

Butterfly Monitoring 2012
rare Charitable Research Reserve



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2012

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1.0 Introduction

1.1 The *rare* Charitable Research Reserve

The *rare* Charitable Research Reserve is a non-profit organization founded in 2001, owning 913 acres of land in the Region of Waterloo where the Speed and Grand Rivers meet. The Reserve exists to preserve the land in perpetuity while focusing on research, education, and conservation goals. The land provides a unique opportunity for research in a green space surrounded by an expanding urban environment.

1.2 Ecological Monitoring

Ecological monitoring is the methodical collection of ecosystem data at regular intervals over time (Spellerberg 2005). The value of long-term monitoring has been previously stressed in the literature (Wolfe *et al.* 1987; Jeffers 1989; Pimm 1991; Vos *et al.* 2000), as it can provide vital information on ecosystem health. Collecting long term ecosystem data not only provides baseline information for future reference, but also allows for observation of ecosystem changes, in response to both natural and human disturbances (Lindenmayer and Likens 2010). Closely tied with detecting changes is the desire to determine the cause of any observed changes (Vaughan *et al.* 2001), and the potential further impacts on the ecosystem.

Ideally, an extensive long-term monitoring program would look at representative areas of an ecosystem, including all biotic and abiotic factors and the interactions between them (Davis 1993). Financial limitations (Caughlan and Oakley 2001) and limited manpower often make this difficult and generally infeasible. It is therefore advantageous to monitor one or several indicator species, which are particularly sensitive to environmental change and relatively easy and cost effective to monitor (Noss 1990). Monitoring indicator species can provide information on the health of a community, and can act as an early warning of environmental damage (Noss 1990).

1.3 Ecological Monitoring Assessment Network (EMAN)

The Ecological Monitoring and Assessment Network (EMAN) was established in 1994 by Environment Canada to more closely monitor environmental changes across Canada and to promote prompt environmental planning decisions (Craig and Vaughan 2001). The network is a collaboration of academic, government, and private sector scientists with the collective goal of “*What is changing and why in Canadian ecosystems*” (Vaughan *et al.* 2001). A set of standardized monitoring protocols for terrestrial, marine, and freshwater systems have been developed and are available without cost to promote comparable long term monitoring across Canada. Until September 2010, an electronic information catalogue system was available for data sharing and metadata analyses (Craig and Vaughan 2001; Environment Canada 2011). The EMAN Coordinating Office is currently closed, preventing data sharing, and the future of EMAN is unknown.

1.4 Lepidoptera Taxonomy

Butterflies and moths together make up the Order Lepidoptera, meaning “scaled wing”. The term butterfly colloquially includes the five true butterfly families (*Papilionidae*, *Nymphalidae*, *Pieridae*, *Lycaenidae*, and *Riodinidae*) and the skipper family (*Hesperiidae*) (Robbins and Opler 1997). There is a common misconception that all moths are drab and dull in colour and fly only at night, and while there is no hard and fast rule to distinguish the two, there are some general characteristics that typically apply (Klots 1979). Most moths rest with their wings flat, have tapered or feathered antennae, use a silk cocoon when pupating, and are nocturnal. Butterflies, especially in temperate regions, are predominately diurnal, with clubbed antennae and folded wings at rest (Klots 1979). There are estimated to be 17,500 butterfly species found around the world (Robbins and Opler 1997; Kristensen et al. 2007), with only 750 inhabiting the Nearctic region (Robbins 1982).

1.5 Why Monitor Butterflies?

Butterflies are excellent indicators of environmental change for several reasons. They have specific habitat requirements throughout their life stages, often needing specific host plants to eat and lay eggs upon, and for feeding as an adult. Thus, butterflies can be very sensitive to habitat loss, caused by both natural and human disturbances, and can be affected by invasive plants in both positive and negative ways. For example, Dog Strangling Vine (*Cynanchum louiseae*) is an invasive milkweed that female Monarchs (*Danaus plexipus*) lay their eggs on. This results in the death of the larva since they do not have the proper food plant to survive (Pridham and Irvine 2008). Conversely, while the invasion of Garlic Mustard (*Alliaria petiolata*) originally appeared to hinder the growth and development of some Pieridae species (Haribal and Renwick 2001; Renwick et al. 2001), there is now some evidence that species are taking advantage of this widespread invader and using it as an effective host (Keeler and Chew 2008). Butterfly sensitivity extends beyond host plants to local weather conditions, where they require warm temperature in order to reach wing temperatures of 25C to fly. Exceptionally cold or rainy flying seasons can inhibit a butterfly’s ability to develop and reproduce. This can also apply on a broader scale to global climate changes. Warmer global temperatures could allow butterflies to extend beyond their tradition range, and so the presence or absence of species in a specific region could be an indication of broad scale environmental change. Additionally, the short life span of butterflies allows for a quick response to ecological pressures.

While the above could be said of many insect species, butterflies in particular make good indicator species because of their size and colourful distinctions between species. Compared to many insect species, butterflies are relatively easy to observe and identify, and in general they invoke a favourable response from the community (Robbins and Opler 1997) allowing for recruitment of volunteers and public help.

1.6 Monitoring Butterflies at **rare** Charitable Research Reserve

Butterfly monitoring started at **rare** in 2006 as a pilot program for EMAN to examine the feasibility of using the Transect Walk Method to examine butterfly abundance and diversity in Canada (Grealey 2006). Baseline data was collected in the first year, and it continued in 2009 and subsequent

years with the goals of documenting trends in butterfly abundance and diversity. This is useful since butterfly trends can be indicative of broad scale insect trends (Thomas and Clarke 2004), which amass a large proportion of biodiversity in the area. Grealey established two transects in 2006; one in Cliffs and Alvares and one in the South Field/Sparrow Field (Figure A.1). She also recommended that annual butterfly counts continue on the property to cover all possible butterfly habitats beyond the established transects. In 2009, an additional transect was added in the newly purchased Thompson Tract, and in 2010 a transect was established in Blair Flats (a newly planted tall grass prairie) which previously had been in agricultural production. Monitoring continued on all four transects in 2011 and 2012. It is important for long term standardized data collection to continue at *rare* for reliable trend estimates and to identify early warning signs of change (van Swaay et al 2008).

2.0 Methods

2.1 Transect Descriptions

Monitoring occurred weekly at four transects at *rare* Charitable Research Reserve (Figure A.2):

Cliffs and Alvares Transect is 3.5km primarily following the Riverside and Grand Trunk Trails. It is composed of mature hardwood stands dominated by American Beech (*Fagus grandifolia*) and Sugar Maple (*Acer saccharum*), deciduous swamps, and limestone cliffs and passes through an extensive floodplain and open alvar habitats.

South Field/Sparrow Field is 3.4km in length and follows field edges, hedgerows, and the South East perimeter of the Indian Woods. The majority of this land was or is used for agriculture with wheat clover in South Field West and corn in South Field East. Sparrow field has been restored to native vegetation for 1-5 years in varying parts and as ongoing research projects occurring. It is at the southern boundary of *rare* property.

Thompson Tract is a 2.2km counter clockwise loop of established trails through meadows, plantations, lowland forests, and upland forest, the latter being dominated by Sugar Maple and American Beech. It is at the western boundary of the *rare* property.

Blair Flats is a 1.3km loop beginning at the large Bur Oak (*Quercus macrocarpa*) just off of Blair Rd. It was previously an agriculture field but was planted as a tallgrass prairie in 2010 as part of a long-term restoration study. The transect heads north from the Bur Oak toward the river, stops at the regenerating portion of the field, turns west towards the *rare* property boundary, continues south before heading east (and parallel to the road) back to the Bur Oak. It is dominated by Goldenrod (*Solidago Canadensis*), Queen Anne's Lace (*Daucus carota*), Black Eyed Susan (*Rudbeckia hirta*), and Tansy (*Tanacetum vulgare*).

2.2 Monitoring Protocol

Butterfly monitoring at *rare* is conducted using the "Transect Walk Method" (Pollard 1977; Pollard & Yates 1993) which is widely used in monitoring schemes around the world (Pollard and Yates 1993; Royer et al. 1998; van Swaay et al. 2008), beginning with Britain in 1976. It involves walking a fixed

route weekly at a uniform pace over a defined amount of time, while making butterfly observations within a given radius. Each transect is split into four to eleven sections based on habitat changes.

Ideally, butterfly monitoring should occur over a 26 week period from April to September (Layberry et al. 1998). Time and monetary constraints have reduced this period at *rare*. In 2006, monitoring occurred over only a five week period from mid-July to August. This was expanded to thirteen weeks in 2009, and again expanded in 2010 and all subsequent years to a fourteen week period from mid-May to mid-August. Butterflies are most active on sunny days during the warmest part of the day, approximately 10 am to 3 pm. It is best for temperatures to be above 13°C if predominantly sunny, and above 17°C if overcast (UK Butterfly Monitoring Scheme; Butterfly Monitoring Scheme Germany), and wind should be less than 5 on the Beaufort scale (Grealey 2006).

Prior to the monitoring season, the observer walked all transects at a uniform pace and flagged stopping points and section breaks as necessary. Coordinates of stopping points and section descriptions can be found in Appendix A: Lists A.1-A.4. Once monitoring began, each transect was walked once per week for a total of fourteen consecutive weeks. Weather conditions were taken into consideration; however, in the absence of rain, it is better to collect the data in less than ideal conditions than to collect no data. To minimize observer bias, one observer monitored all transects throughout the fourteen week period, with occasional assistance by volunteers. Start and end time were recorded before and after each transect along with the initial and end temperatures using a hand-held Kestrel 3000© (Nielson-Kellerman, Boothwyn, PA, USA). The transects were walked at a uniform pace with butterfly observations made within a 10m radius of the observer. Butterflies were visually identified in the field, and caught with a net when necessary to aid identification. Unknown species were photographed and sent to local experts for identification, or if not possible, the most common of all possibilities was recorded. Ten minutes stops were made at the halfway point of each section for stationary butterfly observations, where percent cloud cover was estimated (0-100) and wind speed was recorded based on Beaufort's wind scale (List C.1) with the assistance of the hand-held Kestrel 3000©. Distinctions were made in butterfly recording between those observations made while walking the transects and those made while stopped at halfway points. A standard field recording form can be found in Appendix C: Figure C.1 and on the rare server at LEVEL 4/Research & Monitoring/Ecological Monitoring/Butterflies/Butterfly Monitoring. Occasional stops while walking the transects were permitted for proper identification of butterflies, and recording continued where the stop was made. The observer carried a net and jar to aid with identification at all times. A suggested list of field equipment is in Appendix B: List B.1.

2.3 Data Analysis

Data were analyzed in PASW Statistics 17. Data were compared across years within transects, as each transect varies in distance and direct comparisons between them would not yield true results. Within transects, individual butterfly observations were analyzed using a loglinear Poisson generalized linear model. Pairwise comparisons were performed following significant results to determine where differences occurred.

Additionally, Shannon Diversity Index and species evenness were calculated (Figure 2.1) for each transect in 2012 and reported here along with 2009-2011 values that were previously determined (Dodds 2011).

Shannon index:

$$H = -\sum_{i=1}^S p_i \ln p_i$$

Where p_i is the proportion of individuals belonging to the i th species

Evenness:

$$E_H = H/\ln(S)$$

Where H is the Shannon index and S is the number of species

Figure 2.1: Shannon index and evenness formulas.

3.0 Results

3.1 Transect One- Cliffs and Alvars

In 2012, 46 species and 2828 individuals were observed while monitoring Transect one (Table 3.1). This is almost double the number of individuals seen in 2011, and more than the combined total from the three years previous. In Transect one, the number of individuals has significantly increased each year (Chi-Square=2187, df= 4, $p<0.001$ and all pairwise comparisons $p<0.001$). The number of species observed in this transect has more than doubled since the first monitoring season. The five most abundant species observed here were: Cabbage Whites (n=1412), European Skippers (n=188), Little Wood Satyrs (n=170), Northern Crescents (n=115), and Clouded Sulphurs (n=111). With the exception of Clouded Sulphurs, these are the same species that dominated this transect in 2011. The abundance and regional status of all butterflies observed on this transect are shown in Table 3.2. Figure 3.1 and 3.2 depict all butterflies noted on this transect with less than and more than fifty observations respectively.

The Shannon Diversity Index and species evenness values are reported since 2009 in Table 3.1. The Shannon Diversity Index for 2012 is 2.19, an increase from previous years, and the evenness value is 0.57, which is consistent with findings from previous years.

Table 3.1: Summary of butterfly observations by transect and year with Shannon Diversity Index and evenness scores for full 14-week monitoring programs at *rare* Charitable Research Reserve.

Measures	Transect One				Transect Two				Transect Three			Transect Four		
	2009	2010	2011	2012	2009	2010	2011	2012	2010	2011	2012	2010	2011	2012
Number of Individuals (n)	620	1063	1453	2826	717	1778	1146	2427	938	911	2116	270	298	497
Species Richness (S)	25	33	35	46	24	26	30	37	30	35	38	14	20	35
Shannon-Wiener Index (H)	1.9	2.07	1.77	2.19	1.65	1.42	1.6	1.76	2.37	2.56	2.56	1.3	1.26	2.12
Evenness (E)	0.59	0.59	0.5	0.57	0.52	0.44	0.47	0.49	0.7	0.72	0.71	0.49	0.42	0.6

Table 3.2: All butterflies observed in 2012 monitoring season by species and transect. The Waterloo Regional Status of each species is also shown.

SPECIES	TRANSECT				TOTAL	REGIONAL STATUS
	1	2	3	4		
American Lady	8	9	2	0	19	Common
Appalachian Brown	17	0	0	0	17	Uncommon
Baltimore Checkerspot	1	0	0	0	1	Rare
Banded Hairstreak	1	0	1	0	2	Uncommon
Black Swallowtail	26	55	2	16	99	Very Common
Bronze Copper	4	0	0	1	5	Very Common
Cabbage White	1412	1351	535	259	3557	Very Common
Clouded Sulphur	111	336	314	36	797	Very Common
Columbine Duskywing	0	0	1	0	1	Rare
Common Buckeye	1	4	1	10	16	Uncommon
Common Sootywing	1	2	0	2	5	Rare
Common Wood Nymph	83	27	105	18	233	Very Common
Delaware Skipper	0	1	0	1	2	Common
Dion Skipper	1	0	0	0	1	Rare
Dun Skipper	4	0	2	0	6	Very Common
Eastern Comma	33	6	13	3	55	Very Common
Eastern Tailed Blue	0	1	2	3	6	Uncommon
Eastern Tiger Swallowtail	42	55	30	8	135	Very Common
European Skipper	188	39	87	32	346	Very Common
Eyed Brown	61	0	0	6	67	Very Common
Giant Swallowtail	35	18	10	5	68	Uncommon
Great Spangled Fritillary	14	7	12	5	38	Very Common
Hobomok Skipper	2	5	1	0	8	Common
Inornate Ringlet	106	60	241	9	416	Common
Juvenal's Duskywing	10	6	27	0	43	Rare

Least Skipper	9	0	3	0	12	Uncommon
Little Glassywing	2	0	0	0	2	Uncommon
Little Wood Satyr	170	10	157	1	338	Very Common
Long Dash	11	0	0	0	11	Uncommon
Meadow Fritillary	1	1	0	0	2	Very Common
Milbert's Tortoiseshell	3	0	0	0	3	Uncommon
Monarch	74	237	99	20	430	Very Common
Mourning Cloak	6	6	10	4	26	Very Common
Northern Broken Dash	1	0	0	1	2	Common
Northern Crescent	115	44	122	10	291	Uncommon
Northern Pearly Eye	24	7	72	0	103	Common
Orange Sulphur	18	26	82	2	128	Very Common
Painted Lady	4	7	6	1	18	Common
Pearl Crescent	40	25	36	11	112	Common
Peck's Skipper	2	0	1	1	4	Very Common
Question Mark	37	22	44	6	109	Very Common
Red Admiral	99	36	47	7	189	Very Common
Red Spotted Purple	11	10	9	4	34	Common
Silver-Spotted Skipper	2	1	14	3	20	Uncommon
Silvery Checkerspot	0	1	0	0	1	Rare
Spring Azure	15	1	8	0	24	Common
Summer Azure	6	1	11	2	20	Very Common
Tawny Emperor	0	1	0	5	6	Uncommon
Variegated Fritillary	2	6	0	1	9	Rare
Viceroy	10	2	3	3	18	Very Common
White Admiral	0	1	1	0	2	Uncommon
Wild Indigo Duskywing	3	0	5	1	9	Unknown
Total	2826	2427	2116	497	7866	

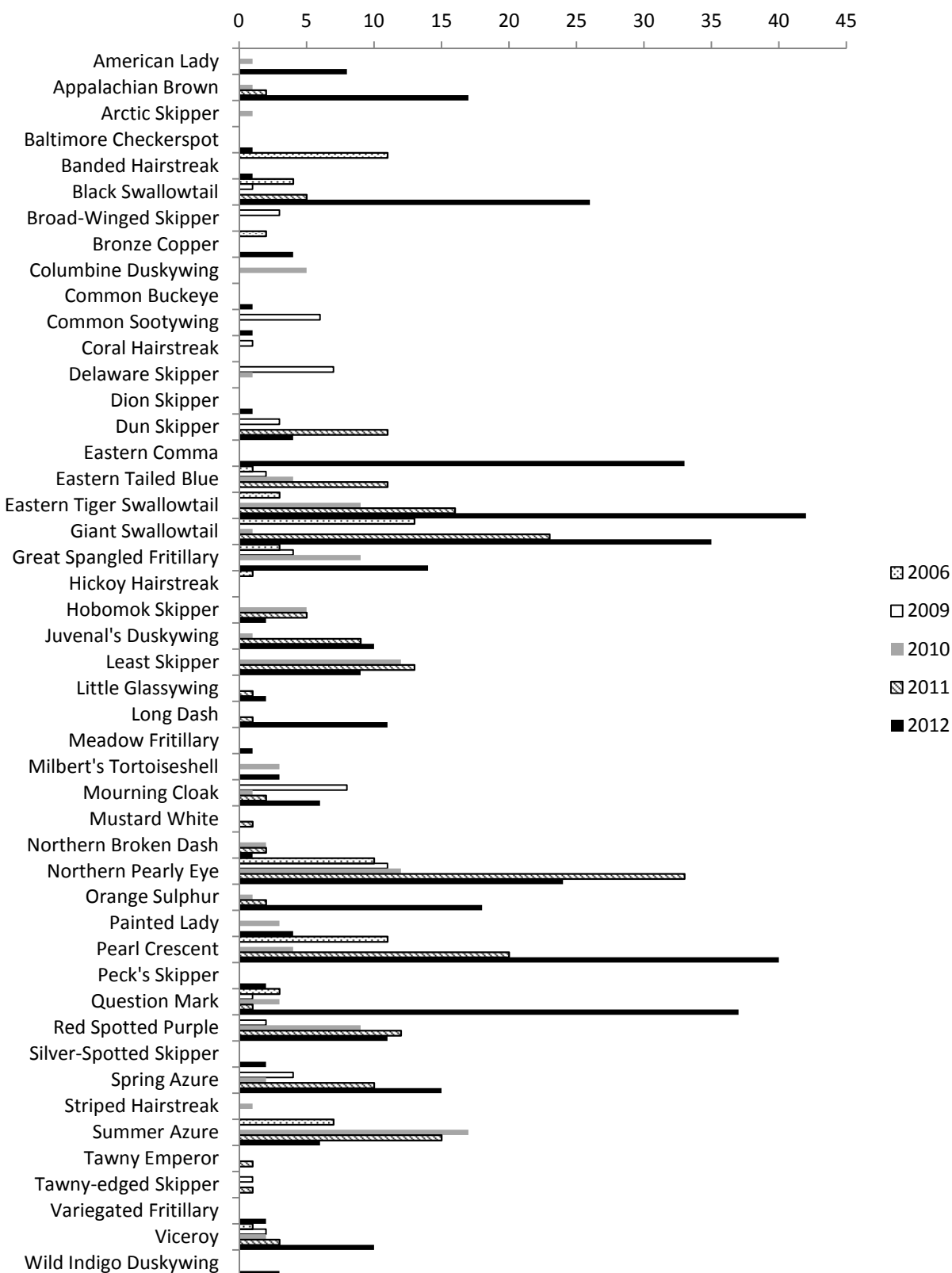


Figure 3.1: Comparison of butterfly observations from Transect one by species from 2006*, 2009-2012. Only butterflies with less than 50 observations are shown.

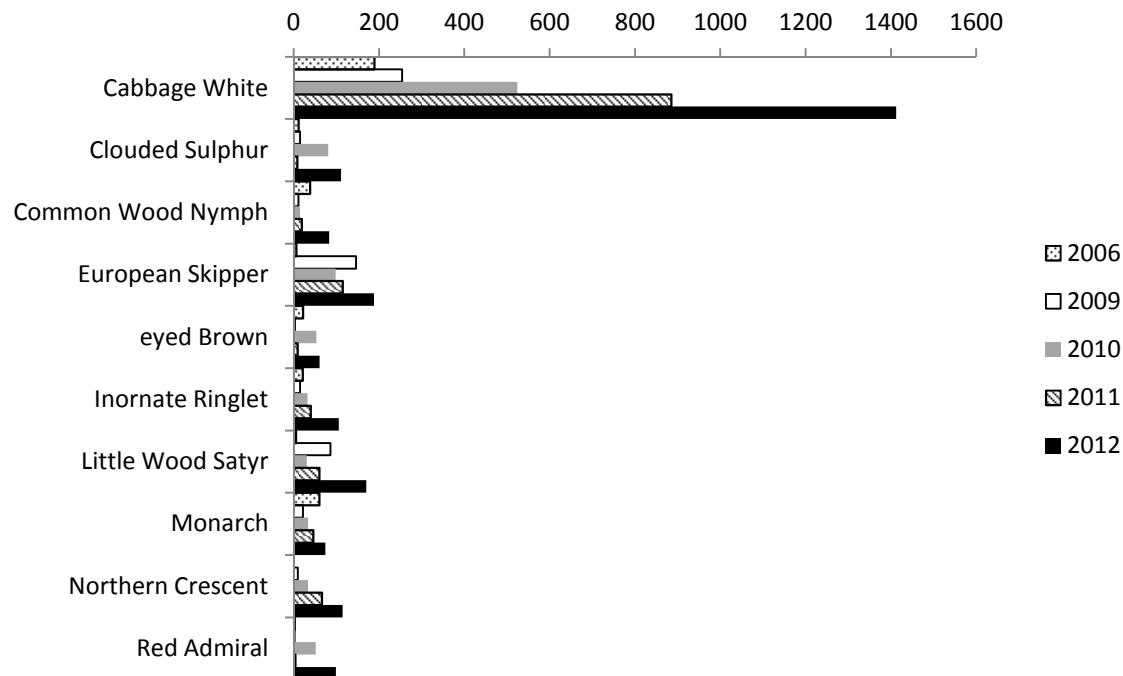


Figure 3.2: Comparison of butterfly observations from Transect one by species from 2006*, 2009-2012. Only butterflies with more than fifty observations are shown.

3.2 Transect Two- South Field/Sparrow Field

In 2012, 38 different species and 2427 individuals were observed while monitoring Transect two (Table 3.1). This is significantly more individuals than observed in previous years (Chi-Square=2066, df=4, $p<0.001$ and all pairwise comparisons $p<0.001$), and a continued exponential increase in species since 2009. The six most abundant species observed here were: Cabbage Whites ($n=1351$), Clouded Sulphurs ($n=336$), Monarchs ($n=237$), Inornate Ringlets ($n=60$), and both Eastern Tiger Swallowtails and Black Swallowtails ($n=55$). With the exception of Eastern Tiger Swallowtails, these species were also the most abundant species in 2011, and Cabbage Whites, Clouded Sulphurs, and Monarchs have been the three most abundant species here since 2009. Red Admirals, which were completely absent from this transect in 2011, returned in numbers resembling those seen in 2010 ($n=36$). The abundance and regional status of all butterflies observed on this transect are shown in Table 3.2. Figure 3.3 and 3.4 depict all butterflies noted on this transect with less than and more than fifty observations respectively.

The Shannon Diversity Index and species evenness values are reported since 2009 in Table 3.1. The Shannon Diversity Index for 2012 is 1.76 and the evenness value is 0.49, the former being a slight increase from previous years, and the latter more similar.

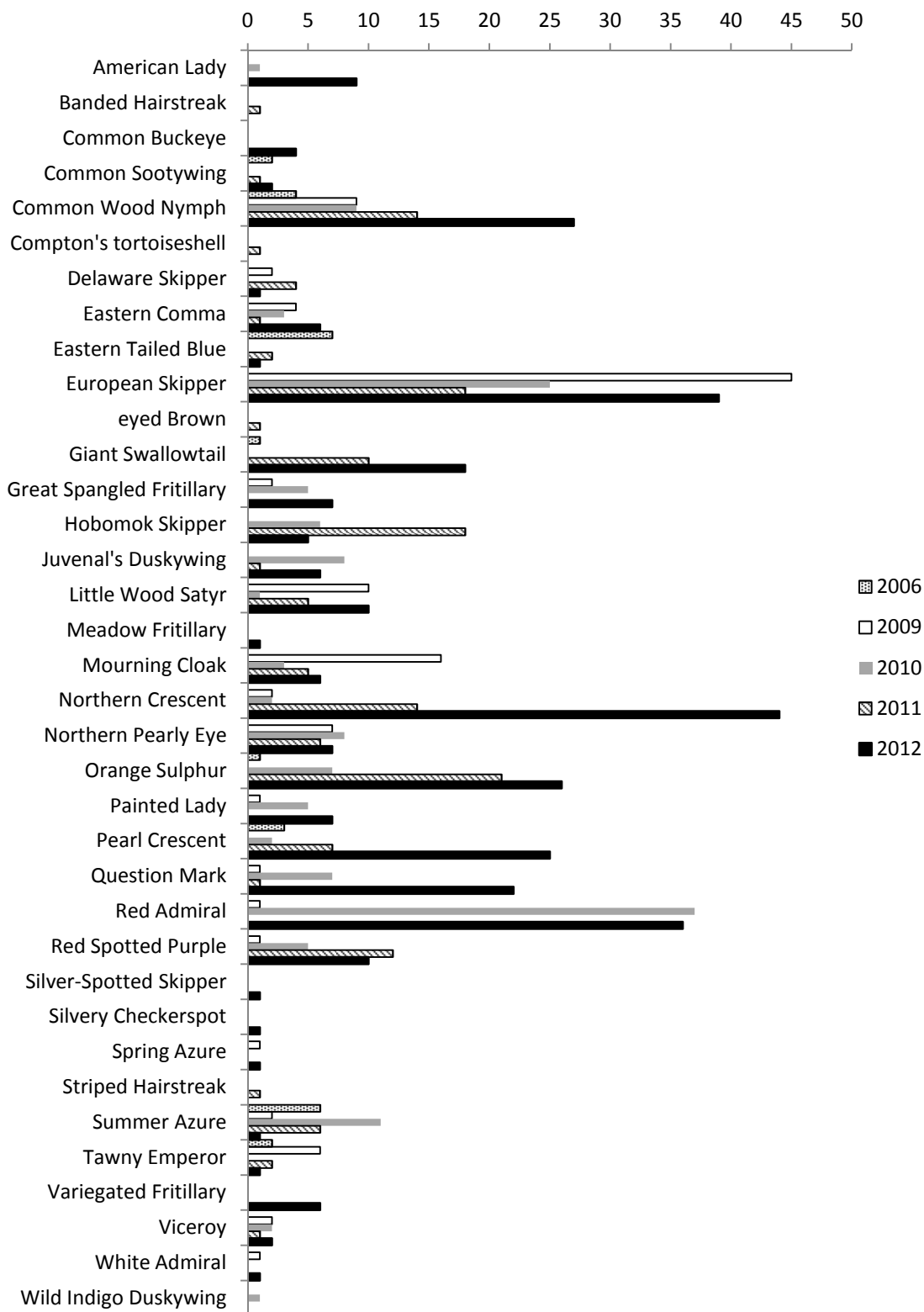


Figure 3.3: Comparison of butterfly observations from Transect two by species from 2006*, 2009-2012. Only butterflies with less than fifty observations are shown.

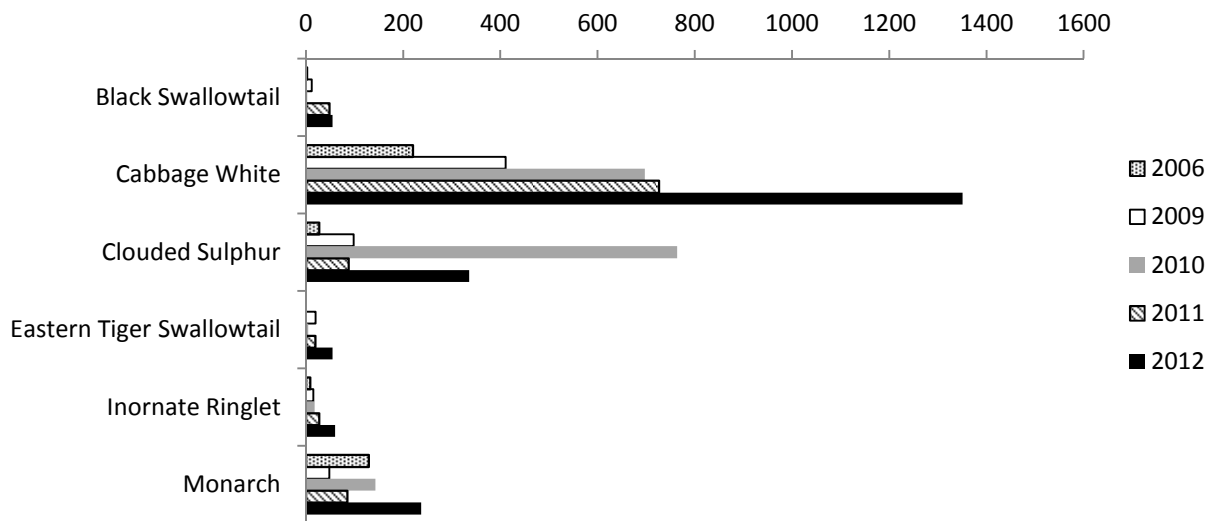


Figure 3.4: Comparison of butterfly observations from Transect two by species from 2006*, 2009-2012. Only butterflies with more than fifty observations are shown.

3.3 Transect Three- Thompson Tract

In 2012, 38 species and 2116 individuals were observed while monitoring Transect three (Table 3.1). This is significantly more individuals than previous years (Chi-Square=1212, df= 3, $p<0.001$ and pairwise comparisons with 2012 $p<0.001$). Only 2010 and 2011 counts do not differ ($p=0.530$). There has been a continued increase in species since the monitoring program began. The five most abundant species observed here were: Cabbage Whites (n=535), Clouded Sulphurs (n=314), Inornate Ringlets (n=241), Little Wood Satyrs (n=157), and Northern Crescents (n=122). Cabbage Whites, Inornate Ringlets, and Northern Crescents were all previously dominant in 2011. The abundance and regional status of all butterflies observed on this transect are shown in Table 3.2. Figure 3.5 and 3.6 depict all butterflies noted on this transect with less than and more than fifty observations respectively.

The Shannon Diversity Index and species evenness values are reported since 2009 in Table 3.1. The Shannon Diversity Index for 2012 is 2.56 and the evenness value is 0.71, both very similar to previous years.

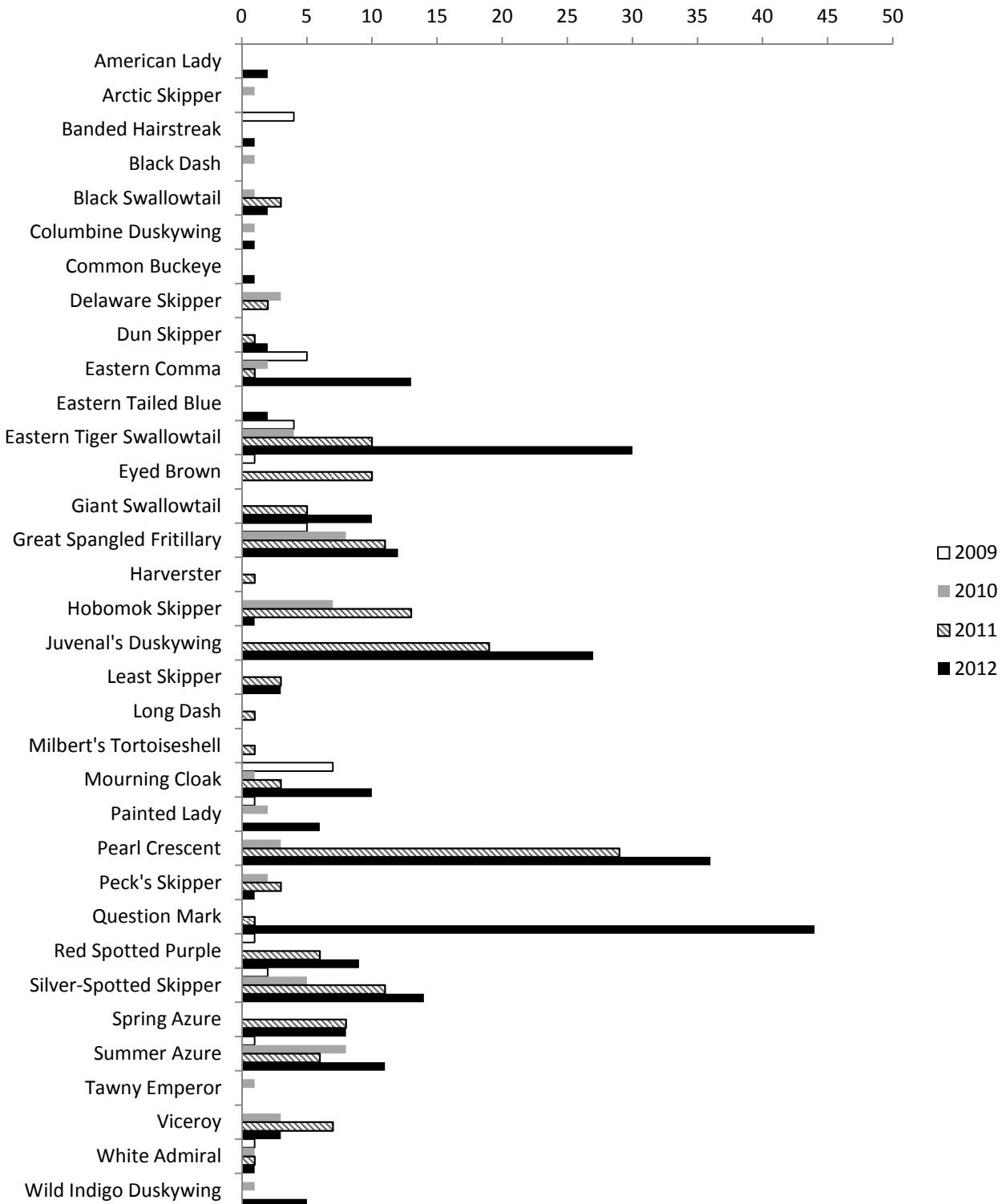


Figure 3.5: Comparison of butterfly observations from Transect three by species from 2006*, 2009-2012. Only butterflies with less than fifty observations are shown.

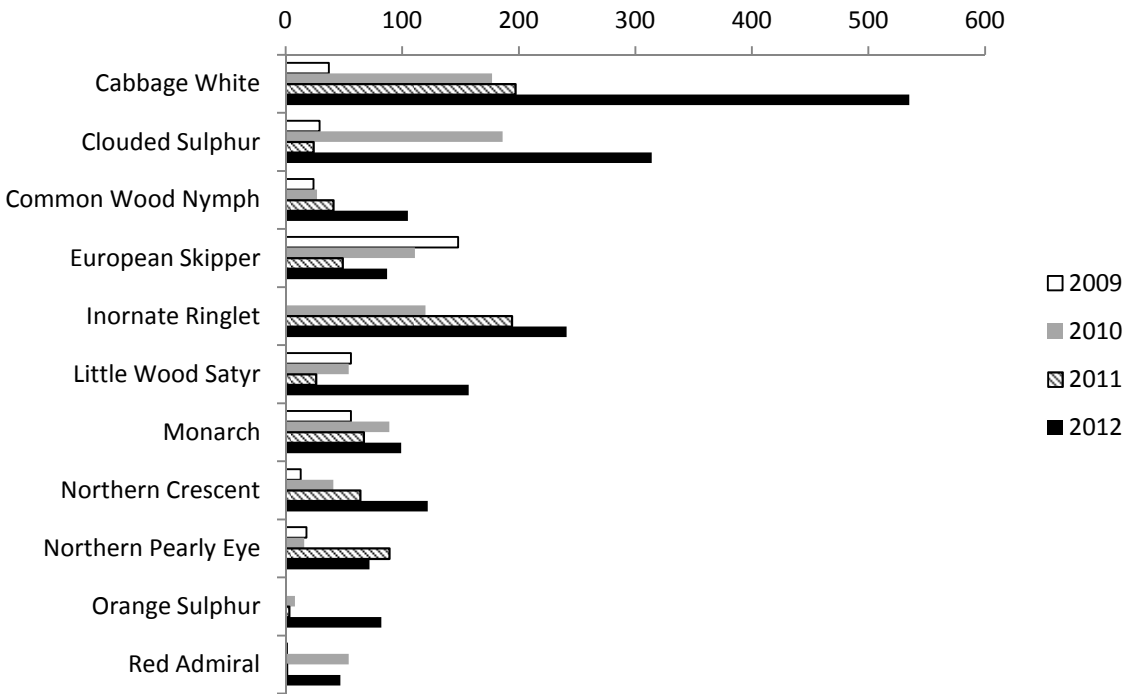


Figure 3.6: Comparison of butterfly observations from Transect three by species from 2006*, 2009-2012. Only butterflies with more than fifty observations are shown.

3.4 Transect four- Blair Flats

In 2012, 35 species and 497 individuals were observed while monitoring Transect four (table x). This is a significant increase in individuals at this site from previous years (Chi-Square=72.88, df= 2, $p<0.001$ and pairwise comparisons with 2012 $p<0.001$). Once again, observations from 2010 and 2011 do not differ ($p=0.240$). Number of species observed at this site increased substantially in 2012. The five most abundant species observed here were: Cabbage Whites ($n=259$), Clouded Sulphurs ($n=36$), European Skippers ($n=32$), Monarchs ($n=20$), and Common Wood Nymphs ($n=18$). Cabbage Whites, Monarchs, and Clouded Sulphurs were all dominant species in 2011. The abundance and regional status of all butterflies observed on this transect are shown in Table 3.2. Figure 3.7 and 3.8 depict all butterflies noted on this transect with less than and more than fifty observations respectively.

The Shannon Diversity Index and species evenness values are reported since 2009 in Table 3.1. The Shannon Diversity Index for 2012 is 2.12 and the evenness value is 0.60, both substantial increases from previous years.

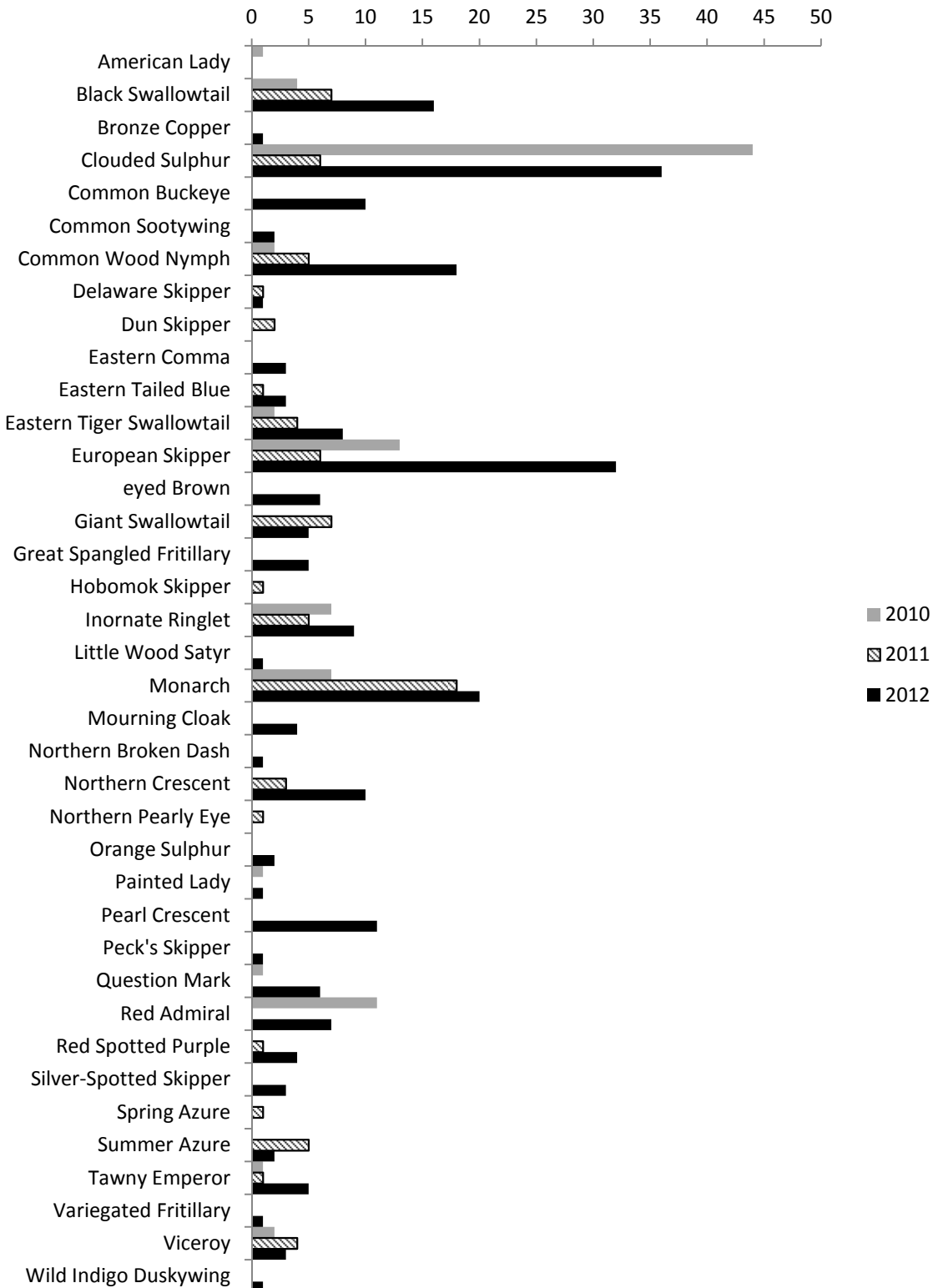


Figure 3.7: Comparison of butterfly observations from Transect four by species from 2006*, 2009-2012. Only butterflies with less than fifty observations are shown.

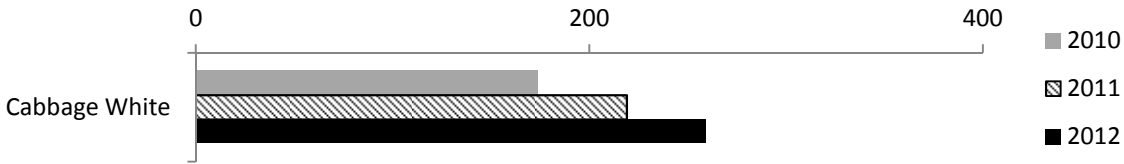


Figure 3.8: Comparison of butterfly observations from Transect four by species from 2006*, 2009-2012. Only butterflies with more than fifty observations are shown.

3.5 Weather and Climate Data

The 2012 monitoring season was primarily a hot, dry summer. Temperatures were higher than previous years in both May and June, and July and August temperatures were consistent with previous years (Figure 3.9). Overall precipitation for the 2012 monitoring season was lower than all previous years, and May in particular received very little rain (Figure 3.10). While precipitation in June 2012 appears high, only four days had rainfall of over 5mm and so butterfly observations were minimally impacted.

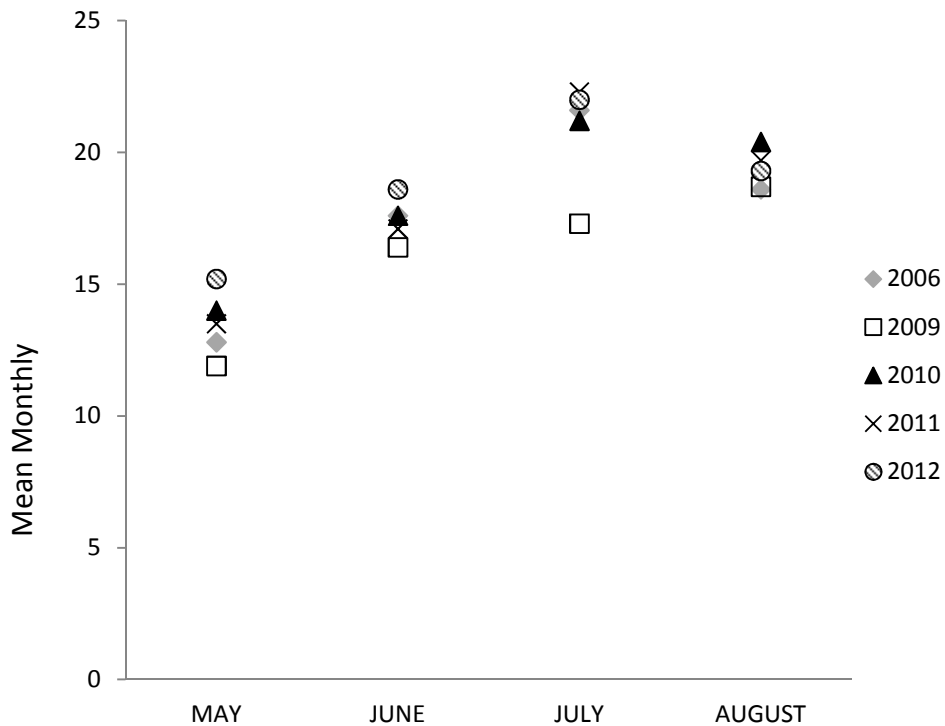


Figure 3.9: Mean month temperatures for Waterloo Region during the monitoring season in 2006, 2009-2012 (Environment Canada-2006/2009 data from Waterloo International Airport Weather Station, and 2010-2012 data from Kitchener-Waterloo Weather Station).

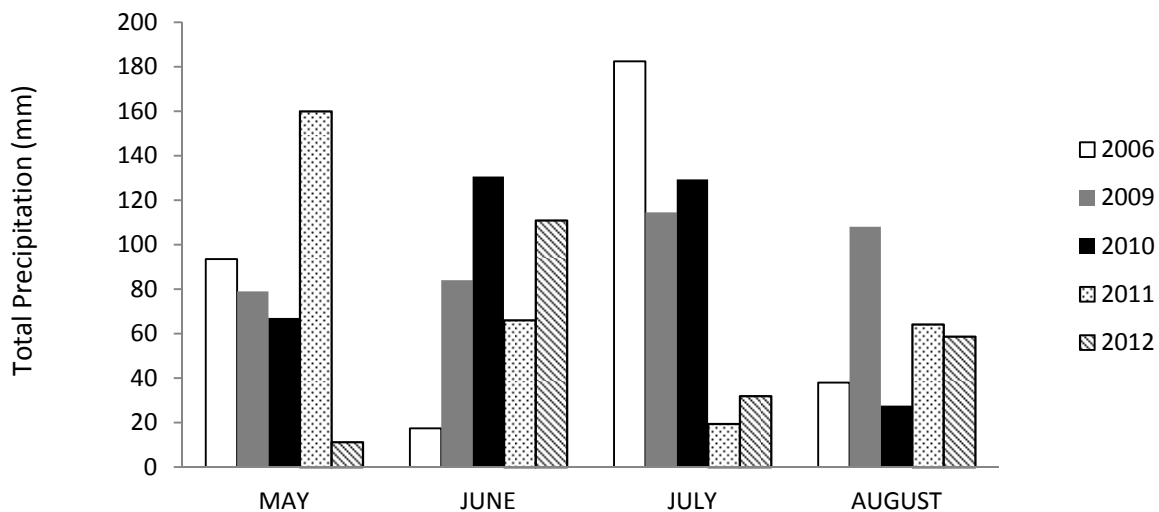


Figure 3.10: Total monthly rainfall for Waterloo Region during the monitoring season in 2006, 2009-2012 (Environment Canada-2006/2009 data from Waterloo International Airport Weather Station, and 2010-2012 data from Kitchener-Waterloo Weather Station).

3.6 Annual Butterfly Count

An annual butterfly count has taken place at *rare* since 2006, with the exception of 2007. Below are the results from the 2012 count. All results can be found in Appendix D.

Cambridge (Rare Charitable Research Reserve), ON. Yr. 6, 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. See 2006 report for habitats. Imminent threats to habitat: None. Habitat changes since last year: Researchers have planted one area previously which was active agriculture with tall grass prairie. This will be an improvement to habitat. **14 July 2012;** 0900-1500 hrs; sun AM 10%, PM 10%; 82-89°F; wind 2-2 mi/hr. 14 observers in 5 parties. **Total party-hours 12; total party-miles on foot 9. Observers:** J. Guenther, M. Hulme, S. Hulme, Jessica Linton (245 Rodney Street, Waterloo, ON, N2J 1G7; jlinton@nrsl.on.ca), A. MacNaughton, J. Quinn, G. Richardson, S. Shiplo, A. Turchin, E. Turchin, J. Turchin, B. Wilson, B. Woodman, E. Woodman.

Black Swallowtail 40, Giant Sw. 6, E. Tiger Sw. 18, Cabbage White 169, Clouded Sulphur 39, Orange Su. 29, E. Tailed-Blue 1, 'Summer' Spring Azure 1, Am. Snout 1, Variegated Fritillary 1, Gr. Spangled Fr. 3, Pearl Crescent 7, N. Cr. 2, Question Mark 1, Mourning Cloak 1, Am. Lady 1, Painted La. 4, Red Admiral 12, Com. Buckeye 1, Red-spotted Purple 4, Viceroy 8, Tawny Emperor 1, N. Pearly-eye 1, Eyed Brown 2, Appalachian Brown 5, Little Wood-Satyr 2, 'Inornate' Com. Ringlet 2, Com. Wood-Nymph 29, Monarch 61, Silver-spotted Skipper 3, Wild Indigo Duskywing 12, European Sk. 1, Peck's Sk. 1, N. Broken-Dash 2, Broad-winged Sk. 2, Dion Sk. 2, Black Da. 12, Dun Sk. 11. **Unidentified:** Skipper Species 3. **Total** 39 species, 501 individuals. **Immatures:** Black Sw. 15 eggs; Am. Snout 1 caterpillar. **Field Notes:** 2012 has been exceptionally dry and hot in southern Ontario.

4.0 Discussion

4.1 Butterfly Diversity and Abundance

7866 individual butterflies were counted during the 2012 butterfly monitoring on four transects, comprising 52 species of butterflies (Table 3.1). This represents 76.5% of the species that have been observed on *rare* property since 2006. Including incidental observations and those made at the annual butterfly count, a total of 55 species were observed in 2012 (80.9% of historically observed *rare* butterflies). The significant increase in butterfly abundance and diversity this year is consistent with record observations across much of Eastern Canada. The probable cause is the weather. Many southern states had exceptionally hot weather early in the year likely triggering butterfly migration north. With consistently hot weather moving northward, the butterflies faced no obstacles to slow their travels, and were able to arrive to Southern Ontario and the rest of Eastern Canada in high abundances after a mild winter and hot start to spring. This also boosted the species richness of butterflies typically seen at *rare*. This year several migrants were seen in higher abundances than ever before including the Red Admiral (*Vanessa atalanta*), American Lady (*Vanessa virginiensis*), Question Mark (*Polygonia interrogationis*), Eastern Comma (*Polygonia comma*), Common Buckeye (*Junonia coenia*), and Variegated Fritillary (*Euptoieta claudia*), that latter two having never been observed during transect monitoring at *rare*.

As in previous years, the non-native Cabbage White (*Pieris rapae*) dominated the area (n=3557), making up over 45% of the total butterflies observed. It was introduced to Canada via Quebec in the 1860s and has subsequently spread rapidly across Canada (Layberry et al. 1998). Members of the Mustard Family (*Brassicaceae*), their host, can be found in abundance on *rare* property (*rare* draft Environmental Management Plan 2012), including the invasive Garlic Mustard (*Alliaria petiolata*) which is widespread.

Both overall abundance and transect-specific abundance increased in 2012 from previous years, as did species richness. While some sites and species show a gradual trend toward higher abundance or richness, in general this year will likely be an anomaly of uncommonly high butterfly counts due to exceptional weather conditions. The earliest date of observation is shown by species in List E.2. Of 69 species observed at *rare* since 2006, 29 species were observed earlier in 2012 than in any previous year (42 %). This is not surprising given the hot spring temperatures and early arrival of many migrants.

While abundance and richness increased in 2012, evenness remained relatively unchanged (Table 3.1). This indicates that while number of species observed increased, there was not a dramatic shift in relative abundances of species from previous years. This is confirmed when looking at the species totals (Table 3.1). The heavily dominant species at each site are fairly constant over the years. New species observed in 2012, occurred in small numbers and did not impact the evenness. The average evenness score in 2012 across all transects is 0.59, meaning that a large portion of the butterflies are observed in similar abundances with several exceptions. This is consistent with what is observed in the field. Shannon Diversity Indices generally increased in 2012, the exception being Transect three which remained the same. The average value is 2.16, signifying an intermediate diversity level for butterflies at

rare. The most individuals and species were observed on Transect one and the least were observed on Transect four.

4.2 Transect One- Cliffs and Alvares

Transect one is the longest transect and thus it is not surprising that it has consistently recorded the highest abundance and richness of butterflies. It boasts a variety of butterfly habitats and so attracts different species in different areas. Five species with a Rare status were observed on this transect in 2012. While it may be the most specious and abundant, it is not the most diverse transect indicating there is a skewed distribution, and a small number of species are observed much more frequently than others. When considering butterfly observations on a per distance travelled basis, 807.4 butterflies were observed per km in 2012.

4.3 Transect Two- South Field/Sparrow Field

Transect two is nearly as long as the first transect, but supports less habitat diversity, and thus a lower species richness. Four species with a Rare status were observed on this transect in 2012. While abundance and richness have consistently increased every year, diversity and evenness remain comparatively low, and in fact both were the lowest of all transects in 2012 (Table 3.1). Fragmentation from an agricultural landscape can limit butterfly movement (Sutcliffe et al. 2002), and a monoculture crop limits the food plant diversity and thus the species of butterflies able to use the land. Over 85% of the butterflies observed here were the six most abundant species. When considering butterfly observations on a per distance travelled basis, 713.8 butterflies were observed per km in 2012.

4.4 Transect Three- Thompson Tract

Transect three, similar to Transect one, offers both meadow and forest habitat and therefore can support a wider variety of butterflies. Butterfly observations here were relatively consistent until 2012, when abundance more than doubled. The meadow habitat here was widely used during the hot weather, and although the swampy area was much drier than in previous years, it offered more water than most locations on the property. The Shannon Diversity Indices at this site have remained consistently high across years, along with the evenness. When considering butterfly observations on a per distance travelled basis, 961.8 butterflies were observed per km in 2012. This area appears to be the most diverse butterfly habitat in the monitoring program.

4.5 Transect Four- Blair Flats

Transect four is different from all other transects, as it has been slowly transitioning over the course of the monitoring program. The conditions and plant composition has changed from year to year along with butterfly richness and diversity, since it was planted as a tall grass prairie in 2010. The homogeneous habitat offers little in diversity for butterfly habitat, and so it is not surprising that the fewest number of species were recorded here. Each year, the species richness, evenness, and diversity has increased perhaps indicating the increased ability of butterflies to make use of this restored habitat.

When considering butterfly observations on a per distance travelled basis, 382.3 butterflies were observed per km in 2012.

4.6 New and Noteworthy Records at *rare* Charitable Research Reserve

31 butterfly species observed at *rare* during the 2012 monitoring season were considered either Common or Very Common based on the regional status assignment (Table 3.2; Linton 2012). The majority of Very Common butterflies were observed at every transect. Seven butterfly species observed during monitoring were considered Rare, with an eighth Rare species (American Snout) observed incidentally while on the property, but not during monitoring. Three of these Rare species were new to *rare* this year: Baltimore Checkerspot (*Euphydryas phaeton*), Variegated Fritillary (*Euptoieta claudia*), and Silvery Checkerspot (*Chlosyne nycteis*).

The Baltimore Checkerspot was netted on June 26th near the first stop on Transect one, and was likely a female based on size. While never before observed on *rare* before, it had been previously noted on an annual butterfly count in 2011 and was again observed during the 2012 butterfly count just off of *rare* property at the Blair Outdoor Education Center. Turtleheads (*Chelone glabra*), the larval foodplant, are found both at the Education Center and on *rare* property, so its absence from *rare* up to this point is curious.

On July 5th, a Variegated Fritillary was netted near the second stop on Transect four. There were eight other sightings through the course of the summer on both the first and second transects, near the riparian meadow along the Grand River (Transect one) and along the agriculture fields (Transect two). The last date observed was August 8th.

The Silvery Checkerspot observed on June 20th, on the second transect near stop seven. It was closely observed, although not netted, along the border of the Indian Woods. This species has not been documented in the region since 1965 (Linton 2012), although its similarity in colour to other crescents may cause some observer bias. It is thought to be declining within its known range (Linton 2012 and references therein).

The four remaining Rare species observed this year were all skippers. One Columbine Duskywing (*Erynnis lucilius*) was observed on May 31st on Transect three in the sixth section, and 43 Juvenal's Duskywings (*Erynnis juvenalis*) were observed in May and early June, found on all transects except Blair Flats. Neither had been observed in the region since the late 1960s until 2010, however their early spring flight may have caused them to be previously overlooked (Linton 2012). Three Common Sootywings (*Pholisora catullus*) were observed between June 7th and July 10th on Transect two and three. It is considered provincially Imperiled, although can be locally common in Southern Ontario, and has been recorded at *rare* several times since 2009 (Linton 2012). Finally, one Dion Skipper (*Euphyes dion*) was netted in the wet sedges at the start of Transect one on July 24th. It had previously only been observed at *rare* during the annual butterfly count. It is also considered provincially Imperiled (Linton 2012).

First observed in the region in 2010 by Jessica Linton, nine Wild Indigo Duskywing (*Erynnis baptisiae*) observations were made during the 2012 monitoring season. While the regional status is Unknown, it is now probable that it is a common resident to the area (J. Linton pers. com.).

Although considered Very Common, the Meadow Fritillary (*Boloria bellona*) was observed during a monitoring transect for the first time in 2012. It has previously been documented only during the annual butterfly counts on *rare* property. The Common Buckeye (*Junonia coenia*) was observed 16 times in 2012 after having never been observed during the monitoring program at *rare*, although it previously has been sighted on the property.

Several Common species were observed in much higher abundances than previously seen. Both the Common Wood-Nymph and the Little Wood-Satyr (*Megisto cymela*) were found to be between two and four times more abundant than previous years. They both overwinter as caterpillars and could have benefited from a mild winter. Inornate Ringlets were also extremely abundant, occurring in two generational waves, one in May and early June and again in late July and August. As larvae, all three species are grass feeders (Carmichael and Vance 2003).

Sulphur butterflies were quite abundant this year, in addition to the dominance of Cabbage Whites previously discussed. Clouded Sulphur populations have previously oscillated at *rare* on a yearly basis and continued to do so. In 2009 and 2011 they were observed less than 150 times (Moore 2009; Dodds 2011), but they irrupted in 2010 with over 1000 observations (Moore 2010) and approached that total once again in 2012 with just less than 800 individuals observed. These fluctuations could be a result of a cooler and wetter start to the season in those poorer years, or could be an artifact of sporadic butterfly irruptions which are known to occur. Orange Sulphur (*Colias eurytheme*) butterflies have had a low relative abundance since the start of butterfly monitoring at *rare*, but experienced a fivefold increase this year. The hot dry temperatures in May could be the cause of this irruption.

The swallowtails at *rare* also had an extremely good year. Eastern Tiger Swallowtail observations increased almost three times from 2011 and previous years. Both Black Swallowtails and Giant Swallowtail (*Papilio cresphontes*) populations have steadily increased since the beginning of monitoring in 2006.

5.0 Conclusions and Recommendations

With almost five full years of successful data, the monitoring program has established good baseline data that can help determine butterfly community changes beyond weather extremes. The restored Blair Flats appear to be supporting more and more butterflies each year, and so continued data collection here is critical to monitor this perceived success. The meadow area near the start of the Thompson Tract seems to be the best area for butterfly observation, and should be targeted for education and outreach programs relating to butterflies. More regeneration and restoration of agriculture fields near Transect two would likely increase butterfly mobility and food source diversity, thus increasing butterfly activity at this transect. Continued monitoring for a full 14 week program on all transects is recommended to allow for a more complete statistical analysis.

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Appendix A: Maps and Coordinates

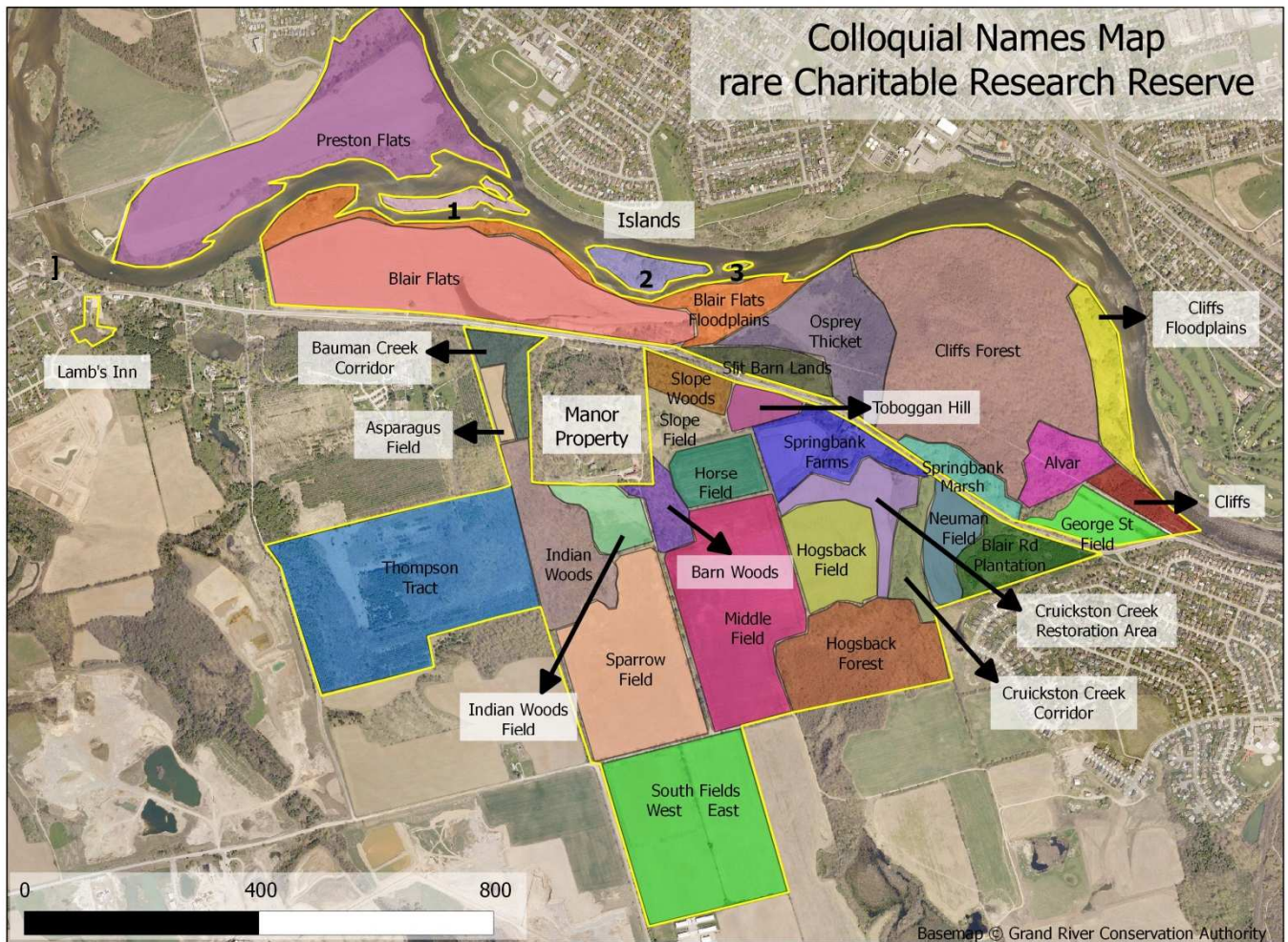


Figure A.1: *rare* Charitable Research Reserve property map.

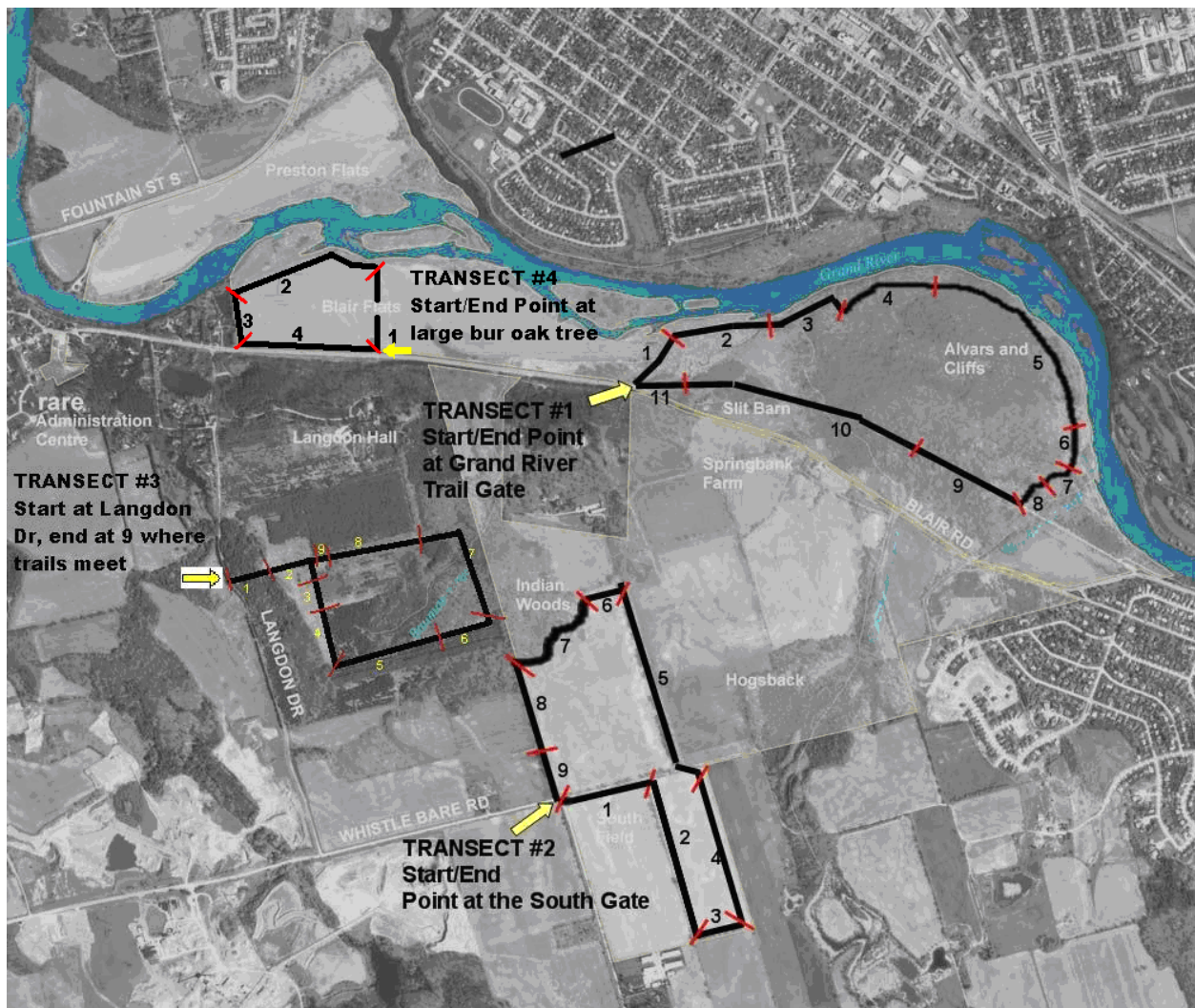


Figure A.2: Location and start/end descriptors of butterfly monitoring transects with section breaks at *rare* Charitable Research Reserve (Moore 2010).

List A.1: Transect One- Butterfly section descriptions with stopping point coordinates (*GPS coordinates accuracy <10m*).

Section one (N 43° 22.980' W 80° 21.541')

- Grasslands
- Milkweeds
- Goldenrod
- Stop past the sedge wetland, toward the river at the solitary shrub

Section two (N 43° 23.025' W 80° 21.426')

- Riparian Meadow
- South side of transect- shrubs and trees
- Stop at old fallen tree in the middle of the field, within direct view of the osprey tower ~100m

Section three (N 43° 23.058' W 80° 21.222')

- Riparian area with trees on south side
- Grasses/sedges
- Small shrubs
- Goldenrods
- Stop in open grass area with small hill on right hand side just after trail turns away from river, before continuing further on into thick shrubs and forest

Section four (N 43° 23.120' W 80° 21.017')

- Forest trail with open canopy areas
- Mainly conifers
- On cliffs
- Stop when path forks to small lookout over the river (left), break in cedar dominance

Section five (N 43° 22.986' W 80° 20.625')

- Deciduous forest trail
- Stop at large fallen tree over trail, trail has moved around log; cliffs on south side and open meadow (milkweed, raspberries, goldenrod, one tall oak) on north side through small gap in trees

Section six (N 43° 22.761' W 80° 20.617')

- Open shrub land
- Stop at alvar on the left hand side of trail right after the old car on the right hand side; large red pine right on trail edge, and large white pine further back near alvar

Section seven (N 43° 22.767' W 80° 20.697')

- Deciduous forest trail
- Stop at large alvar, ~10m after tall Oak

Section eight (N 43° 22.749' W 80° 20.734')

- Open shrub land
- Stop on 2nd boardwalk

Section nine (N 43° 22.793' W 80° 20.901')

- Grand Trunk trail-deciduous forest
- Stop at culvert in wetland

Section ten (N 43° 22.901' W 80° 21.250')

- Grand Trunk trail-dense shrub growth on both sides of trail
- Stop at entrance to Osprey Tower path to the north, and path to Slit Barn to the south

Section eleven (N 43° 22.927' W 80° 21.546')

- Wetland on either side of trail (sedges, cattails, milkweed, goldenrod, purple loosestrife)
- Stop at culvert near Blair rd entrance to Grand Trunk Trail; several trembling aspen trees around, and direct line of sight to stopping point for section 1

List A.2: Transect Two- Butterfly section descriptions with stopping point coordinates (*GPS coordinates accuracy <10m*).

Section one (N 43° 22.177' W 080° 21.691')

- 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.
- Stop at North side of South Field (hay field) in naturalized buffer, directly across from silo at farm

Section two (N 43° 22.048' W 080° 21.560')

- Hedgerow along corn field edge
- Mostly open with some shrubs
- Stop halfway up west side of field 311 (corn field), near solitary Buckthorn shrub & old collapsed wooden structure built into the ground

Section three (N 43° 21.909' W 080° 21.438')

- Hedgerow of deciduous trees along a corn field edge
- Stop halfway along south side of field 311 (corn field); looking across- stop at the end of the tree line before the three single trees

Section four (N 43° 22.050' W 080° 21.404')

- Along the fence on East side on field 311
- Open corn field with few shrubs along fence
- Stop halfway along field edge; blue post on other side of fence (electricity or natural gas?)

Section five (N 43° 22.463' W 080° 21.637')

- Deciduous hedgerow of mostly Oak spp.
- Bordering corn field on east side
- Bordering naturalized agriculture field on west side
- Stop at No Hunting sign across from large branching leafless tree (halfway down hedgerow)

Section six (N 43° 22.554' W 080° 21.742')

- Fenced in corridor/hedgerow at north side of field 310 (south of Cruickston Manor House) with deciduous trees, grapevines, and tall grasses
- North of the transect is corn and south of transect is naturalized agriculture field
- Stop halfway down corridor/hedgerow with Glossy Buckthorn at fence post

Section seven (N 43° 22.457' W 080° 21.841')

- Meadow bordered by deciduous trees (Indian Woods) to the North and natural regeneration to the south
- Stop at fallen tree along old fence, under large maple trees

Section eight (N 43° 22.299' W 080° 21.892')

- Hedgerow of deciduous trees, mostly maple bordering naturalized agriculture field
- Shady areas

- Stop at top of hill where fallen tree is sticking out of the woods; looking across to the east- can see apartment building

Section nine (N 43° 22.212' W 080° 21.857')

- Hedgerow (just east of Grand Allee) of mainly shrubs, vines, and grasses bordering naturalized agriculture field
- Stop on incline past large group of new maples, ~20m before path into Grand Allee)

List A.3: Transect Three- Butterfly section descriptions with stopping point coordinates (*GPS coordinates accuracy <10m*).

Section one (N 43° 22.584' W 080° 22.569')

- Coniferous forest – cedar, shrubs, ash
- Stop by swampy meadow just past culvert- goldenrod, cattails, milkweed

Section two (N 43° 22.601' W 080° 22.469')

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

Section three (N 43° 22.541' W 080° 22.454')

- Black locust plantation and meadow
- Stop halfway through plantation area, where tree has grown around top wire of fence on left side

Section four (N 43° 22.482' W 080° 22.430')

- Meadow – milkweed, golden rod, grasses and sedges
- Spruce forest on east side
- Stop at third Spruce tree on east side, about halfway down the straight portion of trail

Section five (N 43° 22.424' W 080° 22.301')

- Spruce and deciduous forest
- Stop where wet area ends (will change from year to year), small clearing on left past one row of trees

Section six (N 43° 22.476' W 080° 22.064')

- Meadow – grasses and sedges
- Walnut plantation
- Stop halfway down straight section of walnut trees; dead white pine on north side with young maples around it

Section seven (N 43° 22.568' W 080° 22.158')

- Grand Allee trail in Indian Woods
- 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° 22.635' W 080° 22.273')

- Maple Lane
- Deciduous forest – sugar maple, shrubs
- Stop near a small pile of logs on south side

Section nine (N 43° 22.606' W 080° 22.437')

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

List A.4: Transect Four- Butterfly section descriptions with stopping point coordinates (*GPS coordinates accuracy <10m*).

Section 1: (N 43° 23.090' W 080° 22.307')

- Weedy meadow planted for tall grass prairie, recovering from agricultural use
- Horseweed, Black-eyed Susan, goldenrod
- Head out from Bur Oak toward tower in distance; stop halfway before field edge- in between two UofG plant enclosures

Section 2: (N 43° 23.131' W 080° 22.523')

- North side regeneration area, south side planted for tall grass prairie
- Horseweed, milkweed, goldenrod, thistles and burdock
- Stop halfway down field edge

Section 3 (N 43° 23.056' W 080° 22.641')

- East side planted for tall grass prairie, west side hedgerow of shrubs and trees
- Stop halfway- hot tub on west side

Section 4 (N 43° 22.998' W 080° 22.473')

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

Appendix B: Equipment List

List B.1: Butterfly monitoring equipment list.

- Field data sheet and clipboard
- Pencils
- Binoculars
- Field guide (recommended: Carmichael, I., and Vance, A. 2003. Photo Field Guide to the Butterflies of Southern Ontario. St. Thomas Field Naturalist Club Inc., St. Thomas, ON)
- Jar with mesh lid
- Butterfly net
- Digital camera
- Kestrel 3000©
- Stopwatch

Appendix C: Field Data Sheets and Codes

Table C.1: Beaufort wind codes

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	--

BUTTEFLY MONITORING FIELD NOTES									
DATE:				START:				TEMP_START:	
TRANSECT:				FINISH:				TEMP_END:	
1		S:	SUN:	2		S:	SUN:		
W1:			WIND:	W1:			WIND:		
W2:				W2:					
3		S:	SUN:	4		S:	SUN:		
W1:			WIND:	W1:			WIND:		
W2:				W2:					
5		S:	SUN:	6		S:	SUN:		
W1:			WIND:	W1:			WIND:		
W2:				W2:					
NOTES:									

Figure C.1: Sample of butterfly monitoring field sheet

Appendix D: Annual Butterfly Count Results

List D.1: Results from 2008 annual butterfly count

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.

Note: Giant Swallowtail butterfly observed at Springbank garden during the summer of 2008.

List D.2: Results from 2009 annual butterfly count

1. 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.

List D.3: Results from 2010 annual butterfly count

1. 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@nr.si.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.

List D.4: Results from 2011 annual butterfly count

1. Cambridge (Rare Charitable Research Reserve), ON. Yr. 5, 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. See 2006 report for habitats. **03 July 2011;** 0930-1530 hrs; sun AM 76-100%, PM 76-100%; 24-26°F; wind 7-34 mi/hr. 6 observers in 3 parties. **Total party-hours 10; total party-miles on foot 7.** **Observers:** E. Damstra, H. Dodds, B. Foell, Jessica Grealey (709 Keatswood Crescent, Waterloo, ON, N2T 2R6), P. Raspberry, G. Richardson.

E. Tiger Swallowtail 1, Cabbage White 95, Bronze Copper 4, Coral Hairstreak 2, Banded Ha. 3, 'Summer' Spring Azure 3, Silver-bordered Fritillary 2, Pearl Crescent 3, N. Cr. 26, Baltimore Checkerspot 12, Red-spotted Admiral 3, Viceroy 1, Tawny Emperor 2, N. Pearly-eye 13, Eyed Brown 62, Appalachian Brown 3, Little Wood-Satyr 13, Com. Ringlet 4, Com. Wood-Nymph 3, Monarch 10, Wild Indigo Duskywing 1, European Skipper 196, Peck's Sk. 2, Tawny-edged Sk. 5, Crossline Sk. 3, Long Dash 2, Little Glassywing 5, Hobomok Sk. 8. **Total 28 species, 487 individuals.**

Appendix E: Species Lists

List E.1: Common and scientific names of all 69 butterflies observed at *rare* Charitable Research Reserve since 2006.

Common Name	Scientific Name
Acadian Hairstreak	<i>Satyrrium acadicum</i>
American Lady	<i>Vanessa virginiensis</i>
American Snout	<i>Libytheana carinenta</i>
Appalachian Brown	<i>Satyrodes appalachia</i>
Arctic Skipper	<i>Carterocephalus palaemon</i>
Baltimore Checkerspot	<i>Euphydryas phaeton</i>
Banded Hairstreak	<i>Satyrrium calanus</i>
Black Dash	<i>Euphyes conspicua</i>
Black Swallowtail	<i>Papilio polyxenes</i>
Broad-Winged Skipper	<i>Poanes viator</i>
Bronze Copper	<i>Lycaena hyllus</i>
Cabbage White	<i>Pieris rapae</i>
Clouded Sulphur	<i>Colias philodice</i>
Columbine Duskywing	<i>Erynnis lucilius</i>
Common Buckeye	<i>Junonia coenia</i>
Common Sooty Wing	<i>Philodice catullus</i>
Common Wood-Nymph	<i>Cercyonis pegala</i>
Compton Tortoiseshell	<i>Nymphalis vaualbum</i>
Coral Hairstreak	<i>Satyrrium titus</i>
Crossline Skipper	<i>Polites origines</i>
Delaware Skipper	<i>Anatrytone logan</i>
Dion Skipper	<i>Euphyes dion</i>
Dun Skipper	<i>Euphyes vestris</i>
Eastern Comma	<i>Polygonia comma</i>
Eastern Tailed-Blue	<i>Cupido comyntas</i>
Eastern Tiger Swallowtail	<i>Papilio glaucus</i>
European Skipper	<i>Thymelicus lineola</i>
Eyed Brown	<i>Satyrodes Eurydice</i>
Giant Swallowtail	<i>Papilio cresphontes</i>
Grey Comma	<i>Polygonia progne</i>
Great Spangled Fritillary	<i>Speyeria Cybele</i>
Harvester	<i>Feniseca tarquinius</i>
Hickory Hairstreak	<i>Satyrrium caryaevorum</i>
Hobomok Skipper	<i>Poanes hobomok</i>
Inornate Ringlet	<i>Coenonympha tullia</i>
Juvenal's Duskywing	<i>Erynnis juvenalis</i>
Least Skipper	<i>Ancloxypha numitor</i>
Little Glassywing	<i>Pompeius verna</i>
Little Wood-Satyr	<i>Megisto cymela</i>
Little Yellow	<i>Eurema lisa</i>
Long Dash	<i>Polites mystic</i>

Meadow Fritillary	<i>Boloria Bellona</i>
Milbert's Tortoiseshell	<i>Nymphalis milberti</i>
Monarch	<i>Danaus plexippus</i>
Mourning Cloak	<i>Nymphalis antiopa</i>
Mulberry Wing	<i>Poanes massasoit</i>
Mustard White	<i>Pieris oleracea</i>
Northern Broken-Dash	<i>Wallengrenia egeremet</i>
Northern Crescent	<i>Phyciodes cocyta</i>
Northern Pearly-eye	<i>Enodia anthedon</i>
Orange Sulphur	<i>Colias eurytheme</i>
Painted Lady	<i>Vanessa cardui</i>
Pearl Crescent	<i>Phyciodes tharos</i>
Peck's Skipper	<i>Polites peckius</i>
Question Mark	<i>Polygonia interrogationis</i>
Red Admiral	<i>Vanessa atalanta</i>
Red-spotted Purple	<i>Limenitis arthemis astyanax</i>
Silver-Bordered Fritillary	<i>Boloria selene</i>
Silvery Checkerspot	<i>Chlosyne nycteis</i>
Silver-spotted Skipper	<i>Epargyreus clarus</i>
Spring Azure	<i>Celastrina ladon</i>
Striped Hairstreak	<i>Satyrium liparops</i>
'Summer' Spring Azure	<i>Celastrina neglecta</i>
Tawny-edged Skipper	<i>Polites themistocles</i>
Tawny Emperor	<i>Asterocampa clyton</i>
Variegated Fritillary	<i>Euptoieta claudia</i>
Viceroy	<i>Limenitis archippus</i>
White Admiral	<i>Limenitis arthemis arthemis</i>
Wild Indigo Duskywing	<i>Erynnis baptisiae</i>

List E.2: First date of observation for each species noted on **rare** for each monitoring year, annual butterfly counts, and the overall earliest observation.

Species	Earliest Record by Year					Annual Butterfly Counts	Earliest Record at rare
	2006	2009	2010	2011	2012		
Acadian Hairstreak						July 13 (2008)	July 13 (2008)
American Lady			May 20		May 15	July 10 (2010)	May 15 (2012)
American Snout					July 11	July 10 (2010)	July 10 (2010)
Appalachian Brown				July 6	June 18	July 2 (2011)	June 18 (2012)
Arctic Skipper			June 3			July 10 (2010)	June 3 (2010)
Baltimore Checkerspot					June 26	July 3 (2011)	June 26 (2012)
Banded Hairstreak	July 18	July 16		July 12	June 25	July 2 (2011)	June 25 (2012)
Black Dash			June 8		July 14	July 10 (2010)	June 8 (2010)
Black Swallowtail	July 21	May 20	May 4	May 30	May 14	July 10 (2010)	May 4 (2010)
Broad-winged Skipper		July 24			July 14	July 10 (2010)	July 10 (2010)
Bronze Copper	Aug 18				June 6	July 2 (2011)	June 6 (2012)
Cabbage White	July 18	May 12	May 3	May 19	May 14	July 2 (2011)	May 3 (2010)
Clouded Sulphur	July 18	May 22	May 4	May 31	May 14	July 10 (2010)	May 4 (2010)
Columbine duskywing			May 19		May 31		May 19 (2010)
Common Buckeye				Sept 15	June 6		June 6 (2012)
Common Sooty Wing	July 21	June 2		Aug 4	June 7	July 10 (2010)	June 2 (2009)
Common Wood Nymph	July 18	June 16	June 25	June 14	June 18	July 2 (2011)	June 14 (2011)
Compton Tortoiseshell				July 12			July 12 (2011)
Coral Hairstreak		July 16				July 2 (2011)	July 2 (2011)
Crossline Skipper						July 2 (2011)	July 2 (2011)
Delaware Skipper		June 2	May 24	July 11	July 9	July 10 (2010)	June 2 (2009)
Dion Skipper					July 14	July 13 (2008)	July 13 (2008)
Dun Skipper		July 24		July 6	June 26	July 10 (2010)	June 26 (2012)
Eastern Comma	Aug 2	June 30	May 14	June 1	May 15	July 10 (2010)	May 14 (2010)

Eastern Tailed Blue	Aug 18		July 27	July 14	July 11 (2006)	July 11 (2006)
Eastern Tiger Swallowtail	July 18	May 21	June 1	May 14	July 2 (2011)	May 14 (2012)
European Skipper	July 18	June 24	June 14	May 15	July 2 (2011)	May 15 (2012)
Eyed Brown	Aug 2	July 16	July 5	June 8	July 2 (2011)	June 8 (2012)
Giant Swallowtail	July 24		June 8	May 15	July 11 (2006)	May 15 (2012)
Gray Comma					July 19 (2009)	July 19 (2009)
Great Spangled Fritillary	July 18	July 24	July 11	June 18	July 10 (2010)	June 18 (2012)
Harvester			Aug 19			
Hickory Hairstreak	July 18				July 11 (2006)	July 11 (2006)
Hobomok Skipper			June 1	May 30	July 2 (2011)	May 26 (2010)
Inornate Ringlet	Aug 2	June 2	June 6	May 14	July 2 (2011)	May 14 (2012)
Juvenal's Duskywing			May 25	May 14		May 14 (2012)
Least Skipper			Aug 5	May 28	July 19 (2009)	May 28 (2012)
Little Wood Satyr	July 18	June 10	June 8	May 30	July 2 (2011)	May 30 (2012)
Little Glasswing			July 6	July 10	July 2 (2011)	July 2 (2011)
Little Yellow					July 11 (2006)	July 11 (2006)
Long Dash			June 14	May 28	July 2 (2011)	May 28 (2012)
Meadow Fritillary				July 18	July 10 (2010)	July 10 (2010)
Milbert's Tortoiseshell			July 19	June 11		June 11 (2012)
Monarch	July 18	June 22	May 30	May 14	July 2 (2011)	May 14 (2012)
Mourning Cloak		May 25	June 7	May 14	July 10 (2010)	May 4 (2010)
Mustard White			Aug 12			
Northern Broken-Dash				June 26	July 10 (2010)	June 26 (2012)
Northern Crescent		May 21	June 7	June 4	July 10 (2010)	May 21 (2009)
Northern Pearly Eye	July 18	June 30	June 20	June 11	July 10 (2010)	June 3 (2010)
Orange Sulphur	Aug 24		July 19	May 14	July 10 (2010)	May 14 (2012)
Painted Lady		June 4		May 15		May 4 (2010)
Pearl Crescent	July 18		May 25	May 14	July 2 (2011)	May 14 (2012)
Peck's Skipper			July 11	June 18	July 2 (2011)	June 18 (2012)
Question Mark	July 18	June 10	June 7	May 17	July 10 (2010)	May 17 (2012)
Red Admiral	Aug 18	May 14	May 25	May 14	July 10 (2010)	May 3 (2010)

Red Spotted Purple	June 16	June 1	June 14	May 25	July 10 (2010)	May 25 (2012)
Silver-Bordered Fritillary					July 2 (2011)	July 2 (2011)
Silver Spotted Skipper	July 30	June 8	June 20	June 25	July 10 (2010)	June 8 (2010)
Silvery Checkerspot				June 20		June 20 (2012)
Spring Azure	May 13	May 4	May 20	May 15		May 4 (2010)
Striped Hairstreak			July 26		July 11 (2006)	July 11 (2006)
Summer Azure	Aug 2	June 8	July 5	June 11	July 2 (2011)	June 8 (2010)
Tawny Emperor	July 21		Aug 4	July 17	July 10 (2010)	July 17 (2012)
Tawny-Edged Skipper			July 22		July 2 (2011)	July 2 (2011)
Variegated Fritillary				July 5		July 5 (2012)
Viceroy	Aug 2	June 8	June 20	May 25	July 10 (2010)	May 25 (2012)
White Admiral			June 14	Aug 1	July 11 (2006)	June 14 (2011)
Wild Indigo Duskywing		May 17		July 11	July 2 (2011)	May 17 (2010)