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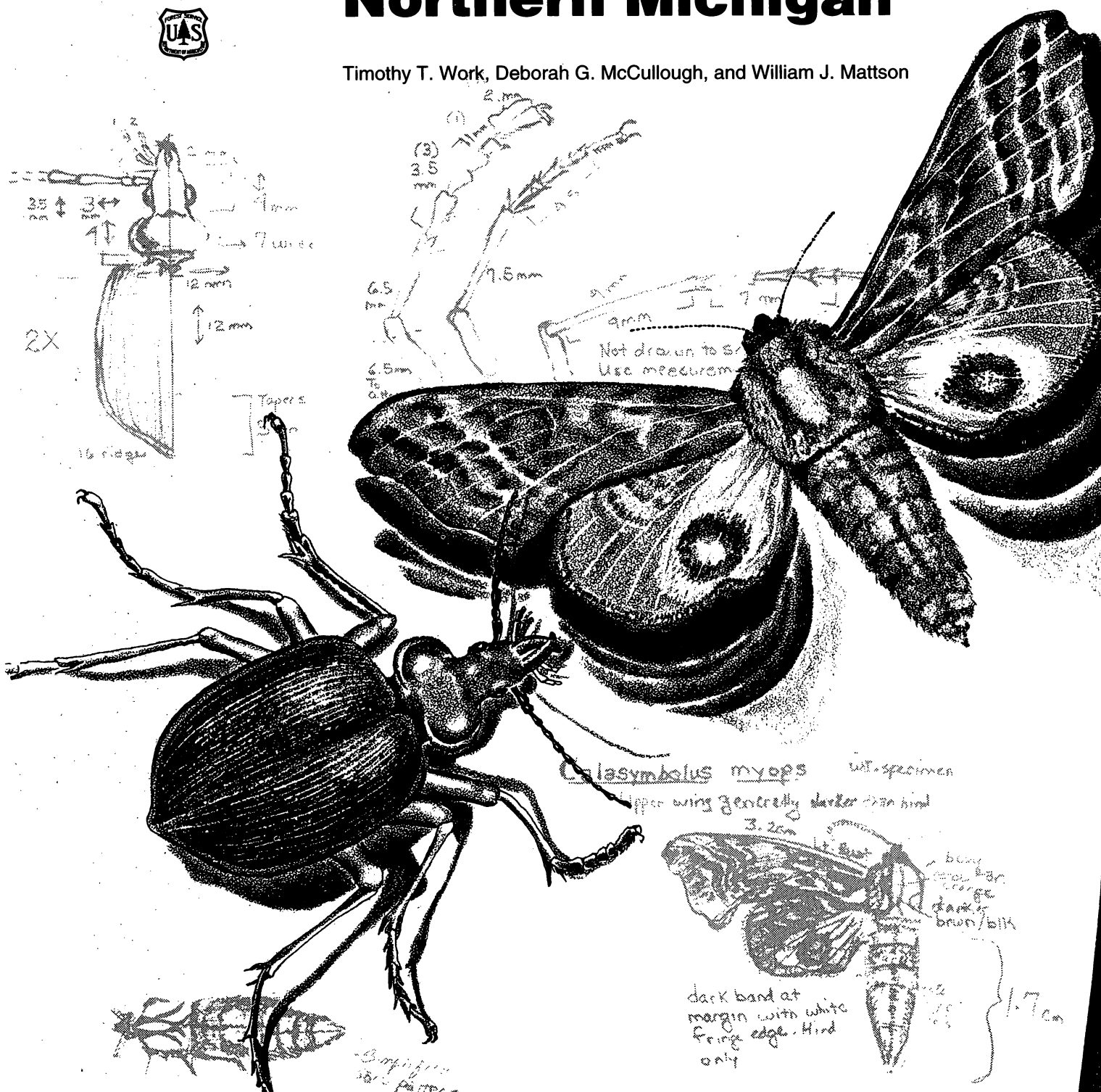

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Moth and Carabid Beetle Species Associated with Two Ecological Landtype Phases in Northern Michigan

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Insects are among the truly critical components of forest ecosystems, affecting many key processes such as decomposition and nutrient cycling, regulation of primary productivity, and pollination. Moreover, they are typically the backbone of most food webs, serving both as prey—the primary protein and mineral sources for a wide variety of animals, and as important, influential predators and parasitoids themselves, helping to regulate populations of potentially damaging herbivores.

Since ecosystem management has become an accepted perspective nearly worldwide in sustainable resource management (Brooks and Grant 1992, Christensen *et al.* 1996, Kessler *et al.* 1992, Thomas 1996), those developing and implementing such complex management plans must have broader and deeper knowledge about all facets of ecosystems (Brooks and Grant 1992, Christensen *et al.* 1996). Not only is this knowledge necessary to initially set sound ecosystem management goals, but it is also important to assess whether management goals are being attained. Although the importance of insects in forests is widely recognized, very few studies have attempted to describe particular insect communities associated with specific forest ecosystems. In this paper, we test the hypothesis Ho: faunal communities are uniquely asembled for each unique forest ecosystem, and in so doing, we also provide a faunal inventory of two major insect groups for two common forest ecosystem units in the Huron-Manistee National Forest in the northern lower peninsula of Michigan.

Ecological classification systems (ECS) provide an integrated framework for studying ecosystems at multiple spatial and temporal scales (Sims *et al.* 1996). In many national forests in the United States, these hierarchical systems are used to identify ecological capabilities or constraints associated with specific areas or sites. An ECS can also be used as a basis for monitoring changes over time. An ECS recently developed for the Huron-Manistee National Forest in northern lower Michigan has as its fundamental unit the ecological landtype phase (ELTP) (Cleland *et al.* 1994). ELTP's have distinct soils, landscape positions, and natural vegetative communities. ELTP's are sub-units of ecological landtypes (ELT's), which in turn are sub-units of landtype associations (LTA's). LTA's often encompass thousands of acres and are defined by major geomorphology and vegetation features.

Plant species composition and structure of overstory and understory vegetation typically have a major influence on diversity, abundance, and species composition of insect communities (Strong *et al.* 1984). We hypothesized, therefore, that insect communities are likely to differ between ELTP's, even though they may be spatially proximate to each other. Description of insect communities associated with specific ELTP's would provide resource managers with valuable biological inventory information and limit the need to repeatedly conduct time- and labor-intensive surveys.

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We surveyed two major groups of insects in two hardwood ELTP's in the Huron-Manistee National Forest during the summers of 1993, 1994, and 1995. In this publication, we provide a list of the species of Lepidoptera (mainly moths) and carabid beetles that were associated with these two ELTP's. Both insect groups were sampled in four replicate sites classified as ELTP 20 and in four sites classified as ELTP 45. ELTP 20 sites are dominated by northern red oak (*Quercus rubra* L.), white oak (*Q. alba* L.) and a low-diversity ground flora (Cleland *et al.* 1994). Soils are typically sandy and xeric with medium to low productivity (Host *et al.* 1987, 1988). In contrast, ELTP 45 sites are dominated by sugar maple (*Acer saccharum* Marsh), with a minor component of American basswood (*Tilia americana* L.) (Cleland *et al.* 1994). Other less abundant overstory species, including red oak, quaking aspen (*Populus tremuloides* Michx.), black cherry (*Prunus serotina* Ehrh.), and white ash (*Fraxinus americana* L.), are often present. ELTP 45 sites also have a notably rich herbaceous understory, well-drained mesic soils, and high productivity (Host *et al.* 1987, 1988; Zak and Pregitzer 1990; Zak *et al.* 1986, 1989).

Lepidoptera and carabid ground beetles are diverse taxa that are important in various forest ecosystem processes. More than 500 species of macrolepidoptera (M. Nielsen, MSU Dept. of Entomology, pers. comm.) and 38 species of ground beetles (Liebherr and Mahar 1979) have been recorded in northern lower Michigan. Defoliating Lepidoptera can affect nutrient cycling, tree mortality, and growth rates, and can alter stand structure (Mattson and Addy 1975). Many carabids are important predators of other arthropods including notorious pest species such as gypsy moth (*Lymantria dispar* L.) (Cameron and Reeves 1990, Weseloh *et al.* 1995). Both lepidopteran and carabid species may be sensitive indicators of habitat quality or disturbance (Martel and Mauffette 1997, Niemela *et al.* 1993).

METHODS

Study Area

Lepidoptera and carabid beetles were sampled from eight stands in the Huron-Manistee National Forest in northern lower Michigan. We randomly chose four stands classified as ELTP 20 and four stands classified as ELTP 45 from maps provided by the Huron-Manistee National Forest. On each site, tree species composition and basal area were recorded in five variable radius plots using a BAF 10 prism.

Although gypsy moth populations were expanding through much of northern Michigan in the late 1980's and early 1990's, no visible defoliation occurred in the Manistee portion of the Huron-Manistee National Forest until 1993 (D. McCullough, unpubl. data; S. Katovich, USDA Forest Service, NA State & Private Forestry, pers. comm.). From 1993 to 1995, gypsy moth populations became established in localized areas of the Manistee, causing moderate to high defoliation in some stands. Outbreak-level populations of gypsy moth typically persisted for 1 to 2 years, then subsided. We estimated the size of gypsy moth populations using mean egg mass counts from four 0.01-ha plots located in each study site (Kolodny-Hirsch 1986). Defoliation of overstory trees was visually estimated in each stand as high (75 to 100 percent), moderate (50 to 75 percent), low (25 to 50 percent), or negligible (<25 percent). Defoliation was further quantified in 1994 and 1995 with a ceptometer (Sunfleck™)[1]. Sensors along the ceptometer quantified photosynthetically active radiation (PAR) penetrating the canopy, and readings were used to estimate leaf area index (LAI) in defoliated and undefoliated stands (Work 1996).

ELTP 20 Stands

Two oak-dominated ELTP 20 stands were located at 44° 00' N, 86° 00' W, near the town of Branch, and two other stands were located at 44° 08' N, 86° 09' W, near the village of Freesoil, all in Mason County. Although northern red oak and white oak dominated the overstory, big tooth aspen (*Populus grandidentata* Michx.) and red maple (*Acer rubrum* L.) together made up close to 30 percent of the canopy in all stands. Overstory trees were approximately 20 m tall. A sparse understory of red maple saplings and witch hazel (*Hamamelis virginiana* L.) of less than 3 cm diameter breast height (d.b.h.) was also present.

Gypsy moth populations caused severe defoliation at Branch sites in 1993 and moderate to severe defoliation at Freesoil sites in 1994 and 1995 (table 1). Heavily defoliated stands had

[1]*Mention of trade names does not constitute endoresement by the USDA Forest Service.*

Table 1.—*Mean density (± SE) of gypsy moth egg masses per hectare and defoliation estimates in ELTP 20 and ELTP 45 stands in northern lower Michigan during the summers of 1993 through 1995*

ELTP	Site	1993	1994	1995
20	Branch			
	No. egg masses	1,293 ± 119.2	849 ± 302.5	49 ± 17.3
	Defoliation	High	None	None
20	Freesoil			
	No. egg masses	5 ± 2.5	233 ± 27.1	1942 ± 388.0
	Defoliation	None	Moderate	High
45	Harrietta			
	No. egg masses	45 ± 17.9	133 ± 29.0	52 ± 17.4
	Defoliation	None	None	None
45	Mesick			
	No. egg masses	187 ± 17.9	168 ± 42.5	11 ± 3.8
	Defoliation	None	None	None

roughly 60 percent of the LAI of undefoliated stands (Work 1996). Trees in stands that had been heavily defoliated re-flushed by late July, and no tree mortality was observed during the course of this 3-year study.

ELTP 45 Stands

Two northern hardwood ELTP 45 stands were located near the town of Mesick at 44° 22' N, 86° 44' W, and two similar sites were located near the village of Harrietta at 44° 19' N, 86° 44' W, all in Wexford County. Northern hardwood species including sugar maple and American basswood dominated the overstory, although other species including black cherry and beech (*Fagus grandifolia* Ehrh.) were scattered on the sites. Overstory trees were approximately 30 m tall, and sites had a dense understory of 1-m-tall sugar maples of less than 3 cm. Gypsy moth populations were negligible in ELTP 45 sites because few preferred host species were present (Liebhold *et al.* 1995).

Insect Sampling

Lepidoptera and carabids were collected from three strata—the overstory canopy, the shrub stratum, and the ground—in each stand. Insects were collected four times during the summer in 1993, 1994, and 1995 at approximately 4-week intervals. In 1993, insects were collected on May 12-13, June 15-17, July 13-15, and August 10-12 from ELTP 20 sites and on May 21-22, June 22-23, July 20-22, and August 18-20 from ELTP 45 sites. In 1994, insects from ELTP 20 sites were collected on May 10-12, June 15-16, July 11-13, and August 9-10 and from ELTP 45 sites on May 18-20, June 20-21, July 19-20, and August 15-17. In 1995, collection dates were May 15-17, June 12-14, July 10-11, and August 15-16 on ELTP 20 sites and May 22-24, June 19-20, July 17-19, and August 21-22 on ELTP 45 sites. Sampling was delayed until the following day if rain or high winds occurred.

Canopy Stratum

In 1993, the overstory canopy was sampled using pole pruners, modified sweepnets with 10-m extending handles, and suspendable UV traps. In 1994 and 1995, pole pruners and extended sweepnets were not used because of the relatively low number of specimens collected relative to the sampling effort needed.

Pole pruners were used in 1993 to clip branch tips, 1 m in length, at 20-m intervals along a 120-m transect located randomly through the stand. Clipped branches were placed in plastic bags until they could be examined for insects. In 1993, sweepnets with extending handles were used to sweep lower canopy foliage at 20-m intervals along a 120-m randomly located transect through each stand. Four sweeps of

the lower canopy foliage with a 50-cm diameter net were made at each stop along the transect.

Ultraviolet traps were used in all 3 years, and each consisted of a 22-watt UV bulb connected to a photosensor and powered by a 6-volt motorcycle battery. UV traps were operated approximately 8 hours beginning at dusk during each monthly sampling period. A collection funnel and bucket loaded with insecticidal pest strips (Vapona™) were attached below the bulb. Ropes were suspended by shooting an arrow with an attached line over a large limb in the middle to upper canopy of a tree at the center of the stand. UV traps were then raised into the lower canopy. Use of a low wattage bulb and a rain cover over the bulb typically restricts potential long-distance attraction of nocturnal insects, resulting in a localized sample reflecting endemic insect populations (Bowden 1982).

Shrub Stratum

Shrub insects were collected using malaise traps and sweepnets. One malaise trap with an insecticidal pest strip was set up in the center of each stand and left open for 24 hours during each monthly sampling period. Shrub vegetation (0.5 to 2 m high) was sampled using a 38-cm diameter sweepnet. Sixteen sweeps (four from each cardinal direction) of vegetation at 20-m intervals were made along a 120-m randomly located transect through the stand between 1000 and 1600 hour.

Ground Stratum

Ground insects were sampled using 10 unbaited pitfall traps located at 10-m intervals along a randomly selected transect through the stand. Pitfall traps had a diameter of 10.5 cm, contained soapy water, and were covered with a four-legged "roof" to minimize capture of non-ground insects and prevent predation by birds. Traps were left open for 24 hours during each monthly sampling period.

Processing and Taxonomic Identification

Adult Lepidoptera were placed in plastic containers lined with tissue paper and stored in a freezer until identified. Only adult Lepidoptera were identified to species because few larvae were collected and resources did not permit the rearing of immatures. All Lepidoptera specimens were pre-sorted and recorded by parataxonomists at Michigan State University, East Lansing, MI. Species identifications of Lepidoptera were made by John Wilterding, Robert Kriegel, and Mogens Nielsen at the Michigan State University Center for Insect Diversity. Carabids were stored in 70 percent EtOH. Carabid identifications were made by T. Work using taxonomic keys developed by Lindroth (1969); taxonomy followed Bousquet and Larochelle (1993). Voucher specimens for all taxa were deposited at the Center for Arthropod Study, Department of Entomology, Michigan State University, East Lansing, MI.

RESULTS

Lepidoptera

Over the course of this 3-year project, 12,346 adult Lepidoptera were collected. The vast majority (94 percent, 11,646 insects) came from UV traps and 5 percent (673 insects) came from malaise traps. A total of 489 Lepidoptera species was collected from the two ELTP's (table 2). Four families, Tortricidae, Noctuidae, Lyonetiidae, and Geometridae, accounted for 77 percent of all Lepidoptera collected (table 3). Of the Lepidoptera/species, 169 were common to both ecosystems, which accounted for 89 percent (10,929 insects) of the total Lepidoptera collection. Collection dates, location, and total abundance of Lepidoptera are reported in table 4.

Table 2.—*Total number of Lepidopteran families, species, and individuals collected from ELTP 20 and ELTP 45 stands in northern lower Michigan during the summers of 1993 through 1995*

	ELTP 20				ELTP 45				Grand total
Year	**1993**	**1994**	**1995**	**Total**	**1993**	**1994**	**1995**	**Total**	
No. families	25	23	26	37	24	21	25	33	39
No. species	171	133	168	343	152	118	173	315	489
No. individuals	1,604	1,691	2,183	5,478	1,994	1,140	3,736	6,870	12,348

Table 3.—*Five most abundant families of Lepidoptera collected from ELTP 20 and ELTP 45 stands in northern lower Michigan during the summers of 1993 through 1995*

Family	No. individuals collected	Relative abundance in percent
Tortricidae	5,996	49
Noctuidae	1,809	15
Lyonetiidae	917	7
Geometridae	739	6
Others (35 families)	2,887	23

ELTP 20 had 156 species that were not found in ELTP 45. Of these unique species, 17 percent (154 individuals) were *Hydrimoena* sp. (Geometridae) and 6 percent (53 individuals) were *Blephanomastix ranalis* (Gn.) (Pyralidae). The remaining 77 percent included 154 species; less than 50 individuals of these species were collected. Of the 154 species, 87 were represented by a single specimen.

ELTP 45 had 129 unique species that were not collected in ELTP 20 stands. ELTP 45 collections were dominated by the two tortricids *Pandemis canadana* Kft. (21 percent, 114 individuals) and *Proteoteras moffatiana* Fern. (15 percent, 83 individuals). Although *Pandemis canadana* was collected in high numbers, it was collected only in July 1995, and only at one site (table 4). *Proteoteras moffatiana*, a bud-boring pest of sugar maple, was collected in all 3 years and at all four ELTP 45 sites (table 4). The remaining 64 percent of the unique Lepidoptera were comprised of 127 species; 64 of these species were represented by a single individual.

Carabid Beetles

Over 3 years, a total of 2,528 carabids representing 59 species was collected (table 5). Most carabids were collected with UV traps (61 percent of total catch; 1,537 individuals) and pitfall traps (39 percent of total catch, 988 individuals). Collection dates, location, and total abundance of carabid species are reported in table 6. Small brachypterous species (short-winged beetles) from the genera *Agonum*, *Bembidion*, *Harpalus*, and *Stenopholus* were mostly collected in UV traps. Larger species (both apterous and/or poor fliers) in the genera *Carabus*, *Myas*, and *Pterostichus* were collected primarily in pitfall traps.

Twenty-five carabid species were collected in both ELTP's, accounting for 93 percent (2,355 beetles) of the total catch. Five species comprised 60 percent of the total catch, namely *Stenopholus comma* (F.), *Carabus goryi* Dej, *Synuchus impunctatus* (Say), *Bembidion partreule* Dey., and *Stenopholus ochropezus* (Say) (table 7). Twenty-one species were unique to ELTP 20; nine of these are typically found in xeric, well-lighted habitats. Twelve species were unique to ELTP 45; nine of which are associated with moist, shady forest habitat. Specialist predators of mollusks such as *Dicaleus teter* Bon., *Scaphinotes bilobus* (Say), and *Spheroderus stanostanus lecontei* Dej. were found only in ELTP 45.

DISCUSSION

Although many of the abundant arthropod species were present in both ELTP 20 and ELTP 45 stands, the less abundant species may be better indicators of the differences between these two ecosystems. Within an ecosystem, insect abundance and diversity are determined by a combination of factors such as food availability (whether plants or prey), food quality, climate, and habitat structure (Strong *et al.* 1984). Abundant species may be common across ecosystems because they are less tightly coupled with these factors or because some of these factors are universally available across ecosystems. Uncommon species may have more stringent requirements, and thus may be more specific to a single habitat or ecosystem. In this study, ELTP 20 and ELTP 45 had 156 and 129 unique species of Lepidoptera, respectively. Although these species do not dominate numerically, they clearly suggest that the insect communities in these ecosystems do indeed differ.

Table 4.—*Abundance, location, and collection date of Lepidoptera in two ELTP's in the Huron-Manistee National Forest*

Family	Genus and Species	No.	Site[1] ELTP 20				ELTP 45				Trap type[2]				Month[3]				Year		
Agonoxenidae	*Glyphipteryx linneella* (Bsk.)	2		B2					M1		1							8	93		95
Arctiidae	*Apantesis parthenice* (W. Kirby)	9		B2	F1	F2	H1				1							8	93		95
	Cisseps fulvicollis (Hbn.)	1				F2					1						7		93		
	Clemensia albata Pack.	19	B1	B2	F1	F2		H2	M1		1					6	7	8		94	95
	Crambidia pallida Pack.	50	B1	B2	F1	F2			M1	M2	1	2						8	93		95
	Cycnia oregonensis (Stretch)	1					H1				1					6					95
	Dryocampa rubicunda (F.)	1				F2					1					6					95
	Halysidota tessellarius (J. E. Smith)	1								M2	1							8	93		
	Haploa reversa (Stretch)	1		B2							1						7			94	
	Holomelina aurantiaca (Hbn.)	5			F1	F2				M2	1						7	8	93		95
	Hypoprepia fucosa Hbn.	63		B2	F1	F2	H1	H2	M1	M2	1						7	8	93	94	95
	Phragmatobia assimilans Wlk.	5					H1	H2	M1		1				5						95
	Spilosoma congrua Wlk.	1		B2							1					6				94	
	sp	1			F1						1					6			93		
Argyresthiidae	*Argyresthia oreasella* Clem.	53		B2	F1	F2		H2	M1	M2	1					6	7	8	93		95
	sp	38		B2	F1	F2	H1	H2	M1	M2	1	2		4		6	7	8		94	95
Blastobasidae	*Gerdana caritella* Bsk.	1						H2			1							8	93		
	sp	340	B1	B2	F1	F2	H1	H2	M1	M2	1	2		4	5	6	7	8	93	94	95
Cochylidae	*sp*	23		B2			H1	H2	M1	M2	1	2				6	7	8	93	94	
Coleophoridae	*Batrachedrinae sp*	2		B2					M1		1					6		8			95
	Coleophora sp	33	B1	B2	F1	F2	H1		M1	M2	1	2				6	7	8		94	95
	sp	24	B1	B2	F1	F2	H1		M1	M2	1	2		4	5	6	7	8	93		95
Cosmopterigidae	*Cosmopteryx sp*	5			F1	F2					1						7				95

(table 4 continued on next page)

(table 4 continued)

Cosmopterigidae	*Euclemensia bassettalla* (Clem.)	2			F1						1						7				95
	sp	2				F2			M1		1	2					7				95
Cossidae	*Acossus centerensis* (Lint.)	1		B2							1					6			93		
Decophoridae	*sp*	1								M2	1						7				95
Drepanidae	*Drepana arcuata* Wlk.	1						H2			1				5						95
Eriocraniidae	*Mnemonica auricyanea* (Wlsm.)	1	B1								1				5				93		
	sp	29	B1	B2		F2	H1	H2	M1		1	2				6	7	8		94	95
Gelechiidae	*Aristotelia sp*	4		B2		F2					1						7	8			95
	Chionodes sp	233	B1	B2	F1	F2	H1	H2	M1	M2	1	2			5	6	7	8			95
	Coleotechnites sp	2				F2					1						7				95
	Dichomeris ligulella Hbn.	2						H2	M1		1	2					7	8			95
	Trichotaphe setosilla Clem.	1			F1						1						7		93		
	Walshia sp	1				F2					1						7		93		
	sp	228	B1	B2	F1	F2	H1	H2	M1	M2	1	2		4	5	6	7	8	93	94	95
Gelechiodea	*sp*	354	B1	B2	F1	F2	H1	H2	M1	M2	1	2			5	6	7	8	93	94	
Geometridae	*Anavitrinelia pampinaria* (Gn.)	7	B1				H1	H2	M1	M2	1	2					7	8	93		95
	Besma endropiaria (G. & R.)	4						H2				2				6			93		
	Besma quercivoraria (Gn.)	3	B1							M2	1	2			5	6	7		93		95
	Biston betularia (L.)	2	B1						M1		1					6				94	95
	Cabera sp	1				F2					1							8	93		
	Cabera variolaria Gn.	2			F1				M1		1							8	93		
	Campaea perlata (Gn.)	18	B1				H1	H2	M1	M2	1	2				6		8	93		95
	Caripeta divisata Wlk.	1			F1						1							8			95
	Cladara anguilineata (G. & R.)	2							M1		1				5					94	
	Cladara atroliturata (Wlk.)	4					H1		M1		1				5						95
	Cladara limitaria (Wlk.)	1							M1		1				5						95
	Cleora projecta (Wlk.)	1									1				5						95

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(table 4 continued)

Geometridae	*Ectropis crepuscularia* (D. & S.)	1			F1						1					6			93		
	Ennominae sp	1			F1						1						7		93		
	Ennomos subsignaria (Hbn.)	5					H1	H2			1						7		93		
	Epimecis hortaria (F.)	1		B2							1					6				94	
	Eubaphe mendica (Wlk.)	1						H2			1						7		93		
	Euchlaena johnsonaria (Fitch)	1						H2				2					7				95
	Euchlaena tigrinaria (Gn.)	1					H1					2				6				94	
	Eugonobapta niveosaria (Gn.)	3					H1	H2			1					6	7		93		
	Eupethicia cymela (Cram.)	4	B1			F2				M2		2	3			6					95
	Eupethicia sp	132	B1		F1	F2	H1	H2	M1	M2	1	2			5	6	7	8	93	94	95
	Heliomata cycladata G. & R.	3		B2			H1		M1		1					6	7			94	95
	Hydria prunivorata (Fgn.)	3					H1	H2		M2	1	2				6	7				95
	Hydria sp	1						H2				2					7			94	
	Hydriomena sp	154	B1	B2	F1	F2					1	2			5	6			93	94	95
	Itame argillacearia (Pack.)	1	B1									2					7				95
	Itame coortaria (Hulst)	11		B2	F1	F2	H1				1						7	8			95
	Itame evagaria (Hulst)	2			F1	F2					1	2				6	7		93	94	
	Itame pustularia (Gn.)	33	B1		F1	F2					1						7	8	93		
	Lobophora montanata Pack.	1							M1		1					6			93		
	Lomographa glomeraria (Grt.)	41				F2	H1	H2	M1	M2	1	2			5					94	95
	Lomographa semiclarata (Wlk.)	2	B1							M2	1	2			5	6			93		95
	Lomographa vestaliata (Gn.)	13	B1		F1				M1	M2	1				5	6	7	8	93	94	95
	Melanolophiini canadaria (Gn.)	3							M1	M2	1	2			5						95
	Mesoleuca ruficilliata (Gn.)	2								M2	1	2						8	93		
	Metanema inatomaria Gn.	1			F1						1							8	93		
	Metarranthis refractaria (Gn.)	1	B1									2				6			93		
	Nematocampa limbata (Haw.)	6					H1	H2	M1	M2	1						7		93		95
	Nepytia canosaria (Wlk.)	2			F1	F2					1							8	93		95
	Orthonama centrostrigaria (Woll.)	9					H1	H2	M1	M2	1	2				6	7	8	93		95
	Orthonama obsipata (F.)	1					H1				1						7				95
	Pero hubneraria (Gn.)	1	B1								1							8		94	
	Plagodis alcoolaria (Gn.)	17	B1		F1	F2			M1	M2	1	2				6	7	8	93	94	95
	Plagodis fervidaria (H. -S.)	3		B2	F1						1				5				93		
	Plagodis phlogosaria (Gn.)	40				F2	H1	H2	M1	M2	1				5	6	7			94	95

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(table 4 continued)

Geometridae	*Plagodis serinaria* H. -S.	4		B2					M1		1				5	6			93		
	Plagodis sp	2			F1			H2			1				5	6			93		
	Probole alienaria H. -S.	2					H1			M2		2			5					94	95
	Protitame virginalis (Hulst)	1				F2					1							8	93		
	Protobormia porcelaria (Gn.)	4				F2			M1	M2	1	2				6	7				95
	Scopula inductata (Gn.)	7		B2	F1	F2	H1		M1		1	2				6		8			95
	Scopula limboundata (Haw.)	1	B1								1						7		93		
	Semiothisa bisignata (Wlk.)	9	B1		F1						1						7		93		95
	Semiothisa ocellinata (Gn.)	1					H1				1						7				95
	Synchlora aerata (F.)	1		B2							1							8			95
	Tetracis cachexiata (Gn.)	12	B1		F1	F2	H1		M1	M2	1	2				6				94	95
	Tetracis crocallata (Gn.)	8						H2	M1	M2	1					6	7		93	94	
	Xanthorhoe ferrugata (Cl.)	1		B2							1							8			95
	sp	139	B1	B2	F1	F2	H1	H2	M1	M2	1	2		4	5	6	7	8	93	94	95
Glyphipterigidae	*Abrenthia cuprea* Bsk.	1							M1		1				5						95
	sp	1				F2					1							8			95
Gracillariidae	*Caloptilia sp*	32	B1	B2		F2	H1		M1	M2	1	2			5	6	7	8	93		95
	sp	26		B2	F1	F2		H2	M1	M2	1			4	5	6	7	8	93	94	95
Hesperiidae	*Erynnis brizo* (Bdv. & LeConte)	2				F2						2		4	5						95
	Poanes hobomok (Harr.)	4	B1	B2	F1	F2						2	3			6					95
Hydroptilidae	*sp*	36	B1	B2		F2					1					6	7			94	
Lasiocampidae	*Malacosoma americanum* F.	2							M1		1						7		93		
	Malacosoma disstria Hbn.	87	B1	B2	F1		H1	H2	M1	M2	1						7		93	94	95
	Phyllodesma americana (Harr.)	18	B1			F2		H2			1	2			5	6			93		95
	sp	1	B1								1				5				93		
Limacodidae	*Apoda biguttata* (Pack.)	1				F2					1						7		93		
	Lithacodes fasciola (H. -S.)	4	B1			F2		H2			1					6	7		93	94	95
	Lithacodes testacea Pack.	1							M1		1						7			94	

(table 4 continued on next page)

(table 4 continued)

Limacodidae	*Tortricidia flexuosa* (Grt.)	23	B1	B2		F2	H1	H2	M1	M2	1	2				6	7			94	95
	Tortricidia pallida (H. -S.)	1							M1		1						7		93		
	sp	1						H2			1					6			93		
Lymantriidae	*Lymantria dispar* (L.)	83	B1	B2	F1	F2	H1	H2	M1	M2	1	2			5	6	7	8	93		
	Orygia leucostigma (J. E. Smith)	2		B2	F1						1					6	7		93		95
	Orygia sp	2				F2					1				5				93		
	sp	7		B2	F1						1					6			93		
Lyonetiidae	*Bucculatrix sp*	1	B1								1					6			93		
	sp	916	B1	B2	F1	F2	H1	H2	M1	M2	1	2		4	5	6	7	8	93	94	95
Nepticulidae	*sp*	84	B1	B2	F1	F2	H1	H2	M1	M2	1	2		4	5	6	7	8	93	94	95
Noctuidae	*Abagrotis alternata* (Grt.)	8		B2	F1		H1		M1	M2	1	2					7	8	93	94	95
	Achatia distincta Hbn.	36	B1	B2	F1	F2	H1	H2	M1	M2	1				5	6			93	94	95
	Acleris sp	5			F1	F2					1			4		6	7				95
	Acronicta dactylina Grt.	1						H2			1					6			93		
	Acronicta haesitata (Grt.)	34	B1	B2	F1	F2					1					6	7			94	95
	Acronicta hamamelis Gn.	14	B1			F2					1					6	7			94	
	Acronicta hasta Gn.	3		B2				H2	M1		1					6	7			94	95
	Acronicta impleta Wlk.	1				F2					1					6					95
	Acronicta inclara Sm.	24	B1	B2		F2				M2	1					6	7		93	94	95
	Acronicta increta Morr.	24	B1	B2		F2			M1		1					6	7		93	94	95
	Acronicta modica Wlk.	7		B2	F1			H2			1						7				95
	Acronicta morula G. & R.	2		B2					M1		1					6				94	95
	Acronicta ovata Grt.	18	B1	B2	F1	F2					1						7	8	93	94	95
	Acronicta retardata (Hbn.)	1				F2					1					6				94	
	Acronicta sp	1				F2					1						7		93		
	Acronicta tritona (Hbn.)	1	B1								1					6				94	
	Agriopodes fallax (H. -S.)	1				F2					1						7		93		
	Agriopodes teratophora (H. -S.)	1				F2					1					6				94	
	Agrotis ipsilon (Hufn.)	2		B2			H1				1				5				93		95

(table 4 continued on next page)

(table 4 continued)

Noctuidae	*Amphipoea americana* (Speyer)	1			F1						1							8			95
	Amphipoea tragopoginis (Cl.)	1								M2	1							8	93		
	Amphipoea velata (Wlk.)	1			F1						1						7				95
	Anagrapha falcifera (Kby.)	1				F2					1				5				93		
	Anaplectoides parsina (D. & S.)	6	B1	B2				H2		M2	1						7	8		94	95
	Anathix ralla (G. & R.)	1							M1		1							8	93		
	Autographa precationis (Gn.)	1							M1			2					7			94	
	Baileya australis (Grt.)	1							M1		1					6			93		
	Baileya ophthalmica (Gn.)	4				F2		H2		M2	1	2			5	6			93	94	95
	Bleptina caradrinalis Gn.	12			F1	F2	H1				1	2				6	7	8	93		95
	Bomolocha baltimoralis (Gn.)	5		B2	F1	F2	H1				1	2			5	6	7	8		94	95
	Bomolocha deceptalis (Wlk.)	8					H1			M2		2				6	7			94	95
	Bomolocha madefactalis (Gn.)	1					H1				1					6					95
	Callopistria cordata (Ljungh)	34	B1	B2	F1	F2	H1	H2	M1		1					6	7	8	93	94	95
	Callopistria mollissima (Gn.)	1					H1				1							8		94	
	Catocala amica (Hbn.)	2			F1	F2					1							8			95
	Catocala antinympha (Hbn.)	1				F2					1							8			95
	Catocala ilia (Cram.)	1	B1								1							8			95
	Catocala unijuga Wlk.	1								M2	1							8			95
	Cerastis tenebrifera (Wlk.)	11					H1	H2	M1	M2	1	2			5					94	95
	Charadra deridens (Gn.)	1							M1		1					6					95
	Chrysanympha formosa (Grt.)	1			F1						1						7		93		
	Chytonix palliatricula (Gn.)	27		B2	F1	F2	H1	H2	M1	M2	1	2				6	7		93	94	95
	Cissusa spadix (Cram.)	40	B1	B2	F1	F2	H1	H2		M2	1	2			5				93	94	95
	Copivaleria grotei (Morr.)	1							M1		1				5						95
	Cosmia calami (Harv.)	21	B1		F1	F2					1						7	8	93	94	
	Crocigrapha normani (Grt.)	40		B2		F2	H1	H2	M1	M2	1	2			5	6			93		95
	Crymodes devastator (Brace)	1							M1		1						7			94	
	Cryphia pallida (B. & L.)	1				F2					1							8		94	
	Egira alternans (Wlk.)	2		B2							1				5				93		95
	Egira dolosa Grt.	53	B1	B2	F1	F2		H2	M1	M2	1	2			5				93	94	95
	Elaphria festivoides (Gn.)	116	B1	B2	F1	F2	H1	H2	M1	M2	1	2				6	7		93	94	95
	Elaphria georgei (Moore & Rawson)	13	B1	B2		F2					1				5	6			93	94	95
	Elaphria veriscolor (Grt.)	2					H1			M2	1					6				94	

(table 4 continued on next page)

(table 4 continued)

Noctuidae	*Enargia decolor* (Wlk.)	1				F2						2						8	93		
	Eueretagrotis attenta (Grt.)	1			F1						1						7				95
	Euplexia benesimilis McD.	2		B2				H2			1					6		8		94	95
	Eupsilia morrisoni (Grt.)	2							M1		1				5					94	
	Eupsilia tristigmata (Grt.)	1				F2						2			5					94	
	Eutolype rolandi Grt.	24			F1						1				5				93		
	Euxoa declarata (Wlk.)	3				F2					1							8			95
	Euxoa messoria (Harr.)	1							M1		1							8	93		
	Euxoa perpolita (Morr.)	1							M1		1							8	93		
	Euxoa redimicula (Morr.)	1							M1		1							8	93		
	Euxoa tessellata (Harr.)	10		B2	F1	F2		H2	M1	M2	1					6	7	8		94	95
	Feltia geniculata G. & R.	8			F1	F2	H1	H2	M1		1						7	8	93	94	95
	Feltia jaculifera (Gn.)	4					H1	H2		M2	1							8	93	94	95
	Galgula partita Gn.	1				F2					1					6				94	
	Graphiphora haruspica (Grt.)	1						H2				2					7			94	
	Hadeninae sp	2					H1				1							8	93		
	Homohadena infixa (Wlk.)	1								M2	1						7				95
	Homorthodes furfurata (Grt.)	52				F2	H1	H2	M1	M2	1	2				6	7	8	93	94	
	Hypenodes caducus (Dyar)	1			F1						1						7		93		
	Hypenodes fractilinea (Sm.)	89	B1	B2	F1	F2	H1			M2	1	2				6	7	8	93	94	95
	Hypenodes sombrus Fgn.	1						H2				2				6				94	
	Hypenodes sp	28		B2	F1	F2	H1		M1		1	2				6	7	8	93	94	95
	Hyperstrotia pervertens (B. & McD.)	35		B2	F1	F2					1					6	7			94	95
	Hyperstrotia villificans (B. & McD.)	3				F2					1					6				94	
	Hyppa xylinoides (Gn.)	1					H1				1				5					94	
	Idia aemula Hbn.	22		B2	F1		H1	H2	M1	M2	1	2				6	7	8	93	94	95
	Idia americalis (Gn.)	12		B2	F1	F2		H2	M1		1	2				6	7	8	93	94	
	Idia diminuendis (B. & McD.)	12				F2					1					6		8	93	94	
	Idia julia (B. & McD.)	25	B1	B2	F1	F2					1	2				6	7	8	93	94	95
	Idia lubricalis (Gey.)	1				F2					1							8	93		
	Idia new species	2						H2		M2	1						7			94	
	Idia rotundalis (Wlk.)	39	B1	B2	F1	F2		H2			1	2					7	8	93		95
	Ipimorpha pleonectusa Grt.	3				F2			M1	M2	1	2						8	93		95
	Lacanobia lilacina (harr.)	1					H1				1						7				95

(table 4 continued on next page)

(table 4 continued)

Noctuidae	*Lacinipolia implicata* McD.	2		B2						M2	1							8			95
	Lacinipolia lorea (Gn.)	1							M1			2				6					95
	Lacinipolia lustralis (Grt.)	1				F2					1						7				95
	Lacinipolia meditata (Grt.)	3					H1	H2	M1		1							8	93		95
	Lacinipolia olivacea (Morr.)	7				F2	H1		M1	M2	1	2				6		8	93	94	
	Lacinipolia renigera (Steph.)	2					H1				1							8	93		
	Lacinipolia vicina (Grt.)	1						H2			1						7				95
	Leucania commoides Gn.	1					H1				1							8		94	
	Leucania pseudargyria Gn.	3			F1				M1		1	2				6	7			94	95
	Leuconycta dipteroides (Gn.)	2	B1							M2	1						7			94	95
	Lithacodia albidula (Gn.)	8	B1	B2		F2	H1		M1		1	2					7		93	94	95
	Lithacodia carneola Gn.	13		B2	F1		H1	H2		M2	1	2				6	7	8	93	94	95
	Lithacodia concinnimacula (Gn.)	3							M1	M2	1					6			93		95
	Lithacodia muscosula (Gn.)	18			F1			H2	M1	M2	1	2				6	7				95
	Lithacodia synochitis (G. & R.)	23			F1	F2	H1	H2	M1	M2	1					6	7			94	95
	Lithophane hemina Grt.	3					H1			M2	1				5			8		94	
	Lithophane innominata (Sm.)	4							M1	M2	1				5			8		94	
	Lithophane patefacta (Wlk.)	2		B2							1				5				93		
	Lithophane petulca Grt.	2	B1							M2	1				5				93		95
	Lithophane semiusta Grt.	16					H1	H2	M1	M2	1				5						95
	Lithophane sp	2		B2							1				5				93		
	Marathyssa inficita (Wlk.)	1							M1		1					6					95
	Meganola minuscula (Zell)	93	B1	B2	F1	F2		H2			1				5	6	7	8	93	94	95
	Melanchra adjuncta (Gn.)	1							M1		1					6			93		
	Melipotus sp	1		B2							1					6			93		
	Morrisonia confusa (Hbn.)	1					H1				1				5					94	
	Morrisonia evicta (Grt.)	6					H1	H2	M1		1	2			5	6				94	95
	Nedra ramosula (Gn.)	7		B2		F2	H1	H2	M1		1				5		7	8		94	95
	Nephalodes minians Gn.	1					H1				1							8	93		
	Nigetia formosalis Wlk.	5	B1		F1	F2					1						7			94	95
	sp	4				F2	H1			M2	1					6	7	8			95
	Noctuinae sp	1	B1								1				5				93		
	Nolinae sp	1				F2					1				5				93		
	Ochropleura plecta (L.)	2		B2	F1						1					6		8	93		95

(table 4 continued on next page)

(table 4 continued)

Noctuidae	*Oligia exhausta* (Sm.)	1					H1				1						7			94	
	Orthodes crenulata (Butler)	3						H2	M1		1					6			93		
	Orthodes cynica Gn.	59	B1	B2			H1	H2	M1	M2	1	2				6	7		93	94	95
	Orthodes sp	6	B1		F1				M1	M2	1					6	7			94	
	Orthosia hibisci (Gn.)	16		B2		F2	H1		M1	M2	1				5						95
	Orthosia revicta (Morr.)	1					H1				1				5						95
	Orthosia rubescens (Wlk.)	20		B2			H1	H2	M1	M2	1				5	6				94	
	Palthis angulalis (Hbn.)	4			F1						1						7		93		
	Peridroma saucia (Hbn.)	4		B2			H1			M2	1				5	6	7			94	
	Phlogophora iris Gn.	2				F2			M1		1					6			93		95
	Phlogophora perculosa Gn.	5					H1	H2	M1		1					6		8	93		95
	Phoberia atomaris Hbn.	18	B1	B2	F1						1				5				93	94	95
	Plathypena scabra (F.)	1				F2					1							8			95
	Polia delecta B. & McD.	2							M1			2				6				94	
	Polia detracta (Wlk.)	6			F1		H1		M1		1	2				6	7		93		95
	Polia latex (Gn.)	3						H2	M1		1					6			93		
	Polia nimbosa (Gn.)	1	B1								1						7				95
	Protorthodes oviduca (Gn.)	17	B1	B2	F1	F2			M1	M2	1				5	6		8	93	94	95
	Proxenus miranda (Grt.)	1				F2					1							8			95
	Psaphida resumens Wlk.	4		B2	F1	F2					1				5				93		95
	Pseudoletia unipuncta (Gn.)	3	B1	B2		F2					1					6	7			94	
	Pseudorthodes vecors (Grt.)	10					H1	H2	M1	M2	1	2				6					95
	Pyreferra ceromatica (Grt.)	1	B1								1				5				93		
	Raphia frater Grt.	55	B1	B2	F1	F2	H1		M1		1				5	6	7	8	93	94	95
	Rhynchagrotis anchocelioides (Gn.)	8				F2	H1		M1	M2	1						7	8	93	94	
	Rhynchagrotis cupida (Grt.)	7					H1		M1	M2	1					6		8	93		95
	Rivulinae sp	5			F1						1						7		93		
	Schinia arcigera (Gn.)	1			F1						1							8			95
	Spaelotis clandestina (Harr.)	2						H2		M2	1					6					95
	Spodoptera frugiperda (J. E. Smith)	1				F2					1							8			95
	Sunira bicolorago (Gn.)	31		B2			H1	H2	M1	M2	1	2						8	93		95
	Synedoida grandirena (Haw.)	6	B1	B2					M1		1					6	7		93	94	95
	Tarachidia erastrioides (Gn.)	1						H2			1					6			93		
	Ulolonche culea (Gn.)	67	B1	B2	F1	F2	H1			M2	1	2			5	6			93	94	95

(table 4 continued on next page)

(table 4 continued)

Noctuidae	*Ulolonche modesta* (Morr.)	6		B2			H1	H2	M1		1	2			5	6			93	94	95
	Xestia tenuicula (Morr.)	1							M1		1							8	93		
	Xestia adela Franc.	2						H2			1						7		93		
	Xestia dolosa Franc.	11	B1				H1	H2	M1	M2	1					6	7			94	95
	Xestia normaniana (Grt.)	25			F1		H1	H2	M1	M2	1	2					7	8	93		95
	Xestia smithii (Snell)	4					H1		M1	M2	1	2					7	8	93	94	
	Xestia sp	1						H2			1					6			93		
	Zale duplicata (Bethune)	1	B1								1				5						95
	Zale helata (Sm.)	1				F2					1				5						95
	Zale lunifera (Hbn.)	1							M1		1				5						95
	Zale minerea (Gn.)	5	B1				H1	H2	M1	M2	1	2			5	6				94	95
	Zale submediana Strand	6					H1	H2			1				5						95
	Zale undularis (Drury)	1				F2						2			5				93		
	Zale unilineata (Grt.)	5	B1	B2						M2	1				5	6			93	94	95
	Zanclognatha jacchusalis (Wlk.)	5			F1		H1	H2			1	2				6	7		93	94	95
	Zanclognatha laevigata (Grt.)	12					H1	H2	M1	M2	1	2					7	8	93	94	95
	Zanclognatha ochreipennis (Grt.)	5		B2	F1	F2				M2	1	2					7	8	93		
	Zanclognatha pedipilalis (Gn.)	5			F1						1	2					7	8			95
	sp	111	B1	B2	F1	F2		H2	M1	M2	1	2			5	6		8	93	94	
Notodontidae	*Dasylopha thytiroides* (Wlk.)	1					H1				1					6			93		
	Ellidia caniplaga (Wlk.)	2						H2	M1		1					6			93		
	Furcula modesta (Hudson)	1	B1								1				5				93		
	Gluphisia septentrionalis Wlk.	27	B1	B2	F1	F2	H1	H2	M1	M2	1				5	6		8	93	94	95
	Heterocampa guttivita (Wlk.)	1	B1									2			5				93		
	Hyperaeschira georgica (H. -S.)	9		B2	F1	F2					1					6				94	
	Lochmaeus bilineata (Pack.)	1							M1		1						7			94	
	Macrurocampa marthesia (Cram.)	2	B1		F1						1					6	7		93		95
	Nadata gibbosa (J. E. Smith)	6	B1	B2	F1		H1	H2			1					6	7	8	93	94	
	Notodonta simplalria Graef	1		B2							1				5				93		
	Peridea angulosa (J. E. Smith)	15	B1	B2				H2			1					6	7	8		94	95
	Peridea basitriens (Wlk.)	43				F2	H1	H2	M1	M2	1	2				6	7	8	93	94	95
	Pheosia rimosa Pack.	4			F1					M2	1					6		8	93	94	
	Schizura leptinoides (Grt.)	2							M1	M2	1	2				6		8	93		95

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Notodontidae	*Symmerista albifrons* (J. E. Smith)	11			F1	F2			M1	M2		1	2				6				93	94	
	sp	8	B1		F1							1	2			5					93		
Oecophoridae	*Agonopterix robiniella* (Pack.)	1						H2					2					7					95
	Antaeotricia schlaegeri (Zell.)	3	B1			F2						1	2				6		8			94	95
	Bibarrambla allenella (Wlsm.)	2				F2				M2		1				5							95
	Callima argenticinctella Clem.	46	B1	B2	F1	F2		H2		M2		1						7	8		93	94	95
	Decantha boreasella (Cham.)	2			F1							1						7			93		95
	Machimia tentoriferella Clem.	1					H1						2						8				95
	Oecophoridae sp	9				F2	H1	H2		M2		1	2					7					95
	Polex coloradella (Wlsm.)	4					H1		M1	M2		1					6	7			93		95
	Psilocorsis sp	97	B1		F1	F2	H1			M2		1					6	7				94	
	sp	4				F2			M1			1					6	7	8		93		
Pieridae	*Phoebis sennae* (L.)	3				F2		H2				1						7			93		
Plutellidae	*Plutella xylostella* (L.)	5		B2		F2	H1					1	2				6	7	8				95
Psychidae	*sp*	2	B1	B2									2					7			93		
Pyralidae	*Acentria nivea* (Olivier)	25			F1	F2	H1			M2		1					6	7	8				95
	Acrobasis sp	6				F2			M1	M2		1						7	8		93		
	Aethiophysa lentiflualis (Zell.)	1				F2						1							8		93		
	Aglossa cuprina Zell.	14	B1	B2	F1	F2		H2				1	2					7	8		93		95
	Blephanomastix ranalis (Gn.)	53	B1	B2	F1	F2						1	2				6		8			94	
	Chrysoteuchia topiaria (Zell.)	2			F1	F2						1						7			93		
	Crambinae sp	20	B1	B2	F1	F2	H1	H2	M1	M2		1	2				6	7	8		93	94	
	Crambus agitatellus Clem.	30	B1		F1	F2	H1		M1	M2		1				5	6	7	8				95
	Crambus albellus Clem.	6			F1	F2		H2		M2		1						7			93		95
	Crambus sp	1							M1			1							8		93		
	Eulogia ochrifrontella (Zell.)	27	B1	B2		F2		H2		M2		1	2					7	8		93	94	95
	Fumibotys fumalis (Gn.)	2					H1	H2				1						7	8		93		95
	Herculia olinalis (Gn.)	6	B1			F2	H1					1	2					7	8		93	94	95
	Herpetogramma pertextalis (Led.)	1				F2						1					6					94	

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(table 4 continued)

Pyralidae	*Microcrambus elegans* (Clem.)	2			F1				M1		1							8	93		
	Munroessa gyralis (Hulst)	3		B2		F2					1						7	8			95
	Munroessa icciusalis (Wlk.)	8	B1		F1	F2	H1				1	2				6		8	93		95
	Nephopterix sp	8			F1			H2	M1	M2	1					6	7			94	
	Nephopterix vetustella (Dyar)	33						H2	M1	M2	1				5	6					95
	Nephopterix virgatella (Clem.)	2						H2	M1		1						7	8			95
	Nymphalinae sp	3			F1						1					6				94	
	Oneida lunulalis (Hulst.)	1				F2					1						7				95
	Ostrinia nubilalis (Hbn.)	16	B1	B2	F1	F2	H1	H2		M2	1	2					7	8			95
	Palpita arsaltealis (Wlk.)	1							M1		1						7			94	
	Parapoynx maculalis (Clem.)	2	B1			F2					1							8			95
	Petrophilia fulicalis (Clem.)	3								M2	1						7				95
	Phycitinae sp	19				F2		H2	M1	M2	1						7	8	93	94	
	Platytes vobisne Dyar	3	B1		F1						1						7				95
	Pyla fusca (Haw.)	1							M1		1							8	93		
	Pyrausta acrionalis (Wlk.)	1					H1				1							8			95
	Pyrausta signatalis (Wlk.)	1				F2					1							8			95
	Pyrausta sp	1					H1				1							8	93		
	Pyraustinae sp	6	B1	B2			H1		M1		1					6	7			94	
	Salebriaria turpidella (Rag.)	4	B1		F1	F2					1						7				95
	Scoparia basalis Wlk.	4					H1				1							8	93		
	Scoparia biplagialis Wlk.	3	B1			F2					1	2					7	8	93		
	Scoparia sp	34	B1	B2	F1	F2	H1	H2	M1	M2	1	2				6	7	8	93		95
	Scoparia/Eudonia sp	71	B1	B2		F2	H1	H2	M1	M2	1	2				6	7	8	93	94	
	Scoparinae sp	4	B1						M1		1	2				6	7			94	
	Sitochroa chortalis (Grt.)	1			F1						1							8	93		
	Synclita tinealis Mun.	4			F1	F2					1							8			95
	Thaumatopsis gibsonella Kft.	4				F2					1							8			95
	Udea rubigalis (Gn.)	1								M2	1						7		93		
	Urola nivalis (Drury)	1			F1						1					6			93		
	sp	74	B1	B2	F1	F2	H1	H2	M1	M2	1	2			5	6	7	8	93	94	95
Satyridae	*Megisto cymela* (Cram.)	7	B1	B2	F1	F2		H2				2				6			93	94	

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(table 4 continued)

Sesiidae	*Syanthedon acerni* (Clem.)	3				F2					1					6				94	
Sphingidae	*Ceratomia undulosa* (Wlk.)	4						H2	M1	M2	1	2				6	7		93	94	95
	Deidemia inscripta (Harr.)	1		B2							1				5				93		
	Pachysphinx modesta (Harr.)	1				F2					1					6				94	
	Paonias excaecatus (J. E. Smith)	2						H2		M2	1					6	7		93		95
	Paonias myops (J. E. Smith)	2					H1			M2	1					6					95
	Sphecodina abbottii (Swainson)	1		B2							1				5						95
	Sphinx gordius Cram.	5			F1	F2					1					6				94	
Thyatiridae	*Euthyatira pudens* (Gn.)	1		B2							1				5				93		
	Habrosyne scripta (Gosse)	1							M1		1					6					95
Tineidae	*Acrolophus sp*	1				F2					1						7		93		
	sp	20			F1	F2	H1		M1		1	2				6	7	8	93	94	95
Tineoidea	*sp*	47	B1	B2	F1	F2	H1	H2	M1	M2	1	2				6	7	8	93	94	
Tortricidae	*Acleris forbesana* (McD.)	2					H1					2					7		93		
	Acleris oxycoccana (Pack.)	3					H1		M1			2					7	8	93		
	Acleris sp	199	B1	B2	F1	F2	H1	H2	M1	M2	1	2				6	7	8	93		
	Ancylis burgessiana (Zell)	9				F2			M1		1				5	6			93	94	95
	Ancylis fuscociliana (Clem.)	3				F2			M1		1	2				6					95
	Ancylis metamelana (Wlk.)	1	B1								1						7		93		
	Ancylis nubeculana (Clem.)	1	B1								1							8		94	
	Archips argyrospila (Wlk.)	164	B1	B2	F1	F2	H1	H2	M1	M2	1					6	7		93	94	95
	Archips cerasivorana (Fitch)	3		B2						M2	1						7		93		95
	Archips fervidana (Clem.)	38			F1	F2		H2			1						7	8	93		
	Archips purpurana (Clem.)	11	B1			F2		H2	M1		1	2				6	7	8	93		
	Archips rosaceana (L.)	4						H2	M1		1							8	93		
	Archips semiferana (Wlk.)	46	B1	B2				H2			1						7			94	95
	Argyrotaenia alisellana (Rob.)	2	B1								1						7				95
	Argyrotaenia mariana (Fern.)	2				F2			M1		1				5						95
	Argyrotaenia quercifoliana (Fitch)	99	B1	B2	F1	F2			M1		1						7	8	93	94	95

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(table 4 continued)

Tortricidae	*Argyrotaenia sp*	5							M1		1					6			93		
	Choristoneura conflictana (Wlk.)	7							M1	M2	1					6					95
	Choristoneura fractivittana (Clem.)	67	B1	B2			H1				1					6			93	94	95
	Choristoneura fumiferana (Clem.)	5						H2	M1		1						7		93		
	Choristoneura obsoletana (Wlk.)	7			F1						1						7		93		
	Choristoneura pinus Free.	49	B1	B2							1	2					7			94	
	Choristoneura rosaceana (Harr.)	1294	B1	B2	F1	F2	H1	H2	M1	M2	1					6	7	8	93	94	95
	Choristoneura sp	6	B1								1						7		93		
	Clepsis melaleucana (Wlk.)	861			F1		H1	H2	M1	M2	1	2		4		6			93	94	95
	Clepsis persicana (Fitch)	7					H1		M1		1					6					95
	Croesia albicomana (Clem.)	32	B1	B2	F1	F2					1	2				6	7	8	93		95
	Croesia semipurpurana (Kft.)	17		B2							1					6				94	
	Ecdytolopha punctidiscana (Dyar)	4				F2					1					6				94	
	Epinota timidella (Clem.)	1		B2							1				5					94	
	Eucosma dorsisignatana (Clem.)	1		B2							1						7				95
	Melissopus latiferreanus Wlsm.	9				F2			M1	M2	1							8	93		95
	Olethreutes appendicea (Zell)	1	B1								1					6			93		
	Olethreutes fasciatana (Clem.)	425	B1	B2	F1	F2	H1	H2		M2	1	2				6	7	8	93		95
	Olethreutes footiana (Fern.)	1				F2					1							8	93		
	Olethreutes nigrana (Hienr.)	1				F2					1							8	93		
	Olethreutes permundana (Clem.)	29				F2		H2	M1		1						7	8	93	94	
	Olethreutes sp	226	B1	B2	F1	F2	H1	H2	M1	M2	1	2				6	7	8	93	94	95
	Olethreutinae sp	447	B1	B2	F1	F2	H1	H2	M1	M2	1	2		4	5	6	7	8	93	94	95
	Pandemis canadana Kft.	114					H1				1						7				95
	Pandemis limitata (Rob.)	5	B1						M1		1						7	8		94	95
	Petrova gemistrigulana (Kft.)	1				F2					1							8	93		
	Phaneta raracana (Kft.)	9			F1	F2					1							8			95
	Platynota flavedana Clem.	1							M1		1							8		94	
	Platynota idaeusalis (Wlk.)	13	B1	B2				H2	M1		1						7	8	93		95
	Proteoteras aesculana (Riley)	1					H1				1							8		94	
	Proteoteras moffatiana Fern.	83					H1	H2	M1	M2	1						7	8	93	94	95
	Pseudexentera costomaculana (Clem.)	2		B2							1				5						95
	Pseudosciaphila duplex (Wlsm.)	3			F1				M1	M2	1					6	7		93		95
	Ptycholoma peritana (Clem.)	546	B1	B2	F1	F2	H1	H2	M1	M2	1	2		4		6	7	8	93	94	95

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Tortricidae	*Sparganothis diluticostana* (Wlsm.)	2						H1			M2		1						7	8		94	95
	Sparganothis directana (Clem.)	3				F1	F2						1	2				6		8	93		
	Sparganothis niveana (Wlsm.)	2								M1			1	2					7		93		
	Sparganothis pettitana (Rob.)	681		B1	B2	F1	F2	H1	H2	M1	M2		1	2		4		6	7	8	93	94	95
	Sparganothis reticulatana (Clem.)	20				F1		H1	H2	M1	M2		1					6	7	8	93	94	95
	Sparganothis sp	1					F2						1							8	93		
	Sparganothis sulfureana (Clem.)	1									M2		1							8	93		
	Sparganothis tristriata Kft.	3						H1	H2				1							8	93		
	Sparganothis unifasciana (Clem.)	1					F2							2					7				95
	Sparganothis xanthoides (Wlk.)	1				F1								2					7			94	
	Syndemis afflictana (Wlk.)	2		B1									1							8		94	
	Tortricinae sp	247		B1	B2	F1	F2	H1	H2	M1	M2		1	2		4		5	6	7	8		94	95
	sp	165		B1	B2	F1	F2		H2	M1	M2		1	2				5	6	7	8	93		
Yponomeutidae	*Atteva punctella* (Cram.)	1					F2						1							8			95
	Yponomeuta multipunctella Clem.	1							H2				1						7				95
	Zelleria haimbachi Bsk.	2							H2				1						7			94	
Zygaenidae	*sp*	1				F1							1					6			93		

[1]Site codes for ELTP 20 (oak-dominated ecosystem) are B1= Branch 1, B2= Branch 2, F1= Freesoil 1 and F2= Freesoil 2. Site codes for ELTP 45 (northern hardwood ecosystem) are H1= Harrietta 1, H2= Harrietta 2, M1= Mesick 1, and M2= Mesick 2.
[2]Trap Type codes are 1= suspended UV trap, 2= malaise, 3= pitfall, and 4= sweepnet.
[3]Month codes are 5 = May, 6= June, 7= July, and 8= August.

Table 5.—*Total number of carabid species collected from ELTP 20 and ELTP 45 stands in northern lower Michigan during the summers of 1993 through 1995*

	ELTP 20				ELTP 45				Grand total
Year	**1993**	**1994**	**1995**	**Total**	**1993**	**1994**	**1995**	**Total**	
No. species	21	32	33	48	16	22	28	38	59
No. individuals	327	515	730	1,572	94	371	491	956	2,528

Table 6.—Abundance, location, and collection date of carabid beetles in two ELTP's in the Huron-Manistee National Forest

Carabid Taxa	No.	Site ELTP 20				ELTP 45				Trap type[2]				Month[3]				Year		
Agonum decorum (Say)	1					H1				1					6					95
Agonum galvestonicum (Csy.)	1								M2	1					6					95
Agonum harrisii Lec.	1				F2					1				5				93		
Agonum placidum (Say)	45	B1		F1	F2	H1	H2	M1	M2	1				5	6	7	8	93	94	95
Agonum sordens Kby.	3	B1			F2					1					6		8		94	95
Amara convexa Lec.	7			F1	F2					1				5			8	93		95
Anisodactylus discoides Dej.	5	B1								1					6				94	
Bembidion americanum Dej.	1			F1						1						7			94	
Bembidion patruele Dej.	96	B1	B2	F1	F2	H1	H2	M1	M2	1					6	7	8	93	94	95
Bembidion versicolor (Lec.)	214	B1	B2	F1	F2	H1	H2		M2	1					6	7	8	93	94	95
Blemus discus (F.)	3			F1	F2					1						7	8			95
Brachinus cordicollis Dej.	1					H1				1					6					95
Calathus gregarius (Say)	2						H2		M2			3				7		93		
Calosoma frigidum Kby.	16	B1	B2	F1	F2	H1				1		3			6		8	93	94	95
Calosoma scrutator (F.)	1				F2							3				7			94	
Carabus goryi Dej.	345	B1	B2	F1	F2	H1	H2	M1	M2			3		5	6	7	8	93	94	95
Carabus serratus Say	4	B1	B2									3			6	7			94	95
Carabus sylvosus Say	1						H2					3					8			95
Chlaenius tricolor tricolor Dej.	10	B1	B2	F1						1						7	8	93	94	95
Clivina dentipes Dej.	1	B1								1					6				94	
Clivina fossor (L.)	42	B1		F1	F2					1				5	6		8	93	94	95
Cymindis americanus Dej.	1						H2					3				7			94	
Cymindis cribricollis Dej.	8		B2			H1	H2					3			6	7	8	93	94	95
Cymindis limbatus	30	B1	B2	F1	F2	H1	H2	M1		1		3		5	6	7	8	93	94	95
Cymindis pilosus Say	5	B1					H2			1		3		5		7		93	94	
Cymindis platicollis	64	B1	B2	F1	F2	H1	H2	M1	M2	1				5	6	7	8		94	95
Dicaelus teter Bon.	5					H1	H2		M2			3		5	6			93	94	

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Dyschirius erythrocerus Lec.	4			F1		H1				1					6		8			95
Dyschirius politus (Dej.)	3		B2	F1	F2					1						7	8			95
Harpalus faunus Say	34		B2	F1	F2	H1	H2	M1	M2	1						7	8		94	95
Harpalus lewisii Lec.	14					H1	H2	M1	M2	1		3			6	7			94	95
Harpalus pensylvanicus (DeG.)	8	B1		F1	F2				M2	1					6	7	8		94	95
Harpalus rufipes (DeG.)	1					H1				1					6				94	
Lebia atriventris Say	1				F2					1				5				93		
Lebia ornata Say	1	B1								1					6				94	
Lebia tricolor Say	3			F1	F2			M1		1				5	6				94	95
Lebia viridis Say	6	B1				H1				1					6		8		94	95
Myas coracinus (Say)	6	B1	B2	F1	F2							3			6	7	8	93	94	
Myas cyanescens Dej.	50		B2			H1	H2	M1	M2			3			6	7	8	93	94	95
Poecilus chaleites (Say)	3	B1			F2					1					6		8		94	95
Pterostichus adoxus (Say)	5					H1		M1				3				7	8	93		
Pterostichus adstrictus Eschz.	19	B1	B2	F1					M2			3		5	6	7		93		
Pterostichus corvinus (Dej.)	23		B2	F1		H1	H2	M1				3		5	6	7	8	93	94	95
Pterostichus melanarius (Ill.)	3	B1		F1	F2							3				7			94	95
Pterostichus mutus (Say)	12		B2									3			6	7		93	94	
Pterostichus pensylvanicus Lec.	128	B1	B2	F1		H1	H2	M1	M2			3		5	6	7	8	93	94	95
Pterostichus sp	3	B1	B2									3				7	8	93		
Pterostichus sp A	112			F1	F2	H1	H2	M1	M2			3				7	8		94	
Scaphinotus bilobus (Say)	5					H1			M2			3				7	8	93	94	95
Sphaeroderus stanostomas lecontei Dej.	8					H1	H2	M1				3		5	6	7	8	93	94	95
Stenopholus comma (F.)	522	B1	B2	F1	F2	H1	H2	M1	M2	1				5	6	7	8	93	94	95
Stenopholus conjunctus (Say)	21	B1		F1		H1		M1	M2	1					6	7			94	95
Stenopholus lineola (F.)	111	B1	B2	F1	F2			M1	M2	1	2			5	6		8	93		95
Stenopholus ochropezus (Say)	213	B1	B2	F1	F2	H1				1		3		5	6	7	8	93	94	95
Synuchus impunctatus (Say)	234	B1	B2	F1	F2	H1	H2	M1	M2	1		3		5	6	7	8	93	94	95
Tachys sp A	8			F1	F2					1						7	8			95
Tachys sp B	4			F1	F2					1						7	8			95
Tachys sp C	1			F1						1							8			95
Trichotichnus dichrous (Dej.)	44	B1	B2		F2	H1	H2	M1	M2	1					6	7	8		94	95

[1]Site codes for ELTP 20 (oak-dominated ecosystem) are B1= Branch 1, B2= Branch 2, F1= Freesoil 1, and F2= Freesoil 2. Site codes for ELTP 45 (northern hardwood ecosystem) are H1= Harrietta 1, H2= Harrietta 2, M1= Mesick 1, and M2= Mesick 2.
[2]Trap Type codes are 1= suspended UV trap, 2= malaise, 3= pitfall, and 4= sweepnet.

Table 7.—*Five most abundant carabid species collected from ELTP 20 and ELTP 45 stands in northern lower Michigan during the summers of 1993 through 1995*

Carabid species	No. beetles collected	Relative abundance in percent
Stenopholus comma (F.)	522	21
Carabus goryi Dej.	345	14
Synuchus impunctatus (Say)	234	9
Bembidion versicolor Dej.	214	8
Stenopholus ochropezus (Say)	213	8

Species richness and abundance data for uncommon species should always be interpreted carefully, with particular attention to sampling intensity and efficiency. When species are represented by a single individual, ecological interpretations of data are limited to presence-absence statements. However, results from our survey provide a framework to begin more intensive investigations of host-plant associations of rare species that appear to be unique to one ELTP.

While Lepidoptera communities are probably linked closely to vegetation characteristics, carabid diversity and abundance may more closely reflect microclimatic gradients. In ELTP 20, almost 50 percent of the unique species are reported to be associated with well-lit, xeric habitats. In contrast, in ELTP 45, 75 percent of the unique species are considered either hygrophagous (associated with humid environs) or associated with prey found in moist habitats. The difference in carabid fauna may correspond to ecosystem differences in habitat features that affect microclimate. ELTP 20 had an open overstory canopy and little understory and ground vegetation, allowing more sunlight to reach the forest floor, increase temperature, and decrease relative humidity. On the other hand, ELTP 45 had a dense canopy and rich understory and ground flora, which presumably led to higher relative humidity and cooler, moister conditions.

The majority of both Lepidoptera and carabids were collected in UV traps. This trapping method, while biased, provided many specimens with relatively little effort and cost. Carabid beetles are commonly sampled using pitfall traps because of the ease and low cost of maintaining traps. However, our results showed a significant proportion of the carabid fauna (61 percent) was underrepresented by pitfalls only. The use of multiple trapping methods can increase the resolution of biodiversity inventories without requiring survey of additional sites or greatly increasing cost and effort of sampling.

Our results should provide baseline data for managers interested in quantifying, conserving, or increasing insect species diversity in these ecosystems. This information may also be useful for entomologists or managers attempting to predict effects of natural disturbance or silvicultural activities on forest insect communities.

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More than 12,300 moths and 2,500 carabid beetles were trapped during 3 years (1993 through 1995) in two different ecological land type phases (ELTP's) in the Huron-Manistee National Forest in Michigan. One ELTP (no. 20) was dominated by oaks, and the other (no. 45) was dominated by sugar maple; each had distinctive kinds of insects, in spite of the fact that many species were shared. Collection dates, trapping method, and the total abundances of each of the 489 moth species, and each of the 59 carabid species are reported.

Key Words: biodiversity, ecosystem management, ELTP, LTA, faunal list.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.