21.26	0.0001
Common Yellowthroat	0.52A	0.097	0.75A	0.106	0.65A	0.086	0.78	0.4590

[a]— Means with the same letter were not significantly different ($P > 0.05$) among tracts using Duncan's multiple range test.

[b]— Scientific names are found in Appendix I.

Appendix 1. Mean abundance per point for bird species recorded on each tract of land on the Camp Dawson Collective Training Area, Kingwood , West Virginia during 2000-2001. Abundances were calculated from double-observer point count data (Forcey 2002). Species that were only observed incidentally outside of point counts have a dash (—) in place of the abundance.

		Briery		Cantonment		Pringle		Overall	
Common Name	Scientific Name[a]	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Great Blue Heron	*Ardea herodias*	0.000	0.000	0.160	0.160	0.000	0.000	0.004	0.004
Green Heron	*Butorides virescens*	0.000	0.000	0.160	0.160	0.000	0.000	0.004	0.004
Turkey Vulture	*Cathartes aura*	0.000	0.000	0.033	0.033	0.033	0.033	0.025	0.013
Canada Goose	*Branta canadensis*	0.000	0.000	0.197	0.181	0.009	0.009	0.055	0.047
Wood Duck	*Aix sponsa*	—	—	—	—	—	—	—	—
Mallard	*Anas platyrhynchos*	0.000	0.000	0.016	0.016	0.000	0.000	0.004	0.004
Common Merganser	*Mergus merganser*	—	—	—	—	—	—	—	—
Sharp-shinned Hawk	*Accipiter striatus*	—	—	—	—	—	—	—	—
Broad-winged Hawk	*Buteo platypterus*	0.015	0.015	0.000	0.000	0.000	0.000	0.004	0.004
Red-tailed Hawk	*Buteo jamaicensis*	0.000	0.000	0.033	0.023	0.000	0.000	0.008	0.006
American Kestrel	*Falco sparverius*	0.000	0.000	0.033	0.023	0.000	0.000	0.008	0.006
Ruffed Grouse	*Bonasa umbellus*	0.015	0.015	0.000	0.000	0.009	0.009	0.008	0.006
Wild Turkey	*Meleagris gallopavo*	0.030	0.021	0.000	0.000	0.009	0.009	0.013	0.007
Killdeer	*Charadrius vociferus*	0.000	0.000	0.590	0.210	0.000	0.000	0.152	0.056
Spotted Sandpiper	*Actitis macularia*	—	—	—	—	—	—	—	—
American Woodcock	*Scolopax minor*	—	—	—	—	—	—	—	—
Mourning Dove	*Zenaida macroura*	0.000	0.000	0.656	0.155	0.064	0.027	0.198	0.045
Black-billed Cuckoo	*Coccyzus erythropthalmus*	0.000	0.000	0.016	0.016	0.018	0.018	0.013	0.009
Yellow-billed Cuckoo	*Coccyzus americanus*	0.121	0.040	0.000	0.000	0.027	0.016	0.046	0.014
Eastern Screech Owl	*Otus asio*	—	—	—	—	—	—	—	—
Barred Owl	*Strix varia*	—	—	—	—	—	—	—	—
Chimney Swift	*Chaetura pelagica*	0.000	0.000	0.344	0.181	0.000	0.000	0.089	0.047
Ruby-throated Hummingbird	*Archilochus colubris*	0.076	0.033	0.016	0.016	0.027	0.020	0.038	0.014
Belted Kingfisher	*Ceryle alcyon*	—	—	—	—	—	—	—	—
Red-bellied Woodpecker	*Melanerpes carolinus*	0.015	0.015	0.016	0.016	0.000	0.000	0.008	0.006
Yellow-bellied Sapsucker	*Sphyrapicus varius*	—	—	—	—	—	—	—	—
Downy Woodpecker	*Picoides pubescens*	0.106	0.038	0.262	0.074	0.164	0.035	0.173	0.027

Appendix I. Continued.

Common Name	Scientific Name	Briery		Cantonment		Pringl		Overall	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Hairy Woodpecker	*Picoides villosus*	0.182	0.057	0.131	0.064	0.109	0.037	0.135	0.029
Northern Flicker	*Colaptes auratus*	0.136	0.043	0.295	0.059	0.127	0.032	0.173	0.025
Pileated Woodpecker	*Dryocopus pileatus*	0.091	0.036	0.115	0.041	0.109	0.035	0.105	0.022
Eastern Wood-Pewee	*Contopus virens*	0.712	0.101	0.246	0.065	0.009	0.009	0.266	0.038
Acadian Flycatcher	*Empidonax virescens*	0.136	0.048	0.295	0.092	0.236	0.053	0.224	0.037
Alder Flycatcher	*Empidonax alnorum*	0.000	0.000	0.000	0.000	0.009	0.009	0.004	0.004
Willow Flycatcher	*Empidonax traillii*	0.000	0.000	0.082	0.042	0.000	0.000	0.021	0.011
Least Flycatcher	*Empidonax minimus*	0.045	0.026	0.000	0.000	0.000	0.000	0.013	0.007
Eastern Phoebe	*Sayornis phoebe*	0.045	0.026	0.164	0.058	0.045	0.024	0.076	0.020
Great Crested Flycatcher	*Myiarchus crinitus*	0.106	0.038	0.000	0.000	0.000	0.000	0.030	0.011
Eastern Kingbird	*Tyrannus tyrannus*	0.000	0.000	0.016	0.016	0.000	0.000	0.004	0.004
White-eyed Vireo	*Vireo griseus*	0.000	0.000	0.033	0.023	0.164	0.044	0.084	0.022
Yellow-throated Vireo	*Vireo flavifrons*	0.015	0.015	0.197	0.056	0.000	0.000	0.055	0.16
Blue-headed Vireo	*Vireo solitarius*	0.061	0.030	0.000	0.000	0.000	0.000	0.017	0.008
Red-eyed Vireo	*Vireo olivaceus*	1.333	0.115	1.115	0.122	1.882	0.101	1.532	0.068
Blue Jay	*Cyanocitta cristata*	0.167	0.055	0.295	0.082	0.245	0.047	0.236	0.034
American Crow	*Corvus brachyrhynchos*	0.348	0.076	0.836	0.157	0.818	0.088	0.692	0.063
Common Raven	*Corvus corax*	0.091	0.042	0.033	0.023	0.009	0.009	0.038	0.014
Purple Martin	*Progne subis*	0.000	0.000	0.000	0.000	0.009	0.009	0.004	0.004
Tree Swallow	*Tachycineta bicolor*	0.000	0.000	0.164	0.117	0.000	0.000	0.042	0.030
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	0.000	0.000	0.000	0.000	0.018	0.013	0.008	0.006
Cliff Swallow	*Petrochelidon pyrrhonota*	0.000	0.000	0.049	0.028	0.000	0.000	0.013	0.007
Barn Swallow	*Hirundo rustica*	0.015	0.015	0.344	0.227	0.009	0.009	0.097	0.059
Black-capped Chickadee	*Poecile atricapilla*	0.258	0.058	0.197	0.061	0.382	0.059	0.300	0.036
Tufted Titmouse	*Baeolophus bicolor*	0.152	0.044	0.295	0.095	0.309	0.051	0.262	0.036
White-breasted Nuthatch	*Sitta carolinensis*	0.106	0.038	0.049	0.028	0.027	0.016	0.055	0.015
Carolina Wren	*Thryothorus ludovicianus*	0.000	0.000	0.148	0.051	0.018	0.013	0.046	0.015
House Wren	*Troglodytes aedon*	0.000	0.000	0.066	0.032	0.009	0.009	0.021	0.009

Appendix 1. Continued.

Common Name	Scientific Name	Briery		Cantonment		Pringle		Overall	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Winter Wren	*Troglodytes troglodytes*	0.045	0.026	0.000	0.000	0.000	0.000	0.013	0.007
Blue-gray Gnatcatcher	*Polioptila caerulea*	0.091	0.036	0.098	0.038	0.018	0.013	0.059	0.015
Eastern Bluebird	*Sialia sialis*	0.000	0.000	0.033	0.023	0.000	0.000	0.008	0.006
Veery	*Catharus fuscescens*	0.152	0.066	0.000	0.000	0.000	0.000	0.042	0.019
Wood Thrush	*Hylocichla mustelina*	0.909	0.098	0.721	0.110	0.727	0.075	0.776	0.053
American Robin	*Turdus migratorius*	0.439	0.092	2.230	0.450	0.064	0.027	0.726	0.132
Gray Catbird	*Dumetella carolinensis*	0.242	0.061	0.344	0.084	0.055	0.022	0.181	0.030
Brown Thrasher	*Toxostoma rufum*	0.000	0.000	0.000	0.000	0.091	0.030	0.042	0.014
European Starling	*Sturnus vulgaris*	0.000	0.000	2.557	0.657	0.000	0.000	0.658	0.183
Cedar Waxwing	*Bombycilla cedrorum*	0.348	0.137	0.410	0.133	0.364	0.069	0.371	0.060
Blue-winged Warbler	*Vermivora pinus*	0.000	0.000	0.049	0.036	0.127	0.034	0.072	0.019
Golden-winged Warbler	*Vermivora chrysoptera*	0.015	0.015	0.016	0.016	0.118	0.038	0.063	0.019
Northern Parula	*Parula americana*	0.000	0.000	0.066	0.032	0.091	0.033	0.059	0.018
Yellow Warbler	*Dendroica petechia*	0.015	0.015	0.475	0.109	0.027	0.016	0.139	0.032
Chestnut-sided Warbler	*Dendroica pensylvanica*	0.485	0.102	0.016	0.016	0.036	0.018	0.156	0.033
Magnolia Warbler	*Dendroica magnolia*	0.000	0.000	0.000	0.000	0.009	0.009	0.004	0.004
Black-throated Blue Warbler	*Dendroica caerulescens*	0.030	0.021	0.000	0.000	0.000	0.000	0.008	0.006
Black-throated Green Warbler	*Dendroica virens*	0.515	0.095	0.016	0.016	0.755	0.087	0.498	0.052
Yellow-throated Warbler	*Dendroica dominica*	0.000	0.000	0.016	0.016	0.000	0.000	0.004	0.004
Prairie Warbler	*Dendroica discolor*	0.045	0.026	0.000	0.000	0.509	0.083	0.249	0.042
Cerulean Warbler	*Dendroica cerulea*	0.106	0.044	0.049	0.028	0.027	0.016	0.055	0.016
Black-and-white Warbler	*Mniotilta varia*	0.379	0.083	0.131	0.049	0.264	0.046	0.262	0.034
American Redstart	*Setophaga ruticilla*	1.061	0.179	0.180	0.072	0.064	0.023	0.371	0.061
Worm-eating Warbler	*Helmitheros vermivorus*	0.015	0.015	0.000	0.000	0.109	0.030	0.055	0.015
Ovenbird	*Seiurus aurocapillus*	0.455	0.095	0.000	0.000	0.645	0.088	0.426	0.051
Louisiana Waterthrush	*Seiurus motacilla*	0.015	0.015	0.000	0.000	0.036	0.018	0.021	0.009
Kentucky Warbler	*Oporornis formosus*	0.167	0.051	0.082	0.042	0.200	0.044	0.160	0.027
Mourning Warbler	*Oporornis philadelphia*	0.000	0.000	0.000	0.000	0.009	0.009	0.004	0.004
Common Yellowthroat	*Geothlypis trichas*	0.515	0.097	0.754	0.106	0.645	0.086	0.637	0.056

Appendix 1. Continued.

Common Name	Scientific Name	Briery		Cantonment		Pringle		Overall	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Hooded Warbler	*Wilsonia citrina*	1.045	0.117	0.049	0.036	0.782	0.085	0.667	0.057
Yellow-breasted Chat	*Icteria virens*	0.000	0.000	0.049	0.036	0.145	0.038	0.080	0.020
Scarlet Tanager	*Piranga olivacea*	0.667	0.092	0.361	0.074	0.627	0.071	0.570	0.046
Eastern Towhee	*Pipilo erythrophthalmus*	1.848	0.147	0.803	0.140	1.182	0.123	1.270	0.083
Chipping Sparrow	*Spizella passerina*	0.227	0.056	0.295	0.100	0.045	0.027	0.160	0.033
Field Sparrow	*Spizella pusilla*	0.273	0.132	0.000	0.000	0.800	0.122	0.447	0.071
Song Sparrow	*Melospiza melodia*	0.167	0.073	1.623	0.181	0.200	0.051	0.557	0.069
Dark-eyed Junco	*Junco hyemalis*	0.030	0.030	0.000	0.000	0.000	0.000	0.008	0.008
Northern Cardinal	*Cardinalis cardinalis*	0.167	0.059	0.738	0.117	0.345	0.058	0.397	0.046
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	0.333	0.076	0.082	0.035	0.082	0.026	0.152	0.027
Indigo Bunting	*Passerina cyanea*	1.242	0.163	1.082	0.124	0.973	0.091	1.076	0.070
Red-winged Blackbird	*Agelaius phoeniceus*	0.015	0.015	1.033	0.230	0.109	0.045	0.321	0.068
Common Grackle	*Quiscalus quiscula*	0.000	0.000	0.918	0.242	0.009	0.009	0.241	0.067
Brown-headed Cowbird	*Molothrus ater*	0.197	0.049	0.164	0.058	0.027	0.016	0.110	0.022
Orchard Oriole	*Icterus spurius*	0.000	0.000	0.049	0.028	0.000	0.000	0.013	0.007
Baltimore Oriole	*Icterus galbula*	0.030	0.021	0.082	0.042	0.000	0.000	0.030	0.013
House Finch	*Carpodacus mexicanus*	0.000	0.000	0.033	0.023	0.000	0.000	0.008	0.006
American Goldfinch	*Carduelis tristis*	0.152	0.049	0.525	0.095	0.373	0.079	0.350	0.047
House Sparrow	*Passer domesticus*	0.000	0.000	0.328	0.163	0.000	0.000	0.084	0.043

a— Scientific names were taken from the AOU Checklist (American Ornithologists' Union 1998).

MAMMALS OF THE CAMP DAWSON COLLECTIVE TRAINING AREA IN PRESTON COUNTY, WEST VIRGINIA

JOSEPH D. OSBOURNE, JAMES T. ANDERSON, DAVID A. HELON, MICHAEL A. MENZEL, JENNIFER M. MENZEL, JOSHUA B. JOHNSON, SHELDON F. OWEN, and JOHN W. EDWARDS, Wildlife and Fisheries Resources, Division of Forestry, West Virginia University, P.O. Box 6125, Morgantown, WV 26506-6125, USA. *Joe.Osbourne@mail.wvu.edu.

ABSTRACT

Mammalian surveys were conducted on the Pringle Training Area (TA), Briery Mountain TA, and Cantonment Area installations of the Camp Dawson Collective Training Area (CDCTA) in Preston County, West Virginia during 2000 and 2001 as part of a faunal survey of the military installation. Small mammals were sampled using Sherman live traps, Tomahawk live traps, Museum Special snap traps, pitfall arrays, and Victor mole traps. Mist nets and call detection were used to sample chiropterans, and carnivores were surveyed with scent stations. A total of 6,696 mammals of 30 different species were collected by trapping. In 2001 the average captures/100 trap nights (CPU) per grid for the Pringle TA ($\bar{x}$ = 34.96, SE = 1.95) was higher than the value for the Cantonment Area ($\bar{x}$= 23.05, SE = 1.83; $P <$ 0.001). Average CPU values for pitfall trapping arrays were similar among tracts of land ($P = 0.177$). Average CPU for *Peromyscus* spp. (white-footed mice [*P. leucopus*] and deer mice [*P. maniculatus*]) was higher on the Pringle TA ($\bar{x}$ = 2.63, SE = 0.33) than the other two tracts of land ($P < 0.004$). Woodland jumping mice (*Napaeozapus insignis*) produced higher CPUs on the Pringle TA ($\bar{x}$ = 1.62, SE = 0.32) and the Cantonment Area ($\bar{x}$= 1.59, SE = 0.63) than on the Briery Mountain TA ($\bar{x}$= 0.13, SE = 0.03; $P <$ 0.001). Shannon diversity was higher on the Pringle TA ($\bar{x}$= 1.78, SE = 0.04) than the Briery Mountain TA ($\bar{x}$= 1.50, SE = 0.07; $P < 0.026$). Six species from the West Virginia Division of Natural Resources Species of Concern List were captured on the CDCTA: pygmy shrew (*Sorex hoyi*), long-tailed shrew (*S. dispar*), Allegheny woodrat (*Neotoma magister*), rock vole (*Microtus chrotorrhinus*), southern bog lemming (*Synaptomys cooperi*), and meadow jumping mouse (*Zapus hudsonius*). Variation in community composition and species distribution among tracts likely was due to differences in habitat type, habitat quality, and human disturbance.

INTRODUCTION

Mammals are vital components of eastern deciduous forest environments. These vertebrates contribute to the overall diversity of life forms and provide valuable functional diversity (Carey and Johnson 1995, Loeb 1999). Small mammals of the orders Insectivora and Rodentia are prey for many avian, mammalian, and reptilian predators (Fedriani et al. 2000, Lekunze et al. 2001). Additionally, many shrews and mice feed on insects, plants, seeds, fruits, and fungi that can potentially alter and dominate forest ecosystems (Carey and Johnson 1995, Liebhold et al. 2000). Small mammals provide many benefits to ecosystem function, and enumeration of these species is important for monitoring the existence of a diverse small mammal community.

Information on mammal distribution in Preston County, West Virginia is scarce, and no previous faunal surveys have been conducted on the Camp Dawson Collective Training Area (CDCTA) properties. Range maps of mammals were analyzed to comprise a list of species with range maps overlapping the study site (Merritt 1987, Wilson and Reeder 1993, Whitaker and Hamilton 1998). There are 58 species of mammals that could occur on the CDCTA. They represent 7 orders: 1 Didelphimorphia, 10 Insectivora, 9 Chiroptera, 3 Lagamorpha, 21 Rodentia, 13 Carnivora and 1 Artiodactyla (Osbourne 2002). The West Virginia Division of Natural Resources (WVDNR) lists 11 of the aforementioned species as rare, but only the Indiana bat (*Myotis sodalis*) is federally endangered (scientific names follow Wilson and Reeder 1993; WVDNR 2000, Osbourne 2002). The other rare species and subspecies listed are all common globally, but rare in certain parts of their range. Several of the species are not likely to occur on the study site, but could possibly be in the area if habitat is suitable.

The primary objectives of this study were to inventory wild mammal species that occur on the CDCTA and compare relative abundance and diversity of small mammals among areas and habitats on the site. To accomplish these goals, various methods of mammal monitoring and management were combined into a collaborative project. One way of increasing efficiency of scientific study in a field with limited funding and resources is by incorporating several different studies into one collection event (Carey and Johnson 1995, Menzel et al. 1999).

STUDY AREA

The study was conducted on the 1,655 ha Camp Dawson Collective Training Area (CDCTA) in Preston County, West Virginia, which is composed of three tracts of land: the Camp Dawson Cantonment Area (378 ha), the Briery Mountain (423 ha), and the Pringle TA (854 ha). The CDCTA is centered on 39° 26' north latitude and 79° 40' west longitude in the Cheat River watershed and is primarily used for military activity, logging, and public recreation (WVARNG 2001). Elevations on the Cantonment Area range from 366 to 853 m above sea level. The primary soils on the property are silt loams, sandy loams, and rubbly complexes (Bell 2001).

The Cantonment Area is the main operating area for the West Virginia Army National Guard (WVARNG), and the property is primarily composed of well maintained lawn, office buildings, an armory, vehicle maintenance buildings, a firing range, and a paved airstrip (WVARNG 2001). Heavily logged, forested mountain slopes and bottomland forest comprise the majority of the non-urbanized portion of the Cantonment Area. The primary cover types on the Cantonment Area are mixed mesophytic forest and successional floodplain forest (Vanderhorst 2001, WVARNG 2001). The predominant cover type on the Briery Mountain TA is mixed montane hardwood forest and sub-xeric oak (*Quercus spp.*) forest (Vanderhorst 2001). The Pringle TA is predominately covered by oak-hickory (*Carya spp.*) forest, with the exception of several open, grassy reclaimed mine areas on top of the mountain and some areas of eastern hemlock (*Tsuga canadensis*) and eastern white pine (*Pinus strobus*) mixed with hardwoods (Vanderhorst 2001).

The climate of Preston County is temperate with moderate winters, relatively warm summers, and equal distribution of precipitation across seasons (Ruffner 1985, Garwood 1996). The mean temperature for Preston County is 8.8 °C, and the total annual precipitation is 137.01 cm (Garwood 1996).

MATERIALS AND METHODS

Sherman Live Trapping

Small mammal live trapping grids were established on 25 forested plots on the Cantonment, Pringle, and Briery Mountain properties from 26 June 2000 to 1 September 2000. Of these, 12 grids were each sampled twice more during the 2000 field season from 8 September 2000 to 14 November 2000 (Osbourne 2002). Six new grids were established in 2001 from 10 May 2001 to 24 May 2001. These 18 grids were each trapped during 5 sampling periods in the 2001 field season from 10 May 2001 to 4 December 2001 (Osbourne 2002).

Each site was a 60 × 60 m grid with 49 trapping stations equally spaced 10 m apart (Jorgensen et al. 1998, Loeb 1999). At each station, 1 collapsible 7.7 × 7.7 × 23 cm Sherman aluminum box trap was set within 1 m of the station center and 1 0.946 L pitfall cup was installed (Jorgensen et al. 1998, Menzel et al. 1999). Grids were trapped for two consecutive nights.

Each Sherman trap was baited with about 10 g of rolled peanut butter and oats (Carey and Johnson 1995). Live rodents were ear-tagged, and live shrews were toe-clipped for related mark-recapture studies (Jorgensen et al. 1998, Menzel et al. 1999). Species, mass, sex, reproductive condition, and trap type were recorded for each animal caught (Jorgensen et al. 1998, Menzel et al. 1999). All dead specimens were collected for preservation in the West Virginia University Vertebrate Collection.

Tomahawk Live Trapping

On 17 of the original 25 grids, 10 23 23 48 cm collapsible Tomahawk cage traps were placed around the exterior of the grid to prevent disturbance of Sherman traps by carnivores. These traps also were set on 28 of the grids during various sessions of trapping in 2001. Tomahawk traps were placed at den and latrine sites of Allegheny woodrats (*Neotoma magister*) from 22 September 2000 to 26 September 2000 on the Pringle Tract.

A Tomahawk live trapping grid was established on the Pringle TA in 2000. During the 2001 field season, one Tomahawk grid was sampled on Briery Mountain TA and two grids were set on the Cantonment Area. Each Tomahawk grid consisted of 49 cage traps evenly spaced on a 180 180 m grid. Tomahawk traps were baited with about 20 g of the rolled oat bait (Carey and Johnson 1995).

Snap Trapping

Museum Special snap traps were used on 5 sites on the Pringle TA, 3 sites on the Briery Mountain TA, and 3 sites on the Cantonment Area in habitat not covered by the live trapping grids. Each snap trap grid was 2 x 20 with 15 m spacing (Carey and Johnson 1995). This strip-grid design allowed for the sampling of forest gradients from openings to interior, stream reaches, and open fields. Two traps were placed at each site within 1 m of the marking flag. At each site, one randomly chosen trap was baited with rolled peanut butter and oats, and the other trap was baited with rolled peanut butter and cracked corn. Each grid was set for three consecutive nights.

Pitfall Trapping

Small mammals were collected from pitfall traps used to survey herpetofauna (Spurgeon 2002). Pitfall array design was modeled after structures used by Bury and Corn (1987), Mengak and Guynn (1987), and Greenberg et al. (1994). Two different types of pitfall arrays were used in this study. The first was a 5-bucket cross-shaped design with a 19 L bucket in the center and at each end point of 4 lengths of 7.5 m silt fencing. The second design was a straight 7.5 m silt fence with one bucket on each side of the ends for a total of four buckets per array. Silt fence is a geotextile commonly used in roadside erosion control (FNWGD 2000). A small amount of water was placed in the bottom of each bucket to prevent desiccation of amphibians (Spurgeon 2002).

Chiropteran Surveys

Chiropteran surveys were performed from 1-2 September 2000, 7-9 May 2001, and 12 June 2001. Survey methods included mist netting, harp trapping, and acoustical monitoring. The Pringle TA and the Cantonment Area were surveyed using mist nets placed over streams, ponds, and road ruts. All three tracts of the CDCTA were surveyed using acoustical monitoring equipment. One harp trap was set at the entrance to a mine portal on the top of Pringle Mountain.

In addition to mist nets, acoustical surveys of bat communities were conducted on all three tracts of the CDCTA. Acoustical monitoring allows distinction among bat species or species groups using search-phase call characteristics as recorded by the Anabat system

(Titley Electronics, Ballina, Australia). Calls of hand-released bats were recorded to establish a call library for each bat species in the study area. Calls were recorded using an Anabat bat II detector linked directly to a laptop computer via a Zero Crossing Analysis Interface Module (ZCAIM, Titley Electronics, Ballina, Australia).

Predator Surveys

Scent stations baited with fatty-acid tablets were used to assess large carnivore populations during the 2000 and 2001 field seasons. Stations were set 480 m apart to avoid predator overlap, and specific sites were randomly selected as roadside (< 5 m from road) or interior (≥ 100 m from road; Traviani et al. 1996, Warrick and Harris 2001). Scent stations consisted of a 1 m diameter area cleared, leveled off, and covered with 3-5 cm of sifted sand (Traviani et al. 1996). Stations were examined for tracks the day after they were set (Warrick and Harris 2001). Tracks were identified and recorded along with number and direction. A total of 52 scent stations, 26 roadsides and 26 interiors, were set on the CDCTA (Cantonment Area [13], Briery Mountain TA [18], Pringle TA [21]). Scent stations were operated in August, September, and October 2000 and in June and July 2001 (Helon et al. 2003).

Mole Trapping

Victor Out-of-Sight® (Model 0631) and plunger (Model 0645; Woodstream Corporation, Lititz, Pennsylvania) traps were used to target mole species on the CDCTA. All traps were checked every other day for captures and sprung traps. Dates and locations of mole trapping can be found in Osbourne (2002).

DATA ANALYSES

Sherman live trap, snap trap, and pitfall data were analyzed as catch per unit effort (CPU) with numbers reported as captures per 100 trap nights. Corrections were made for sprung and damaged traps in the Sherman live trap and snap trap calculations (Nelson and Clarke 1973). Average CPU values for species representing 10% of all captures in pitfall traps were compared among tracts and between years. Shannon diversity, Pielou's evenness, and species richness were calculated for pitfall data because pitfalls were spread across all three tracts and produced the largest sample sizes for comparison among tracts and between years (Magurran 1988, Krohne 1998). In addition to tract and year, diversity indices were calculated by vegetative community type to describe diversity of small mammals based on vegetative type (Vanderhorst 2001). A Sorenson coefficient of community similarity also was calculated among tracts for pitfall arrays. This coefficient model incorporates the number of species that two tracts have in common to produce a percentage of community similarity (Krebs 1999). Sorenson similarity values also were calculated for vegetative communities by incorporating the number of species in a specific community with the total number of species in all other communities combined. Only number of captures and species captured were reported for chiropteran mist-netting, tomahawk trapping, and 0.946 L pitfalls because of low capture success.

Statistical Application Software (SAS Institute, Cary, North Carolina, USA) was used for all statistical analyses. Analysis of Variance (ANOVA) was used to compare CPU and diversity indices for pitfall data. The independent variables tested in these ANOVA models were year, tract, and year by tract with dependent variables being CPU values and Shannon diversity. Assumptions of normality were tested with the univariate procedure in SAS. Bartlett's Test was used for homogeneity of variances. Tukey's Studentized Range Test was used to identify differences among tracts when significant F values ($\alpha = 0.05$) were obtained. The same ANOVA model was used to compare CPU data for Sherman live trap grids and chiropteran call surveys. Because each tract was not represented in each year of snap trapping, ANOVA models were used to detect differences in year and tract separately.

RESULTS

A total of 40 mammalian species was observed on the CDCTA during the study (Appendix 1): Briery Mountain TA (24 species), Cantonment Area (30), and Pringle TA (40). Six of these species are currently listed as rare or threatened by the WVDNR (WVDNR 2000): pygmy shrew, long-tailed shrew, Allegheny woodrat, rock vole, southern bog lemming, and meadow jumping mouse. No federally threatened or endangered mammalian species were documented on the CDCTA during our surveys.

Trapping and active sampling effort produced 6,696 individuals of 30 species on the CDCTA during the 2000 and 2001 field seasons. The Briery Mountain TA trapping effort produced 945 individuals of 19 species, Cantonment Area trapping produced 1,905 individuals of 26 species, and trapping on the Pringle TA produced 3,846 individuals of 30 species. Scent station surveys added six species to the total number observed, and the other three species were observed but not documented in sampling effort.

Sherman Live Trapping

Overall, 1,564 individuals were captured in 13,009 trap nights on the CDCTA using Sherman live traps. A year-tract interaction occurred in the ANOVA model of CPU data for Sherman live trapping grids ($F_{1, 110} = 9.83$, $P = 0.002$). Therefore, a separate ANOVA was run for each year. During the 2000 field season there was no difference between the CPU values for the Pringle TA ($\bar{x} = 14.93$, SE = 1.13) and the Cantonment Area ($\bar{x} = 13.04$, SE = 1.13; $F_{1, 34} = 1.06$, $P = 0.310$). However, the mean CPU for Sherman grids on the Pringle TA during 2001 ($\bar{x} = 34.96$, SE = 1.95) was greater than the value for the Cantonment Area ($\bar{x} = 23.05$, SE = 1.83; $F_{1, 91} = 16.16$, $P < 0.001$).

The most common species captured were the white-footed mouse and deer mouse, which were analyzed together as the genus *Peromyscus* spp. and represented 74% of all captures. Other common species were northern short-tailed shrew (*Blarina brevicauda*; 9%), southern red-backed vole (*Clethrionomys gapperi*; 4%), eastern chipmunk (*Tamias striatus*; 3%), and southern flying squirrel (*Glaucomys volans*; 1%). An interaction between year and tract was observed during analysis of CPU values for *Peromyscus* spp. ($F_{1, 110} = 7.75$, $P = 0.006$). Average CPU values for *Peromyscus* spp. were similar between the Cantonment Area ($\bar{x} = 7.68$, SE = 0.93) and Pringle TA ($\bar{x} = 9.86$, SE = 1.38) during 2000 ($F_{1, 34} = 1.86$, $P = 0.182$), but the Pringle TA ($\bar{x} = 31.34$, SE = 2.07) showed a higher CPU than the Cantonment Area ($\bar{x} = 16.67$, SE = 1.51) in 2001 ($F_{1, 76} = 23.94$, $P < 0.001$). Abundance of northern short-tailed shrews was similar between the Pringle TA ($\bar{x} = 2.33$, SE = 0.29) and the Cantonment Area ($\bar{x} = 1.93$, SE = 0.21; $F_{1, 110} = 0.08$, $P = 0.785$). Southern red-backed voles were more abundant on the Pringle TA ($\bar{x} = 1.67$, SE = 0.32) than the Cantonment Area ($\bar{x} = 0.13$, SE = 0.07; $F_{1, 110} = 8.87$, $P = 0.004$). There were similar CPU values for eastern chipmunks on the Pringle TA ($\bar{x} = 0.64$, SE = 0.14) and Cantonment Area ($\bar{x} = 0.69$, SE = 0.13; $F_{1, 110} = 0.96$, $P = 0.329$). Relative abundance of southern flying squirrels was similar between the Pringle TA ($\bar{x} = 0.40$, SE = 0.10) and the Cantonment Area ($\bar{x} = 0.19$, SE = 0.07; $F_{1, 110} = 1.18$, $P = 0.279$). Interactions of tract and year were not significant for northern short-tailed shrews, southern red-backed voles, eastern chipmunks, or southern flying squirrels ($F_{1, 110} \leq 2.57$, $P \geq 0.112$).

Rare species captured in Sherman live traps included Allegheny woodrat and meadow jumping mouse, both of which are listed as species of concern by the WVDNR (WVDNR 2000, Osbourne 2002). Long-tailed weasels (*Mustela frenata*) also were infrequent visitors of Sherman traps. The smaller shrew species such as masked shrew and smoky shrew (*Sorex fumeus*) were rare in Sherman traps but much more common in pitfall traps.

The small 0.934 L pitfall cups provided 7,634 trap nights and 159 captures over two years. Species captured in these pitfalls were the masked shrew, smoky shrew, northern short-tailed shrew, woodland jumping mouse, *Peromyscus* spp., and southern red-backed vole.

Tomahawk Live Trapping

Tomahawk Livetraps on Sherman grids produced 34 individuals of six species in 1,044 potential trap nights during 2000 and 2001: Virginia opossum (*Didelphis virginiana*; n = 22), eastern cottontail (*Sylvilagus floridanus*; n = 4), raccoon (*Procyon lotor*; n = 2), red squirrel (*Tamiasciurus hudsonicus*; n = 2), eastern fox squirrel (*Sciurus niger*; n = 2), and Allegheny woodrat (n = 2). Woodrat trapping yielded 13 individuals in 73 potential trap nights. The squirrel grids on the Pringle TA, Cantonment Area, and Briery Mountain TA provided 618 trap nights and 12 captures of five different species: Virginia opossum (n = 6), red squirrel (n = 2), long-tailed weasel (n = 2), woodchuck (*Marmota monax*; n = 1), and raccoon (n = 1).

Snap Trapping

Overall, snap trapping captured 284 individuals of nine species in 2,144 trap nights. For the grids trapped in 2000, the Briery Mountain TA ($\bar{x}$ = 11.43, SE = 5.12) showed similar results to the Cantonment Area ($\bar{x}$ = 14.99, SE = 6.79; $F_{1,3} = 0.14$, $P = 0.734$). In 2001, there was no difference ($F_{1,4} = 0.63$, P = 0.472) between the CPU values for Briery Mountain TA ($\bar{x}$ = 11.15, SE = 0) and the Pringle TA ($\bar{x}$ = 17.32, SE = 3.17). The most abundant species captured were *Peromyscus* spp. (70%) and southern red-backed voles (8%). Rare species included southern bog lemming and meadow jumping mouse (WVDNR 2000, Osbourne 2002).

Pitfall Trapping

Pitfall trapping captured 4,548 individuals of 21 small mammal species in 53,766 trap nights. All three tracts produced similar CPU values for all species combined ($F_{2,57} = 1.79$, $P = 0.177$; Table 1).

The five most abundant species captured were masked shrew (n = 1,502, 33%), *Peromyscus* spp. (n = 773, 17%), smoky shrew (n = 537, 11%), northern short-tailed shrew (n = 504, 11%), and woodland jumping mouse (n = 473, 10%). *Peromyscus* spp. were captured more frequently on Pringle than Briery Mountain and the Cantonment Area ($F_{2,57}$ = 6.03, $P = 0.004$; Table 1). No difference was observed between the Briery Mountain and Cantonment Area CPU values for *Peromyscus* spp. Woodland jumping mice were more abundant on Pringle and the Cantonment Area than Briery Mountain, but Cantonment and Pringle values were similar ($F_{2,57} = 9.97$, $P <$ 0.001). Relative abundance of masked shrews ($F_{2,57} = 3.00$, $P = 0.058$), smoky shrews ($F_{2,57}$ = 1.14, $P = 0.327$), and northern short-tailed shrews ($F_{2,57} = 2.32$, $P = 0.107$) were similar among tracts. Interactions of tract and year were not significant for masked shrews, *Peromyscus* spp., smoky shrews, woodland jumping mice, or northern short-tailed shrews ($F_{2,57} \leq 1.30$, $P \geq$ 0.279). Other frequently captured species were meadow jumping mouse (n = 413, 9%), meadow vole (*Microtus pennsylvanicus*; n = 210, 5%), and southern red-backed vole (n = 118, 3%).

Species captured infrequently in pitfall traps included pygmy shrew and rock vole, which are state species of concern (WVDNR 2000). Other infrequently captured species were hairy-tailed mole (*Parascalops breweri*), least weasel (*Mustela nivalis*), southern flying squirrel, and eastern cottontail (Table 1). The long-tailed shrew and southern bog lemming are other species from the WVDNR state species of concern list that were captured in pitfall traps on the CDCTA.

Diversity ($F_{2,57} = 3.88$, $P = 0.026$) and evenness ($F_{2,57} = 3.33$, $P = 0.043$) were higher on the Pringle TA than the Briery Mountain TA with no difference in diversity or evenness between the Pringle TA and the Cantonment Area or between the Briery Mountain TA and the Cantonment Area (Table 1). No difference in species richness was observed among tracts ($F_{2,57} = 0.75$, $P = 0.479$). No interaction was observed between tract and year in diversity, evenness, or richness ($F_{2,57} \leq 0.49$, $P \geq 0.618$).

The highest Shannon diversity indices were observed in developed areas and hemlock ravines, while the lowest Shannon indices were observed on former agricultural lands ($F_{11, 50}$ = 4.68, $P < 0.001$; Table 2). Pielou's evenness index also was different between vegetative communities ($F_{11, 50} = 3.99$, $P < 0.001$) with developed area and mixed mesophytic forests of colluvial slopes producing the highest evenness values and sub-xeric oak forests producing the lowest evenness indices. Species richness was similar across vegetative community types ($F_{11, 50} = 1.61$, $P = 0.124$). Community similarity values were highest in mixed mesophytic forests of colluvial slopes (94%), successional forests of low elevation plains (88%), and old fields (88%). The lowest Sorenson values were observed in former agricultural land (54%), disturbed areas (59%), and roads (59%). Sorenson indices were 92% for Pringle and Briery, 90% for Pringle and Cantonment, and 92% for Briery Mountain and the Cantonment Area.

Chiropteran Surveys

Bats were surveyed at 27 mist-net nights at eight survey areas during fall 2000 and summer 2001. Overall, 21 individuals of five species were captured: big brown bat (*Eptesicus fuscus*; $n = 2$), eastern red bat (*Lasiurus borealis*; $n = 1$), little brown bat (*Myotis lucifugus*; $n = 2$), northern myotis (*Myotis septentrionalis*; $n = 8$), and eastern pipistrelle (*Pipistrellus subflavus*; $n = 8$).

A total of 638 call sequences were recorded in 21 detector-nights during fall 2000 and summer 2001 on the CDCTA. Six bat species were recorded: eastern pipistrelle (n = 120 call sequences), big brown bat ($n = 143$), little brown bat ($n = 181$), northern myotis (n = 16), eastern red bat ($n = 27$), and hoary bat (*Lasiurus cinereus*; $n = 39$). All species produced similar numbers of calls among the three tracts of land ($P > 0.05$; Osbourne 2002). An additional 13 sequences were emitted by myotids, but could not be classified to species. A total of 86 call sequences were not identifiable and were placed into the non-identifiable category.

Predator Surveys

A total of 15 identifiable species were recorded at predator scent stations on the CDCTA (Osbourne 2002). Bobcat (*Felis rufus*) and coyote (*Canis latrans*) were rare visitors of scent stations. Raccoons and Virginia opossums were abundant on all tracts of the CDCTA. Black bear (*Ursus americanus*) tracks were found regularly on the Pringle Tract and were recorded on Pringle and Briery Mountain scent stations. Striped skunk (*Mephitis mephitis*) was identified on the Pringle TA during the July 2001 sampling period.

Mole Trapping

No captures were recorded in 869 trap nights with Out-of-Sight® and plunger mole traps on the CDCTA. Though mole trapping did not produce any results, 10 starnose moles (*Condylura cristata*) and 4 hairy-tailed moles were collected from pitfall traps in 2001.

DISCUSSION

Of the 59 species whose range maps overlap the study site, 40 (68%) were observed on the CDCTA during 2000 and 2001 (Merritt 1987, Wilson and Reeder 1993, Whitaker and Hamilton 1998). Trapping and active sampling effort produced 30 (51%) species, and 10 species (17%) were recorded through visual observation or sign. Thus, 19 species with range maps overlapping the study site were not observed in this study (Osbourne 2002).

House mouse (*Mus musculus*) and Norway rat (*Rattus norvegicus*) are common rodents throughout the United States, but neither species was observed on the CDCTA during the course of this study. However, no sampling was conducted in the immediate vicinity of the main office buildings on the Cantonment Area. House mice and Norway rats are typically found in and around dwellings inhabited by humans (Merritt 1987, Whitaker and Hamilton 1998). Red fox (*Vulpes vulpes*) and gray fox (*Urocyon *cinereoargenteus*) are relatively common carnivores that were not detected in scent station surveys on the CDCTA (Merritt 1987, Whitaker and Hamilton 1998). Surprisingly, coyotes were detected, but red and gray foxes did not visit scent stations. Muskrats (*Ondatra zibethicus*), common throughout the United States, also were not observed on the study site. The CDCTA lacks an extensive wetland system, but there are several wetland patches and ponds that would provide adequate habitat for a generalist wetland species like the muskrat (Merritt 1987). Presence of American beaver (*Castor canadensis*) was confirmed through observation of beavers, lodges, gnawed tree trunks, and slides of matted vegetation around wetlands. These are the same general signs used to detect muskrats, so there is the possibility that some sign was mistakenly identified. River otters (*Lontra canadensis*) were not recorded and probably do not exist on the study area due to low water quality from acid mine drainage and the associated lack of fish in the streams on the CDCTA.

Five species from the WVDNR species of concern list that have ranges overlapping the study site were not detected on the CDCTA. The chiropteran surveys conducted in this study were not extensive, and three of these five species are uncommon bats rarely noted in this region of the country. Any future monitoring should include more exhaustive surveys of the chiropteran communities of the CDCTA to determine if any of these uncommon species occurs on the property. The other rare species not captured were the least shrew (*Cryptotis parva*) and the eastern spotted skunk (*Spilogale putorius*). The least shrew is generally an inhabitant of open, early successional habitat types like old fields and abandoned pastures (Whitaker 1974, Merritt 1987, Whitaker and Hamilton 1998). Patches of open grassland and old-field habitat are present on all three tracts of the CDCTA (Vanderhorst 2001). Whitaker (1974) notes the difficulty in trapping this species with conventional methods, and our lack of captures could be due to this difficulty combined with the patchy distribution of the species. The eastern spotted skunk is patchily distributed throughout its range and occurs in brushy or densely wooded habitats and on agricultural lands (Merritt 1987, Kinlaw 1995). The inability to capture this species could be attributed to its localized distribution or the lack of Tomahawk trapping effort in dense, brushy habitat types.

There appears to be a healthy population of Allegheny woodrats along the steep, rocky slope of interior hardwood forest on the south end of the Pringle TA. The mature mast trees in this area provide a valuable food base for the woodrats, and the large rocky outcroppings provide shelter and protection (Wiley 1980). Habitat characteristics that affect woodrat numbers include percent rock cover and aspect (Balcom and Yahner 1996). Human caused disturbance like forest fragmentation do not directly decrease numbers of woodrats (Balcom and Yahner 1996). However, any timbering activities that occur in or near areas where woodrats reside should take into account the need to provide a reasonable amount of forest cover around large, rocky south-facing slopes for the maintenance of woodrat populations on the CDCTA (Wiley 1980). In addition, consistent monitoring of woodrat populations will provide valuable information on local population status and health.

In this region of the country, southern bog lemmings are found in a variety of habitats, but they are most commonly found in wet meadows on reclaimed mines (Linzey 1983, Merritt 1987). The riparian habitat along the Cheat River and its tributaries is important habitat for southern bog lemmings on the CDCTA (Linzey 1983). These habitat types are most prevalent on the Cantonment Area and the Pringle TA (Vanderhorst 2001). However, southern bog lemmings were occasional or common on all three tracts of the CDCTA.

Meadow jumping mice are rare in West Virginia because of a statewide lack of suitable habitat for the species. However, compared to other parts of the state, the CDCTA provides a large amount of habitat for this species. The number of meadow jumping mice captured in this study, especially on the Cantonment Area and reclaimed mine sections of the Pringle TA, is a testament to this fact. Grassy fields and wet meadows are ideal habitat for meadow jumping mice (Whitaker 1972, Merritt 1987, Whitaker and Hamilton 1998). Therefore, these grassland patches should be maintained and enhanced to provide cover and forage for meadow jumping mice and southern bog lemmings (Anderson et al. 2002). Because native grassland habitat is scarce throughout the state of West Virginia, it is important to conserve the patches that do exist.

Pygmy shrews, long-tailed shrews, and rock voles are generally found in moist, rocky areas of deciduous or mixed deciduous-conifer forest and along cool mountain streams (Long 1974, Kirkland 1981, Kirkland and Jannett 1982). These are about the same habitat characteristics as other shrew and vole species that occur on the CDCTA (Merritt 1987, Whitaker and Hamilton 1998). Little is known about the life histories and ecology of the pygmy shrew and the long-tailed shrew (Long 1974, Merritt 1987). Management of habitat specifically for pygmy shrews or long-tailed shrews is virtually impossible given the lack of information on life history characteristics and habitat requirements of these species (Long 1974, Kirkland 1981).

Maintenance of wooded, rocky slopes is the best management strategy for protecting most of the rare small mammal species that occur on the CDCTA. Given the remoteness and inaccessibility of steep rocky slopes on the CDCTA properties, a hands-off management scheme might be the best option for protecting small mammal habitat. Of course, consistent monitoring of rare species is crucial for managers to recognize problems and concerns before they reach catastrophic levels. All rare species on the CDCTA property should be monitored at least every few years to avoid the loss of species due to anthropogenic factors.

Sherman live trapping produced a variety of small mammal species including long-tailed weasels, red squirrels, and Virginia opossums that are not targeted by this trapping method and uncommon in Sherman traps due to the size of these animals. *Peromyscus* spp. are the most common wild rodents across the United States (Merritt 1987, Whitaker and Hamilton 1998), and it was no surprise that white-footed mice and deer mice comprised 74% of all Sherman live trap captures (Merritt 1987, Loeb 1999). Average CPU for Sherman live trapping grids were much greater in 2001 than 2000 (Osbourne 2002). Small mammal populations frequently fluctuate in cycles due to various habitat and climatic factors (Carey and Johnson 1995, Krohne 1998). These data show that managers must be wary of data collected in a single year on small mammals and population estimates calculated from those data. Managers should create a sampling design that incorporates multiple years of trapping to account for population cycles and stochastic events that can affect population estimates. Though snap trap grids were set in areas not sampled by Sherman grids, southern bog lemming was the only species sampled in snap trap grids that was absent from Sherman trapping.

Overall, pitfall trapping provided the best information on the small mammal communities of the CDCTA. Pitfalls provided the highest number of overall captures and highest number of different small mammal species. These results are consistent with studies comparing capture success of different trapping methods (Williams and Braun 1983, McComb et al. 1991). Though not statistically tested in this study, CPU values for pitfall trapping were lower than those produced by live trapping and snap trapping. Species composition of capture results also was different. Larger rodents like *Peromyscus* spp., voles, and chipmunks were more likely to be captured in live traps and snap traps, while small shrew species were most abundant in pitfall traps (McComb et al. 1991). However, the drawback of pitfall trapping is the high mortality rate. These results suggest a combination of trapping methods is the best way to sample the entire community of small mammal species on the CDCTA.

Shannon diversity indices for small mammal species trapped in pitfall arrays were similar between years, so there appears to be no reduction in diversity associated with pitfall trapping (Osbourne 2002). Shannon diversity was significantly higher on the Pringle TA than the Briery Mountain TA, with no difference detected between Pringle and Cantonment values or Cantonment and Briery Mountain values. The higher diversity on the Pringle TA is most likely due to the greater variety of habitat types on the Pringle TA (Vanderhorst 2001). Briery Mountain is a relatively homogeneous landscape of recently logged, young forest with several small open areas. The Pringle TA provides areas of young forest, mature forest, open mine land, scrub-shrub grassland, conifer forest, riparian habitat, and several small wetlands (Vanderhorst 2001). The analysis of Shannon diversity by vegetative community type also produced higher diversity indices on the Pringle TA and the Cantonment Area than the Briery Mountain TA (Osbourne 2002). One factor contributing to the lower indices in the sub-xeric oak forest, agricultural land, and disturbed areas could be the low number of pitfall arrays located in these areas. However, several other community types contained one or two pitfall arrays and produced higher Shannon diversity values.

All bats captured and recorded by Anabat detectors on the CDCTA are common in West Virginia and were expected to be present at Camp Dawson. Moreover, on the basis of range and ecology, it is possible that silver-haired bats (*Lasioncyteris noctivagans*) occur at Camp Dawson during migration in spring and fall. Although Indiana bats are reported in West Virginia during the winter (Stihler 1992), they rarely occur in West Virginia during the summer (Owen et al. 2001). Camp Dawson does not occur in the typical range of the Indiana bat, so it is unlikely, but not impossible, that Indiana bats occur on the site.

All species sampled by predator scent stations are relatively common in West Virginia and the eastern United States (Merritt 1987, Whitaker and Hamilton 1998). The long-tailed weasel and striped skunk were unexpected visitors because mustelids are uncommon visitors of predator scent stations (Warrick and Harris 2001). Future scent station monitoring should continue to include interior and edge stations to fully assess local carnivore populations.

ACKNOWLEDGMENTS

Funding for this project was provided by the West Virginia Army National Guard, the West Virginia Agricultural and Forestry Experiment Station, and the West Virginia University Research Corporation. Special thanks are extended to G. E. Seidel, J. W. Edwards, and L. B. Williams for statistical advice and reviewing this manuscript. We also thank B. E. Adams, C. K. Balcombe, L. R. Barhorst-Montas, J. M. Calhoun, S. L. Helon, F. R. Montas, J. C. McFee, E. R. Phillips, M. D. Phillips, T. J. Polesiak, N. S. Riley, A. B. Spurgeon, L. E. Toothman, H. W. Weaver, J. D. Werther, M. M. Whitmore, M. R. Woody, and A. K. Zadnik for help with field sampling. The West Virginia University Animal Care and Use Committee approved the protocols used in this study (00-0405). This is scientific article number 2912 of the West Virginia University Agricultural and Forestry Experiment Station.

LITERATURE CITED

Anderson, J. T., G. M. Forcey, J. D. Osbourne, and A. B. Spurgeon. 2002. Wildlife management plan for the Camp Dawson Collective Training Area, Kingwood, West Virginia. Division of Forestry, West Virginia University, Morgantown, West Virginia, USA.

Balcom, B. J., and R. H. Yahner. 1996. Microhabitat and landscape characteristics associated with the threatened Allegheny woodrat. Conservation Biology 10:515-525.

Bell, J.W. 2001. Soil survey of Camp Dawson, Preston County, West Virginia. U.S.D.A. Natural Resources Conservation Service, Moorefield, West Virginia, USA.

Bury, R. B., and P. S. Corn. 1987. Evaluation of pitfall trapping in northwestern forests: trap arrays with drift fences. Journal of Wildlife Management 51:112-119.

Carey, A. B., and M. L. Johnson. 1995. Small mammals in managed, naturally young, and old-growth forests. Ecological Applications 5:336-352.

Fedriani, J. M., T. K. Fuller, R. M. Sauvajot, and E. C. York. 2000. Competition and intraguild predation among three sympatric carnivores. Oecologia 125:258-270.

FNW Geosynthetics Division (FNWGD). 2000. http://www.geosyntheticproducts.com.

Garwood, A. N., editor. 1996. Weather America: The latest detailed climatological data for over 4,000 places with rankings. Toucan Valley Publications, Milpitas, California, USA.

Greenberg, C. H., D. G. Neary, and L. D. Harris. 1994. A comparison of herpetofaunal sampling effectiveness of pitfall, single-ended, and double-ended funnel traps used with drift fences. Journal of Herpetology 28:319-324.

Helon, D. A., J. T. Anderson, and J. D. Osbourne. 2003. Comparison of interior versus roadside scent stations. Game and Wildlife Science 19:303-312.

Jorgensen, E. E., S. Demarais, S. M. Sell, and S. P. Lerich. 1998. Modeling habitat suitability for small mammals in Chihuahuan desert foothills of New Mexico. Journal of Wildlife Management 62:989-996.

Kinlaw, A. 1995. *Spilogale putorius.* Mammalian Species 511:1-7.

Kirkland, G. L., Jr. 1981. *Sorex dispar* and *Sorex gaspensis.* Mammalian Species 155:1-4.

Kirkland, G. L., Jr., and F. J. Jannett, Jr. 1982. *Microtus chrotorrhinus*. Mammalian Species 180:1-5.

Krebs, C. J. 1999. Ecological methodology. Second edition. Addison Wesley Longman, Menlo Park, California, USA.

Krohne, D. T. 1998. General ecology. Wadsworth, Belmont, California, USA.

Lekunze, L. M., A. U. Ezealor, and T. O. Aken. 2001. Prey groups in the pellets of the barn owl (*Tyto alba*) in the Nigerian savanna. African Journal of Ecology 39:38-44.

Liebhold, A., J. Elkinton, P. Williams, and R. M. Muzika. 2000. What causes outbreaks of the gypsy moth in North America? Population Ecology 42:257-266.

Linzey, A.V. 1983. *Synaptomys cooperi.* Mammalian Species 210:1-5.

Loeb, S. C. 1999. Responses of small mammals to coarse woody debris in a southeastern pine forest. Journal of Mammalogy 80:460-471.

Long, C. A. 1974. *Microsorex hoyi* and *Microsorex thompsoni*. Mammalian Species 33:1-4.

Magurran, A. E. 1988. Ecological diversity and its measurement. Princeton University Press, Princeton, New Jersey, USA.

McComb, W. C., R. G. Anthony, and K. McGarigal. 1991. Differential vulnerability of small mammals and amphibians to two trap types and two trap baits in Pacific Northwest Forests. Northwest Science 65:109-115.

Mengak, M. T., and D. C. Guynn. 1987. Pitfalls and snap traps for sampling small mammals and herpetofauna. American Midland Naturalist 118:284-288.

Menzel, M. A., W. M. Ford, J. Laerm, and D. Krishon. 1999. Forest to wildlife openings: habitat gradient analysis among small mammals in the southern

Appalachians. Forest Ecology and Management 114:227-232.
Merritt, J. F. 1987. Mammals of Pennsylvania. University of Pittsburgh Press, Pittsburgh, Pennsylvania, USA.
Nelson, L., Jr., and F. W. Clarke. 1973. Correction for sprung traps in catch/effort calculations of trapping results. Journal of Mammalogy 54:295-298.
Osbourne, J. D. 2002. Effects of edge and coarse woody debris on small mammal communities in riparian and upland habitats in northern West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.
Owen, S. F., M. A. Menzel, W. M. Ford, B. R. Chapman, K. V. Miller, J. W. Edwards and P. B. Wood. 2001. First summer record of female Indiana myotis, *Myotis sodalis*, in West Virginia. Journal of the Elisha Mitchell Scientific Society 117:132-134.
Ruffner, J. A. 1985. Climates of the states: National Oceanic and Atmospheric Administration narrative summaries, tables, and maps for each state with overview of state climatologist programs. Volume 2. National Oceanic and Atmospheric Administration, Gale Research Company, Washington, D.C., USA.
Spurgeon, A. B. 2002. Comparison of herpetofaunal species' composition and response to edge on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.
Stihler, C. W. and V. Brack, Jr. 1992. A survey of hibernating bats in Hellhole Cave, Pendleton County, West Virginia. Proceedings of the West Virginia Academy of Science. 64:97-103.
Traviani, A. R., R. Laffilte, and M. Delibes. 1996. Determining the relative abundance of European red foxes by scent-station methodology. Wildlife Society Bulletin 24:500-504.
Vanderhorst, J. 2001. Plant community classification and mapping of Camp Dawson Collective Training Area, Preston County, West Virginia. Nongame Wildlife and Natural Heritage Program, Wildlife Resources Section, Division of Natural Resources, Elkins, West Virginia, USA.
Warrick, G. D., and C. E. Harris. 2001. Evaluation of spotlight and scent-station surveys to monitor kit fox abundance. Wildlife Society Bulletin 29:827-832.
West Virginia Army National Guard (WVARNG). 2001. Integrated Natural Resources Management Plan. Camp Dawson, Preston County, West Virginia, USA.
West Virginia Division of Natural Resources (WVDNR). 2000. Rare Species List: Vertebrates.
Whitaker, J. O., Jr. 1972. *Zapus hudsonius.* Mammalian Species 11:1-7.
Whitaker, J. O., Jr. 1974. *Cryptotis parva.* Mammalian Species 43:1-8.
Whitaker, J. O., Jr, and W. J. Hamilton, Jr. 1998. Mammals of the eastern United States. Cornell University Press, Ithaca, New York, USA.
Wiley, R.W. 1980. *Neotoma floridana.* Mammalian Species 139:1-7.
Williams, D. F., and S. E. Braun. 1983. Comparison of pitfall and conventional traps for sampling small mammal populations. Journal of Wildlife Management 47:841-845.
Wilson, D. E., and D. M. Reeder, editors. 1993. Mammal Species of the World. Smithsonian Institution Press, Washington, D. C., USA.

Table 1. Captures per 100 trap nights, Shannon diversity, Pielou evenness, and species richness for small mammals captured in pitfall trapping arrays on the Camp Dawson Collective Training Area in Preston County, West Virginia during 2000 and 2001.

	Tract[ab]					
	BM		CA		PT	
Species or Index	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Masked shrew	4.477a	0.917	2.175a	0.308	3.695a	0.574
Smoky shrew	0.978a	0.505	0.901a	0.187	1.370a	0.217
Long-tailed shrew	0.056	0.023	0.026	0.026	0.054	0.019
Pygmy shrew	0.016	0.016	0.003	0.003	0.009	0.009
Northern short-tailed shrew	0.483a	0.119	0.619a	0.107	1.038a	0.164
Hairy-tailed mole	0.000	0.000	0.020	0.013	0.002	0.002
Star-nosed mole	0.004	0.004	0.046	0.019	0.011	0.009
Eastern cottontail	0.000	0.000	0.003	0.003	0.004	0.004
Eastern chipmunk	0.094	0.045	0.275	0.124	0.046	0.015
Southern flying squirrel	0.004	0.004	0.003	0.003	0.000	0.000
Peromyscus spp.	1.220b	0.329	1.300b	0.266	2.634a	0.327
Southern red-backed vole	0.314	0.106	0.207	0.079	0.285	0.074
Meadow vole	0.310	0.104	1.012	0.344	0.483	0.140
Rock vole	0.000	0.000	0.000	0.000	0.020	0.020
Woodland vole	0.008	0.008	0.030	0.023	0.046	0.020
Meadow vole	0.310	0.104	1.012	0.344	0.483	0.140
Rock vole	0.000	0.000	0.000	0.000	0.020	0.020
Woodland vole	0.008	0.008	0.030	0.023	0.046	0.020
Southern bog lemming	0.106	0.048	0.133	0.047	0.151	0.037
Meadow jumping mouse	0.231	0.081	3.625	1.385	0.571	0.171
Woodland jumping mouse	0.130b	0.030	1.588a	0.632	1.622a	0.323
Least weasel	0.004	0.004	0.000	0.000	0.013	0.009
Long-tailed weasel	0.008	0.008	0.000	0.000	0.004	0.004
All species combined	8.469a	1.499	11.994a	1.838	12.057a	1.192
Shannon Diversity	1.497b	0.067	1.664ab	0.098	1.779a	0.037
Pielou Evenness	0.708b	0.025	0.773ab	0.030	0.796a	0.015
Species Richness	1.412a	0.262	1.668a	0.236	1.727a	0.208

[a] BM = Briery Mountain TA, CA = Cantonment Area, PT = Pringle Tract.
[b] The same letter following means indicates no difference among tract ($P > 0.05$).

Table 2. Shannon Diversity, Pielou's Evenness Index, Species Richness, Sorenson Community Similarity Index, and number of arrays by vegetative community (Vanderhorst 2001) for small mammals captured in pitfall traps on the Camp Dawson Collective Training Area in Preston County, West Virginia during 2000 and 2001.

Vegetation Community	Number of Arrays	Sorenson Index[b]	Shannon Diversity[a] $\bar{x}$	Shannon Diversity[a] SE	Pielou Evenness[a] $\bar{x}$	Pielou Evenness[a] SE	Species Richness[a] $\bar{x}$	Species Richness[a] SE
Developed	2	77	1.883a	0.175	0.848a	0.033	2.843a	0.475
Hemlock ravine	1	77	1.878a	0.025	0.786abc	0.040	0.975a	0.353
Mixed mesophytic forest of colluvial slopes	8	94	1.849ab	0.054	0.841a	0.018	1.502a	0.271
Successional floodplain forest	3	73	1.775ab	0.072	0.790abc	0.025	0.836	0.117
Old field	8	88	1.768ab	0.070	0.810ab	0.025	1.648a	0.341
Successional forest of low elevation plains	7	88	1.739ab	0.076	0.766abc	0.024	1.564a	0.396
Road	1	59	1.643ab	0.065	0.798ab	0.080	2.668a	0.429
Pine plantation	2	73	1.633abc	0.082	0.709abc	0.036	1.485a	0.543
Mixed montane hardwood forest	4	77	1.515abc	0.080	0.715abc	0.032	1.877a	0.483
Disturbed	1	59	1.476abc	0.380	0.728abc	0.117	2.449a	0.254
Sub-xeric oak forest	1	69	1.248bc	0.131	0.568c	0.031	0.807a	0.319
Agricultural land	2	54	1.013c	0.217	0.592bc	0.085	1.976a	0.567

[a] The same letter following means in a column indicates no difference ($P > 0.05$).
[b] Sorenson Indices represent a comparison of each vegetative community to the pooled community of all other vegetative community types.

Appendix 1. Relative abundance of mammalian species observed on the Camp Dawson Collective Training Area (CDCTA) in Preston County, West Virginia during 2000 and 2001. Species with an * were captured on the CDCTA, and relative abundance for these species was calculated using number of individuals captured. For species observed but not captured relative abundance was based on frequency of observation.

		Relative Abundance[ab]		
Common Name	Scientific Name	BM	CA	PT
*Virginia opossum	*Didelphis virginiana*	R	O	O
*Masked shrew	*Sorex cinereus*	A	A	A
*Smoky shrew	*Sorex fumeus*	C	A	A
*Long-tailed shrew	*Sorex dispar*	O	R	O
*Pygmy shrew	*Sorex hoyi*	R	R	R
*Northern short-tailed shrew	*Blarina brevicauda*	C	A	A
*Starnose mole	*Condylura cristata*	R	R	R
*Hairytail mole	*Parascalops breweri*		R	R
*Little brown bat	*Myotis lucifugus*			R
*Northern myotis	*Myotis septentrionalis*		R	R
*Eastern pipistrelle	*Pipistrellus subflavus*			R
*Big brown bat	*Eptesicus fuscus*		R	R
Eastern red bat	*Lasiurus borealis*			R
Hoary bat	*Lasiurus cinereus*		R	R
*Eastern cottontail	*Sylvilagus floridanus*		R	R
American beaver	*Castor canadensis*			O
Woodchuck	*Marmota monax*	O	R	O
*Eastern fox squirrel	*Sciurus carolinensis*	R	R	R
*Red squirrel	*Tamiasciurus hudsonicus*		R	R
*Southern flying squirrel	*Glaucomys volans*	R	O	O
*Deer mouse	*Peromyscus maniculatus*	C	C	A
*White-footed mouse	*Peromyscus leucopus*	A	A	A
*Allegheny woodrat	*Neotoma magister*			O
*Southern bog lemming	*Synaptomys cooperi*	O	O	C
*Southern red-backed vole	*Clethrionomys gapperi*	C	C	A
*Meadow vole	*Microtus pennsylvanicus*	C	A	C
*Woodland vole	*Microtus pinetorum*	R	R	O
*Rock vole	*Microtus chrotorrhinus*			R
*Meadow jumping mouse	*Zapus hudsonius*	C	A	C
*Woodland jumping mouse	*Napaeozapus insignis*	C	A	A
Black bear	*Ursus americanus*	R		R
Coyote	*Canis latrans*			R
Domestic dog	*Canis domesticus*			R

Appendix 1. Continued.

Common Name	Scientific Name	Relative Abundance[ab]		
		BM	CA	PT
*Raccoon	*Procyon lotor*	A	A	A
*Least weasel	*Mustela nivalis*	R	R	R
*Long-tailed weasel	*Mustela frenata*	R	R	R
*Striped skunk	*Mephitis mephitis*			R
Bobcat	*Felis rufus*			R
Domestic cat	*Felis catus*		R	R
White-tailed deer	*Odocoileus virginianus*	A	A	A

[a] BM = Briery Mountain TA, CA = Cantonment Area, PT = Pringle Tract.
[b] Abundant (A) = >100, Common (C) = 20-100, Occasional (O) = 5-20, and Rare (R) = 0-5.

HERPETOFAUNAL ABUNDANCE AND DISTRIBUTION ON THE CAMP DAWSON COLLECTIVE TRAINING AREA, PRESTON COUNTY, WEST VIRGINIA

AMY B. SPURGEON and JAMES T. ANDERSON,* Wildlife and Fisheries Resources Program, Division of Forestry, West Virginia University, P. O. Box 6125, Morgantown, WV 26506-6125, USA. *jander25@wvu.edu.

ABSTRACT

Herpetofaunal (reptiles and amphibians) species composition, relative abundance, and diversity were evaluated on the Cantonment Area, Briery Mountain Training Area, and the Pringle Tract Training area of the Camp Dawson Collective Training Area (CDCTA), in Preston County, West Virginia, as a requirement under the Sikes Act (16 USC 670a et seq.), Army Regulation (AR) 200-3, and Department of Defense Instruction 4715.3. Herpetofauna were sampled using drift fences and pitfall traps with double-ended funnel traps, area searches, and incidental findings. A total of 1,450 individuals of 28 species were documented on site. Pitfall arrays captured 1,187 individuals of 24 species (11 salamander, 7 anuran, 1 turtle, 5 snake). The most common species were Eastern Red-backed Salamanders (*Plethodon cinereus*), Red-spotted Newts (*Notophthalmus v. viridescens*), American Toads (*Bufo americanus*), and Wood Frogs (*Rana sylvatica*). These species varied in abundance among the three study sites. American Toad abundance (no. captures/100 trap nights) was greater on Briery Mountain (= 0.32, SE = 0.071) than on Pringle Tract ($\bar{x}$ = 0.09, SE = 0.040; P = 0.018); conversely, Wood Frog abundance was greater on Pringle Tract ($\bar{x}$ = 0.32, SE = 0.058) than on Briery Mountain ($\bar{x}$ = 0.10, SE = 0.035, P = 0.007). No difference was detected among the three tracts for relative abundance of all species combined (P = 0.200) or mean species diversity (P = 0.584). Complete searches accounted for 258 individuals of 10 species (7 salamander, 2 anuran, 1 snake). The most common species from searches were Allegheny Mountain Dusky Salamanders (*Desmognathus ochrophaeus*), Seal Salamanders (*D. monticola*), and Red-backed Salamanders. Northern Red Salamanders (*Pseudotriton r. ruber*), listed as a West Virginia rare species, were documented on all three tracts of the CDCTA. A diversity of habitats should be maintained to conserve the herpetofaunal diversity present on site. Long-term monitoring should be implemented to track population changes due to habitat alteration and training activities.

INTRODUCTION

Historically, amphibians and reptiles received little attention in regards to conservation planning because scientists lacked interest in these taxonomic groups, knowledge concerning their population trends and processes was limited, and funding for research was scant (Phillips 1990, Dunson et al. 1992, Drost and Fellers 1996). Currently, the status of herpetofaunal species is becoming a more prominent topic in the scientific community because of their important role in ecosystems. Vitt et al. (1990), Dunson et al. (1992), Blaustein (1994), and Pechmann and Wilbur (1994) all support the concept that amphibians serve as biological indicators of environmental stresses. Their indicator status is attributable to certain physiological characteristics that include permeable eggs, gills, and skin that readily absorb materials from the environment (Duellman and Trueb 1986), and complex life cycles that include both aquatic and terrestrial life stages (Noble 1931). Amphibians are consumers of invertebrates and other vertebrates, are a major prey item for fish, birds, mammals, and aquatic insects, and in certain ecosystems comprise a biomass as great or greater than that of birds and small mammals (Burton and Likens 1975, Blaustein and Wake 1990). Indeed, herpetofauna are important indicators of ecosystem health and function.

Recent reports indicate that frogs, toads, and salamanders are undergoing a global population decline (Beebee 1983, Blaustein and Wake 1990, Wake 1991, Pechmann and Wilbur 1994, Lips 1999). Certain reptile species also are declining. Wood Turtle (*Clemmys insculpta*) population declines in Connecticut (Garber and Burger 1995) and extirpation of Eastern Hog-nosed Snakes (*Heterodon platirhinos*), Northern Diamond-backed Watersnakes (*Nerodia r. rhombifer*), Red-bellied Watersnakes (*N. e. erythrogaster*), and Graham's Crayfish Snakes (*Regina grahamii*) in Kansas over a 60-year period have been documented (Busby and Parmalee 1996). Reasons for population declines include habitat destruction due to timber harvesting (Grialou et al. 2000), pollution and acidification (Dunson et al. 1992), predation (Blaustein and Wake 1990, Wake 1991), competition (Jaeger 1970), natural fluctuations (Pechmann et al. 1991), and various other human impacts (Garber and Burger 1995).

Ecological studies have never been conducted on the Camp Dawson Collective Training Area in Preston County, West Virginia, but are required under the Sikes Act (16 USC 670a et seq.), Army Regulation (AR) 200-3, and Department of Defense Instruction 4715.3. The objective of this study was to determine relative distribution, abundance, and diversity of reptiles and amphibians on the Camp Dawson Collective Training Area.

STUDY AREA

The study was conducted on the Camp Dawson Cantonment Area, Briery Mountain, and Pringle Tract, which are installations on the CDCTA in Preston County, West Virginia (Spurgeon 2002). The CDCTA encompasses 1,655 ha of land that is used for military training. The Pringle Tract and the Cantonment Area fall within the Gilpin-Rayne-Wharton soil type, while Briery Mountain falls primarily in the Dekalb soil type (Bell 2001). Numerous vegetative communities exist on the CDCTA, but two main forest types occur within its boundaries. Areas of high elevation contain a mix of chestnut oak (*Quercus prinus*), scarlet oak (*Q. coccinea*), and black oak (*Q. velutina*) (Vanderhorst 2001). Lower elevations contain a mix of tulip poplar (*Liriodendron tulipifera*), white oak (*Q. alba*), and northern red oak (*Q. rubra*) (Vanderhorst 2001). More details on the individual study tracts are found in Osbourne et al. (2002) and Spurgeon (2002).

West Virginia has moderately severe winter weather, with extreme conditions occurring in the mountainous areas of the east. Preston County is classified as humid mesothermal with a continental climate (temperatures range from 3.5°C to 14.1°C), prevailing westerly winds, an average annual precipitation of 137 cm, and average annual snowfall of 371 cm (Garwood 1996).

METHODS

Pitfall arrays

Drift fence pitfall arrays, designed to target small, surface-active herpetofaunal species (Greenberg et al. 1994) were modified from Mengak and Guynn (1987), Greenberg et al. (1994), and Bury and Corn (1987). Two different pitfall arrangements were used as primary capture techniques for herpetofauna (Spurgeon 2002). The first trapping array (full array) consisted of four 7.5-m lengths of nylon silt fencing and five pitfall buckets (Enge 2001). At the ends of the four arms and at the center where the four fences met, a single, 19 L bucket was buried flush with the ground. The second type of array (transect array) was constructed with the same materials; however, only one 7.5-m fence was used with two 19-L buckets buried at each end of the fence. A small amount of water (0-5 cm) was kept in the bottom of each bucket to provide a dry substrate for some rodents, but reduce the possibility of escape and desiccation of captured herpetofauna (Spurgeon 2002).

Double-ended funnel traps, constructed from aluminum hardware cloth and plastic funnels, were installed at each array with one trap along each side of a fence section to target snakes (Bury and Corn 1987, Spurgeon 2002). The body of the funnel trap measured 46 cm in length and each funnel had an outside diameter of 10 cm and an inner-opening diameter of 5 cm. Traps were held in place by clearing away all debris and making a shallow depression in the soil for traps to rest. Rocks, sticks, and soil were packed against the trap and between the trap and fence to stabilize the trap and prevent organisms from passing through the gaps.

Full array locations were placed in upland and riparian areas. An area was considered upland if it was $\geq$ 100 m from a body of water, whereas riparian areas were centered on a significant water source. Locations for transect arrays were established on edges (Hunter 1990) and included roads, forests, fields, and stream orders 1-4. One transect array was installed 1 m from an edge and the second 100 m interior to the first. Of the 23 pitfall arrays operated during the 2000 field season, 13 were full arrays and 10 were transects. In 2001 there were 20 full arrays and 20 transect arrays. Details on the distribution of arrays by type and tract are found in Spurgeon (2002). Traps were left open continually and checked every 24-72 hrs from 5 July to 27 October 2000 and 6 April to 31 October 2001.

Complete searches

Complete searches for reptiles and amphibians were conducted on areas that were not conducive to pitfall array locations (i.e., too rocky or steep). Searches also were conducted to increase sample size of captured species. To conduct a search, an area was selected near an edge and 5 25 m distance categories (0-25, 26-50, 51-75, 76-100, and 101-125 from the edge) were delineated. Within each distance category, 1 8 x 8 m quadrat was randomly chosen, flagged, and searched (Heyer et al. 1994). Searches involved turning over rocks, logs, leaf litter, and the organic layer of soil to look for any species that may be residing there. With two people conducting the searches, each 8 x 8 m quadrat took about 30 minutes to search, depending on amount of cover items to overturn. Six searches were conducted during September and October 2000, and 28 searches were conducted from June to August 2001 (Spurgeon 2002). In addition to these procedural search methods, turtle trapping and incidental encounters also were recorded on each of the three tracts (Spurgeon 2002).

Species documentation

Herpetofauna scientific and common names were taken from Crother (2001). Total body length (nearest mm) and mass were recorded for each individual captured. Mass (nearest mg) was obtained by placing individuals in a plastic bag and, using a spring scale, both the bag and the specimen were weighed; bag mass was then subtracted from the total. Methods for marking individuals were modified from Martof (1953), Brown and Parker (1976), and Cagle (1939) and included toe-clip, scale-clip, or shell-notch sequences for amphibians, snakes, and turtles, respectively. Using small fingernail clippers, toes were clipped at an angle and the digit removed was recorded. Antibacterial cream was applied to the digit to prevent infection. Ventral scale clipping on snakes was performed with surgical scissors and the number of scales from the vent was recorded for identification (Brown and Parker 1976). Turtle shells were notched using pliers and then notch location was recorded.

Statistical analysis

Relative abundance of each species was determined based on the number of captures obtained from each array and search. Marked individuals were not included in abundance estimates, as they had already been counted when initially captured. Diversity of species across the Cantonment Area, Briery Mountain, and the Pringle Tract and over the 2-year sampling period was evaluated for pitfall arrays using the Shannon diversity index (Krebs 1999).

Analysis of variance was used to determine if any differences occurred for herpetofaunal abundance and species diversity among the three tracts. Year was included as a dependent variable to test for the tract by year interaction, but results of differences between years were not presented to save space. The experimental unit used to calculate herpetofaunal abundance was the array. Due to differences in pitfall designs, trap nights for full arrays were calculated as if the arms were four separate units; therefore, trap nights were calculated for eight buckets and eight funnel traps. Transect arrays were treated as only one unit, thus trap nights were calculated for two buckets and two funnel traps. Tukey's Honestly Significant difference procedure was used to compare significance in mean number of captures/100 trap nights between tracts following a significant *F*-test ($P < 0.05$) (Krebs 1999). Sorenson's coefficient of similarity (Krebs 1999) was used to compare species composition among the three tracts based on data from pitfall arrays. We used SAS for data analysis (SAS Institute 1995) and assumptions of normality and homogeneity of variance were evaluated by plotting residuals.

RESULTS

Species Occurrence

During 2000 and 2001, 1,450 individuals of 28 species were documented on the CDCTA (Table 1). Twenty-four species, 18 amphibian and 6 reptile, were recorded via trapping and search efforts (413 individuals of 19 species on the Cantonment Area, 335 individuals of 17 species on Briery Mountain, and 697 individuals of 17 species on the Pringle Tract). Four other species were documented through visual encounter (Painted Turtle [*Chrysemys picta*], Eastern Box Turtle [*Terrapene c. Carolina*], Northern Black Racer [*Coluber c. constrictor*], and Common Watersnake [*Nerodia s. sipedon*]).

Pitfall arrays

Pitfall arrays were operated for 25,944 trap nights and produced 453 individuals of 22 species (17 amphibian, 5 reptile) in 2000 and 734 individuals of 18 species (14 amphibian, 4 reptile) in 80,776 trap nights during 2001. Among the 3 tracts, the Pringle Tract had fewer species captured, 12 for both years, but higher individual captures, 215 in 2000 and 399 in 2001. The Briery Mountain and the Cantonment Area each had 15 species captured in 2000 and 14 species in 2001. Individuals captured were 110 and 135 for Briery Mountain, and 128 and 200 for the Cantonment Area over the respective sampling years.

The four most abundant species over all three tracts and across both years were Wood Frogs (13.5% of all pitfall captures), American Toads (14.9%), Red-spotted Newts (16.2%), and Red-backed Salamanders (29.0%; Table 2). Abundance was similar across the three tracts for Red-backed Salamanders ($F_{2,20} = 3.09$, $P = 0.057$) and Red-spotted Newts ($F_{2,20} = 2.86$, $P = 0.070$) (Table 2). American Toad abundance was greater on Briery Mountain than on the Pringle Tract, but was similar between the Cantonment Area and Briery Mountain and also between the Cantonment Area and Pringle Tract ($F_{2,20} = 4.25$, $P = 0.018$) (Table 2). Mean captures/100 trap nights for Wood Frogs was higher on the Pringle Tract than on Briery Mountain, but otherwise was similar between tracts ($F_{2,20} = 5.70$, $P = 0.007$) (Table 3). There were no interaction between year and tract for any of these species ($P > 0.05$).

Overall herpetofaunal abundance was similar among the Cantonment Area ($\bar{x} = 1.58$, SE = 0.398), Briery Mountain ($\bar{x} = 1.06$, SE = 0.176), and the Pringle Tract ($\bar{x} = 1.62$, SE = 0.286) ($F_{2,20} = 1.68$, $P = 0.200$). Shannon diversity also was similar among the Cantonment Area ($\bar{x} = 0.120$, SE = 0.026), Briery Mountain ($\bar{x}$ = 0.094, SE = 0.021), and the Pringle Tract ($\bar{x}$ = 0.116, SE = 0.017) ($F_{2,19}$ = 0.55, P = 0.584). There were no interactions between year and tract for overall herpetofaunal abundance ($F_{2,20}$ = 0.89, P = 0.425) or species diversity ($F_{2,19}$ = 1.10, P = 0.352).

Sorenson similarity values for 2000 showed 67% similarity in species composition among all three tracts of the Camp Dawson Collective Training Area. Sorenson values increased over all tracts in 2001, with Briery Mountain and the Pringle Tract having 84% species similarity. Species composition between the Cantonment Area and Briery Mountain was 78% similar, while the Cantonment Area and the Pringle Tract were 76% similar. For the combined years, the Cantonment Area and Briery Mountain had 72% species similarity, the Cantonment Area and the Pringle Tract had 76% similarity, and Briery Mountain and the Pringle Tract had 71% similarity.

Complete searches

From the six searches conducted in 2000, six species and 40 individuals were captured; from the 28 searches conducted in 2001, eight species and 218 individuals were documented. Red-backed Salamanders were the most abundant species captured during search efforts (Table 3). Each year, three species comprised the greatest percentage of total captures. Red-backed Salamanders comprised about 40% of total captures for both 2000 and 2001, while Allegheny Mountain Dusky Salamanders comprised nearly 25% of all captures for both years. In 2000, 25% of total captures consisted of Northern Slimy Salamanders (*Plethodon glutinosus*); in 2001, Seal Salamanders comprised 26% of total captures from complete searches.

DISCUSSION

Species documentation

In West Virginia, there are 87 documented herpetofaunal species (34 salamander, 3 toad, 11 frog, 13 turtle, 6 lizard, and 20 snake species) (T. K. Pauley, Marshall University, personal communication, Green and Pauley 1987). Preston County is located in the Allegheny Mountain section of the state and is home to 44 (50.6% of state total) herpetofaunal species (15 salamander, 2 toad, 6 frog, 3 turtle, 2 lizard, 16 snake). Twenty-eight of the 44 species (64%) were documented in this study.

Amphibian species captured were those we most likely expected to observe. Reptile species were secretive and overall few individuals were captured. Only one Eastern Box Turtle was observed throughout the entire study area, even though they are widely distributed and commonly found in many terrestrial habitats (Green and Pauley 1987). Painted Turtles were documented on several occasions in ponds on the Cantonment area, although none were captured in pitfalls or turtle traps (Spurgeon 2002). Overall, few snakes were observed in the field. Neither of the two venomous snake species in the state, the Northern Copperhead (*Agkistrodon contortrix mokasen*) and Timber Rattlesnake (*Crotalus horridus*), were encountered. Although reports have been made of their occurrence near the CDCTA, habitat suitable for the timber rattlesnake may be lacking. During the course of the 2-year survey, anywhere from three to six crewmembers were in the field, but no sightings of any of either species were made, which strengthens the claim that few of these species likely occur on the CDCTA.

Rare species

Four species previously documented in Preston County are listed as state species of concern by the Natural Heritage Program of the West Virginia Division of Natural Resources (Green Salamanders [*Aneides aeneus*], Northern Red Salamanders, Common Ribbonsnakes [*Thamnophis s. sauritus*], and Mountain Earthsnakes [*Virginia valeriae pulchra*]) (West Virginia Division of Natural Resources 2000). Northern Red Salamanders were the only listed species documented in this study. This species has a global ranking of G5 and a state ranking of S3, which indicates the species is rare to common (20-100 occurrences) (Mitchell et al. 1999). This species is widely distributed throughout West Virginia (Green and Pauley 1987); although, Pauley believes the species is declining. In 2000, only two individuals were recorded on Briery Mountain. However, in 2001, the species was documented on Briery Mountain (two individuals), the Cantonment Area (17), and the Pringle Tract (1).

In West Virginia, the Green Salamander's range is concentrated in the Allegheny Plateau from Monongalia and Preston counties southwest to the Big Sandy River (Green and Pauley 1987). Green Salamanders are most common at lower elevations (518-549 m). However, they are known to occur above 915 m at Droop Mountain in Pocahontas County and on the northern rim of the Blackwater Canyon in Tucker County (Pauley 1993). The sedentary nature of this species (Gordon 1961) makes it difficult to account for its current population status, which makes it possible that the species may be more common than present records indicate (Pauley 1993). However, over-collecting and loss of habitat in some areas have justified its listing as a species of special concern by the WVDNR (Mitchell et al. 1999). Studies conducted in the Southern Appalachians (North and South Carolina, Georgia, and Alabama) indicate that the green salamander is essentially a cliff-dweller, whose optimal habitat includes narrow, deep crevices on rock faces that are well shaded by mature or dense forest vegetation (Gordon and Smith 1949, Green and Pauley 1987). Certain areas on the CDCTA, particularly on the Pringle Tract, could serve as possible habitat for this species, but the nocturnal habits of this species makes it somewhat obscure and, therefore, difficult to observe in the field (Gordon and Smith 1949). Some of the most suitable areas were searched at night, but no individuals were detected. We recommended that more searches be conducted to determine if this species does exist on the CDCTA. Observations should be completed during the breeding season, (late May and early June) and fall (September and October), when male-gravid female pairs are most active (Cupp 1971, Canterbury and Pauley 1994). Searches should be conducted between dusk and 2300 hrs, which has been identified as the peak period of activity in this species (Gordon 1961).

Common Ribbonsnakes have only been documented and confirmed in five counties in West Virginia (Green and Pauley 1987). There has been an unverified record of the species in Preston County (Green and Pauley 1987). Common Ribbonsnakes are listed as a species of special interest, which means it is either endemic or its taxonomic status, is uncertain (Mitchell et al. 1999). This ranking is based primarily on the loss of wetlands in West Virginia as well as the lack of data on the status of populations (Mitchell et al. 1999). The small number and area of wetlands on Camp Dawson (Lee et al. 2001) indicates that this species is unlikely to occur on the military training base.

Mountain Earthsnakes only occur in higher elevations in West Virginia and have only been reported in four counties in the state (Pauley 1993). This species is believed to occur from Terra Alta in Preston County south to Elleber Knob in Pocahontas County (Pauley 1984). McCoy (1965) is the only published account of the species in Preston County. Mountain Earthsnakes are listed as a species of special interest because of its limited distribution in montane areas and lack of data on the status of known populations (Mitchell et al. 1999). It is likely that this species does not occur on Camp Dawson.

Species composition among tracts

Based on the results of Sorenson Coefficient calculations, similarity in species composition among the three tracts of the CDCTA is moderately high. Of the 28 species documented throughout the CDCTA, over half (52%) were common to all three tracts. These included American Toads, Northern Green Frogs (*Rana clamitans melanota*), Allegheny

Mountain Dusky Salamanders, Pickerel Frogs (*R. palustris*), Eastern Red-backed Salamanders, Red-spotted Newts, Northern Slimy Salamanders, Seal Salamanders, Wood Frogs, Northern Red Salamanders, Eastern Gartersnakes (*Thamnophis s. sirtalis*), Northern Spring Salamanders (*Gyrinophilus p. porphyriticus*), Four-toed Salamanders (*Hemidactylium scutatum*), and Black Ratsnakes (*Elaphe o. obsoleta*). Three species, Eastern Snapping Turtles (*Chelydra s. serpentina*), Northern Ring-necked Snakes (*Diadophis punctatus edwardsii*), and Common Watersnakes were not found on the Briery Mountain but occurred on both the Cantonment Area and the Pringle Tract.

Even though the distribution of species across the three tracts of the CDCTA were not highly varied, there is reason to believe that certain species were only found on particular sites because of differences in available habitat on each tract. Those species found exclusively on the Cantonment Area included Long-tailed Salamanders (*Eurycea l. longicauda*), Northern Spring Peepers (*Pseudacris c. crucifer*), Gray Tree Frogs (*Hyla chrysoscelis or H. versiclor*), Fowler's Toads (*Bufo fowleri*), and Painted Turtles. The proximity of the Cantonment Area to the Cheat River, which overflows its banks and provides pools and wetlands, as well as other water sources, provides habitat suitable to the characteristics of these species. Long-tailed Salamanders are most commonly found along streams and seeps and are often found in association with Northern two-lined Salamanders (*Eurycea bislineata*) and Green Salamanders (Green and Pauley 1987). One Long-tailed Salamander was recorded from the Cantonment Area on an array adjacent to a stream. Pollution of aquatic systems poses a threat for this and most other riparian-dwelling species; therefore, it is unlikely that this species would be found on the Pringle Tract, as acid mine drainage has impacted most streams on this tract. Northern Spring Peeper and Gray Treefrog are commonly found near ponds during the breeding season and in open woodlands at other times (Green and Pauley 1987). Both of these species were recorded near one of the ponds on the Cantonment Area. It is reasonable to believe that these species would occupy similar habitats on the other tracts. Fowler's Toads are primarily found on sandy floodplains and river bottoms (Green and Pauley 1987). Therefore, it is likely that this species is only common to the Cantonment Area and the floodplain bordering this tract.

The same holds true for Painted Turtles, which were documented in one pond on the Cantonment Area. Populations of this species are greatest in ponds with a mud or silt bottom and where an abundance of aquatic vegetation can provide protection, food, and basking sites for the species (Ream and Ream 1966, Green and Pauley 1987). It is not likely that Painted Turtles would occur in many of the ponds on the Pringle Tract, as minimal amounts of aquatic vegetation are present in these ponds. However, an unconfirmed sighting was made in one pond on the Pringle Tract.

Two snake species, two salamander species, and one reptile species specific to the Briery Mountain were the Eastern Milksnake (*Lampropeltis t. triangulum*), Smooth Greensnake (*Opheodrys vernalis*), Northern Dusky Salamander (*Desmognathus fuscus*), Northern Two-lined Salamander, and Eastern Box Turtle. The two salamander species are most commonly found in small streams and seep areas (Green and Pauley 1987). We suspect that Northern Dusky Salamanders and Northern Two-lined Salamanders occur on the Cantonment area, but not on the acid mine drainage impacted Pringle Tract. There was a reported sighting of a single Eastern Box Turtle during one occasion on Briery Mountain (L. B. Williams, West Virginia Army National Guard, personal communication). The Smooth Greensnake is most often found in meadows and open grassy habitats (Green and Pauley 1987). One individual of this species was recorded in an array on the Briery Mountain that was located in a large, open field with a brushy thicket bordering a large section of the field. As a result of recent logging, this tract is currently in an early successional stage of mixed montane hardwood and sub-xeric oak forest (Vanderhorst 2001), both of which are undesirable habitats for Smooth Greensnakes (Mitchell et al. 1999). To ensure the continued existence of this species on the Briery Mountain, it may be necessary to actively maintain this area as an open field by inhibiting succession and the encroachment of hardwood trees (Anderson et al. 2002). Based on habitats used by Smooth Greensnakes (grassy fields, woodlands, rocky hillsides, and deserted dwellings [Green and Pauley 1987]), it is likely that this species could occur on the Pringle Tract, which is comprised of nearly 70 ha of old-field habitat (Vanderhorst 2001).

Northern Black Racers were documented exclusively on the Pringle Tract. Two individuals were recorded in August at an open field site under a large metal platform that made a suitable basking site for the species. Northern Black Racers have nearly identical habitat characteristics as Black Ratsnakes. Black Ratsnakes are often found in grassland and woodland borders; along rocky hillsides; in swamps and marshland; in old, abandoned buildings; and under objects such as boards, tin, or tarpaper (Green and Pauley 1987). In some studies, overall reptile abundance was increased on sites that had been logged, due to increased ambient temperature that resulted from removal of the canopy (McLeod and Gates 1998). Therefore, we suspect that the Northern Black Racer may occur on Briery Mountain as logging activities have created several fragmented areas throughout the forested landscape.

Shannon diversity index values indicated no significant difference in species diversity among the three tracts. This most likely is attributed to the relatively similar vegetative habitats in which trapping arrays were located. Vegetative community types, defined by Vanderhorst (2001), were not equally represented among tracts or by pitfall trapping locations. Most trap sites were located in forested stands that are known to be significantly more abundant in amphibian species (Enge and Marion 1986, McLeod and Gates 1998). Forested sites not only provided increased canopy coverage, but greater soil moisture and ground cover that were conducive to the microhabitat requirements of many species of amphibians (Grover 1998, McLeod and Gates 1998).

Method effectiveness and future recommendations

Methods used in this study were those most commonly used in evaluating herpetofaunal abundances. Several studies have evaluated the effectiveness of these trapping methods (Bury and Corn 1987, Mengak and Guynn 1987, Greenberg et al. 1994, Enge 2001). The results of these studies suggest that pitfall array designs are most effective at targeting a variety of herpetofaunal species when both pitfalls (19 L) and double-ended funnel traps are employed in combination with drift fences that are a minimum of 5 m in length. Enge (2001) discusses several reasons why pitfall arrays vary in their effectiveness of producing high species diversities and abundances; these include pitfall traps smaller than 19 L buckets, poorly constructed or maintained funnel traps, funnel traps that are short (< 86 cm) and have small opening diameters (< 20 cm), and the effect of predators removing trapped animals. Pitfall traps and silt fencing used in this study were ideal for capturing herpetofaunal, as well as small mammal species (Osbourne 2002). Funnel traps were of sufficient size for most herpetofaunal species documented in this study. Little maintenance was required upon installation of pitfalls; however, in the event of a heavy rainstorm, repairs of drift fences and buckets were often needed. Washouts due to rain and possible disruption by predators were the only problems encountered with the funnel traps.

Depending on research objectives, future herpetofaunal monitoring via pitfall arrays should be conducted during early spring and fall months when captures are markedly higher. During the summer months, time should be concentrated on capturing snake species and conducting nocturnal searches for herpetofauna, particularly the green salamander. Monitoring should continue to be conducted at least every five years to track population changes over time.

ACKNOWLEDGMENTS

This project was funded by the West Virginia Army National Guard, West Virginia University Research Corporation, and the West Virginia Agricultural and Forestry Experiment Station. We thank T. K. Pauley, J. A. Wooten, P. M. Mazik, L. B. Williams, and A. M. Anderson for reviewing this manuscript. We also thank J. M. Calhoun, D. A. Helon, S. L. Helon, J. C. McFee, L. R. Barhorst-Montas, F. R. Montas, J. D. Osbourne, M. D. Phillips, E. R. Phillips, T. J. Polesiak, N. S. Riley, L. E. Toothman, H. W. Weaver, J. D. Werther, M. D. Whitmore, and M. R. Woody for assistance with installation of pitfall arrays. We thank L. B. Williams and G. A. Blackhurst, for providing us with this opportunity to assist in the management of Camp Dawson's herpetofauna. This is scientific article number 2913 of the West Virginia University Agricultural and Forestry Experiment Station.

LITERATURE CITED

Anderson, J. T., G. M. Forcey, J. D. Osbourne, and A. B. Spurgeon. 2002. Wildlife management plans for the Camp Dawson Collective Training Area, Kingwood, West Virginia. West Virginia University, Morgantown, West Virginia, USA.

Beebee, T. J. C. 1983. The natterjack toad. Oxford University Press, New York, New York, USA.

Bell, J. W. 2001. Soil survey of Camp Dawson, Preston County, West Virginia. USDA Natural Resources Conservation Service, Moorefield, West Virginia, USA.

Blaustein, A. R. 1994. Chicken little or Nero's fiddle? A perspective on declining amphibian populations. Herpetologica 50:85-87.

Blaustein, A. R., and D. B. Wake. 1990. Declining amphibian populations: A global phenomenon? Trends in Ecology and Evolution 5:203-204.

Brown, W. S., and W. S. Parker. 1976. A ventral scale clipping system for permanently marking snakes (Reptilia, Serpentes). Journal of Herpetology 10:247-249.

Burton, T. M., and G. E. Likens. 1975. Energy flow and nutrient cycling in salamander populations in the Hubbard Brook Experimental Forest, New Hampshire. Ecology 56:1068-1080.

Bury, R. B., and P. S. Corn. 1987. Evaluation of pitfall trapping in northwestern forests: trap arrays with drift fences. Journal of Wildlife Management 51:112-119.

Busby, W. H., and J. R. Parmelee. 1996. Historical changes in a herpetofaunal assemblage in the Flint Hills of Kansas. American Midland Naturalist 135:81-91.

Cagle, F. R. 1939. A system of marking turtles for future identification. Copeia 1939:170-173.

Canterbury, R. A., and T. K. Pauley. 1994. Time of mating and egg deposition of West Virginia populations of the salamander *Aneides aeneus*. Journal of Herpetology 28:431-434.

Conant, R., and J. T. Collins. 1998. A field guide to reptiles and amphibians: eastern and central North America. Third edition. Houghton-Mifflin, New York, New York, USA.

Crother, B. I., editor. 2001. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence on our understanding. SSAR Herpetological Circular 29.

Cupp, P. V., Jr. 1971. Fall courtship of the green salamander, *Aneides aeneus*. Herpetologica 27:308-310.

Drost, C. A., and G. M. Fellers. 1996. Collapse of a regional frog fauna in the Yosemite area of California Sierra Nevada, USA. Conservation Biology 10:414-425.

Duellman, W. E., and L. Trueb. 1986. Biology of amphibians. McGraw Hill, New York, USA.

Dunson, W. A., R. L. Wyman, and E. S. Corbett. 1992. A symposium on amphibian declines and habitat acidification. Journal of Herpetology 26:349-352.

Enge, K. M. 2001. The pitfalls of pitfall traps. Journal of Herpetology 35:467-478.

Enge, K. M., and W. R. Marion. 1986. Effects of clearcutting and site preparation on herpetofauna of a north Florida flatwoods. Forest Ecology and Management 14:177-192.

Garber, S. D., and J. Burger. 1995. A 20-year study documenting the relationship between turtle decline and human recreation. Ecological Applications 5:1151-1162.

Garwood, A. N. 1996. Weather America. Toucan Valley Publications, Milpitas, California, USA.

Gordon, R. E. 1961. The movement of displaced green salamanders. Ecology 42:200-202.

Gordon, R. E., and R. L. Smith. 1949. Notes on the life history of the salamander *Aneides aeneus*. Copeia 1949:173-175.

Green, N. B., and T.K. Pauley. 1987. Amphibians and reptiles in West Virginia. University of Pittsburgh Press, Pittsburgh, Pennsylvania, USA.

Greenberg, C. H., D. G. Neary, and L. D. Harris. 1994. A comparison of herpetofaunal sampling effectiveness of pitfall, single-ended, and double-ended funnel traps used with drift fences. Journal of Herpetology 28:319-324.

Grialou, J. A., S. D. West, and R. N. Wilkins. 2000. The effects of forest clearcut harvesting and thinning on terrestrial salamanders. Journal of Wildlife Management 64:105-113.

Grover, M. C. 1998. Influence of cover and moisture on abundances of the terrestrial salamanders *Plethodon cinereus* and *Plethodon glutinosus*. Journal of Herpetology 32:489-497.

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D. C., USA.

Hunter, M. L., Jr. 1990. Wildlife, forests, and forestry: principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, New Jersey, USA.

Jaeger, R. G. 1970. Potential extinction through competition between two species of terrestrial salamanders. Evolution 24:632-642.

Krebs, C. J. 1999. Ecological methodology. Second edition. Addison Wesley Longman, Menlo Park, California, USA.

Lee, A. A., D. D. Evans, M. Bishop, T. Wilson, and M. Mauney. 2001. Delineation of wetlands and other regulated waters of Camp Dawson, WV. U. S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, Mississippi.

Lips, K. R. 1999. Mass mortality and population declines of anurans at an upland site in Western Panama. Conservation Biology 13:117-125.

Martof, B. S. 1953. Territoriality in the green frog, *Rana clamitans*. Ecology 34:165-174.

McCoy, C. J. 1965. Mountain earth snake in West Virginia. The Redstart 32:108.

McLeod, R. F. and J. E. Gates. 1998. Response of herpetofaunal communities to forest cutting and burning at Chesapeake Farms, Maryland. American Midland Naturalist 139:164-177.

Mengak, M. T., and D. C. Guynn, Jr. 1987. Pitfalls and snap traps for sampling small mammals and herpetofauna.

American Midland Naturalist 118:284-288.

Mitchell, J. C., T. K. Pauley, D. I. Withers, S. M. Roble, B. T. Miller, A. L. Braswell, P.V. Cupp, and C. S. Hobson. 1999. Conservation status of the southern Appalachian herpetofauna. Virginia Journal of Science 50:13-36.

Noble, G. K. 1931. The biology of amphibia. McGraw-Hill, New York, New York, USA.

Osbourne, J. D. 2002. Effects of edge and coarse woody debris on small mammal communities in riparian and upland habitats in northern West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Osbourne, J. D., J. T. Anderson, L. B. Williams, and J. A. Simcoe. 2002. Natural resource management on the Camp Dawson Collective Training Area in Preston County, West Virginia. Proceedings of the West Virginia Academy of Sciences 74:1-7.

Pauley, T. K. 1984. The distribution of Virginia valeriae pulchra in West Virginia. Proceedings of the West Virginia Academy of Science 56:6-7.

Pauley, T. K. 1993. Amphibian and reptiles of the upland forests. Pages 179-196 *in* S. L. Stephenson, editor. Upland Forests of West Virginia. McClain Publishing Company, Parsons, West Virginia, USA.

Pechmann, J. H. K., D. E. Scott, R. D. Semlitsch, J. P. Caldwell, L. J. Vitt, and W. Gibbons. 1991. Declining amphibian populations: the problem of separating human impacts from natural populations. Science 253:892-895.

Pechmann, J. H. K., and H. M. Wilbur. 1994. Putting declining amphibian populations in perspective: natural fluctuations and human impacts. Herpetologica 50:65-84.

Phillips, K. 1990. Where have all the frogs and toads gone? BioScience 40:422-424.

Ream, C., and R. Ream. 1966. The influence of sampling method on the estimation of population structure in painted turtles. American Midland Naturalist 75:325-338.

SAS Institute. 1995. SAS/STAT User's Guide. SAS Institute, Cary, North Carolina, USA.

Spurgeon, A. B. 2002. Comparison of herpetofaunal species composition and response to edge on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Vanderhorst, J. 2001. Plant community classification and mapping of the Camp Dawson Collective Training Area, Preston County, West Virginia. West Virginia Division of Natural Resources, Elkins, West Virginia, USA.

Vitt, L. J., J. P. Caldwell, H. M. Wilbur, and D. C. Smith. 1990. Amphibians as harbingers of decay. BioScience 40:418.

Wake, D. B. 1991. Declining amphibian populations. Science 253:860.

West Virginia Division of Natural Resources. 2000. Natural Heritage Program rare species list. www.dnr.state.wv.us/wvwildlife/species_checklist.htm

Table 1. List of all amphibians and reptiles captured via pitfall arrays, complete searches, and visual encounters on the Camp Dawson Collective Training Area, Preston County, West Virginia, during 2000 and 2001.

Family	Common name	2000			2001		
		Cantonment	Briery	Pringle	Cantonment	Briery	Pringle
Salamandridae	Red-spotted Newt (eft)	7	11	25	11	39	93
Plethodontidae	Northern Dusky Salamander	0	1	0	0	2	0
Plethodontidae	Mountain dusky salamander	12	4	5	41	7	36
Plethodontidae	Seal Salamander	8	2	0	36	24	0
Plethodontidae	Eastern Red-backed Salamander	44	35	116	35	63	149
Plethodontidae	Northern Slimy Salamander	17	4	16	3	7	26
Plethodontidae	Four-toed Salamander	1	4	11	1	4	10
Plethodontidae	Northern Spring Salamander	0	1	0	4	0	0
Plethodontidae	Northern Red Salamander	0	2	0	17	2	1
Plethodontidae	Northern Two-lined Salamander	0	0	0	1	2	3
Plethodontidae	Long-tailed Salamander	1	0	0	0	0	0
Bufonidae	American Toad	17	36	8	45	47	24
Bufonidae	Fowler's Toad	2	0	0	0	0	0
Hylidae	Northern Spring Peeper	3	0	0	0	0	0
Hylidae	Gray Treefrog	2	0	0	0	0	0
Ranidae	Northern Green Frog	7	4	1	22	1	34
Ranidae	Wood Frog	20	9	31	32	11	95
Ranidae	Pickerel Frog	7	8	1	9	1	3
Chelydridae	Eastern Snapping Turtle	1	0	1	2	0	0
Emydidae	Eastern Painted Turtle	1	0	0	0	0	0
Emydidae	Eastern Box turtle	0	0	0	0	0	0
Colubridae	Common Watersnake	1	0	1	0	1	0
Colubridae	Eastern Gartersnake	3	1	0	0	0	0
Colubridae	Northern Ring-necked Snake	0	0	2	1	1	3

Table 1. Continued.

Family	Common name	2000 Cantonment	2000 Briery	2000 Pringle	2001 Cantonment	2001 Briery	2001 Pringle
Colubridae	Northern Black Racer	0	0	1	0	0	0
Colubridae	Smooth Greensnake	0	1	0	0	0	0
Colubridae	Black Ratsnake	0	0	1	0	0	0
Colubridae	Eastern Milksnake	0	0	0	0	2	0
TOTALS		154	123	220	260	214	479

Table 2. Mean captures/100 trap nights for each of the 24 herpetofaunal species documented via pitfall arrays on the 3 tracts of the Camp Dawson Collective Training Area, Preston County, West Virginia, during 2000 and 2001.

	Cantonment Area		Briery Mountain		Pringle Tract	
Common name	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Red-backed Salamander	0.454	0.234	0.181	0.066	0.599	0.150
Red-spotted Newt (eft)	0.120	0.050	0.264	0.076	0.306	0.068
American Toad	0.223	0.039	0.324	0.071	0.089	0.040
Wood Frog	0.158	0.048	0.100	0.035	0.318	0.058
Northern Dusky Salamander	0.000	0.000	0.008	0.005	0.000	0.000
Mountain Dusky Salamander	0.110	0.058	0.019	0.015	0.036	0.016
Seal Salamander	0.099	0.083	0.008	0.008	0.000	0.000
Slimy Salamander	0.070	0.051	0.023	0.013	0.094	0.028
Four-toed Salamander	0.006	0.006	0.047	0.018	0.083	0.033
Northern Spring Salamander	0.011	0.008	0.004	0.004	0.000	0.000
Northern Red Salamander	0.028	0.028	0.012	0.008	0.001	0.001
Northern Two-lined Salamander	0.000	0.000	0.002	0.002	0.000	0.000
Long-tailed Salamander	0.012	0.012	0.000	0.000	0.000	0.000
Fowler's Toad	0.006	0.006	0.000	0.000	0.000	0.000
Northern Spring Peeper	0.015	0.012	0.000	0.000	0.000	0.000
Gray Treefrog	0.006	0.004	0.000	0.000	0.000	0.000
Green Frog	0.111	0.044	0.017	0.012	0.064	0.023
Pickerel Frog	0.122	0.073	0.033	0.021	0.006	0.003
Eastern Snapping Turtle	0.011	0.007	0.000	0.000	0.002	0.002
Eastern Gartersnake	0.015	0.009	0.012	0.009	0.006	0.004
Northern Ring-necked Snake	0.000	0.000	0.000	0.000	0.013	0.006
Smooth Greensnake	0.000	0.000	0.004	0.004	0.000	0.000
Black Ratsnake	0.000	0.000	0.000	0.000	0.002	0.002
Eastern Milksnake	0.000	0.000	0.004	0.003	0.000	0.000

Table 3. Means and standard errors for herpetofaunal species documented among the 5 distance categories in which complete searches were conducted throughout the Camp Dawson Collective Training Area, Kingwood, West Virginia, during 2000 and 2001.

	Distance categories									
	0-25 m		26-50 m		51-75 m		76-100 m		101-125 m	
Variable	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Overall herpetofaunal abundance	1.47	0.340	1.35	0.290	1.65	0.400	1.41	0.320	1.71	0.500
Overall species richness	0.85	0.140	0.71	0.150	0.79	0.150	0.82	0.140	0.62	0.130
Species diversity	0.36	0.050	0.35	0.030	0.36	0.040	0.33	0.030	0.36	0.040
Abundance										
Red-backed Salamander	0.50	0.140	0.56	0.170	0.82	0.272	0.53	0.180	0.56	0.232
Mountain Dusky Salamander	0.44	0.228	0.15	0.100	0.24	0.112	0.32	0.167	0.47	0.308
Seal Salamander	0.18	0.149	0.26	0.114	0.35	0.227	0.29	0.187	0.53	0.287
Red-spotted Newt	0.00	0.000	0.03	0.029	0.00	0.000	0.03	0.029	0.09	0.065
Slimy Salamander	0.18	0.060	0.12	0.118	0.15	0.075	0.06	0.041	0.06	0.041
Northern two-lined Salamander	0.00	0.000	0.00	0.000	0.06	0.041	0.09	0.065	0.00	0.000
Four-toed Salamander	0.00	0.000	0.00	0.000	0.00	0.000	0.03	0.029	0.00	0.000
Northern Spring Peeper	0.00	0.000	0.00	0.000	0.03	0.029	0.00	0.000	0.00	0.000
American Toad	0.06	0.041	0.03	0.029	0.00	0.000	0.03	0.029	0.00	0.000
Northern Ring-necked Snake	0.00	0.000	0.00	0.000	0.00	0.000	0.03	0.029	0.00	0.000

FISH OCCURRENCE ON THE CAMP DAWSON COLLECTIVE TRAINING AREA, KINGWOOD, WEST VIRGINIA

STUART A. WELSH,* West Virginia Cooperative Fish and Wildlife Research Unit, West Virginia University, Morgantown, WV 26506-6125, USA. * swelsh@wvu.edu, JAMES T. ANDERSON, West Virginia University, Division of Forestry, Wildlife and Fisheries Resources Program, Morgantown, WV 26506-6125, and DAN A. CINCOTTA, West Virginia Division of Natural Resources, Elkins, WV 26241.

ABSTRACT

During July and August 2000, we inventoried fishes of the Camp Dawson Collective Training Area, Kingwood, West Virginia to assist the West Virginia Army National Guard with an Integrated Natural Resources Management Plan (INRMP). Fishes were sampled with 1.5 m x 3.0 m x 0.125 cm (5 ft x 10 ft x 1/8 in) seine and back-pack electrofisher at 13 sites (4 ponds and 9 stream sites). Objectives were to compile a list of fish species that occur within the Camp Dawson Collective Training Area and document the presence of rare species. Although West Virginia does not have federally threatened or endangered fishes, the Natural Heritage Program of the West Virginia Division of Natural Resources (WVDNR) maintains a list of rare species. Popeye shiners (*Notropis ariommus*) and bluebreast darters (*Etheostoma camurum*) are listed by WVDNR as rare species and have been collected in the Cheat River mainstem in previous surveys. We collected 22 fish species, including bluebreast darters. No fishes were collected at eight sites; most stream sites without fishes were severely impacted by acid mine drainage (AMD). An additional 19 fish species have been collected during previous surveys by WVDNR near the Camp Dawson area. Although we did not collect popeye shiners during our surveys, we expect it occurs in the Cheat River within the Camp Dawson Collective Training Area. Acid mine drainage clearly has the largest impact on aquatic stream fauna within the Camp Dawson Collective Training Area, and may explain the absence of many species during our surveys.

INTRODUCTION

The Sikes Act (16 U.S.C. §§ 670a et seq.) mandates development and implementation of an INRMP for lands used by military departments. A five year INRMP for Camp Dawson Collective Training Area, Preston County, West Virginia, was completed and approved in 2001 (West Virginia Army National Guard 2001). The INRMP, in part, requires faunal surveys with emphasis on federally threatened and endangered species. Although West Virginia does not have federally listed fish species, the West Virginia Wildlife Diversity Program (WVWDP) of the West Virginia Division of Natural Resources (WVDNR) lists three rare species that occur within the Cheat River drainage; popeye shiner (*Notropis ariommus*), Cheat minnow (*Pararhinichthys bowersi*), and bluebreast darter (*Etheostoma camurum*) (WVWDP 2000). The primary objective of our faunal inventory was to determine if rare species occur within the Camp Dawson Collective Training Area.

Few ichthyofaunal surveys have been conducted on the Camp Dawson Collective Training Area. Fishes collected during surveys of Cheat River near Camp Dawson, however, are likely representative of those that occur within the Camp Dawson Collective Training Area. The WVDNR conducted rotenone surveys on 18 September 1995 and 20 August 1999 near Rowlesburg, West Virginia (approximately 16 km upstream of Camp Dawson) and on 19 August 1999 near Albright, West Virginia (approximately 4 km downstream of Camp Dawson). Also, fishes collected in surveys within or near Camp Dawson were reported by Core et al. (1959) and Stauffer et al. (1995).

MATERIALS AND METHODS

Study area

The Camp Dawson Collective Training Area, managed and operated by the West Virginia Army National Guard, is comprised of three non-contiguous training areas: Cantonment Area (378 ha, state and federally owned), Briery Mountain Tract (423 ha, state owned), and Pringle Tract (854 ha, privately owned). The Cheat River bisects Camp Dawson Proper, and several of its tributaries occur within the Volkstone (Church Creek Run), Briery Mountain (Stamping Ground Run), and Pringle tracts (Pringle Run). The Cheat River mainstem at Camp Dawson is influenced by AMD from Pringle Run, Lick Run, Church Creek Run, and tributaries upstream of Camp Dawson. Collectively, Camp Dawson has 33.8 km of streams, 3.4 ha of ponds, and 3.8 ha of wetlands (Lee et al. 2001). More details on the study area are found in Forcey (2002), Osbourne (2002), and Spurgeon (2002).

Fish collections

Thirteen sites (4 ponds and 9 stream sites) were sampled, which represent most of the aquatic area on Camp Dawson, with a 1.5 m x 3.0 m x 0.125 cm (5 ft x 10 ft x 1/8 in) seine or back-pack electrofisher on 18 July and 24 August, 2000, as part of a faunal survey of the Camp Dawson Collective Training area. The Cheat River and tributaries that occur within Camp Dawson's three primary training areas were sampled, and include Stamping Ground Run, Pringle Run, Lick Run, Church Creek Run, and four ponds. A 100-m section, with all available habitat types (pool, run, and riffles), was sampled within each tributary. Additionally, a 100 m section of Cheat River was sampled upstream of the mouth of Pringle Run, and 100 m sections were sampled on each side of the island in the Cheat River adjacent to Camp Dawson. Collections within the Cheat River were limited to backwater island habitats and near-shore habitats.

RESULTS AND DISCUSSION

A total of 41 fish species have been reported from within or near the Camp Dawson Collective Training Area. We collected 22 fish species during 2000 (Table 1). An additional 19 fish species were collected previously by WVDNR in 1995 and 1999 during rotenone surveys near the Camp Dawson area (Table 1).

Fishes were not collected from seven tributaries and a small pond on the Volkstone Tract during July and August 2000. Pringle Run (3 sites), Church Creek Run (1 site), and Lick Run (1 site) were without fishes and severely degraded by AMD. The absence of fishes at two sites on Stamping Ground Run may reflect the headwater sampling location or a lack of suitable habitat, rather than water quality.

Rare species

Popeye shiners (*Notropis ariommus*) were not collected during July and August 2000, but were collected during WVDNR rotenone surveys within the vicinity of Camp Dawson. The WVDNR conducted rotenone surveys on Cheat River near Rowlesburg (18 September 1995 and 20 August 1999) and Albright (19 August 1999), and collected 23, 15, and 71 popeye shiners, respectively. The probability of detecting rare species is low when backpack electrofishing in a large river (Thompson et al. 1998), and our surveys during July and August 2000 probably failed to detect the presence of popeye shiners. Popeye shiners are likely present within the Camp Dawson Collective Training Area given their occurrence upstream and downstream of Camp Dawson in 1999. We collected bluebreast darters in Cheat River above the mouth of Pringle Run. The WVDNR collected 326, 60, and 91 bluebreast darters during rotenone surveys at Rowlesburg (1995 and 1999) and Albright (1999), respectively. The Cheat minnow has not been collected in the vicinity of Camp Dawson. Previous surveys (Stauffer et al. 1995; WVDNR Unpublished data) indicate that the distribution of the Cheat minnow within the Cheat River watershed is restricted to areas upstream of Camp Dawson. Additional studies are needed to delineate the range of this species.

Acid Mine Drainage is clearly the largest threat to stream fishes within the Cheat River and tributaries within and near the Camp Dawson Collective Training area. Despite water quality issues, surveys indicate that popeye shiners and bluebreast darters are abundant in the Cheat River in the vicinity of Camp Dawson.

ACKNOWLEDGMENTS

This project was funded by the West Virginia Army National Guard, West Virginia University Research Corporation, and the West Virginia Agricultural and Forestry Experiment Station. Distribution data were provided by F. Jernejcic (WVDNR) and F. Schwartz. We thank K. J. Hartman and F. Jernejcic for reviewing this manuscript. This is scientific article number 2914 of the West Virginia University Agricultural and Forestry Experiment Station.

LITERATURE CITED

Core, E.L., B.G. Anderson, L.H. Taylor, C.H. Baer, R.L. Birch, C. Norman, F.J. Schwartz, F.D. Basnett, H.J. Rohr, J.W.A. Burley, J.W. Gorman, J. Hamilton, K. Hatfield, W. Meredith, J. Sawyer, and G. Struthers. 1959. Biological investigations of Cheat Lake. Dept. of Biology, West Virginia University, Morgantown. 39 pp.

Forcey, G. M. 2002. An evaluation of double-observer point count techniques and avian habitat use on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Osbourne, J. D. 2002. Effects of edge and coarse woody debris on small mammal communities in riparian and upland habitats in northern West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Spurgeon, A. B. 2002. Comparison of herpetofaunal species composition and response to edge on the Camp Dawson Collective Training Area, Preston County, West Virginia. Thesis, West Virginia University, Morgantown, West Virginia, USA.

Stauffer, J. R., J. M. Boltz, and L. R. White. 1995. The fishes of West Virginia. Proceedings of the Academy of Natural Sciences of Philadelphia 146:1-389.

Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, New York, New York, USA.

West Virginia Army National Guard. 2001. Integrated natural resources management plan and environmental assessment. West Virginia Army National Guard, Kingwood, West Virginia, USA.

West Virginia Natural Heritage Program. 2000. Rare species list of vertebrates. Division of Natural Resources, Elkins, West Virginia, USA.

Table 1. List of fish species occurring within or near Camp Dawson Collective Training Area, Kingwood, West Virginia.

Common Name	Species	Survey[a]
Central stoneroller	*Campostoma anomalum*	WVDNR,FWV,S
Spotfin shiner	*Cyprinella spiloptera*	WVDNR,FWV
Common carp	*Cyprinus carpio*	WA
Silverjaw minnow	*Ericymba buccata*	FWV,S
Striped shiner	*Luxilus chrysocephalus*	WVDNR,FWV
River chub	*Nocomis micropogon*	WVDNR,WA,FWV,S
Popeye shiner	*Notropis ariommus*	WVDNR
Silver shiner	*Notropis photogenis*	WVDNR,WA,FWV,S
Rosyface shiner	*Notropis rubellus*	WVDNR,WA,FWV,S
Sand shiner	*Notropis stramineus*	WA, FWV,S
Mimic shiner	*Notropis volucellus*	WVDNR
Bluntnose minnow	*Pimephales notatus*	WVDNR,FWV
Blacknose dace	*Rhinichthys atratulus*	WVDNR,FWV,S
Longnose dace	*Rhinichthys cataractae*	WVDNR,FWV,S
Creek chub	*Semotilus atromaculatus*	WVDNR,WA,FWV,S
White sucker	*Catostomus commersoni*	WVDNR,FWV,S
Northern hogsucker	*Hypentelium nigricans*	WVDNR,WA,FWV,S
Golden redhorse sucker	*Moxostoma erythrurum*	WVDNR,WA,FWV,S
Yellow bullhead	*Ameiurus natalis*	WVDNR, WA
Brown bullhead	*Ameiurus nebulosus*	FWV
Stonecat	*Noturus flavus*	WVDNR,WA,FWV
Brindled madtom	*Noturus miurus*	WVDNR
Brown trout	*Salmo trutta*	WVDNR
Brook trout	*Salvelinus fontinalis*	WVDNR
Mottled sculpin	*Cottus bairdi*	WVDNR,FWV
Rock bass	*Ambloplites rupestris*	WVDNR,WA,FWV
Black crappie	*Pomoxis nigromaculatus*	WA
Smallmouth bass	*Micropterus dolomieu*	WVDNR,WA,FWV
Largemouth bass	*Micropterus salmoides*	WVDNR,WA
Green sunfish	*Lepomis cyanellus*	WVDNR,FWV
Pumpkinseed	*Lepomis gibbosus*	FWV,S
Bluegill	*Lepomis macrochirus*	WVDNR,WA,FWV
Longear sunfish	*Lepomis megalotis*	WA
Greenside darter	*Etheostoma blennioides*	WVDNR,WA,FWV,S
Rainbow darter	*Etheostoma caeruleum*	WVDNR
Bluebreast darter	*Etheostoma camurum*	WVDNR,WA,FWV
Fantail darter	*Etheostoma flabellare*	WVDNR, WA
Johnny darter	*Etheostoma nigrum*	WVDNR,WA
Variegate darter	*Etheostoma variatum*	WVDNR,WA,FWV,S
Banded darter	*Etheostoma zonale*	WVDNR,WA,FWV,S
Logperch	*Percina caprodes*	WVDNR,FWV

[a] FWV= Fishes of West Virginia (Stauffer et al. 1995), WA= Welsh and Anderson (July-August 2000), and WVDNR (1995 and 1999 rotenone surveys), S= F.J. Schwartz (Core et al. 1959, field notes 1956).