Orthoptera Species Diversity & Composition at Wilderness State Park

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Ecology & Evolutionary Biology 442, Biology of Insects
13 August 2011
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Abstract

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Introduction

Throughout the world today, the conservation of biological diversity is a more pressing issue than ever before. We are constantly discovering new reasons why the preservation of various organisms is ultimately vital to our planet's overall health. Pre-human extinction rates were 100-1000 times less than extinction rates today, suggesting that the exponential growth of the human population may be taking a serious toll on a wide range of species (Pimm *et al.* 1995). Individuals of nearly all taxa are affected by a number of current anthropogenic environmental problems: atmospheric pollution and climate change, habitat destruction, intensive farming, invasive species, and overpopulation (Rield 1995). To begin the process of preserving various species in response to the issues above, their ecology must be well understood and population

growth trends fairly well documented (Hayek 2010). Without this information, it may be difficult to know where to begin in preserving a species and the environment that it requires to thrive.

Some of the most powerful resources we have for conducting conservation-based surveys and studies are natural areas that are protected by law. In the United States, we are fortunate to have a number of national and state parks in which flora and fauna are carefully monitored and protected. Spanning the country, these parks can be host to a wide array of habitats such as woodlands, canyons, deserts, wetlands, marine habitats and mangroves, and mountains (Pimm *et al.* 1995). Because these areas are largely undisturbed by human activity, we are able to compare past population trends to the present, and predict future trends (Hayek 2010). This is important in constructing methods of conservation for the unique biota located within each area. Increasingly scientists are turning to these parks as study sites to better understand ecological interactions, as well as how our planet is affected by human activity (Pimm *et al.* 1995).

The Great Lakes region is composed of a wide array of landforms and ecosystems that all affect biodiversity. Located in Emmet County, Michigan, Wilderness State Park is an area within this diverse region, and consists of many unique habitats and microhabitats. The terrain covers approximately 10,512 acres and is a mixture of coniferous and hardwood forests (DuFresne 2005). Some of the habitats interspersed throughout this mixture include sand dunes, forests, meadows, and various wetland systems such as ponds and swamps. Among the various biota found within the park, insects play key functional roles in the described habitats and almost every other terrestrial or freshwater ecosystem (McGeoch et al 2010). A thorough understanding of these roles and the population trends of the insects within the park will provide a strong baseline for future studies to work with: an extremely important factor when considering issues such as global climate change.

Among the insects abundant in Wilderness State Park, Orthopterans (grasshoppers, crickets, and katydids) are easily accessible and therefore good candidates for biodiversity surveys. There are close relationships between the health of various ecosystems and the Orthopterans that live there; the biodiversity of Orthopterans in an ecosystem can provide important clues as to how that habitat functions and stays healthy,

or how it can become unbalanced (Wei-Zhong et al 2006). Considered pests in many parts of the world, short-horned grasshoppers can inflict severe damage upon grasslands, crops, agricultural fields, and gardens if their populations are not properly managed. As terrestrial herbivores that feed in open fields in large concentrations, these insects are all potentially destructive if they become too abundant (Ross 1993). In the United States, rangeland damage occurs heavily in the West, whereas damage in Michigan is sporadic and typically much less severe (Bland 2003). The number of eggs laid in a particular spot plays a large role in determining whether or not vegetation will be depleted, and in temperate regions most eggs are laid in summer. Potential pest species in Michigan include *Melanoplus sanguinipes sanguinipes* (migratory grasshopper) and *Melanoplus femurrubrum* (red-legged grasshopper), both of which are found in Wilderness State Park (Bland 2003). Katydids and most crickets in Michigan are relatively harmless; mole crickets (*Gryllotalpidae*) are pests of residential lawns and golf courses in more southwestern states (Dunn 1996). Though many are considered pests, Orthopterans do play significant functional roles in many ecosystems; they are an important source of food and protein for humans in various parts of the world such as Africa and Asia, and are a vital link in the food web for other animals worldwide (Ross 1993). Orthopterans are distributed throughout the world, and of the more than 12,800 species found worldwide, 600 species live in North America and 61 in Michigan (Ross 1993). Because of their ecological and economic important, it is vital to know the Orthopteran species composition of different regions in North America, including those within Wilderness State Park.

Like many insects, Orthopterans are highly responsive to even slight variations in living conditions, some being so dependent on certain conditions that they cannot survive outside of a particular habitat (Dunn 1996). For this reason it is important to sample a variety of habitats when compiling the species composition/biodiversity of a particular region or state park. Common in Wilderness State Park, sand dunes provide little shade and sparse (but varied) vegetation; despite this, various Orthopterans thrive there such as the state-threatened Lake Huron Locust (*Trimerotropis huroniana*). In contrast, meadows and grasslands provide dense cover and abundant vegetation, and are likely to support a wider assortment of plant-feeding grasshoppers and katydids (Dunn 1996). Because of

the ecological differences from habitat to habitat within the park, the species composition of the Orthopterans differs in each. Surveying the populations of different local species can help us answer questions pertaining to ecological interactions between Orthopterans and their biotic environment, and the overall health of the ecosystems in which they live (Dunn 1996).

Measures of the alpha and beta diversity of Orthopterans in each habitat can be used to carry out an assessment of species composition in a particular habitat within the park. The term *alpha diversity* is commonly used when examining a single habitat, and in simple terms is the diversity *within the habitat* being assessed. The *beta* diversity provides information concerning the difference in the numbers of species surveyed *between* habitats (Hayek *et al.* 2010). These two measures helped us carry out an assessment of what grasshopper, cricket, and katydid species live in particular habitats, giving us a clearer understanding of the overall Orthopteran species composition of the park and the significance of this. Because habitat-specific species can greatly influence park management decisions about whether to modify or maintain a particular habitat, this survey is of great importance.

Materials & Methods

Survey Locations: Insect collection occurred within five different habitats in Wilderness State Park over four separate trips. Each collection lasted for a period of one hour in the mid-afternoon. The first collection occurred in a wooded environment on Nebo Trail (45.753°N, 84.878°W) on July 14th, 2011. This trail extends a significant length of the park and cuts through various forest environments and open fields. The second collection took place on a sand dune on South Sturgeon Bay (45.706 N, 84.952 W) on July 21st, 2011. This habitat is very distinct in that it is extremely sandy with sparse vegetation nearest to the shore. The third collection took place in a field near Big Stone Creek (45.742 N, 84.897 W), also on July 21st, 2011. This area was somewhat of a hybrid of the two previous sites, with tall grasses/meadows and woodland on the borders. The fourth collection occurred at Waugoshance Point (45.757°N, 84.972°W) on July 28th, 2011. This site is swampy and has an abundance of tall grasses that meet the tree line that separates

the point from the lakeshore. The final collection occurred along the road that leads to the previously sampled Waugoshance Point (45.7542 N, 84.9420 W) on August 4th, 2011. This area is densely wooded but very sunny.

Insect Collection: Aerial and sweep nets were used at all five collection sites. The sweep net is most effective where vegetation is dense and aerial netting is more difficult. A group of three students sampled each area for the hour and captured as many Orthopterans as possible. After sweeping, nets were inspected for Orthopterans; any that were spotted were picked from the net and immediately placed inside the cyanide killing jars, with the exception of the endangered Lake Huron locust (*Trimerotropis huroniana*). These individuals were counted and noted on paper by each individual member, then released. To check for this species, we grasped individuals by the thorax and spread the forewing to look for particular patterns and colors. The Lake Huron locust has a prominent dark band on its wing that is easily identifiable in the field, and this is how we distinguished them from other species. Insects of other orders were discarded from the net to clean it before the next sweeping. Aerial netting was employed in areas with sparser vegetation such as the sand dune, where the collector could take advantage of flying Orthopterans by netting them out of the air. After each one-hour sampling, all group members' collected Orthopterans were pooled and placed in containers corresponding to each collection site.

On July 28th, 2011, pitfall traps were deployed at three of the five sites for a period of seven days. Two traps each were placed at Waugoshance Point (45.757°N, 84.972°W), the forest off of Nebo Trail (45.753°N, 84.878°W), and the South Sturgeon Bay dune (45.706 N, 84.952 W). These traps are set at ground level so that passing insects fall in and are unable to crawl out. We placed them in somewhat secluded areas at each site to avoid disturbance by human activity. To deploy a pitfall trip, a small spade was used to remove a section of soil about 6 inches deep. A large plastic cup was inserted into this hole and the earth was packed tightly around it, but not covering the top. This left no space in between the soil and the cup for insects to fall in to. To maximize the amount of insects collected in the traps, three plastic pieces 18 inches long and 4 inches tall were evenly spaced about the top of the cup and sunk into the soil an inch or two. Together these pieces created long alleys that would encourage the insects towards the

trap by making escape more difficult. To complete each trap, the cups were filled with about 4 inches of Propylene glycol, which kills the insects. Upon collection, the traps were emptied into jars to be sorted later at the lab; here, each trap's collected Orthopterans were placed into a vial of alcohol for preservation. All individuals collected were keyed to the species level using the following guide: *The Orthoptera of Michigan: Biology, Keys, and Descriptions of Grasshoppers, Katydids, and Crickets* (Bland, 2003).

Statistical Analysis: The species richness for all sites was calculated by tallying the number of species of grasshoppers, crickets, and katydids. The species diversity of each separate site was determined using the Simpson's Index and the inverse of that index. A species accumulation curve was created based on the chao 1 estimate. The Shannon Index was used was used to define the Alpha diversity (diversity of species in each habitat); the beta diversity was also calculated.

Results

A total of 263 Orthopterans were collected from all five sites, and are represented as follows: 17 different species, 13 of which were Acrididae, 2 of which were Gryllidae, 1 of which was Rhaphidophoridae, and 1 of which was Tettigoniidae (Table 1). The species accumulation curve (Figure 1) shows an estimation of the number of species in Wilderness State Park, calculated using the chao 1 method. The alpha diversity, or how diverse each sampling area is, is represented in Table 2 and was calculated for each site using the Simpson's and Shannon indices, as well as the inverse of the Simpson's index. The beta diversity was calculated to 0.4166. Table 3 illustrates comparisons of our results to other state records and those from the University of Michigan Biological Station (UMBS) in Cheboygan County, Michigan; an "X" indicates that the species has been found in the area marked.

Discussion

Because different species of Orthopterans occupy a wide range of habitats, our five unique sampling sites were a very important factor in conducting this survey. The highest number of different species was found at Waugoshance Point, while the highest abundance of individuals total was found at the South Sturgeon Bay sand dune. These

results can be attributed to the differences in the habitats. Waugoshance Point has tall grasses, dense shrubs in certain areas, and can become flooded or dry depending on the season; it is relatively unstable compared to the other habitats sampled. Individuals who make their home here must be able to take advantage of these varying conditions, and this may be a reason for the higher species diversity. The changing conditions allow room for different species to specialize somewhat in a particular microhabitat or on a certain grass (Ross 1993). *Melanoplus sanguinipes*, or the migratory grasshopper, was very abundant on the point, with 48 individuals captured during the sampling. This species is successful in a number of areas in North America with herbaceous plant cover, and feeds on many species of plants (Bland 2003). This would make Waugoshance Point an ideal home for it, and could account for the high number of individuals collected. The second most abundant species on the point was *Allonemobius fasciatus,* the Striped Ground cricket, with 29 individuals caught. The majority of these crickets were caught in the pit fall traps. This species is commonly found in wooded areas and meadows (Bland 2003), which is descriptive of a large area of the point. The other eight species of Orthopterans found on the point were not nearly as abundant, which is why the site itself did not have the highest Orthoptera abundance.

With 125 individuals collected, the South Sturgeon Bay sand dune had the highest species abundance of all five sites (Table 1). Four species were particularly abundant: *Melanoplus stonei* (45 individuals), the endangered *Trimerotropis huroniana* (32 individuals), *Camnula pellucida* (21 individuals), and *Melanoplus sanguinipes* (17 individuals). *M. stonei* and *T. huroniana* were found at this habitat exclusively, giving insight into their ecological preferences. The sand dunes provide a variety of vegetation for grasshoppers to colonize, though it isn't as abundant as the grasses on Waugoshance Point, for example (Hubbell 1925). *M. stonei* prefers to live and eat around drier grasses and shrubs, which make up a large part of the sand dune flora and may be responsible for it's abundance on the dune (Bland 2003). The preferred habitat of *T. huroniana* is sparsely vegetated, healthily functioning sand dunes; on the dunes it is often the dominant Acrididae species, and its numbers rapidly decline moving away from the dune towards more heavily vegetated habitats (Michigan DNR). The species is threatened mainly due to heavy development of the Great Lakes shorelines, which has destroyed or greatly

degraded its specialized habitat (Michigan DNR). In order to preserve this species, the sand dunes must be properly managed; the abundance of the species at the Sturgeon Bay dune may be a sign that the area is being properly managed and preserved.

The Nebo trail sampling showed a great decline in individuals collected, which can be attributed to a number of factors. First, collection at this site was much more difficult than collection in the vast, open habitats like the sand dune and Waugoshance point. Many individuals were sighted but were able to escape into the very dense vegetation and evade collection. The highest number of individuals collected was *Ceuthophilus meridional,* a species of camel cricket. These crickets tend to prefer cool, damp areas as their habitat, and they feed on leaf debris (Bland 2003). Along the Nebo trail there is a huge abundance of damp leaf litter, making it an ideal habitat for a camel cricket. Various grasshopper species may have been lacking in this habitat due to the lack of open field/meadow type vegetation such as tall grasses, upon which many grasshoppers prefer to feed. Pitfall traps proved to be a successful method of collection for species in this environment, more so than sweep or aerial netting techniques.

The road leading to Waugoshance point was a less successful collection site than the Nebo Trail, with only four individuals collected during the one-hour sampling. Again, difficulty capturing sighted individuals played a role in these results. However, both of the species caught, *Booneacris glacialis* and *Melanoplus islandicus* were found exclusively in this habitat. The first species is a wingless grasshopper found in northern regions. Both species prefer "basking" in openings of light that filter through the canopy (Bland 2003), which is why the *B. glacialis* individual may have been found sitting relatively still in the middle of the road.

The Big Stone Creek habitat was in between the four described samplings as far as species abundance, with 38 individuals collected total. Twenty-nine of these individuals were the species *Dissosteira carolina*, the Carolina locust, which was only found in two other sites in very low abundance. Many of these individuals were also sighted but not caught, as they have a successful evasion strategy: bursts of short but strong flight away from a perceived threat (Dunn 1996). This species was the dominant one of this habitat, taking advantage of the different pond side flora. Katydids were found in relative abundance at this site as well which is expected, as they prefer damp meadows

(Bland 2003). Aside from the Waugoshance point road, this site had the least diversity of the five sampled, which could be attributed to its unique ecology.

During our survey we found 17 different species total of Orthopterans, though this is not representative of the total number of species that live in Wilderness State Park. Because we only collected five times, the species accumulation curve (Fig 1) calculates that there are 32 species of Orthopterans in the park. We might expect to find more species with more thorough or frequent sampling, and perhaps deploying pit traps in more habitats than three. Collecting at times other than the afternoon might also produce different species that appear in the morning or evening, or occupy a different niche. Species turnover between the habitats (beta diversity) was not particularly high or low; two species (*D. carolina* and *G. pennsylvanicus*) occurred in the same three sites, and *M. sanguinipes* occurred in three different sites. No species occurred in all five sites, which might have been unusual considering the differences between the habitats. Our beta diversity value of .4166 indicates that there was not a significantly high turnover rate.

Our results indicate that Wilderness State Park has high species richness for Acrididae (grasshoppers) compared to the property owned by the UMBS. This property isn't as diverse as that of Wilderness State Park, and does not have such distinct habitats and ecosystems within it. There are no sand dunes within the UMBS property, and this is where we found various species in high abundance during our Wilderness State Park sampling. During our sampling we found six species that were not previously on the UMBS records, further demonstrating the species diversity of the park.

Our survey of the Orthoptera at Wilderness State Park aided in our understanding of the functioning of the habitats there and how the park management might continue to preserve them. Results like the abundance of *T. huroniana* on the sand dunes provide insight into why preserving that habitat might be important. Similarly, Waugoshance point had fairly high species diversity, suggesting that it is a healthy habitat that may be home to a wide array of taxa beyond Orthopterans and even insects. Though every species we collected during our samplings has been found before in the state of Michigan, the relatively small size of the park and the decent amount of species we found there is evidence that the preservation of that land seems to be successful, and it may serve as a conservation model for other areas in the country and beyond.

Table 1: Orthoptera Species of Wilderness State Park by Collection Site

Species	Waugoshance Point Marsh (45.757°N, 84.975°W)	South Sturgeon Bay Dunes (45.706°N, 84.952°W)	Nebo Trail (45.753°N, 84.878°W)	Big Stone Creek (45.742°N, 84.897°W)	Waugoshance Point Road (45.753°N, 84.943°W)	Total
Allonemobius fasciatus	29	2				31
Arphia sulphurea	1					1
Booneacris glacialis					1	1
Camnula pellucida	2	21				23
Ceuthophilus meridional			7			7
Chloealtis conspersa			1			1
Chortophaga viridifasciata	5		1			6
Conocephalus fasciatus	2			7		9
Dissosteira carolina	1	2		29		32
Gryllus pennsylvanicus	1	1		1		3
Melanoplus bivittatus				1		1
Melanoplus borealis	1					1
Melanoplus islandicus					3	3
Melanoplus sanguinipes	48	17	1			66
Melanoplus stonei		45				45
Trimerotropis huroniana		32				32
Trimerotropis verruculata	1					1
Total	**91**	**120**	**10**	**38**	**4**	**263**

Table 2: Beta Diversity & Diversity Indices

	Waugoshance Point Marsh	South Sturgeon Bay Dunes	Nebo Trail	Big Stone Creek	Waugoshance Point Road
Simpson's Index	0.3775	0.2569	0.4667	0.6074	0.5
Reciprocal Simpson Index	2.649	3.893	2.143	1.646	2
Shanon Wiener (ln)	1.277	1.479	0.9404	0.7094	0.5623
Multiple-site similarity / Beta diversity	0.4166				

Table 3a: Species Comparison, Acrididae. The bolded rows are the species not previously found in Emmet County, MI

Wilderness State Park	UMBS	State of Michigan	Order	Family	*Genus Species*
	X	X	Orthoptera	**Acrididae**	*Arphia pseudonietana*
X		**X**	**Orthoptera**	**Acrididae**	***Arphia sulphurea***
X		**X**	**Orthoptera**	**Acrididae**	***Booneacris glacialis canadensis***
X	X	X	Orthoptera	**Acrididae**	*Camnula pellucida*
X	**X**	**X**	**Orthoptera**	**Acrididae**	***Chloealtis conspersa***
	X	X	Orthoptera	**Acrididae**	*Chorthippus curtipennis*
X	**X**	**X**	**Orthoptera**	**Acrididae**	***Chortophaga viridifasciata***
X	X	X	Orthoptera	**Acrididae**	*Dissosteira carolina*
X	X	X	Orthoptera	**Acrididae**	*Melanoplus bivittatus*
X		**X**	**Orthoptera**	**Acrididae**	***Melanoplus borealis***
	X	X	Orthoptera	**Acrididae**	*Melanoplus fasciatus*
X		**X**	**Orthoptera**	**Acrididae**	***Melanoplus islandicus***
X	X	X	Orthoptera	**Acrididae**	*Melanoplus sanguinipes*
X		X	Orthoptera	**Acrididae**	*Melanoplus stonei*
	X	X	Orthoptera	**Acrididae**	*Pardalophora apiculata*
	X	X	Orthoptera	**Acrididae**	*Spharagemon collare*
X		X	Orthoptera	**Acrididae**	*Trimerotropis huroniana*
X		X	Orthoptera	**Acrididae**	*Trimerotropis verruculata*

Table 3b: Species Comparison, Gryllidae, Rhaphidophoridae, Tetrigidae, & Teggigoniidae

X	X	X	Orthoptera	**Gryllidae**	*Allonemobius fasciatus*
X	X	X	Orthoptera	**Gryllidae**	*Gryllus pennsylvanicus*
	X	X	Orthoptera	**Gryllidae**	*Gryllus veletis*
	X	X	Orthoptera	**Gryllidae**	*Oecanthus nigricornis*
	X	X	Orthoptera	**Rhaphidophoridae**	*Ceuthophilus latens*
X		X	Orthoptera	**Rhaphidophoridae**	*Ceuthophilus meridionalis*
	X	X	Orthoptera	**Tetrigidae**	*Nomotettix cristatus*
	X	X	Orthoptera	**Tetrigidae**	*Paratettix cucullatus*
	X	X	Orthoptera	**Tetrigidae**	*Tetrix arenosa*
	X	X	Orthoptera	**Tetrigidae**	*Tetrix ornata*
X	X	X	Orthoptera	**Tettigoniidae**	*Conocephalus fasciatus*

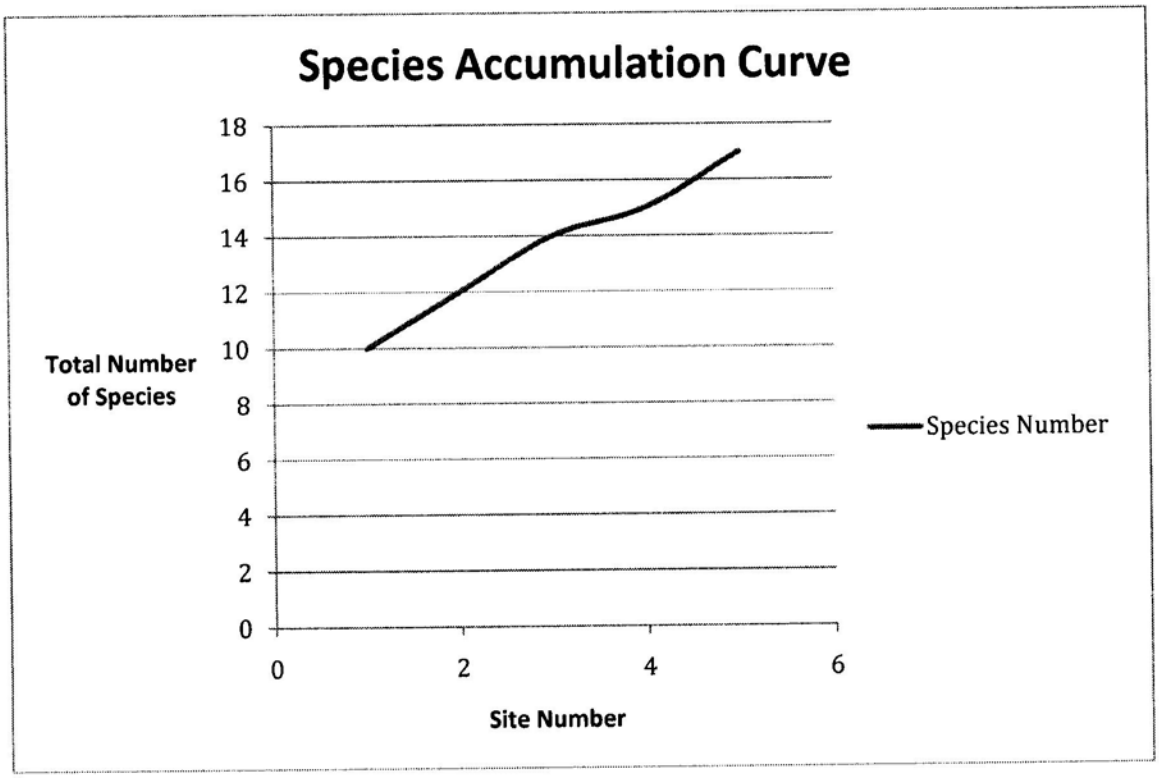

Figure 1: Species number we may expect with further sampling

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