

Butterfly Monitoring at *rare* Charitable Research Reserve: 2010



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Acknowledgements

First of all, a big thank you is extended to the Carolinian Canada Coalition (CCC) who funded my co-op position at *rare* for two summer terms, in 2009 and 2010. The Carolinian Canada Student Intern Program works with the Faculty of Environment at the University of Waterloo and the CCC to provide job opportunities to students within this faculty. Assistance for the program was provided by the Ministry of Natural Resources and Parks Canada.

Gratitude is extended to the Science Horizons program funded by Environment Canada's Ecological Monitoring and Assessment Network (EMAN), who provided funds to hire Laura Robson, who assisted with the butterfly monitoring. As well, Environment Canada funded the EMAN program that provided the original contract for Jessica Grealey to set up the butterfly monitoring protocol at *rare*. Also, a thank you goes to Emma Clements, for volunteering to help with butterfly monitoring throughout the season.

1.0 Background

1.1 *rare* Charitable Research Reserve

All data was collected at *rare* Charitable Research Reserve in Cambridge, Ontario, which is a non-profit organization founded in 2001. The reserve consists of 913 acres of land at the confluence of the Grand and Speed Rivers. The goal of *rare* is to conserve the land by focusing on research, education, conservation, and ecological restoration (*rare*, 2008). The organization's mission statement is "To create a self-sustaining model of preservation, conservation and enhancement techniques which stimulates a general awareness of our natural heritage" (*rare*, 2008).

The *rare* property contains many different landscapes and ecological niches that are home to numerous species of plants and animals that are regionally, provincially, nationally and globally at risk (*rare*, 2008). Throughout the reserve there are more than 24 habitat types, including 6 of 8 pre-settlement landscapes.

1.2 Ecological Monitoring

Ecological monitoring and research have continuously provided solutions to many different environmental management problems (Vaughan et al., 2001). Monitoring provides decision-makers with dependable data in order to handle variable environmental conditions and preserve a healthy environment and a sustainable economy (Vaughan et al., 2001).

Monitoring consists of taking regular observations and measurements at consistent intervals over a period of time (Vaughan et al., 2001). The duration of time is crucial to the purpose and design of the monitoring program (Vaughan et al., 2001).

Two fundamental reasons for ecosystem monitoring are the following: to establish baseline data that portrays the current condition of ecosystem components, and to detect changes over time, in particular, those that are greater than the natural variation determined by the baseline data collection (Vaughan et al., 2001).

1.3 Ecological Monitoring and Assessment Network (EMAN)

EMAN consists of a network of individuals and organizations carrying out ecological monitoring within Canada to increase identification and documentation of ecosystem changes (EMAN, 2007). The EMAN Coordinating Office (EMAN CO) works within the network to improve the efficacy of monitoring, with the intention of developing knowledgeable decision-makers that will encourage environmental awareness in Canada (EMAN, 2007).

1.4 Why Monitor Butterflies?

Butterfly monitoring can offer insight into changes taking place on the property, whether these are negative or positive modifications. For example, this monitoring can estimate the success or failure of natural regeneration that has been occurring at *rare* since 2004.

Another beneficial aspect of butterfly monitoring is their use as ecological indicators of environmental change. For example, the absence of certain butterfly species can indicate larger environmental threats (New et al., 1995). Butterflies have complex life cycles that allow them to be good indicators of the health of herbaceous communities, herbivorous arthropods and other taxonomic groups (Waltz & Covington, 2004).

Environmental change from human or natural disturbances can be indicated by butterflies (Hogsden and Hutchinson, 2004). For example, these organisms are disturbed by changes in local weather, irradiance, climate and the availability of host plants for their larval and adult stages (Hogsden & Hutchinson, 2004).

Since butterflies can be an early indication of environmental change, it is necessary to monitor their populations in order to note these alterations, which could otherwise be left unnoticed and undocumented.

Another reason to monitor these populations is that they are reasonably easy to observe, compared to other types of insects. Also, butterflies are seriously affected by habitat loss since females will only lay their eggs on species-specific host plants and if these plants are absent, the population will collapse (Grealey, 2006a). Another reason for using butterflies as indicators is because of their short life span, making it easy to detect changes in population over more than one generation in a short period of time (Grealey, 2006a). As well, butterflies are a cold-blooded insect, which makes them vulnerable to changes in weather, as their wings must reach a temperature of 25°C before they can take flight. Harsh weather events, cold periods and unanticipated frosts can drastically affect their population numbers (Grealey, 2006a). Lastly, butterfly monitoring can provide indications of global warming as there has been recent evidence of butterflies appearing outside of their normal range due to increases in temperature (Grealey, 2006a).

2.0 Methodology

A common method for butterfly monitoring is the use of transect counts, which have been implemented by organizations such as Britain's Butterfly Monitoring Scheme that was initiated in 1976. This method does not disrupt butterfly behaviour and it also does not

take excessive amounts of time or labour. Additionally, an index of population size is created and it can be used to determine changes in abundance.

In 2006, Jessica Grealey set up the butterfly monitoring protocol on *rare* property. This monitoring protocol was also repeated in 2009 and in 2010. The reason for repeating the protocol is to detect any changes that have transpired from 2006 to present.

Transect methodology was utilized for the 2006, 2009 and 2010 monitoring seasons and consisted of the observer walking a fixed route (transect), while recording all butterflies observed within a 10 metre distance in all directions (Grealey, 2006b).

The number of transects monitored on the property has grown every year monitoring has taken place (see Appendix A for the transect map). In 2006, Jessica Grealey established Transect #1 and Transect #2, while Charlotte Moore added Transect #3 in 2009 and Transect #4 in 2010. See Appendix B for complete transect descriptions.

Each transect is 1-3 kilometres in distance and is monitored once a week, weather permitting. The transects are divided into sections based on habitat changes and a 10 minute stop is made in approximately the middle of each section to record species within a 10 m radius (Grealey, 2006b).

A standard recording form is used for all transects in order to accurately record butterflies (see Appendix C). The form includes the start and end times, as well as the temperature at the beginning and end of monitoring. Also noted are the wind speed, which is recorded using the Beaufort Wind Scale (see Appendix D) and the percentage of sun versus clouds during the monitoring session. Throughout each section the level of sunshine is recorded, using an “s” for sunny, a “c” for cloudy, “c&s” for more cloud cover than sun, and “s&c” for more time with the sun shining than cloud cover.

Temporary stops are allowed to properly identify butterflies. Recording begins again from where the stop was made. A butterfly net should be taken along on all transects in order to encourage accurate identification. If a butterfly cannot be identified, in the absence of an expert, the more common species of butterfly should be recorded. Also, a digital camera can be helpful to verify an individual afterwards and misidentification can be rectified (Grealey, 2006b). Local experts that can be used for identification include: Jessica Grealey, Larry Lamb and Glenn Richardson.

The ideal monitoring season is approximately 26 weeks, which starts in the first week of April and ends in the last week of September (Grealey, 2006b). Due to time and monetary restraints, the recording seasons at *rare* have been reduced. In 2006, the season was five weeks, taking place from mid-July to August. The 2009 season was 13 weeks, running from mid-May to mid-August, while the 2010 season consisted of 14 weeks, including mid-May to mid-August.

Individual transects should be monitored during the best time of day for butterfly activity, which is mid-day, and a minimum of once a week, (Grealey, 2006b). Climatic restraints can make it challenging to complete monitoring at the beginning and end of the season, as warm weather and a wind speed of less than five on the Beaufort Wind Scale are required.

The butterfly counts can be used to create an index of abundance that consists of stratified random sampling and the sum of average weekly counts, to allow comparisons to be made between transects. Butterfly species cannot be compared to one another and must be monitored independently because of divergences in their behaviour that abundance indices cannot compare (Grealey, 2006b). For example, one species may be conspicuous, while another has discreet behavioural tactics (Grealey, 2006b).

3.0 Annual Butterfly Count

Annual butterfly counts have occurred at *rare* in the summers of 2006, 2007, 2009 and 2010 in order to supplement transect monitoring, which only occurs in a few areas of the property.

During the 2006 count there were a total of 38 species and 727 individuals observed (Grealey, 2006b). A butterfly count was not conducted in 2007 due to unfavourable weather conditions. The 2008 count found 42 species and 1,590 individuals (see Appendix E for the full 2008 results), while the 2009 count had 29 species and 463 individuals (see Appendix F for the full 2009 results). The low number of species and individuals in 2009 can be attributed to the cool, wet weather that occurred throughout the 2009 recording season and during the butterfly count event. The 2010 butterfly count found 39 species and 683 individuals throughout the day (see Appendix G for the full 2010 results). Notable species from the 2010 butterfly count include the American Snout, which is a rare migrant in Ontario, the Tawny Emperor that is uncommon and local in the region, and the Little Glassywing, which is uncommon in the region and had never been recorded at *rare* before this count.

4.0 Results

Butterfly data cannot be compared across all monitoring seasons for all monitoring weeks because the monitoring period varied in length in each of the three monitoring seasons. For instance, in 2006 monitoring took place for five weeks, starting July 18 and ending August 24, while in 2009, data was collected from May 18-August 14 and in 2010, data was collected from May 17-August 19. The same five week time period was compared between the 2006 and 2009 data after monitoring was completed in 2009. This same five week period from 2010 will be compared to the 2006 and 2009 data from the same weeks. Since data has been collected for a longer time period in 2009 and 2010, it is possible to make comparisons among more weeks from those two seasons.

The results from Transects #1 and #2 have a sub-section for mid-July to mid-August results, for comparison of 2006, 2009 and 2010 data. As well, Transect #3 has a sub-section of July-August results for comparison of 2009 and 2010 data. Transect #4 was implemented in 2010 and will not be compared to other transects as only baseline data was collected in this season.

The total number of butterflies by species and transect for the entire 2010 monitoring season can be found in Table 1, which states the total number of individuals observed was 4,049. The total number of species and individuals per transect is summarized in Table 2.

4.1 Climatic Data

In general, the weather for May-August 2010 was warm and dry, which is ideal for butterflies. The average monthly temperature for 2006-2010 can be found in Figure 1, while the average monthly precipitation is found in Figure 2.

As a result of the fair weather conditions this summer, the first time a species appeared this season was recorded, in order to compare these emerging butterfly dates to ones in future monitoring (see Appendix H).

4.2 Transect #1 Monitoring Results

Monitoring data has been collected on this transect in 2006, 2009 and 2010.

4.2.1 Mid-July to Mid-August Results

For this five week period in 2010 there were a total of 21 species observed, which included 327 individual butterflies, while in 2009 there were 19 species and 279 individuals, and in 2006 there were 22 species and 424 individuals recorded (see Figure 3).

4.2.2 May-August Results

Monitoring in 2009 and 2010 overlapped for the same 13 weeks from mid-May to mid-August, which allows comparisons to be made between transects that were monitored for this time period. On Transect #1 there were a total of 966 individuals of 31 different species observed in 2010, while in 2009 there were 620 individual butterflies of 25 different species (see Figure 4).

4.3 Transect #2 Results

Data has been collected on this transect in 2006, 2009 and 2010.

4.3.1 Mid-July to Mid-August Results

In 2010, from mid-July to mid-August on Transect #2 there were a total of 1088 individual butterflies of 16 different species, while 2009 monitoring had 15 species and 275 individuals, and 2006 data consisted of 413 individual butterflies of 13 different species (see Figure 5).

4.3.2 May-August Results

Throughout May and August of 2010 there were a total of 24 species and 1,616 individuals observed, while the same 13 weeks in 2009 had 275 individuals of 15 different species (see Figure 6).

Table 1 – Total Number of Butterflies Observed by Species and Transect in 2010

	Transect #1	Transect #2	Transect #3	Transect #4	Total
Species Common Name					
American Lady	1	1	0	1	3
Appalachian Brown	1	0	0	0	1
Arctic Skipper	1	0	1	0	2
Black Dash	0	0	1	0	1
Black Swallowtail	0	3	1	4	8
Cabbage White	524	697	177	174	1572
Clouded Sulphur	81	764	186	44	1075
Columbine Duskywing	5	0	1	0	6
Common Wood Nymph	15	9	27	2	53
Delaware Skipper	1	0	3	0	4
Eastern Comma	4	3	2	0	9
Eastern Tiger Swallowtail	9	5	4	2	20
European Skipper	98	25	111	13	247
Eyed Brown	53	0	0	0	53
Giant Swallowtail	1	0	0	0	1
Great Spangled Fritillary	9	5	8	0	22
Hobomok Skipper	5	6	7	0	18
Inornate Ringlet	32	18	120	7	177
Juvenal's Duskywing	1	8	0	0	9
Least Skipper	12	0	0	0	12
Little Wood Satyr	31	1	54	0	86
Milbert's Tortoiseshell	3	0	0	0	3
Monarch	34	143	89	7	273
Mourning Cloak	1	3	1	0	5
Northern Broken-Dash	2	0	0	0	2
Northern Crescent	34	2	41	0	77
Northern Pearly Eye	12	8	16	0	36
Orange Sulphur	1	7	8	0	16
Painted Lady	3	5	2	1	11
Pearl Crescent	4	2	3	0	9
Peck's Skipper	0	0	2	0	2
Question Mark	3	7	0	1	11
Red Admiral	52	37	54	11	154
Red Spotted Purple	9	5	0	0	14
Silver-Spotted Skipper	0	0	5	0	5
Spring Azure	2	0	0	0	2
Summer Azure	17	11	8	0	36
Tawny Emperor	0	0	1	1	2
Viceroy	2	2	3	2	9
White Admiral	0	0	1	0	1
Wild Indigo Duskywing	0	1	1	0	2
Total	1063	1778	938	270	4049

Table 2 – Total Number of Butterfly Species and Individuals Observed by Transect in 2010

Transect Number	Number of Species	Number of Individuals
1	34	1063
2	27	1778
3	30	938
4	14	270

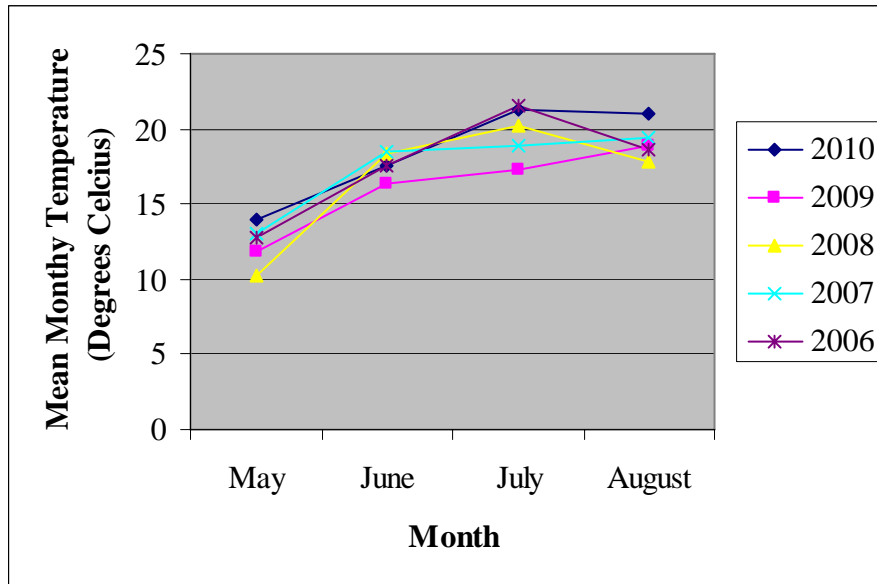


Figure 1 – Average Monthly Temperature in Waterloo Region, May-August, 2006-2010 (Environment Canada, 2010).

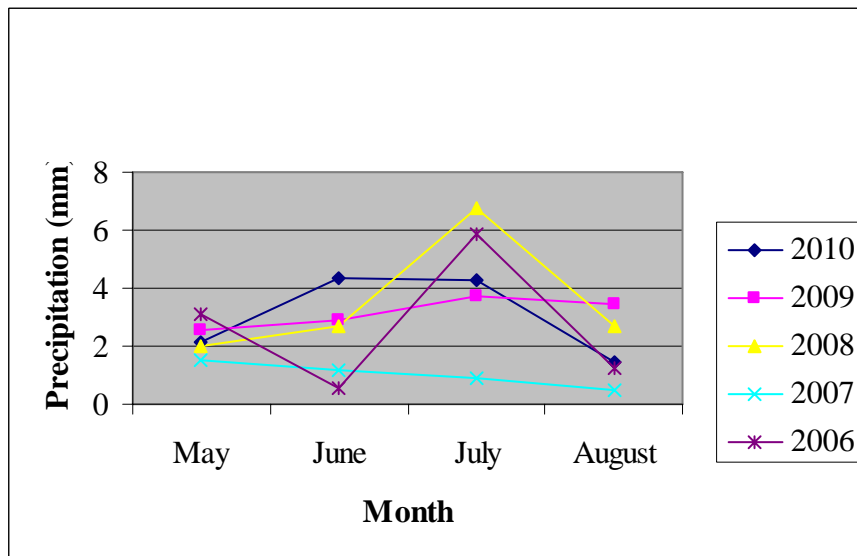


Figure 2 – Average Monthly Precipitation in Waterloo Region, May-August, 2006-2010 (Environment Canada, 2010).

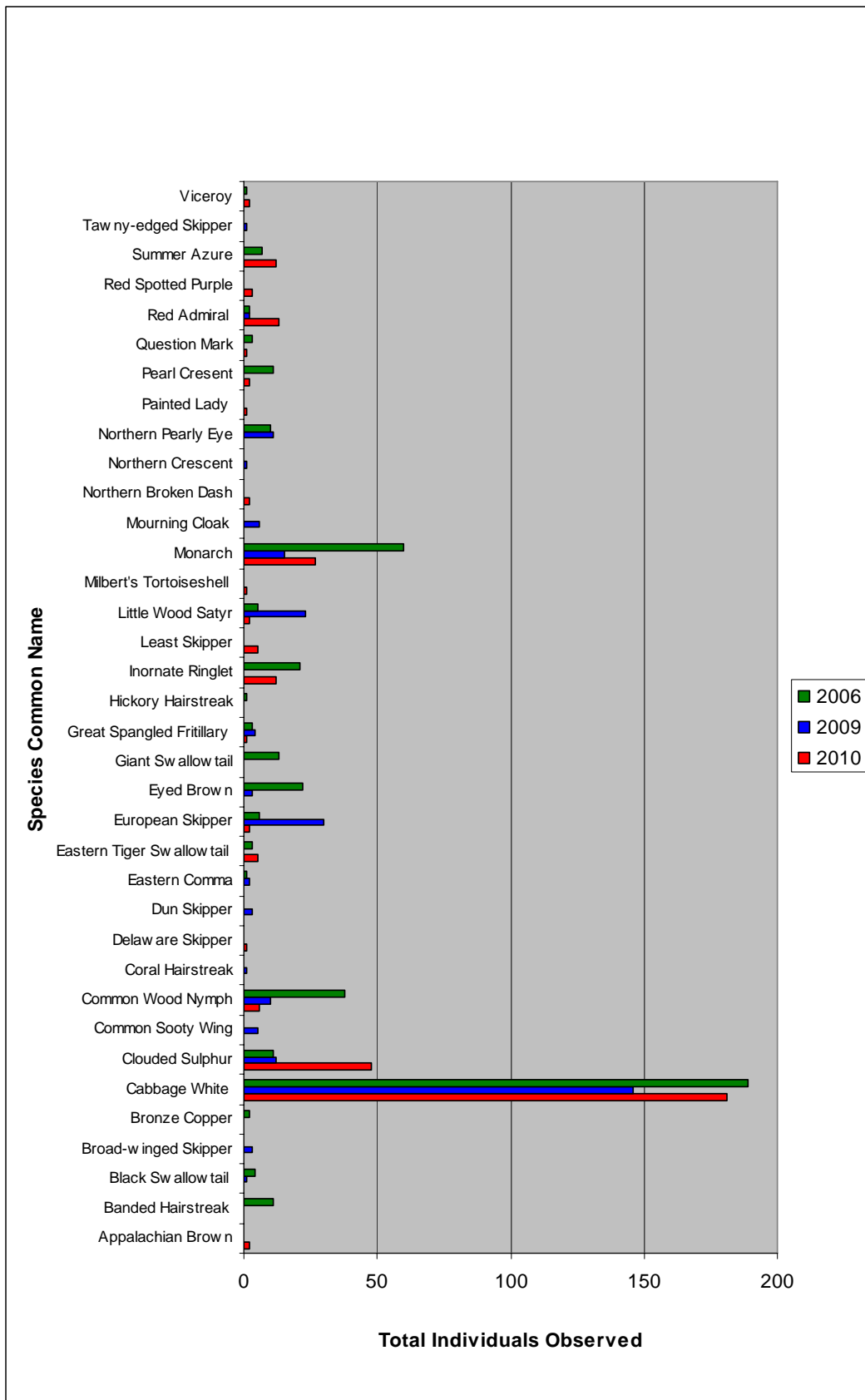


Figure 3 – Total Butterfly Abundance on Transect #1 in July-August of 2006, 2009 and 2010.

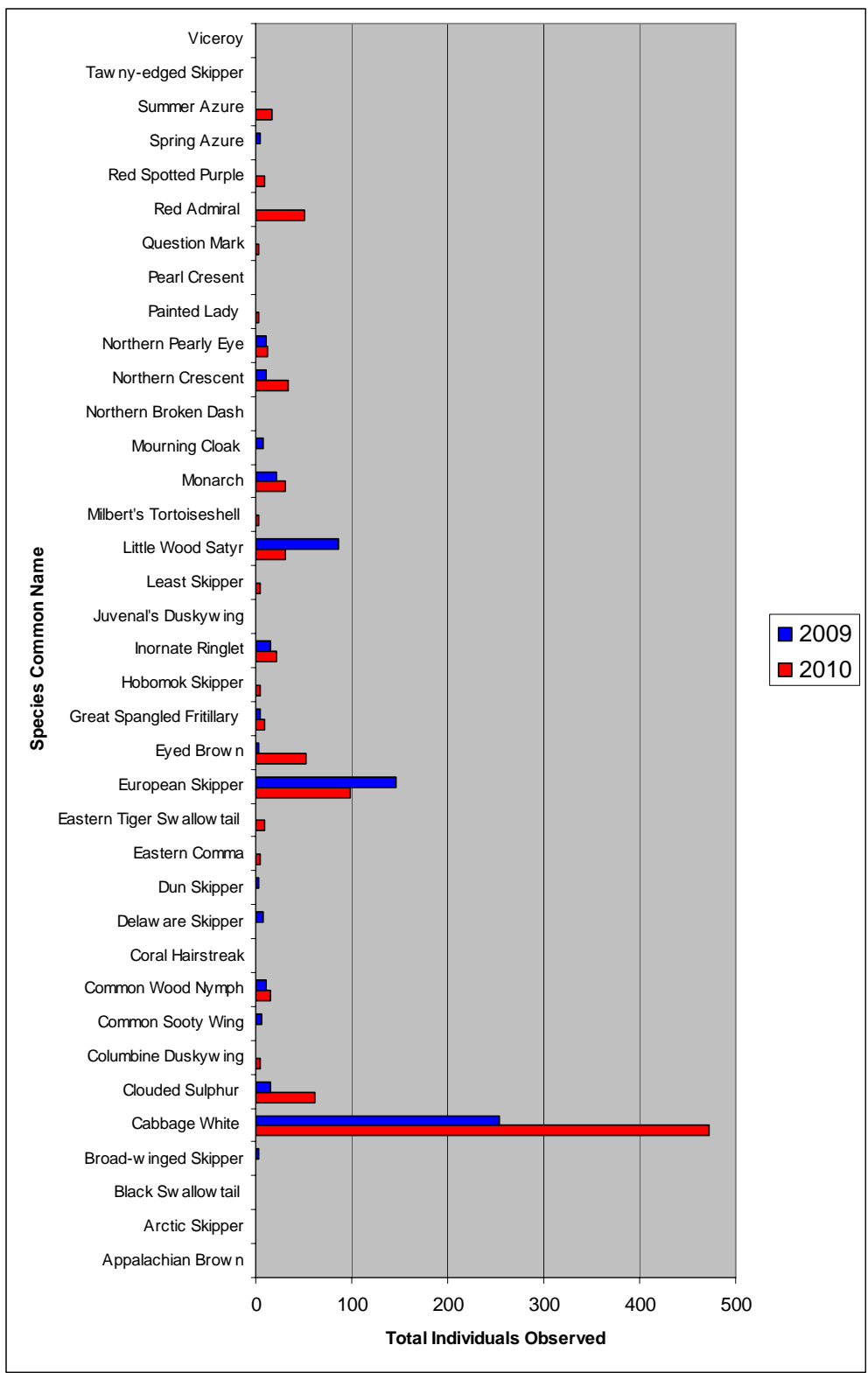


Figure 4 – Total Butterfly Abundance on Transect #1 for May-August in 2009 and 2010.

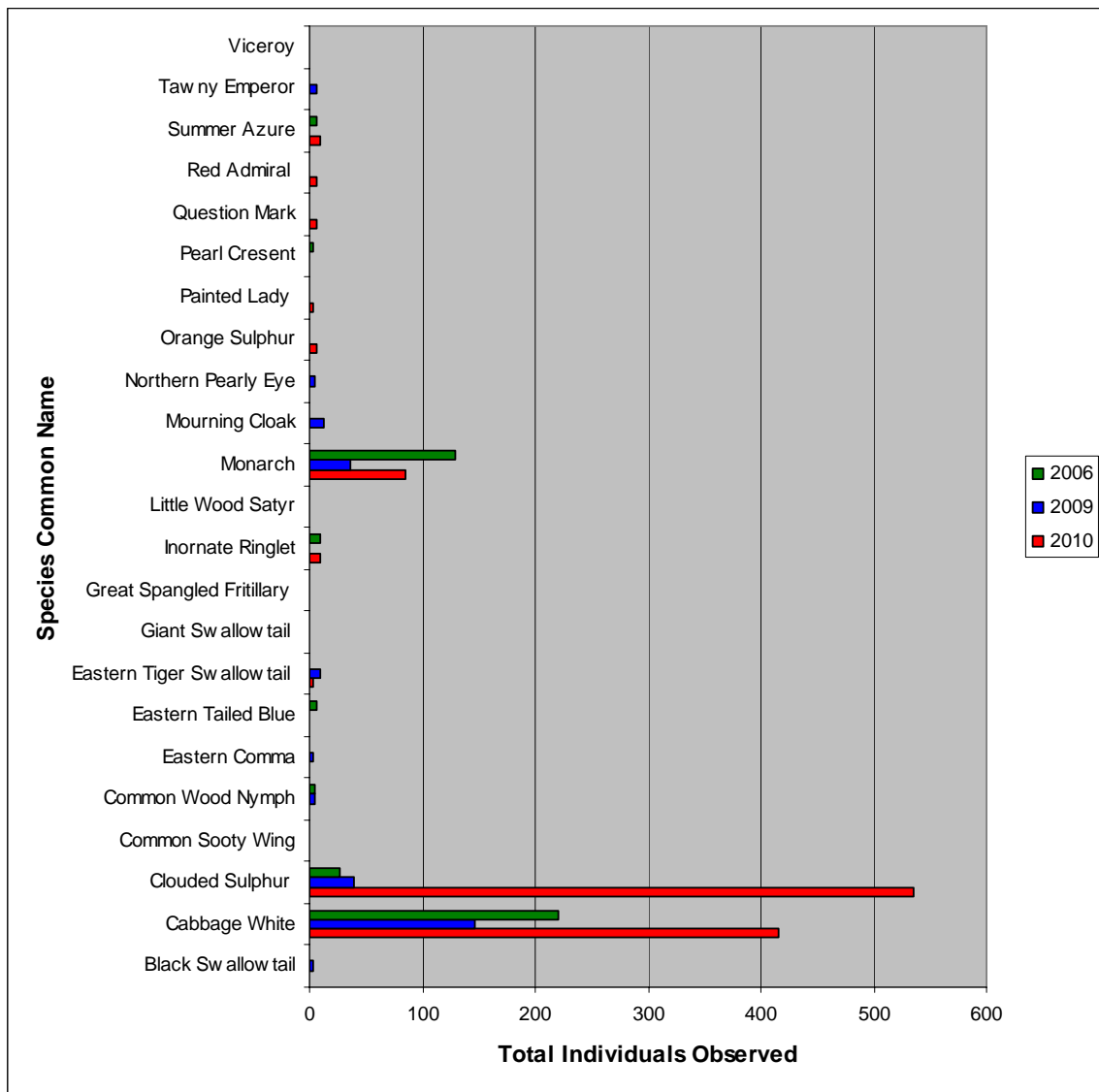


Figure 5 – Total Butterfly Abundance on Transect #2 for July-August in 2006, 2009 and 2010.

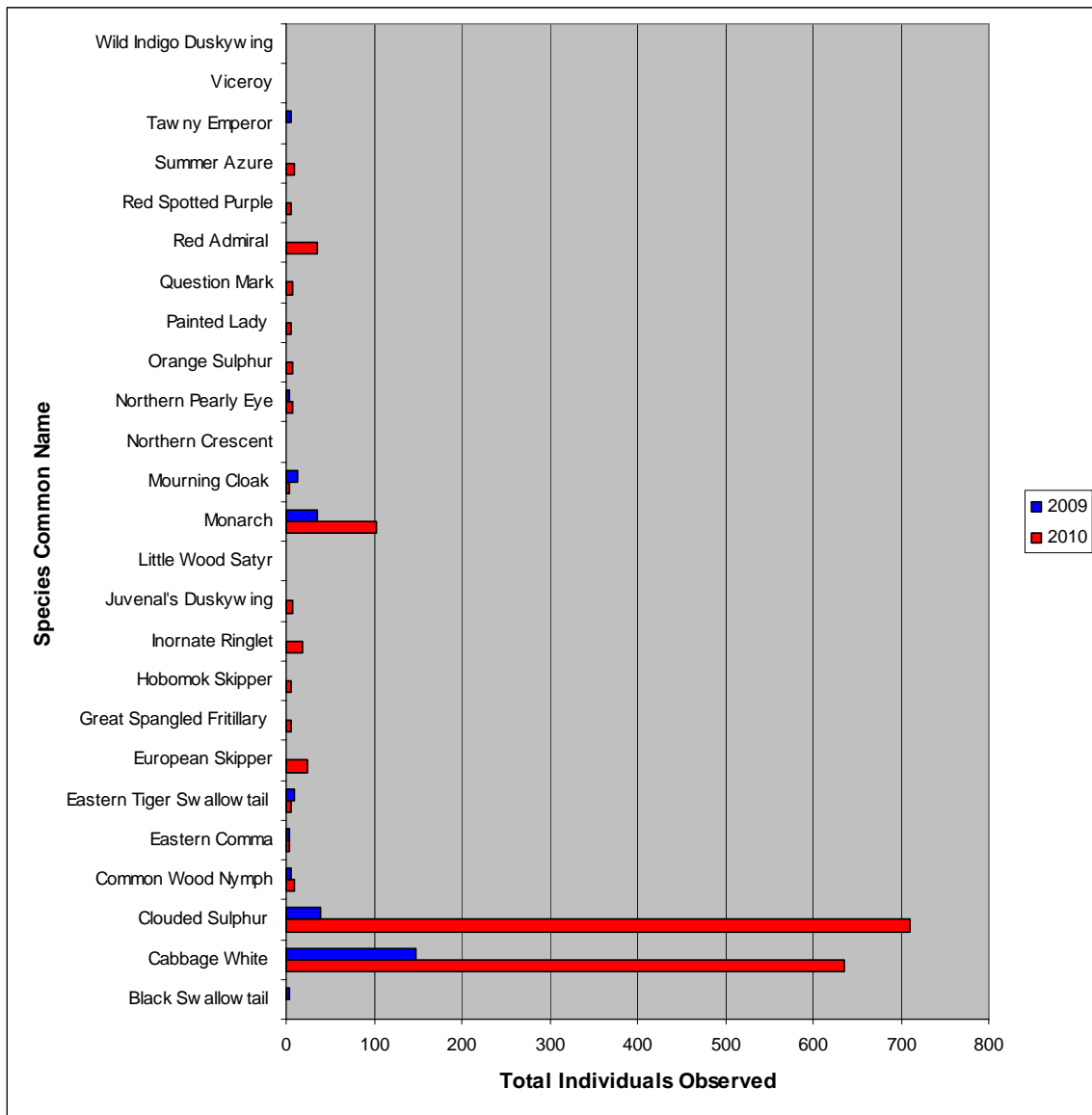


Figure 6 – Total Butterfly Abundance on Transect #2 for May-August in 2009 and 2010.

4.4 Transect #3 Results

Transect #3 was implemented in 2009 and was monitored from July 1-August 14, which is the time period that is compared to the 2010 data.

4.4.1 July-August Results

The 2010 monitoring season had 275 individuals of 20 different species, while the 2009 data consisted of 414 individuals of 20 species of butterflies (see Figure 7).

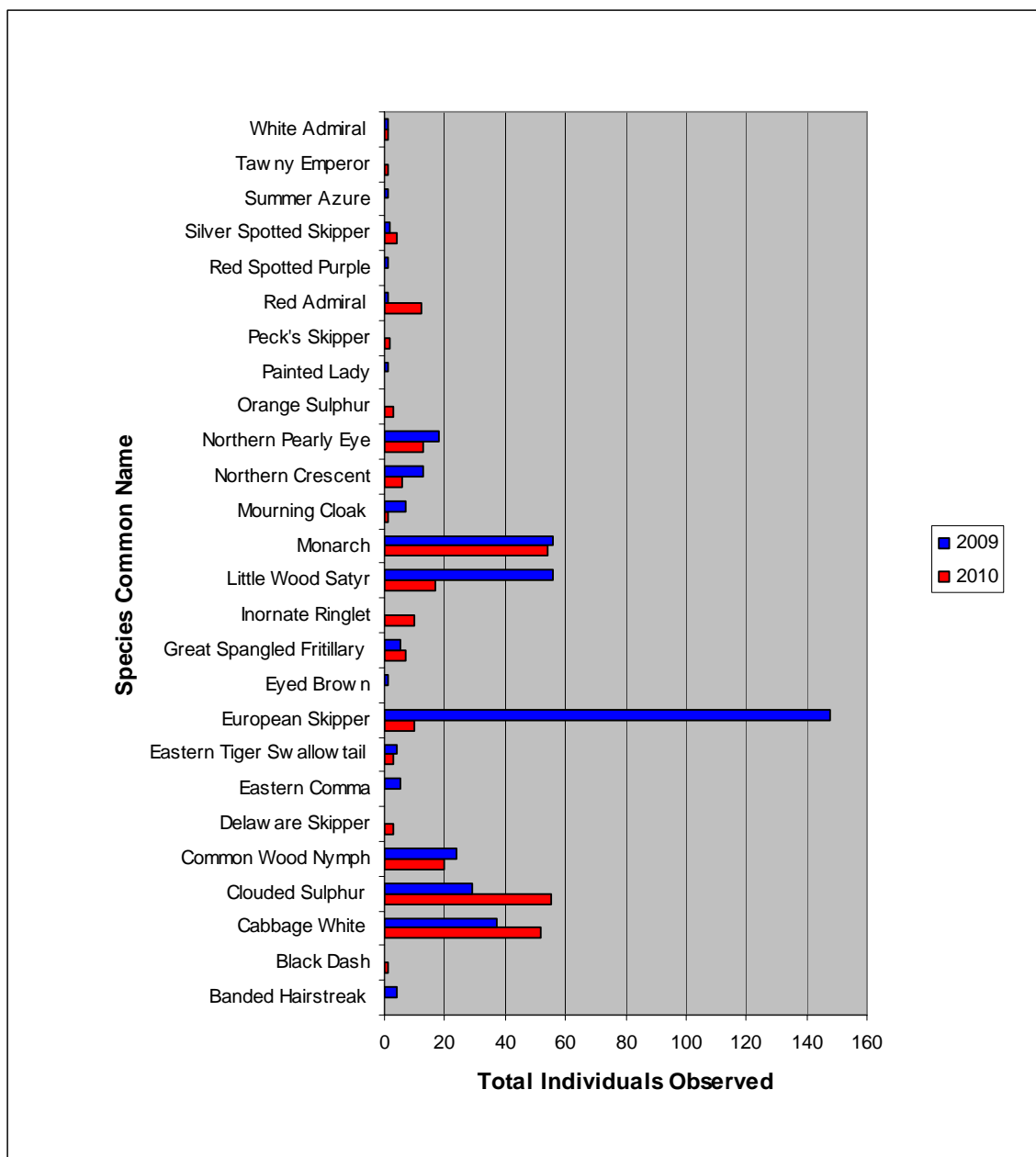


Figure 7 – Total Butterfly Abundance on Transect #3 for July-August in 2009 and 2010.

4.5 Transect #4 Results

This transect was created in 2010 in order to collect baseline data on this area of the property. The data will not be compared to other sites because of differences in habitat and the absence of data from previous years. Transect #4 is located on the Blair Flats and surrounds the 43 acres of land that were planted with tall grass prairie species in the last week of March in 2010. See Appendix I for the list of species planted.

4.5.1 May-August Results

The total number of individuals observed in Transect #4 from May-August was 270 and there were 14 different species of butterflies found in this area (see Figure 8).

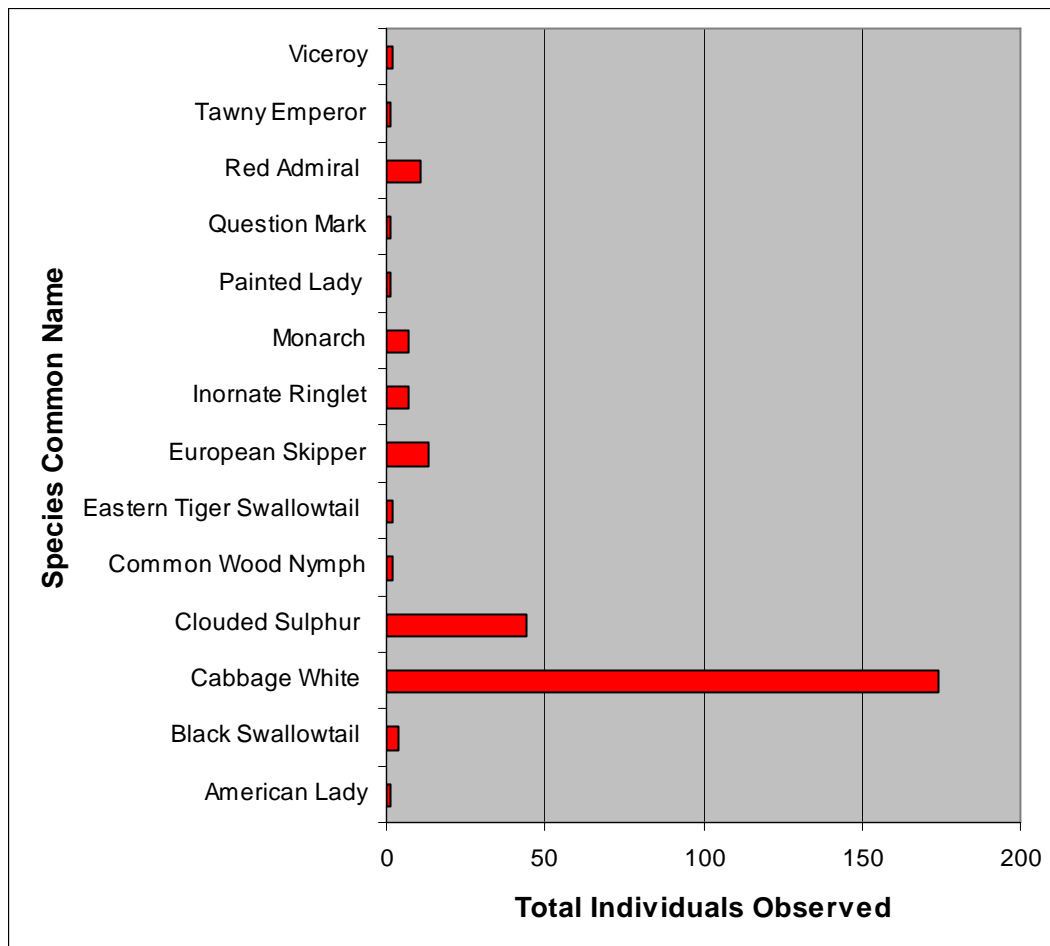


Figure 8 – Total Butterfly Abundance on Transect #4 for May-August 2010.

5.0 Discussion

5.1 Transect Trends in 2010

Collectively, the top five observed butterfly species on all transects were the Cabbage White (1,572), Clouded Sulphur (1,075), Monarch (273), European Skipper (247) and Inornate Ringlet (177). These butterflies are common throughout their respective ranges and have maintained high individual populations at *rare* for the years monitoring has occurred.

5.1.1 Transect #1

The most abundant butterflies found on Transect #1 differ from the general trend created by all four transects. The top five most noted butterflies were the Cabbage White (524), European Skipper (98), Clouded Sulphur (81), Eyed Brown (53) and Red Admiral (52).

In particular, the Red Admiral butterfly had an incredible population increase this spring, which was noted in different places in the region. This transect contains arguably the most diverse habitat of all the transects, which can provide an explanation for the high number of Eyed Brown butterflies that are restricted to wet meadows with sedges and only occur in Transect #1. One notable species that was recorded on this transect was the Giant Swallowtail, which has been absent from *rare* property since 2008.

As well, this transect contained the highest diversity of butterfly species, with 34 different species being observed there in 2010 and the second highest number of individuals, with 1,063. It must be kept in mind that this transect is physically the longest, as it is approximately 3 km in length and contains the most habitat changes, which causes 11 stops to be made along the way.

5.1.2 Transect #2

Transect #2 followed the same general trend as the one set by all four transects. The five most populous species on this transect were the Clouded Sulphur (764), Cabbage White (697), Monarch (143), Red Admiral (37) and European Skipper (25).

The first section of this transect is mainly planted with alfalfa and clover, which are the host plants for Clouded Sulphur and explain the large population of the species along this transect. The hedgerows and meadows in this transect also contain significant milkweed populations, which attract large numbers of Monarchs.

In 2010, this transect had 27 different species of butterflies and 1,778 individuals. This is the second most diverse transect of the four and the highest number of individual butterflies. The vast majority (over 80%) of the individuals are Clouded Sulphur or Cabbage White butterflies, which dominate this transect in vast numbers because of the meadow and hedgerow habitat.

5.1.3 Transect #3

The most common butterflies on this transect were the same five species found most abundantly on the other transects. The most numerous species recorded were the following: Clouded Sulphur (186), Cabbage White (177), Inornate Ringlet (120), European Skipper (111) and Monarch (89).

A main portion of the habitat in this transect is open meadow, which appeals to the five species listed above. As well, this area contains by far the most milkweed plants of any of the transects, which attracts a large number of Monarchs.

This transect had 938 individuals of 30 different species throughout the 2010 monitoring season. This is the third highest of the four in terms of individuals and diversity, although Transects #1 and #2 are significantly longer in length than this transect.

5.1.4 Transect #4

In general, this transect had drastically less individuals and diversity than the other three transects. The five most common butterflies were the Cabbage White (177), Clouded

Sulphur (44), European Skipper (13), Red Admiral (11), and the Inornate Ringlet and Monarch (both with 7).

At the beginning of the monitoring season this transect was mostly bare soil, as it had recently been planted with tall grass prairie species. Therefore, the number of host and nectar plants available to butterflies was severely reduced and it is reasonable to expect a low number of individuals and decreased diversity. It is estimated to take about three years for the planted species to dominate and in the meantime, the field has been taken over by horseweed and other annual weeds that do not entice butterflies to the area.

There were 270 individuals noted in Transect #4 this year, which consisted of 14 different species. This is significantly less than the other transects, but the much shorter distance and recently disturbed habitat provide explanations for the low numbers.

The point of monitoring this year was to record baseline data on the field, and as the prairie species grow, hopefully so will the abundance and variety of butterflies. In particular, *rare* is expecting to attract butterflies that have prairie host plants, which may not be found in other areas in the region.

5.2 Comparison of 2006, 2009 and 2010 Data

Data was collected on Transects #1 and #2 in 2006, 2009 and 2010. There is a five week period that overlaps among the three years, which is what was analyzed. Only data that is overlapping can be compared as butterfly abundance and diversity can escalate dramatically with increased monitoring time.

5.2.1 Transect #1

All three years had fairly similar numbers of species and individuals on this transect. The diversity of species has remained fairly constant, ranging from 19-22 species a year, while the number of individuals has ranged from 279-424. The year with the lowest number of individuals was 2009, which can be partially attributed to the poor weather conditions of that monitoring season.

In general, the same species have remained abundant on this transect, including the Cabbage White, Clouded Sulphur and Monarch. The most notable changes are that in 2010 there have been quite a few more Clouded Sulphurs and Red Admiral butterflies, and less Common Wood Nymphs and Northern Pearly-eyes than previous years. As well, there were no butterflies in the hairstreak family found on this transect in 2010, while 2009 and 2006 monitoring had 13 in total.

The individual number of butterflies has increased since 2009 and is closer to the 2006 data, indicating the foul weather of 2009 was a contributing factor to the low individual numbers of that year. The habitat in Transect #1 has remained similar throughout the years, with no regeneration/restoration or significant changes occurring, which is another reason for the stable populations and diversity.

5.2.2 Transect #2

The number of individuals and the diversity have changed over the years on this transect. The diversity has increased from 13-16 over four years and the number of individuals has ranged from 275-1,088, the latter being from 2010.

Since 2006, the number of species has grown from 13 to 16, which could be partially due to increased regeneration efforts on this transect. Portions of the area have been left to naturally regenerate since as early as 2004 (see Appendix J), and every year more land is taken out of agricultural production. As the land is regenerating, the habitat is changing, which has proven to be beneficial to butterflies, based on the increasing diversity over time. As well, the number of individual butterflies has dramatically increased, as the 2010 monitoring had more than twice the number of individuals found in 2006 and more than three times that of 2009.

Notable species changes that have taken place include the increase in Cabbage White, and especially, in Clouded Sulphur butterflies in this transect. The Cabbage Whites have doubled over time and the Clouded Sulphur population has become 13 times bigger than 2009 and 19 times larger than 2006. Also, the Monarch population has fluctuated over the years, with a large population in 2006, smaller numbers in 2009 and an increase in 2010. The number of Orange Sulphurs increased in 2010, which are most likely attracted to the alfalfa and clover species found in this transect. Finally, the Tawny Emperor was absent from this transect in 2010, although it was found here in 2006 and 2009.

Continued regeneration of this transect should show a steady increase in butterfly numbers and diversity as mono-crop agriculture is taken out of production and is gradually succeeded by naturalized meadows.

5.3 Comparison of 2009 and 2010 Data

Butterfly monitoring in 2009 and 2010 took place from mid-May to mid-August, which allows further comparisons to be made between these two years, which the shorter 2006 season does not allow. There is a thirteen week overlap of monitoring between Transects #1 and #2 from 2009 and 2010, while Transect #3 has a seven week period that can be compared from 2009 and 2010.

5.3.1 Transect #1

The diversity and number of individuals have changed from 2009 to 2010, but it is difficult to draw sound conclusions from these variations because of the poor weather conditions in 2009. The low diversity and number of individuals can be at least partially attributed to the cooler, wetter weather during the 2009 monitoring season, since there have been minimal habitat changes on this transect from 2009 to 2010.

Nonetheless, the number of species has increased from 25 in 2009 to 31 in 2010. A few butterflies that have never been found on *rare* property before 2010 were observed in Transect #1, including the Arctic Skipper, Columbine Duskywing and the Hobomok Skipper.

The number of individual butterflies grew by more than 300, which could also be due to weather conditions. Butterflies that significantly increased in abundance from 2009 to 2010 were: Cabbage White, Clouded Sulphur, Eastern Tiger Swallowtail, Eyed Brown, Northern Crescent, Red Admiral and Summer Azure. Contrastingly, some species decreased in the number of individuals from 2009 to 2010, including the European Skipper and the Little Wood Satyr.

In general, the warmer weather of the 2010 monitoring season certainly played a role in the increasing number of species and individuals from the year before. Transect #1 has continued to be the most diverse transect on the property, although this is likely due to the fact that it is the longest transect and contains the most habitat changes. Overall, monitoring this transect has shown that butterfly populations are stable or increasing on this area of the property.

5.3.2 Transect #2

This transect showed a dramatic increase in the number of species and individual butterflies. The number of species increased from 14 to 25 and the individuals from 275 to 1,616, which is considerably more than the increase in Transect #1, indicating there is another contributing factor besides weather conditions. An increasing amount of land has been allowed to naturally regenerate in Transect #2, which is a likely reason for the incredible increase in individuals and the number of species.

Two more species that have never been recorded on *rare* property before 2010 were found in Transect #2, including the Juvenal's Duskywing and the Wild Indigo Duskywing, the latter which has not been recorded anywhere in the Region of Waterloo before 2010. This butterfly has adapted to using crown vetch as its host plant, instead of wild indigo, which has allowed the butterfly to spread throughout southern Ontario where this plant has invaded disturbed meadows and is used along roadsides as a soil stabilizer.

The number of individuals on this transect had more than a five-fold increase, which is mostly due to the rise in Cabbage White and Clouded Sulphur butterflies, but is nevertheless a notable increase. Other species that have noticeably increased on this transect are the European Skipper, Inornate Ringlet, Monarch and Red Admiral.

Overall, this transect has significantly increased in the number of species and individuals from 2009 to 2010. This could be due to changing weather conditions, but also because of natural regeneration efforts on the land surrounding the transect.

5.3.3 Transect #3

Transect #3 was added to the monitoring protocol partway through the 2009 recording season, allowing 7 weeks of data collection to occur from July 1-August 14, while data was collected on this transect for 14 weeks in 2010, from May 17-August 16. The seven weeks of overlap are compared between the two years.

The data between 2009 and 2010 on this transect shows a very different trend than the other transects. This is the only transect in which the number of individual butterflies decreased from 2009 to 2010, while the number of species remained steady at 20.

Both recording seasons yielded 20 different species, although these were not exactly the same species in both years. In 2009, six species were observed that were not found in 2010; these included the Banded Hairstreak, Eastern Comma, Eyed Brown, Painted Lady, Red-Spotted Purple and the Summer Azure. The Banded Hairstreak from 2009 is notable because there were no hairstreaks recorded on any of the transects in 2010. The six species recorded in 2010, but not in 2009, were the Black Dash Skipper, Delaware Skipper, Inornate Ringlet, Orange Sulphur, Peck's Skipper and Tawny Emperor. The Tawny Emperor is significant as this is a regionally rare butterfly that had previously only been found in Transect #2.

There was a decrease in the number of individual butterflies observed in 2010 from the 2009 observations, which was not found on Transect #1 or #2. The biggest difference is the number of European Skippers observed, which was much lower in 2010. One explanation is that the weather was warm and dry in April and May of 2010, which caused some butterflies to emerge early and end their flight season sooner. This may have been the case with European skippers as there were 111 individuals observed in Transect #3 in 2010, and 101 of those occurred in weeks 3-6, which cannot be compared to the 2009 data. The weather in 2009 was much cooler and wetter, which can cause butterflies to emerge later than usual in the season. In general, European Skippers are typically out from early June to mid-July, which was observed in 2010, while in 2009 the peak was delayed further into the season. As well, there was a decrease in Little Wood Satyrs and an increase in Cabbage White, Clouded Sulphur and Red Admirals, which was also noted in Transects #1 and #2.

The habitat in this transect was not negatively affected between 2009 and 2010, therefore, there is no cause for alarm over the decrease in number of individual butterflies. Differing weather conditions between the two years may provide an explanation for the difference, especially because the number of European Skippers was similar when comparing the entire 2010 monitoring data.

6.0 Conclusions

Overall, butterfly diversity on the property has been maintained and in some cases, improved. Transects #1 and #3 have maintained their diversity, while the number of species observed on Transect #2 has increased.

The number of individual butterflies increased on most transects since 2009 and was close to the figures observed in 2006, while Transect #2 widely surpassed the number of individuals from other years.

Baseline data was collected on Transect #4 this year, which will be vital to future monitoring efforts on this area of the property. The species composition may become very different as the tall grass prairie develops and it is imperative to have baseline data from before the time that prairie species mature, in order to document these changes.

Monitoring data from 2010 has shown that butterfly habitat is being preserved or improved on the property, which is extremely important as natural ecosystems continue to be destroyed worldwide.

In particular, Monarch populations have been maintained since 2006 and this is the only species on the property that is provincially and nationally listed as a “special concern” by the Committee on the Status of Endangered Wildlife in Canada. Preserving Monarch habitat at *rare* is important since these butterflies are at risk and monitoring populations on the property will help to indicate if the population is remaining stable

7.0 Recommendations

The main recommendation after the 2010 monitoring season is to ban pesticide use from anywhere on *rare* property. One of the charity’s mandates is to preserve the land in perpetuity, which should include banning the use of pesticides on agricultural land that is rented to a local farmer.

After banning the use of pesticides, even more land should be taken out of agricultural production. Typically, the crops being planted are corn and soy beans, which butterflies will not use as host or nectar plants. Particularly, the agricultural land surrounding Transect #2 should be completely taken out of production in order to further foster butterfly populations.

As well, monitoring must continue every year for the same 14 week (or more) period that has taken place in 2010. This will allow comparisons to be made to past monitoring, as well as the documenting of future populations. Butterflies are excellent indicators of habitat health and environmental change, which the collected data should continually analyze.

Another recommendation is that the annual butterfly count should continue to be hosted by *rare*, in order to locate species with specialized or localized niches. The count consistently locates species that are not found in the transect monitoring data. Also, this year there was a butterfly identification workshop held at *rare* to increase public awareness and knowledge about butterflies. This should continue to be held in order to encourage community members to attend the annual butterfly count and to foster local butterfly knowledge.

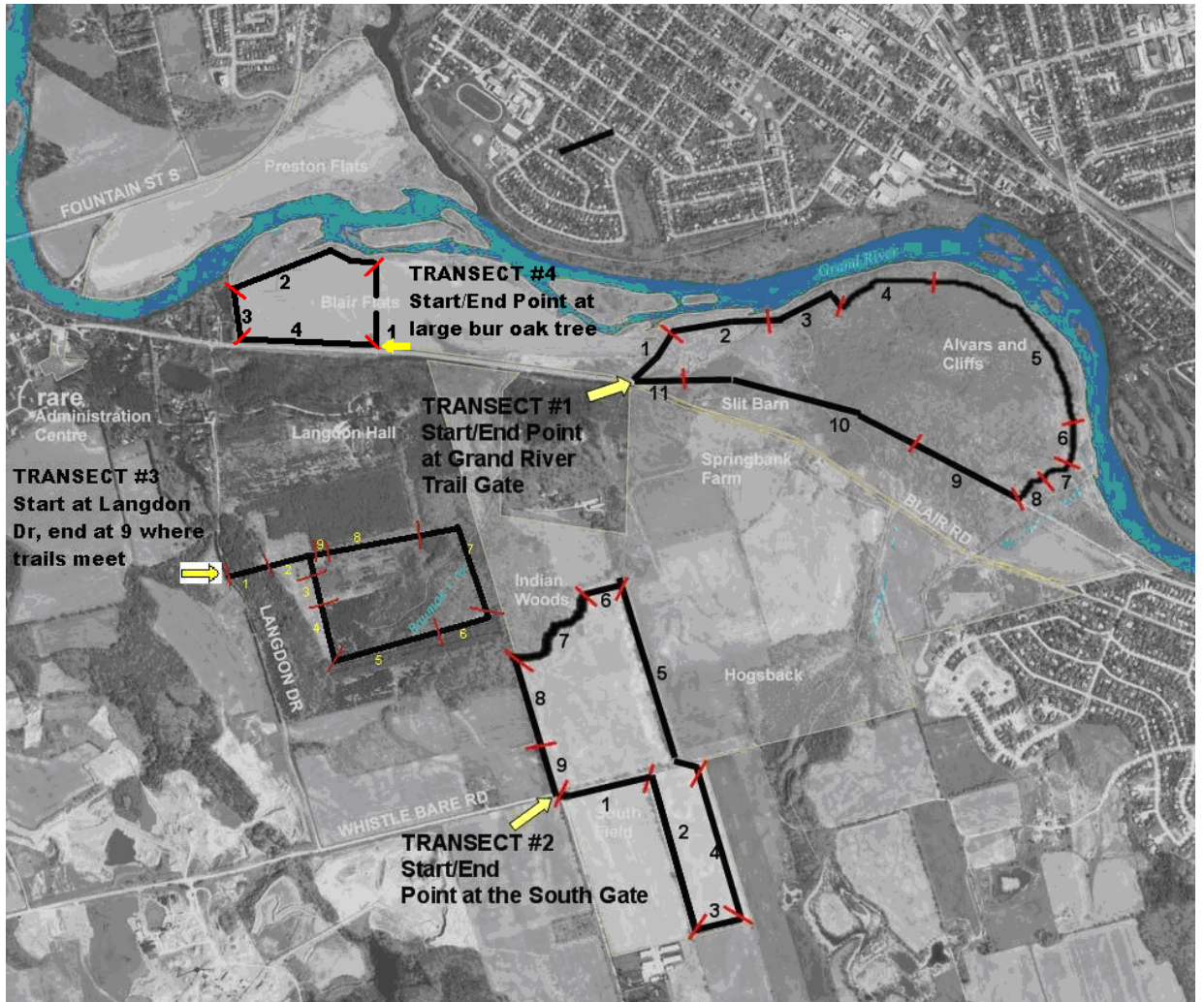
Finally, a useful tool for analyzing monitoring data would be to use multivariate statistics to separate the effects of weather on butterfly populations. Inferences can be made about the effect of weather on butterfly numbers and behaviour, but unless sound statistical analysis is completed, these guesses cannot be founded.

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Appendices

Appendix A – Transect Map of rare Property



Appendix B – Transect Descriptions

Transect One - Meadow/Cliffs & Alvars

Section one (N 43° 22.980' W 80° 21.475')

- Grasslands
- Milkweeds
- Goldenrod

Section two (N 43° 23.053' W 80° 21.254')

- Riparian Meadow
- South side of transect- shrubs and trees

Section three (N 43° 23.053' W 80° 21.254')

- Riparian area with trees on south side
- Grasses/sedges
- Small shrubs
- Goldenrods

Section four (N 43° 23.119' W 80°21.037')

- Forest trail with open canopy areas
- Mainly conifers
- On cliffs

Section five (N 43° 22.966' W 80°20.605')

- Deciduous forest trail

Section six (N 43° 22.767' W 80°20.625')

- Open shrub land

Section seven (N 43° 23.016' W 80° 20.650')

- Deciduous forest trail

Section eight (N 43° 22.709' W 80° 20.694')

- Open shrub land

Section nine (N 43° 22.812' W 80° 20.892')

- Grand Trunk trail-deciduous forest

Section ten (N 43° 22.912' W 80° 21.303')

- Grand Trunk trail-dense shrub growth on both sides of trail

Section eleven (N 43° 22.927' W 80° 21.552')

- Wetland on either side of trail

Transect Two - Agricultural and Hedgerow

Section one (N 43° 22.192' W 080° 21.703')

- Meadow-south side of transect
- Deciduous trees & shrubs- north side of transect
- Bordering a mix of alfalfa, red fescue, perennial wild rye, buckwheat, winter wheat, and oats field.

Section two (N 43° 22.043' W 080° 21.555')

- Hedgerow along a soy bean field edge
- Mostly open with some shrubs

Section three (N 43° 21.915' W 080° 21.411')

- Hedgerow of deciduous trees along a soy bean field edge

Section four (N 43° 22.058' W 080° 21.401')

- Open soy bean field

Section five (N 43° 22.359' W 080° 21.585')

- Deciduous hedgerow of mostly Oak spp.
- Bordering corn field on east side
- Bordering soy bean on west side

Section six (N 43° 22.551' W 080° 21.735')

- Hedgerow with deciduous trees, grapevines and tall grasses
- North of the transect is corn and south of transect is soy bean

Section seven (N 43° 22.459' W 080° 21.855')

- Meadow bordered by deciduous trees (Indian Woods) to the North and natural regeneration and soy bean to the south

Section eight (N 43° 22.296' W 080° 21.888')

- Hedgerow of deciduous trees, mostly maple bordering soy bean field
- Shady areas

Section nine (N 43° 22.215' W 080° 21.861')

- Hedgerow of shrubs, vines, and grasses bordering soy bean field

Transect Three - Langdon Drive

Section one (N 43° 22.342' W 080° 22.374')

- Coniferous forest – cedar, shrubs, ash
- Stop by swamp

Section two (N 43° 22.358' W 080° 22.282')

- Meadow species – milkweed, golden rod, grasses, sedges
- Stop at junction of trails

Section three (N 43° 22.324' W 080° 22.272')

- Black locust plantation and meadow
- Stop halfway

Section four (N 43° 22.280' W 080° 22.253')

- Meadow – milkweed, golden rod, grasses and sedges
- Spruce forest on east side
- Stop near single coniferous tree on west side

Section five (N 43° 22.254' W 080° 22.172')

- Spruce and deciduous forest
- Stop where wet area ends (will change from year to year)

Section six (N 43° 22.288' W 080° 22.230)

- Meadow – grasses and sedges
- Walnut plantation
- Stop halfway

Section seven (N 43° 22.374' W 080° 22.390')

- Langdon Hall trail
- Deciduous forest – sugar maple, beech and oak
- Woodland plants/flowers – may apple, solomon's seal, trillium, ferns
- Stop on cement bridge over Bauman Creek

Section eight (N 43° 22.373' W 080° 22.189')

- Laneway
- Deciduous forest – sugar maple, shrubs
- Stop near pile of logs

Section nine (N 43° 22.362' W 080° 22.267')

- Meadow – vetch, grasses and sedges
- Scattered trees and shrubs, golden rod
- Stop halfway before the junction of trails

Transect 4 – Blair Flats (Planted for tall grass prairie in March, 2010)

Section 1: (N 43° 23.470' W 080° 22.187')

- Weedy meadow planted for tall grass prairie, recovering from agricultural use
- Horseweed, Black-eyed Susan, goldenrod

Section 2: (N 43° 23.910' W 080° 22.294')

- North side regeneration area, south side planted for tall grass prairie
- Horseweed, milkweed, goldenrod, thistles and burdock

Section 3 (N 43° 23.330' W 080° 22.384')

- East side planted for tall grass prairie, west side hedgerow of shrubs and trees

Section 4 (N 43° 23.020' W 080° 22.283')

- North side planted for tall grass prairie, south side hedgerow along Blair Road
- Horseweed, thistles, poison ivy, shrubs, Manitoba maple

Appendix C – Sample Recording Form

Butterfly Recording Form- Southern Ontario																
Year: 2010			Date: Aug 11		Recorder: C.Moore											
Site Name: rare Charitable Research Reserve Transect# 1																
Start Time: 10:30			End Time: 13:35		Start Temp: 28.4C				End Temp: 29.1C							
Sun. 85%			Wind Speed: Gentle breeze													
SECTION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
American Lady																0
Appalachian Brown																0
Arctic Skipper																0
Banded Hairstreak																0
Black Dash																0
Black Swallowtail																0
Broad-winged Skipper																0
Bronze Copper																0
Cabbage White	29	14	3	1	3	2		2		3	7					64
Clouded Sulphur	5	9				3		2								19
Columbine Duskywing																0
Common Sooty Wing																0
Common Wood Nymph																0
Crossline Skipper																0
Delaware Skipper	1															1
Dun Skipper																0
Eastern Comma																0
Eastern Tailed Blue																0
Eastern Tiger Swallowtail																0
European Skipper																0
Eyed Brown																0
Giant Swallowtail																0
Great Spangled Fritillary																0
Hickory Hairstreak																0
Hobomok Skipper																0
Inornate Ringlet		3	4			1										8

Juvenal's Duskywing																	0
Least Skipper	2																2
Little Wood Satyr																	0
Little Yeloo																	0
Long Dash																	0
Milbert's Tortoiseshell																	0
Monarch	9	1									1						11
Mourning Cloak																	0
Northern Broken Dash																	0
Northern Crescent																	0
Northern Pearly Eye																	0
Orange Sulphur																	0
Painted Lady																	0
Pearl Cresent											1						1
Peck's Skipper																	0
Question Mark					1												1
Red Admiral																	0
Red Spotted Purple																	0
Silver-Spotted Skipper																	0
Spring Azure																	0
Striped Hairstreak																	0
Summer Azure																	0
Tawny Emperor																	0
Tawny-edged Skipper																	0
Viceroy																	0
White Admiral																	0
Wild Indigo Duskywing																	0
SECTION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Sunshine	s	s	s	s&c	s	s	s	s	s	s&c	s						107

Notes:

Appendix D – The Beaufort Wind Scale

FORCE	DESCRIPTION	SPECIFICATIONS FOR USE ON LAND
0	Calm	Calm; smoke rises vertically.
1	Light air	Direction of wind shown by smoke drift, but not by wind vanes.
2	Light Breeze	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	Moderate Breeze	Raises dust and loose paper; small branches are moved.
5	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	Strong Breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	Near Gale	Whole trees in motion; inconvenience felt when walking against the wind.
8	Gale	Breaks twigs off trees; generally impedes progress.
9	Severe Gale	Slight structural damage occurs (chimney-pots and slates removed).
10	Storm	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	Violent Storm	Very rarely experienced; accompanied by wide-spread damage.
12	Hurricane	--

Appendix E – 2008 Annual Butterfly Count Results

Cambridge (rare Charitable Research Reserve), ON. Yr. 2, 43°22.9'N 80°21.3'W, center at center N of Blair Rd. about 1.7 mi E of jct. of Blair Rd. and Fountain St. in Cambridge. See 2006 report for habitats. Elevation: 928-928 ft. **13 July 2008**; 0930-1500 hrs; sun AM 76-100%, PM 51-75%; 15-28°F; wind 13-17 mi/hr. 14 observers in 5 parties. **Total party-hours 6; total party-miles on foot 9. Observers:** E. Barkley, M. Burrell, M. Cassidy, Jessica Grealey (709 Keatswood Crescent, Waterloo, ON N2T 2R6), S. Hentsch, C. Humphrey, K. Jackson, L. Lamb, G. Michalenko, M. Muir, G. Richardson, J. Turchin, M. Wolosinecky, L. Work.

Black Swallowtail 4, E. Tiger Sw. 19, Cabbage White 816, Clouded Sulphur 85, Orange Su. 10, Coral Hairstreak 15, Acadian Ha. 4, Banded Ha. 59, Hickory Ha. 1, Striped Ha. 20, E. Tailed-Blue 2, 'Summer' Spring Azure 2, **Am. Snout 2**, Gr. Spangled Fritillary 8, Meadow Fr. 2, Pearl Crescent 3, N. Cr. 12, Question Mark 2, E. Comma 1, Mourning Cloak 29, Am. Lady 4, Red Admiral 4, Red-spotted Admiral 12, Viceroy 1, **Tawny Emperor 1**, N. Pearly-eye 23, Eyed Brown 25, Appalachian Brown 3, Little Wood-Satyr 63, Com. Wood-Nymph 154, Monarch 14, Silver-spotted Skipper 2, European Sk. 127, Peck's Sk. 1, Tawny-edged Sk. 24, Long Dash 1, N. Broken-Da. 3, Delaware Sk. 15, Dion Sk. 2, **Black Da. 6**, Dun Sk. 8, Polygonia sp. 1. **Total 42 species, 1,590 individuals.**

The highlighted species are special to *rare*- they are highly local and not known in many places within the region.

Appendix F – 2009 Annual Butterfly Count Results

Cambridge (rare Charitable Research Reserve), ON. Yr. 3, 43°22.9'N, 80°21.3'W, center at N of Blair Rd. about 1.7 mi E of jct. of Blair Rd. and Fountain St. in Cambridge. Floodplain; agricultural; old field; cliffs & alvars; hedgerows; old growth forest; early successional; roadside. **19 July 2009**; 1030-1530 hrs; sun AM 11-25%, PM 11-25%; 64-70°F; wind 13-24 mi/hr. 16 observers in 5 parties. **Total party-hours 24; total party-miles on foot 9. Observers:** E. Damstra, G. Grainge, Jessica Grealey (709 Keatswood Crescent, Waterloo, ON, N2T 2R6), K. Hodder, L. Lamb, C. Moore, I. Moore, S. O'Neil, C. Pomeroy, G. Richardson, J. Shea, V. Slocombe, B. Snider, C. Snider, E. Snider, W. Watson.

Black Swallowtail 1, E. Tiger Sw. 1, Cabbage White 151, Clouded Sulphur 25, Orange Su. 3, Coral Hairstreak 1, Banded Ha. 8, Gr. Spangled Fritillary 4, Pearl Crescent 12, N. Cr. 2, E. Comma 3, Gray Comma 1, Red Admiral 1, Red-spotted Admiral 1, Tawny Emperor 2, N. Pearly-eye 20, Eyed Brown 24, Appalachian Brown 11, Little Wood-Satyr 20, Com. Wood-Nymph 75, Monarch 11, Least Skipper 1, European Sk. 62, Peck's Sk. 1, Tawny-edged Sk. 2, Delaware Sk. 6, Broad-winged Sk. 1, Black Dash 1, Dun Sk. 12. **Total 29 species, 463 individuals. Field Notes:** Count originally scheduled for July 18th but was re-scheduled for the 19th. Conditions were not ideal (cool, overcast) but were consistent with the unusually cool and rainy weather experienced in southern Ontario this summer. On average, temperatures are 6 degrees Celsius cooler.

Appendix G – 2010 Annual Butterfly Count Results

Cambridge (rare Charitable Research Reserve), ON. Yr. 4, 43.3817°, -80.355°, center at N of Blair Rd. about 1.7 mi E of jct. of Blair Rd. and Fountain St. in Cambridge.

Floodplain; riparian; agricultural field and hedgerow; open meadow; wet meadow; forested; thicket; alvar; gravel trail; marsh. Habitat changes since last year: A large area has been seeded this year for a tall grass prairie restoration project. This will no doubt increase and improve butterfly habitat within the reserve. **10 July 2010;** 0930-1530 hrs; sun AM 76-100%, PM 76-100%; 68-83°F; wind 2-2 mi/hr. 19 observers in 6 parties.

Total party-hours 25; total party-miles on foot 9. Observers: R. Beaubien, T. Beaubien, E. Damstra, S. Fogo, G. Grainge, Jessica Grealey (709 Keatswood Crescent, Waterloo, ON, N2T 2R6; jgrealey@nrsi.on.ca), J. Grealey, K. Hodder, L. Lamb, A. MacNaughton, G. Michalenko, C. Moore, G. Richardson, B. Snider, E. Snider, E. Turchin, J. Turchin, W. Watson, M. Wolosinecky.

Black Swallowtail 27, E. Tiger Sw. 6, Cabbage White 187, Clouded Sulphur 93, Orange Su. 3, 'Summer' Spring Azure 2, Am. Snout 1, Gr. Spangled Fritillary 5, Meadow Fr. 1, Pearl Crescent 1, N. Cr. 2, Question Mark 8, E. Comma 2, Mourning Cloak 1, Am. Lady 5, Red Admiral 78, Red-spotted Purple 1, Viceroy 2, Tawny Emperor 4, N. Pearly-eye 18, Eyed Brown 7, Appalachian Brown 2, Little Wood-Satyr 8, Com. Wood-Nymph 73, Monarch 70, Silver-spotted Skipper 1, ¹**Wild Indigo Duskywing 9**, Com. Sootywing 1, Arctic Sk. 1, European Sk. 18, Peck's Sk. 1, Tawny-edged Sk. 6, N. Broken-Dash 1, Little Glassywing 2, Delaware Sk. 3, Broad-winged Sk. 1, ²**Black Da. 24**, Dun Sk. 5.

Unidentified: Polygonia sp. 3. **Total** 39 species, 683 individuals. **Field Notes:** ¹This species is widespread in Waterloo Region for the first time in 2010. Previously very rare.

²Local population known from this area but uncommon in the Region of Waterloo.

Appendix H – First Observation of Notable Butterfly Species at *rare* in 2010*

Species Common Name	Date
Eastern Comma	May-14
Wild Indigo Duskywing	May-17
Question mark	May-19
Mourning Cloak	May-19
Columbine Duskywing	May-19
Inornate Ringlet	May-19
Eastern Tiger Swallowtail	May-19
American Lady	May-20
European Skipper	May-24
Delaware Skipper	May-24
Spring Azure	May-24
Black Swallowtail	May-25
Hobomok Skipper	May-26
Juvenal's Duskywing	May-26
Red-Spotted Purple	Jun-01
Northern Crescent	Jun-03
Northern Pearly-eye	Jun-03
Arctic Skipper	Jun-03
Silver-Spotted Skipper	Jun-08
Little Wood Satyr	Jun-08
Eyed Brown	Jun-15
Great Spangled Fritillary	Jun-21
Milbert's Tortoiseshell	Jul-07
Monarch	Jul-07

*Note: those species observed in the first few or last few weeks of recording were not given a first appearance date as these species could have easily emerged earlier than this recording.

Appendix I – Tall Grass Prairie Species Planted in Blair Flats

RARE - Proposed TGP Species List			
Species Name	Common Name	NATIVE	CLOSEST
		<25KM?	OCCURANCE
MESIC TO DRY PRAIRIE SPECIES (Mechanical Seed Everywhere)			
<i>Anemone cylindrica</i>	Cylindrical Anemone	Y	
<i>Anemone virginiana</i>	Virginia Anemone	Y	
<i>Aster ericoides</i>	Heath Aster	Y	
<i>Aster laevis</i>	Smooth Aster	Y	
<i>Aster novae-angliaea</i>	New England Aster	Y	
<i>Desmodium canadensis</i>	Showy Tick Trefoil	Y	
<i>Heliopsis helianthoides</i>	Oxeye	Y	
<i>Lespedeza capitata</i>	Roundheaded Bushclover	Y	
<i>Monarda fistulosa</i>	Wild Bergamot	Y	
<i>Penstemon digitalis</i>	Foxglove Beardtongue	Y	
<i>Penstemon hirsutus</i>	Hairy Beardtongue	Y	
<i>Potentilla arguta</i>	Prairie Cinquefoil	Y	
<i>Pycnanthemum virginianum</i>	Virginia Mountain Mint	Y	
<i>Ratibida pinnata</i>	Grey-headed Coneflower		Dutton Prairie
<i>Rudbeckia hirta</i>	Black-eyed Susan	Y	
<i>Solidago juncea</i>	Early Goldenrod	Y	
<i>Solidago nemoralis</i>	Grey Goldenrod	Y	
<i>Solidago ptarmicoides</i>	Upland White Goldenrod	Y	
<i>Solidago rigida</i>	Stiff Goldenrod		Dutton Prairie
<i>Verbena hastata</i>	Blue Vervain	Y	
<i>Andropogon gerardii</i>	Big Bluestem	Y	
<i>Bromus kalmii</i>	Kalm's Brome	Y	
<i>Elymus canadensis</i>	Canada Wild Rye	Y	
<i>Schizachyrium scoparium</i>	Little Bluestem	Y	
<i>Sorghastrum nutans</i>	Indian Grass	Y	
WET PRAIRIE SPECIES (hand seed into select wet spots)			
<i>Asclepias incarnata</i>	Swamp Milkweed	Y	
<i>Carex vulpinopidae</i>	Fox Sedge	Y	
<i>Helianthus giganteus</i>	Tall Sunflower		Dutton Prairie
<i>Liatris spicata</i>	Dense Blazing-star		Dutton Prairie
<i>Rudbeckia laciniata</i>	Green-headed Coneflower	Y	
<i>Scirpus atrovirens</i>	Dark Green Bullrush	Y	
<i>Scirpus cyperinus</i>	Wool-grass	Y	
<i>Silphium terrebinthanum</i>	Prairie Dock		Brantford
<i>Spartina pectinata</i>	Prairie Chordgrass	Y	
<i>Vernonia missuricaa</i>	Missouri Ironweed		Dutton Prairie
<i>Veronicastrum virginianum</i>	Culver's-root		Walpole Is.
DRY ONLY PRAIRIE SPECIES (hand seed into selected dry ridges on site)			
<i>Asclepias tuberosa</i>	Butterfly Milkweed	Y	
<i>Aster ooctangelis</i>	Sky Blue Aster	Y	
<i>Bouteloua curtipendula</i>	Side-oats Grama		Brantford
<i>Verbena stricta</i>	Hoary Vervain		Norfolk

Appendix J – Land Taken Out of Agriculture at *rare* in the Vicinity of South Field and Indian Woods

