

## Introduction

Parks at the national and state level are outlets for recreational fun and often are preserved for geological features with aesthetic values. Another purpose of parks is to preserve biodiversity and this topic has become ever more significant. Biodiversity is important for ecological health, productivity, and even has a part in economic affairs in many industries from fishing to medicine (NPCA, 2011). Human activities have now reached around the globe causing many species to reach the edge of extinction (Cincotta and Engelman, 2000) through pollution, habitat loss and more. National and state parks have become the little grounds left where species can proliferate, and if humans cannot uphold biodiversity in these preserves, then it is likely that biodiversity will never be saved (NPCA, 2000).

Located in the northwest tip of the Lower Peninsula lies one of Michigan's most renowned state parks. Wilderness State Park has many diverse habitats spanning an area of more than 10,000 acres and offers a rich and diverse selection of organisms. Before the 1900's, this plot of land was logged but has now regrown to allow some extraordinary animals to forage and nest here such as the nation's iconic bald eagle. Other endangered species such as the dwarf lake iris, piping plover, and Lake Huron locust, also utilize the land to maintain their numbers (Michigan, 2011). Along with many other federal parks (ATBI Alliance, 2011), Wilderness State Park has recently taken action to have a complete species inventories to better preserve biodiversity, beginning with insects.

This study investigates the insects of the order Orthoptera within the park. With many different habitats in Wilderness State Park, the Orthopteran fauna is quite diverse and it's valuable to be able to gauge what is there. This order Orthoptera is one of the most familiar due to their higher populations, sounds, and frequent use as live bait.

Orthopterans are classified by thickened sclerotized front wings and enlarged femur and tibia in the hind legs modified for jumping. This is not to say that it is always the case; some cave dwellers are wingless. Orthopterans also have varied mechanisms of creating sounds for use in communication (Bland et al., 1978). All insects within the order Orthoptera are hemimetabolous. Nymphs emerge from eggs laid within the soil or vegetation and feed on plant material for multiple instars until reaching adulthood. Wing pads typically become more developed with each molt through the instars (Marshall, 2006).

Wilderness State Park lacks an inventory of Orthopterans, but this information would be valuable for ecological and management purposes. This project aims to bridge that gap by investigating the diversity, species richness, and population densities of the Orthopteran community at different habitats within the state park. This project will create a baseline data set of insects that has many potential uses. It will be an important source of information for management decisions as well as conservation plans for the park; especially with endangered species present such as the Lake Huron locust, *Trimerotropis huroniana* (Welch, 1998). It will also offer excellent background information for studies on environment, trophic levels, and general ecology.

## Methods

**Study Site:** The sampling was done at Wilderness State Park in Emmet County, Michigan, specifically five different sites. One of the sites is a marsh (45.757°N, 84.972°W) at Waugoshance point surveyed July 28, 2011 from 12:00 pm to 1:00 pm. The south shore of Waugoshance Point is a swampy region that is prone to dry periods. There are tall grasses throughout the region with deciduous trees on the out-skirts of the area. The second study site took place in a forest off of Nebo Trail (45.753°N, 84.878°W) July 14, 2011 from 2:00 pm to 3:00 pm. Nebo Trail is located more inland within the state park and the trail travels through a canopy of trees with small open fields of tall grasses. The third was at a dune site off of Lakeview Road called South Sturgeon Bay (45.706 N, 84.952 W) July 21, 2011 from 2:00 pm to 3:00 pm. There was a beach was sandy with rolling dunes, there were a few shrubs and grasses with denser tree biota further inland. The fourth site was in along a gravel road with small ranges of open fields near a pond close to Big Stone Creek (45.742 N, 84.897 W) surveyed on July 21, 2011 from 12:00 pm to 1:00 pm. The area had some paths with some short and tall grasses and dense forest on the sides. The last study location was by Waugoshance Point Road (45.753°N, 84.943°W) surveyed August 4, 2011. The site was along a road in a dense forest.

**Insect Sampling:** Aerial nets and sweep nets were used to catch Grasshoppers (*Acrididae*), crickets (*Gryllidae*), and katydids (*Tettigonidae*) for one hour at each location. A group of students sampled the area by collecting as many as they could in the time frame and placing the captured Orthopterans in cyanide jars. Other groups were collecting other orders and families but also picked up Orthopterans along the way.

Pitfall traps were placed at three of the five sites on July 28, 2011 and left out for one week. Two pitfall traps each were placed at Waugoshance point, the forest off Nebo Trail, and the South Sturgeon Bay Dunes. The pit traps were constructed by digging a hole deep enough to fit an 18oz plastic cup flush with the ground and placing four plastic boards (6x45.5cm) slightly elevated above the cup in a manner that formed a + shape. A square plastic board (12.7x12.7cm) was then placed on top of the four boards to provide protection from rain for the cup below it. The traps were placed in conspicuous spots at each site to avoid human interactions.

Also important to note, the Lake Huron Locus, *Trimerotropis huroniana*, was tallied when collected and not killed because it was listed as an endangered species. All Orthoptera caught were keyed to the species level using the book: *The Orthoptera of Michigan: Biology, Keys, and Descriptions of Grasshoppers, Katydid, and Crickets* (Bland, 2003). A reference sample for each species was kept for UMBS/Wilderness State Park records.

**Statistical analysis:** For each site, the number of species of grasshoppers, crickets, and katydids was tallied. Species richness was then calculated for each site using Simpson Index of biodiversity. Alpha diversity was also assessed using Shanon-Weiner Index. Beta diversity was then calculated by the method described in Diserud 2007. Chao 1 was used to make a species accumulation graph.

## **Results**

A total of 263 Orthoptera were caught representing 17 different species (Table 1); 14 species of Acrididae, 2 species of Gryllidae, and 1 species of Rhaphidophoridae. An estimation of the number of species in the park using the chao 1 method gave an estimate of about 32 species in the park. This is shown in the species accumulation curve (Figure 1). The Simpson's index, reciprocal index and Shannon Wiener (ln) was calculated for each site (Table 2). This represents the alpha diversity of each site. The beta diversity, or species turnover to between sites, was calculated to be 0.4166.

## **Discussion**

Of the five sites, the most Orthopterans were collected at Sturgeon Bay Dunes. This site received the highest Shannon Weiner value (alpha diversity) due to a high number of species and relatively even distribution (Table 2). Sturgeon Bay Dune has different regions of potential habitats within itself and offers a diverse selection of vegetation that can host a large population. The dunes also offer a degree of protection for predation. However, it is important to note the ease of collecting in the dune region. Specimens were easiest to locate and capture here compared to any of the other sites which may have resulted in the high abundance collected.

*Melanoplus stonei* and *Trimerotropis huroniana* were the two most abundant species within the dune habitat. *M. stonei* feeds primarily on dry grasses and are present in jack pine barrens and dry soils (Bland, 2003) and *T. huroniana* feed primarily on beach grass, dune grass, wheatgrass, wormwood and dead insects washed on shore (Scholtens, 1997). Sturgeon Bay Dunes have all of the above mentioned factors which make it a very suitable environment for the two species. Furthermore, *T. huroniana* display many behavioral actions which are highly dependent on the dunes. If flying away from the area, they will immediately turn around and head back towards the dunes (Scholtens, 1997).

In contrast, Waugoshance Point Road had the least amount of specimens collected and lowest alpha diversity (Table 2). This could be attributed to the lack of open patches of grass alongside the road that frequently encounters disturbance. This area was also difficult for the group to collect due to difficulty seeking the Orthopterans among the low vegetation.

An area that exhibited high amount of species but relatively weak abundance distribution was Waugoshance Point marsh. Waugoshance Point had the second highest value of alpha diversity (Table 2) and 10 species was caught here. However seven of the ten species only had less than three specimens. This site was relatively friendly for sampling by nets and encompassed a large open area with plentiful vegetation for food source.

*Melanoplus sanguinipes* and *Allonemobius fasciatus* accounted for 79% of the total species collected at Waugoshance Point. This is expected because *M. sanguinipes* primarily inhabit mixed grass-forb habitats but are also common in boggy sites or arid grasslands (Bland, 2003). Similarly, *A. fasciatus* are widespread throughout Michigan in low, wet areas such as a marsh (Bland, 2003). Waugoshance Point goes through dry and wet periods which produce areas suitable for the two species as well as a mix of vegetation and plants to feed on.

*Dissosteira carolina* accounted for 60% of specimens at Big Stone Creek. This species frequently lays camouflaged on dusty grounds such as gravel roads or dirt paths which is the exactly condition of the Big Stone Creek site. *D. Carolina* feed on grasses, horse tail and selected forbs (Bland, 2003) which were located in grassy patches along the gravel road.

The species turnover rate (beta diversity) was calculated out to be 0.4166 (Diserud and Ødegaard, 2007) and indicates that there is moderate turnover across the five sites. This value ranges from 0 to 1 in that 0 indicates that the sites sampled had completely similar species and a value of 1 indicates completely dissimilar species between sites.

Of course there are more species located in Wilderness State Park that were not captured during our survey. Chao 1 indicated that if more trials were performed a total of roughly 32 species exists in the park. The 95% confidence interval is between 20.27 - 85.76. An explanation for this wide interval is due to the fact that we only performed one trial at each of the 5 sites. Chao 1 was chosen because our methods of sampling followed well with its assumptions (Chao, 1987). We performed sampling without replacement and assume that the total number of species in the park could not be lower than that of what we already found.

Our sample of species occurring in Wilderness State Park was compared to another area's records of a similar size, the property owned by University of Michigan Biological Station. Over many years UMBS has researched general diversity in the areas on site and in between Emmet and Cheboygan Counties. The records indicate that 24 species of Orthoptera have been found, a number slightly larger than what our five hour sampling produced. This is to be expected because UMBS has put in much more effort and time. However, our sampling did record species that have never before been found in the area. This is likely because Wilderness State Park offers habitats that UMBS lacks. The dune areas of the park offered a dynamic habitat for many Orthopterans. For example, a high abundance of *Melanoplus stonei* and *Trimerotropis huroniana* was found there but have not been record on UMBS properties. In addition, Wilderness and UMBS have many habitats that are similar which suggests that species found in one site ought to be found in the other site.

There are currently 137 species of Orthoptera found in Michigan (Bland, 2003). Our sampling did not find species new to Michigan however there were six new county records according to chartings by Bland, 2003. To put in perspective, Wilderness State Park represents only a small fraction of total land mass of Michigan (0.017%) and yet the 17 species sampled represent 12.4% of all Michigan Orthopteran. According to the Chao 1 statistic, the 10,000 acres of Wilderness State Park accounts for roughly one quarter of the entire Michigan Orthoptera species.

This newly revealed information is valuable to future park management decisions and evaluations. The distribution of Orthoptera seems to be all across the park and thus any changes in habitats are likely to affect the Orthoptera population in one way or another. Much more work can be done on this project. We strongly suggest repeating trials of this project in future summers as it will further solidify the baseline data and reach towards the Chao 1 estimate.

## Resources:

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Table 1. Results of sampling across five different sites in Wilderness State Park

Species	(45.757°N, 84.972°W) Waugoshance Point Marsh	(45.753°N, 84.878°W) Nebo Trail	(45.706 N, 84.952 W) South Sturgeon Bay Dunes	(45.742 N, 84.897 W) Big Stone Creek	(45.753°N, 84.943°W) Waugosha nce Point Road	Total
<i>Allonemobius fasciatus</i>	29		2			31
<i>Arphia sulphurea</i>	1					1
<i>Booneacris glacialis</i>					1	1
<i>Camnula pellucida</i>	2		21			23
<i>Ceuthophilus meridional</i>		7				7
<i>Chloealtis conspersa</i>		1				1
<i>Chortophaga viridifasciata</i>	5	1				6
<i>Conocephalus fasciatus</i>	2			7		9
<i>Dissosteira carolina</i>	1		2	29		32
<i>Gryllus pennsylvanicus</i>	1		1	1		3
<i>Melanoplus bivittatus</i>				1		1
<i>Melanoplus borealis</i>	1					1
<i>Melanoplus islandicus</i>					3	3
<i>Melanoplus sanguinipes</i>	48	1	17			66
<i>Melanoplus stonei</i>			45			45
<i>Trimerotropis huroniana</i>			32			32
<i>Trimerotropis verruculata</i>	1					1
Total	91	10	120	38	4	

Table 2. Alpha and Beta diversity values of five sample sites.

Site	Simpson's index	Reciprocal Simpson's index	Shanon Wiener (ln)
Waugoshance Point Marsh	0.3775	2.649	1.277
Nebo Trail	0.4667	2.143	0.9404
South Sturgeon Bay Dunes	0.2569	3.893	1.479
Big Stone Creek	0.6074	1.646	0.7094
Waugoshance Point Road	0.5	2	0.5623

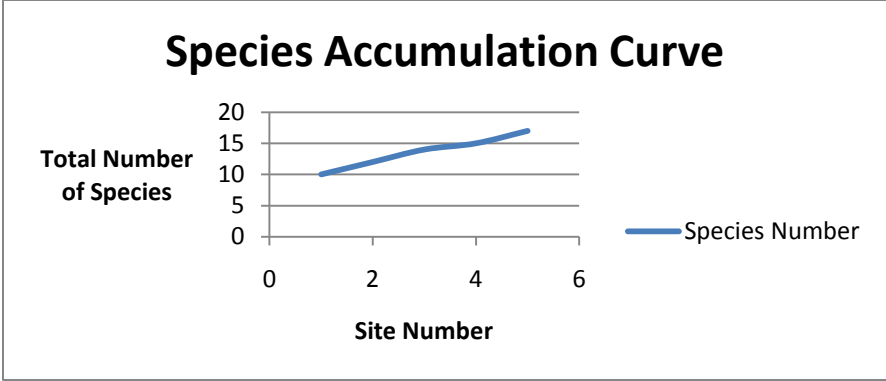


Figure 1. Species Accumulation Curve of 5 sites sampled.  
Chao 1 value projected 32 species which could not be shown here.