ABSTRACT OF THESIS

DIET AND PREY ABUNDANCE OF THE OZARK BIG-EARED BAT (*CORYNORHINUS TOWNSENDII INGENS*) IN ARKANSAS

Although moths are the primary prey of the Ozark big-eared bat (*Corynorhinus townsendii ingens*), it is unclear how this prey base varies over the landscape. I investigated patterns of moth occurrence around roosts of this federally endangered bat and examined its diet to determine what prey were consumed. Different habitats were sampled via blacklight traps during June-August 2004 and May-August 2005 near roosts at two study areas in Arkansas. Marion County is a fragmented landscape; therefore, habitats studied were upland forest, riparian forest, edge, and field. Crawford County lies in the Ozark National Forest; therefore, habitats studied were sawtimber, poletimber, and sapling size classes. Moths were enumerated, yielding measures of abundance and taxonomic richness as well as microlepidopteran (< 20 mm wingspan) biomass. I collected 8,720 moths in 2005, constituting ≥ 314 species within 22 families. Fields yielded a lower abundance and taxonomic richness of moths than other habitats in Marion County ($P < 0.05$). These demographics were not related to roost location. Conversely, abundance and taxonomic richness of moths in Crawford County did not vary by habitat, but by roost location ($P < 0.05$). Common moth families ($n > 100$) varied in selection of forested habitats ($P < 0.01$). Patterns of woody vegetation suggested that species richness, not density or forest structure, was correlated with moth occurrence. Moth wings discarded by the Ozark big-eared bat were collected from roosts to assess prey consumption. Noctuid and Notodontid moths were consistently consumed by the Ozark big-eared bat in both counties, but consumption of other taxa differed. Geometridae and, to a lesser extent, Arctiidae were consumed in Marion County, but were generally not consumed in Crawford County. In contrast, Sphingidae were a portion of the diet in Crawford County, but were not consumed in Marion County. Differential consumption patterns could reflect differences in land use or habitat availability between counties. Future management around roosts should encourage heterogeneity of forest habitat, specifically through maintenance of riparian and cliffline habitats, as these areas enrich the diversity of forest moth assemblages and potentially serve as foraging corridors for the Ozark big-eared bat within prey-rich habitats.

KEYWORDS: bats, *Corynorhinus townsendii*, lepidoptera, moths, predator-prey interactions

DIET AND PREY ABUNDANCE OF THE OZARK BIG-EARED BAT
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By

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2006

DIET AND PREY ABUNDANCE OF THE OZARK BIG-EARED BAT
(*CORYNORHINUS TOWNSENDII INGENS*) IN ARKANSAS

THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the College of Agriculture at the University of Kentucky

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2006

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CHAPTER 1: INTRODUCTION

The Ozark big-eared bat (*Corynorhinus townsendii ingens*; OB) is a subspecies of the Townsend's big-eared bat (TB) endemic to the Ozark Mountains of northeast Oklahoma (Caire et al. 1989) and northwest Arkansas (Sealander and Heidt 1990). This subspecies was listed as federally endangered in 1979 (US Fish and Wildlife Service 1984, agency hereafter USFWS), and has yet to recover. Presumed to be extirpated from Missouri, this subspecies is known to roost in over 100 caves, cliffs, and talus piles throughout its current range (USFWS 1995). Despite this fact, population numbers of OB remain precariously low throughout the distribution of this subspecies (Clark et al. 1997). The total surviving OB population is probably less than 2,000 individuals, with ca. 1,400 of these bats inhabiting a few caves in eastern Oklahoma (Harvey and Redman 2003). The Arkansas population for the winter 2002-2003 was estimated at 200 individuals combined for the two known hibernacula (Harvey and Redman 2003). Surveys of the four known maternity caves in Arkansas yielded a population estimate over 500 individuals for the summer 2003 (Harvey and Redman 2003). As a consequence of a low population size concentrated in a limited number of known roost sites, this bat is in a position susceptible to acts of disturbance on the landscape surrounding their restricted distribution.

Though it is known that OB is a moth specialist, specific taxa within its diet are unknown beyond the ordinal level (Leslie and Clark 2002). Further, previous studies of habitat use by this bat (Clark et al. 1993, Wethington et al. 1996) and its prey (Leslie and Clark 2002) have only considered broadly classified habitats. My research increases the specificity of habitats under study to obtain information more applicable to management decisions. Finally, the lack of data regarding changes in moth assemblages (language sensu Fauth et al. 1996) with changes in habitat, further inhibits management decisions, as it is unclear how anthropogenic manipulations of vegetation are likely to affect the prey base of OB. It is these points that I addressed to aid land stewards in their actions to recover this species from the precipice of extinction.

1.1 Project Objectives and Hypotheses Tested

This project evaluated prey availability and consumption of OB. The goal of this project was to provide a database that will permit a more knowledgeable approach to management decisions regarding OB and its habitat, ultimately lending support to the long-term recovery objectives for this imperiled species. The objectives of this research project were as follows:

1) Develop a list of the abundance of moth species by taxonomic families present within a 10-km radius of known OB roosts in Arkansas.
2) To quantify the seasonal abundance or biomass of moths, by species and family, at major habitats present within a 10-km radius of roosts used by OB in Arkansas.
3) To determine if relationships exist between the abundance and diversity of moth species and the presence and diversity of woody plant species in the habitats examined.
4) To determine at the most specific taxon possible the moth prey of OB in Arkansas and, to the extent allowed, eastern Oklahoma.

5) To determine if prey selection of moths by OB is a consequence of landscape occurrence or due to morphological susceptibility of prey.

These objectives played an integral role in addressing the following hypotheses:

H_A: The moth assemblages surrounding OB roosts in Arkansas vary by location and landscape.

H_A: OB exhibits dietary selection among available moth taxa.

1.2 Natural History and Ecology of the Ozark Big-Eared Bat

TB is a medium-sized bat (5-13 g) within the family Vespertilionidae with a distinguishable appearance (Kunz and Martin 1982, Sealander and Heidt 1990). The pinnae are very large with narrow tips. This bat is characterized by prominent lumps on each side of the muzzle in front of the eyes. TB is distinguished from its relative, the Rafinesque's big-eared bat (*C. rafinesquii*; RB), by its pelage, as TB possesses pinkish buff hairs on the abdomen, hairs that do not project beyond the toes, and hair of solid coloration (Sealander and Heidt 1990). Though identification of these bats is somewhat difficult, their distributions coincide only slightly in the state of Arkansas, with overlap limited to southwest Crawford County (Sealander and Heidt 1990). Distribution maps suggest RB is generally not found in the Ozarks except in the southwest reaches of this region (Sealander and Heidt 1990).

*Corynorhinu*s, once a subgenus within *Plecotus* (Handley 1959), is now generally recognized as the generic taxon of TB (e.g., Bogdanowicz et al. 1998, Hoofer and Van den Bussche 2001). This species is the most variable of the North American plecotine bats, with five subspecies distributed throughout the continent (Kunz and Martin 1982). There exist two subspecies of TB in the eastern United States, the Virginia big-eared bat (*C. t. virginianus*; VB) and the species studied in this project, OB (Harvey and Barkley 1990). These two eastern subspecies are viewed as relict populations of TB due to post-Pleistocene climate change (Kunz and Martin 1982). These two subspecies and their congener, RB, represent the complex of plecotine bats present in the eastern United States (Barbour and Davis 1969).

OB is a cave-obligate species roosting in caves or mines throughout the year (Sealander and Heidt 1990), though different caves are typically used during cold and warm seasons (Harvey and Barkley 1990). The cave shelters used by OB are variable in their form and composition, ranging from karst limestone (e.g., Blue Heaven Cave) to sandstone talus (e.g., Devil's Hollow roost area). Regardless of a roost's character, OB are "twilight roosters," tending to roost in well-ventilated areas near cave entrances that are relatively warm compared to other portions of the cave (Harvey and Barkley 1990, Sealander and Heidt 1990); a behavior that no doubt contributes to its imperiled position (USFWS 1995). If temperatures in roosts become too extreme, these bats will move to more thermally stable portions of the cave (Harvey and Barkley 1990, Sealander and Heidt 1990). Temperatures in hibernacula (caves used for hibernation) are ca. 12° C or less, but always above freezing (Harvey and Barkley 1990, Sealander and Heidt 1990, Harvey and Redman 2003). Maternity groups roost during summer months in warm portions of caves (Harvey and Barkley 1990) and disband in August after the young are weaned (Sealander and Heidt 1990). There is little conclusive evidence for where males roost during the summer months, but it is assumed they typically are solitary roosters

(Harvey and Barkley 1990, Clark et al. 1993, Harvey and Redman 2003), as solitary OB are occasionally encountered at feeding roosts during the summer (W. Puckette, USFWS, pers. comm.).

There has been little study of the reproduction of TB in the eastern United States, but extensive work on TB in California has been done by Pearson et al. (1952). Though physiological patterns and sequence of events are probably the same or very similar, the timing of these events surely varies by geography and climate (Kunz and Martin 1982, Sealander and Heidt 1990). Despite this, general seasonal inferences can be made in the application of existing data to eastern TB species (e.g., Shoemaker 1994). Spermatogenesis in males occurs during late summer, and reaches its peak in September, after which the testes begin to atrophy with appearance of sperm in the epididymides (Kunz and Martin 1982). Mating occurs from October to February while at the hibernacula, and the sexes segregate in spring when maternity colonies are formed (Sealander and Heidt 1990). Females store sperm until ovulation, when fertilization and gestation occur (Kunz and Martin 1982), typically from February to April (Sealander and Heidt 1990). Parturition of a single offspring occurs in late May or early June (Sealander and Heidt 1990). Young TB grow rapidly, becoming volant at about three weeks old and reach nearly full size at one month (Sealander and Heidt 1990).

It is generally accepted that plecotine bats use a hover-gleaning foraging strategy (taking prey from vegetation and surfaces while in flight; Norberg and Raynor 1987), an uncommon, but well represented strategy in the forests of North America (Burford et al. 1999, Lacki et al. 2007). It is hypothesized that plecotine bats, and gleaners in general, act as "predatory cheaters," as this strategy imparts little evolutionary pressure upon the auditory adaptations of insect prey (Faure et al. 1993, Burford et al. 1999). In direct relation to this, *Corynorhinus* of eastern North America are thought to be moth specialists, demonstrating high selection for this insect order (> 80% volume in diet; Lacki et al. 2007). Despite knowledge of this general pattern in prey selection, the diet of OB is taxonomically unknown below the ordinal level (Leslie and Clark 2002), in contrast to the more comprehensive research that exists for RB (Hurst and Lacki 1997, Lacki and LaDeur 2001) and VB (Dalton et al. 1986, Sample and Whitmore 1993, Burford and Lacki 1998). The ecomorphology (biological context associated with a species' morphology; Karr and James 1975) of these bats, particularly their echolocation structure and flight capability, make *Corynorhinus* iconic examples of foraging specialists in North American forests (Lacki et al. 2007).

The echolocation structure of TB, adept at distinguishing insect prey from background substrate and clutter such as vegetation (sensu Schnitzler and Kalko 2001), is categorized as broadband frequency-modulated (FM) echolocation emitted for short periods of time (≤ 2 ms; Norberg and Raynor 1987). Frequencies range from 20-90 kHz at repetitions of 10-20 s (Kunz and Martin 1982). Low intensity, short echolocation pulses are thought to allow high precision in the discrimination of prey targets on vegetation over short distances without overlap of echolocation pulses (Schnitzler and Kalko 2001); a call structure parsimonious with the hover-gleaning strategy (Norberg and Raynor 1987). The relatively low intensity echolocation (40 to 50 db lower than *Myotis lucifugus*) that TB uses appears to coincide with the large pinnae that are a distinguishing character (Kunz and Martin 1982). In conjunction with this, passive-listening is also employed by gleaners such as TB; it is hypothesized that listening for prey-generated sounds reduces the risk of alerting prey (Norberg and Raynor 1987, Anderson and Racey 1991, Anderson and Racey 1993, Waters and Jones 1996, Waters 2003). TB possesses two regions of auditory sensitivity, one near the fundamental frequency and the other near the second harmonic (Kunz and Martin 1982). Keenly tuned hearing, in conjunction with the ability of these bats to directionally orient pinnae (Kunz and Martin 1982), grants a highly effective auditory perception of the nocturnal forest world. Further, the remarkable hearing and relatively quiet echolocation of gleaners such as TB yield a foraging advantage against eared insect prey that is not afforded with aerial hawking (Faure et al. 1993).

Flight of TB, and plecotine bats in general, is specialized for maneuverability (Kunz and Martin 1982, Norberg and Raynor 1987). Plecotine bats possess a relatively low wing loading (mass of bat divided by total wing area; sensu Aldridge and Rautenbach 1987) which allows a higher degree of maneuverability (Norberg and Raynor 1987, Kunz and Martin 1982). Even with this similarity, differences exist between RB and the TB of eastern North America. RB possesses an average aspect ratio (the length of the wingspan squared divided by the surface area of the wing; sensu Aldridge and Rautenbach 1987) and relatively long-wings, yielding an agile, slow-flying bat adapted to forage along edges of clutter (Norberg and Raynor 1987). In regard to these biometrics, TB is further adapted for maneuverability in a complex forest environment. TB possesses an average wingspan and a low aspect ratio (Kunz and Martin 1982, Norberg and Raynor 1987), permitting slow flight close to and within clutter (Norberg and Raynor 1987).

Radiotelemetry research in Oklahoma has provided information regarding foraging activities of OB. Maximum distances to foraging areas reported for adult female

OB were 4.2 km in late lactation (Clark et al. 1993). Regardless, median distances traveled to foraging areas by adult females were less than 2 km during other times of the year (Clark et al. 1993, Wethington et al. 1996). Male OB moved a maximum distance of 5.5 km to foraging areas, though the median distance traveled was 2.4 km (Wethington et al. 1996). The number of foraging areas per female OB varied from one to four during a given telemetry period (Clark et al. 1993, Wethington et al. 1996), and consisted of sizes ranging from 0.37 km^2 to 7.27 km^2 (Clark et al. 1993). Males varied less than females in their use of foraging habitat by using only one or two foraging areas ranging in size from 0.2 km^2 to 1.6 km^2 (Wethington et al. 1996).

Comparison of this information with data compiled for VB in eastern Kentucky (Adam et al. 1994) suggests that OB possesses a larger foraging area. In addition, OB seems to forage over larger areas than that of RB (Hurst and Lacki 1999, Menzel et al. 2001). Due to these patterns, research examining prey availability of OB should consider a larger foraging area than that of either RB or VB.

Hypotheses regarding foraging and maneuverability of bats within clutter that are based on ecomorphology (e.g., Norberg and Raynor 1987) appear to be correct for the plecotine bats of eastern North America, though plasticity exists in particular habitats used across the distributions of these bats (Hurst and Lacki 1999). Differences in wing morphology between TB and RB may be reflected in variation in habitat use between the species. Research suggests that RB tends to use interior forest habitats, whereas TB tends to use forest clearings and riparian areas (Lacki et al. 2007). RB is known to inhabit a diversity of forest types. Bottomland hardwood habitat (Clark 1990, Clark 1991b), hardwood hammocks, and pine flatwoods (Moore 1949) were traditionally thought to be habitat used by this bat, though further research has revealed selection for both pine-dominated upland habitats (England et al. 1990, Menzel et al. 2001) and upland oak-hickory habitat (Hurst and Lacki 1999).

In general, TB is found throughout a mixture of both conifer and mesic deciduous forest (Kunz and Martin 1982), with eastern subspecies favoring well-drained oak-hickory forest generally associated with cliffs, caves, and rock ledges (Barbour and Davis 1969, USFWS 1995). VB appears quite variable in habitat use. Clifflines and the immediate forest near these areas were selected by some VB in Kentucky (Adam 1992, Lacki et al. 1993, Adam et al. 1994), though VB has also been found to forage in a diversity of open habitats, using “old field” habitat in Kentucky (Burford and Lacki 1995) and field habitat in Virginia (agricultural [corn and alfalfa]; Dalton et al. 1989).

Habitat use and selection by OB has been studied and, like its congeners, is not parsimonious. OB primarily forage near tree and shrubs (USFWS 1995, Clark et al. 1993, Harvey and Redman 2003) and are thought to use edge habitats along intermittent streams and mountain slopes (Clark 1991a). Clark et al. (1993) found that female OB used edge between forest and open habitat more than expected and forest habitat less than expected. Open habitat (pasture, crop, or native grasses) was used in proportion to its availability during early and late lactation, but was avoided in mid-lactation. In agreement with this are findings by Wilhide et al. (1998) based on OB radiotracked at Reed Cave in Marion County, Arkansas. Though no effort at quantitative analysis was made, mapping of radiotelemetry points suggested OB followed the courses of intermittent streams and gullies. At a finer resolution of habitat data (25 m) than that of Clark et al. (1993), Wethington et al. (1996) contrastingly found that female OB used habitats (forest, open, and edge) in proportion to their availability, but males used forest habitat more than expected during the month of September. In an attempt to standardize analysis with that of Clark et al. (1993), Wethington et al. (1996) examined a coarser resolution of habitat (76 m), but again female OB used habitats in proportion to their availability. From these radiotelemetry studies, inferences regarding habitat use of OB and potential sources of causation are difficult.

CHAPTER 2: STUDY AREA

There are two counties with known maternity roost locations of OB within the Ozark Mountains of Arkansas (Harvey and Redman 2003; Figure 2.1). One maternity roost area is north-central Arkansas in Marion County. The other roost location is in northwest Arkansas in Crawford County. Forests in both areas consist of upland hardwoods, typical of the forests throughout the Ozark Mountains. These forests are comprised of an overstory of oak (*Quercus* sp.) and hickory (*Carya* sp.), that play a keystone role within the upland hardwood forest ecosystem of the Ozark Mountains (Spetich 2004). Pines (*Pinus* sp.) are also a component, particularly in the more southerly and westerly portions of the region, but are not as common or dominant as they are in southern portions of the state (Woods et al. 2004). Due to varied anthropogenic disturbance, the matrices of habitat surrounding roosts in these two counties are quite different from one another.

2.1 Marion County

Marion County is located in extreme northern Arkansas near the Missouri border and is within the Ozark Highlands region (Level III Ecoregion; Woods et al. 2004). At a finer resolution, Marion County is dominated by two physiographic areas: the Elk River Hills, a dissected portion of the Springfield Plateau, and the White River Hills, a dissected portion of the Salem Plateau (Woods et al. 2004). The study area is more typical of the Elk River Hills. Ridges with elevations of 300 – 400 m are dissected by small streams, yielding a convoluted landscape of steep valleys separated by narrow ridges (Wilhide et al. 1998, Woods et al. 2004). Immediately to the north of this study area is Bull Shoals Lake. Land in the study area is predominantly in private ownership and is fragmented by agricultural use (i.e., cattle fields, small-scale cropping, poultry farms, and logging). There are three known caves in this area that are used by OB. They are the hibernaculum, Marble Falls Cave, and two maternity caves, Blue Heaven Cave and Reed Cave.

Marble Falls Cave and the surrounding forest stand (ca. 100 ha) are part of the Slippery Hollow Natural Area owned and managed by the Arkansas Natural Heritage Commission, an agency of the Department of Arkansas Heritage (ANHC). Marble Falls Cave is the northernmost cave of the three roosts found in Marion County. This is a limestone cave consisting of a steeply-graded, large single tunnel. The talus-littered floor serves as the hibernaculum used by OB in Marion County. The upland slopes of the interior of the hollow are forested with a mix of post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and shortleaf pine, whereas more mesic conditions with a mix of red (*Q. rubra*) and white oak (*Q. alba*), basswood (*Tilia americana*), and maple (*Acer* sp.) dominate the lower slopes (www.naturalheritage.com/ areas/detail.asp? map_num=10).

Reed Cave, and the surrounding area (ca. 57 ha), are also a part of the Slippery Hollow Natural Area under stewardship of ANHC. Reed Cave has experienced greater use as a maternity roost by OB in recent years, and it is thought that this cave is now used by the majority of the females in the Marion County population during summer (Harvey and Redman 2003; B. Sasse, Arkansas Game and Fish Commission, pers. comm.; agency hereafter AGFC). Though anthropogenic disturbance has historically been known to occur here, it is significantly less than at Blue Heaven Cave and can be partially attributed to this cave not being denoted on USGS quadrangle maps. This limestone cave is centrally located in a small box canyon between Marble Falls and Blue Heaven Caves. The forestlands surrounding the box canyon cave are dominated by oak-hickory upland habitat, but an area of sandy, xeric, conifer-dominated habitat is found north of the cave near the access trail.

Blue Heaven Cave, and its surrounding area (ca. 2-4 ha), is under the stewardship of The Nature Conservancy (TNC). This limestone cave is the most southerly located of the three caves under study in Marion County. Blue Heaven is a cave historically used by maternity-roosting OB, but roost and exit counts have decreased in size in recent years (Harvey and Barkley 2003; B. Sasse, AGFC, pers. comm.). This cave is located ca. 100 m from a well known county road on a steep, xeric, chirt-laden slope. Forests on the slopes are a mix of oak-hickory, but vegetation becomes denser below the cave as the stream is approached. Habitat here is more mesic and cove-like. As a consequence of the location and accessibility, visitation has been frequent, particularly by artifact thieves. A gate was installed at the cave entrance a few years ago but, despite this protection, disturbance at the cave entrance continues as vandals regularly attempt to tunnel under the gate system.

2.2 Crawford County

Crawford County is directly north of the Arkansas River along the Oklahoma border, and consequently lies both in the Arkansas Valley and Boston Mountain regions (Level III Ecoregions, Woods et al. 2004). The OB population present in Crawford

County lies in the midst of the Boston Mountain Ranger District of the Ozark National Forest. The topography here is rugged, best described as deep hollows and steep benched ridges (www.agfc.com/wma_lakes/wma_white_rock.html) occurring at elevations of 450-550 m (US Geological Survey, Fern Quadrange).

Specifically, the maternity population of OB in this county is within Devil's Hollow, located in the White Rock Wildlife Management Area ca. 3.2 km west of White Rock Mountain. This hollow lies at the junction of the Upper and Lower Boston Mountain physiographic areas, but is more typical of the lower elevations of the Upper Boston Mountains (Level IV Ecoregion; Woods et al. 2004). Feeding roosts have been found within this hollow, as well as in the forests surrounding the maternity area (W. Puckette, USFWS, pers. comm.). Additionally, there is a western area of the national forest along the Oklahoma border, Whitzen Hollow, which possesses multiple feeding roosts. This area, though not associated with the OB population in the Devil's Hollow area, was also considered in this study.

Devil's Hollow provides a harbor for OB. The hollow itself is difficult to access by vehicle and, as a consequence, is rarely visited. Land stewards have blocked, gated, and allowed vegetation to grow over vehicle access to the hollow from the ridge top. Entrance to the hollow from lower elevations entails fording a stream without actual road access. Consequently, anthropogenic disturbance in the interior of this hollow is minimal.

The slopes within Devil's Hollow are rugged, and become littered with sandstone talus near the stream. Sections of the southern interior slope near the stream have witnessed landslides over geological time, resulting in the formation of a sandstone shelf with the stream directly below. The large boulders that create this shelf have formed a maze-work of caves, with small rooms and many interconnecting nooks and crannies (W. Puckette, USFWS, pers. comm.). It is the talus that has provided OB with multiple locations for maternity and feeding roosts. Mature, unburned oak-hickory forest dominates the upper elevation ridge-sides, but vegetation becomes more cove-like deeper in the hollow.

The north-facing exterior slope of Devil's Hollow is the location of two accessible feeding roosts of OB. A tall cliff (> 10 m) provides a rock shelter used as a stopping point for OB while foraging, as the base of this cliff is littered with sandstone talus. The two roosts are located close to one another in this rubble. These roosts are in the midst of an oak-hickory sawtimber stand that was burned in 2003. Consequently, this stand is clear of undergrowth and the understory is quite scarce.

Whitzen Hollow is located on the western edge of the Ozark National Forest in the Lower Boston Mountains physiographic area (Level IV Ecoregion; Woods et al. 2004), along the Oklahoma border within the Lee Creek unit of the Boston Mountain Ranger District. The upland hardwood western slope of this hollow is littered with a limestone network of cracks and passages. There are 14 caves along this cliffline that are known to serve as feeding roosts of OB (W. Puckette, USFWS, pers. comm). The feeding roosts here are not associated with the Devil's Hollow population, but are likely from a population in Oklahoma or an undiscovered maternity colony of OB (W. Puckette, USFWS, pers. comm.). Discarded moth wings have been collected at Whitzen Hollow by the U.S. Fish and Wildlife Service since 2003. These wings were preserved (frozen) for the possibility of analysis, and were used in this study. Though not directly associated with maternity populations of OB in Arkansas, the incorporation of data from Whitzen

Hollow played a beneficial role in providing an additional foraging territory of OB to study.

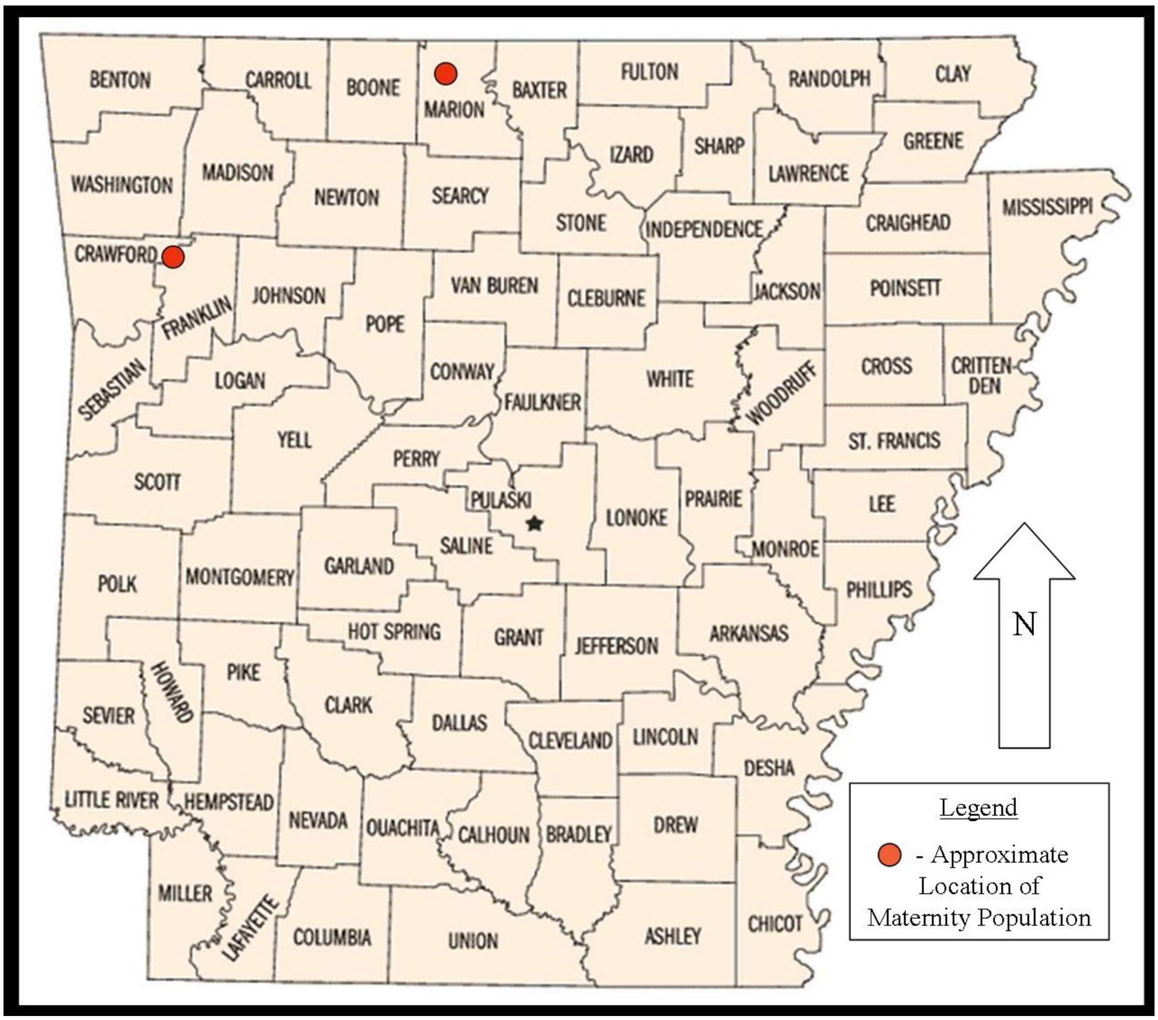

Figure 2.1. General locations of two maternity populations of the Ozark big-eared bat in Arkansas (not to scale).

CHAPTER 3: METHODOLOGY

This aim of this study was to make inferences regarding both use and availability of prey of OB in Arkansas counties possessing maternity populations. Inferences of resource use by OB were indirect (i.e., OB individuals were never viewed consuming prey); hence this study is delineated a “Design 1” study under the classification scheme of Thomas and Taylor (1990). Further, the study was observational in nature, or, an “impact study” (Miller et al. 2003). Treatments associated with experimental units were not rigorously applied, but were observations extracted from an existing system. Finally, this project assumed a mixed model (Model III; Zar 1999) with habitat type being a fixed effect and roost locations being a random effect. Roost locations within a county served as a block effect so that extraneous variation due to landscape position could be addressed in the analysis (Zar 1999). As the habitats under study differed by county, each county was separate and distinct from the other regarding design and analysis (i.e., as two different studies). Landscapes for sampling moth assemblage were chosen according to the major habitats designated for each project site, and as approved by the AGFC. These habitats served as treatments affecting moth assemblages (the potential prey base of OB).

As the majority of Marion County is a rural, fragmented landscape, the habitats under study were: upland forest, riparian forest, edge, and field. Specifically, edge habitats were delimited as the interface of forested and non-forested areas. Field habitats considered were agricultural pastureland consisting of non-native grasses used for grazing and hay production. Riparian habitat was not defined by presence of a running stream, but instead by vegetation change and the ephemeral presence of water (Pyatt Quadrangle, USGS). As the majority of Crawford County is managed national forestland, habitats were ultimately a function of the size class of given stands of timber. The habitats under study here were: sawtimber (Stand Condition Class 10, “mature,” > 30.5 cm diameter), poletimber (Stand Condition Class 11, “immature,” < 20.3 cm diameter), and sapling (Stand Condition Class 13, “adequately stocked”) size classes, as defined by the USFS (Silvicultural Practices Handbook: FSH 2471.1 R8).

Sampling locations were selected for all habitats at a given roost area and where within 10 km of the given roost. A radius of 10 km surrounding each maternity roost was chosen for analysis, because this radius represents an area that includes the entire size range of distances moved by foraging OB recorded in the literature (Clark et al. 1993, Wethington et al. 1996). In Marion County, this included the three known roost areas: Marble Falls (hibernaculum), Reed Cave (maternity roost), and Blue Heaven Cave (maternity roost). In Crawford County, this included: the interior of Devil’s Hollow (maternity and feeding roosts; hereafter simply referred to as Devil’s Hollow), the northern outward slope of Devil’s Hollow (feeding roosts; hereafter simply referred to as the North Face area), and the western cliffline of Whitzen Hollow (feeding roosts). The choice of sampling locations was based on three factors: representation of the habitat under study, potential access by OB (i.e., flyways), and accessibility to collect data. Sampling locations were spaced far enough apart to ensure no overlap in collection of the moth assemblage (i.e., moths in one location were not be able to see the blacklights of two separate sample sites due to topographic relief and distances > 100 m).

3.1 Prey Availability - Survey of Lepidopteran Assemblages

The time constraints dealt with during the 2004 summer resulted in a pilot field season with simplified methodologies and a less intensive sampling effort than the subsequent full field season of summer 2005. As a consequence of differences between methods for the two field seasons, data collected on moth assemblages during the pilot field season could not be incorporated into statistical analyses.

3.1.1 Pilot Field Season – Summer 2004

The pilot field season allowed familiarization with study areas, choice of sampling sites, evaluation of effective methodologies, and honing of the overall efficiency of the sampling regimen. Though the data collected during this period were not comparable with that of the full field season, the pilot portion of this research was invaluable not only in establishing an efficient system of moth sampling, but also in providing an initial survey of the moth assemblage and allowing the development of taxonomic identification skills necessary for the intensive sampling that followed in summer 2005.

Moths were trapped at each sample site using a 10 w blacklight trap (Universal Light Trap, Bioquip Products, Gardena, CA; Figure 3.1). A cotton wad soaked in ethyl acetate was placed in each trap to kill the moths collected. Traps were placed on the ground at sample sites beginning at sunset and operated for five hours, or the time a battery ran at full charge. The resulting sample units, the collected moths, were removed the day following collection, sorted into containers, and placed in cool storage for later identification.

The 2004 sampling season took place from 8 July to 11 August (Table 3.1) and resulted in a single night of sampling at each roost location. Approximately one week occurred between trap nights. This allowed evaluation of the local landscape surrounding a roost location and selection of sampling sites prior to sampling. Moth sampling was completed following the establishment of sample sites, as weather permitted. If inclement weather prevented a full five hours of sampling, the area was resampled only after all other roost locations were sampled. Sampling was alternated between Marion and Crawford counties, with specific roost locations within a county chosen randomly. This approach lessened temporal variation associated with hatch times of moth species over the course of the summer.

3.1.2 Full Field Season – Summer 2005

The techniques for sampling moth assemblages did not vary between the 2004 and 2005 field seasons, but there were changes in the application of the sampling technique. Moth assemblages were surveyed using the previously specified blacklight trap method, but traps were suspended 2.5 m in the air using a pole and pulley system (Figure 3.1). This change was instituted to standardize methodology (sensu Burford et al. 1999). Not only did this presumably increase sampling efficacy by increasing the perceptive distance of traps to the moths, but also allowed a more direct comparison with past research.

Methodology was further modified by sampling moths throughout an entire night, as opposed to just five hours past sunset. This alteration permitted cursory evaluation of differences in moth abundance due to time of night, a source of variation not accounted for by Burford et al. (1999). This was accomplished by using two blacklight traps at a given habitat which ran at different times of the night. A second "duplicate" sample site was established adjacent to each previously established sample site within a given habitat. On a given trap night, the two sites were randomly assigned to operate either "early night," for five hours post-sunset, or "late night," running ca. five hours after "early night" until sunrise. As this change in methods doubled the number of blacklight traps set out on a given night, and as personnel was limited, Edwards-style DC timer switches (#2835 Bioquip Products, Gardena, CA) were used to standardize activation and deactivation of blacklight traps for the two time intervals. "Duplicate" sample sites were established ca. 50 m away from previously established sample sites in the hope of reducing microsite and microclimate variation that might possibly influence the moth-catch, while preventing sampling bias that could exist due to the addition of the "late night" time period. Sampling bias could arise if moths were attracted to the "early night" blacklight trap, but did not succumb to the ethyl acetate before the "late night" blacklight trap was activated and the "early night" blacklight trap deactivated. The effective attraction distances of light traps higher-powered than those used in this study (125 w) have been estimated at less than 25 m (Muirhead-Thomson 1991), so a spacing of 50 m was deemed adequate to prevent bias.

A wide array of physical conditions is known to impact the flight patterns of moths and also the efficacy of blacklight traps (e.g., Yela and Holyoak 1997, Butler et al. 1999). Abiotic conditions, namely measures of temperature and light, were collected on trap nights during the 2005 sampling season (Appendix 1). This project sought a continuous sampling regimen through the summer, so an attempt was made to document the physical conditions potentially impacting moth-catch.

The 2005 sampling season occurred from 20 May to 3 August (Table 3.1). Richness of moth species in temperate forest systems is known to peak throughout early June to late August (Rings et al. 1992, Thomas and Thomas 1994, Thomas 2001). Though mid- to late August were unsampled due to academic commitments, a continuous approach was used throughout the remainder of the summer ensuring that sampling effort spanned the majority of the optimal time period at regular intervals. Sampling was randomly-generated and alternated between roost locations in each county as previously outlined during the pilot field season. Four iterations of moth sampling were collected over the course of 2005 resulting in a total of twenty-four trap nights, a more frequent sampling regimen covering a longer portion of the warm season than that used the previous summer. The number of trap nights was ultimately dependent upon weather, so trap nights were planned on nights with fair weather. Though the night of 4 June experienced short bouts of precipitation in the early morning hours (ca. 2:00-4:00 a.m.), it did not impact the quality of moths necessary for identification. As a consequence of the drought in the Ozark Mountains during this field season (Figures 3.2 and 3.3), there was no resampling of roost locations necessary due to inclement weather.

3.2 Prey Consumption – Collection of Culled Wings

As with the other *Corynorhinus* of eastern North America (Sample and Whitmore 1993, Hurst and Lacki 1997, Burford and Lacki 1998, Lacki and LaDeur 2001), OB will often intermittently roost while foraging. While roosting, wings of moth prey are discarded while the body of the moth is eaten. Culled moth wings were collected at the previously specified roost locations at periodic intervals throughout the 2004 and 2005 field seasons (Table 3.2). This data necessitated the assumption that all recovered moth wings were culled by OB, though predation was never witnessed (i.e., moth wings could conceivably have been culled by other bat species or phoebe (*Sayornis phoebe*)). Potential error as a result of this assumption was judged to be limited, as: 1) culled wings were collected only at roosts visually verified in the past as used by OB (via W. Puckette, USFWS, pers. comm., for "limited use" roosts); 2) the congenor, RB, is not known to occur in the study areas; 3) the majority of culled moth wings were recovered within roosts, limiting bias associated with phoebe; 4) other bat species do not habitually cull wings of depredated moths, as do *Corynorhinus*. This portion of the study was conducted under agreement with all the involved federal and state agencies. Collection visits were spaced intermittently throughout the summer and were ultimately dependent upon convenience for the accompanying agency personnel and myself, in that roost locations were visited while I was in an area sampling the moth assemblage. Wings were carefully collected using forceps to avoid further damage and stored in plastic bags or glass vials. Additional culled wings were procured from the USFWS (S. Hensley and W. Puckette). These wings had been collected since 2003 in Crawford County, Arkansas, as well as in adjacent counties in Oklahoma (Adair, Delaware, and Johnson). All culled wings were placed in cool storage following collection for later identification and analysis.

3.3 Identification of Prey

Moths and discarded moth wings were identified to the lowest taxon possible using guides in Covell (1984) and Holland (1903), as well as the reference collection compiled by L. Shoemaker and M. Lacki at the University of Kentucky (ca. 1993-1994). A reference collection for species in both counties was developed to aid in subsequent identification of moths. This collection was not comprehensive due to the limited number of specimens caught for many species and the destructive nature often necessary in identification; however, it was representative of most taxa identified. Reference collections facilitated identification of discarded moth wings to the lowest taxon possible.

Bats of the genus *Corynorhinus* feed extensively on macrolepidopterans, or larger sized moth taxa (Sample and Whitmore 1993, Hurst and Lacki 1997, Burford and Lacki 1998, Lacki and LaDeur 2001; see Covell 1984 for taxonomic delineation between macrolepidoptera and microlepidoptera). Therefore, emphasis in identification and analysis was placed on moths with wingspans of ≥ 20 mm. This value was the lower limit of the size of moth prey of RB in Kentucky (Hurst and Lacki 1997), and includes the single wing length of the smallest moths (13 mm) eaten by VB in Kentucky (Burford and Lacki 1998). All moths < 20 mm in wingspan were considered microlepidoptera; these were combined for a single estimate of biomass (dry weight) of small moths at each sample site (hereafter, ML mass). Hereafter, use of the term "moth" (e.g., moth abundance) is in reference to lepidoptera with wingspans of ≥ 20 mm, incorporating all moths taxonomically considered macrolepidoptera and also some microlepidoptera (i.e., Oecophoridae, Yponomeutidae, Cossidae, Tortricidae, Zygaenidae, Megalopygidae, Limacodidae, and Pyralidae). All moths with wingspans < 20 mm are exclusively referred to as microlepidoptera. Though taxonomically incorrect, this semantic delineation is necessary in the context and inferential limits of this project, as smaller moths were not enumerated or identified.

3.4 Characterization of Habitat

Habitat data were gathered at each site where moths were sampled. A 20 m radius, circular plot was centered at each sampling point and information regarding occurrence of woody plants, as well as selected stand/landscape attributes, was collected on 19 July – 21 July 2005 in Crawford County and 9 August – 10 August 2005 in Marion County. This addition was recommended by Burford et al. (1999) to help better understand the relationships of moth abundance to the habitats sampled. The focus of this research precluded comprehensive analyses of all landscape attributes measured; consequently, inferences as to the habitat component of this research in the discussion is limited to patterns of occurrence of woody plants as they relate to the occurrence of moths.

3.5 Population Surveys of the Ozark Big-Eared Bat

Population surveys of OB maternity sites were conducted in conjunction with this project during both field seasons. These maternity colonies were surveyed via evening exit counts or daytime roost counts (Appendix 2). All surveys were conducted under the discretion of the respective agency land stewards and were attended by the AGFC or USFWS.

3.6 Data Analysis

Variation of the prey base was analyzed in regard to both this assemblage as a whole, as well as specific taxa (families); patterns of prey consumption by OB were then interpreted as they related to moth taxa. Patterns of woody vegetation were analyzed in tandem to discern specific patterns relating to occurrence of moths.

3.6.1 Landscape Variation of Lepidopteran Prey

It is known that taxa present within a moth assemblage vary with seasonality (Rings et al. 1992, Shoemaker 1994, Thomas and Thomas 1994, Lepš et al. 1998, Thomas 2001, Summerville and Crist 2003, Summerville and Crist 2005). Considering these data, two decisions were reached on analysis of moth assemblages. First, given that patterns of seasonal change in moth assemblages are well documented, and that sample size in this project was limited, no attempt was made to evaluate temporal changes in moth assemblages. This factor would have provided little in the way of novel information regarding moth populations and would have reduced the statistical power of the given test to detect spatial variation. Relatedly, thought was given to a repeated-measures approach, but this choice was rejected in favor of simple analysis of variance (ANOVA). A repeated-measures approach implicitly includes the remensuration of the same "experimental subject" (sensu Zar 1999), i.e., experimental unit. While blacklight sampling was conducted at the same sites throughout the field season, the experimental unit being sampled was the moth assemblage itself. Given that moth assemblages are ephemeral by nature (i.e., species and even broods within species occur sporadically throughout the warm season; Covell 1984), I viewed the four iterations of sampling throughout the 2005 field season as independent of one another. Thomas and Thomas (1994) suggest non-independence may exist between blacklight trap samples if trap nights are ≤ 10 days apart. Considering this general guideline, independence between trap nights was met with a singular exception (the Reed Cave area between second and third sampling periods; Table 3.1). As a consequence of this logic, the less powerful repeated-measures approach (Zar 1999), was declined in favor of an simple ANOVA model, with the moth assemblage on a given trap night serving as the experimental unit.

The importance of habitat type and roost location to the moth assemblage in each county was compared using a nested, two-way ANOVA (SAS Institute, Inc. 1992). Tests considered four assemblage demographics: moth abundance (mean number of moths captured), family richness (mean number of moth families captured), species richness (mean number of moth species captured), and the ML mass (mean biomass of microlepidopterans captured), respectively (Burford et al. 1999). Homogeneity of variance of these moth demographics was tested using a Variance Ratio F_{MAX} test, with the data analyzed based on log-transformed values if variances were heterogeneous (Sokal and Rohlf 1969). The effect that time of night had on the moth assemblage was incorporated into analysis as a nested (hierarchical) effect (Zar 1999). As the "duplicate" sample sites within given habitat types were within close proximity to one another, and were assumed to represent the same ecological conditions, "duplicate" sites were not considered statistically independent from one another. This lack of independence necessitated the nested approach. When ANOVAs were significant, a Tukey's Honest Significant Difference (HSD) means separation procedure was employed (Zar 1999). Tukey's HSD is a conservative means separation procedure in comparison to similar procedures (e.g., Newman-Keuls, Fisher's Least Significant Differences; Zar 1999). This approach helped reduce Type I error, a worthy consideration in this study due to the multiple ANOVAs that were conducted.

The relative abundance of moths caught at different habitats was compared using Chi-square goodness-of-fit tests for each study area (county), a historically common test of resource use (Thomas and Taylor 1990). Intrinsic to my use of this analysis is the assumption that moths are equally distributed throughout a given habitat; or occurrence of moth taxa was the same regardless of where sampling occurs in the habitat. Tests for selection were made at the family level in cases where sample size was $\geq$ 100 moths per family. Though this minimum limit was arbitrary, it was necessary to delimit "common" moth families for which habitat analysis was meaningful and to exclude families of rarer occurrence where the small sample size could yield differences in habitat selection simply by chance alone (Cochran 1954, Johnson 1980). Burford et al. (1999) considered families with a minimum sample size of 150 moths appropriate for analysis, but examined a greater diversity of habitats (five categories). The reduced habitat groupings used in my study made my sample size to habitat ratio comparable to that of Burford et al. (1999) and also allowed the incorporation of more taxonomic families in the analysis. When the null hypothesis of proportional habitat selection was rejected for a moth family ($P < 0.01$; Burford et al. 1999), a Bonferroni z-statistic ($\alpha = 0.05$) was used to determine if selection was more or less than expected (Neu et al. 1974, Burford et al. 1999).

3.6.2 Consumption of Lepidopteran Prey

Patterns of prey consumption were interpreted in light of data on selection of habitats by moth families in the two counties, but not on moth demographics. Prey selection of OB was not compared to data for the abundance of moth by taxa, as it was not possible to infer that non-depredated moth families were truly available to OB as potential prey (i.e., perhaps a moth taxon, though nocturnal, was in some way temporally, spatially, or morphologically segregated from the prey base available to OB). It was consequently difficult to delimit the available prey base for comparison with known prey consumed via culled wings. Alternatively, inferences on prey consumption were based on congruencies of habitat occurrence for both identified prey taxa of moths and known habitats used by OB from studies on foraging behavior (Clark et al. 1993, Wethington et al. 1996, and Wilhide et al. 1998).

3.6.3 Effect of Habitat on Lepidopteran Assemblages

The effects of habitat and roost location on woody vegetation in each county were compared using a nested, two-way analysis of variance (SAS Institute, Inc. 1992), as previously described for the analyses of moth demographics. Habitat variables expressed as a proportion (e.g., percent slope) were arcsine transformed to normalize their distribution (Zar 1999). Additionally, homogeneity of the variance of habitat variables was tested using a Variance Ratio F_{MAX} test, with the data analyzed based on log-transformed values if variances were heterogeneous (Sokal and Rohlf 1969). Tests considered four "summary" variables of the woody plant assemblage that were thought to potentially explain patterns of moth demographics across landscapes: mean abundance of woody stems (per ha), mean abundance of snags (per ha), mean richness of woody plant species (per plot), and mean total basal area (m^2/ha). A Tukey's HSD means separation procedure was employed when ANOVAs were significant (Zar 1999).

Multiple linear regression (MLR) models were developed in an effort to use the entire suite of habitat characters to predict moth demographics. Candidates for use as predictor variables were compared based on R^2 values to assess their ability to explain variation in moth abundance and richness of moth species (M. Lacki, University of Kentucky, pers. comm.). Promising variables were then screened for collinearity via variance inflation factors, tolerance, and collinearity diagnostics (SAS Institute, Inc. 1992). The resulting candidate variables, selected for their predictive power and reduced interactive properties, were then used in MLRs to predict moth demographics in a forward stepwise fashion (SAS Institute, Inc. 1992).

Table 3.1. Dates of moth sampling in Marion and Crawford counties, Arkansas, during summers 2004 and 2005.

Field Season	**Roost Location**	**Sampling Date**
2004	Blue Heaven	7 July
	North Face	15 July[a]
	Reed	21 July
	Devil's Hollow	27 July
	Marble Falls	6 August
	Whitzen Hollow	10 August
	North Face	11 August
2005	Whitzen Hollow	20 May
	Marble Falls	23 May
	North Face	25 May
	Blue Heaven	30 May
	Devil's Hollow	2 June
	Reed	4 June[b]
	North Face	7 June[c]
	Marble Falls	9 June
	Devil's Hollow	14 June
	Reed	16 June
	Whitzen Hollow	18 June
	Blue Heaven	20 June
	Reed	23 June
	Devil's Hollow	27 June
	Marble Falls	29 June
	North Face	8 July
	Blue Heaven	12 July
	Whitzen Hollow	14 July
	North Face	22 July
	Reed	25 July
	Devil's Hollow	28 July
	Blue Heaven	30 July
	Whitzen Hollow	1 August
	Marble Falls	3 August

[a] Inclement weather prevented full sampling. Resampled area on 11 August 2004.

[b] Precipitation passed through sampling area, but was not continuous through the trap night and did not impede quality of specimens. Site was not resampled.

[c] Black bear (*Ursus americanus*) disturbed a trap system (Poletimber, Site 2).

Table 3.2. Summary of the collection of culled moth wings at OB roosts in Arkansas and Oklahoma, 2003 - 2005.

Date of Visit	County, State	Cave Location (Code if Applicable)	Personnel Present[a]	Number of Wings Recovered
21 July 2003	Crawford, AR	CW28 BT3b	WP	22
21 July 2003	Crawford, AR	CW28 BT3a	WP	5
25 July 2003	Crawford, AR	Whitzen Hollow (CW2306)	WP	17
25 July 2003	Crawford, AR	Whitzen Hollow (CW2334)	WP	9
December 2003	Adair, OK	AD17	WP, SH	15
23 December 2003	Adair, OK	Charlie Owl Cave	WP	2
31 December 2003	Delaware, OK	DL21	WP, SH	2
26 June 2004	Adair, OK	AD19	WP	4
23 July 2004	OK	PP98 BT1	WP	2
8 August 2004	Crawford, AR	Whitzen Hollow (CW2307)	LD, WP	8
8 August 2004	Crawford, AR	Whitzen Hollow (CW2335)	LD, WP	13
8 August 2004	Crawford, AR	Whitzen Hollow (CW2306)	LD, WP	17
8 August 2004	Crawford, AR	Whitzen Hollow (CW2334)	LD, WP	42
20 December 2004	Adair, OK	AD17	WP, SH	28
14 April 2005	Crawford, AR	Whitzen Hollow (CW2334)	LD, ML	1
16 April 2005	Marion, AR	Reed	LD, ML	1
16 April 2005	Marion, AR	Marble Falls	LD, ML	1
16 April 2005	Marion, AR	Blue Heaven	LD, ML	3
30 April 2005	Delaware, OK	DL21	WP	6
10 May 2005	Marion, AR	Blue Heaven	LD	4
20 May 2005	Crawford, AR	Whitzen Hollow (CW2334)	LD	1
20 May 2005	Crawford, AR	Whitzen Hollow (CW2307)	LD	8
3 June 2005	Adair, OK	AD41	WP	1
3 June 2005	Adair, OK	AD42	WP	2
20 June 2005	Crawford, AR	Whitzen Hollow (CW2334)	LD	4
20 June 2005	Crawford, AR	Whitzen Hollow (CW2307)	LD	4

Table 3.2. (continued)

Date of Visit	County, State	Cave Location (Code if Applicable)	Personnel Present[a]	Number of Wings Recovered
30 June 2005	Marion, AR	Marble Falls	LD	3
7 July 2005	Crawford, AR	Devil's Hollow	LD, SH, WP	2
12 July 2005	Crawford, AR	North Face	LD, WP, SH	1
12 July 2005	Crawford, AR	Devil's Hollow	LD, WP, SH	3
12 July 2005	?	JN24 BT3	WP	2
12 July 2005	Marion, AR	Reed	LD, BS	12
18 July 2005	Adair, OK	AD30	WP	5
25 July 2005	Marion, AR	Blue Heaven	LD, BS	1
2 August 2005	?	SY48 BT3	WP	1
2 August 2005	?	SY48 BT4	WP	8
3 August 2005	Marion, AR	Marble Falls	LD	1
5 August 2005	Crawford, AR	Whitzen Hollow (CW2334)	LD, WP	7
5 August 2005	Crawford, AR	Whitzen Hollow (CW2335)	LD, WP	8
5 August 2005	Crawford, AR	Whitzen Hollow (CW2307)	LD, WP	29
5 August 2005	Crawford, AR	Whitzen Hollow (CW2308)	LD, WP	6
15 August 2005	Marion, AR	Reed	LD, DK	20

[a]Personnel (abbreviation) attending collections as follows: AG&FC – B. Sasse (BS); UKY – L. Dodd (LD), M. Lacki (ML); USFWS – W. Puckette (WP), S. Hensley (SH), and D. Kampwerth (DK)

Figure 3.1. A blacklight trap suspended 2.5 m above the ground via a pulley system.

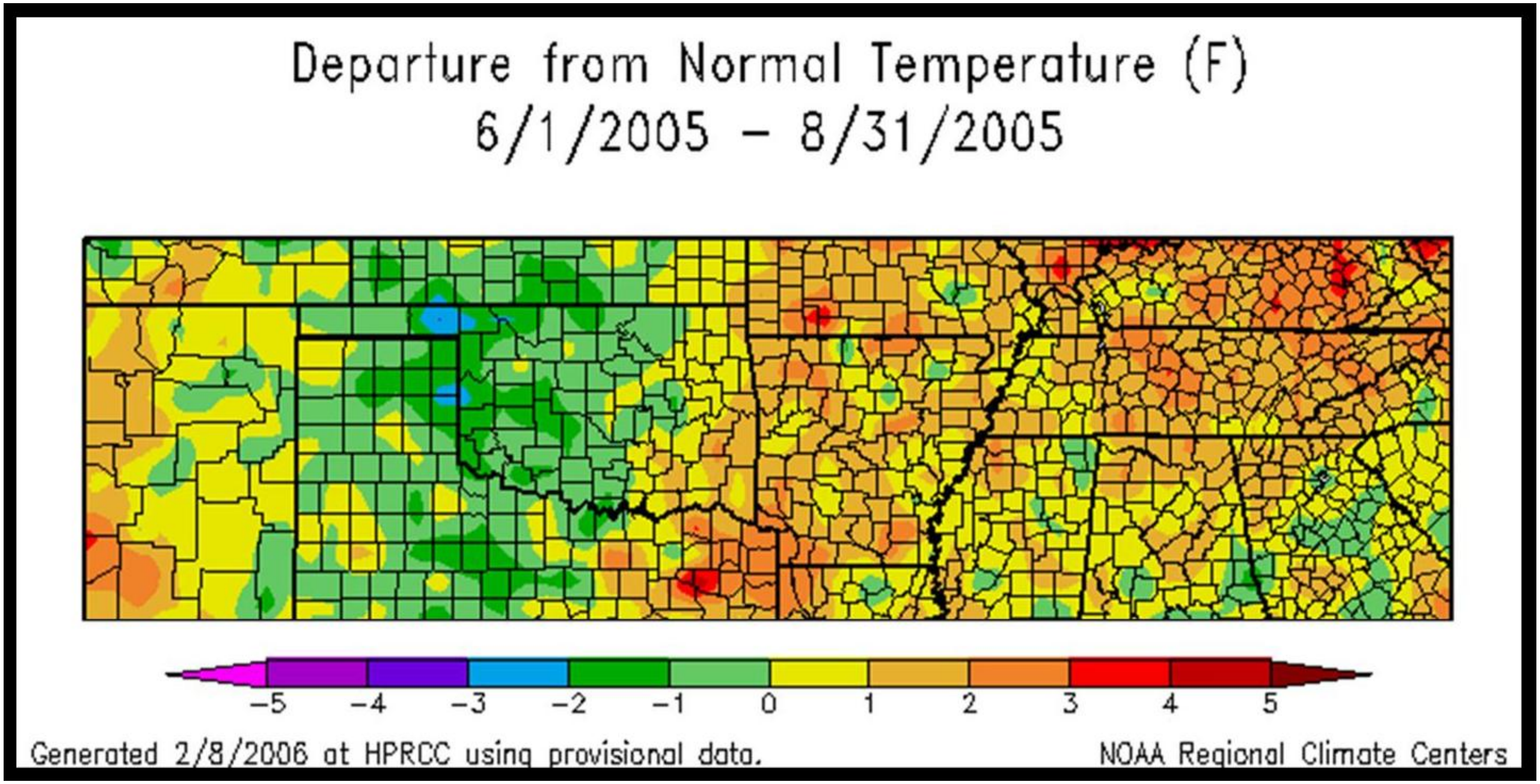

Figure 3.2. Departure of seasonal temperatures from mean values during 1 June to 31 August 2005 for Arkansas and surrounding areas. Adapted from graphics at the National Oceanic and Atmospheric Administration: NOAA Southern Regional Climate Center Website (http://www.srcc.lsu.edu/).

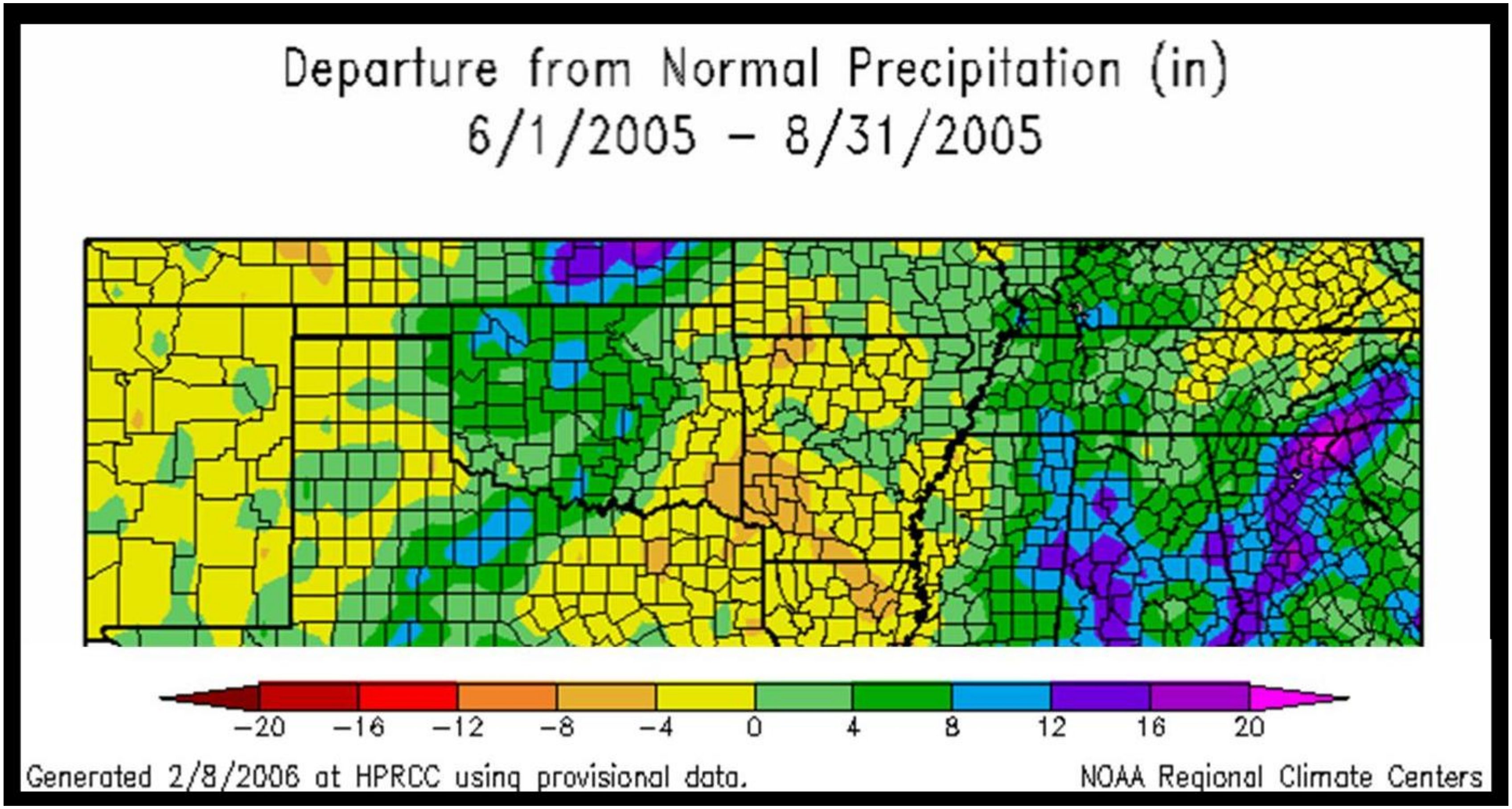

Figure 3.3. Departure of seasonal precipitation from mean values from 1 June to 31 August 2005 for Arkansas and surrounding areas. Adapted from graphics at the National Oceanic and Atmospheric Administration: NOAA Southern Regional Climate Center Website (http://www.srcc.lsu.edu/).

CHAPTER 4: RESULTS

The results of this study are broken into three sections: variation of lepidoptera across the landscape in both study areas, consumption of prey, specifically lepidoptera, by OB, and characterization of the habitats understudy.

4.1 Availability of Lepidoptera – 2004 Data

All roost locations were visited once during summer 2004, resulting in six trap nights and 21 blacklight trap operations (Table 3.1). A total of 1,656 moths were captured during summer 2004, representing 16 families and ≥ 150 species. A total of 1,108 moths was captured in Marion County (Appendices 3 and 4), whereas 548 moths were captured in Crawford County (Appendices 5 and 6). The Noctuidae were the most speciose family recorded in both counties and, thus, were the most abundant family overall with 473 individuals caught in Marion County and 250 individuals in Crawford County (Appendices 3-6).

Other common families (n ≥ 10 specimens within a given county) in summer 2004 were Arctiidae, Apatelodidae, Geometridae, Limacodidae, Notodontidae, Pyralidae, and Saturniidae (Appendices 3-6). Families of occasional occurrence (≤ 10 individuals within a county) were Drepanidae, Epiplemidae, Megalopygidae, Oecophoridae, Sphingidae, Thyatiridae, Tortricidae, and Yponomeutidae (Appendices 3-6).

Two taxa were notably abundant in the Reed Cave area sampled on 21 July. The genus *Apantesis* was caught in large numbers, constituting 60 of the 138 arctiids caught on that night (Appendix 4). *Lambdina fervidaria* was also extremely abundant on this night, constituting 70 of the 104 geometrids caught (Appendix 4).

Trends were discerned in the moth assemblages of both counties during the 2004 field season with regard to both habitat and roost location. In Marion County, moth demographics were generally lower in field habitats, but other habitats yielded similar results (Table 4.1). The Blue Heaven area consistently yielded lower moth abundance and lower species diversity. In Crawford County, sapling timber consistently yielded lower moth demographics than poletimber or sawtimber (Table 4.2). The Whitzen Hollow area consistently yielded high moth demographics when compared to the other roost locations in Crawford County.

4.2 Availability of Lepidoptera – 2005 Data

Four iterations of moth sampling were completed over the course of the summer, resulting in a total of 24 trap nights (Table 3.1). There was a total of seven trap malfunctions during these twenty-four nights where a blacklight trap did not activate/deactivate properly (Table 4.3). Without this data, there were a total of 161 blacklight trap samples. Trapping effort for this summer yielded a total of 8,720 moths, representing 22 taxonomic families and 314 species (Appendices 7-12).

4.2.1 Lepidopteran Demographics of Marion County

A total of 4,209 moths was caught in Marion County, representing ≥ 249 species (Appendices 7-9). Noctuidae was the most abundant and diverse family, with 1,486 individuals captured over the course of the summer. Other common families ($n \geq 100$ specimens caught through the summer) included: Arctiidae, Geometridae, Lasiocampidae, Notodontidae, Pyralidae and Tortricidae.

Three species in Marion County were found at relatively high occurrence. *Hypoprepia fucosa* dominated the Arctiidae, with 451 individuals of this species caught out of the 781 total for the entire family. *H. fucosa* was found in wooded and edge habitats (Appendix 7), and the bulk of these moths were caught at the Reed Cave area (Appendix 8). *Lambdina fervidaria* was also frequently caught, numbering 113 individuals of 520 total moths within the Geometridae. This moth was predominately captured in wooded habitats, but sparsely occurred in edge and field habitats (Appendix 7). Again, most of the individuals of this species were captured in the Reed Cave area, but the species was also present at other roost locations in Marion County (Appendix 8). A final species of relatively high occurrence was the pest, *Malacosoma americanum*. A total of 304 individuals of this species was captured in Marion County. This species was recorded in wooded and edge habitats (Appendix 7), primarily in the Blue Heaven and Reed Cave areas (Appendix 8).

Overall models for each of the moth demographics were significant (all P = 0.0001; Table 4.4). Variation of moth demographics in Marion County was primarily due to habitat (Table 4.5), as opposed to roost location (Table 4.6).

Field habitats yielded lower measures of moth abundance, richness of moth families, and richness of moth species when compared to other habitats in Marion County (all P = 0.0001, Table 4.5). ML mass also varied by habitat (P = 0.001); however, Tukey's HSD procedure did not isolate any specific habitat differences.

Variation attributable to roost location was limited to ML mass (Table 4.4). ML mass was higher in the Reed Cave area than at other roost locations (*P* = 0.0002, Table 4.6). Moth abundance, richness of moth families, and richness of moth species did not vary by roost location (*P* = 0.12, *P* = 0.18, and *P* = 0.29, respectively).

The impact of the interaction effect of habitat by roost location varied with moth demographics (Table 4.4). Moth abundance and ML mass were most affected (*P* = 0.004 and *P* = 0.001, respectively), whereas family richness and species richness were not (*P* = 0.61 and *P* = 0.09, respectively). Impact of the nested effect, or variation due to time of night, could only be attributed to ML mass (Table 4.4). ML mass was greater during the early half of trap nights (n = 46; $\bar{x}$ = 0.2273 g, SE = 0.054 g) as opposed to the latter half of nights (n = 46; $\bar{x}$ = 0.0889 g, SE = 0.028 g; *P* = 0.02).

4.2.2 Lepidopteran Demographics of Crawford County

A total of 4,511 moths were caught in Crawford County, representing ≥ 267 species (Appendices 10-12). Noctuidae was the most abundant and diverse family, with 1,262 individuals captured in summer 2005. Other common families (n ≥ 100 specimens caught through the summer) included: Arctiidae, Geometridae, Notodontidae, Pyralidae, Saturniidae, and Tortricidae.

Two taxa exhibited relatively high occurrence within Crawford County. *Halysidota tessellaris* comprised 281 individuals of the 836 total arctiids captured. This species was found in all size classes of timber (Appendix 10), primarily at the Whitzen Hollow and Devil's Hollow interior areas (Appendix 11). The pest species, *Malacasoma americanum*, totaled 92 individuals in samples from Crawford County. Occurrence of this species was primarily within Devil's Hollow interior (Appendix 10) at all size classes of timber, though most common in the sapling size (Appendix 11).

Overall models for moth abundance, family richness, species richness, and ML mass were all significant (P = 0.0001, P = 0.0003, P = 0.003, P = 0.039, respectively; Table 4.7). In contrast to Marion County, variation in moth demographics in Crawford County was a product of roost location (Table 4.8). No demographic varied by habitat (Table 4.9).

A consistent ordination was discernable between roost locations in Crawford County for moth abundance, family richness, and species richness (Table 4.8). These demographics were consistently high at Whitzen Hollow and low at the North Face roosting area, with Devil's Hollow interior varying from intermediate to high. Moth abundance varied with roost location in Crawford County (P = 0.0001). Richness of moth families was lower at the North Face roost location than at the Whitzen Hollow and Devil's Hollow roost locations (P = 0.0002). Richness of moth species was higher at Whitzen Hollow than at North Face, with Devil's Hollow being intermediate in species richness (P = 0.002). ML mass did not vary by roost location (P = 0.06).

The impact of the interaction effect of habitat by roost location varied with moth demographic (Table 4.7). Moth abundance, richness of moth families, and richness of moth species were affected (P = 0.001, P = 0.002, P = 0.01, respectively), whereas ML mass was not (P = 0.26). Impact of the nested effect in Crawford County, as in Marion County, was only associated with ML mass. ML mass was greater during the early half of trap nights (n = 36; $\bar{x}$ = 0.1926 g, SE = 0.036 g) than the latter half of nights (n = 33; $\bar{x}$ = 0.0717 g, SE = 0.012 g; P = 0.04).

4.2.3 Seasonal Observations of Lepidoptera

Temporal changes were noted over the course of the summer in 2005. The total numbers of moths appeared to change with sampling period in both Marion County (Appendix 9, Figure 4.1) and Crawford County (Appendix 12, Figure 4.1). The moth catch in Marion County was at its highest during the first and last sampling periods (20 May – 4 June, 22 July – 3 August), seeming to slump during June and early July. The moth catch in Crawford County appeared to escalate over the first three sampling periods, and then dropped in numbers in the fourth sampling period (23 June – 14 July).

Changes over the course of the summer were also noted in the common moth families ($n \geq 100$ specimens). General patterns emerge from data for moths in both Marion County (Figure 4.2) and Crawford County (Figure 4.3). Arctiidae peaked during the first portion of the summer, tapering of in numbers during the later sampling dates. The Geometridae and Notodontidae tended to increase in number sampling periods. The Lasiocampidae and Tortricidae, both common in Marion County, decreased over the course of the summer. The Lasiocampidae (genus *Malacosoma*) did so precipitously, with nearly all individuals in this family captured in the first sampling period. The Noctuidae and Pyralidae were more erratic, exhibiting higher capture success during the first and last sampling periods.

4.2.4 Habitat Selection by Lepidoptera

Moth taxa varied in their occurrence across habitats in both Marion County (Appendix 7) and Crawford County (Appendix 10). In Marion County, the highest number of moths and highest number of species occurred in forested habitats. The least numbers of moths and species were caught in field habitats. In Crawford County, the highest abundance of moths occurred in the poletimber size class. The number of species found in each size class was relatively close, though most species of moths were captured in the sawtimber size class. The least number of moths were captured in the sapling size class and the fewest species of moths were captured in the poletimber size class.

Common moth families (n ≥ 100 specimens) varied in their relative use of habitat in both Marion County (Table 4.10) and Crawford County (Table 4.11). Field habitat was precluded from analyses of habitat selection by family as review of raw family totals (Table 4.10) and moth demographics (Table 4.5) already illustrated that occurrence of moths in this habitat was nominal. Disproportionate occurrence (i.e., selection or avoidance) of habitat was found in the Arctiidae, Geometridae, Lasiocampidae, Noctuidae, and Notodontidae in Marion County ($P < 0.01$, Table 4.12), and the Arctiidae, Geometridae, Notodontidae, and Saturniidae in Crawford County ($P < 0.01$, Table 4.12). In Marion County, edge habitat was avoided by all moth families. Upland forests were selected by all families, with the exception of the Saturniidae which occurred there proportionately. The Arctiidae, Noctuidae, and Notodontidae all selected riparian forests, but this habitat was proportionately used by the Geometridae and Lasiocampidae. In Crawford County, sapling habitat was used proportionately by the Geometridae; other moth families avoided this habitat. The poletimber habitat was used proportionately by the Saturniidae; other moth families selected this habitat. Finally, the sawtimber size class was used proportionately by the Notodontidae and Saturniidae, selected by the Arctiidae, and avoided by the Geometridae.

4.3 Consumption of Prey by the Ozark Big-Eared Bat

Culled moth wings were recovered from a total of 42 visits to OB roosts (Table 3.2). The majority (28) of these visits was made during 2005, though visits were also made in 2003 and 2004 (seven visits each). Of all roost collections, 20 searches were made at roosts in Crawford County, nine at roosts in Marion County, and 13 at roost locations in Oklahoma. I was present at all searches in Marion County and all but two roost visits in Crawford County. I was not present at any search in Oklahoma.

A total of 579 remnants of insect prey was collected at OB roosts. Insect orders other than Lepidoptera were also identified: Coleoptera, Blattodea, Hymenoptera, Diptera, Neuroptera, Odonata, and Orthoptera (Table 4.13). A total of 331 lepidopteran wings was recovered, 269 of which were identifiable beyond the ordinal level.

Moth prey was identified to eight different taxonomic families (Table 4.14). The Noctuidae was the most diverse and abundant family of moths eaten by OB, with 157 individuals recorded representing ≥ 29 species. The Sphingidae, Notodontidae, Geometridae were also fairly common, though occurrence varied among states and counties. A total of 59, 20, and 15 specimens were identified to these families, respectively. Less common families of prey included the Arctiidae, Lasiocampidae, Pyralidae, and Saturniidae, with eight, four, two, and four individuals identified, respectively.

4.5 Comparison of Lepidopteran Availability and Consumption

Similarities existed between the two counties in moth availability and consumption by OB in Arkansas. Noctuidae represent the majority of moths available over the entire summer of 2005 in both Marion and Crawford counties, and were also the moths most often consumed by OB in both locations (Tables 4.15 and 4.16, respectively; Figures 4.4 and 4.5, respectively). Arctiidae and Pyralidae were the next most abundant families available in both counties, but were rarely consumed by OB. A single Pyralid wing was recovered in each county. Arctiidae contributed 6.5% of the prey consumed by OB in Marion County, but were never collected in Crawford County. Notodontidae comprised 4.5% of the moths in Marion County and 8.3% in Crawford County. Consumption of this family was higher than availability in both counties, being 10.9% and 7.7%, respectively.

A noticeable difference existed between the prey families identified in Marion and Crawford counties, in that Sphingidae and Geometridae were consumed in varied amounts. Availability between Marion and Crawford counties was relatively constant for both the Geometridae (12.4% and 14.1%, respectively) and Sphingidae (0.2% and 0.3%, respectively; Tables 4.15 and 4.16, respectively). At 28.3%, the Geometridae were a major component of the diet of OB in Marion County (Table 4.15). The Sphingidae were absent from the OB diet here. In Crawford County, though, Sphingidae were a major component of the diet, comprising 26.8% of the total number of culled moth wings found (Table 4.16). As prey, the Geometridae were nominal, with a single wing from this family recovered (Table 4.16).

4.6 Habitat Characterization

All habitat variables measured at Marion County sample sites, including site attributes, measures of woody plant occurrence, and the enumeration of woody species, are presented in Appendices 13, 14, and 15, respectively. Habitat variables for Crawford County are presented in the same fashion in Appendices 16, 17, and 18.

4.6.1 Woody Vegetation in Marion County

Woody vegetation in Marion County varied with regard to both habitat and roost location. Field and edge habitats by definition possessed reduced or nominal assemblages of woody plants; therefore, analysis of woody plant characters was limited to the upland and riparian forest habitats. Overall, models for abundance of woody stems, richness of woody species, and stand BA were significant ($P = 0.001$, $P = 0.004$, $P = 0.021$, respectively; Table 4.17). There was no variation in snag abundance ($P = 0.15$).

Abundance of woody stems varied by both forest and roost location (Tables 4.18 and 4.19, respectively). Riparian forest had a higher abundance of woody stems than upland forest ($P = 0.0004$). In addition, Blue Heaven area was higher in abundance of woody stems than the Marble Falls and Reed cave areas ($P = 0.002$).

Richness of woody species varied by both forest and roost location (Tables 4.18 and 4.19, respectively). Riparian forest had higher richness of woody species than upland forest ($P = 0.002$). All roost locations varied in their richness of woody species ($P = 0.002$), with Blue Heaven area being most speciose, followed by Marble Falls then the Reed cave area.

Stand BA varied by forest (Table 4.18), but not roost location (Table 4.19). Stand BA of upland forest was higher than that of riparian forest ($P = 0.001$).

The interaction of forest by roost location had a significant effect on abundance of woody stems and richness of woody species ($P = 0.003$ and $P = 0.03$, respectively) but not snag abundance or stand BA (P = 0.41 and P = 0.69, respectively; Table 4.17). The nested effect (non-independence between duplicate sites) was not significant for abundance of woody stems, richness of woody species, snag abundance, or stand BA (P = 0.09, P = 0.27, P = 0.90, and P = 0.58, respectively; Table 4.17).

4.6.2 Woody Vegetation in Crawford County

Woody vegetation in Crawford County varied with regard to both habitat (size class of timber) and roost location. Overall, models for each of the woody vegetation attributes were significant for abundance of woody stems, richness of woody species, and snag abundance (P = 0.003, P = 0.005, and P = 0.04, respectively); stand BA was at a moderate level (P = 0.06; Table 4.20).

Abundance of woody stems varied by both size class of timber and roost location (Tables 4.21 and 4.22, respectively). Sapling habitat was higher than poletimber and sawtimber habitats (P = 0.0001). Devil's Hollow was higher in abundance of abundance of woody stems than the North face area, with Whitzen Hollow intermediate to these locations (P = 0.02).

Richness of woody species varied by both size class of timber and roost location (Tables 4.21 and 4.22, respectively). Sawtimber class habitat was lower than poletimber and sapling size classes (P = 0.001). Whitzen Hollow was higher than the North Face area regarding richness of woody species, with Devil's Hollow intermediate to these locations (P = 0.01).

Snag abundance varied by roost location (Table 4.22), but not by size class of timber (Table 4.21). There were less snags within Devil's Hollow than at Whitzen Hollow or the North Face area ($P = 0.03$).

Overall stand BA varied by size class of timber (Table 4.21), but not by roost location (Table 4.22). BA was lower in sapling habitat than in poletimber and sawtimber habitat ($P = 0.01$).

The interaction of timber size class and roost location was significant for richness of woody species and snag abundance ($P = 0.04$ and $P = 0.01$, respectively), but not abundance of woody stems or stand BA (both $P = 0.14$; Table 4.20). The nested effect (non-independence between duplicate sites) was not significant for abundance of woody stems, richness of woody species, snag abundance, or stand BA ($P = 0.49$, $P = 0.48$, $P = 0.37$, and $P = 0.67$, respectively; Table 4.20).

4.6.3 Models of Prey Abundance and Richness

All habitat measures, except one, were considered for inclusion into MLRs modeling two moth demographics, total abundance and species richness. Aspect of sampling location (Appendices 13 and 16) was omitted due to the circular nature of the data and the implications this presented for linear statistical analysis (Zar 1999).

Snag abundance, abundance of woody stems, richness of woody species, and distance to water were selected as predictor variables for moth abundance based on ANOVAs (Table 4.23). Other habitat variables (Appendixes 13, 14, 16, and 17) were judged as explaining insufficient amounts of variation associated with moth abundance ($P > 0.15$, $R^2 < 0.5$). Screening for multicollinearity resulted in the rejection of richness of woody species as a predictor variable, due to its non-independence with abundance of woody stems (Table 4.23), which seemed a more biologically-meaningful variable for the prediction of moth abundance. The MLR was then constructed in a forward step-wise fashion, with an entry $\alpha = 0.15$ used to incorporate all three remaining predictor variables (Table 4.24).

Snag abundance, abundance of woody stems, richness of woody species, and stand BA were selected as predictor variables for richness of moth species based on ANOVAs (Table 4.25). Other habitat variables (Appendices 13, 14, 16, and 17) were judged as explaining insufficient variation associated with moth abundance ($P > 0.15$, $R^2 < 0.5$). A number of predictor variables (i.e., multiple measures of BA; Appendices 14 and 17) showed marginal potential for use in modeling, and were rejected in favor of the most simplistic, management-friendly variable (i.e., overall stand BA). Screening for multicollinearity resulted in the rejection of abundance of woody stems as a predictor variable due to its non-independence with richness of woody species (Table 4.25). The latter variable seemed a more biologically-meaningful measure for the prediction of richness of moth species. The MLR was then constructed in a forward step-wise fashion, with an entry $\alpha = 0.15$ used to incorporate snag abundance and richness of woody species as predictor variables (Table 4.26).

Table 4.1. Demographics of moth assemblages in Marion County, Arkansas, during the summer 2004.

	Roost Location			
	Blue Heaven	**Reed**	**Marble Falls**	**Mean (±SE)**
Upland Forest				
Moth Abundance (#/trap)	59	149	173	127 (34.7)
Species Richness (#/trap)	20	27	25	24 (2.1)
Microlep Biomass (g/trap)	0.117	2.501	0.273	0.964 (0.77)
Riparian Forest				
Moth Abundance (#/trap)	18	115	120	84 (33.2)
Species Richness (#/trap)	7	18	21	15 (4.3)
Microlep Biomass (g/trap)	0.143	2.190	0.138	0.824 (0.68)
Field				
Moth Abundance (#/trap)	19	94	19	44 (25.0)
Species Richness (#/trap)	7	15	8	10 (2.5)
Microlep Biomass (g/trap)	0.166	0.787	0.021	0.325 (0.23)
Edge				
Moth Abundance (#/trap)	86	126	130	114 (14.1)
Species Richness (#/trap)	18	16	30	21 (4.4)
Microlep Biomass (g/trap)	0.252	1.606	0.146	0.668 (0.47)

Table 4.2. Demographics of moth assemblages in Crawford County, Arkansas, during the summer 2004.

	Roost Location			
	Devil's Hollow	**North Face**	**Whitzen Hollow**	**Mean (±SE)**
Sawtimber				
Moth Abundance (#/trap)	80	58	80	73 (7.3)
Species Richness (#/trap)	22	19	29	23 (3.0)
Microlep Biomass (g/trap)	0.184	0.031	0.471	0.229 (0.13)
Poletimber				
Moth Abundance (#/trap)	72	40	100	71 (17.3)
Species Richness (#/trap)	17	19	31	22 (4.4)
Microlep Biomass (g/trap)	0.209	0.032	0.337	0.193 (0.09)
Sapling				
Moth Abundance (#/trap)	23	38	57	39 (9.8)
Species Richness (#/trap)	16	18	21	18 (1.5)
Microlep Biomass (g/trap)	0.065	0.012	0.127	0.068 (0.03)

Table 4.3. Missing data due to blacklight trap malfunctions in Arkansas during the summer 2005.

Sampling Date	Sampling Period	County	Roost Location	Habitat Type	Site	Time of Night
25 May	First	Crawford	North Face	Poletimber	2	Late
9 June	Second	Marion	Marble Falls	Upland Forest	1	Early
20 June	Second	Marion	Blue Heaven	Upland Forest	2	Early
23 June	Third	Marion	Reed	Edge	2	Late
14 July	Third	Crawford	Whitzen Hollow	Sapling	2	Late
22 July	Fourth	Crawford	North Face	Sapling	1	Late
3 August	Fourth	Marion	Marble Falls	Edge	1	Late

Table 4.4. ANOVAs associated with moth demographics for Marion County, Arkansas, summer 2005. Partitioning of variation used Type III sums of squares.

Response Variable	Source of Variation	DF	Sum of Squares	F value	Level of Significance
Moth Abundance	Model	15	18.24	10.29	0.0001
	Error	76	8.99		
	Habitat	3	14.04	39.58	0.0001
	Nest Effect / Time of Night	4	0.872	1.84	0.13
	Roost Location	2	0.508	2.15	0.12
	Habitat x Roost Location	6	2.48	3.49	0.004
Family Richness	Model	15	2.45	5.24	0.0001
	Error	76	2.37		
	Habitat	3	2.03	21.67	0.0001
	Nest Effect / Time of Night	4	0.147	1.18	0.33
	Roost Location	2	0.111	1.77	0.18
	Habitat x Roost Location	6	0.141	0.75	0.61
Species Richness	Model	15	8.42	8.82	0.0001
	Error	76	4.84		
	Habitat	3	7.01	36.67	0.0001
	Nest Effect / Time of Night	4	0.403	1.58	0.19
	Roost Location	2	0.159	1.25	0.29
	Habitat x Roost Location	6	0.725	1.90	0.09
ML Mass	Model	15	0.336	5.18	0.0001
	Error	76	0.329		
	Habitat	3	0.084	6.43	0.001
	Nest Effect / Time of Night	4	0.055	3.17	0.02
	Roost Location	2	0.083	9.56	0.0002
	Habitat x Roost Location	6	0.105	4.05	0.001

Table 4.5. Demographics of moth assemblages in Marion County, Arkansas, in relation to habitat during summer 2005. Different letters within columns are different at $P < 0.05$.

		Mean (±SE) per Light Trap			
Habitat	**n**	**Total Abundance**	**Family Richness**	**Species Richness**	**ML Mass (g)**
Riparian Forest	24	70.3 (9.9) a	6.9 (0.41) a	21.5 (2.3) a	0.254 (0.07) a
Upland Forest	22	70.0 (12.0) a	7.0 (0.29) a	19.4 (1.7) a	0.235 (0.09) a
Edge	22	35.0 (5.1) a	6.0 (0.35) a	16.0 (1.8) a	0.127 (0.05) a
Field	24	8.9 (2.0) b	3.1 (0.42) b	4.8 (0.9) b	0.020 (0.004) a

Table 4.6. Demographics of moth assemblages in Marion County, Arkansas, related to roost location during summer 2005. Different letters within columns are different at $P < 0.05$.

		Mean (±SE) per Light Trap			
Roost Location	**n**	**Total Abundance**	**Family Richness**	**Species Richness**	**ML Mass (g)**
Reed	31	62.5 (10.2) a	5.6 (0.44) a	16.0 (1.9) a	0.290 (0.07) a
Blue Heaven	31	40.7 (7.1) a	6.3 (0.39) a	19.0 (1.7) a	0.043 (0.007) b
Marble Falls	30	33.8 (6.7) a	5.2 (0.45) a	13.9 (2.1) a	0.141 (0.05) b

Table 4.7. ANOVAs associated with moth demographics for Crawford County, Arkansas, summer 2005. Partitioning of variation used Type III sums of squares.

Response Variable	Source of Variation	DF	Sum of Squares	F value	Level of Significance
Moth Abundance	Model	11	4.16	4.99	0.0001
	Error	57	4.32		
	Habitat	2	0.044	0.29	0.75
	Nest Effect / Time of Night	3	0.297	1.31	0.28
	Roost Location	2	2.06	13.57	0.0001
	Habitat x Roost Location	4	1.63	5.36	0.001
Family Richness	Model	11	0.599	3.91	0.0003
	Error	57	0.794		
	Habitat	2	0.013	0.48	0.62
	Nest Effect / Time of Night	3	0.025	0.59	0.62
	Roost Location	2	0.273	9.80	0.0002
	Habitat x Roost Location	4	0.262	4.70	0.002
Species Richness	Model	11	1.55	3.06	0.003
	Error	57	2.62		
	Habitat	2	0.014	0.15	0.86
	Nest Effect / Time of Night	3	0.142	1.03	0.39
	Roost Location	2	0.663	7.21	0.002
	Habitat x Roost Location	4	0.665	3.62	0.01
ML Mass	Model	11	4.09	2.06	0.039
	Error	57	10.31		
	Habitat	2	0.237	0.66	0.52
	Nest Effect / Time of Night	3	1.64	3.03	0.04
	Roost Location	2	1.10	3.03	0.06
	Habitat x Roost Location	4	0.980	1.36	0.26

Table 4.8. Demographics of moth assemblages in Crawford County, Arkansas, related to roost location during summer 2005. Different letters within columns are different at $P < 0.05$.

		Mean (±SE) per Light Trap			
Roost Location	**n**	**Total Abundance**	**Family Richness**	**Species Richness**	**ML Mass (g)**
Whitzen Hollow	23	93.3 (10.8) a	9.3 (0.45) a	29.0 (2.6) a	0.193 (0.04) a
Devil's Hollow	24	64.5 (9.0) b	8.2 (0.39) a	21.7 (2.1) ab	0.094 (0.02) a
North Face	22	37.2 (5.5) c	6.6 (0.48) b	17.0 (2.0) b	0.118 (0.05) a

Table 4.9. Demographics of moth assemblages in Crawford County, Arkansas, in relation to habitat during summer 2005.

		Mean (±SE) per Light Trap			
Habitat	**n**	**Total Abundance**	**Family Richness**	**Species Richness**	**ML Mass (g)**
Poletimber	23	73.9 (11.0)	8.5 (0.47)	24.0 (2.6)	0.180 (0.05)
Sawtimber	24	64.1 (9.5)	8.1 (0.61)	22.1 (2.4)	0.105 (0.02)
Sapling	22	57.9 (9.1)	7.5 (0.30)	21.7 (2.3)	0.120 (0.03)

Table 4.10. Occurrence of common moth families ($n \geq 100$ specimens) across habitats in Marion County, Arkansas, during summer 2005. Total does not include Field as this habitat was excluded in analysis. X^2 goodness-of-fit tests were significant if $X^2_{calc} > 9.21_{0.01,2}$.

Moth Family	**Upland Forest**	**Riparian Forest**	**Edge**	**Field**	**Total**	$\mathbf{X^2_{calc}}$
Arctiidae	328	346	85	22	781	168.0
Geometridae	176	261	67	16	520	112.6
Lasiocampidae	119	129	65	8	321	22.7
Noctuidae	560	544	291	91	1486	97.9
Notodontidae	85	64	28	11	188	28.2
Pyralidae	161	194	142	30	527	8.4
Tortricidae	63	70	62	11	206	0.58

Table 4.11. Occurrence of common moth families (n ≥ 100 specimens) across habitats, in Crawford County, Arkansas, during summer 2005. X^2 goodness-of-fit tests were significant if $X^2_{calc} > 9.21_{0.01,\,2}$.

Moth Family	**Sapling**	**Poletimber**	**Sawtimber**	**Total**	$\mathbf{X^2_{calc}}$
Arctiidae	122	391	323	836	140.1
Geometridae	194	266	177	637	21.0
Noctuidae	445	413	404	1262	2.2
Notodontidae	67	168	138	373	43.3
Pyralidae	219	260	280	759	7.6
Saturniidae	19	45	37	101	10.5
Tortricidae	40	36	41	117	0.36

Table 4.12. Relative habitat use of moth families (n > 100 specimens) determined by black-light sampling in Marion and Crawford counties, Arkansas, during summer of 2005. Habitat selection was tested using Bonferroni z-statistics and indicated whether a habitat was selected, used proportionately, or avoided ($P < 0.05$). A dash (-) denotes proportionate occurrence; blank spaces indicate analysis was not made (n < 100 specimens).

	Marion County			**Crawford County**		
Moth Family	**Edge**	**Riparian Forest**	**Upland Forest**	**Sapling**	**Poletimber**	**Sawtimber**
Arctiidae	Avoid	Select	Select	Avoid	Select	Select
Geometridae	Avoid	Select	-	-	Select	Avoid
Lasiocampidae	Avoid	Select	-			
Noctuidae	Avoid	Select	Select			
Notodontidae	Avoid	-	Select	Avoid	Select	-
Pyralidae	-	-	-	-	-	-
Saturniidae				Avoid	-	-
Tortricidae	-	-	-	-	-	-

Table 4.13. Insect taxa identified in the diet of OB from the collection of remnants at known roost locations, 2003-2005. Oklahoma roosts are in Adair and Delaware counties.

	Number of Prey Remnants Recovered			
	Arkansas		Oklahoma	Total for All Areas
Prey Order	**Marion County**	**Crawford County**		
Blattodea	1	37	52	90
Coleoptera	7	99	34	140
Diptera		5		5
Hymenoptera	1	3	2	6
Neuroptera		3	1	4
Odonata		2		2
Orthoptera		1		1
Prey Remnants Other Than Lepidoptera	**9**	**150**	**89**	**248**
Lepidoptera	46	207	78	331
Total Prey Remnants	**55**	**357**	**167**	**579**

Table 4.14. Moth prey identified in the diet of OB from the collection of culled wings at known roost locations, 2003-2005. Oklahoma roosts are in Adair and Delaware counties.

	Number of Wings Recovered		
	Arkansas		Oklahoma
Prey Taxa	**Marion Co.**	**Crawford Co.**	
Arctiidae			
Apantesis sp.			2
Ecpantheria scribonia			3
Halysidota tessellaris	3		
Total Arctiids	3		5
Geometridae			
Anticlea multiferata	2		
Dichordia iridaria		1	
Epimecis hortaria	1		
Euchlaena sp.	1		
Euchlaena pectinaria	2		1
Hydria prunivorata	2		
Hypagyrtis unipunctata	2		
Patalene olyzonaria	1		
Probole nyssaria	1		
Selinia kentaria	1		
Total Geometrids	13	1	1
Lasiocampidae			
Malacosoma americanum			4
Noctuidae			
Family	13	36	1
Abagrotis alternata		5	
Acronicta sp.		6	2
Acronicta americana		3	
Acronicta lobeliae			2
Agrotis sp.		1	
Agrotis ipsilon		1	
Allotria elonympha			3
Amphipyra pyramidoides		2	3
Argyrogrammia basigera		2	
Callopistria cordata			1
Catocala sp.	4	2	9
Catocala ilia		4	
Euparthenos nubilis		2	

Table 4.14. (continued)

Prey Taxa	Arkansas		Oklahoma
	Marion Co.	Crawford Co.	
Eupsilia sp.	4		
Heliothis zea		1	
Hypsoropha monilis		1	
Lacinipolia renigera		3	
Leucania sp.		3	
Orthodes cynica		4	
Paectes pygmaea		1	
Panopoda carneicosta		4	
Panopoda rufimargo		3	
Panthea furcilla			1
Platysenta sutor		2	
Protolampra brunneicollis		2	
Pseudaletia unipuncta		8	
Pseudorthodes vecors	1		
Renia sp.		2	
Renia fraternalis		1	
Scolicocampa liburna		2	
Zale sp.			2
Zale lunata	2	6	1
Zanclognatha sp.		1	
Total Noctuids	24	108	25
Notodontidae			
Family	3	3	
Datana sp.			1
Datana angusii		2	
Lochmaeus bilineata	1		
Lochmaeus manteo		2	
Nadata gibbosa	1	5	
Nirece bidentata		1	
Symmerista albifrons			1
Total Notodontids	5	13	2
Pyralidae			
Blepharomastix ranalis	1		
Pantographa limata		1	
Saturnidae			
Automeris io			2
Sphingicampa bicolor			2

Table 4.14. (continued)

	Arkansas		Oklahoma
Prey Taxa	Marion Co.	Crawford Co.	
Sphingidae			
Family			5
Darapsa myron		3	2
Laothoe juglandis		42	7
Total Sphingids		45	14
Total Moths Identified	46	168	55

Table 4.15. Percentage of moths, by family, collected in blacklight trap samples (availability) and at OB roosts (consumption) in Marion County, Arkansas, summer 2005.

Moth Family	**Available**		**Consumed**	
	n	**%**	**n**	**%**
Noctuidae	1486	35.3	24	52.2
Arctiidae	781	18.6	3	6.5
Pyralidae	527	12.5	1	2.2
Geometridae	520	12.4	13	28.3
Lasiocampidae	321	7.6	-	-
Tortricidae	206	4.9	-	-
Notodontidae	188	4.5	5	10.9
Saturniidae	47	1.1	-	-
Oecophoridae	38	0.9	-	-
Limacodidae	27	0.6	-	-
Lymantriidae	22	0.5	-	-
Yponomeutidae	15	0.4	-	-
Megalopygidae	8	0.2	-	-
Sphingidae	8	0.2	-	-
Mimallonidae	4	0.1	-	-
Apatelodidae	3	0.1	-	-
Drepanidae	3	0.1	-	-
Epiplemidae	2	< 0.1	-	-
Cossidae	1	< 0.1	-	-
Pterophoridae	1	< 0.1	-	-
Zygaenidae	1	< 0.1	-	-
Total Moths	**4209**	**100%**	**46**	**100%**

Table 4.16. Percentage of moths, by family,collected in blacklight trap samples (availability) and at OB roosts (consumption) in Crawford County, Arkansas, summer 2005.

Moth Family	**Available**		**Consumed**	
	n	**%**	**n**	**%**
Noctuidae	1262	28	108	64.3
Arctiidae	836	18.5	-	-
Pyralidae	759	16.8	1	0.6
Geometridae	637	14.1	1	0.6
Notodontidae	373	8.3	13	7.7
Tortricidae	117	2.6	-	-
Saturniidae	101	2.2	-	-
Lasiocampidae	92	2	-	-
Limacodidae	59	1.3	-	-
Lymantriidae	59	1.3	-	-
Yponomeutidae	53	1.2	-	-
Megalopygidae	42	0.9	-	-
Oecophoridae	42	0.9	-	-
Epiplemidae	28	0.6	-	-
Apatelodidae	15	0.3	-	-
Cossidae	13	0.3	-	-
Sphingidae	12	0.3	45	26.8
Zygaenidae	7	0.2	-	-
Mimallonidae	2	<0.1	-	-
Drepanidae	1	<0.1	-	-
Thyatiridae	1	<0.1	-	-
Total Moths	**4511**	**100%**	**168**	**100%**

Table 4.17. ANOVAs associated with woody growth of two forested habitats in Marion County, Arkansas. Partitioning of variation uses Type III sums of squares.

Response Variable	Source of Variation	DF	Sum of Squares	F value	Level of Significance
Woody Stem Abundance	Model	7	0.349	41.24	0.001
	Error	4	0.005		
	Habitat / Forest Type	1	0.148	122.12	0.0004
	Nest Effect / Site Duplication	2	0.011	4.51	0.09
	Roost Location	2	0.110	45.53	0.002
	Habitat x Roost Location	2	0.080	33.24	0.003
Woody Species Richness	Model	7	0.134	24.58	0.004
	Error	4	0.003		
	Habitat / Forest Type	1	0.042	54.56	0.002
	Nest Effect / Site Duplication	2	0.003	1.82	0.27
	Roost Location	2	0.073	47.20	0.002
	Habitat x Roost Location	2	0.015	9.72	0.03
Snag Density	Model	7	0.375	3.08	0.15
	Error	4	0.070		
	Habitat / Forest Type	1	0.050	2.86	0.17
	Nest Effect / Site Duplication	2	0.003	0.10	0.90
	Roost Location	2	0.283	8.12	0.04
	Habitat x Roost Location	2	0.039	1.12	0.41
Stand BA	Model	7	0.277	10.13	0.021
	Error	4	0.016		
	Habitat / Forest Type	1	0.248	63.59	0.001
	Nest Effect / Site Duplication	2	0.005	0.63	0.58
	Roost Location	2	0.020	2.62	0.19
	Habitat x Roost Location	2	0.003	0.41	0.69

Table 4.18. Attributes of woody growth (Mean (±SE)) of two forested habitats in Marion County, Arkansas. Different letters within columns are different at $P < 0.05$.

Forested Habitat	n	Woody Stem Abundance (#/ha)	Woody Species Richness (# species/plot)	Snag Density (#/ha)	Stand BA (m^2/ha)
Riparian	6	4501.4 (683.6) a	20.0 (1.77) a	151.2 (19.1) a	14.3 (1.1) a
Upland	6	2584.4 (229.2) b	15.0 (1.53) b	122.1 (27.1) a	28.5 (1.3) b

Table 4.19. Attributes of woody growth (Mean (±SE)) of forested habitats in different roost locations in Marion County, Arkansas. Different letters within columns are different at *P* < 0.05.

Roost Location	**n**	**Woody Stem Abundance (#/ha)**	**Woody Species Richness (# species/plot)**	**Snag Density (#/ha)**	**Stand BA (m^2/ha)**
Blue Heaven	4	4640.7 (908.0) a	21.0 (1.1) a	87.6 (18.7) a	20.7 (3.9) a
Marble Falls	4	3418.8 (818.6) b	18.25 (2.8) b	125.4 (17.9) ab	24.1 (4.4) a
Reed	4	2569.1 (30.9) b	13.25 (0.85) c	197.0 (15.0) b	19.5 (4.4) a

Table 4.20. ANOVAs associated with woody growth of forested habitats in Crawford County, Arkansas. Partitioning of variation uses Type III sums of squares.

Response Variable	Source of Variation	DF	Sum of Squares	F value	Level of Significance
Woody Stem Abundance	Model	11	1.27	12.73	0.003
	Error	6	0.054		
	Habitat / Size Class of Timber	2	1.00	55.41	0.0001
	Nest Effect / Site Duplication	3	0.024	0.90	0.49
	Roost Location	2	0.144	7.97	0.02
	Habitat x Roost Location	4	0.096	2.65	0.14
Woody Species Richness	Model	11	0.299	10.01	0.005
	Error	6	0.016		
	Habitat / Size Class of Timber	2	0.182	33.49	0.001
	Nest Effect / Site Duplication	3	0.008	0.94	0.48
	Roost Location	2	0.054	9.94	0.01
	Habitat x Roost Location	4	0.055	5.11	0.04
Snag Density	Model	11	0.957	4.53	0.04
	Error	6	0.115		
	Habitat / Size Class of Timber	2	0.006	0.17	0.85
	Nest Effect / Site Duplication	3	0.073	1.27	0.37
	Roost Location	2	0.272	7.08	0.03
	Habitat x Roost Location	4	0.605	7.87	0.01
Stand BA	Model	11	0.480	3.80	0.06
	Error	6	0.069		
	Habitat / Size Class of Timber	2	0.240	10.45	0.01
	Nest Effect / Site Duplication	3	0.187	0.54	0.67
	Roost Location	2	0.100	4.33	0.07
	Habitat x Roost Location	4	0.121	2.64	0.14

Table 4.21. Attributes of woody growth (Mean (±SE)) of different size classes of timber in Crawford County, Arkansas. Different letters within columns are different at *P* < 0.05.

Habitat	n	Woody Stem Abundance (#/ha)	Woody Species Richness (# species/plot)	Snag Density (#/ha)	Stand BA (m^2/ha)
Poletimber	6	1466.0 (87.3) a	17.2 (1.50) a	86.2 (11.7) a	28.1 (4.3) a
Sawtimber	6	1420.9 (226.1) a	11.5 (1.12) b	79.6 (10.3) a	28.5 (2.9) a
Sapling	6	4737.5 (788.5) b	19.7 (1.63) a	102.2 (29.8) a	16.3 (2.2) b

Table 4.22. Attributes of woody growth (Mean (±SE)) of different roost locations in Crawford County, Arkansas. Different letters within columns are different at $P < 0.05$.

Roost Location	**n**	**Woody Stem Abundance (#/ha)**	**Woody Species Richness (# species/plot)**	**Snag Density (#/ha)**	**Stand BA (m^2/ha)**
Whitzen Hollow	6	2914.7 (943.0) ab	18.8 (2.52) a	106.1 (24.6) a	19.5 (1.3) a
Devil's Hollow	6	2995.6 (946.0) a	15.7 (0.88) ab	61.0 (13.3) b	22.6 (3.7) a
North Face	6	1714.1 (370.6) b	13.8 (1.85) b	100.8 (12.6) a	30.8 (4.7) a

Table 4.23. Screening of candidate habitat variables for predicting moth abundance in the Ozark Mountains of Arkansas.

Predictor Variable	Source of Variation	DF	Sum of Squares	F value	Level of Significance	R^2	Tolerance	Variance Inflation Factor
Snag Abundance (#/ha)	Model	94	52.01	1.47	0.05	0.68	0.333	3.01
	Error	66	24.92					
Woody Stem Richness (#/ha)	Model	94	63.86	2.10	0.001	0.75	0.083	12.06
	Error	66	21.33					
Woody Species Richness (#/plot)	Model	94	9.65	2.14	0.001	0.75	0.079	12.72
	Error	66	3.17					
Distance to Water (m)	Model	94	42.44	1.3	0.13	0.65	0.914	1.09
	Error	66	22.85					

Table 4.24. A stepwise multiple linear regression modeling moth abundance against selected habitat variables. All data used in construction of model was normalized ($\log_{10} + 1$).

Step	Variable	Parameter Estimate	Standard Error	F-Value	Level of Significance	Partial R^2	Model R^2
	Intercept	0.75425	0.19901				
1	Snag Abundance (#/ha)	0.33005	0.07136	108.23	0.0001	0.4050	0.4050
2	Woody Stem Richness (#/ha)	0.13004	0.06906	5.03	0.0264	0.0183	0.4233
3	Distance to Water (m)	-0.07528	0.04765	2.50	0.1161	0.0090	0.4324

Table 4.25. Screening of candidate habitat variables for predicting moth species richness in the Ozark Mountains of Arkansas.

Predictor Variable	Source of Variation	DF	Sum of Squares	F value	Level of Significance	R^2	Tolerance	Variance Inflation Factor
Snag Abundance (#/ha)	Model	44	48.10	4.40	0.0001	0.63	0.129	7.75
	Error	116	28.82					
Woody Stem Richness (#/ha)	Model	44	50.21	3.78	0.0001	0.59	0.083	12.04
	Error	116	34.98					
Woody Species Richness (#/plot)	Model	44	7.78	4.07	0.0001	0.61	0.083	12.40
	Error	116	5.04					
Stand BA (m^2/ha)	Model	44	19.73	3.36	0.0001	0.56	0.173	5.77
	Error	116	15.46					

Table 4.26. A stepwise multiple linear regression modeling moth species richness against selected habitat variables. All data used in construction of model was normalized ($\log_{10} + 1$).

Step	Variable	Parameter Estimate	Standard Error	F-Value	Level of Significance	Partial R^2	Model R^2
	Intercept	0.41294	0.08660				
1	Snag Abundance (#/ha)	0.18350	0.04939	113.93	0.0001	0.4174	0.4174
2	Woody Species Richness (#/plot)	0.41627	0.12099	11.84	0.0007	0.0406	0.4580

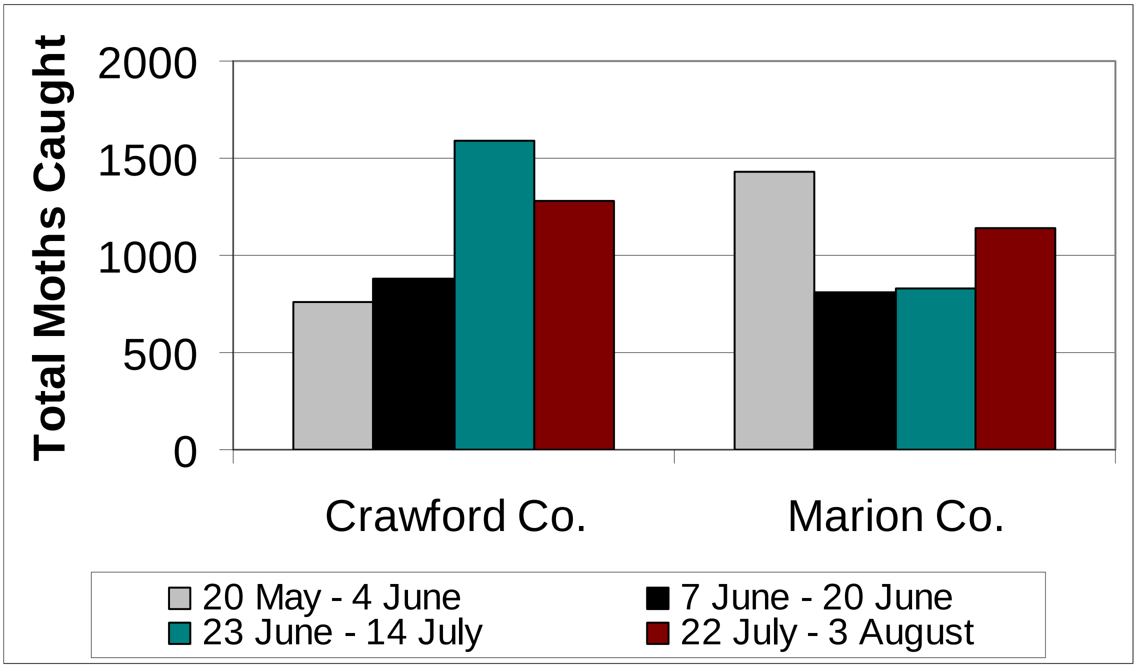

Figure 4.1. Moths captured in blacklight traps over the four sampling periods during the summer of 2005 in Marion County and Crawford counties, Arkansas.

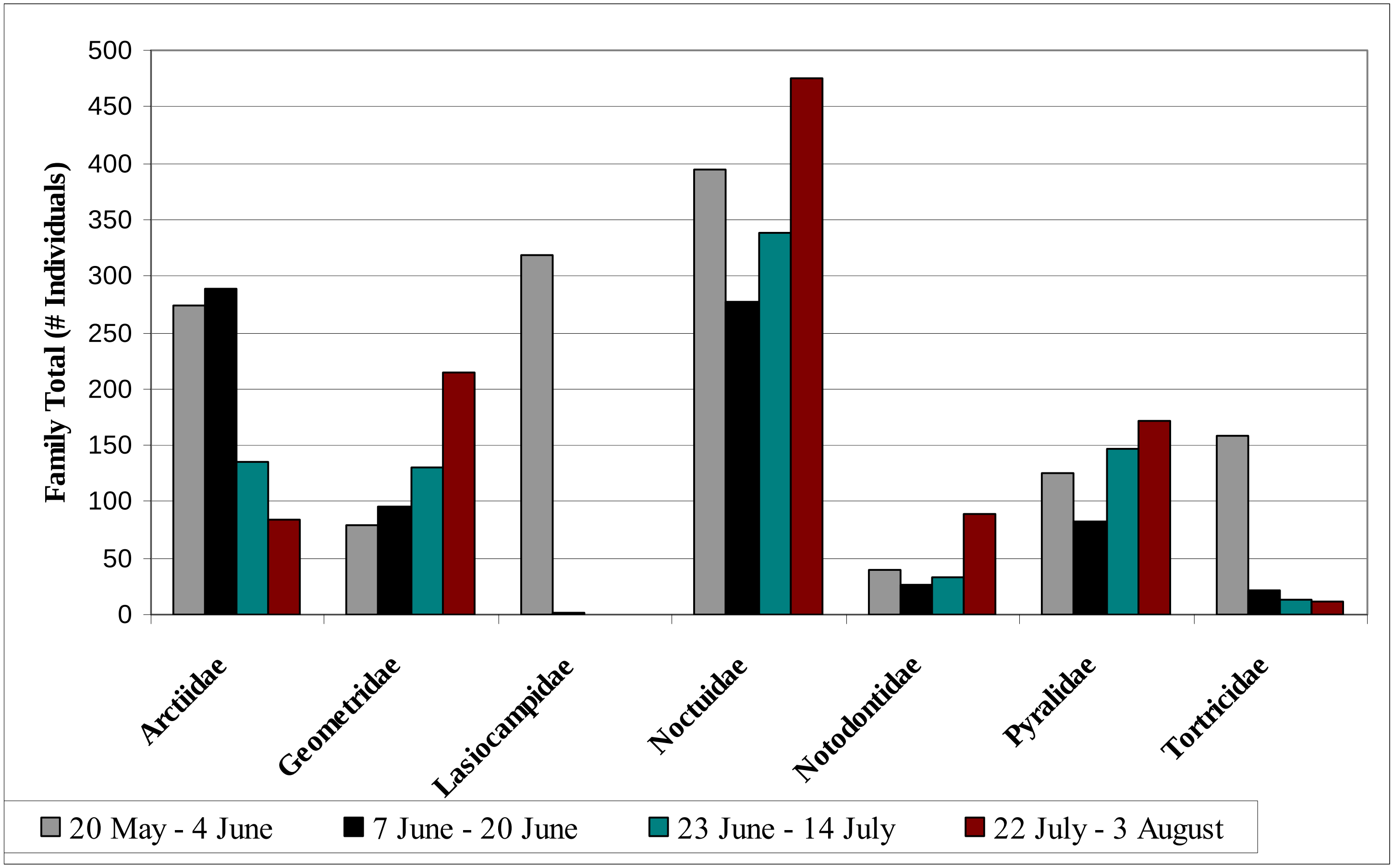

Figure 4.2. Variation in abundance of moth families (n ≥ 100 specimens) over sampling periods during the summer of 2005 in Marion County, Arkansas.

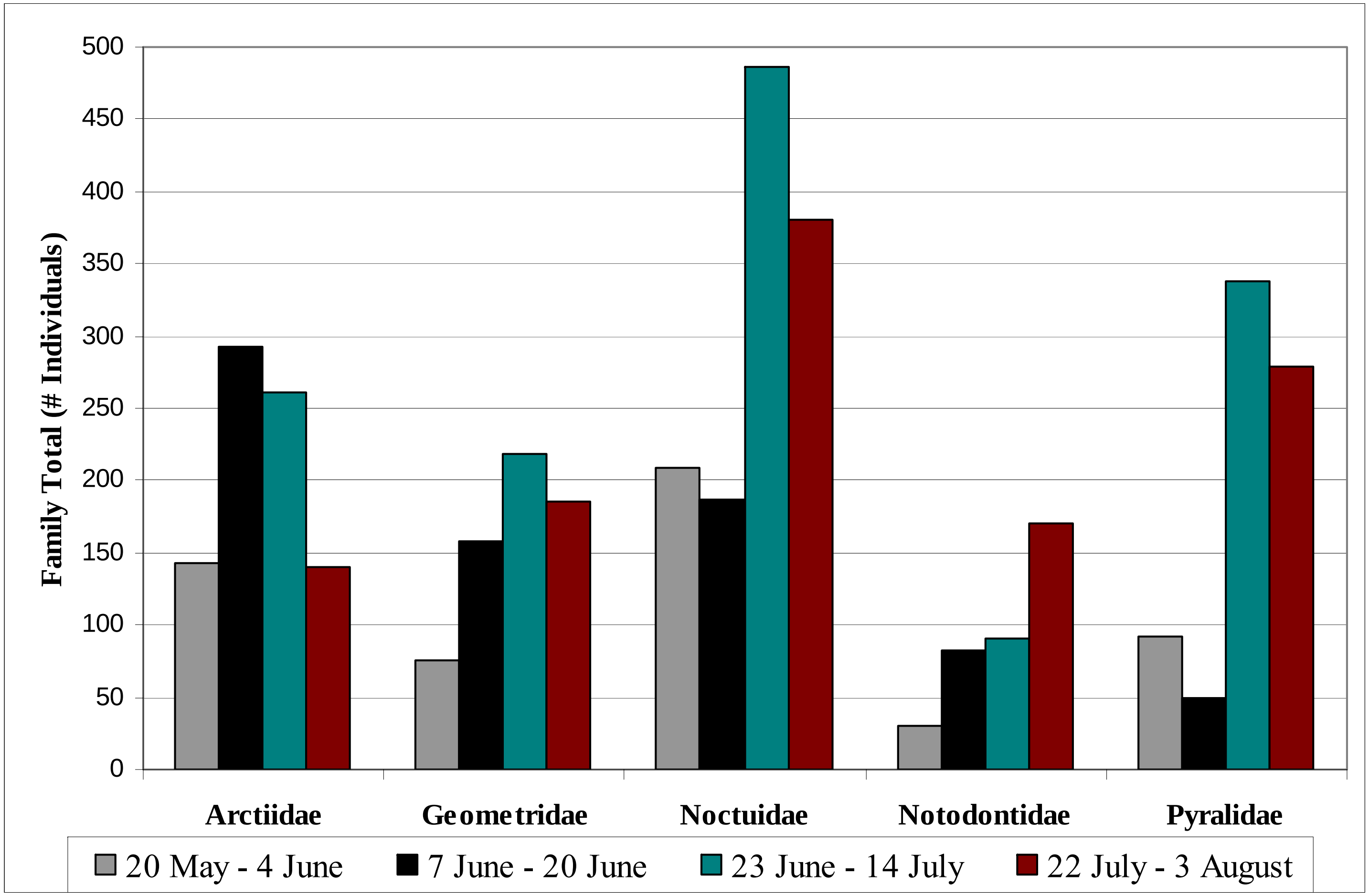

Figure 4.3. Variation in abundance of moth families (n ≥ 100 specimens) over sampling periods during the summer of 2005 in Crawford County, Arkansas.

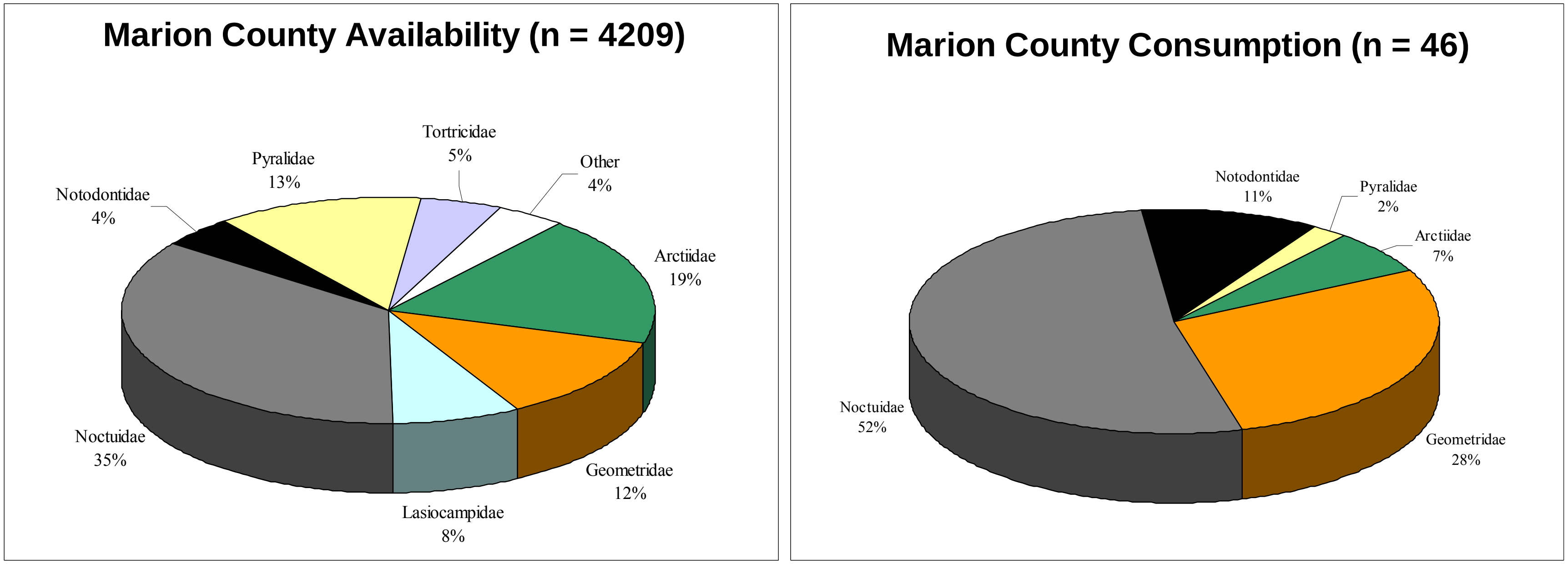

Figure 4.4. Relative availability (summer 2005) and consumption of moth families by the Ozark big-eared bat in Marion County, Arkansas.

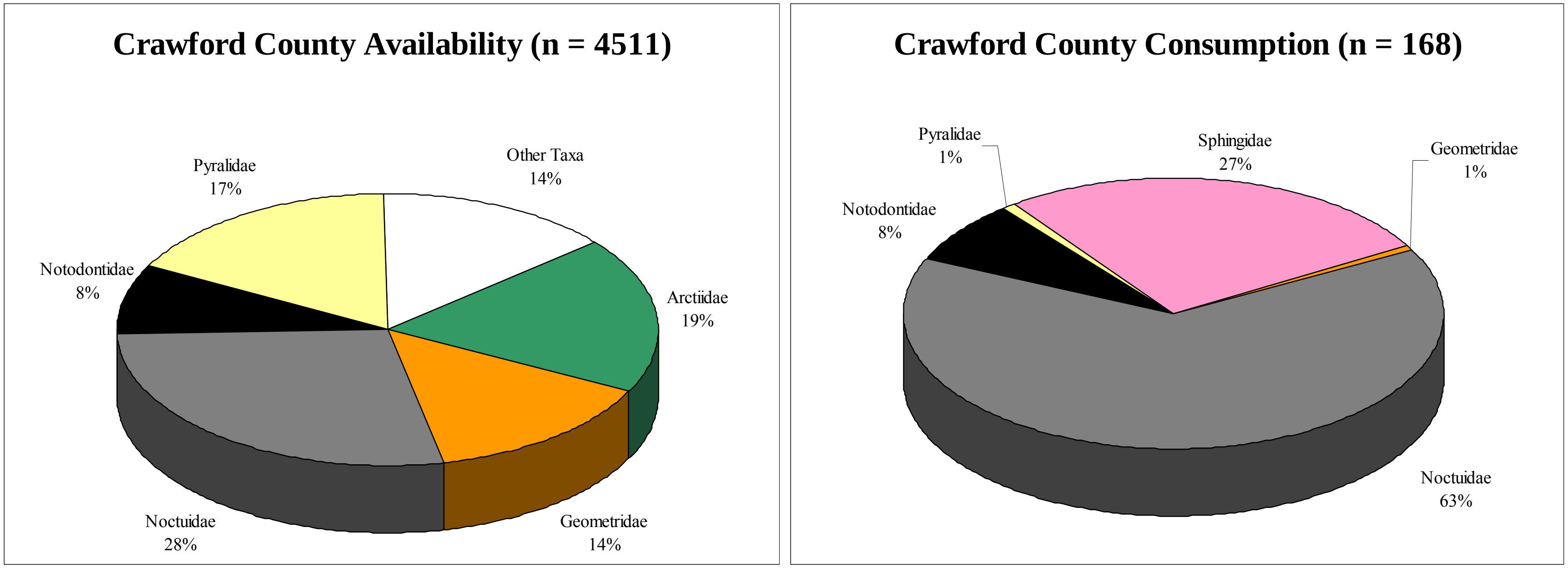

Figure 4.5. Relative availability (summer 2005) and consumption of moth families by the Ozark big-eared bat in Crawford County, Arkansas. Note that sphingids comprised 0.3 % of moths available (consolidated within Other Taxa).

CHAPTER 5: DISCUSSION

This study is discussed in three sections. First, results are interpreted as to their contribution to knowledge of lepidoptera in temperate forest systems and the subsequent implications for OB, as well as the predator-prey interaction between *Corynorhinus* and lepidoptera. Next, limitations of this study are realized, both in terms of study design and the resulting inferences. Finally, specific recommendations are provided for future management of OB.

5.1 Variation of Lepidopteran Assemblages

Insects are one of the most hyperdiverse assemblages in forest ecosystems (Stork 1988) with lepidoptera among the most speciose of insects in the forests of the eastern United States (Hammond and Miller 1998). Their species richness, second among insects only to the Coleoptera (beetles), is astounding, with approximately 120,000 species recognized worldwide (Covell 1984). This study documents the occurrence of $\geq$ 347 different species of moths occurring in the Ozark region of Arkansas (Appendix 19), a testament to the diversity and complexity of form of the moths found in the deciduous forests of the eastern United States (Appendix 20).

I find it difficult to explain the variation observed for microlepidoptera. ML mass (i.e., a measure of abundance) was the singular demographic that varied by time of night, in that abundance was higher during the first portion of the night. A potential explanation is a difference in the diel activity patterns between larger moths and microlepidoptera. Temperatures on trap nights were higher at sunset vs. sunrise (Appendix 1), an abiotic factor known to impact moth catch (Yela and Holyoak 1998). Perhaps many microlepidoptera tend to be crepuscular or diurnal or, due to smaller body size, are more responsive to higher temperature than moths. This could lead to disproportionate activity of microlepidoptera, whereas it was not apparent for larger moths. This is a tenuous argument, but as I did not focus identification efforts on microlepidoptera, in fact circumventing this via a simple biomass estimate, I am not knowledgeable regarding the taxonomy and life histories of microlepidoptera. I am further puzzled by the variation of microlepidoptera found across roost locations in Marion County (Table 4.6). Comparison of woody plant attributes by roost location in Marion County leaves little in the way of possible explanations for the high abundance of microlepidoptera in the Reed Cave area (Table 4.19). Woody richness was lowest at this site, but seems an unlikely explanation for increase in the abundance of any herbivorous insect. Further review of other habitat variables (Appendices 13-15) does not lend direction either; I find little explanation for this response. As other demographics do not consider microlepidoptera, and microlepidoptera appear to not follow trends and patterns of these other demographics, they are precluded from the following discussion.

Despite puzzling results for microlepidoptera, the demographics of larger moths known to be consumed by *Corynorhinus* (i.e., wingspans > 20mm) are more conclusive. Inferences can be made from my data regarding the variation of moth assemblages in accordance with habitat and location over the landscape in both Marion and Crawford counties. Additionally, a number of congruencies exist between moth demographics and patterns of woody vegetation, suggesting certain correlations between moth assemblages and their host plant base. Specifically, it appears that the diversity of woody species within a landscape is more related to moth demographics, as opposed to stand condition (i.e., basal area, timber size class, or ecotype). Further, data from Crawford County suggests the value of landscape position as a regulation of forest lepidoptera.

Moth demographics in Marion County varied as a response habitat (Table 4.5), rather than roost location (Table 4.6). The difference between field and forested habitat was not unexpected considering fields were of relatively homogenous graminoid composition. Burford et al. (1999) found a trend mirroring this in forest clearings versus forest habitats. Though overall demographics of moth assemblages were not found to differ in clearings, Burford et al. (1999) found that richness of moth species was lowest here and, further, occurrence in this habitat was also lowest for a number of common moth families (Arctiidae, Geometridae, Limacodidae, and Noctuidae). Even so, the disparity I found between forested and field habitats was striking. As clearing habitats considered by Burford et al. (1999) were wildlife openings within a forest matrix, I assume the host plant base used by forest moths was more readily available in this habitat category than in the field habitats of this study. This is a condition indicated by my data to support a greater abundance and diversity of prey for OB. This study, and previous work (Burford et al. 1999, Leslie and Clark 2002, Summerville and Crist 2002), support the conclusion that open habitats possess moth assemblages lower in diversity and abundance than those found in forest habitats. Further, my study suggests that the abundance and diversity of moths in relatively homogeneous herbaceous-dominated agricultural habitat pales in comparison to that found in forested habitat.

Relating to this, an edge effect (heightened biodiversity at the juncture of two different habitats; Yahner 2000) was not apparent at edge habitat in Marion County. As expected, edges possessed a blended assemblage of field and forest associated moth species but, not surprisingly, the majority of moth taxa were those found primarily in forest habitats (Appendix 5). This indicates why edge habitat did not differ from forested habitats (Table 4.5), as moth assemblages along edges are “spillover” from the forest interior. These “matrix spillover effects” (sensu Summerville and Crist 2003) may alter moth assemblages across a forest/agricultural setting, and push towards homogeneity in a fragmented landscape (Summerville et al. 1999, Davies et al. 2001, Summerville and Crist 2003, Summerville 2004). Thus, it is sensible that the paucity of moths in the herbaceous field habitat contributed to the general reduction of moth demographics in our edge classification, and that moth assemblages were primarily a consequence of the adjoining forest.

Notably, landscape position of roosts in Marion County did not affect moth demographics. I find two explanations for this. Roosts here are more centralized geographically than those studied in Crawford County. Consequently, variation of floristic patterns and species pools of moths on both a landscape and regional level is less likely in comparison to roosts found in Crawford County. Further, Marion County is a fragmented landscape. Disturbance patterns here have produced two primary habitats that are extremely different (forestland and agricultural use). I believe data here might simply reflect the presence or absence of a base of woody host plants impacting moth demographics across the landscape, as opposed to finer-scale patterns of woody plant occurrence that appear related to variation in moth demographics by roost location.

Moth demographics in Crawford County varied with landscape position of roost locations as opposed to habitat. This is readily explainable given patterns observed in

Marion County. No difference in demographics was found in Marion County, where delineation between forest type was quite coarse (riparian versus upland). In light of this, it is not surprising that a difference was not discerned on a refined characterization of forest in Crawford County.

Scale of disturbance has been linked with idiosyncrasies surrounding lepidopteran response in tropical forests (Hill et al. 1995, Hamer and Hill 2000, Summerville and Crist 2002). However, studies of these tropical systems have largely yielded two patterns of lepidopteran diversity following silvicultural havest (Summerville and Crist 2002): 1) species richness does not vary greatly between stands regenerating from harvest and those unharvested, and 2) species richness is depressed in stands regenerating as a monoculture following a clear-cut, but only marginally affected by less intensive management. My data are allied with the first pattern; differences in stand structure (in part a consequence of harvest regime) did not have a noticeable effect on the occurrence of moths (species richness or otherwise). This is in agreement with related work in temperate forest systems (Burford et al. 1999, Summerville and Crist 2002). It is hypothesized that forest structure and, correspondingly, harvest regime are, in effect, “snap-shots” of a forest’s seral condition and changes in the occurrence of moths occur when change in a forest system (i.e., harvest) surpasses a “threshold” of floristic change (e.g., clear-cutting; Summerville and Crist 2002).

Habitat and landscape patterns of moths are made clear by examing woody plant assemblages among habitats and roost locations. Clear differences exist among forest habitats in Marion County (Table 4.18) and Crawford County (Table 4.21) in both diversity and abundance of woody plants but, despite these vegetation differences, such variation was not reflected in moth demographics. Specifically, these data suggest that BA is not a corollary with overall occurrence of moths. The relation of abundance of woody stems with occurrence of moths is less clear, but it is worth noting that this measure of woody plant density considered all stems > 1 m tall. Thus, this measure took into account understory and low-lying woody plant species, whereas BA is more a measure of overstory density. Consequently, stem density is potentially confounded with diversity of woody species. In contrast to measures of abundance, it appears that richness of woody species is a potential corollary with the occurrence of moths. This pattern was present in both study areas, but was operating at differing levels of resolution. Data from Marion County illustrated disparate differences of the occurrence of moths between woody and herbaceous-dominated habitats. I believe the effect of landscape position on moth demographics in Crawford County suggests finer-scale differences associated with the richness of woody species.

Our knowledge of the community dynamics of not only moths, but insects in general, point to specific scale-related patterns in temperate forest ecosystems. As Summerville et al. (2003) summarize: 1) composition of insect assemblages varies more over landscape scales, even when total richness does not; 2) species dominance and evenness are determined at finer scales; and 3) changes in richness occur at all spatial scales as variation unique to that scale is encountered. Just as the occurrence of lepidoptera has been demonstrated to be linked with site-level patterns of disturbance (Intachat et al. 1997, Burford et al. 1999, Summerville and Crist 2002, Summerville and Crist 2003), patterns further suggest that lepidoptera are also tightly linked with variation in landscape and regional habitats (Hammond and Miller 1998, Hill 1999, Summerville et al. 2001, Beck et al. 2002, Hamer et al. 2003, Summerville et al. 2003). Data for Crawford County is indicative of the value of landscape position in regulation of forest Lepidoptera, potentially as a consequence of floristic variation at regional scale (Usher and Keiller 1998, Summerville and Crist 2002, Summerville and Crist 2003). Indeed, the correspondence of moth demographics and richness of woody plants at roosts in this county (Tables 4.8 and 4.21, respectively) suggest a linkage between the total occurrence of moths and broader spatial scales as it relates to floristic diversity.

5.2 Variation of Lepidopteran Taxa

The varied occurrence of moth families by habitat raises interesting discussion regarding foraging habitat used by OB. It is generally accepted that OB forages along forest edges as a means of capitalizing on an abundant prey source while maneuvering in a less structurally-complex area than the forest interior (Harvey and Redman 2003). What has remained unclear is the relationship between what edge habitats are used by OB and what habitats provide the most ample prey base for OB. My data provide insight and a clearer understanding of resource use by OB. Despite the static nature of moth assemblages across forest and edge habitats, moth families varied in selection of habitat type (Table 4.12). Availability of habitats across the landscape in both study areas hold potential consequences for the foraging habits of OB.

Whereas past study of OB has documented differences in moth abundance between forest and open (pasture) habitat (Leslie and Clark 2002), this effort assumed all moths were prey for OB. While this assumption should not be dismissed, it should be verified: further steps are needed to evaluate variation of specific moth prey. My data provide evidence that densities of moth taxa eaten by OB are higher in forested habitats in the landscape matrix surrounding OB roosts (Clark et al. 1996, USFWS 1995) in Marion County. Forest in Marion County was generally selected by common moth families (Table 4.12), with the exception of the Pyralidae and Tortricidae which failed to significantly vary in use of any forest and edge habitat (Table 4.10). In contrast, edge habitat was avoided by all moth families that showed habitat selection. Further, data indicate that families of moth prey occur in lower abundance along edges than that in interior forest (Table 4.12); a condition that presumably would decrease the foraging success of OB along the edges of forest and field. Comparison of habitat selection of moth families with consumption of moths by OB suggests forests provide a more ample supply of prey than edge habitat.

These data indicate that riparian forest could be of particular importance in the provision of moth prey. This is due to the diversity of geometrids identified as prey in this study area (Table 4.14), and the number of geometrids found in riparian forest (261 individuals) versus upland forest (176 individuals; Appendix 5). Additionally, the presence of *Halysidota tessellaris* as prey in Marion County (3 wings, 6.5% of identified diet; Tables 4.13 and 4.14), though limited, further suggests use of riparian forest by OB. *H. tessellaris* was widespread in its occurrence across habitats (Appendix 7) and the landscape (Appendix 8) of Marion County, but was far more common in riparian forest (59 individuals) than upland forest (15 individuals) or edge habitat (17 individuals). Thus, patterns of prey consumption in Marion County suggest use of forested habitats by OB as foraging areas. Further, I assert that riparian forest may be of particular importance to OB due to the relative abundance and diversity of prey found in comparison to upland forest and because of the potential of this habitat as a foraging corridor for OB (Clark 1991a, Wilhide et al. 1998)

Habitat selection by moth families in Crawford County was less definitive and, consequently, generalizations such as those for Marion County are more difficult to make. The Pyralidae and Tortricidae, as in Marion County, failed to vary across any habitat, but notably the Noctuidae failed to vary either (Table 4.11). Though moth families here were found proportionately throughout different size classes of timber, my data do suggest one trend (Table 4.12). Sapling habitat was never selected by a moth family and was generally avoided by those families that varied in habitat use. In contrast, pole-sized timber was generally selected by those families that varied in habitat use. Lastly, sawtimber habitat was by and large used proportionately, though it was selected by arctiids and avoided by geometrids. From these data it appears that young, dense sapling stands (Table 4.21) are used less than older, larger-diameter timber stands by many moth taxa. Besides this, it is difficult to make generalizations regarding habitat use by moth taxa, as family selection varied.

It is difficult to address congruency of habitats with the major prey consumed by OB in Crawford County. The bulk of prey was Noctuidae and Sphingidae (64.3% and 26.8%, respectively, Table 4.16). Noctuids, as a family, did not vary across habitats (Table 4.11), but different noctuid prey taxa varied in their habitats of occurrence (e.g., *Orthodes cynica* was found only in sapling habitat, *Acronicta americana* was found in sawtimber and sapling habitat, and *Catocala ilia* was found in sawtimber, poletimber, and sapling habitat; Appendix 6). In contrast to the hyperabundance of noctuids (1,262 individuals), only 12 sphingids were captured in Crawford County during 2005, accounting for 0.3% of the entire moth assemblage (Table 4.16). Well below the "common" denotation necessary for selection analysis (n > 100 specimens), this family occurred primarily in sawtimber and poletimber habitats (5 and 6 moths, respectively), with only a single individual recorded in sapling habitat (*Manduca* sp., Appendix 6). Despite difficulties surrounding inferences as to the most size-class of timber richest in prey, one conclusion can be drawn. Sapling habitat in Crawford County was extremely dense in comparison to poletimber and sawtimber habitats (Table 4.21, Appendix 17). Flight in the interior of such an area would be exceedingly difficult, even for a clutter-adapted bat species such as OB. Overgrowth of vegetation, in conjunction with no selection of this habitat by moths, suggests that foraging in the interior of such habitats would be unproductive for OB given that other size classes of timber were available or, in other words, it is not parsimonious for OB to use such a dense habitat when other habitats are equally rich in available prey.

The results of this study provide support for past studies on the foraging habits of OB and, further, hint at why there were discrepancies in past radiotelemetry research. Clark (1991) and Clark et al. (1993) found that the OB of eastern Oklahoma used edge-habitats along intermittent streams and mountain slopes. In agreement with this, work by Wilhide et al. (1998) suggested OB used areas of reduced clutter by following riparian corridors. In contrast, Wethington et al. (1996) found use between forest, edge, and open habitats proportional to availability for female OB, but that male OB used forest habitat more than expected during the month of September. It is interesting that such an incongruency was found considering that analyses were even standardized post hoc by

Wethington et al. (1996) and still yielded the result of proportional habitat use by OB females.

Wethington et al. (1996) suggest that, due to ecomorphology, OB is less limited by the constraints of flight in different habitat settings. The maneuverability of OB does not lock it into a singular, particular niche, but affords accessibility to a diversity of habitats, some of which presumably are not accessible to other ecomorphologically-restrained species of forest-dwelling bats. As a consequence, foraging habitat of OB may be more a consequence of occurrence of prey, rather than a strict association with the amount of clutter, but, as Wethington et al. (1996) indicated, inferences are limited without data on prey availability and distribution over the landscape.

This idea gains credence upon further consideration of the occurrence of moths as a product of temporal and spatial variation. An apparent difference within the designs of the two contrasting radiotelemetry studies was time of year; a potential root of the differing results (USFWS 1995). The study by Clark et al. (1993) took place mid-summer over the course of maturation of OB pups (8-17 June, 28 June-7 July, and 17-26 July in 1988) and the Wethington et al. (1996) study during late summer (11-22 October 1991, 23 August - 3 September, and 10-23 September 1992). A review of the literature for the assemblages of forest lepidoptera of eastern temperate forests shows that species diversity tends to be highest in early June and late August (Rings et al. 1992, Thomas and Thomas 1994, Thomas 2001). This, in conjunction with findings from this study and that of Burford et al. (1999), further support the argument that temporal and spatial variation of moth assemblages can explain the varied observations of habitat use by OB. I suggest that OB foraging along edge habitat are more efficient through the summer when moth assemblages are most diverse and potentially most abundant, in that the probability of OB encountering prey is heightened as a consequence of the peak occurrence of moths. This potentially explains the patterns of selection found by Clark et al. (1993). At what point, though, does it become unprofitable for OB to use edges as foraging habitat? More specifically, when or what conditions make prey densities along “hard” edges unprofitable as foraging areas for OB? Perhaps by September, as the warm season is closing, a decreased occurrence of moths along edges renders this habitat less suitable to OB, whereas interior forest still provide a relatively high occurrence of moths; a condition consistant with the results of Wethington et al. (1996).

Efficiency of foraging by a predator is a consequence of both the prey and the surrounding environment. With regard to Clark et al. (1993) and Wethington et al. (1996), I suggest that perhaps foraging efficiency of OB switches from being a product of habitat factors (i.e., OB’s attempt to reduce clutter) to simply finding enough prey later in the season. OB is a dietary specialist but, as Wethington et al. (1996) suggest, OB could potentially function as a habitat generalist capitalizing on spatiotemporal occurrence of prey. It is likely that OB, as proposed for its congener VB (Adam et al. 1994), is quite flexible and may capitalize on local landscape patterns and forage in a diversity of habitats; I suggest that this is potentially explained by the interaction of foraging efficiency and abundance of prey.

My study incorporated a number of recommendations from Burford et al. (1999). Due to similar methodology, comparisons of the occurrence of moth families can be made between these two studies. Burford et al. (1999) considered a number of habitats: mature (70-80 yrs), saw (30-50 yrs), and pole (<30 yrs) age classes of timber, as well as human-maintained clearings within the forest (wildlife openings). Mature timber habitats were located along clifflines, which can be viewed as a type of edge habitat.

A number of abundant moth families considered for habitat selection analysis by Burford et al. (1999) were also considered “common” in my study and analyzed as well. These reoccurring families were: Pyralidae, Geometridae, Notodontidae, Arctiidae, and the Noctuidae. Consideration of these families reveals a similar result between my study and that of Burford et al. (1999); clearings were never selected by moths and were avoided by the Arctiidae, Geometridae, and Notodontidae. This is consistant with my data in that occurrence of moths in field habitat was nominal relative to forest.

Generalization of the occurrence of moths in both poletimber and sawtimber habitat was clearer for Burford et al. (1999) than my study. Burford et al. (1999) found no disproportionate use of poletimber habitat by moth families, with the exception of the arctiids, who selected this timber class. Contrastingly, Burford et al. (1999) found that sawtimber habitat was selected by moth families, with the exception of noctuids, who avoided this timber class. These trends are not reflected in my data, but are potentially explained by differences in classification of timber (i.e., my data was delineated by size class of timber, not age). Whereas poletimber was the youngest age class (<30 yrs) of timber considered by Burford et al. (1999), my study considered both a poletimber and a sapling size class of timber. In my study, poletimber habitats were not avoided by moth families and, contrastingly, sapling timber was never selected by moth families. Perhaps my distinction between poletimber and sapling habitats, not recognized by Burford et al. (1999), resulted in varied use, yet the consolidation of these habitats by Burford et al. (1999) resulted in proportionate use.

5.3 Lepidopteran Consumption by the Ozark big-eared bat

Selection of prey by a bat is in part a function of prey size, as the upper size limit of prey consumption is constrained by the size of the bat itself (Aldridge and Rautenbach 1987). Shoemaker (1994) found that VB did not consume moths of all body size; it is logical that this held true for OB as well. Using data from Covell (1984), I noted the range of wingspans for moth species identified as prey of OB (Figure 5.1). I used literature values for wingspan rather than measuring actual culled wings for four reasons: 1) morphology often varies between fore and hind wings on the same species, both of which were identified in this study; 2) collected culled wings varied in their state of degradation and, as a consequence, some wings were not complete; 3) estimation of prey wingspan requires the inclusion of moth body size, a potential source of error (Shoemaker 1994); and 4) precedence existed for this method (Shoemaker 1994), allowing for direct comparison. Mean wingspan of prey was calculated using the number of culled wings found per species as an index of relative consumption. The mean wingspan of prey consumed by OB was 4.8 cm, close to that documented for VB (4.7cm; Shoemaker 1994). Specifically, the smallest prey species recorded for OB was *Blepharomastix ranalis* (Pyralidae, wingspan 1.6-2 cm), whereas the largest prey species were *Catocala ilia* (Noctuidae, wingspan 6.5-8.2 cm) and *Ecpantheria scribonia* (Arctiidae, wingspan 5.7-9.1 cm). As with Shoemaker (1994), my data indicated that prey species of morphologically large moth families (i.e., Sphingidae and Saturniidae) were of the smaller limit of the size range of moths in these families, suggesting that OB, like VB, is constrained by the maximum size of prey it can handle or consume.

The moth prey identified in this study further extend our knowledge of the diet of *Corynorhinus* in eastern North America (Table 5.1). Prior to this study, 76 distinct moth species or genera within 8 taxonomic families had been identified in the diets of VB and RB (61 and 29 species or genera, respectively; Sample and Whitmore 1993, Hurst and Lacki 1997, Burford and Lacki 1998, Lacki and LaDeur 2001). This study included the addition of 34 new species or genera. Comparison of moth consumption among OB, VB, and RB reveal a number of similarities (Table 5.1). A diversity of Noctuidae and Geometridae are represented in the diets of *Corynorhinus*. Notodontidae are also represented, but less so for RB. To a lesser extent, the Sphingidae and Arctiidae reoccur across the diets of *Corynorhinus*. Notably, my data add to the prey list by extending species counts found within common prey families, as well as by adding three new families of moth prey (Lasiocampidae, Pyralidae, and Saturniidae). Though our knowledge of the bat-moth interaction grows more with each study that identifies the prey of these foraging specialists, there is a paucity of data regarding prey consumption in western North America. Specifically, research on the diet of the western subspecies of TB is necessary to obtain a complete understanding of the predator-prey relationship of moths and plecotine bats.

Though availability of moth taxa remained relatively constant between my two study areas, consumption by OB did vary (Tables 4.15 and 4.16). Specifically, two trends were noticeable. The Noctuidae and Notodontidae were consumed heavily in both counties relative to their occurrence. Contrastingly, consumption of the families Arctiidae, Geometridae, and Sphingidae differed between counties. The Geometridae and, to a lesser extent, the Arctiidae were consumed in Marion County, whereas evidence on predation of the Sphingidae was absent. In Crawford County, the Sphingidae were a major component of the prey identified, as opposed to a general absence of the Arctiidae and Geometridae. These varied consumption patterns could be a consequence of differences in land use, or potentially may be a reflection of differences in habitat use by OB in the two study areas.

The Noctuidae accounted for more than half of the diet of OB in both Marion and Crawford counties (Tables 4.14 and 4.15). This was not unexpected considering it is the largest of all lepidopteran families (Covell 1984) and, further, its prominence in the diets of VB (Sample and Whitmore 1993, Shoemaker 1994, Burford and Lacki 1998) and RB (Hurst and Lacki 1997, Lacki and LaDeur 2001). The hyper-abundance of this family no doubt contributes to its dominance within the diet of *Corynorhinus*; it is the moth taxa most consistently exploited these bats. Unfortunately, the widespread occurrence and consumption of this taxon clouds inferences regarding specific habitats used by OB in Arkansas.

Notodontidae were also consumed in proportion to their availability in both counties (Tables 4.14 and 4.15). The presence of this family in the diet of OB was expected considering it is the fifth largest lepidopteran family in North America (Covell 1984), and its known occurrence as prey of VB (Sample and Whitmore 1993, Shoemaker 1994, Burford and Lacki 1998) and RB (Hurst and Lacki 1997, Lacki and LaDeur 2001). This study further affirms that this family of forest moths is a resource consistently used by *Corynorhinus*. Consideration of this family is merited in future management, as research suggests the Notodontidae hold potential as an indicator taxon of “coarse-scale” disturbance impacts on assemblages of forest moths (Summerville et al. 2004).

The Geometridae are the third most common family in North America (Covell 1984). This family was consumed heavily, more than double the availability, by OB in Marion County (28.3 %, n = 13), but was essentially absent from the diet of OB in Crawford County (0.6 % of diet, n = 1). This differential consumption is interesting, as geometrids have been identified as prey of VB (Sample and Whitmore 1993, Shoemaker 1994, Burford and Lacki 1998). Geometrids are also known prey of RB, but their prominence within the diet varies in occurrence (ca. 24 %, n = 33, Lacki and LaDeur 2001; ca. 1 %, n = 1, Hurst and Lacki 1997). It is apparent in this study that OB selects geometrid prey in Marion County but does not in Crawford County. Geometrids in Marion County varied in occurrence among forest habitat (Table 4.12), supporting the conclusion that riparian forest provide an ample supply of geometrid prey and is a habitat potentially exploited by OB. In contrast, habitat selection by the Geometridae in Crawford County does not lend itself to generalization regarding useful habitat for OB.

The Arctiidae are perhaps the most thoroughly studied prey taxon of the moth-bat interaction, due to their tactics in countering predation by bats (Miller and Surlykke 2001, Waters 2003). Arctiids are typically colored in an aposomatic fashion, an indication of unpalatability to predators (Frazer and Rothschild 1960). Many arctiids can detect the echolocation calls of bats and, through use of their tympana, emit high frequency clicking sounds that serve to deter bat depredation. Though a diversity of moth taxa (eight superfamilies) and other insects (Dictyoptera, Neuroptera, Orthoptera; possibly Coleoptera and Diptera) possess hearing mechanisms and use evasive flight to counter predation, only arctiids, and certain nymphalid butterflies that co-occur in bat hibernacula, are known within the Lepidoptera to produce sound to deter predation

(Miller and Surlykke 2001). Three hypotheses have been proposed in explanation of this sound production by arctiids (Shoemaker 1994, Waters 2003): 1) clicks startle echolocating bats, allowing time for escape (Humphries and Driver 1970); 2) clicks serve as an aposomatic signal to bats, indicating unpalatability (Dunning 1968, Surlykke and Miller 1985); and 3) clicks confuse an echolocating bat, "jamming" the signal and allowing escape (Fullard et al. 1979). Past studies have tended to support the aposematism hypothesis and, though research does not rule out the startle or jamming hypotheses, it does suggest that bats quickly habituate to clicking sounds (Miller and Surlykke 2001, Waters 2003). Recently, Hristov and Conner (2005), through manipulation of diet and sound production of four species of arctiids, have provided evidence that big brown bats (*Eptesicus fuscus*) only responded to the clicks of arctiids when paired with defensive chemistry (i.e., unpalatability); sound evidence for the aposematism hypothesis.

Though an abundant moth family in North America, arctiids are uncommon in the diet of *Corynorhinus* (Sample and Whitmore 1993, Shoemaker 1994, Hurst and Lacki 1997, Burford and Lacki 1998); though there is an exception. Lacki and LaDeur (2001) found that arctiids, particularly *Halysidota tessellaris*, comprised a portion of the diet of RB (13.5%, n=10). My data indicate that arctiids do occur in the diet of OB, though their presence is limited (Table 4.14). Arctiids were found to be consumed in Marion County at a level lower than their occurrence in the landscape (Table 4.15) and, further, no culled wings from this family were recovered in Crawford County (Table 4.16). Specifically, as with Lacki and LaDeur (2001), consumption in Arkansas was limited to *H. tessellaris* (Table 4.14). Culled wings recovered in Oklahoma further extend the species consumed within this family, including *Ecpantheria scribonia* and the genus *Apantesis* (Table 4.14). These data support the conclusion that consumption of arctiids by OB is relatively low in comparison with other prey taxa. Even so, consideration of this family for future management is merited, as research suggests the Arctiidae hold potential as an indicator taxon of species richness for assemblages of forest moths (Summerville et al. 2004)

I suggest that consumption of arctiids by *Corynorhinus*, while limited, is potentially a consequence of the ecomorphology and foraging strategy employed by these bats. Gleaners are thought to exploit prey through short, low-intensity echolocation calls and passive listening (Miller and Surlykke 2001, Schnitzler and Kalko 2001), i.e., through the element of surprise. Consequently, it is logical that arctiid moths capable of sound production would often not be alerted to use this ability when depredated by a gleaning bat; potentially resulting in unrealized handling and consumption of arctiid prey. Relatedly, echolocation of low-intensity, or echolocation that is allotonic to the tuning of the moth's ear (sensu Fullard 1998), in conjunction with an aerial-hawking tactic, would again result in the "mistaken" handling and consumption of the would-be arctiid saboteur. Even so, as Hristov and Conner (2005) illustrate, arctiid moths vary in palatability and sound production, so consumption within this taxon is surely to vary as well.

A final taxon substantially consumed by OB was the Sphingidae. This family was absent from the culled wings collected in Marion County (Table 4.15), but accounted for more than a quarter of those collected in Crawford County (Table 4.16). Consumption was limited to two species: *Laothoe juglandis*, and to less extent, *Darapsa myron* (Table 4.14). Interestingly, the Sphingidae were rarely captured in both study areas, representing less than 1% of the moths captured in either county. *L. juglandis* was a species rarely captured; only a single individual was recovered in blacklight traps (Appendices 11 and 12). The bulk of consumption of this species (31 of the 42 wings) was recovered from Whitzen Hollow, but were collected much later in the summer (8 August; Table 3.2). This incongruency can be explained by the fact that *L. juglandis* has multiple (≤ 3) broods throughout May to August (Covell 1984). As my last trapping date in Whitzen Hollow was 1 August (Table 3.1), approximately one week before culled wing collection, it is possible that my sampling missed this last brood of the season. Regardless, these data indicate that *L. juglandis* is a taxa heavily exploited by OB. This is not surprising for a sphingid taxon, considering Shoemaker (1994) found a similar instance with VB and the consumption of *Deidamia inscripta*.

Equally interesting is the absence of sphingids from the diet of OB in Marion County. This further supports the suggestion that OB in Marion County forages in forested habitat. Sphingids were rare in forested habitats (a single individual per habitat), but were more common in field habitat (5 individuals; Appendix 7). *L. juglandis* was not recorded in Marion County, suggesting an explanation for the absence of predation on sphingids in this study area, i.e., if this prey species was present I would have expected it to be heavily exploited as in Crawford County.

Though sphingid moths were not consumed as heavily as the Noctuidae, or as consistently as the Notodontidae, I suggest this family of moths holds importance in the diet of *Corynorhinus*. Evidence suggests taxa within this family are an often exploitable, and profitable, prey resource for *Corynorhinus*, potentially as a consequence of the family's morphology (large size, relatively small wing area; Shoemaker 1994), flight habit (hovering; Shoemaker 1994), and earless nature.

Past research has noted an absence of the Saturniidae within the diet of *Corynorhinus*; an interesting outcome given predation on sphingids (Shoemaker 1994). A novel observation in this study was the presence of two saturniid taxa in the diet of OB in Oklahoma (*Automeris io* and *Sphingicampa bicolor*). To my knowledge, this is the first documentation of this family in the diet of *Corynorhinus*. Even so, I view this incidence as a rarity, as only four culled wings were collected and the remnants were never collected in Arkansas. Potential explanations for the absence of this family in the diet of *Corynorhinus* include flight style and large size which might influence capture and/or handling by the bat (Shoemaker 1994). Saturniid moths, generally speaking, are large, conspicuous taxa; the depredated species I recorded were smaller-sized representatives of the family. These data support the argument that saturniid size inhibits handling by *Corynorhinus*, though this study provides evidence that smaller family members are a food resource for OB.

While often abundant in both study areas, smaller-sized families of moths near the 20 mm wingspan "cut-off" for microlepidoptera were generally not consumed by OB (e.g., Pyralidae, Tortricidae; Tables 4.14 and 4.15). The Pyralidae are the second most common lepidopteran family in North America (Covell 1984) and were amply abundant in both Marion and Crawford counties but, despite this, were nominally consumed (a single culled wing collected in each study area; Tables 4.14 and 4.15, respectively). This was not surprising, considering that Shoemaker (1994) also found that while Pyralidae were abundant in the foraging territories of VB, there was no evidence of depredation. As with past research (Sample and Whitmore 1993, Hurst and Lacki 1997, Lacki and LaDeur 2001), culled wings of smaller-sized moths were not found in this study. A number of potential explanations for this absence of small moth prey does exist, but the problem is that it cannot be directly addressed. Three potential explanations for this include: 1) a wingspan of ca. 20 mm represents the upper size limit of moth consumed on the wing by *Corynorhinus* (Burford and Lacki 1998), 2) *Corynorhinus* does not invest time and energy in the consumption of smaller moths (Shoemaker 1994, in reference to Pyralidae), or 3) small moths avoid *Corynorhinus* in some fashion (Shoemaker 1994, in reference to Pyralidae). As with previous studies, my project offers no assured answer, but it is interesting to note the evidence of predation of *Blepharomastix ranalis* in Marion County (collected at Marble Falls on 3 August 2005; Table 4.14). This is a member of the Pyralidae that I captured throughout the summer of 2005 primarily in Marion County (Appendix 9, but see Appendix 12). With a wingspan of 1.6-2.0 mm (Covell 1984), this was the smallest prey taxa recorded for OB and, to my knowledge, of *Corynorhinus*. When processing moths from blacklight traps I would often collect this species, both at and below the wingspan "cut off" of 20 mm (i.e., many of this species were considered microlepidoptera and were consolidated into the biomass estimate). This instance supports the argument that OB does preys on smaller-sized moths. Unfortunately, if this is true, these moths are indeed eaten whole while the bat is in flight (Burford and Lacki 1998); a consequence making their identification and enumeration within the diet of *Corynorhinus*, at present, impossible.

A number of larger-sized moth families were not consumed by OB as well. I feel this absence is in part explainable due to rarer spatial or temporal occurrence, as exemplified by the Lasiocampidae. In Marion County, the Lasiocampidae (primarily *Malacosoma americanum*) represented 7.6% of the entire moths captured throughout the summer of 2005 (Table 4.15), but were not found to be consumed by OB in Arkansas. The emergence and presence of *M. americanum* are highly ephemeral, with a single brood emerging from late May – June (Covell 1984). I recorded a high occurrence (321 individuals in Marion County, 92 individuals in Crawford County) of this taxon during the first sampling period (Appendix 9), specifically from 30 May to 4 June (Appendix 10). Unfortunately, my visitation of roosts did not coincide with the emergence of *M. americanum*. Despite this, I suspect these early summer outbreaks do not strongly impact the diet of OB as culled wings of this taxon were not found during later collection dates, which I would have expected considering their hirsute, stout wing morphology (i.e., I would expect these wings to persist longer than others in the adverse conditions on a roost floor). Though *M. americanum* was identified as prey of OB in Oklahoma, the dates of these wing collections were 20 December 2004 and 30 April 2005. These individuals were certainly consumed by OB in the years previous to collection, as collection dates differ from the short emergence time of this species.

Three prey taxa of OB in Arkansas were not recorded during blacklight sampling in 2004 and 2005: *Selinia kentaria* (Geometridae), *Argyrogrammia basigera* (Noctuidae), and *Eupsilia* sp. (Noctuidae). A review of data and literature provide multiple explanations for these incongruencies. Culled wings of *S. kentaria* and *Eupsilia* were collected at Reed Cave on 15 August 2005, ca. two weeks after blacklight sampling was completed; therefore, it is possible that these taxa did not emerge until after my sampling was complete. This explanation is most likely for *Eupsilia*, a cold season flier (September

– May, Covell 1984), as opposed to *S. kentaria*, which flies throughout the summer but becomes scarce towards the end of summer (emerges from March – early August; Covell 1984). Interestingly, *S. kentaria* was recorded as prey of VB by Shoemaker (1994) but, as with this study, was not captured at blacklight traps either. For this reason, I suspect that this taxon (and potentially *Eupsilia* and *A. basigera*) does not exhibit a phototactic response and, as a consequence, was excluded from blacklight samples. The absence of *A. basigera* is less directly explainable. The culled wings of this taxon were recovered in 2003, before I began blacklight trapping; potentially this species was not present during the sampling efforts of 2004 and 2005, though Covell (1984) gives no indication of an aestivation period. Another potential explanation is that the distribution of this taxon across the landscape and region may have precluded it from my sampling locations.

Despite these minor incongruencies, strong conclusions can be made regarding moth consumption by OB. Specifically, data suggest that OB selects prey with regard to their occurrence across the landscape and as a consequence of the biology of the prey itself. Consumption of a diversity of moth taxa in Marion County provide some indication that foraging by OB in this study area was a consequence of the occurrence of moths. In contrast, data from Crawford County indicate that OB can and will exploit specific moth taxa (i.e., *L. juglandis*). Even so, it is apparent that OB preys upon a diversity of moth taxa (Table 4.14), many of which are dependent upon a forest plants as hosts (Table 5.2).

Interestingly, prey recovered at roosts of OB was not limited to Lepidoptera (Table 4.13). Even so, moths were by far the most frequent prey recovered. Other insect orders were generally found in limited amounts, but the Blattodea and Coleoptera recovered in Crawford County, Arkansas and Oklahoma were notable exceptions. While evidence from these areas seems counter to the classification of OB as a moth specialist (Lacki et al. 2007), a number of caveats exist. First, roost visitation and the collection of culled wings in Oklahoma and, in part, Crawford County was not standardized or repetitive throughout a given summer. Relatedly, Coleoptera and, less so, Blattodea are hard-bodied, chitoneous insects, whereas Lepidoptera are soft-bodied. Consequently, I think these groups could have been over-represented in these unstructured collection regimes.

Data regarding consumption of non-lepidopteran prey by OB, while intriguing, should be interpreted with caution.These data do not negate the view of OB as a moth specialist; this would be a knee-jerk conclusion and counter to both our understanding of *Corynorhinus* in eastern North America (Dalton et al. 1986, Sample and Whitmore 1993, Hurst and Lacki 1997, Burford and Lacki 1998, Lacki and LaDeur 2001) and past study of OB itself (Leslie and Clark 2002). Rather, these data suggest that, though moths do comprise the majority of their diet, OB will take other prey groups, presumably as the occasion arises. Just as foraging strategies are not exclusive (i.e., hover-gleaning versus aerial hawking; Ratcliffe and Dawson 2003), this data indicates that OB may take prey other than moths when profitable.

Prey taxa documented in this study hold consequence for our knowledge of the dietary habits of *Corynorhinus* in eastern North America. Consumption patterns of OB reflect those of VB and RB, but expand our understanding of the moths preyed upon by *Corynorhinus*. OB does appear to prey upon a certain size of moths, and both upper and lower size limits previously documented for *Corynorhinus* are met by OB. My data suggest that perhaps our understanding of prey size of *Corynorhinus* has been confined in the past. Finally, a number of taxa within the diet of OB are novel for *Corynorhinus*. This is not surprising considering the westerly occurrence of OB in comparison to VB and RB. As two of the three novel families were found in Oklahoma, this stresses the need for continued research to identify prey important to *Corynorhinus*, not only in Oklahoma, but throughout western North America as well.

5.4 Project Limitations

There is no standard approach to assess prey availability for bats. Further, it is accepted that "true availability" of insect prey to the bats can never be known (Whitaker 1994). All my methods represent insect abundance, a relative measure of availability (Whitaker 1994). It is for this reason that there was no direct analysis between blacklight traps (availability) and culled moth wings (consumption), as the potential of Type I error was too great for such a consideration to be made with an imperiled species.

Light traps are biased towards phototactic taxa of moths but, despite this, light traps are widely considered the standard technique for sampling entire moth assemblages (Southwood 1978, Covell 1984). Consequently, moth taxa that were diurnal, not phototactic, or that are only attracted to bait were not sampled in this study. As taxa with these characters are undersampled with blacklight traps, demographics of moth assemblages are also underestimated and should be considered conservative estimates (Summerville et al. 2001).

A final constraint of this project was the absence of fire as a factor in the treatment scheme for habitats. Prescription fire is an important tool in the management of forestlands by the USFS in Arkansas and has historically played a role in establishing of the upland oak ecosystem of the Ozark Mountains, dating back ca. 5,000 years (Spetich 2004). Fire plays an integral ecological role in the maintenance of the upland oak-hickory forest type by inhibiting invasion into the overstory by more shade-tolerant species (Spetich 2004). Prescription burning is a widespread management tool within the Ozark National Forest, and noticeably impacted the Crawford County study area. Previous to this study, the interior of Devil's Hollow was not burned (to prevent disturbance to the OB maternity colony), though the North Face area was burned. As a consequence, some roosts and moth sampling sites in Crawford County were subjected to burning, while others were not. Though this surely confounds results in Crawford County, I feel it also provides an indication of the effect of landscape position on the occurrence of moths as a consequence of different disturbance patterns, and hints at the possible effects fire may have on the occurrence of moths. Research on fire effects on lepidoptera are limited and generally only consider diurnal species (e.g., Dunwiddie 1991, Fleishman 2000, Fredericksen and Fredericksen 2002, Huntzinger 2003, but see Gerson and Kelsey 1997, Siemann et al. 1997). Further research regarding silvicultural impacts on the occurrence of moths should consider the role prescription burning may play; I see the potential for both long and short-term consequences from changes in the availability of woody plants that serve as hosts, as well as the potential for widespread mortality of phototactic moth species (e.g., Siemann et al. 1997).

5.5 Management Recommendations

A need exists to preserve both an ample prey base and effective foraging areas for OB. As suggested for the congener VB (Adam et al. 1994), management should consider each population of this bat separately, due to the fragmented and sensitive nature of this species. Isolated maternity areas of OB should be managed at a site level, as each may require different specific management actions.

With regard to foraging base, timber class and rotation age in a forest is a central consideration of silvicultural management. My results suggest that stand condition (size, age, BA) is not a corollary with the overall occurrence of moths. Relatedly, silvicultural harvest by necessity reduces overstory density, but typically is not deleterious to the richness of plant species in the overstory. The conclusion, therefore is that responsible silvicultural harvesting may not present a severe impact to the quality of foraging areas of OB. Accepting this with reservation, any silvicultural management that reduces the diversity of woody plants in the understory may have serious consequences for the prey base of OB. Land stewards should strive to maintain a diversity of flora, specifically through the creation of different habitats in areas where OB is known to occur.

My data indicate that, though overall abundance and taxonomic richness of moths does not vary with stand condition, the occurrence of specific moth taxa does; a potential concern regarding the prey base of OB. Consequently, a diversity of non-timber production areas may be important in maintaining floral and habitat heterogeneity. A richer prey base of moths may be promoted through the maintenance of a patchwork of forest habitats supporting a diversity of flora.

Specifically, riparian areas provide a diversity of unique woody species, contributing to an enriched assemblage of forest moths. Furthermore, these areas may function as foraging corridors for OB throughout the forest surrounding roosts. The importance of riparian corridors is a general trend suggested in bat literature (but is often not founded on empirical evidence; Lacki et al. 2007). In this case, riparian corridors may provide effective foraging territory needed by this species. Clifflines potentially provide additional edge for foraging while maintaining the high prey densities associated with interior forest. “Hard edges” are known to be used by OB, though evidence in this study suggests that field habitat provides a prey base nominal in comparison to forested habitat. Though not as condusive to high prey densities (Burford et al. 1999), forest clearings may provide foraging habitat more open than that of interior forest edges, while still maintaining an adjacent forest source for prey. In summary, future management should encourage a patchwork of forest habitats with a multitude of corridors to facilitate foraging areas, particularly around maternity roosts of OB.

The effects of prescription burning are not known and consequently are in need of study. Burning is deleterious to the diversity of woody plants in the short term, but regrowth from low intensity fires can be relatively quick. By limiting burns temporally and spatially, stewards might encourage a diversity of moths. Burning at present, if used, should be restricted to the periphery of home ranges around maternity roosts of OB. Adverse short-term effects may be minimized via temporal and spatial rotation of burning and application to small tracts of forestland. There should be no widespread burning of forest in the core areas around OB maternity roosts in Arkansas (within 2.0 km;

considering Clark et al. 1993, Wethington et al. 1996, and Wilhide et al. 1998) until more is known about effects of fire on moth, not butterfly, assemblages.

Table 5.1. Moth taxa recorded as prey of *Corynorhinus* in the eastern United States.

Prey Taxon	***C. t. ingens***	***C. t. virginianus*** [a]	***C. rafinesquii*** [b]
Arctiidae			
Apantesis sp.	**X**		
Ecpantheria scribonia	**X**		**X**
Estigmene acrea		**X**	
Grammia virgo		**X**	
Halysidota tessellaris	**X**		**X**
Haploa sp.			**X**
Geometridae			
Anticlea multiferata	**X**		
Campaea perlata		**X**	**X**
Dichorda iridaria	**X**		
Ectropis crespuscularia		**X**	
Epimecis hortaria	**X**	**X**	**X**
Euchlaena sp.	**X**		
Euchlaena amoenaria		**X**	
Euchlaena irraria			**X**
Euchlaena pectinaria	**X**	**X**	
Euchlaena tigrinaria		**X**	
Eusarca confusaria		**X**	
Eutrapela clemataria		**X**	**X**
Hydria prunivorata	**X**		
Hypagyrtis unipunctata	**X**		
Itame pustularia		**X**	
Melanolophia canadaria		**X**	
Nacophora quernaria			**X**
Patalene olyzonaria	**X**		
Plagodis fervidaria		**X**	
Probole nyssaria	**X**		**X**
Prochoerodes transversata			**X**
Selenia kentaria	**X**	**X**	
Tetracis cachexiata			**X**
Lasiocampidae			
Malacosoma americanum	**X**		

Table 5.1. (continued)

	C. t. ingens	***C. t. virginianus*** [a]	***C. rafinesquii*** [b]
Lymantridae			
Dasychira basiflava		**X**	
Megalopygidae			
Lagoa crispata			**X**
Noctuidae			
Abagrotis alternata	**X**	**X**	**X**
Acronicta sp.	**X**	**X**	**X**
Acronicta americana	**X**	**X**	
Acronicta innotata			**X**
Acronicta lobeliae	**X**		
Acronicta radcliffei			**X**
Acronicta spinigera		**X**	
Agrotis sp.	**X**		
Agrotis ipsilon	**X**	**X**	
Allagrapha aerea			**X**
Allotria elonympha	**X**		
Amphipyra pyramidoides	**X**	**X**	
Argyrogramma basigera	**X**		
Autographa biloba		**X**	
Callopistria cordata	**X**		
Catocala sp.	**X**	**X**	**X**
Catocala epione		**X**	
Catocala ilia	**X**		
Catocala neogama		**X**	
Catocala paleogama		**X**	
Catocala vidua		**X**	
Chaetaglaea sericea			**X**
Chytonix palliatricula		**X**	
Cosmia calami		**X**	
Crocigrapha normani		**X**	
Euparthenos nubilis	**X**	**X**	
Euplexia benesimilis		**X**	
Eupsilia sp.	**X**		
Euxoa bostoniensis		**X**	

Table 5.1. (continued)

	C. t. ingens	***C. t. virginianus*** [a]	***C. rafinesquii*** [b]
Euxoa immixta		**X**	
Heliothis zea	**X**		
Hypsoropha hormos		**X**	
Hypsoropha monilis	**X**		
Lacinipolia renigera	**X**	**X**	
Leucania sp.	**X**		
Lithophane antennata		**X**	
Lithophane hemina		**X**	
Metalectra discalis		**X**	
Metaxaglaea semitaria		**X**	
Oligia modica		**X**	
Orthodes cynica	**X**		
Orthosia alurina		**X**	
Orthosia hibisci		**X**	
Orthosia rubescens		**X**	
Paectes pygmaea	**X**		
Panopoda carneicosta	**X**		
Panopoda rufimargo	**X**	**X**	**X**
Panthea furcilla	**X**		
Parallelia bistriaris		**X**	**X**
Peridroma saucia		**X**	
Platysenta sutor	**X**		
Polia sp.			**X**
Polia latex			**X**
Polia purpurissata		**X**	
Protolampra brunneicollis	**X**		
Pseudaletia unipuncta	**X**	**X**	**X**
Pseudorthodes vecors	**X**		
Renia sp.	**X**		
Renia fraternalis	**X**		
Scolecocampa liburna	**X**		**X**
Scoliopteryx libatrix			**X**
Zale sp.	**X**	**X**	
Zale bethunei		**X**	
Zale lunata	**X**		
Zanclognatha sp.	**X**		

Table 5.1. (continued)

	C. t. ingens	***C. t. virginianus*** [a]	***C. rafinesquii*** [b]
Notodontidae			
Datana sp.	**X**		**X**
Datana angusii	**X**		
Heterocampa sp.		**X**	
Heterocampa guttivitta		**X**	
Heterocampa umbrata		**X**	
Lochmaeus bilineata	**X**		
Lochmaeus manteo	**X**	**X**	
Nadata gibbosa	**X**	**X**	**X**
Nirece bidentata	**X**		
Peridea angulosa		**X**	
Schizura sp.		**X**	
Symmerista albifrons	**X**		
Pyralidae			
Blepharomastix ranalis	**X**		
Pantographa limata	**X**		
Saturnidae			
Automeris io	**X**		
Sphingicampa bicolor	**X**		
Sphingidae			
Darapsa myron	**X**	**X**	**X**
Darapsa pholus		**X**	**X**
Deidamia inscripta		**X**	**X**
Laothoe juglandis	**X**	**X**	
Lapara coniferarum		**X**	
Thyatiridae			
Euthyatira pudens		**X**	

[a] Data from Sample and Whitmore (1993), Burford and Lacki (1998)

[b] Data from Hurst and Lacki (1997), Lacki and LaDeur (2001)

Table 5.2. Larval food and habitat requirements of moth species recorded as prey of the Ozark big-eared bat. Data from Covell (1984).

Prey Taxa (# wings collected)	**Larval Food**	**Larval Habitat (Pest Species)**
Arctiidae		
Ecpantheria scribonia (3)	Wide variety; banana, cabbage, cherry, dandelion, maple, orange, sunflowers, violets, willow	Variable; forest, clearing, agriculture
Halysidota tessellaris (3)	Alder, ash, birch, elm, hazelnut, hickory, oak, tulip-tree, walnut, willow, other tree species	Forest
Geometridae		
Anticlea multiferata (2)	Willow-herb	?
Dichordia iridaria (1)	Staghorn sumac, winged sumac	Clearing (disturbance site)
Epimecis hortaria (1)	Pawpaw, poplar, sassafras, tulip-tree	Forest
Euchlaena pectinaria (3)	wild cherry	Forest
Hydria prunivorata (2)	wild cherry	Forest
Hypagyrtis unipunctata (2)	Alder, birch, fir, hickory, oak, pine, willow, many other tree species	Forest
Patalene olyzonaria (1)	Junipers and possibly pine	Forest
Probole nyssaria (1)	Dogwood	Forest
Selinia kentaria (1)	Basswood, beech, birch, maple, oak, other forest tree species	Forest
Lasiocampidae		
Malacosoma americanum (4)	Many woody species, especially of the rose family; apple, crab-apple, cherry	Forest, agriculture, a serious pest **(Eastern Tent Caterpillar)**

Table 5.2. (continued)

Prey Taxa (# wings collected)	**Larval Food**	**Larval Habitat (Pest Species)**
Noctuidae		
Abagrotis alternata (5)	Apple, ash, cherry, oak, peach	Forest, agriculture **(Mottle Gray Cutworm)**
Acronicta americana (3)	Alder, ash, birch, elm, hickory, maple, oak, poplar, walnut, willow	Forest
Acronicta lobeliae (2)	black cherry and oak	Forest
Agrotis ipsilon (1)	Cultivated plants; clover, corn, lettuce, potato, tobacco	Clearing, agriculture **(Black Cutworm)**
Allotria elonympha (3)	Black gum, sour-gum, hickory, walnut	Forest
Amphipyra pyramidoides (5)	Apple, grape, hawthorn, oak, poplar, raspberry, redbud, rhododendron, walnut	Forest
Argyrogrammia basigera (2)	Unrecorded	?
Callopistria cordata (1)	Ferns	Forest
Catocala ilia (4)	Oak; including black, burr, red and white oaks	Forest
Euparthenos nubilis (2)	Locust, particularly black locust	Forest
Heliothis zea (1)	Cultivated plants; corn, cotton, tomato, tobacco	Clearing, agriculture **(Corn Earworm)**
Hypsoropha monilis (1)	Persimmon	Forest
Lacinipolia renigera (3)	Wild and cultivated plants; apple trees, cabbage, clover, corn, tobacco	Variable; forest, clearing, agriculture **(Bristly Cutworm)**
Orthodes cynica (4)	Larva has been reared on plantain	?
Paectes pygmaea (1)	Sweetgum	Forest

Table 5.2. (continued)

Prey Taxa (# wings collected)	**Larval Food**	**Larval Habitat (Pest Species)**
Panopoda carneicosta (4)	Basswood, hickory, oak, willow	Forest
Panopoda rufimargo (3)	Beech, oak	Forest
Panthea furcilla (1)	Larch, pine, spruce	Forest
Platysenta sutor (2)	Celery, marigolds, *Wedelia trilobata* (Fla.)	Clearing
Protolampra brunneicollis (2)	Blueberry, clover, tobacco, and others	Variable; forest, clearing, agriculture
Pseudaletia unipuncta (8)	Alfalfa, corn, other grains, grasses, vegetables, young fruit trees, wild plants, ornamentals	Clearing, agriculture, a serious pest **(Armyworm)**
Pseudorthodes vecors (1)	Asters, dandelion, grasses, other low plants	Clearing
Renia fraternalis (1)	Dead leaves of trees	Forest
Scolicocampa liburna (2)	Borer of decaying chestnut, oak, and hickory. Food may actually be fungus	Forest
Zale lunata (9)	Maple, plum, willow, other woody species	Forest
Notodontidae		
Datana angusii (2)	Birch, butternut, hickory, linden, and walnut	Forest
Lochmaeus bilineata (1)	Basswood, beech, birch, linden, and oak	Forest
Lochmaeus manteo (2)	Beech, birch, elm, hawthorn, linden, oak, walnut, other tree species	Forest **(Variable Oakleaf Caterpillar)**
Nadata gibbosa (6)	Birch, cherry, maple, oak, plum, other tree species	Forest
Nirece bidentata (1)	Elm	Forest
Symmerista albifrons (1)	Oak	Forest

Table 5.2. (continued)

Prey Taxa (# wings collected)	Larval Food	Larval Habitat (Pest Species)
Pyralidae		
Blepharomastix ranalis (1)	Leaves of *Chenopodium* species	?
Pantographa limata (1)	Basswood, oak, rock elm	Forest
Saturnidae		
Automeris io (2)	Birch, clover, corn, elm, maple, oak, willow, other plants	Variable; forest, clearing, agriculture
Sphingicampa bicolor (2)	Honey locust, Kentucky coffee-tree	Forest
Sphingidae		
Darapsa myron (5)	Ampelopsis, viburnums, Virginia creeper	Forest
Laothoe juglandis (49)	Butternut, hickory, cherry species, walnut	Forest

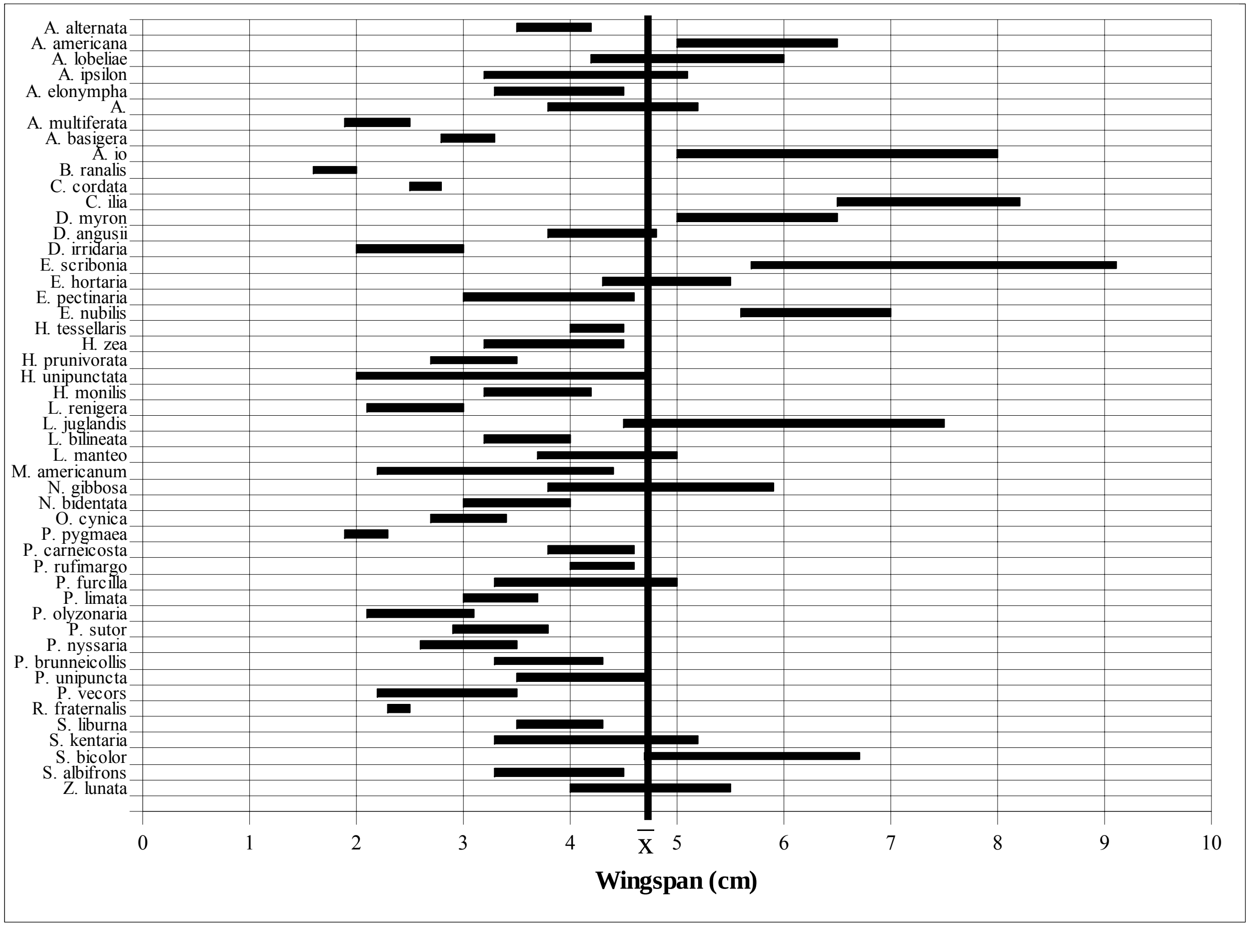

Figure 5.1. Wingspan range of moth species collected at roost locations of the Ozark big-eared bat in Arkansas and Oklahoma. Horizontal bars represent the range of wingspan values for individual prey species; vertical line represents the mean wingspan relative to species consumption. Wingspan data from Covell (1984).

APPENDICES

The following appendices provide a comprehensive record of the observations of this study. Lists of moth taxa provide a detailed database of the spatial and temporal occurrence of moth taxa in the study areas.

Appendix 1. Variables characterizing nights of blacklight sampling in Marion and Crawford counties, Arkansas, during the summer 2005.

Sampling Period	Date	Roost Location[a]	Trap Assortment for Early Night [b]	Light at Sunset (lx) [c]	Sunset Time	Sunrise Time	Sunset Temp (°C)	Sunrise Temp (°C)
1	20 May	WH	X1, P2, S1	76	20:19	6:09	23	15
1	23 May	MF	U1, R1, F1, E2	292	20:18	5:59	27	14
1	25 May	NF	X1, P1, S2	244	20:23	6:07	17	14
1	30 May	BH	U1, R1, F2, E2	271	20:26	5:57	19	13
1	2 June	DH	X2, P2, S2	265	20:28	6:03	23	15
1	4 June	RD	U2, R2, F1, E1	149	20:28	5:56	22	18
	6 June	**New Moon**						
2	7 June	NF	X1, P2, S1	289	20:30	6:01	22	19
2	9 June	MF	U1, R2, F1, E2	278	20:29	5:53	22	18
2	14 June	DH	X1, P2, S2	287	20:34	6:02	19	13
2	16 June	RD	U2, R2, F2, E1	140	20:36	5:53	18	16
2	18 June	WH	X2, P1, S2	172	20:35	6:03	23	17
2	20 June	BH	U2, R2, F1, E2	284	20:33	5:54	17	14
3	23 June	RD	U1, R2, F1, E1	317	20:33	5:55	23	22
3	27 June	DH	X2, P2, S2	259	20:36	6:05	20	17
3	29 June	MF	U1, R2, F2, E2	194	20:34	5:56	25	22
	6 July	**New Moon**						
3	8 July	NF	X2, P2, S2	211	20:35	6:10	19	12
3	12 July	BH	U1, R1, F2, E2	126	20:31	6:04	22	20
3	14 July	WH	X1, P1, S1	189	20:33	6:14	27	23
4	22 July	NF	X2, P2, S2	338	20:28	6:17	28	24
4	25 July	RD	U2, R1, F1, E2	170	20:23	6:13	28	27
4	28 July	DH	X1, P1, S2	312	20:24	6:24	23	17
4	30 July	BH	U2, R1, F2, E1	346	20:19	6:17	23	19
4	1 August	WH	X2, P1, S1	194	20:21	6:27	24	21
4	3 August	MF	U1, R1, F1, E2	236	20:15	6:20	26	21
	5 August	**New Moon**						

[a] Location (Code): Blue Heaven Cave (BH), Devil's Hollow (DH), Marble Falls Cave (MF), North Face (NF), Reed Cave (RD), Whitzen Hollow (WH).

[b] Habitat (Code): Upland Forest (U), Riparian Forest (R), Field (F), Edge (E), Sapling (X), Poletimber (P), Sawtimber (S); 1, 2 denotes site replication.

[c] Light readings were also taken at one hour and five hours post sunset, but never varied from 0 - 1 lx. Due to this lack of variance, these additional light measurements were not incorporated into the table.

Appendix 2. Population notes on the Ozark big-eared bat in Arkansas, 2004 and 2005.

As expected, estimates of the Marion County population were lower at the anthropogenically-disturbed maternity colony at Blue Heaven Cave, as compared to the maternity colony at Reed Cave. An emergence count was performed at Blue Heaven Cave on 7 July 2004 by L. Dodd and B. Sasse. Emergence activity occurred from 8:20 – 9:15 pm and peaked at ca. 8:45 pm. The tally average between L. Dodd and B. Sasse was 25 bats. Reed Cave and the hibernaculum, Marble Falls Cave, were checked in 2004 by L. Dodd and B. Sasse during the day of 20 July. A number of roosting Ozark big-eared bats occupied the right hand passage in Reed Cave. This consisted of one large cluster and two small clusters < 0.6 m from the large cluster. The total occupied roosting area was ca. 0.01 m^2. No Ozark big-eared bat was present in Marble Falls Cave.

An emergence count of Blue Heaven Cave was again conducted on 25 July 2005 by L. Dodd and B. Sasse. The tally average between L. Dodd and B. Sasse was 23 bats emerging. Additionally, Reed Cave was visited twice in 2005. L. Dodd and B. Sasse visited Reed Cave on the night of 12 July and performed an exit count. A total of 50 bats exited the cave, but the estimate was judged to be incomplete due an inadequate view of the cave entrance with the night vision equipment. This was the first time an exit count had been performed at this maternity site; consequently knowledge of specific emergence locations at the cave entrance was unknown. Reed Cave was visited again on 15 August by L. Dodd and D. Kampwerth. Nightfall came and went with no bat exiting the cave. The cave was entered at D. Kampwerth's discretion. A solitary Ozark big-eared bat was found in the back of the main chamber of the cave, but no other bat was seen. D. Kampwerth was confident that the colony had moved from this summer roost to the hibernaculum, Marble Falls Cave.

Due to the geology of the talus rock shelters within Devil's Hollow, an emergence count of this maternity colony was not possible during 2004 or 2005. Therefore, population information was limited to observations while collecting culled moth wings.

The Devil's Hollow area was visited in 2004 on the day of 12 July by L. Dodd, W. Puckette, and S. Hensley. Two Ozark big-eared bats were disturbed into flight at the maternity colony location. As a consequence, personnel left to prevent further disturbance. Indicators of bat presence (i.e., guano or staining) were also observed while investigating feeding roosts in this vicinity. The feeding roosts of the northern exterior slope of Devil's Hollow were also visited on this same date. No Ozark big-eared bat was seen, but fresh guano was present at one of the two talus shelters.

Devil's Hollow was visited on 7 July 2005 by L. Dodd, W. Puckette, S. Hensley, and R. Stark. Two dead young of the year were found, one at each of the historic maternity roost shelters. These carcasses were secured by the USFWS personnel. The maternity colony was found at a nearby bluffline. The colony was beneath a rock overhang within a shadowed area, but was nearly exposed to open daylight. A roosting area of 0.6 m in diameter was hastily estimated to avoid disturbance of the colony. Time constraints prohibited visitation of the feeding roosts on the northern exterior slope of Devil's Hollow.

As with the Devil's Hollow area, investigation of population activity at the Whitzen Hollow feeding roosts was limited to observations during collection of culled moth wings. This area was visited in on 8 August in 2004 by L. Dodd and W. Puckette. No Ozark big-eared bat was seen. No guano was noted either, but use of this karst area by bats was assured by the number of culled wings recovered in this area. Whitzen Hollow was visited repeatedly during the summer of 2005 for the collection of culled moth wings, but visitation of specific caves in this area varied as a consequence of accompanying personnel and time constraints (Table 3). As in 2004, no Ozark big-eared bat was seen. Guano was apparent on rare occasions, but staining was not seen. Again, the numbers of culled wings recovered throughout the summer were indicative of continued bat use.

Appendix 3. Occurrence of moths in Marion County, Arkansas, during the 2004 field season, sorted by habitat.

	Moth Catch by Habitat			
Taxon	Upland Forest	Riparian Forest	Edge	Field
Apatelodidae				
Apatelodes torrefacta	2	6	2	1
Olceclostera angelica		2		
Arctiidae				
Family level		2		
Apantesis sp.	1	1	42	28
Cisseps fulvicollis			21	4
Cisthene packardii			1	
Cycnia inopinatus		1		
Cycnia tenera			3	1
Estigmene acrea			2	
Grammia oithona				1
Halysidota tessellaris	10	17	13	10
Haploa clymene	2			2
Holomelina sp.			1	
Holomelina opella			1	
Hypoprepia fucosa	10		3	
Pyrrharctica isabella			10	8
Spilosoma virginica	2		3	
Arctiid Total	25	21	100	54
Geometridae				
Family level	24	50	19	
Anacamptodes defectaria				1
Anacamptodes ephyraria	1			
Besma quercivoraria			1	
Epimecis hortaria	1		1	
Euchlaena sp.	5			
Euchlaena amoenaria	2			
Euchlaena irraria			1	
Euchlaena pectinaria	5	8	3	

Appendix 3. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Euchlaena tigrinaria	1			
Eumacaria latiferrugata			1	
Hypagyrtis unipunctata			26	
Lambdina fervidaria	57	31	6	7
Leptostales rubromarginaria			4	
Nemoria lixaria	2			
Patalene olyzonaria	2			
Pero hubneraria		6	2	
Plagodis alcoolaria				1
Plagodis fervidaria	2		1	
Plagodis phlogosaria	1			
Probole amicaria	3	1	3	
Xanthotype urticaria		1		
Geometrid Total	106	97	68	9
Limacodidae				
Family level	5	2		3
Apoda y-inversum	2		1	
Prolimacodes badia	2			
Tortricidia flexuosa		1		
Megalopygidae				
Norape ovina	1	3	2	
Noctuidae				
Family level	26	8	28	23
Abagrotis alternata	4	2		
Acronicta sp.	113	15	19	1
Agrotis ipsilon				1
Allotria elonympha	1	2		
Amphipyra pyramidoides	1		1	
Caenurgina erechtea				6
Catocala sp.	7			
Catocala agrippina	1			
Catocala amica	4			

Appendix 3. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Catocala ilia	2	2		
Catocala lacrymosa	1			
Catocala nebulosa	1			
Catocala neogama		1		
Catocala retecta	1			
Heliothis turbatus/phloxiphagus			2	
Hemeroplanis scopulepes			1	
Idia americalis	13	6	18	1
Leucania scirpicola			6	2
Mocis texana	1			
Orthodes crenulata	3		2	1
Pangrapta decoralis			2	
Panopoda carneicosta	9	1		2
Panopoda rufimargo	6	1		2
Plathypena scabra		3		
Polygrammate hebraeicum	21	40	4	
Pseudeva purpurigera	1			
Renia sp.		2		
Renia discoloralis				3
Renia nemoralis	1			
Schinia arcigera			1	
Schinia lynx			2	
Schinia trifascia			1	
Tetanolita mynesalis			34	
Thioptera nigrofimbria	1	2		1
Zanclognatha cruralis		1	5	
Noctuid Total	218	86	126	43
Notodontidae				
Family level	3	1		13
Datana contracta			1	
Datana ministra				2
Heterocampa obliqua			2	
Nadata gibbosa	6	2	5	

Appendix 3. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Notodontid Total	9	3	8	15
Pyralidae				
Family level	8	13	12	
Crambus agitatellus			9	
Desmia funeralis	1	1	5	
Hymenia perspectalis			1	
Palpita magniferalis		2		
Pantographa limata		7		
Pyralid Total	9	23	27	0
Saturniidae				
Family level				1
Actias luna	1	5	1	
Anisota stigma	1			
Citheronia regalis				1
Eacles imperialis		3		
Saturniid Total	2	8	1	2
Sphingidae				
Darapsa myron				1
Manduca sp.		1		
Thyatiridae				
Habrosyne scripta			1	
Tortricidae				
Choristoneura parrallela			4	
Yponomeutidae				
Atteva punctella			2	4
Total Moths	**381**	**253**	**342**	**132**

Appendix 4. Occurrence of moths in Marion County, Arkansas, during the 2004 field season, sorted by roost location.

	Moth Catch by Roost Location		
Taxon	Blue Heaven	Reed	Marble Falls
Apatelodidae			
Apatelodes torrefacta	4	5	2
Olceclostera angelica			2
Arctiidae			
Family level	2		
Apantesis sp.	7	60	5
Cisseps fulvicollis		25	
Cisthene packardii	1		
Cycnia inopinatus		1	
Cycinia tenera		4	
Estigmene acrea		2	
Grammia oithona		1	
Halysidota tessellaris	17	25	8
Haploa clymene	1	3	
Holomelina sp.	1		
Holomelina opella	1		
Hypoprepia fucosa		1	12
Pyrrharctica isabella		16	2
Spilosoma virginica			5
Arctiid Total	30	138	32
Geometridae			
Family level	10	19	64
Anacamptodes defectaria			1
Anacamptodes ephyraria	1		
Besma quercivoraria			1
Epimecis hortaria	1		1
Euchlaena sp.	3	2	
Euchlaena amoenaria		2	
Euchlaena irraria	1		
Euchlaena pectinaria	5	7	4

Appendix 4. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Euchlaena tigrinaria			1
Eumacaria latiferrugata	1		
Hypagyrtis unipunctata			26
Lambdina fervidaria	15	70	16
Leptostales rubromarginaria	4		
Nemoria lixaria	2		
Patalene olyzonaria		2	
Pero hubneraria		1	7
Plagodis alcoolaria	1		
Plagodis fervidaria	2	1	
Plagodis phlogosaria	1		
Probole amicaria			7
Xanthotype urticaria			1
Geometrid Total	47	104	129
Limacodidae			
Family level		10	
Apoda y-inversum	2		1
Prolimacodes badia			2
Tortricidia flexuosa			1
Megalopygidae			
Norape ovina	5	1	
Noctuidae			
Family level	20	30	35
Abagrotis alternata	1	2	3
Acronicta sp.	22	59	67
Agrotis ipsilon			1
Allotria elonympha		3	
Amphipyra pyramidoides		1	1
Caenurgina erechtea			6
Catocala sp.		6	1
Catocala agrippina	1		
Catocala amica		2	2

Appendix 4. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Catocala ilia		2	2
Catocala lacrymosa			1
Catocala nebulosa			1
Catocala neogama		1	
Catocala retecta		1	
Heliothis turbatus/phloxiphagus		2	
Hemeroplanis scopulepes			1
Idia americalis		9	29
Leucania scirpicola			8
Mocis texana		1	
Orthodes crenulata			6
Pangrapta decoralis			2
Panopoda carneicosta	7	3	2
Panopoda rufimargo	3	5	1
Plathypena scabra			3
Polygrammate hebraeicum	6	55	4
Pseudeva purpurigera		1	
Renia sp.			2
Renia discoloralis	3		
Renia nemoralis			1
Schinia arcigera			1
Schinia lynx			2
Schinia trifascia			1
Tetanolita mynesalis			34
Thioptera nigrofimbria	1		3
Zanclognatha cruralis	2	1	3
Noctuid Total	66	184	223
Notodontidae			
Family level	1	13	3
Datana contracta			1
Datana ministra		2	
Heterocampa obliqua			2
Nadata gibbosa	1	10	2

Appendix 4. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Notodontid Total	2	25	8
Pyralidae			
Family level	12	5	16
Crambus agitatellus	9		
Desmia funeralis	3		4
Hymenia perspectalis			1
Palpita magniferalis		2	
Pantographa limata			7
Pyralid Total	24	7	28
Saturniidae			
Family level		1	
Actias luna			7
Anisota stigma		1	
Citheronia regalis		1	
Eacles imperialis		2	1
Saturniid Total	0	5	8
Sphingidae			
Darapsa myron	1		
Manduca sp.			1
Thyatiridae			
Habrosyne scripta			1
Tortricidae			
Choristoneura parrallela			4
Yponomeutidae			
Atteva punctella	1	5	
Total Moths	**182**	**484**	**442**

Appendix 5. Occurrence of moths in Crawford County, Arkansas, during the 2004 field season, sorted by habitat.

	Moth Catch by Habitat Type		
Taxon	Sawtimber	Poletimber	Sapling
Apatelodidae			
Apatelodes torrefacta	3		1
Arctiidae			
Family level		1	
Cisseps fulvicollis	2		
Halysidota tessellaris	13	10	5
Holomelina sp.		1	
Hypoprepia fucosa	1	6	
Hypoprepia miniata	3		
Spilosoma virginica			1
Arctiid Total	19	18	6
Drepanidae			
Oreta rosea			1
Epiplemidae			
Calledapteryx dryopterata			1
Geometridae			
Family level	19	5	
Antepione thisoaria			1
Cyclophora pendulinaria		1	
Dichorda iridaria			2
Dyspteris abortivaria		1	1
Ectropis crepuscularia			1
Epimecis hortaria		1	4
Euchlaena amoenaria	2		
Euchlaena pectinaria	4	5	1
Eutrapela clemetaria	2	1	
Heterophleps refusaria			1
Hypagyrtis unipunctata		1	1

Appendix 5. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Iridopsis larvaria	3		1
Lambdina fervidaria	1	2	
Leptostales rubromarginaria	2		
Lomographa vestaliata	1	1	
Mellilla xanthometata	6		
Pero hubneraria	4	5	27
Protoboarmia porcelaria	1		
Scopula limboundata			1
Geometrid Total	45	23	41
Limacodidae			
Family level	4	2	
Apoda y-inversum		1	
Lithacodes fasciola			4
Tortricidia flexuosa			1
Megalopygidae			
Norape ovina		1	
Noctuidae			
Family level	19	30	10
Acronicta sp.	22	10	5
Acronicta americana	1		1
Allotria elonympha		6	1
Bomolocha sp.	2	2	
Bomolocha bijugalis			1
Callopistria mollissima		1	
Catocala amica	2		
Catocala flebilis	1		
Catocala obscura		3	
Catocala vidua			1
Elaphria festivoides	2		
Elaphria grata			1
Eudryas grata	1	1	1

Appendix 5. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Euparthenos nubilis	2		1
Euplexia benesimilis	4	3	3
Faronta diffusa	1		
Idia americalis	7	13	
Isogona tenuis		1	3
Lithacodia carneola	2		
Orthodes crenulata	17		1
Pangrapta decoralis		6	
Panopoda carneicosta		2	
Panopoda rufimargo	2	1	
Parallelia bistriaris			1
Plathypena scabra		1	1
Platysenta vecors			1
Polygrammate hebraeicum	6	6	1
Pseudorthodes vecors			1
Renia sp.		1	1
Renia discoloralis		2	
Scolicocampa liburna		1	1
Tetanolita mynesalis	9	11	
Thioptera nigrofimbria	1	2	3
Tricholita signata		1	
Xestia smithii	1		
Zale lunifera			1
Zanclognatha sp.		4	
Noctuid Total	102	108	40
Notodontidae			
Family level	4	9	3
Datana sp.	1		
Datana perspicua	2	1	1
Heterocampa obliqua		2	2
Heterocampa subrotata			2
Macrurocampa marthesia		1	
Nadata gibbosa	1	1	
Oligocentra lignicolor			1

Appendix 5. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Peridea angulosa		1	
Symmerista albifrons	2		
Notodontid Total	10	15	9
Oecophoridae			
Antaeotricha sp.			2
Pyralidae			
Family level	8	10	4
Crambus agitatellus	1	12	1
Desmia funeralis	5	7	6
Pantographa limata	2		
Polygrammodes flavidalis		1	
Pyralid Total	16	30	11
Saturniidae			
Actias luna	6	3	
Antheraea polyphemus			1
Dryocampa rubicunda	4	2	
Eacles imperialis	2	2	
Sphingicampa bicolor	1		
Saturniid Total	13	7	1
Sphingidae			
Ceratomia hageni	1		
Laothoe juglandis	2	1	
Paonias excaecatus	1		
Paonias myops	1		
Tortricidae			
Family level		2	
Sparganothis reticulatana		1	

Appendix 5. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Yponomeutidae			
Atteva punctella	1	3	
Total Moths	**218**	**212**	**118**

Appendix 6. Occurrence of moths in Crawford County, Arkansas, during the 2004 field season, sorted by roost location.

	Moth Catch by Roost Location		
Taxon	Devil's Hollow	North Face	Whitzen Hollow
Apatelodidae			
Apatelodes torrefacta	4		
Arctiidae			
Family level			1
Cisseps fulvicollis			2
Halysidota tessellaris	20	3	5
Holomelina sp.			1
Hypoprepia fucosa			7
Hypoprepia miniata			3
Spilosoma virginica	1		
Arctiid Total	21	3	19
Drepanidae			
Oreta rosea		1	
Epiplemidae			
Calledapteryx dryopterata			1
Geometridae			
Family level	16	2	6
Antepione thisoaria			1
Cyclophora pendulinaria		1	
Dichorda iridaria		2	
Dyspteris abortivaria			2
Ectropis crepuscularia	1		
Epimecis hortaria	1	2	2
Euchlaena amoenaria			2
Euchlaena pectinaria	8		2
Eutrapela clemetaria	2		1
Heterophleps refusaria			1
Hypagyrtis unipunctata		2	

Appendix 6. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Iridopsis larvaria		4	
Lambdina fervidaria	3		
Leptostales rubromarginaria			2
Lomographa vestaliata			2
Mellilla xanthometata			6
Pero hubneraria	6	15	15
Protoboarmia porcelaria		1	
Scopula limboundata		1	
Geometrid Total	37	30	42
Limacodidae			
Family level	2		4
Apoda y-inversum			1
Lithacodes fasciola	1		3
Tortricidia flexuosa	1		
Megalopygidae			
Norape ovina			1
Noctuidae			
Family level	27	5	27
Acronicta sp.	5	16	16
Acronicta americana			2
Allotria elonympha		7	
Bomolocha sp.		4	
Bomolocha bijugalis	1		
Callopistria mollissima			1
Catocala amica	2		
Catocala flebilis		1	
Catocala obscura		1	2
Catocala vidua		1	
Elaphria festivoides		2	
Elaphria grata			1
Eudryas grata	2		1
Euparthenos nubilis		2	1

Appendix 6. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Euplexia benesimilis	5	5	
Faronta diffusa		1	
Idia americalis	12	1	7
Isogona tenuis		3	1
Lithacodia carneola			2
Orthodes crenulata		17	1
Pangrapta decoralis		6	
Panopoda carneicosta			2
Panopoda rufimargo			3
Parallelia bistriaris		1	
Plathypena scabra			2
Platysenta vecors			1
Polygrammate hebraeicum	4	3	6
Pseudorthodes vecors		1	
Renia sp.	2		
Renia discoloralis		2	
Scolicocampa liburna			2
Tetanolita mynesalis		5	15
Thioptera nigrofimbria			6
Tricholita signata			1
Xestia smithii		1	
Zale lunifera			1
Zanclognatha sp.		1	3
Noctuid Total	60	86	104
Notodontidae			
Family level	9	1	6
Datana sp.			1
Datana perspicua	2	1	1
Heterocampa obliqua	2		2
Heterocampa subrotata	1		1
Macrurocampa marthesia		1	
Nadata gibbosa	2		
Oligocentra lignicolor	1		

Appendix 6. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Peridea angulosa		1	
Symmerista albifrons	2		
Notodontid Total	19	4	11
Oecophoridae			
Antaeotricha sp.			2
Pyralidae			
Family level	9	4	9
Crambus agitatellus	1	1	12
Desmia funeralis	2		16
Pantographa limata	2		
Polygrammodes flavidalis	1		
Pyralid Total	15	5	37
Saturniidae			
Actias luna	7		2
Antheraea polyphemus			1
Dryocampa rubicunda	2	4	
Eacles imperialis	4		
Sphingicampa bicolor			1
Saturniid Total	13	4	4
Sphingidae			
Ceratomia hageni			1
Laothoe juglandis			3
Paonias excaecatus	1		
Paonias myops		1	
Tortricidae			
Family level			2
Sparganothis reticulatana		1	

Appendix 6. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Yponomeutidae			
Atteva punctella	1	1	2
Total Moths	**175**	**136**	**237**

Appendix 7. Occurrence of moths in Marion County, Arkansas, during the 2005 field season, sorted by habitat.

	Moth Catch by Habitat			
Taxon	Upland Forest	Riparian Forest	Edge	Field
Apatelodidae				
Olceclostera angelica		1	1	1
Arctiidae				
Apantesis sp.		6	9	3
Cisseps fulvicollis			2	3
Cisthene packardii	8	6	4	
Clemensia albata	17	8	4	
Crambidia sp.	15	13	2	2
Cycnia tenera		1	1	
Ecpantheria scribonia			1	
Euerythra phasma	1	1	1	
Grammia anna	2	7	3	1
Grammia arge			1	
Grammia figurata			3	1
Grammia oithona				1
Halysidota tessellaris	15	59	17	6
Haploa clymene			1	
Haploa contigua		1		
Haploa reversa	1			
Holomelina sp.	2	5	3	
Holomelina aurantiaca			1	1
Holomelina opella	4	6		
Hypoprepia fucosa	236	194	21	
Pyrrharctia isabella		2	1	3
Spilosoma sp.		1		
Spilosoma congrua	25	34	9	
Spilosoma virginica	2	2	1	1
Arctiid Total	328	346	85	22
Cossidae				
Prionoxystus robiniae	1			

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Drepanidae				
Oreta rosea		3		
Epiplemidae				
Calledapteryx dryopterata		2		
Geometridae				
Family	15	8	8	4
Anacamptodes sp.	5	4		
Anacamptodes defectaria		3	2	
Anacamptodes ephyraria	1	6	1	
Antepione thisoaria			2	
Besma sp.	1			
Besma endropiaria		1	1	
Besma quercivoraria	3			
Calothysanis amaturaria		1		
Cyclophora pendulinaria	4	2	1	
Dichorda iridaria		1		
Dyspteris abortivaria		1		
Ecliptopera atricolorata		3		
Ectropis crepuscularia		1	1	
Epimecis hortaria	1			
Eubaphe mendica	2	2	1	
Euchlaena sp.		1		
Euchlaena pectinaria	1	1		
Eudeilinea herminiata		2		
Eulithis diversilineata	1	3	1	
Eupithecia sp.	2	9		
Eupithecia miserulata	10	20	10	
Eusarca confusaria		1	3	
Eutrapela clemetaria		3		
Glena cribrataria	2	2		
Glenoides texanaria	7	8		2
Heterophleps triguttaria		1		
Hypagyrtis unipunctata	13	31	1	
Hypomecis umbrosaria		2		

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Idaea demissaria			1	
Idaea furciferata	8	11	2	
Itame sp.	1			
Lambdina fervidaria	40	60	7	6
Leptostales rubromarginaria	2	15	7	
Lomographa vestaliata	1	11	2	
Lytrosis unitaria	24	9	2	
Mellilla xanthometata		1		
Metarranthis sp.	1			
Metarranthis angularia	3			
Nematocampa limbata		3		
Nemoria lixaria	2	1	1	
Orthonama centrostrigaria		5	1	
Orthonama obstipata	1	2		1
Patalene olyzonaria	1	2		
Pero hubneraria	1		1	
Phigalia sp.		1		
Plagodis alcoolaria	3	3	3	2
Plagodis fervidaria	8	2		
Pleuroprucha insulsaria				1
Prochoerodes transversata		5		
Protitame virginalis	3	1	2	
Protoboarmia porcelaria		1	1	
Scopula limboundata	1	5	3	
Semiothisa sp.	1			
Semiothisa continuata	1			
Semiothisa granitata			1	
Semiothisa multilineata	3	2		
Semiothisa ocellinata	1			
Semiothisa quadrinotaria		1		
Semiothisa transitaria	2	2	1	
Xanthotype urticaria		1		
Geometrid Total	176	261	67	16

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Lasiocampidae				
Malacosoma americanum	109	129	60	6
Malacosoma disstria	10		5	2
Limacodidae				
Family	2	9	1	
Apoda y-inversum		1		
Euclea delphinii		2		
Isa textual	3			
Lithacodes fasciola		4	3	
Prolimacodes badia	1	1		
Limacodid Total	6	17	4	0
Lymantriidae				
Dasychira sp.	3	1	3	1
Dasychira obliquata	5	6	1	
Orgyia sp.		1		
Orgyia leucostigma	1			
Megalopygidae				
Lagoa crispate	3	2		2
Norape ovina			1	
Mimallonidae				
Lacosoma chiridota	1	1	1	1
Noctuidae				
Family	97	117	40	22
Acronicta sp.	16	9	6	
Acronicta afflicta	4	4	1	
Acronicta americana			2	
Acronicta haesitata	23	6	8	1
Acronicta interrupta			1	
Acronicta modica	4	2	2	1
Acronicta ovata	8	4	3	

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Acronicta retardate	8	2	1	
Acronicta tritona	1			
Agriopodes fallax	1		1	
Agriopodes teratophora	1			
Agrotis ipsilon		1		
Allagrapha aeria				1
Allotria elonympha	4	5	4	
Argyrostrotis anilis			1	
Autographa biloba				1
Baileya sp.	3			
Baileya levitans	1	2		
Balsa labecula	5	10	4	
Bleptina caradrinalis	2	8	3	
Bomolocha sp.		2	1	
Caenurgia chloropha			3	2
Caenurgina erechtea			8	4
Callopistria cordata	1	2	2	
Catocala sp.	1		1	
Catocala amica	6			
Catocala andromedae	1	2		
Catocala dejecta				1
Catocala gracilis	2	6		
Catocala ilia	6	2		
Catocala nebulosa			1	
Catocala obscura	1			
Catocala retecta				1
Catocala ultronia			1	
Cerma cerintha	1			
Charadra deridens	1			
Chytonix palliatricula	7		2	
Cosmia calami	12	2	3	1
Elaphria grata	1		1	3
Elaphria versicolor		4	1	
Euagrotis lubricans				1
Eudryas grata		1		
Faronta diffusa			3	

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Galgula partita		2	22	9
Harrisimemna trisignata		1		
Homohadena badistriga	1			
Homophoberia apicosa		1		
Hyperstrotia pervertens	43	35	12	
Hypsoropha hormos			2	
Hypsoropha monilis	2		1	
Idia americalis	10	5	4	
Isogona tenuis		2		
Lacinipolia lorea		1		
Lacinipolia renigera	3	7	15	3
Lesmone detrahens			1	
Leucania sp.	2	11	19	6
Leucania inermis			3	
Leucania scirpicola	2	2	13	4
Lithacodia sp.			1	
Lithacodia carneola	1	5	3	
Lithacodia muscosula	1	44	1	
Macrochilo absorptalis	2			1
Meganola minuscula	1		2	
Mocis texana	1		1	
Ogdoconta cinereola	3	3	1	1
Orthodes crenulata		1	1	
Orthodes cynica	1	4	1	
Paectes sp.			1	
Paectes abrostoloides	1			
Paectes oculatrix		1		
Paectes pygmaea	1	2		
Palthis sp.	1	3		
Pangrapta decoralis		1	4	
Panopoda sp.		1		
Panopoda carneicosta				1
Panopoda rufimargo	1			1
Panthea furcilla	3		1	
Phalaenophana pyramusalis	3	5	7	16
Phosphila miselioides	1			

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Plathypena scabra	1	4	2	
Platysenta vecors	1	3	1	
Polia sp.	3	1		
Polygrammate hebraeicum	19	58	14	
Protolampra brunneicollis		1		
Proxenus miranda				2
Pseudaletia unipuncta			1	
Ptichodis herbarum		1		
Rachiplusia ou	1			
Renia sp.	7	1	1	
Renia discoloralis	3	3	1	1
Renia fraternalis	3	2	1	
Renia sobrialis	17	10	4	1
Schinia arcigera			1	
Schinia lynx		2	6	1
Schinia trifascia			1	
Schrankia macula	13	2	2	
Scolecocampa liburna	2			
Spodoptera ornithogalli		1		
Spragueia sp.	2		1	
Stiriodes obtusa		2	1	
Tarachidia candefacta		1		2
Tetanolita mynesalis	174	71	23	
Thioptera nigrofimbria	1	29	6	2
Zale sp.	1	1		
Zale lunata	1		1	
Zanclognatha sp.	6	10	1	1
Zanclognatha cruralis	3	9	3	
Zanclognatha obscuripennis		4		
Noctuid Total	560	544	291	91
Notodontidae				
Family	24	17	5	2
Clostera inclusa		1		

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Datana sp.	1			
Datana angusii		8		
Datana contracta	1	2	2	1
Datana ministra			1	
Datana perspicua	4	2		1
Heterocampa sp.			2	
Heterocampa guttivitta	6	4		
Heterocampa obliqua	7	5	3	2
Heterocampa subrotata	1			
Heterocampa umbrata	3		2	1
Hyperaeschra georgica	17	1	1	
Lochmaeus bilineata	2	1	4	
Macrurocampa marthesia	8	1	1	
Nadata gibbosa	10	9	6	2
Nerice bidentata	1	1		
Oligocentria lignicolor		2		
Peridea basitriens		4		1
Schizura ipomoeae		4		
Schizura leptinoides		2		1
Symmerista albifrons			1	
Notodontid Total	85	64	28	11
Oecophoridae				
Family	1	1		
Antaeotricha sp.		1		
Antaeotricha leucillana		3	1	
Antaeotricha schlaegeri	2	1	4	
Psilocorsis sp.	13	8	3	
Oecophorid Total	16	14	8	0
Pterophoridae				
Platyptilia carduidactyla		1		

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Pyralidae				
Family	30	30	46	9
Blepharomastix ranalis	28	42	9	4
Compacta capitalis		1		
Crambus sp.				1
Crambus agitatellus	5	33	21	3
Crambus laqueatellus	1	3	7	1
Desmia funeralis	5	8	3	1
Diacme elealis	1	1		
Helvibotys helvialis	1		1	
Herculia olinalis	50	5	14	1
Palpita magniferalis	6	41	6	
Polygrammodes flavidalis	8	10		4
Pyrausta sp.			1	
Pyrausta acrionalis		4		
Sparganothis reticulatana			3	
Tetralopha asperatella	20	12	5	
Udea rubigalis	5		10	1
Urola nivalis	1	4	16	5
Pyralid Total	161	194	142	30
Saturniidae				
Actias luna		3	3	3
Anisota stigma		2	1	
Antheraea polyphemus	4			
Automeris io	2	2	1	2
Dryocampa rubicunda				1
Eacles imperialis	5	10	3	5
Saturniid Total	11	17	8	11
Sphingidae				
Ceratomia undulosa				2
Darapsa myron	1		1	
Darapsa pholus				2

Appendix 7. (continued)

Taxon	Upland Forest	Riparian Forest	Edge	Field
Paonias excaecatus		1		1
Tortricidae				
Family	15	18	17	1
Archips argyrospila	18	18	6	5
Argyrotaenia sp.		1		
Argyrotaenia alisellana	2	1	24	
Argyrotaenia quercifoliana	8	3	2	1
Choristoneura sp.	4			
Choristoneura parallela	2	6	2	
Choristoneura pinus			3	
Choristoneura rosaceana	14	22	8	4
Sparganothis reticulatana		1		
Tortricid Total	63	70	62	11
Yponomeutidae				
Atteva punctella		3	1	1
Yponomeuta sp.	1	8	1	
Zygaenidae				
Harrisina americana		1		
Total Moths	**1541**	**1687**	**770**	**211**

Appendix 8. Occurrence of moths in Marion County, Arkansas, during the 2005 field season, sorted by roost location.

	Moth Catch by Roost Location		
Taxon	Blue Heaven	Reed	Marble Falls
Apatelodidae			
Olceclostera angelica	2		1
Arctiidae			
Apantesis sp.	13	2	3
Cisseps fulvicollis		5	
Cisthene packardii	3	11	4
Clemensia albata	14	4	11
Crambidia sp.	8	13	11
Cycnia tenera	1	1	
Ecpantheria scribonia		1	
Euerythra phasma	2		1
Grammia anna	5	2	6
Grammia arge		1	
Grammia figurata	2		2
Grammia oithona		1	
Halysidota tessellaris	40	24	33
Haploa clymene		1	
Haploa contigua		1	
Haploa reversa		1	
Holomelina sp.	1	4	5
Holomelina aurantiaca	2		
Holomelina opella	4	6	
Hypoprepia fucosa	55	361	35
Pyrrharctia isabella	1	1	4
Spilosoma sp.		1	
Spilosoma congrua	16	33	19
Spilosoma virginica	3	3	
Arctiid Total	170	477	134
Cossidae			
Prionoxystus robiniae		1	

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Drepanidae			
Oreta rosea	3		
Epiplemidae			
Calledapteryx dryopterata			2
Geometridae			
Family	14	13	8
Anacamptodes sp.	3	2	4
Anacamptodes defectaria	2		3
Anacamptodes ephyraria		7	1
Antepione thisoaria	2		
Besma sp.		1	
Besma endropiaria		1	1
Besma quercivoraria	2	1	
Calothysanis amaturaria	1		
Cyclophora pendulinaria		5	2
Dichorda iridaria	1		
Dyspteris abortivaria			1
Ecliptopera atricolorata		1	2
Ectropis crepuscularia	1		1
Epimecis hortaria	1		
Eubaphe mendica	2	2	1
Euchlaena sp.		1	
Euchlaena pectinaria	1	1	
Eudeilinea herminiata	2		
Eulithis diversilineata	1	2	2
Eupithecia sp.	11		
Eupithecia miserulata	25	4	11
Eusarca confusaria	2		2
Eutrapela clemetaria			3
Glena cribrataria		2	2
Glenoides texanaria	2	12	3
Heterophleps triguttaria		1	
Hypagyrtis unipunctata	14	20	11
Hypomecis umbrosaria		2	

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Idaea demissaria		1	
Idaea furciferata	5	15	1
Itame sp.		1	
Lambdina fervidaria	24	66	23
Leptostales rubromarginaria	17	3	4
Lomographa vestaliata	2	2	10
Lytrosis unitaria	7	24	4
Mellilla xanthometata			1
Metarranthis sp.		1	
Metarranthis angularia		3	
Nematocampa limbata		3	
Nemoria lixaria	2		2
Orthonama centrostrigaria	3	1	2
Orthonama obstipata	3		1
Patalene olyzonaria	2	1	
Pero hubneraria		1	1
Phigalia sp.	1		
Plagodis alcoolaria	4	3	4
Plagodis fervidaria		9	1
Pleuroprucha insulsaria	1		
Prochoerodes transversata	5		
Protitame virginalis	4	2	
Protoboarmia porcelaria		1	1
Scopula limboundata	6	2	1
Semiothisa sp.		1	
Semiothisa continuata	1		
Semiothisa granitata		1	
Semiothisa multilineata	2	2	1
Semiothisa ocellinata	1		
Semiothisa quadrinotaria	1		
Semiothisa transitaria	1	4	
Xanthotype urticaria			1
Geometrid Total	179	225	116

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Lasiocampidae			
Malacosoma americanum	128	161	15
Malacosoma disstria	9	8	
Limacodidae			
Family	1	7	4
Apoda y-inversum			1
Euclea delphinii	2		
Isa textula	1	2	
Lithacodes fasciola	2	4	1
Prolimacodes badia		1	1
Limacodid Total	6	14	7
Lymantriidae			
Dasychira sp.	5	2	1
Dasychira obliquata	5	6	1
Orgyia sp.	1		
Orgyia leucostigma		1	
Megalopygidae			
Lagoa crispata	1	1	5
Norape ovina		1	
Mimallonidae			
Lacosoma chiridota	2	2	
Noctuidae			
Family	65	133	78
Acronicta sp.	4	21	6
Acronicta afflicta		8	1
Acronicta americana			2
Acronicta haesitata	5	20	13
Acronicta interrupta			1
Acronicta modica	2	5	2
Acronicta ovata	2	8	5

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Acronicta retardata		8	3
Acronicta tritona			1
Agriopodes fallax	1		1
Agriopodes teratophora	1		
Agrotis ipsilon			1
Allagrapha aeria		1	
Allotria elonympha	1	4	8
Argyrostrotis anilis			1
Autographa biloba		1	
Baileya sp.		3	
Baileya levitans		1	2
Balsa labecula	1	5	13
Bleptina caradrinalis	3	2	8
Bomolocha sp.	1		2
Caenurgia chloropha	5		
Caenurgina erechtea	4	6	2
Callopistria cordata		3	2
Catocala sp.		1	1
Catocala amica	1	5	
Catocala andromedae	1	2	
Catocala dejecta	1		
Catocala gracilis	1	6	1
Catocala ilia	1	3	4
Catocala nebulosa	1		
Catocala obscura			1
Catocala retecta	1		
Catocala ultronia		1	
Cerma cerintha	1		
Charadra deridens	1		
Chytonix palliatricula	4	4	1
Cosmia calami		12	6
Elaphria grata	4		1
Elaphria versicolor	3		2
Euagrotis lubricans	1		
Eudryas grata	1		
Faronta diffusa			3

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Galgula partita	25	7	1
Harrisimemna trisignata	1		
Homohadena badistriga		1	
Homophoberia apicosa	1		
Hyperstrotia pervertens	10	66	14
Hypsoropha hormos	2		
Hypsoropha monilis		1	2
Idia americalis	7	4	8
Isogona tenuis	2		
Lacinipolia lorea	1		
Lacinipolia renigera	11	7	10
Lesmone detrahens			1
Leucania sp.	30	4	4
Leucania inermis	3		
Leucania scirpicola	8	5	8
Lithacodia sp.	1		
Lithacodia carneola	1	4	4
Lithacodia muscosula	25	8	13
Macrochilo absorptalis		3	
Meganola minuscula	2	1	
Mocis texana	1	1	
Ogdoconta cinereola	6	2	
Orthodes crenulata		2	
Orthodes cynica	3		3
Paectes sp.			1
Paectes abrostoloides		1	
Paectes oculatrix			1
Paectes pygmaea		1	2
Palthis sp.	2	2	
Pangrapta decoralis	4		1
Panopoda sp.			1
Panopoda carneicosta	1		
Panopoda rufimargo	2		
Panthea furcilla		2	2
Phalaenophana pyramusalis	8	20	3
Phosphila miselioides		1	

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Plathypena scabra	3	2	2
Platysenta vecors	1	2	2
Polia sp.		4	
Polygrammate hebraeicum	5	53	33
Protolampra brunneicollis		1	
Proxenus miranda	2		
Pseudaletia unipuncta	1		
Ptichodis herbarum	1		
Rachiplusia ou		1	
Renia sp.		5	4
Renia discoloralis	1	6	1
Renia fraternalis	1	4	1
Renia sobrialis		23	9
Schinia arcigera			1
Schinia lynx		1	8
Schinia trifascia			1
Schrankia macula	11	4	2
Scolecocampa liburna		2	
Spodoptera ornithogalli	1		
Spragueia sp.	3		
Stiriodes obtusa	3		
Tarachidia candefacta	2		1
Tetanolita mynesalis	95	122	51
Thioptera nigrofimbria	21	7	10
Zale sp.		2	
Zale lunata	1		1
Zanclognatha sp.	8	8	2
Zanclognatha cruralis	4	11	
Zanclognatha obscuripennis	1	2	1
Noctuid Total	439	666	381
Notodontidae			
Family	15	21	12
Clostera inclusa			1
Datana sp.		1	

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Datana angusii	7	1	
Datana contracta	4	1	1
Datana ministra	1		
Datana perspicua	4	2	1
Heterocampa sp.	2		
Heterocampa guttivitta	3	5	2
Heterocampa obliqua	7	2	8
Heterocampa subrotata	1		
Heterocampa umbrata	4	2	
Hyperaeschra georgica	10	4	5
Lochmaeus bilineata	6		1
Macrurocampa marthesia	4	5	1
Nadata gibbosa	7	6	14
Nerice bidentata	1		1
Oligocentria lignicolor			2
Peridea basitriens	2		3
Schizura ipomoeae	3		1
Schizura leptinoides			3
Symmerista albifrons	1		
Notodontid Total	82	50	56
Oecophoridae			
Family			2
Antaeotricha sp.	1		
Antaeotricha leucillana	3	1	
Antaeotricha schlaegeri	1		6
Psilocorsis sp.	7	12	5
Oecophorid Total	12	13	13
Pterophoridae			
Platyptilia carduidactyla	1		

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Pyralidae			
Family	33	32	50
Blepharomastix ranalis	11	51	21
Compacta capitalis			1
Crambus sp.			1
Crambus agitatellus	35	11	16
Crambus laqueatellus	5	2	5
Desmia funeralis	6	5	6
Diacme elealis	2		
Helvibotys helvialis		2	
Herculia olinalis	7	47	16
Palpita magniferalis	11		42
Polygrammodes flavidalis	2	16	4
Pyrausta sp.	1		
Pyrausta acrionalis	4		
Sparganothis reticulatana			3
Tetralopha asperatella	7	20	10
Udea rubigalis	4	7	5
Urola nivalis	8	12	6
Pyralid Total	136	205	186
Saturniidae			
Actias luna	3		6
Anisota stigma	2		1
Antheraea polyphemus		4	
Automeris io	1	5	1
Dryocampa rubicunda		1	
Eacles imperialis	11	2	10
Saturniid Total	17	12	18
Sphingidae			
Ceratomia undulosa	1		1
Darapsa myron			2
Darapsa pholus	2		

Appendix 8. (continued)

Taxon	Blue Heaven	Reed	Marble Falls
Paonias excaecatus	1		1
Tortricidae			
Family	13	15	23
Archips argyrospila	18	28	1
Argyrotaenia sp.		1	
Argyrotaenia alisellana		2	25
Argyrotaenia quercifoliana	7	7	
Choristoneura sp.	3		1
Choristoneura parallela	2	5	3
Choristoneura pinus		3	
Choristoneura rosaceana	9	29	10
Sparganothis reticulatana		1	
Tortricid Total	52	91	63
Yponomeutidae			
Atteva punctella	3		2
Yponomeuta sp.	1		9
Zygaenidae			
Harrisina americana	1		
Total Moths	**1259**	**1936**	**1014**

Appendix 9. Occurrence of moths in Marion County, Arkansas, during the 2005 field season, sorted by sampling period.

	Moth Catch by Sample Period			
Taxon	First	Second	Third	Fourth
Apatelodidae				
Olceclostera angelica				3
Arctiidae				
Apantesis sp.	3		4	11
Cisseps fulvicollis			5	
Cisthene packardii	15	3		
Clemensia albata	26	3		
Crambidia sp.	4	11	17	
Cycnia tenera				2
Ecpantheria scribonia		1		
Euerythra phasma	3			
Grammia anna	13			
Grammia arge			1	
Grammia figurata	2		1	1
Grammia oithona				1
Halysidota tessellaris	1	5	32	59
Haploa clymene				1
Haploa contigua		1		
Haploa reversa		1		
Holomelina sp.	8			2
Holomelina aurantiaca			2	
Holomelina opella	5	3	2	
Hypoprepia fucosa	133	251	67	
Pyrrharctia isabella	4			2
Spilosoma sp.			1	
Spilosoma congrua	53	9	1	5
Spilosoma virginica	4		2	
Arctiid Total	274	288	135	84
Cossidae				
Prionoxystus robiniae			1	

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Drepanidae				
Oreta rosea	1			2
Epiplemidae				
Calledapteryx dryopterata				2
Geometridae				
Family	12	4	9	10
Anacamptodes sp.		9		
Anacamptodes defectaria				5
Anacamptodes ephyraria		2	6	
Antepione thisoaria		1		1
Besma sp.			1	
Besma endropiaria			2	
Besma quercivoraria	2	1		
Calothysanis amaturaria	1			
Cyclophora pendulinaria		5	1	1
Dichorda iridaria			1	
Dyspteris abortivaria			1	
Ecliptopera atricolorata		1	2	
Ectropis crepuscularia	1			1
Epimecis hortaria				1
Eubaphe mendica		2	3	
Euchlaena sp.				1
Euchlaena pectinaria				2
Eudeilinea herminiata		1		1
Eulithis diversilineata		2	3	
Eupithecia sp.		2	9	
Eupithecia miserulata	9	6	15	10
Eusarca confusaria	2	2		
Eutrapela clemetaria			3	
Glena cribrataria				4
Glenoides texanaria				17
Heterophleps triguttaria		1		
Hypagyrtis unipunctata	11	15	1	18
Hypomecis umbrosaria			2	

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Idaea demissaria		1		
Idaea furciferata		8	13	
Itame sp.	1			
Lambdina fervidaria		1	23	89
Leptostales rubromarginaria		6	6	12
Lomographa vestaliata	2		11	1
Lytrosis unitaria	28	6	1	
Mellilla xanthometata	1			
Metarranthis sp.			1	
Metarranthis angularia		3		
Metarranthis hypochraria				
Nematocampa limbata		3		
Nemoria lixaria			3	1
Orthonama centrostrigaria		2	4	
Orthonama obstipata		2	1	1
Patalene olyzonaria				3
Pero hubneraria				2
Phigalia sp.			1	
Plagodis alcoolaria			1	10
Plagodis fervidaria				10
Pleuroprucha insulsaria				1
Prochoerodes transversata		4	1	
Protitame virginalis	6			
Protoboarmia porcelaria	1	1		
Scopula limboundata	2	1	2	4
Semiothisa sp.		1		
Semiothisa continuata				1
Semiothisa granitata		1		
Semiothisa multilineata		1	1	3
Semiothisa ocellinata				1
Semiothisa quadrinotaria			1	
Semiothisa transitaria	1		2	2
Xanthotype urticaria				1
Geometrid Total	80	95	131	214

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Lasiocampidae				
Malacosoma americanum	302	2		
Malacosoma disstria	17			
Limacodidae				
Family	6			6
Apoda y-inversum			1	
Euclea delphinii			2	
Isa textual				3
Lithacodes fasciola		3	2	2
Prolimacodes badia				2
Limacodid Total	6	3	5	13
Lymantriidae				
Dasychira sp.	7	1		
Dasychira obliquata			5	7
Orgyia sp.				1
Orgyia leucostigma		1		
Megalopygidae				
Lagoa crispate	1	1	5	
Norape ovina				1
Mimallonidae				
Lacosoma chiridota	3	1		
Noctuidae				
Family	55	71	92	58
Acronicta sp.	14	2	4	11
Acronicta afflicta	1		1	7
Acronicta americana	2			
Acronicta haesitata	6	1	1	30
Acronicta interrupta			1	
Acronicta modica	2	1	1	5
Acronicta ovata	2			13

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Acronicta retardate	2	3	3	3
Acronicta tritona				1
Agriopodes fallax	1			1
Agriopodes teratophora	1			
Agrotis ipsilon				1
Allagrapha aeria	1			
Allotria elonympha	4	2	2	5
Argyrostrotis anilis		1		
Autographa biloba	1			
Baileya sp.	3			
Baileya levitans		1		2
Balsa labecula	1	1	15	2
Bleptina caradrinalis	2		1	10
Bomolocha sp.	2			1
Caenurgia chloropha	1		1	3
Caenurgina erechtea	1	5	2	4
Callopistria cordata	1	1	1	2
Catocala sp.	1		1	
Catocala amica				6
Catocala andromedae		1	1	1
Catocala dejecta				1
Catocala gracilis			4	4
Catocala ilia			2	6
Catocala nebulosa			1	
Catocala obscura				1
Catocala retecta				1
Catocala ultronia				1
Cerma cerintha			1	
Charadra deridens		1		
Chytonix palliatricula	2		2	5
Cosmia calami		12	6	
Elaphria grata				5
Elaphria versicolor		1		4
Euagrotis lubricans				1
Eudryas grata	1			
Faronta diffusa	1	2		

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Galgula partita	7	5	1	20
Harrisimemna trisignata				1
Homohadena badistriga		1		
Homophoberia apicosa	1			
Hyperstrotia pervertens	11	28	44	7
Hypsoropha hormos			2	
Hypsoropha monilis	3			
Idia americalis	3	4	3	9
Isogona tenuis		1		1
Lacinipolia lorea	1			
Lacinipolia renigera	24	2	2	
Lesmone detrahens	1			
Leucania sp.		2	2	34
Leucania inermis				3
Leucania scirpicola	21			
Lithacodia sp.				1
Lithacodia carneola	2	1	2	4
Lithacodia muscosula	10	7	1	28
Macrochilo absorptalis	1			2
Meganola minuscula	3			
Mocis texana				2
Ogdoconta cinereola	1		2	5
Orthodes crenulata		1	1	
Orthodes cynica	6			
Paectes sp.				1
Paectes abrostoloides				1
Paectes oculatrix				1
Paectes pygmaea	1			2
Palthis sp.				4
Pangrapta decoralis	1		1	3
Panopoda sp.			1	
Panopoda carneicosta			1	
Panopoda rufimargo			1	1
Panthea furcilla				4
Phalaenophana pyramusalis	18	2	4	7
Phosphila miselioides			1	

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Plathypena scabra	1		3	3
Platysenta vecors	2		1	2
Polia sp.				4
Polygrammate hebraeicum	25	3	17	46
Protolampra brunneicollis			1	
Proxenus miranda				2
Pseudaletia unipuncta				1
Ptichodis herbarum			1	
Rachiplusia ou				1
Renia sp.	1	5	2	1
Renia discoloralis		1	3	4
Renia fraternalis	1		4	1
Renia sobrialis	5	14	13	
Schinia arcigera				1
Schinia lynx	1			8
Schinia trifascia				1
Schrankia macula	11		4	2
Scolecocampa liburna		2		
Spodoptera ornithogalli			1	
Spragueia sp.				3
Stiriodes obtusa		2	1	
Tarachidia candefacta				3
Tetanolita mynesalis	104	74	49	41
Thioptera nigrofimbria	7	8	13	10
Zale sp.	1			1
Zale lunata	1		1	
Zanclognatha sp.	8	5	4	1
Zanclognatha cruralis	3	3	8	1
Zanclognatha obscuripennis			1	3
Noctuid Total	394	277	339	476
Notodontidae				
Family	15	9	8	16
Clostera inclusa	1			
Datana sp.				1

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Datana angusii			1	7
Datana contracta	2		1	3
Datana ministra				1
Datana perspicua			4	3
Heterocampa sp.			2	
Heterocampa guttivitta	1	6		3
Heterocampa obliqua				17
Heterocampa subrotata			1	
Heterocampa umbrata	3	2	1	
Hyperaeschra georgica	12	1	3	3
Lochmaeus bilineata		1		6
Macrurocampa marthesia	4	3	2	1
Nadata gibbosa	1	3	10	13
Nerice bidentata		1		1
Oligocentria lignicolor	1			1
Peridea basitriens				5
Schizura ipomoeae				4
Schizura leptinoides				3
Symmerista albifrons				1
Notodontid Total	40	26	33	89
Oecophoridae				
Family	2			
Antaeotricha sp.			1	
Antaeotricha leucillana	1			3
Antaeotricha schlaegeri	7			
Psilocorsis sp.	3	4	11	6
Oecophorid Total	13	4	12	9
Pterophoridae				
Platyptilia carduidactyla	1			

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Pyralidae				
Family	24	14	35	42
Blepharomastix ranalis	6	9	63	5
Compacta capitalis	1			
Crambus sp.		1		
Crambus agitatellus	4	9	25	24
Crambus laqueatellus	8	4		
Desmia funeralis	3	2	2	10
Diacme elealis				2
Helvibotys helvialis				2
Herculia olinalis	42	22	5	1
Palpita magniferalis	9			44
Polygrammodes flavidalis	16	4	2	
Pyrausta sp.		1		
Pyrausta acrionalis	1	1	1	1
Sparganothis reticulatana			3	
Tetralopha asperatella			2	35
Udea rubigalis	5	8	3	
Urola nivalis	6	8	6	6
Pyralid Total	125	83	147	172
Saturniidae				
Actias luna		1		8
Anisota stigma			1	2
Antheraea polyphemus	4			
Automeris io		2		5
Dryocampa rubicunda	1			
Eacles imperialis			1	22
Saturniid Total	5	3	2	37
Sphingidae				
Ceratomia undulosa		1		1
Darapsa myron	1		1	
Darapsa pholus				2

Appendix 9. (continued)

Taxon	First	Second	Third	Fourth
Paonias excaecatus			2	
Tortricidae				
Family	20	16	8	7
Archips argyrospila	47			
Argyrotaenia sp.			1	
Argyrotaenia alisellana	27			
Argyrotaenia quercifoliana	12	2		
Choristoneura sp.	3	1		
Choristoneura parallela		1	5	4
Choristoneura pinus	3			
Choristoneura rosaceana	46	2		
Sparganothis reticulatana				1
Tortricid Total	158	22	14	12
Yponomeutidae				
Atteva punctella				5
Yponomeuta sp.	2			8
Zygaenidae				
Harrisina americana	1			
Total Moths	**1431**	**808**	**832**	**1138**

Appendix 10. Occurrence of moths in Crawford County, Arkansas, during the 2005 field season, sorted by habitat.

Taxon	Moth Catch by Habitat Sawtimber	Poletimber	Sapling
Apatelodidae			
Apatelodes torrefacta	2	7	3
Olceclostera angelica	1	1	1
Arctiidae			
Apantesis sp.	7	1	2
Cisseps fulvicollis	1		
Cisthene packardii		3	
Clemensia albata	28	27	2
Crambidia sp.	37	20	12
Cycnia tenera	2		
Ecpantheria scribonia	9	3	
Euchaetes egle	6		1
Euerythra phasma	1	8	1
Grammia anna	11	9	13
Halysidota tessellaris	102	116	63
Haploa clymene	1	1	4
Haploa contigua	9	8	2
Haploa reversa		1	2
Holomelina sp.	1		
Holomelina opella	24		
Hyphantria cunea	4	7	12
Hypoprepia fucosa	36	153	2
Pyrrharctia isabella	2		
Spilosoma sp.			1
Spilosoma congrua	40	34	3
Spilosoma virginica	2		2
Arctiid Total	323	391	122
Cossidae			
Prionoxystus robiniae	3	4	6

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Drepanidae			
Oreta rosea		1	
Epiplemidae			
Calledapteryx dryopterata	4	11	
Callizzia amorata	6	4	3
Geometridae			
Family	18	26	18
Anacamptodes sp.		4	
Anacamptodes defectaria	6	5	5
Anacamptodes ephyraria	1		6
Antepione thisoaria	1		
Anticlea multiferata			1
Besma endropiaria		1	
Besma quercivoraria		1	1
Cyclophora pendulinaria	4	8	1
Dyspteris abortivaria		1	
Ecliptopera atricolorata	2	6	
Ectropis crepuscularia	1	7	2
Epimecis hortaria		1	2
Eubaphe mendica	2	1	
Euchlaena amoenaria		3	1
Euchlaena irraria			1
Euchlaena obtusaria		1	
Euchlaena pectinaria	1	3	1
Euchlaena tigrinaria			1
Eudeilinea herminiata	2		
Eulithis diversilineata		1	3
Eupithecia sp.	28		
Eupithecia miserulata	9	15	18
Eusarca confusaria		2	3
Eutrapela clemetaria			2
Exilis pyrolaria		1	1
Glena cribrataria	11	5	4
Glenoides texanaria		28	1

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Heliomata cycladata			3
Heterophleps sp.			1
Heterophleps refusaria			1
Heterophleps triguttaria			2
Hydria prunivorata			2
Hypagyrtis unipunctata	6	19	13
Hypomecis umbrosaria			1
Idaea sp.			1
Idaea demissaria			1
Idaea furciferata	7	3	3
Iridopsis larvaria		1	
Itame sp.	6	46	5
Lambdina fervidaria	17	10	2
Leptostales rubromarginaria	9	5	10
Lomographa vestaliata	6	4	35
Lytrosis unitaria	2	4	4
Mellilla xanthometata	5	1	
Metarranthis sp.		1	
Metarranthis hypochraria	1	4	1
Nemoria sp.	1	2	
Nemoria lixaria	1	2	2
Orthonama centrostrigaria	1	4	4
Orthonama obstipata		2	
Patalene olyzonaria	7	8	2
Pero hubneraria		3	5
Phigalia sp.		1	2
Plagodis sp.	1		
Plagodis alcoolaria	2	1	1
Plagodis phlogosaria		1	2
Probole nyssaria	2	4	
Prochoerodes transversata		1	4
Protitame virginalis	1		
Protoboarmia porcelaria	2	3	1
Scopula limboundata	5	7	
Semiothisa multilineata	2	1	2
Semiothisa ocellinata	2	3	6

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Semiothisa promiscuata	5	4	3
Semiothisa quadrinotaria			2
Tetracis crocallata		1	
Xanthotype urticaria			1
Geometrid Total	177	266	194
Lasiocampidae			
Malacosoma americanum	15	17	60
Limacodidae			
Family	4	2	4
Adoneta spinuloides	3	2	2
Apoda biguttata		1	
Apoda y-inversum	1		5
Euclea delphinii		1	
Isa textula		1	3
Lithacodes fasciola	4	9	6
Parasa chloris	1	2	2
Prolimacodes badia	1		2
Tortricidia flexuosa	1	2	
Limacodid Total	15	20	24
Lymantriidae			
Family	3	4	
Dasychira sp.	4	1	2
Dasychira obliquata	19	9	8
Dasychira tephra	2		
Orgyia sp.	1	1	1
Orgyia leucostigma		3	1
Lymantriid Total	29	18	12

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Megalopygidae			
Family	1		
Lagoa crispata	5	1	2
Norape ovina	12	10	11
Mimallonidae			
Lacosoma chiridota	2		
Noctuidae			
Family	73	96	77
Acronicta sp.	8	7	9
Acronicta afflicta	4	4	3
Acronicta americana	5		1
Acronicta funeralis	1		3
Acronicta haesitata	4	6	14
Acronicta impleta	2	1	6
Acronicta inclara	1		
Acronicta lithospila	1		2
Acronicta lobeliae	2		
Acronicta modica	3	1	6
Acronicta noctivaga	1		
Acronicta retardata	1	3	3
Agriopodes fallax	1	1	1
Agriopodes teratophora	2		
Agrotis ipsilon	1	2	1
Allagrapha aeria	1		
Allotria elonympha	10	6	6
Anicla infecta			1
Anorthodes tarda			4
Baileya australis	2	1	
Baileya levitans	29	43	34
Balsa labecula	5	3	5
Balsa tristrigella		1	
Bleptina caradrinalis	4	1	2
Bomolocha sp.		2	2
Bomolocha abalienalis			1

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Bomolocha sordidula			1
Caenurgia chloropha		2	1
Caenurgina erechtea	1		
Callopistria mollissima		7	
Catocala sp.	2		
Catocala andromedae	1		
Catocala dejecta			1
Catocala epione			1
Catocala gracilis	2		
Catocala ilia	2	2	3
Catocala judith		1	3
Catocala junctura	1		
Catocala ultronia			3
Cerma cerintha	1	1	
Chytonix palliatricula	5	1	5
Cosmia calami	1		1
Elaphria grata		2	1
Elaphria versicolor			16
Eosphoropteryx thyatyroides	1		1
Epidelta metonalis	1		
Eudryas grata	1	6	2
Euparthenos nubilis			1
Euplexia benesimilis	1	6	1
Faronta diffusa			1
Galgula partita	5	2	2
Harrisimemna trisignata	1		1
Heliothis zea			1
Homohadena badistriga			1
Hyperstrotia pervertens	4	1	12
Hypsoropha hormos	1		2
Hypsoropha monilis			1
Idia aemula	1		
Idia americalis	9	7	7
Isogona tenuis		1	1
Lacinipolia renigera	8		5
Leucania sp.	2	2	5

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Lithacodia carneola	10	15	17
Lithacodia muscosula	14	8	6
Macrochilo absorptalis	1		
Mocis texana	1	1	1
Nedra ramosula	1		
Ogdoconta cinereola	6	5	7
Orthodes crenulata		1	2
Orthodes cynica			40
Ozarba aeria		2	
Paectes abrostoloides	1	1	2
Paectes oculatrix	2		2
Paectes pygmaea	2	2	1
Palthis sp.	5	4	11
Panopoda carneicosta			1
Panopoda rufimargo	1		2
Phalaenophana pyramusalis	9	5	10
Plathypena scabra	2		3
Platysenta sutor		2	1
Platysenta vecors	2	5	2
Polia sp.		1	
Polygrammate hebraeicum	37	42	36
Protolampra brunneicollis	1		
Renia sp.	2	7	5
Renia discoloralis		2	5
Renia fraternalis			1
Renia nemoralis		4	
Rivula propinqualis			1
Schrankia macula	1	5	2
Scolecocampa liburna			1
Spodoptera ornithogalli	5	4	1
Stiriodes obtusa	1		1
Tetanolita mynesalis	38	54	5
Thioptera nigrofimbria	31	10	7
Trichoplusia ni	1		
Zale sp.	2	3	1
Zale lunata	1		

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Zanclognatha sp.	4	3	5
Zanclognatha cruralis	7	3	
Zanclognatha lituralis			1
Zanclognatha obscuripennis	4	5	4
Noctuid Total	404	413	445
Notodontidae			
Family	35	57	21
Clostera inclusa	1		
Datana sp.		2	
Datana angusii	4	3	
Datana contracta	13	6	4
Datana ministra		1	
Datana perspicua	7	11	3
Heterocampa biundata		2	
Heterocampa guttivitta	23	25	10
Heterocampa obliqua	18	15	9
Heterocampa subrotata		2	1
Hyperaeschra georgica	2	4	
Lochmaeus bilineata	2	5	6
Lochmaeus manteo	11	4	2
Macrurocampa marthesia	4	10	
Nadata gibbosa	6	10	5
Nerice bidentata	2	1	1
Oligocentria lignicolor		4	2
Oligocentria semirufescens	1		
Peridea basitriens		1	
Schizura ipomoeae	4	3	
Schizura leptinoides	1		
Symmerista albifrons	4	2	3
Notodontid Total	138	168	67

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Oecophoridae			
Family	1	2	1
Antaeotricha sp.	2		
Antaeotricha leucillana	4	2	
Antaeotricha schlaegeri	1		5
Psilocorsis sp.	12	7	5
Oecophorid Total	20	11	11
Pyralidae			
Family	54	63	58
Blepharomastix ranalis	4	6	14
Clydonopteran tecomae			2
Compacta capitalis	3		
Conchylodes ovulalis		4	1
Crambus agitatellus	25	38	13
Crambus laqueatellus	1	1	1
Desmia funeralis	23	19	20
Epipagis huronalis	2		
Helvibotys helvialis	3	5	2
Herculia olinalis	2	2	1
Munroessa gyrales	1		
Nomophila nearctica			1
Palpita magniferalis	110	93	76
Pantographa limata	14	9	3
Polygrammodes flavidalis	1	1	
Pyrausta sp.			1
Pyrausta acrionalis	4		
Sparganothis reticulatana	2		
Tetralopha asperatella	19	13	22
Udea rubigalis	9	5	4
Urola nivalis	3	1	
Pyralid Total	280	260	219

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Saturniidae			
Actias luna	8	10	7
Anisota stigma	2		
Antheraea polyphemus	3	4	1
Automeris io	4	5	1
Citheronia regalis	3		
Dryocampa rubicunda	16	12	6
Eacles imperialis	1	14	4
Saturniid Total	37	45	19
Sphingidae			
Family		1	
Darapsa myron	1	1	
Laothoe juglandis	1		
Manduca sp.			1
Paonias excaecatus	3	3	
Paonias myops		1	
Sphingid Total	5	6	1
Thyatiridae			
Pseudothyatira cymatophoroides			1
Tortricidae			
Family	10	4	6
Archips argyrospila		10	1
Argyrotaenia alisellana	7	3	1
Choristoneura sp.	7		
Choristoneura parallela	12	11	3
Choristoneura rosaceana	4	8	29
Sparganothis reticulatana	1		
Tortricid Total	41	36	40

Appendix 10. (continued)

Taxon	Sawtimber	Poletimber	Sapling
Yponomeutidae			
Atteva punctella	11	8	31
Yponomeuta sp.	2		1
Zygaenidae			
Harrisina americana	3	1	1
Pyromorpha dimidiata	2		
Total Moths	**1538**	**1699**	**1274**

Appendix 11. Occurrence of moths in Crawford County, Arkansas, during the 2005 field season, sorted by roost location.

	Moth Catch by Roost Location		
Taxon	Devil's Hollow	North Face	Whitzen Hollow
Apatelodidae			
Apatelodes torrefacta	4	1	7
Olceclostera angelica	1		2
Arctiidae			
Apantesis sp.			10
Cisseps fulvicollis			1
Cisthene packardii	2		1
Clemensia albata	17	12	28
Crambidia sp.	19		50
Cycnia tenera			2
Ecpantheria scribonia	1	4	7
Euchaetes egle			7
Euerythra phasma	1	7	2
Grammia anna	12	12	9
Halysidota tessellaris	121	27	133
Haploa clymene	1	4	1
Haploa contigua	9	1	9
Haploa reversa	3		
Holomelina sp.	1		
Holomelina opella	13		11
Hyphantria cunea	19	2	2
Hypoprepia fucosa	154	5	32
Pyrrharctia isabella			2
Spilosoma sp.		1	
Spilosoma congrua	52	12	13
Spilosoma virginica	1	1	2
Arctiid Total	426	88	322
Cossidae			
Prionoxystus robiniae	6	7	

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Drepanidae			
Oreta rosea			1
Epiplemidae			
Calledapteryx dryopterata	10		5
Callizzia amorata	3	2	8
Geometridae			
Family	19	13	30
Anacamptodes sp.	2	1	1
Anacamptodes defectaria	12	1	3
Anacamptodes ephyraria	2	4	1
Antepione thisoaria	1		
Anticlea multiferata		1	
Besma endropiaria	1		
Besma quercivoraria	2		
Cyclophora pendulinaria	5	8	
Dyspteris abortivaria	1		
Ecliptopera atricolorata	4	1	3
Ectropis crepuscularia	3	2	5
Epimecis hortaria	1		2
Eubaphe mendica			3
Euchlaena amoenaria			4
Euchlaena irraria		1	
Euchlaena obtusaria			1
Euchlaena pectinaria	4		1
Euchlaena tigrinaria		1	
Eudeilinea herminiata	2		
Eulithis diversilineata	1	1	2
Eupithecia sp.	14		14
Eupithecia miserulata	8	13	21
Eusarca confusaria	1	3	1
Eutrapela clemetaria		1	1
Exilis pyrolaria			2
Glena cribrataria	6	2	12
Glenoides texanaria			29

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Heliomata cycladata		1	2
Heterophleps sp.			1
Heterophleps refusaria			1
Heterophleps triguttaria			2
Hydria prunivorata		1	1
Hypagyrtis unipunctata	5	4	29
Hypomecis umbrosaria			1
Idaea sp.			1
Idaea demissaria			1
Idaea furciferata	7		6
Iridopsis larvaria		1	
Itame sp.	14	42	1
Lambdina fervidaria	22	5	2
Leptostales rubromarginaria		5	19
Lomographa vestaliata	30	7	8
Lytrosis unitaria	4	6	
Mellilla xanthometata	1		5
Metarranthis sp.	1		
Metarranthis hypochraria	5	1	
Nemoria sp.			3
Nemoria lixaria	3	1	1
Orthonama centrostrigaria	4	4	1
Orthonama obstipata		1	1
Patalene olyzonaria	2	2	13
Pero hubneraria	3	2	3
Phigalia sp.	1		2
Plagodis sp.	1		
Plagodis alcoolaria		3	1
Plagodis phlogosaria		1	2
Probole nyssaria	2	2	2
Prochoerodes transversata	1	3	1
Protitame virginalis			1
Protoboarmia porcelaria	2		4
Scopula limboundata	4	2	6
Semiothisa multilineata		2	3
Semiothisa ocellinata	1	5	5

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Semiothisa promiscuata			12
Semiothisa quadrinotaria		1	1
Tetracis crocallata	1		
Xanthotype urticaria			1
Geometrid Total	203	155	279
Lasiocampidae			
Malacosoma americanum	83	6	3
Limacodidae			
Family	3	2	5
Adoneta spinuloides	3	1	3
Apoda biguttata	1		
Apoda y-inversum	3	3	
Euclea delphinii	1		
Isa textula	1	2	1
Lithacodes fasciola	7	4	8
Parasa chloris	1		4
Prolimacodes badia	1		2
Tortricidia flexuosa	1	2	
Limacodid Total	22	14	23
Lymantriidae			
Family	7		
Dasychira sp.	6		1
Dasychira obliquata	15	6	15
Dasychira tephra		2	
Orgyia sp.	1		2
Orgyia leucostigma			4
Lymantriid Total	29	8	22

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Megalopygidae			
Family			1
Lagoa crispata	5	2	1
Norape ovina		2	31
Mimallonidae			
Lacosoma chiridota	1		1
Noctuidae			
Family	87	52	107
Acronicta sp.	8	7	9
Acronicta afflicta	3	6	2
Acronicta americana	1	5	
Acronicta funeralis	4		
Acronicta haesitata	12	9	3
Acronicta impleta	6	1	2
Acronicta inclara	1		
Acronicta lithospila	3		
Acronicta lobeliae		2	
Acronicta modica	6	3	1
Acronicta noctivaga		1	
Acronicta retardata	4	2	1
Agriopodes fallax	3		
Agriopodes teratophora	2		
Agrotis ipsilon	1		3
Allagrapha aeria			1
Allotria elonympha	11	8	3
Anicla infecta			1
Anorthodes tarda			4
Baileya australis	1		2
Baileya levitans	24	22	60
Balsa labecula	6	5	2
Balsa tristrigella			1
Bleptina caradrinalis			7
Bomolocha sp.		2	2
Bomolocha abalienalis	1		

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Bomolocha sordidula			1
Caenurgia chloropha		2	1
Caenurgina erechtea			1
Callopistria mollissima	1	3	3
Catocala sp.		2	
Catocala andromedae		1	
Catocala dejecta	1		
Catocala epione	1		
Catocala gracilis	1	1	
Catocala ilia	2	4	1
Catocala judith	1	1	2
Catocala junctura			1
Catocala ultronia		1	2
Cerma cerintha		2	
Chytonix palliatricula	6		5
Cosmia calami	2		
Elaphria grata	1	1	1
Elaphria versicolor			16
Eosphoropteryx thyatyroides	1	1	
Epidelta metonalis			1
Eudryas grata	5	4	
Euparthenos nubilis		1	
Euplexia benesimilis	6	2	
Faronta diffusa			1
Galgula partita	1	3	5
Harrisimemna trisignata			2
Heliothis zea	1		
Homohadena badistriga			1
Hyperstrotia pervertens	2	1	14
Hypsoropha hormos	1		2
Hypsoropha monilis		1	
Idia aemula	1		
Idia americalis	7	5	11
Isogona tenuis			2
Lacinipolia renigera			13
Leucania sp.	4	1	4

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Lithacodia carneola	9	8	25
Lithacodia muscosula	6		22
Macrochilo absorptalis			1
Mocis texana		1	2
Nedra ramosula			1
Ogdoconta cinereola	4	7	7
Orthodes crenulata	1	1	1
Orthodes cynica	2	30	8
Ozarba aeria		2	
Paectes abrostoloides	1	1	2
Paectes oculatrix	1	1	2
Paectes pygmaea		2	3
Palthis sp.	1	6	13
Panopoda carneicosta		1	
Panopoda rufimargo		1	2
Phalaenophana pyramusalis	5	5	14
Plathypena scabra	1	1	3
Platysenta sutor			3
Platysenta vecors	5	2	2
Polia sp.		1	
Polygrammate hebraeicum	20	29	66
Protolampra brunneicollis		1	
Renia sp.	5	2	7
Renia discoloralis		2	5
Renia fraternalis			1
Renia nemoralis			4
Rivula propinqualis			1
Schrankia macula	1	3	4
Scolecocampa liburna		1	
Spodoptera ornithogalli	1	3	6
Stiriodes obtusa			2
Tetanolita mynesalis	11	8	78
Thioptera nigrofimbria	10	5	33
Trichoplusia ni		1	
Zale sp.		1	5
Zale lunata			1

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Zanclognatha sp.	4	2	6
Zanclognatha cruralis			10
Zanclognatha lituralis			1
Zanclognatha obscuripennis	2		11
Noctuid Total	319	290	653
Notodontidae			
Family	30	28	55
Clostera inclusa			1
Datana sp.	1		1
Datana angusii	2		5
Datana contracta	3	4	16
Datana ministra			1
Datana perspicua	13	3	5
Heterocampa biundata			2
Heterocampa guttivitta	34	6	18
Heterocampa obliqua	30	4	8
Heterocampa subrotata	1	1	1
Hyperaeschra georgica	1		5
Lochmaeus bilineata	5	2	6
Lochmaeus manteo	13	1	3
Macrurocampa marthesia	7	3	4
Nadata gibbosa	11	1	9
Nerice bidentata	2	1	1
Oligocentria lignicolor	2		4
Oligocentria semirufescens	1		
Peridea basitriens	1		
Schizura ipomoeae	6		1
Schizura leptinoides			1
Symmerista albifrons			9
Notodontid Total	163	54	156

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Oecophoridae			
Family	2		2
Antaeotricha sp.			2
Antaeotricha leucillana			6
Antaeotricha schlaegeri	2	3	1
Psilocorsis sp.	11	1	12
Oecophorid Total	15	4	23
Pyralidae			
Family	53	48	74
Blepharomastix ranalis	8	3	13
Clydonopteran tecomae			2
Compacta capitalis	3		
Conchylodes ovulalis	3		2
Crambus agitatellus	22	2	52
Crambus laqueatellus			3
Desmia funeralis	12	12	38
Epipagis huronalis			2
Helvibotys helvialis	3	5	2
Herculia olinalis	2	2	1
Munroessa gyrales	1		
Nomophila nearctica	1		
Palpita magniferalis	26	6	247
Pantographa limata	17	4	5
Polygrammodes flavidalis	2		
Pyrausta sp.	1		
Pyrausta acrionalis	1		3
Sparganothis reticulatana	2		
Tetralopha asperatella	17	24	13
Udea rubigalis	1	5	12
Urola nivalis	4		
Pyralid Total	179	111	469

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Saturniidae			
Actias luna	13	4	8
Anisota stigma			2
Antheraea polyphemus	4	2	2
Automeris io	5	3	2
Citheronia regalis	2		1
Dryocampa rubicunda	16	9	9
Eacles imperialis	6		13
Saturniid Total	46	18	37
Sphingidae			
Family	1		
Darapsa myron	1	1	
Laothoe juglandis			1
Manduca sp.		1	
Paonias excaecatus	2		4
Paonias myops		1	
Sphingid Total	4	3	5
Thyatiridae			
Pseudothyatira cymatophoroides			1
Tortricidae			
Family	7	4	9
Archips argyrospila		3	8
Argyrotaenia alisellana		4	7
Choristoneura sp.			7
Choristoneura parallela	7	2	17
Choristoneura rosaceana	6	13	22
Sparganothis reticulatana		1	
Tortricid Total	20	27	70

Appendix 11. (continued)

Taxon	Devil's Hollow	North Face	Whitzen Hollow
Yponomeutidae			
Atteva punctella	4	26	20
Yponomeuta sp.			3
Zygaenidae			
Harrisina americana	4		1
Pyromorpha dimidiata			2
Total Moths	**1547**	**818**	**2146**

Appendix 12. Occurrence of moths in Crawford County, Arkansas, during the 2005 field season, sorted by sampling period.

	Moth Catch by Sampling Period			
Taxon	First	Second	Third	Fourth
Apatelodidae				
Apatelodes torrefacta			11	1
Olceclostera angelica			2	1
Arctiidae				
Apantesis sp.	5		2	3
Cisseps fulvicollis		1		
Cisthene packardii	1	1	1	
Clemensia albata	38	13	3	3
Crambidia sp.		52	17	
Cycnia tenera		2		
Ecpantheria scribonia	1	11		
Euchaetes egle	1	5		1
Euerythra phasma	1	6	1	2
Grammia anna	33			
Halysidota tessellaris	10	21	131	119
Haploa clymene		5	1	
Haploa contigua		17	2	
Haploa reversa		3		
Holomelina sp.	1			
Holomelina opella	11	8	5	
Hyphantria cunea		2	21	
Hypoprepia fucosa	18	120	53	
Pyrrharctia isabella	1			1
Spilosoma sp.				1
Spilosoma congrua	19	24	24	10
Spilosoma virginica	3	1		
Arctiid Total	143	292	261	140
Cossidae				
Prionoxystus robiniae			11	2

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Drepanidae				
Oreta rosea			1	
Epiplemidae				
Calledapteryx dryopterata	2	7	5	1
Callizzia amorata	8	1	2	2
Geometridae				
Family	11	9	27	15
Anacamptodes sp.	1	1	1	1
Anacamptodes defectaria	1		1	14
Anacamptodes ephyraria			2	5
Antepione thisoaria		1		
Anticlea multiferata	1			
Besma endropiaria			1	
Besma quercivoraria		1	1	
Cyclophora pendulinaria	1	10	2	
Dyspteris abortivaria			1	
Ecliptopera atricolorata		3	4	1
Ectropis crepuscularia	1	3	3	3
Epimecis hortaria		2		1
Eubaphe mendica	2			1
Euchlaena amoenaria	1		1	2
Euchlaena irraria		1		
Euchlaena obtusaria				1
Euchlaena pectinaria				5
Euchlaena tigrinaria			1	
Eudeilinea herminiata			2	
Eulithis diversilineata		1		3
Eupithecia sp.		14	14	
Eupithecia miserulata	21	6	13	2
Eusarca confusaria	1	3	1	
Eutrapela clemetaria		2		
Exilis pyrolaria	1	1		
Glena cribrataria	4	2	8	6
Glenoides texanaria		1	28	

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Heliomata cycladata	2	1		
Heterophleps sp.		1		
Heterophleps refusaria		1		
Heterophleps triguttaria	1	1		
Hydria prunivorata	1	1		
Hypagyrtis unipunctata	3	3	8	24
Hypomecis umbrosaria		1		
Idaea sp.		1		
Idaea demissaria		1		
Idaea furciferata		6	7	
Iridopsis larvaria		1		
Itame sp.	4	43	7	3
Lambdina fervidaria			8	21
Leptostales rubromarginaria		4	10	10
Lomographa vestaliata	4		12	29
Lytrosis unitaria	3	7		
Mellilla xanthometata		2	3	1
Metarranthis sp.			1	
Metarranthis hypochraria	4	2		
Nemoria sp.			3	
Nemoria lixaria			4	1
Orthonama centrostrigaria		2	7	
Orthonama obstipata	2			
Patalene olyzonaria			11	6
Pero hubneraria			2	6
Phigalia sp.		2	1	
Plagodis sp.			1	
Plagodis alcoolaria			3	1
Plagodis phlogosaria			3	
Probole nyssaria		2	1	3
Prochoerodes transversata			4	1
Protitame virginalis				1
Protoboarmia porcelaria		6		
Scopula limboundata	3	8		1
Semiothisa multilineata			3	2
Semiothisa ocellinata			5	6

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Semiothisa promiscuata	2		2	8
Semiothisa quadrinotaria		1	1	
Tetracis crocallata				1
Xanthotype urticaria	1			
Geometrid Total	76	158	218	185
Lasiocampidae				
Malacosoma americanum	86	6		
Limacodidae				
Family	4	1	4	1
Adoneta spinuloides			4	3
Apoda biguttata			1	
Apoda y-inversum			1	5
Euclea delphinii			1	
Isa textula			1	3
Lithacodes fasciola	2	8	6	3
Parasa chloris			5	
Prolimacodes badia		1	1	1
Tortricidia flexuosa	3			
Limacodid Total	9	10	24	16
Lymantriidae				
Family			7	
Dasychira sp.	7			
Dasychira obliquata		14	11	11
Dasychira tephra	2			
Orgyia sp.				3
Orgyia leucostigma		4		
Lymantriid Total	9	18	18	14

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Megalopygidae				
Family				1
Lagoa crispata			8	
Norape ovina		1	29	3
Mimallonidae				
Lacosoma chiridota		1	1	
Noctuidae				
Family	66	60	67	53
Acronicta sp.	2	3	3	16
Acronicta afflicta	1	1	6	3
Acronicta americana	1	1	1	3
Acronicta funeralis				4
Acronicta haesitata		4	10	10
Acronicta impleta				9
Acronicta inclara				1
Acronicta lithospila		1		2
Acronicta lobeliae	1		1	
Acronicta modica		1	3	6
Acronicta noctivaga				1
Acronicta retardata	2	1	1	3
Agriopodes fallax	1	1		1
Agriopodes teratophora			1	1
Agrotis ipsilon			2	2
Allagrapha aeria			1	
Allotria elonympha	8	1	9	4
Anicla infecta			1	
Anorthodes tarda	4			
Baileya australis		3		
Baileya levitans	8	3	93	2
Balsa labecula			13	
Balsa tristrigella			1	
Bleptina caradrinalis	3			4
Bomolocha sp.		1	2	1
Bomolocha abalienalis				1

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Bomolocha sordidula	1			
Caenurgia chloropha		3		
Caenurgina erechtea				1
Callopistria mollissima		4	2	1
Catocala sp.				2
Catocala andromedae			1	
Catocala dejecta				1
Catocala epione				1
Catocala gracilis			2	
Catocala ilia		2	4	1
Catocala judith	1			3
Catocala junctura			1	
Catocala ultronia		1	1	1
Cerma cerintha			2	
Chytonix palliatricula	1	3	2	5
Cosmia calami		1	1	
Elaphria grata			1	2
Elaphria versicolor	2		11	3
Eosphoropteryx thyatyroides			2	
Epidelta metonalis			1	
Eudryas grata	1	1	6	1
Euparthenos nubilis	1			
Euplexia benesimilis			5	3
Faronta diffusa	1			
Galgula partita	1		2	6
Harrisimemna trisignata			2	
Heliothis zea				1
Homohadena badistriga		1		
Hyperstrotia pervertens	4	9	3	1
Hypsoropha hormos				3
Hypsoropha monilis			1	
Idia aemula				1
Idia americalis		5	10	8
Isogona tenuis				2
Lacinipolia renigera	13			
Leucania sp.		1	4	4

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Lithacodia carneola	2	3	26	11
Lithacodia muscosula	4		4	20
Macrochilo absorptalis			1	
Mocis texana			1	2
Nedra ramosula		1		
Ogdoconta cinereola		3	13	2
Orthodes crenulata			1	2
Orthodes cynica	32	8		
Ozarba aeria				2
Paectes abrostoloides			3	1
Paectes oculatrix	2		2	
Paectes pygmaea	1		4	
Palthis sp.			12	8
Panopoda carneicosta	1			
Panopoda rufimargo		1	2	
Phalaenophana pyramusalis	3	5	5	11
Plathypena scabra			2	3
Platysenta sutor		3		
Platysenta vecors	1		4	4
Polia sp.				1
Polygrammate hebraeicum	21	7	47	40
Protolampra brunneicollis			1	
Renia sp.	1	7	4	2
Renia discoloralis			7	
Renia fraternalis				1
Renia nemoralis			4	
Rivula propinqualis		1		
Schrankia macula	1		4	3
Scolecocampa liburna		1		
Spodoptera ornithogalli	2		3	5
Stiriodes obtusa			2	
Tetanolita mynesalis		21	22	54
Thioptera nigrofimbria	4	2	20	22
Trichoplusia ni		1		
Zale sp.	2	3		1
Zale lunata			1	

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Zanclognatha sp.	2	2	6	2
Zanclognatha cruralis	6	4		
Zanclognatha lituralis		1		
Zanclognatha obscuripennis	1	1	6	5
Noctuid Total	209	187	486	380
Notodontidae				
Family	14	14	38	47
Clostera inclusa	1			
Datana sp.			2	
Datana angusii		4	2	1
Datana contracta	2	2	10	9
Datana ministra				1
Datana perspicua			6	15
Heterocampa biundata		2		
Heterocampa guttivitta	2	38	12	6
Heterocampa obliqua			4	38
Heterocampa subrotata			1	2
Hyperaeschra georgica		2	1	3
Lochmaeus bilineata		1	3	9
Lochmaeus manteo		4	1	12
Macrurocampa marthesia	5	4		5
Nadata gibbosa	1	6	5	9
Nerice bidentata		1	2	1
Oligocentria lignicolor			3	3
Oligocentria semirufescens			1	
Peridea basitriens				1
Schizura ipomoeae				7
Schizura leptinoides				1
Symmerista albifrons	5	4		
Notodontid Total	30	82	91	170

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Oecophoridae				
Family	1		1	2
Antaeotricha sp.	2			
Antaeotricha leucillana			2	4
Antaeotricha schlaegeri	3	1	2	
Psilocorsis sp.	3	9	12	
Oecophorid Total	9	10	17	6
Pyralidae				
Family	27	18	84	46
Blepharomastix ranalis		1	15	8
Clydonopteran tecomae	1		1	
Compacta capitalis	3			
Conchylodes ovulalis				5
Crambus agitatellus		4	32	40
Crambus laqueatellus	2	1		
Desmia funeralis	15	8	12	27
Epipagis huronalis				2
Helvibotys helvialis		1	6	3
Herculia olinalis		2	2	1
Munroessa gyrales		1		
Nomophila nearctica				1
Palpita magniferalis	30	3	122	124
Pantographa limata		6	12	8
Polygrammodes flavidalis			2	
Pyrausta sp.			1	
Pyrausta acrionalis		4		
Sparganothis reticulatana			2	
Tetralopha asperatella			43	11
Udea rubigalis	13	1	1	3
Urola nivalis	1		3	
Pyralid Total	92	50	338	279

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Saturniidae				
Actias luna	9	11		5
Anisota stigma			2	
Antheraea polyphemus	4	3		1
Automeris io	1	4	4	1
Citheronia regalis		1	1	1
Dryocampa rubicunda	11	10	11	2
Eacles imperialis				19
Saturniid Total	25	29	18	29
Sphingidae				
Family				1
Darapsa myron			1	1
Laothoe juglandis		1		
Manduca sp.				1
Paonias excaecatus		3	1	2
Paonias myops			1	
Sphingid Total	0	4	3	5
Thyatiridae				
Pseudothyatira cymatophoroides	1			
Tortricidae				
Family	5	4	6	5
Archips argyrospila	11			
Argyrotaenia alisellana	11			
Choristoneura sp.	6	1		
Choristoneura parallela	2	2	10	12
Choristoneura rosaceana	23	12	6	
Sparganothis reticulatana			1	
Tortricid Total	58	19	23	17

Appendix 12. (continued)

Taxon	First	Second	Third	Fourth
Yponomeutidae				
Atteva punctella	4		20	26
Yponomeuta sp.			2	1
Zygaenidae				
Harrisina americana	2	3		
Pyromorpha dimidiata	2			
Total Moths	**765**	**878**	**1589**	**1279**

Appendix 13. Site attributes of locations used for blacklight sampling in Marion County, Arkansas, 2005.

Roost Location	Habitat	Site	Elevation (m)	Slope (%)	Aspect (º)	Distance to Forest Edge (m)	Distance to Water (m)	Distance to Ridgetop (m)
Blue Heaven Cave	Upland Forest	1	338	37	89	120	118	120
Blue Heaven Cave	Upland Forest	2	326	36	67	144	122	144
Blue Heaven Cave	Riparian Forest	1	338	38	102	215	0	215
Blue Heaven Cave	Riparian Forest	2	303	18	72	217	0	217
Blue Heaven Cave	Field	1	373	8	241	50	455	47
Blue Heaven Cave	Field	2	374	8	250	40	517	30
Blue Heaven Cave	Edge	1	370	32	71	0	302	145
Blue Heaven Cave	Edge	2	356	30	74	0	262	145
Marble Falls Cave	Upland Forest	1	370	22	46	285	270	35
Marble Falls Cave	Upland Forest	2	350	32	315	285	270	70
Marble Falls Cave	Riparian Forest	1	332	66	228	340	80	240
Marble Falls Cave	Riparian Forest	2	331	55	321	340	50	240
Marble Falls Cave	Field	1	365	5	57	150	175	50
Marble Falls Cave	Field	2	367	5	62	130	165	50
Marble Falls Cave	Edge	1	365	31	258	0	520	90
Marble Falls Cave	Edge	2	356	10	97	0	600	80
Reed Cave	Upland Forest	1	379	15	225	116	259	30
Reed Cave	Upland Forest	2	375	10	202	175	286	20
Reed Cave	Riparian Forest	1	353	6	180	450	450	150
Reed Cave	Riparian Forest	2	361	5	182	450	450	180
Reed Cave	Field	1	391	5	357	155	473	50
Reed Cave	Field	2	389	7	27	143	522	100
Reed Cave	Edge	1	381	3	272	0	572	175
Reed Cave	Edge	2	379	4	253	0	576	150

Appendix 14. Attributes of woody vegetation in locations used for blacklight sampling in Marion County, Arkansas, 2005.

Roost Location	**Habitat [a]**	**Site**	**Snags (#/ha)**	**Woody Stems (#/ha)**	**Woody Species (#/20m plot)**	**BA Stand (m^2/ha)**	**BA Live Stems (m^2/ha)**	**BA Trees >25cm (m^2/ha)**	**BA Live Stems >25cm (m^2/ha)**
Blue Heaven Cave	Upland Forest	1	71.6	3391.0	18	29.8	27.5	21.8	19.5
Blue Heaven Cave	Upland Forest	2	47.8	2913.4	21	24.1	21.8	19.5	17.2
Blue Heaven Cave	Riparian Forest	1	135.3	6805.8	23	12.6	10.3	4.6	4.6
Blue Heaven Cave	Riparian Forest	2	95.5	5452.6	22	16.1	13.8	3.4	3.4
Blue Heaven Cave	Edge	1	23.9	1472.6	15	6.9	6.9	2.3	2.3
Blue Heaven Cave	Edge	2	47.8	1345.2	15	9.2	9.2	0.0	0.0
Marble Falls Cave	Upland Forest	1	127.4	2316.4	14	32.1	26.4	18.4	16.1
Marble Falls Cave	Upland Forest	2	95.5	1727.3	13	31.0	26.4	23.0	18.4
Marble Falls Cave	Riparian Forest	1	103.5	4990.9	24	14.9	10.3	10.3	5.7
Marble Falls Cave	Riparian Forest	2	175.1	4640.7	22	18.4	16.1	9.2	6.9
Marble Falls Cave	Edge	1	79.6	2149.2	13	27.5	23.0	11.5	11.5
Marble Falls Cave	Edge	2	111.4	1329.3	16	24.1	19.5	9.2	9.2
Reed Cave	Upland Forest	1	159.2	2650.7	11	28.7	28.7	16.1	16.1
Reed Cave	Upland Forest	2	230.8	2507.4	13	25.3	25.3	11.5	11.5
Reed Cave	Riparian Forest	1	207.0	2579.0	15	13.8	10.3	2.3	2.3
Reed Cave	Riparian Forest	2	191.0	2539.2	14	10.3	10.3	2.3	2.3
Reed Cave	Edge	1	79.6	2260.6	10	10.3	10.3	9.2	9.2
Reed Cave	Edge	2	31.8	732.3	11	11.5	11.5	11.5	11.5

[a] Field habitat is not included in this appendix, as measures were nominal relative to forested habitats.

Appendix 15. Woody species present within 20 m of blacklight sampling locations in Marion County, Arkansas, 2005.

Habitat [a]	**Upland Forest**						**Riparian Forest**						**Edge**					
Roost Location [b]	**BH**	**BH**	**MF**	**MF**	**RD**	**RD**	**BH**	**BH**	**MF**	**MF**	**RD**	**RD**	**BH**	**BH**	**MF**	**MF**	**RD**	**RD**
Site	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Woody Taxa																		
Acer rubrum			X	X					X	X	X	X						
A. saccharum									X	X								
Amelanchier arborea	X	X	X			X	X	X	X	X	X		X			X		
Asimina triloba		X					X	X	X	X								
Callicarpa americana									X									
Carpinus caroliniana									X	X	X							
Carya sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Celtis sp.	X	X					X	X		X		X	X	X				X
Cercis canadensis	X	X					X	X	X	X								
Cornus florida	X	X	X	X	X	X	X	X	X	X	X	X			X	X		
Diospyros virginiana													X	X			X	X
Fraxinus americana	X	X					X	X	X	X			X					
F. pennsylvanica								X										
Ilex vomitoria ?							X	X										
Juglans nigra	X	X					X						X	X				
Juniperus virginiana	X	X			X	X	X	X	X	X	X	X	X	X	X	X		
Lindera benzoin ?							X											
Morus rubra		X		X			X	X	X	X		X		X				
Nyssa sylvatica	X	X	X	X	X	X	X	X	X	X	X	X			X	X		
Ostrya virginiana			X				X		X	X								
Pinus echinata					X	X			X				X	X	X	X	X	X
Platinus occidentalis							X											
Prunus serotina			X	X		X		X	X		X	X	X			X	X	X
Quercus sp.						X											X	
Q. alba	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Q. marilandica	X														X			
Q. muehlenbergii		X					X	X	X	X								
Q. rubra	X	X	X	X	X		X	X	X	X	X	X		X		X		
Q. stellata	X	X				X		X							X			X

Appendix 15. (continued)

Habitat [a]	Upland Forest						Riparian Forest						Edge					
Roost Location [b]	**BH**	**BH**	**MF**	**MF**	**RD**	**RD**	**BH**	**BH**	**MF**	**MF**	**RD**	**RD**	**BH**	**BH**	**MF**	**MF**	**RD**	**RD**
Site	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Woody Taxa																		
Q. velutina	X	X	X	X	X	X			X		X	X	X	X	X	X	X	X
Rhamnus caroliniana ?	X	X	X	X			X	X		X	X	X	X	X	X	X		
Rhus copallina															X	X	X	X
Robinia pseudoacacia																		
Sassafras albidum	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Styrax grandifolia											X	X						
Ulmus alata	X	X						X					X	X				
U. americana																X		
U. rubra		X					X	X	X	X			X	X			X	X
Vaccinium sp.	X		X	X	X	X	X		X						X	X		
Viburnum rufidulum		X	X	X	X		X	X	X	X	X					X		

[a] Field habitat is not included in this appendix, as occurrence of woody species was nominal in comparison to forested habitats. The woody species recorded in field habitat were: *Carya* sp., *Diospyros virginiana, Juglans nigra, Pinus echinata, Prunus serotina, Quercus rubra, Q. stellata, Q. velutina, Rhus copallina, Robinia pseudoacacia,* and *Sassafras albidum.*

[b] Location (Code): Blue Heaven Cave (BH), Marble Falls Cave (MF), Reed Cave (RD).

? Denotes questionable identification.

Appendix 16. Site attributes of locations used for blacklight sampling in Crawford County, Arkansas, 2005.

Roost Location	Habitat	Site	Elevation (m)	Slope (%)	Aspect (º)	Distance to Forest Edge (m)	Distance to Water (m)	Distance to Ridgetop (m)
Devil's Hollow	Sapling	1	563	5	265	55	130	0
Devil's Hollow	Sapling	2	557	5	265	125	175	0
Devil's Hollow	Poletimber	1	390	30	218	850	80	910
Devil's Hollow	Poletimber	2	390	34	200	850	150	910
Devil's Hollow	Sawtimber	1	417	33	328	750	120	460
Devil's Hollow	Sawtimber	2	417	32	348	750	200	460
North Face	Sapling	1	486	15	10	90	760	70
North Face	Sapling	2	502	12	10	120	760	95
North Face	Poletimber	1	566	41	346	125	1400	125
North Face	Poletimber	2	564	45	345	120	1400	120
North Face	Sawtimber	1	563	56	49	80	640	80
North Face	Sawtimber	2	521	65	55	80	640	80
Whitzen Hollow	Sapling	1	316	33	162	170	140	150
Whitzen Hollow	Sapling	2	320	30	166	170	140	150
Whitzen Hollow	Poletimber	1	310	15	112	160	120	600
Whitzen Hollow	Poletimber	2	310	22	90	180	120	600
Whitzen Hollow	Sawtimber	1	258	40	58	80	50	400
Whitzen Hollow	Sawtimber	2	272	32	70	120	50	400

Appendix 17. Attributes of woody vegetation in locations used for blacklight sampling in Crawford County, Arkansas, 2005.

Roost Location	Habitat	Site	Snags (#/ha)	Woody Stems (#/ha)	Woody Species (#/20m plot)	BA Stand (m^2/ha)	BA Live Stems (m^2/ha)	BA Trees >25cm (m^2/ha)	BA Live Stems >25cm (m^2/ha)
Devil's Hollow	Sapling	1	15.9	7450.6	16	13.8	0.0	0.0	0.0
Devil's Hollow	Sapling	2	39.8	3510.4	17	9.2	4.6	4.6	2.3
Devil's Hollow	Poletimber	1	71.6	1592.0	19	26.4	26.4	20.7	20.7
Devil's Hollow	Poletimber	2	55.7	1249.7	13	31.0	25.3	25.3	17.2
Devil's Hollow	Sawtimber	1	71.6	1910.4	14	25.3	20.7	17.2	17.2
Devil's Hollow	Sawtimber	2	111.4	2260.6	15	29.8	21.8	23.0	23.0
North Face	Sapling	1	63.7	2674.6	19	12.6	12.6	0.0	0.0
North Face	Sapling	2	127.4	3032.8	18	24.1	16.1	0.0	0.0
North Face	Poletimber	1	103.5	1432.8	14	32.1	27.5	25.3	25.3
North Face	Poletimber	2	135.3	1225.8	15	44.8	36.7	37.9	31.0
North Face	Sawtimber	1	111.4	939.3	9	40.2	33.3	40.2	33.3
North Face	Sawtimber	2	63.7	979.1	8	31.0	24.1	26.4	24.1
Whitzen Hollow	Sapling	1	191.0	5978.0	27	17.2	12.6	0.0	0.0
Whitzen Hollow	Sapling	2	175.1	5779.0	21	20.7	16.1	0.0	0.0
Whitzen Hollow	Poletimber	1	71.6	1791.0	22	16.1	16.1	9.2	6.9
Whitzen Hollow	Poletimber	2	79.6	1504.4	20	18.4	18.4	16.1	16.1
Whitzen Hollow	Sawtimber	1	55.7	1416.9	12	19.5	17.2	12.6	12.6
Whitzen Hollow	Sawtimber	2	63.7	1018.9	11	25.3	25.3	14.9	14.9

Appendix 18. Woody species present within 20 m of blacklight sampling locations in Crawford County.

Habitat			**Sapling**						**Poletimber**						**Sawtimber**			
Roost Location [a]	**DH**	**DH**	**NF**	**NF**	**WH**	**WH**	**DH**	**DH**	**NF**	**NF**	**WH**	**WH**	**DH**	**DH**	**NF**	**NF**	**WH**	**WH**
Site	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Woody Taxa																		
Acer rubrum	X	X			X	X			X	X			X	X	X	X	X	X
A. saccharum			X	X				X			X	X						
Amelanchier arborea	X	X		X			X		X	X			X		X	X		
Asimina triloba			X	X			X	X	X					X				
Aralia spinosa			X	X														
Callicarpa americana							X	X										
Carpinus caroliniana					X													
Carya sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Celtis sp.		X	X	X	X	X	X	X			X	X						
Cercis canadensis	X	X	X	X	X	X	X	X			X	X	X	X				
Cornus drummondii					X													
C. florida			X	X	X	X	X			X	X	X	X	X			X	X
Crataegus sp	X	X			X	X												
Diospyros virginiana					X	X												
Fraxinus americana	X	X	X	X	X	X	X	X	X		X	X		X			X	X
Hamamelis virginiana						X				X			X	X				
Ilex decidua ?							X	X			X	X						
Juglans nigra											X	X						
Juniperus virginiana					X	X				X	X	X					X	
Lindera benzoin ?					X		X				X	X						
Liquidambar styraciflua			X	X	X				X	X			X	X				
Morus rubra			X	X	X	X					X	X						
Nyssa sylvatica				X	X	X			X	X			X	X	X	X	X	X
Ostrya virginiana		X	X	X	X	X	X	X	X		X	X	X	X			X	X
Pinus echinata										X								
Prunus serotina	X	X	X	X	X	X	X	X	X	X					X	X	X	X
Quercus alba	X	X	X		X	X	X		X	X	X		X	X	X	X	X	X
Q. muehlenbergii			X	X	X		X	X			X	X					X	
Q. rubra	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X

Appendix 18 (continued)

Habitat	Sapling						Poletimber						Sawtimber					
Roost Location [a]	**DH**	**DH**	**NF**	**NF**	**WH**	**WH**	**DH**	**DH**	**NF**	**NF**	**WH**	**WH**	**DH**	**DH**	**NF**	**NF**	**WH**	**WH**
Site	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Woody Taxa																		
Q. stellata											X							
Q. velutina	X		X		X	X			X		X							
Rhamnus caroliniana ?						X					X	X	X					
Rhus glabra	X	X																
Robinia pseudoacacia		X							X	X		X			X	X		
Sassafras albidum			X	X	X	X				X		X	X	X	X			
Ulmus alata	X	X			X	X												
U. rubra	X	X	X	X	X		X	X				X						X
Vaccinium sp.	X	X	X	X	X		X		X	X	X	X		X				
Viburnum rufidulum	X				X	X	X				X	X						

[a] Location (Code): Devil's Hollow (DH), "North Face" of Devil's Hollow (NF), Whitzen Hollow (WH).

? Denotes questionable identification.

Appendix 19. A list of all moth species captured in blacklight traps in Marion and Crawford counties, Arkansas, summers 2004 and 2005.

Apatelodidae
Apatelodes torrefacta
Olceclostera angelica

Arctiidae
Apantesis sp.
Cisseps fulvicollis
Cisthene packardii
Clemensia albata
Crambidia sp.
Cycnia inopinatus
Cycnia tenera
Ecpantheria scribonia
Estigmene acrea
Euchaetes egle
Euerythra phasma
Grammia anna
Grammia arge
Grammia figurata
Grammia oithona
Halysidota tessellaris
Haploa clymene
Haploa contigua
Haploa reversa
Holomelina aurantiaca
Holomelina opella
Hyphantria cunea
Hypoprepia fucosa
Hypoprepia miniata
Pyrrharctia isabella
Spilosoma congrua
Spilosoma virginica

Cossidae
Prionoxystus robiniae

Drepanidae
Oreta rosea

Epiplemidae
Calledapteryx dryopterata
Callizzia amorata

Geometridae
Anacamptodes defectaria
Anacamptodes ephyraria
Antepione thisoaria
Anticlea multiferata
Besma endropiaria
Besma quercivoraria
Calothysanis amaturaria
Cyclophora pendulinaria
Dichorda iridaria
Dyspteris abortivaria
Ecliptopera atricolorata
Ectropis crepuscularia
Epimecis hortaria
Eubaphe mendica
Euchlaena amoenaria
Euchlaena irraria
Euchlaena obtusaria
Euchlaena pectinaria
Euchlaena tigrinaria
Eudeilinea herminiata
Eulithis diversilineata
Eumacaria latiferrugata
Eupithecia miserulata
Eusarca confusaria
Eutrapela clemetaria
Exilis pyrolaria
Glena cribrataria
Glenoides texanaria
Heliomata cycladata
Heterophleps refusaria
Heterophleps triguttaria
Hydria prunivorata
Hypagyrtis unipunctata
Hypomecis umbrosaria
Idaea demissaria

Idaea furciferata
Iridopsis larvaria
Itame sp.
Lambdina fervidaria
Leptostales rubromarginaria
Lomographa vestaliata
Lytrosis unitaria
Mellilla xanthometata
Metarranthis angularia
Metarranthis hypochraria
Nematocampa limbata
Nemoria lixaria
Orthonama centrostrigaria
Orthonama obstipata
Patalene olyzonaria
Pero hubneraria
Phigalia sp.
Plagodis alcoolaria
Plagodis fervidaria
Plagodis phlogosaria
Pleuroprucha insulsaria
Probole sp.
Probole nyssaria
Prochoerodes transversata
Protitame virginalis
Protoboarmia porcelaria
Scopula limboundata
Semiothisa continuata
Semiothisa granitata
Semiothisa multilineata
Semiothisa ocellinata
Semiothisa promiscuata
Semiothisa quadrinotaria
Semiothisa transitaria
Tetracis crocallata
Xanthotype urticaria

Lasiocampidae
Malacosoma americanum
Malacosoma disstria

Limacodidae
Adoneta spinuloides
Apoda biguttata
Apoda y-inversum
Euclea delphinii
Isa textula
Lithacodes fasciola
Parasa chloris
Prolimacodes badia
Tortricidia flexuosa

Lymantriidae
Dasychira obliquata
Dasychira tephra
Orgyia leucostigma

Megalopygidae
Lagoa crispata
Norape ovina

Mimallonidae
Lacosoma chiridota

Noctuidae
Abagrotis alternata
Acronicta afflicta
Acronicta americana
Acronicta funeralis
Acronicta haesitata
Acronicta impleta
Acronicta inclara
Acronicta interrupta
Acronicta lithospila
Acronicta lobeliae
Acronicta modica
Acronicta noctivaga
Acronicta ovata
Acronicta retardata
Acronicta tritona
Agriopodes fallax
Agriopodes teratophora
Agrotis ipsilon
Allagrapha aeria

Appendix 19. (continued)

Allotria elonympha
Amphipyra pyramidoides
Anicla infecta
Anorthodes tarda
Argyrostrotis anilis
Autographa biloba
Baileya australis
Baileya levitans
Balsa labecula
Balsa tristrigella
Bleptina caradrinalis
Bomolocha abalienalis
Bomolocha bijugalis
Bomolocha sordidula
Caenurgia chloropha
Caenurgina erechtea
Callopistria cordata
Callopistria mollissima
Catocala agrippina
Catocala amica
Catocala andromedae
Catocala dejecta
Catocala epione
Catocala gracilis
Catocala flebilis
Catocala ilia
Catocala judith
Catocala junctura
Catocala lacrymosa
Catocala nebulosa
Catocala neogama
Catocala obscura
Catocala retecta
Catocala ultronia
Catocala vidua
Cerma cerintha
Charadra deridens
Chytonix palliatricula
Cosmia calami
Elaphria festivoides
Elaphria grata
Elaphria versicolor
Eosphoropteryx thyatyroides
Epidelta metonalis
Euagrotis lubricans
Eudryas grata
Euparthenos nubilis
Euplexia benesimilis
Faronta diffusa
Galgula partita
Harrisimemna trisignata
Heliothis zea
Hemeroplanis scopulepes
Homohadena badistriga
Homophoberia apicosa
Hyperstrotia pervertens
Hypsoropha hormos
Hypsoropha monilis
Idia aemula
Idia americalis
Isogona tenuis
Lacinipolia lorea
Lacinipolia renigera
Lesmone detrahens
Leucania inermis
Leucania scirpicola
Lithacodia carneola
Lithacodia muscosula
Macrochilo absorptalis
Meganola minuscula
Mocis texana
Nedra ramosula
Ogdoconta cinereola
Orthodes crenulata
Orthodes cynica
Ozarba aeria
Paectes abrostoloides
Paectes oculatrix
Paectes pygmaea
Pangrapta decoralis
Panopoda carneicosta
Panopoda rufimargo
Panthea furcilla
Parallelia bistriaris
Phalaenophana pyramusalis
Phosphila miselioides

Plathypena scabra
Platysenta sutor
Platysenta vecors
Polia sp.
Polygrammate hebraeicum
Protolampra brunneicollis
Proxenus miranda
Pseudaletia unipuncta
Pseudeva purpurigera
Pseudorthodes vecors
Ptichodis herbarum
Rachiplusia ou
Renia discoloralis
Renia fraternalis
Renia nemoralis
Renia sobrialis
Rivula propinqualis
Schinia arcigera
Schinia lynx
Schinia trifascia
Schrankia macula
Scolecocampa liburna
Spodoptera ornithogalli
Spragueia sp.
Stiriodes obtusa
Tarachidia candefacta
Tetanolita mynesalis
Thioptera nigrofimbria
Tricholita signata
Trichoplusia ni
Xestia smithii
Zale lunata
Zale lunifera
Zanclognatha cruralis
Zanclognatha lituralis
Zanclognatha obscuripennis

Notodontidae
Clostera inclusa
Datana angusii
Datana contracta
Datana ministra
Datana perspicua
Heterocampa biundata
Heterocampa guttivitta
Heterocampa obliqua
Heterocampa subrotata
Heterocampa umbrata
Hyperaeschra georgica
Lochmaeus bilineata
Lochmaeus manteo
Macrurocampa marthesia
Nadata gibbosa
Nerice bidentata
Oligocentria lignicolor
Oligocentria semirufescens
Peridea angulosa
Peridea basitriens
Schizura ipomoeae
Schizura leptinoides
Symmerista albifrons

Oecophoridae
Antaeotricha leucillana
Antaeotricha schlaegeri
Psilocorsis sp.

Pterophoridae
Platyptilia carduidactyla

Pyralidae
Blepharomastix ranalis
Clydonopteran tecomae
Compacta capitalis
Conchylodes ovulalis
Crambus agitatellus
Crambus laqueatellus
Desmia funeralis
Diacme elealis
Epipagis huronalis
Helvibotys helvialis
Herculia olinalis
Hymenia perspectalis
Munroessa gyrales
Nomophila nearctica
Palpita magniferalis

Pantographa limata
Polygrammodes flavidalis
Pyrausta acrionalis
Sparganothis reticulatana
Tetralopha asperatella
Udea rubigalis
Urola nivalis

Saturniidae
Actias luna
Anisota stigma
Antheraea polyphemus
Automeris io
Citheronia regalis
Dryocampa rubicunda
Eacles imperialis
Sphingicampa bicolor

Sphingidae
Ceratomia hageni
Ceratomia undulosa
Darapsa myron
Darapsa pholus
Laothoe juglandis
Manduca sp.
Paonias excaecatus
Paonias myops

Thyatiridae
Habrosyne scripta
Pseudothyatira cymatophoroides

Tortricidae
Archips argyrospila
Argyrotaenia alisellana
Argyrotaenia quercifoliana
Choristoneura parallela
Choristoneura pinus
Choristoneura rosaceana
Sparganothis reticulatana

Yponomeutidae
Atteva punctella
Yponomeuta sp.

Zygaenidae
Harrisina americana
Pyromorpha dimidiata

Appendix 20. Characteristics of common moth families in the castern United States. Adapted from Shoemaker (1994).

Family (Common Name)	# Species in North America	Wingspan (cm)	Morphology	Larval Food Plants	Other
Noctuidae (Owlet Moths)	2,900+	1.2 - 17	Triangular, resembling arrowheads; grey/brown forewing pattern	Foliage, dead leaves, fungi, lichens. Some are cutworms, borers, miners.	Nocturnal; tympanum present and oriented outward or to rear; moths often phototaxic; some exhibit evasive behaviour to bats
Geometridae (Inchworm Moths)	1,400+	1.0 - 6.0	Broad and fragile wings; body slender	Feed on leaf exterior	Nocturnal; tympanum present and oriented outward or to rear; moths often phototaxic; some exhibit evasive behaviour to bats
Pyralidae (Snout and Grass Moths)	1,375+	0.9 - 3.7	Forewing elongate and held out to side or over the body; "stick-like" in appearance	Scavengers of organic material; Some are leaf-rollers, leaf borers	Tympanum present on the base of abdomen, located ventrally but facing anteriorly
Arctiidae (Tiger, Wasp, Lichen Moths)	265	1.2 - 7	Forewing white, yellow, red, or orange with black marks	Herbaceous and woody plants, some lichens	Nocturnal or diurnal depending on species; tympanum present and oriented to the rear; some exhibit evasive responses to bats; some unpalatable
Notodontidae (Prominents)	140	2.3 - 6.2	Often have tufts that project off forewing	Leaves of plants	Tympanum present and facing Ventrally; larvae often vibrantly colored and strangely shaped

Appendix 20. (continued)

Family (Common Name)	**# Species in North America**	**Wingspan (cm)**	**Morphology**	**Larval Food Plants**	**Other**
Sphingidae (Sphinx or Hawk Moths)	125	2.8 - 17.5	Robust body pointed at ends; forewing stream-lined, being pointed or "swept back;" hindwing smaller	Woody and herbacious plants	Nocturnal, diurnal, crepuscular, depending on species; tympana absent, though some "hear" via modified mouth parts; strong fliers with rapid wingbeat
Saturniidae (Giant Silkworm and Royal Moths)	68	3.0 - 15.0	Head small, held close to thorax; broad wings	Leaves of trees and shrubs	Nocturnal, diurnal, crepuscular, depending on species; tympana absent; among the largest moths in North America
Lymantriidae (Tussock Moths)	32	1.5 - 6.7	Appearance resembles many Notodontids; wings mostly brownish to gray or white; bodies tend to be somewhat hairy	Foliage of trees and shrubs, but usually not herbaceous plants	A family of serious forest pests; larvae generally very hairy, some with conspicuous or urticating tufts

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