

Initial Survey of Pentatomoidea (Hemiptera) and Vespidae (Hymenoptera) in Wilderness State Park

Report to Wilderness State Park and Michigan DNR

by

Brian Scholtens and the 2014 UMBS summer Biology of Insects class

This report continues work completed during the summers of 2011-2013 by the Biology of Insects class. During the summer of 2014 the class studied six additional families of insects, focusing on the five families of the superfamily Pentatomoidea (Pentatomidae, Acanthosomatidae, Scutelleridae, Cormelaenidae, Cydnidae) and the family Vespidae in the Hymenoptera (wasps, bees and ants), of Wilderness State Park. The members of the Pentatomoidea are commonly known as the stink bugs and their relatives. Some of these species are occasionally crop pests, and some serve as potential predatory control agents. They are usually obvious in habitats and relatively easy to sample with sweep nets. The Vespidae represent the most common wasp species in both woodland and open areas. Many species are truly social, with all reproduction done by one queen with a colony of female workers that builds over the course of the summer. These insects are very important pollinators and also serve as controls for pest insects because they take them as prey for larvae. We had initial potential lists for both groups based on published regional lists and specimens at UMBS and the University of Michigan Museum of Zoology (UMMZ), but we expected to add significantly to these lists for both groups.

Materials and Methods

The summer 2014 Biology of Insects class from the University of Michigan Biological Station continued the effort started in 2011 of surveying insect groups in Wilderness State Park. The class formed 2 working groups, each group choosing a different insect group to survey. The working groups surveyed 1) Pentatomoidea (stink bugs and their relatives), and 2) Vespidae (hornets, yellow jackets, paper wasps, and some solitary wasps). Over the course of 6 weeks, each group sampled multiple different locations in the park that were selected as likely habitats for their insect groups. During each sampling period, working groups sampled a given area intensely for about 1 hour. The Pentatomoidea group used primarily sweep netting as their collection technique, but also employed hand picking and inspecting insects washed up on the beach. The Vespidae group used exclusively aerial nets for collection, focusing on worker individuals visiting flowers or sampling individuals near known nests (for social species).

The major sampling locations were the marsh and dunes on Waugoshance Pt., the pond and clearings south of the main campground area, the Nebo Trail and associated clearings, Sturgeon Bay including both dune areas (north and south regions) and nearby wooded areas, and the boat launch area near the campground. We also examined and

included historical records from the collections at UMBS and UMMZ and from the Scholtens collection.

Each group collected representatives of each species to confirm identifications and provide a reference collection. These collections will be stored at the University of Michigan Biological Station. Pentatomidae were identified using McPherson (1982) and Paiero et al. (2013). Vespidae were identified using primarily Buck et al. (2008) and Kimsey & Carpenter (2012). All groups were pinned using standard techniques (Triplehorn & Johnson 2005).

Results

The two working groups sampled extensively, and were successful in accumulating significant species lists (although additional species in both taxa would be expected with more extensive sampling). Overall the working groups documented 1 species of Acanthosomatidae, 2 species of Corimelaenidae, 13 species of Pentatomidae, 3 species of Scutelleridae, and 21 species of Vespidae (Table 1), based on 164 individual collection or observation records (Appendix 1). Based on previous records from the UMMZ, UMBS and Scholtens collections we documented 2 species of Pentatomidae, 1 species of Scutelleridae, 1 species of Corimelaenidae, and 8 species of Vespidae as county records (Emmet County), with 1 species of Vespidae possibly being a state record, *Ancistrocerus waldenii*, found twice on Waugoshance Pt. County records are indicated by asterisks in Table 1.

For our focus groups, the most productive habitats were open areas, including beaches, fields and marshes. Vespidae were especially abundant wherever there were good stands of flowers. Pentatomoidea were not abundant in any habitat, but most were found in wet or moist areas, such as the coastal wetlands. A complete listing of all individuals captured or sighted is found in Appendix 1.

In addition to this survey, 71 additional species from previously surveyed families (2011-2013) have been added to the list from Wilderness State Park (Table 2). These species were found in subsequent years, or were located in historical collections. In total, over four summers the Biology of Insects classes have documented 340 species of insects in 28 families at Wilderness State Park. Appendix 2 includes a complete list of species from all families surveyed from 2011-2014.

Discussion

As a first effort, our working groups did a good job of building a species list for the groups we sampled. Very few areas in any part of the country have had significant insect surveys completed. Recently, some national and state parks have had survey efforts that have resulted in large species lists and significant findings (e.g. Great Smoky Mountains National Park (Scholtens and Wagner 2007)). These surveys often find undescribed species or significant range extensions. They always provide extensive distribution, abundance and phenological information about the species present in the parks. Our survey continues an effort to gather this kind of information for Wilderness State Park.

An usually late spring and cool summer in the region made our sampling of Pentatomoidea somewhat disappointing. Species in this group typically overwinter as adults, becoming active in the spring (McPherson 1982). Our summer session starts after this initial period of activity for most species, and we only picked up a few species very early in the summer. The second generation in a typical summer produces adults by mid July, but the overwintering adults were late in egg laying and nymphal development was somewhat delayed by the cool summer temperatures. Second generation adults were just becoming common as we had to end our sampling. As a result, we certainly undersampled this group of families (Pentatomidae, Scutelleridae, Acanthosomatidae, Corimelaenidae) during the summer. We were able to add some additional records by surveying historical collections from the University of Michigan Museum of Zoology, the University of Michigan Biological Station, and the Scholtens collection.

Most of the species in these families are herbivores, feeding on individual plant cells by sucking out the contents with their beak-like mouthparts. Some members of the Pentatomidae are significant pests in agricultural fields, e.g the brown marmorated stink bug (McPherson & McPherson 2000), but most species have little economic impact. Most don't seem to have a great deal of host plant specialization. One subfamily of Pentatomidae, the Asopinae, are predators, feeding on a variety of other insects, including other stink bugs (McPherson 1982). The most unusual species that we located during our survey was *Phimodera binotata*, an uncommon shield bug that has only occasionally been found in Michigan. This was found on the dunes of Sturgeon Bay in the early summer, associated with a population of Pitcher's thistle. Because of the poor sampling this summer, a number of additional species are expected from the Park, and will, no doubt, show up with additional sampling effort. Based on previous state lists, none of the species we found are state records (McPherson 1970, 1979; Swanson 2012).

Members of the family Vespidae were much more common, particularly in the late summer as populations of the social wasp species grew significantly. These social species are an important part of nearly all ecosystems in Wilderness State Park. They act as pollinators and significant predators of many other insects, probably serving as population control for some herbivores (Akre & Davis 1978). Individual queens start new nests each spring, foraging for insects to raise the first brood. The resulting offspring are all daughters that then act as workers, continuing to provision larvae from eggs laid by the queen. Over the summer, the population builds, with new queens and males produced in the fall. At that time mating occurs, workers and males die and queens overwinter to start next year's nests (Evans & West-Eberhard 1970). These nests take one of three forms, 1) a free hanging nest with open larval cells, 2) a free hanging nest with larval cells covered by an outer layer, or 3) a nest in a cavity with the same larval cells (Akre et al. 1981; Kimsey & Carpenter 2012). In all cases the nests are formed from paper scraped from wood in the environment and combined with saliva, then regurgitated and applied to the nest (Akre & Davis 1978).

The other part of the family (subfamily Eumeninae) consists of solitary wasps. All females in this group construct their own nests, provision them with insects, and lay eggs on these insects to provide larvae with food during development. Most of these species nest in long narrow cavities, such as hollow stems, but a few construct mud nests (Krombein 1967; Cowan 1991; Bequaert 1938).

Two unusual species of Vespidae that our survey found were 2 species of solitary wasps, *Ancistrocerus catskill* and *Ancistrocerus waldenii*. These are both county records, and *A. waldenii* may be a state record, although no good previous list exists for the state. Both of these species nest in cavities, and both were found in dune habitats, although they are not limited to dunes throughout their range (Krombein 1967; Buck et al. 2008).

Although we did not find any paper wasps (genus *Polistes*) in the Park this summer, they are recorded historically and are certainly an important element of the fauna. In northern Michigan a single species, *Polistes fuscatus*, is native, but a second, introduced species, *P. dominulus*, has become common in lower Michigan and has started to appear in the area of the Park (Gamboa et al. 2004; Judd & Carpenter 1996). We expect to find *P. dominulus* in the park. So far, *P. dominulus* coexists with *P. fuscatus*, but watching the status of populations of the native *P. fuscatus* versus the introduced *P. dominulus* may be worthwhile (Cervo et al. 2000).

Many species of Pentatomoidea not recorded from the Park are known from the upper part of the Lower Peninsula and most likely would be located with additional sampling effort. The two most effect ways to increase our knowledge of this group would be by 1) more intensive sweep sampling, particularly in the late summer and fall, and 2) light trapping. Sampling of Vespidae is much more complete, but one or two social species and several solitary species are still likely to occur in the park. Aerial netting at flowers is the most effect way of completing this part of the survey, but it is likely to take an extended effort as rarer species are sought.

Acknowledgements

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Table 1. Species of Acanthosomatidae, Corimelaenidae, Pentatomidae, Scutelleridae and Vespidae documented from Wilderness State Park from late June through August 2014 (and historical records). County records indicated by asterisks.

Hemiptera

Acanthosomatidae

Elasmucha lateralis

Corimelaenidae

Galgupha aterrima

*Galgupha ovalis**

Pentatomidae

Acrosternum hilare

Apoecilus bracteatus

Banasa dimidiata

Chlorochroa persimilis

Coenus delius

*Euschistus ictericus**

Euschistus servus

Euschistus tristigmus

Holcostethus limbolarius

*Picromerus bidens**

Podisus serieventris

Stiretrus fimbriatus

Thyanta custator accerra

Scutelleridae

Eurygaster alternatus

Homaemus aeneifrons

*Phimodera binotata**

Hymenoptera

Vespidae

Ancistrocerus adiabatus

*Ancistrocerus albophaleratus**

Ancistrocerus antilope

Ancistrocerus catskill

Ancistrocerus unifasciatus

*Ancistrocerus waldenii**

Dolichovespula adulterina

Dolichovespula arenaria

Dolichovespula maculata

*Dolichovespula norvegicoides**

*Eumenes crucifera**

Euodynerus foraminatus

*Euodynerus leucomelas**
*Parancistrocerus pennsylvanicus**
Polistes fuscatus
Stenodynerus fundatiformis
Symmorphus albomarginatus
*Symmorphus canadensis**
Vespula consobrina
Vespula flavopilosa
*Vespula vulgaris**

Table 2. Additional records of 71 species from previously surveyed families (2011-2013) in Wilderness State Park. These additions were found in the summers after the initial surveys and located in historical records. County records indicated by asterisks.

Odonata

Aeshnidae

Aeshna tuberculifera
Aeshna umbrosa
Gomphaeshna furcillata

Corduliidae

Cordulia shurtleffi

Libellulidae

Leucorrhinia glacialis
Plathemis lydia

Coenagrionidae

Enallagma civile

Lestidae

Lestes unguiculatus
Lestes vigilax

Orthoptera

Acrididae

Spharagemon collare

Tettigoniidae

Orchelimum vulgare
Orphulella speciosa

Tetrigidae

Paratettix cucullatus

Lepidoptera

Hesperiidae

Carterocephalus palaemon
Erynnis icelus
Erynnis juvenalis
Euphyes bimacula
*Euphyes conspicua**

Lycaenidae

Callophrys niphon
Celastrina ladon
Glaucopsyche lygdamus
Lycaena phlaeas
Satyrium calanus

Nymphalidae

Nymphalis antiopa

Coleoptera

Cerambycidae

Bellamira scalaris
Callimoxys sanguinicollis
Cyrophorus verrucosus
Eutrichillus biguttatus
Leptura subhamata
Microgoes oculatus
Molorchus bimaculatus
Saperda calcarata (corrected ID for *S. vestita* in previous list)
Stictoleptura canadensis

Chrysomelidae

Acalymma vittatum
Altica canadensis
Altica corni
Calligrapha multipunctata
Calligrapha spiraeae
Chalepus walshi
Chrysolina quadrigemina
Cryptocephalus calidus
Derocrepis carinata
Entomoscelis americana
Pachybrachis cephalicus
Pachybrachis nigricornis
Pachybrachis peccans

Pyrrhalta alni

Coccinellidae

Brachiacantha ursina

Hippodamia quinquesignata

Hippodamia variegata

Psyllobora vigintimaculata

Diptera

Tabanidae

Chrysops cuclux

Chrysops sordidus

Hybomitra lurida

Bombyliidae

Bombylius mexicanus

Hemipenthes webberi

Syrphidae

Blera analis

Brachyopa ferruginea

Cheilosia shannoni

Chrysogaster ca. robusta

Eupeodes americanus

Eupeodes latifasciatus

Eupeodes perplexus

Helophilus latifrons

Lejops lineatus

Platycheirus hyperboreus

Rhingia nasica

Sericomyia militaris

Temnostoma alternans

Temnostoma balyras

Temnostoma trifasciatus

Species	County	Location	Date	Collector	Notes	Family	Collection
<i>Elasmucha lateralis</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	2-Aug-13	Brian Scholtens		Acanthosomatidae	BGS
<i>Galgupha aterrima</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	10-Jul-14	Brian Scholtens		Corimelaenidae	BGS
<i>Galgupha aterrima</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	10-Jul-14	Brian Scholtens		Corimelaenidae	BGS
<i>Galgupha aterrima</i>	Emmet	WSP, Sturgeon Bay dunes, T39N R5W Sec 5	10-Jul-00	Joseph Reznick		Corimelaenidae	UMBS
<i>Galgupha ovalis</i>	Emmet	WSP, Nebo Trail; 45.753N 84.878W	24-Jul-14	Brian Scholtens		Corimelaenidae	BGS
<i>Acrosternum hilare</i>	Emmet	WSP, Sturgeon Bay dunes north; 45.7126N 84.9429W	3-Jul-14	Sydney K. Wickenheiser		Pentatomidae	BGS
<i>Apoecilus bracteatus</i>	Emmet	WSP, Waugoshance Island	23-Aug-21	S. Moore		Pentatomidae	UMMZ
<i>Banasa dimidiata</i>	Emmet	WSP, Big Stone Bay	30-Jul-21	T. H. Hubbell		Pentatomidae	UMMZ
<i>Banasa dimidiata</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	31-Jul-14	Johanna Nifosi		Pentatomidae	BGS
<i>Chlorochroa persimilis</i>	Emmet	WSP	4-Oct-96	M. O'Brien	MFO961004-2	Pentatomidae	UMMZ
<i>Chlorochroa persimilis</i>	Emmet	WSP	6-Oct-96	M., A. & M. O'Brien	MFO961006-1	Pentatomidae	UMMZ
<i>Chlorochroa persimilis</i>	Emmet	WSP, on dunes at Sturgeon Bay, T39N R5W Sec 5	10-Jul-00	Joseph Reznick		Pentatomidae	UMBS
<i>Chlorochroa persimilis</i>	Emmet	WSP, Sturgeon Bay dunes, T38N R5W Sec 5 & 8	26-Jul-00		on <i>Tanacetum huronense</i>	Pentatomidae	UMBS
<i>Chlorochroa persimilis</i>	Emmet	WSP, Sturgeon Bay dunes, T38N R5W Sec 5 & 8	26-Jul-00		on <i>Tanacetum huronense</i>	Pentatomidae	UMBS
<i>Chlorochroa persimilis</i>	Emmet	WSP, Waugoshance Pt.	2-Aug-21	S. Moore		Pentatomidae	UMMZ
<i>Coenus delius</i>	Emmet	WSP, boat launch field; 45.7472N 84.9100W	10-Jul-14	Matt Pierle	on <i>Verbascum thapsus</i>	Pentatomidae	BGS
<i>Coenus delius</i>	Emmet	WSP, Waugoshance Pt.	2-Aug-21	S. Moore		Pentatomidae	UMMZ
<i>Euschistus ictericus</i>	Emmet	WSP, O'Neal Flooding; 45.7129N 84.9044W	4-Aug-11	Brian Scholtens		Pentatomidae	BGS
<i>Euschistus servus</i>	Emmet	WSP, boat launch; 45.748N 84.909W	10-Jul-14	Amanda L. Treviño		Pentatomidae	BGS
<i>Euschistus tristigmus</i>	Emmet	WSP, boat launch field; 45.7477N 84.9087W	10-Jul-14	Sydney K. Wickenheiser		Pentatomidae	BGS
<i>Euschistus tristigmus</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	10-Jul-14	Brian Scholtens		Pentatomidae	BGS
<i>Euschistus tristigmus</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	2-Aug-13	Brian Scholtens		Pentatomidae	BGS
<i>Euschistus tristigmus</i>	Emmet	WSP, Nebo Trail; 45.753N 84.878W	3-Jul-14	Brian Scholtens		Pentatomidae	BGS
<i>Euschistus tristigmus</i>	Emmet	WSP, Sturgeon Bay dunes, T39N R5W Sec 5	10-Jul-00	Joseph Reznick		Pentatomidae	UMBS
<i>Euschistus tristigmus</i>	Emmet	WSP, Waugoshance Island	23-Aug-21	S. Moore		Pentatomidae	UMMZ
<i>Holcostethus limbolaris</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-21	S. Moore		Pentatomidae	UMMZ
<i>Holcostethus limbolaris</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-21	S. Moore		Pentatomidae	UMMZ
<i>Picromerus bidens</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	20-Jul-12	Brian Scholtens		Pentatomidae	BGS
<i>Podisus serieventris</i>	Emmet	WSP, Waugoshance Pt.	2-Aug-21	S. Moore		Pentatomidae	UMMZ
<i>Stiretrus fimbriatus</i>	Emmet	WSP, boat launch field; 45.7472N 84.9100W	10-Jul-14	Liesl Oeller		Pentatomidae	BGS
<i>Thyanta custator accerra</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	20-Jul-12	Brian Scholtens		Pentatomidae	BGS
<i>Thyanta custator accerra</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	31-Jul-14	Matt Pierle		Pentatomidae	BGS
<i>Thyanta custator accerra</i>	Emmet	WSP, Sturgeon Bay dunes, T39N R5W Sec 5 & 8	26-Jul-00			Pentatomidae	UMBS
<i>Eurygaster alternatus</i>	Emmet	WSP, marsh next to Goose Bay, T39N R5W Sec 19	10-Jul-00	Joseph Reznick		Scutelleridae	UMBS
<i>Eurygaster alternatus</i>	Emmet	WSP, marsh next to Goose Bay, T39N R5W Sec 19	10-Jul-00	Joseph Reznick		Scutelleridae	UMBS
<i>Eurygaster alternatus</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-21	S. Moore		Scutelleridae	UMMZ
<i>Eurygaster alternatus</i>	Emmet	WSP, Waugoshance Pt.	5-Aug-21	S. Moore		Scutelleridae	UMMZ
<i>Eurygaster alternatus</i>	Emmet	WSP, Waugoshance Pt.	5-Aug-21	S. Moore		Scutelleridae	UMMZ
<i>Eurygaster alternatus</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-64			Scutelleridae	UMBS
<i>Eurygaster alternatus</i>	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	6-Jul-12	Brian Scholtens		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	7-Aug-12	Brian Scholtens		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, end of gravel; 45.7528N 84.9202W	20-Jul-12	Brian Scholtens		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, Nebo Trail field; 45.7513N 84.8799W	12-Aug-11	Brian Scholtens		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Liesl Oeller		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Liesl Oeller		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Liesl Oeller		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Liesl Oeller		Scutelleridae	BGS
<i>Homaemus aeneifrons</i>	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Johanna Nifosi		Scutelleridae	BGS

Homaemus aeneifrons	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Ivan Monagan		Scutelleridae	BGS
Homaemus aeneifrons	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Brian Scholtens		Scutelleridae	BGS
Homaemus aeneifrons	Emmet	WSP, Nebo Trail field; 45.753N 84.878W	24-Jul-14	Brian Scholtens		Scutelleridae	BGS
Homaemus aeneifrons	Emmet	WSP, Sturgeon Bay, T38N R5W NW 1/4 of Sec 8	9-Aug-00	Brian Scholtens		Scutelleridae	BGS
Homaemus aeneifrons	Emmet	WSP, Waugoshance Pt.	4-Aug-21	S. Moore		Scutelleridae	UMMZ
Homaemus aeneifrons	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	31-Jul-14	Johanna Nifosi		Scutelleridae	BGS
Homaemus aeneifrons	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	31-Jul-14	Brian Scholtens		Scutelleridae	BGS
Phimodera binotata	Emmet	WSP, Sturgeon Bay dunes; 16T E0659398 N5063381	1-Jul-14	Jaclyn Inkster		Scutelleridae	BGS
Ancistrocerus adiabatus	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
Ancistrocerus adiabatus	Emmet	WSP, dunes Gill Rd.; 45.7126N 84.9429W	15-Aug-13	Brian Scholtens		Vespidae	BGS
Ancistrocerus adiabatus	Emmet	WSP, Nebo field; 45.753N 84.878W	12-Jul-13	Brian Scholtens		Vespidae	BGS
Ancistrocerus adiabatus	Emmet	WSP, Nebo trailhead; 45.7549N 84.8771W	1-Aug-13	Brian Scholtens		Vespidae	BGS
Ancistrocerus adiabatus	Emmet	WSP, Waugoshance Pt.	4-Aug-64			Vespidae	UMBS
Ancistrocerus adiabatus	Emmet	WSP, Waugoshance Pt.	4-Aug-64			Vespidae	UMBS
Ancistrocerus albophaleratus	Emmet	WSP, Goose Pond; 45.743N 84.897W	10-Jul-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus albophaleratus	Emmet	WSP, pond S. of campground; 45.7434N 84.8973W	7-Aug-12	Brian Scholtens		Vespidae	BGS
Ancistrocerus albophaleratus	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	2-Aug-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus albophaleratus	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	2-Aug-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus albophaleratus	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	16-Jun-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus antilope	Emmet	WSP	1-Aug-46	H. B. Hungerford		Vespidae	UMBS
Ancistrocerus antilope	Emmet	WSP	1-Aug-46	H. B. Hungerford		Vespidae	UMBS
Ancistrocerus antilope	Emmet	WSP, Waugoshance Pt.	4-Aug-64			Vespidae	UMBS
Ancistrocerus catskill	Emmet	WSP, boat launch field; 45.747N 84.910W	10-Jul-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus catskill	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	2-Aug-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus catskill	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	2-Aug-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus catskill	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus unifasciatus	Emmet	WSP	1-Aug-46	H. B. Hungerford		Vespidae	UMBS
Ancistrocerus unifasciatus	Emmet	WSP, Nebo Trail; 45.752N 84.878W	24-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
Ancistrocerus waldenii	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	15-Jun-14	Brian Scholtens		Vespidae	BGS
Ancistrocerus waldenii	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula adulterina	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Amanda L. Treviño		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Amanda L. Treviño		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Amanda L. Treviño		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Amanda L. Treviño		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Amanda L. Treviño		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
Dolichovespula arenaria	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS

<i>Dolichovespula arenaria</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	7-Aug-12	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Goose Pond; 45.743N 84.897W	2-Aug-14	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Nebo Trail; 45.752N 84.878W	24-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Nebo Trail; 45.752N 84.878W	24-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Nebo Trail; 45.752N 84.878W	24-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Nebo Trail; 45.753N 84.878W	24-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Nebo trailhead; 45.7549N 84.8771W	1-Aug-13	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	2-Aug-14	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	2-Aug-14	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	2-Aug-14	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-64			Vespidae	UMBS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-64			Vespidae	UMBS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula arenaria</i>	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Dolichovespula maculata</i>	Emmet	WSP	19-Aug-88	M. & A. O'Brien		Vespidae	UMMZ
<i>Dolichovespula maculata</i>	Emmet	WSP	4-Oct-96	M O'Brien	MFO961004-2	Vespidae	UMMZ
<i>Dolichovespula maculata</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	10-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Dolichovespula maculata</i>	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
<i>Dolichovespula maculata</i>	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
<i>Dolichovespula maculata</i>	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
<i>Dolichovespula maculata</i>	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
<i>Dolichovespula norvegicoides</i>	Emmet	WSP, Nebo trailhead; 45.7549N 84.8771W	1-Aug-13	Brian Scholtens		Vespidae	BGS
<i>Eumenes crucifera</i>	Emmet	WSP, Nebo Trail; 45.752N 84.878W	24-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Euodynerus foraminatus</i>	Emmet	WSP	1-Aug-46	H. B. Hungerford		Vespidae	UMBS
<i>Euodynerus foraminatus</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	10-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Euodynerus foraminatus</i>	Emmet	WSP, Nebo Trail; 45.752N 84.878W	3-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Euodynerus leucomelas</i>	Emmet	WSP, Nebo Trail; 45.752N 84.878W	3-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Parancistrocerus pennsylvanicus</i>	Emmet	WSP, Bliss Beach; 45.6898N 84.9661W	28-Jul-11	Brian Scholtens		Vespidae	BGS
<i>Parancistrocerus pennsylvanicus</i>	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	3-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Parancistrocerus pennsylvanicus</i>	Emmet	WSP, Sturgeon Bay dunes; 45.713N 84.943W	3-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Polistes fuscatus</i>	Emmet	WSP	19-Aug-88	M. & A. O'Brien		Vespidae	UMMZ
<i>Polistes fuscatus</i>	Emmet	WSP	6-Oct-96	M., A., & M. O'Brien	MFO961005-1	Vespidae	UMMZ
<i>Polistes fuscatus</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	20-Jul-12	Brian Scholtens		Vespidae	BGS
<i>Stenodynerus fundatiformis</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-60	R. E. Beer		Vespidae	UMBS
<i>Symmorphus albomarginatus</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Ivan V. Monagan, Jr.		Vespidae	BGS
<i>Symmorphus albomarginatus</i>	Emmet	WSP, boat launch; 45.7477N 84.9087W	10-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Symmorphus canadensis</i>	Emmet	WSP, Nebo Trail; 45.753N 84.878W	3-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Vespula consobrina</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Vespula consobrina</i>	Emmet	WSP, boat launch field; 45.747N 84.910W	31-Jul-14	Brian Scholtens		Vespidae	BGS
<i>Vespula consobrina</i>	Emmet	WSP, Waugoshance Pt.	4-Aug-64			Vespidae	UMBS
<i>Vespula flavopilosa</i>	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
<i>Vespula flavopilosa</i>	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
<i>Vespula flavopilosa</i>	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ

Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, near lakeshore	31-Aug-48	R. M. Bailey		Vespidae	UMMZ
Vespula flavopilosa	Emmet	WSP, O'Neill Flooding; 45.7128N 84.9044W	2-Aug-14	Brian Scholtens		Vespidae	BGS
Vespula flavopilosa	Emmet	WSP, O'Neill Flooding; 45.7128N 84.9044W	2-Aug-14	Brian Scholtens		Vespidae	BGS
Vespula vulgaris	Emmet	WSP, Bliss Beach; 45.706N 84.952W	23-Jul-13	Brian Scholtens		Vespidae	BGS
Vespula vulgaris	Emmet	WSP, Waugoshance Pt.; 45.757N 84.972W	31-Jul-14	Brian Scholtens		Vespidae	BGS

Appendix 2: Summary of all species identified during 4 years of insect surveys at Wilderness State Park, 2011-2014. County records are indicated by asterisks.

Odonata

Aeshnidae

Aeshna canadensis
Aeshna clepsydra *
Aeshna tuberculifera
Aeshna umbrosa
Anax junius
Gomphaeshna furcillata

Calopterygidae

Calopteryx maculata

Coenagrionidae

Amphagrion saucium
Argia fumipennis
Chromagrion conditum
Enallagma civile
Enallagma ebrium
Enallagma hageni
Ischnura posita
Ischnura verticalis
Nehalennia irene

Corduliidae

Cordulia shurtleffi
Dorocordulia libera *
Somatochlora walshii

Gomphidae

Gomphus exilis
Gomphus spicatus
Hagenius brevistylus
Ophiogomphus rupinsulensis

Lestidae

Lestes eurinus *
Lestes disjunctus
Lestes unguiculatus
Lestes vigilax

Libellulidae

Celithemis elisa
Leucorrhinia frigida
Leucorrhinia intacta
Leucorrhinia proxima
Leucorrhinia glacialis
Ladona julia
Libellula luctuosa *
Libellula pulchella

Libellula quadrimaculata
Nannothemis bella
Plathemis lydia
Sympetrum costiferum
Sympetrum danae
Sympetrum internum
Sympetrum obtrusum
Sympetrum rubicundulum
Sympetrum vicinum

Orthoptera

Acrididae

Arphia sulphurea *
Booneacris glacialis *
Camnula pellucida
Chloealtis conspersa *
Chorthippus curtipennis
Chortophaga viridifasciata *
Dissosteira carolina
Melanoplus bivittatus
Melanoplus borealis *
Melanoplus islandicus
Melanoplus sanguinipes
Melanoplus stonei
Spharagemon collare
Spharagemon marmorata *
Trimerotropis huroniana
Trimerotropis verruculata

Gryllidae

Allonemobius fasciatus *
Gryllus pennsylvanicus

Rhaphidophoridae

Ceuthophilus meridionalis

Tetrigidae

Paratettix cucullatus

Tettigoniidae

Conocephalus fasciatus
Orchelimum vulgare
Orphulella speciosa

Hemiptera

Acanthosomatidae

Elasmucha lateralis

Corimelaenidae

Galgupha aterrima

*Galgupha ovalis**

Pentatomidae

Acrosternum hilare
Apoecilus bracteatus
Banasa dimidiata
Chlorochroa persimilis
Coenus delius
*Euschistus ictericus**
Euschistus servus
Euschistus tristigmus
Holcostethus limbolarius
*Picromerus bidens**
Podisus serieventris
Stiretrus fimbriatus
Thyanta custator accerra

Scutelleridae

Eurygaster alternatus
Homaemus aeneifrons
*Phimodera binotata**

Coleoptera

Cerambycidae

*Anelaphus parallelus **
Bellamira scalaris
Callimoxys sanguinicollis
Cyrophorus verrucosus
*Enaphalodes rufulus **
Eutrichillus biguttatus
Leptura plebeja
Leptura subhamata
Microgoes oculatus
Molorchus bimaculatus
Orthosoma brunneum
Parandra brunnea
Pygoleptura nigrella
Saperda calcarata
*Saperda mutica **
Saperda populnea moesta
Stictoleptura canadensis
*Strangalepta abbreviata **
Tetraopes tetraophthalmus
*Trigonarthris minnesotana **
*Trigonarthris proxima **
Typocerus velutinus

Urographis fasciatus *

Chrysomelidae

Acalymma vittatum
Altica browni?*
*Altica canadensis**
*Altica chalybea**
Altica corni
Altica subplicata
Anomoea laticlavia
Calligrapha multipunctata
Calligrapha spiraeae
Chalepus walshi
Chrysolina quadrigemina
Chrysochus auratus
Chrysomela scripta
Cryptocephalus calidus
Cryptocephalus notatus
*Deloyala guttata**
Derocrepis carinata
Diabrotica undecimpunctata
Diachus auratus
Diachus catarius
Disonycha alternata
*Disonycha arizonae**
*Distigmoptera apicalis**
Donacia fulgens?*
Donacia pubescens
Entomoscelis americana
Exema canadensis
Labidomera clivicollis
Leptinotarsa decemlineata
*Lexiphanes saponatus**
*Ophraella notata**
Pachybrachis cephalicus
Pachybrachis nigricornis
Pachybrachis peccans
*Phratora purpurea**
Pyrrhalta alni
Pyrrhalta decora
Trirhabda canadensis

Coccinellidae

Anatis mali
*Anisosticta bitriangularis**
Brachiacantha ursina

Chilocorus stigma
Coccinella novemnotata
*Coccinella septempunctata**
Coccinella transversoguttata
*Coccinella trifasciata**
*Coleomegilla maculata**
Cycloneda munda
Harmonia axyridis
Hippodamia convergens
Hippodamia parenthesis
Hippodamia quinquesignata
Hippodamia variegata
*Hyperaspis binotata**
*Mulsantina hudsonica**
Psyllobora vigintimaculata
Scymnus sp.

Lepidoptera

Hesperiidae

Ancyloxypha numitor
Carterocephalus palaemon
Erynnis icelus
Erynnis juvenalis
Euphyes bimacula
*Euphyes conspicua**
Euphyes ruricola
*Poanes viator **
Poanes hobomok
Polites mystic
Polites themistocles
*Polites origenes **
Polites peckius
Thymelicus lineola
*Wallengrenia egeremet **

Lycaenidae

Callophrys niphon
Celastrina ladon
Celastrina neglecta
Cupido comyntas
Feniseca tarquinius
Glaucopsyche lygdamus
Lycaena dorcas
Lycaena phlaeas
Satyrium calanus
Satyrium titus
Satyrium liparops

Satyrium acadicum

Nymphalidae

Aglais milberti

Cercyonis pegala

Coenonympha tullia

Danaus plexippus

Junonia coenia

Lethe eurydice

Lethe anhedon

Limenitis arthemis astyanax

Limenitis archippus

Nymphalis antiopa

Phyciodes coctya

Speyeria cybele

Speyeria atlantis

Speyeria aphrodite

Papilionidae

Papilio canadensis

Papilio polyxenes

Pieridae

Colias eurytheme

Colias philodice

Pieris rapae

Pieris oleracea

Hymenoptera

Vespidae

Ancistrocerus adiabatus

*Ancistrocerus albophaleratus**

Ancistrocerus antilope

Ancistrocerus catskill

Ancistrocerus unifasciatus

*Ancistrocerus waldenii**

Dolichovespula adulterina

Dolichovespula arenaria

Dolichovespula maculata

*Dolichovespula norvegicoides**

*Eumenes crucifera**

Euodynerus foraminatus

*Euodynerus leucomelas**

*Parancistrocerus pennsylvanicus**

Polistes fuscatus

Stenodynerus fundatiformis

Symmorphus albomarginatus

*Symmorphus canadensis**

Vespula consobrina

Vespula flavopilosa
*Vespula vulgaris**

Diptera

Tabanidae

Chrysops vittatus
Chrysops aberrans
*Chrysops montanus**
*Chrysops delicatulus**
Chrysops sordidus
Chrysops sackeni
*Chrysops frigidus**
*Chrysops macquarti**
*Chrysops univittatus**
Chrysops cuclux
Chrysops excitans
*Chrysops aestuans**
*Chrysops cincticornis**
*Chrysops mitis**
*Chrysops carbonarius**
*Tabanus atratus**
*Tabanus catenatus**
*Tabanus marginalis**
*Tabanus similis**
Hybomitra zonalis
Hybomitra sodalis
*Hybomitra pechumani**
Hybomitra lasiophthalma
Hybomitra nuda
Hybomitra lurida
Hybomitra trepida
*Hybomitra epistates**
*Hybomitra affinis**

Bombyliidae

Bombylius mexicanus
Bombylius pygmaeus
*Poecilognathus sulphureus**
*Tmemophlebia coquilletti**
*Systoechus vulgaris**
*Lepidophora lutea**
*Poecilanthrax tegminipennis**
*Poecilanthrax alcyon**
Exoprosopa fascipennis
*Exoprosopa fasciata**
*Dipalta banksi**

*Paravilla separata**
*Chrysanthrax dispar**
*Villa arenicola**
Villa lateralis
*Villa nigra**
*Villa pretiosa**
*Villa nigricauda**
*Hemipenthes comanche**
*Hemipenthes seminigra**
Hemipenthes sinuosa
Hemipenthes webberi

Syrphidae

Allograpta obliqua
Blera analis
Brachyopa ferruginea
Chalcosyrphus nemorum
*Chalcosyrphus piger**
Cheilosia shannoni
Chrysogaster ca. robusta
*Epistrophella emarginatus**
Eristalis anthophorina
Eristalis arbustorum
Eristalis dimidiata
*Eristalis hirta**
*Eristalis stipator**
Eristalis transversa
Eupeodes americanus
Eupeodes latifasciatus
Eupeodes perplexus
Helophilus fasciatus
Helophilus latifrons
*Lejops chrysotomus**
Lejops lineatus
*Melanostoma mellinum**
*Paragus haemorrhous**
Platycheirus hyperboreus
*Platycheirus quadratus**
*Pyrophaena granditarsis**
Rhingia nasica
Sericomyia militaris
Sphaerophoria contigua
Spilomyia fusca
*Spilomyia sayi**
Syritta pipiens
Syrphus rectus

*Syrphus ribesii**
Temnostoma alternans
Temnostoma balyras
*Temnostoma barberi**
Temnostoma trifasciatus
Toxomerus geminatus
*Toxomerus marginatus**
Xylota angustiventris
Xylota ejuncida
*Xylota subfasciata**