

## A multi-year survey of the butterflies (Lepidoptera Rhopalocera) of a defined area of the Triestine karst, Italy

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### ABSTRACT

A photographic survey of butterflies (Lepidoptera Rhopalocera) was carried out over a period of three years (2011, 2012 and 2013) in an area around the villages of Malchina, Ceroglie and Slivia, the municipality of Duino-Aurisina near Trieste, in the Friuli Venezia-Giulia region, northeast Italy. Historically, this area of the Triestine karst has been influenced by human activities. Grazing intensity, however, has declined over the past 50-100 years, leading to encroachment of the forested areas over previously more open grasslands. During the three-year survey period, sampling intensity, measured as the number of days during which butterflies were observed and/or photographed, increased from year to year. In 2012 and 2013, especially surveys began in February and continued into December. During the three years, a total of 79 species (Papilionidae, 3; Pieridae, 11; Lycaenidae, 17; Riodinidae, 1; Nymphalidae, 37, including 15 Satyrinae; and Hesperidae, 10), including seven listed as either endangered or near-threatened in Europe, were identified. Among the species of European conservation value recorded were: *Scolitantides orion*, *Melitaea aurelia*, *Melitaea trivialis*, *Argynnis niobe*, *Hipparchia statilinus*, *Coenonympha oedippus* and *Carcharodus flocciferus*. Strong local populations of the following regionally threatened, declining and/or protected species were also recorded: *Euphydryas aurinia*, *Brintesia circe*, *Arethusana arethusana*, *Hipparchia fagi*, *Pyronia tithonus* and *Coenonympha arcania*. Such intensive surveys covering several months of each year provide in-depth knowledge of butterfly fauna in an area of changing land use, and can provide a benchmark for future surveys against a background of continued land-use change, as well as other pressures such as climate change.

### KEY WORDS

Butterflies; Rhopalocera; Triestine karst; environmental change; biodiversity.

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### INTRODUCTION

The character of the Triestine karst is determined by its climate and geology. Climatically, it represents a transitional area between the Mediterranean and Continental/pre-alpine zones. Geologically, the underlying limestone rocks contribute to features such as exposed rocky outcrops, dolinas (depressions caused by the collapse of underground caves), thin soils and little surface water (although

some artificial ponds have been created) (Poldini, 1989).

These physical conditions have combined with historic land-use changes to create the patchwork of habitats for which the Triestine karst is known today. The original oak forest was felled in historic times and for many years the area was heavily grazed. With a general cessation in grazing, regrowth has occurred and currently mixed woodlands dominated by *Ostrya carpinifolia* Scop., while *Carpinus*

*betulus* L., *Fraxinus ornus* L., *Quercus petraea* (Matt.) Liebl. and *Q. pubescens* Willd. are also widespread. Many areas of open grassland exist, including some considered as Mediterranean maquis and some cut for hay. Other areas are decreasing in size, however, as bushes and trees, including *Cotinus coggygria* Scop. and *Prunus mahaleb* L., encroach on formerly grazed or cultivated areas. The grassy areas that remain contain a mixture of xerothermic herbaceous species with a peak flowering period between mid May and mid June (Poldini, 1989). Naturalised areas of *Pinus nigra* J.F. Arnold, introduced for timber in the 1850s, also survive in pockets.

In the dolinas, where temperature inversions mean that a depth of 60 m is equivalent to an elevation of 1,500 to 1,600 m above sea level in winter and 500 m in summer (Touring Club Italiano, 1999), tree species other than *O. carpiniifolia* dominate and the microclimate ensures the survival of glacial relict plant communities.

Meanwhile, close to the villages, small-scale vineyards and vegetable plots provide mainly for local consumption. The combination of these physical and biological conditions has created a unique, biodiverse environment. Paolucci (2010), for example, includes 214 species in his guide to the butterflies of northeast Italy, including the regions of Trentino Alto Adige, Veneto and Friuli Venezia Giulia (the Triveneto) - or some 44% of the 482 European species, the karst playing host to well over a hundred species.

The encroachment of woodland into open grassy areas due to the abandonment of formerly grazed areas, however, continues to change the character of the Triestine karst, impacting on the fauna and flora. Van Swaay & Warren (2001), for example, have noted that the abandonment of agricultural land and/or changing habitat management affects some 65% of threatened butterfly species in Europe, while widespread loss and reduction in size of breeding habitats resulting in habitat isolation and fragmentation affects 83% of Europe's threatened species. Many species listed by Paolucci (2010) thus exist in fragmented habitats or at the edge of their ranges.

Overlayed across such biological and anthropogenic influences, climate change is also having noticeable effects on the distribution of many European butterfly species (Roy & Sparks, 2000; Roy et al., 2001; Warren et al., 2001; Stefanescu et

al., 2003), and will continue to do so for the foreseeable future (Settele et al., 2008).

Given the importance of several Italian locations for butterfly diversity and conservation (van Swaay & Warren, 2006), alongside the lack of any systematic recording scheme in the country (van Swaay et al., 2012a), this study set out, through surveying the butterfly fauna of a restricted area of the Triestine karst, to establish a benchmark against which future surveys to determine the ongoing impacts of local land-use and/or climate-induced changes can be compared.

## MATERIAL AND METHODS

### *Study area*

A photographic survey of butterflies (Lepidoptera Rhopalocera) was carried out over a period of three years in an area around the villages of Malchina, Ceroglie and Slivia, the municipality of Duino-Aurisina near Trieste, in the Friuli Venezia-Giulia region, northeast Italy, close to the border with Slovenia (Fig. 1). The highest elevation in the region is Monte Ermada (323 m) to the west of the surveyed zone, which is crossed by several rough tracks and paths. The main paths included in the surveys described herein mostly either start from or pass through Malchina, and include parts of the Gemina path, the Vertikala, CAI 31 and other marked paths (Fig. 1; Anonymous, 2005), and pass through various habitats, including vegetable plots, vineyards, woodlands, dolinas, and grassland that may or may not be cut for hay. There are also several ponds in the study area, in particular one at Malchina and two close to Slivia.

In Malchina itself, many gardens have nectariferous plants such as *Lavandula* L., *Mentha* L. and *Origanum* L. that flower especially in July and attract butterflies from the surrounding areas. The author's south-facing garden is one such example.

### *Equipment*

During sampling sessions, pictures were taken of as many butterflies encountered as possible - if possible including both upper- and under-wing views to assist with accurate identification. For the most part, a Pentax K-k digital camera (typically set

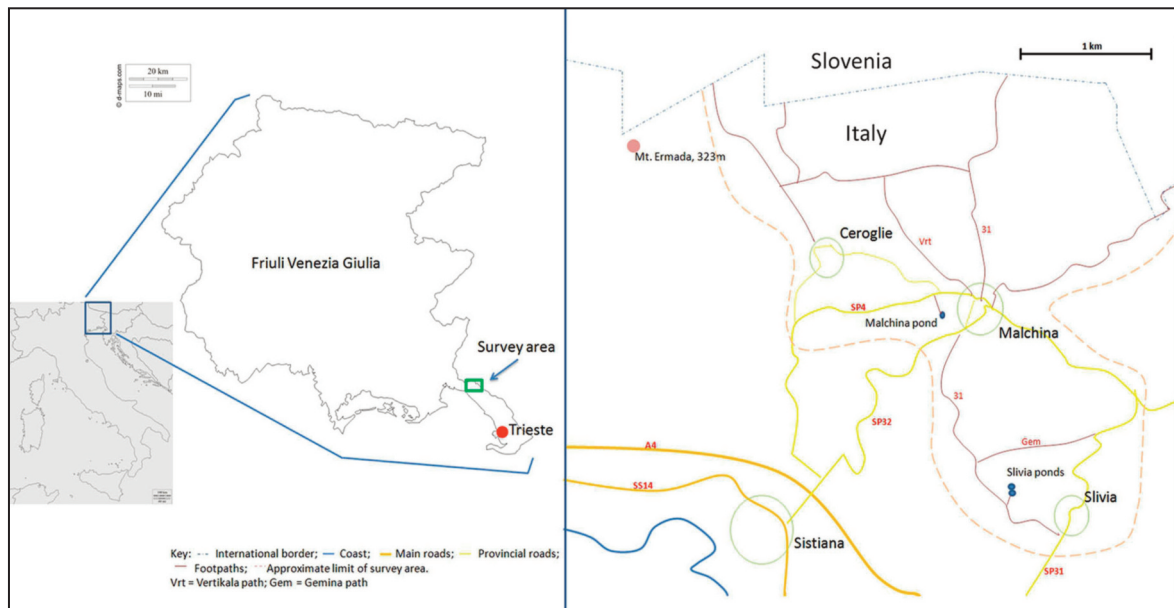


Figure 1. Study area. Left: location of the area surveyed in this study in relation to the rest of Italy, the Friuli Venezia Giulia region and the city of Trieste. The area highlighted in green is shown in more detail to the right. (Outline maps courtesy of d-maps.com). Right: details of roads plus key tracks and paths and other features of the survey area between Ceroglie, Malchina and Slivia north to the border between Italy and Slovenia.

to 200 ASA) was used in tandem with a Sigma 105 mm macro lens. On other occasions, other digital devices such as a compact camera or smartphone were used to record specimens. In addition, especially in 2013 and for those species that are easier to identify definitively (e.g. *Iphiclides podalirius*, male *Anthocharis cardamines*, male *Colias croceus* or *Vanessa atalanta*), butterflies identified without being photographed were recorded as ‘observed’.

### Sampling technique/intensity

Surveys were undertaken over three consecutive years by following the rough tracks, footpaths and field margins in the survey area. No attempt was made to quantify the numbers of a given species observed.

Sampling intensity increased during the course of the three years, as outlined in Table 1. In most cases, surveys were carried out for at least 30 minutes and usually for between 60 to 120 minutes. Surveys were also typically carried out on hot (for the time of year), sunny days with minimal cloud cover.

In 2011, photographs were taken ad hoc, with no attempt to systematically record all sightings, rather just a few notable occurrences. In addition, in most cases, the actual sampling actual dates were

not precisely recorded, just the month. In nine sampling instances, the month is recorded only as either June or July (Table 1).

In 2012, more intense efforts were made to photograph or identify all butterflies observed. Survey dates (59 in total) were accurately recorded (Table 1).

In 2013, attempts were made to photograph or identify all butterflies observed. As in 2012, sampling occasions noted in Table 1 as being undertaken in the author’s garden often lasted just a few minutes and tended to be limited to the period of flowering of the *Lavandula*, *Mentha* and *Origanum* plants. In other cases, butterflies observed during days when no specific (photographic) survey was undertaken were also recorded (12 such occasions). In 2013, including sampling occasions when either only observations were recorded or when no butterflies were seen (despite favourable conditions), a total of 61 sampling sessions were undertaken (Table 1).

### Identification and analysis

To identify the species recorded, various guide books were consulted, especially Paolucci (2010)

and Tolman & Lewington (1997). In cases of uncertainty, experts belonging to the Forum Entomologi Italiani (<http://www.entomologiitaliani.net>) were consulted by posting suitable photographs online. The author also gratefully acknowledges the assistance of Lucio Morin, a local butterfly expert, for help with either the identification or confirmation of the identification of a number of specimens.

Among those species that can be difficult to distinguish from photographs, L. Morin (pers. comm.) also confirms that the species found in the sampling area are *Leptidea sinapis*, not *L. reali*, *Colias alfacariensis* Ribbe, 1905, not *C. hyale* (Linnaeus, 1758), and *Plebejus argus*, not *Pl. idas* (Linnaeus, 1761). In the case of white Pieridae, especially when no suitable photograph was obtained, individuals could often only be identified to the genus level (*Pieris*). In 2011 or 2012, *Pieris* spp. were not regularly recorded, either as photographs or as 'observed'. Species names are valid as per the listing on Fauna Europea ([www.faunaeur.org](http://www.faunaeur.org)). It should be noted, however, that Fauna Europea considers *Hamearis lucina* (Linnaeus, 1758) as a member of the family Riodinidae, whereas it is now included among the Lycaenidae by many authors. The conservation status of the species observed is based on the European Red List of Butterflies (van Swaay et al., 2010), the list provided by van Swaay et al. (2012b) for the European Habitats Directive, and the list for the Triveneto region provided by Paolucci (2010).

## RESULTS

### *Environmental variables*

A total of 482, 1,208 and 1,657 photographs were retained from sampling surveys carried out in 2011, 2012 and 2013, respectively. These photographs accounted for 156, 479 and 738 individual butterflies in each of the three years, respectively. In addition, in 2013, some 128 individuals were recorded as 'observed' but not photographed.

During these three years, 79 butterfly species were recorded. Of these, 45 were recorded in 2011 when sampling was less intensive, 63 in 2012, and 70 in 2013 (Tables 2, 3 and 4).

Of the 79 species recorded, 3 belonged to the family Papilionidae; 11 to the Pieridae; 17 to the Lycaenidae; one to the Riodinidae; 37 to the

Nymphalidae, of which 15 were Satyrinae; and 10 to the Hesperidae.

In early 2012, no butterflies were observed or photographed during the single sampling date in February (12th), although they were on two of three dates in March (on 11th and 24th, but not on 26th). Likewise, in 2013, no butterflies were observed or photographed on the February sampling date (16th), while they were recorded on one of the two sampling dates in March (on 3rd, but not on 22nd), and on nine of 10 dates in April (not on 15th). Among the early-season (up to mid April) species recorded were *Pieris rapae*, *P. napi*, *Gonepteryx rhamni*, *Libythea celtis*, *Nymphalis polychloros*, *Pararge aegeria* and *Erynnis tages*.

In the second half of April, 15 species were recorded in 2012 (including one specimen of *Zerynthia polyxena* on 30 April) and 16 in 2013 (Tables 3 and 4). Among these in 2013 was *V. atalanta*, which was also regularly recorded in early March 2014.

With regard to late-season records, in 2012, butterflies were recorded on 2 and 3 November, but not 22nd. No sampling was undertaken in December 2012. In 2013, butterflies were recorded on three of four dates in November (1, 10 and 17th, but not on 24th), and on one of two dates in December (on 14th but not on 7th). These late-season species (observed in November and into early December), included *C. crocea*, *L. celtis*, *V. atalanta* and *Cacyreus marshalli*.

The highest number of species recorded in a single day was 24 (on 24 August 2013), with more than 20 species also being recorded on six other occasions in 2013 (22 June, 13 and 20 July, 16 and 18 August and 9 September). In 2012, the maximum number of species recorded in a single day was 17 (on 17 July).

Comparing the number of species observed during half-month periods (Tables 2, 3 and 4), 37 species were recorded in the second half of July 2013, with 50 species recorded for the month as a whole (Table 4). Similarly, in 2012, more species were recorded in July than any other month (37), although the diversity was greater in the first half of the month (29 species compared to 19 in the second half of the month) (Table 3).

Among the species most commonly recorded (depending on their respective flight periods) were *I. podalirius*, *P. rapae* and *P. mannii*, *Pl. argus*, *Polyommatus icarus*, *Po. bellargus*, *V. atalanta*,

*Melanargia galathea* f. *procida*, *Maniola jurtina* and *Coenonympha pamphilus*. Among the most commonly recorded HesperIIDae were *E. tages*, *Hesperia comma* and *Ochlodes sylvanus*.

Other species were relatively common in some years, but not recorded in other years. *Aporia crataegi*, for example, was recorded in 2011 and 2013 but not in 2012. Likewise, *Hipparchia statilinus* and *Coenonympha oedippus* were recorded only in 2012, and *Aricia agestis* and *Pontia edusa* only in 2013 (Tables 2, 3 and 4).

Also of note were variant forms of some species. *M. galathea* was always present as *M. galathea* f. *procida*, along with a small percentage of f. *leucomelas*. Likewise, a small percentage of *Argynnis paphia*, were f. *valesina*.

Species recorded rarely (i.e. no more than two individuals recorded in any one year) in the area surveyed include *Z. polyxena*, *Callophrys rubi*, *Leptotes pirithous*, *Cupido argiades*, *Cyaniris semiargus*, *Po. daphnis*, *Scolitantides orion*, *Nymphalis antiopa*, *Aglais io*, *Polygonia c-album*, *Melitaea aurelia*, *Brenthis hecate*, *Argynnis adippe*, *A. niobe*, *C. oedippus*, *Carcharodus alceae*, *Carcharodus floccifera* and *Spialia serorius*. Among these, *Z. polyxena*, *S.orion*, *N. antiopa*, *M. aurelia*, *B. hecate* and *C. oedippus* are notable owing to their conservation status (see below).

Of particular interest are seven species recorded in the survey area that are included in the European Red List of Butterflies (van Swaay et al., 2010). The conservation status of these species is outlined in Table 5. In addition, van Swaay et al. (2010) also note that *Euphydryas aurinia*, *C. oedippus* and *Z. polyxena* are listed in 16, 2 and 1 European LIFE projects (see <http://ec.europa.eu/environment/life/>), respectively, with special efforts being made towards their conservation.

A number of other species recorded in the three-year survey are also of regional conservation interest (Table 6). Other than species such as *Callophrys rubi*, *N. antiopa* and *Melitaea trivialis* that were recorded infrequently, healthy populations of vulnerable and locally protected species (including *L. celtis*, *E. aurinia*, *Brintesia circe*, *Arethusana arethusa*, *Hipparchia fagi* and *Coenonympha arcania*) were recorded in the survey area.

The case of *E. aurinia* is interesting in that no individuals were recorded south of the road that bisects the village of Malchina (SS4); although

never abundant, it was observed in reasonable numbers in localized areas north of SS4, but never far (no more than 500 m) from Malchina itself. Likewise, all individuals of *C. oedippus* were recorded within an area of radius no more than 150 m, also to the north of Malchina.

In addition to those species highlighted in Table 6, a further five species found in the survey area are recorded by Paolucci (2010) as being lower risk/near threatened (LR/NT) in the Triveneto region: *Cupido alcetas*, *S. orion*, *Hamearis lucina*, *Melitaea athalia* and *Minois dryas*. Of these, *H. lucina* and *M. dryas* are also relatively common and well distributed throughout most of the survey area (Tables 2, 3 and 4).

Likewise, Paolucci (2010) records the following species as data deficient (DD) in the Triveneto region: *P. manni*, *Favonius quercus*, *C. argiades*, *N. polychloros*, *M. aurelia*, *A. niobe* and *C. floccifera*. Of these, *P. manni* and, early in the season, *N. polychloros* both maintain reasonable populations in the survey area (Tables 3 and 4). Thus, the three-year survey undertaken by the author helps to fill some of these data gaps.

## DISCUSSION

The total of 79 species recorded during the three-year survey period compares favorably with other areas of Europe. In the whole of the United Kingdom, for example, there are just 57 resident plus two regular migrant species (Asher et al., 2001). Wagner et al. (2013) recorded 49 butterfly species from 27 sites along an altitude gradient in Bavaria, Germany; while Veronivnik et al. (2011a) recorded between 42 and 61 species each year during a five-year survey (2007-2011) of a disused army base at Mlake in Slovenia, recording a total of 95 species overall. In northern Italy, Marini et al. (2009) recorded 60 butterfly species through sampling 44 hay meadow parcels during a single year (2007) in the Trento region, while Boriani et al. (2005) sampled nine sites of three different rural habitat types in Emilia-Romagna in 2002 and 2003, identifying 39 species. The total also compares well with the 91 butterfly species recorded by Carrara (1926) following many years of collection and study in the area around Trieste (immediately to the east of the area that is the focus of this study and covering a much larger area).

Month-Dates/ Year	Feb 16-28	Mar 1-15	Mar 16-31	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun 1-15	Jun 16-30	Jul 1-15	Jul 16-31
2011	0	0	0	1	1	5 <sup>1</sup>	5 <sup>1</sup>	3 <sup>2</sup>	3 <sup>2</sup>	9 <sup>3</sup>	9 <sup>3</sup>
2012	1 <sup>4</sup>	1	2	1	6 <sup>5</sup>	4	3	1	7 <sup>1</sup>	9 <sup>1</sup>	8 <sup>6</sup>
2013	1 <sup>4</sup>	1	1 <sup>4</sup>	2	8 <sup>10</sup>	5 <sup>11</sup>	3 <sup>11</sup>	6 <sup>11</sup>	4 <sup>11</sup>	5 <sup>11</sup>	7 <sup>7, 11</sup>
Month-Dates/ Year	Aug 1-15	Aug 16-31	Sept 1-15	Sept 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec 1-15	Total	
2011	5	5	3	3	2	2	0	0	0	28	
2012	4 <sup>7</sup>	4	3	2	0 <sup>8</sup>	0 <sup>8</sup>	2	1	0	59	
2013	1 <sup>7, 11</sup>	3 <sup>4</sup>	2	2 <sup>11</sup>	3	1	2 <sup>11</sup>	2 <sup>9</sup>	2 <sup>12</sup>	61	

Table 1. Sampling intensity broken down into half-month intervals. Sampling occasions marked as ‘in author’s garden’ or ‘observations only’ (see footnotes) were less intense than other occasions that involved excursions along the various paths highlighted in Fig. 1. <sup>1</sup> Of which 3 occasions in author’s garden, Malchina. <sup>2</sup> Of which 2 occasions in author’s garden, Malchina. <sup>3</sup> Refers to June and July together, of which 7 occasions in author’s garden, Malchina. <sup>4</sup> No butterflies observed. <sup>5</sup> One sampling date included two periods (30 April, a.m. and p.m.). <sup>6</sup> Of which 6 in author’s garden, Malchina. <sup>7</sup> Of which 1 occasion in author’s garden, Malchina. <sup>8</sup> Owing to other commitments, no surveys were undertaken during October 2012. <sup>9</sup> No butterflies observed. Sampling carried out in evening (17:50-18:20) after warm sunny day. <sup>10</sup> Of which 2 occasions: ‘observations’ only (no photographs) - within Malchina itself. <sup>11</sup> Of which 1 occasion: ‘observations’ only (no photographs) - within Malchina itself. <sup>12</sup> Of which 1 occasion: ‘observations’ only (no photographs) (14 December) within Malchina itself. No butterflies recorded on other sampling date (7 December).

TOTAL SPECIES 45	April (1) <sup>1</sup>	May (5)	June (3)	June- July (9)	Aug (5)	Sept (3)	Oct (2)
<b>PAPILIONIDAE</b>							
<i>Iphiclides podalirius</i> (Linnaeus, 1758)		__x__	__X	x_x__			
<i>Papilio machaon</i> Linnaeus, 1758			__x	x_x__			
<b>PIERIDAE</b>							
<i>Anthocharis cardamines</i> (Linnaeus, 1758)	o						
<i>Aporia crataegi</i> (Linnaeus, 1758)		__X_					
<i>Pieris mannii</i> (Mayer, 1851)						__x_	
<i>Pieris rapae</i> (Linnaeus, 1758)			__x_				
<i>Leptidea sinapis</i> (Linnaeus, 1758)	x	__x__					
<i>Colias croceus</i> (Fourcroy, 1785)		__x_				x__	x_
<i>Gonepteryx rhamni</i> (Linnaeus, 1758)			__x_				
<b>LYCAENIDAE</b>							
<i>Favonius quercus</i> (Linnaeus, 1758)						__x	
<i>Satyrium ilicis</i> (Esper, 1779)		__x__					
<i>Lycaena phlaeas</i> (Linnaeus, 1761)						__x_	
<i>Cacyreus marshalli</i> Butler, 1898							x_
<i>Cupido argiades</i> (Pallas, 1771)				__x__			

Table 2 (1/2). Summary of butterfly species recorded and observed in the study area in 2011. <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month (or June/July period). <sup>2</sup> Actual sampling session not recorded. x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	April (1) <sup>1</sup>	May (5)	June (3)	June- July (9)	Aug (5)	Sept (3)	Oct (2)
<i>Plebejus argus</i> (Linnaeus, 1758)		__x	x__	_X_Xx_			x__
<i>Plebejus argyrognomon</i> (Bergsträsser, 1779)		_x__					
<i>Polyommatus bellargus</i> (Rottemburg, 1775)		_X__		x_____	__xx_	Xxx	
<i>Polyommatus icarus</i> (Rottemburg, 1775)		_X__			__xx_	__x	_x
<b>RIODINIDAE</b>							
<i>Hamearis lucina</i> (Linnaeus, 1758)		x_____		___x_	___x		
<b>NYMPHALIDAE</b>							
<i>Vanessa atalanta</i> (Linnaeus, 1758)						__x	
<i>Vanessa cardui</i> (Linnaeus, 1758)						_x_	
<i>Limenitis reducta</i> Staudinger, 1901				_x_____		x__	
<i>Melitaea aurelia</i> Nickerl, 1850					___x		
<i>Melitaea didyma</i> (Esper, 1778)						xx_	
<i>Euphydryas aurinia</i> (Rottemburg, 1775)	X	___x_					
<i>Issoria lathonia</i> (Linnaeus, 1758)						x_x	
<i>Argynnis paphia</i> (Linnaeus, 1758)					x_x__		
<i>Argynnis adippe</i> (Denis et Schiffermüller, 1775)			x__				
<i>Boloria dia</i> (Linnaeus, 1767)					x <sup>2</sup>		
<i>Brenthis hecate</i> (Denis et Schiffermüller, 1775)			x__				
<i>Melanargia galathea procida</i> (Linnaeus, 1758)			x__				
<b>NYMPHALIDAE, Satyrinae</b>							
<i>Minois dryas</i> (Scopoli, 1763)					xxx_x	x__	
<i>Brintesia circe</i> (Linnaeus, 1775)						_x_	
<i>Arethusana arethusa</i> (Denis et Schiffermüller, 1775)					xxx_x	_x_	
<i>Hipparchia fagi</i> (Scopoli, 1763)				__xx__	xxx_x	x__	
<i>Hipparchia semele</i> (Linnaeus, 1758)						__X	_x
<i>Lasiommata maera</i> (Linnaeus, 1758)		_x__		__x_____		_x_	
<i>Pararge aegeria</i> (Linnaeus, 1758)						__x	
<i>Pyronia tithonus</i> (Linnaeus, 1767)						_x_	
<i>Maniola jurtina</i> (Linnaeus, 1758)			x__		__x__	_x_	
<i>Coenonympha arcania</i> (Linnaeus, 1761)		_X__					
<i>Coenonympha pamphilus</i> (Linnaeus, 1758)	x	__xx_	xx_		_xXx_	__xx	_x
<b>HESPERIIDAE</b>							
<i>Erynnis tages</i> (Linnaeus, 1758)					___x		
<i>Hesperia comma</i> (Linnaeus, 1758)					__xx_		
<i>Ochlodes sylvanus</i> (Esper, 1777)			x__	x_____	__x__		
<b>No. of species/month</b>	<b>3</b>	<b>14</b>	<b>11</b>	<b>10</b>	<b>14</b>	<b>21</b>	<b>6</b>

Table 2 (2/2). Summary of butterfly species recorded and observed in the study area in 2011. <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month (or June/July period). <sup>2</sup> Actual sampling session not recorded. x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

TOTAL SPECIES 63	Feb (1) <sup>1</sup>	March 1-15(1)	March 16-31(2)	April 1-15(1)	April 16-30(6)	May 1-15(4)	May 16-31(3)	June 1-15(1)	June 16-30(6)
<b>PAPILIONIDAE</b>									
<i>Iphiclides podalirius</i>					x___		__x		__xx
<i>Zerynthia polyxena</i> (Denis et Schiffermüller, 1775) <sup>2</sup>					___x				
<b>PIERIDAE</b>									
<i>Anthocharis cardamines</i>					__x__				
<i>Pieris mannii</i>									
<i>Pieris napi</i> Linnaeus, 1758				x					x___
<i>Pieris rapae</i>			x__		x___			x	x_x_xx
<i>Pieris</i> sp.									
<i>Leptidea sinapis</i>					__xx__				
<i>Colias alfacariensis</i> Ribbe, 1905					__xx__				
<i>Colias croceus</i>									__x__
<i>Colias</i> sp.									
<i>Gonepteryx rhamni</i>					x___				
<b>LYCAENIDAE</b>									
<i>Favonius quercus</i>									__x__
<i>Satyrium ilicis</i>									__xx__
<i>Callophrys rubi</i> (Linnaeus, 1758)					__x__				
<i>Lycaena phlaeas</i>									
<i>Leptotes pirithous</i> (Linnaeus, 1767)									
<i>Cacyreus marshalli</i>									
<i>Celastrina argiolus</i> (Linnaeus, 1758)									
<i>Cupido alcetas</i> (Hoffmannsegg, 1804)					__x_x	xx__			
<i>Scolitantides orion</i> (Pallas, 1771)					___x				
<i>Plebejus argus</i>						__X	X__	X	__xx_
<i>Plebejus argyrognomon</i>									
<i>Polyommatus bellargus</i>						__x	__x_		xx__
<i>Polyommatus icarus</i>						__Xx		x	x___
<i>Polyommatus</i> sp.									
<b>RIODINIDAE</b>									
<i>Hamearis lucina</i>					__xx_	xxx_			
<b>NYMPHALIDAE</b>									
<i>Libythea celtis</i> (Laicharting, 1782)		x		x	x___				
<i>Vanessa atalanta</i>									
<i>Vanessa cardui</i>									
<i>Nymphalis polychloros</i> (Linnaeus, 1758)		X		x					

Table 3 (1/4). Summary of butterfly species recorded and observed in the study area in II-VI.2012. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 (Table 2). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.



Species	Feb (1) <sup>1</sup>	March 1-15(1)	March 16-31(2)	April 1-15(1)	April 16-30(6)	May 1-15(4)	May 16-31(3)	June 1-15(1)	June 16-30(6)
<i>Polygonia c-album</i> (Linnaeus, 1758)								x	
<i>Limenitis reducta</i>							_x_		
<i>Melitaea athalia</i> (Rottemburg, 1775)						__x			__x_
<i>Melitaea aurelia</i>								x	
<i>Melitaea cinxia</i> (Linnaeus, 1758)					_x_x_	_x_			
<i>Melitaea didyma</i>									X_x_
<i>Melitaea trivia</i> (Denis et Schiffmüller, 1775)								x	_x_x_
<i>Euphydryas aurinia</i>					__xxx_	_xx_			
<i>Issoria lathonia</i>									x____
<i>Argynnis paphia</i>									_x_x_
<i>Boloria dia</i>					xxxx_				
<i>Brenthis daphne</i> (Bergsträsser, 1780)								x	
<i>Brenthis hecate</i>									x____
<i>Melanargia galathea procida</i>								x	xx_xx_
<i>Minois dryas</i>									
<i>Brintesia circe</i>									_x____
<i>Arethusana arethusa</i>									
<i>Hipparchia fagi</i>									
<i>Hipparchia statilinus</i> (Hufnagel, 1766)									
<i>Hipparchia semele</i>									
<i>Lasiommata maera</i>							_x	x	x_x_
<i>Lasiommata megera</i> (Linnaeus, 1767)									
<i>Pararge aegeria</i>				x	__x_				xx____
<i>Pyronia tithonus</i>									
<i>Maniola jurtina</i>								X	xx_xx_
<i>Coenonympha arcania</i>							_X_	x	_x____
<i>Coenonympha oedippus</i> (Fabricius 1787)									
<i>Coenonympha pamphilus</i>					xxx_x_	__xx		x	xX_x_
<b>HESPERIIDAE</b>									
<i>Carcharodus alceae</i> (Esper, 1780)						x____			
<i>Erynnis tages</i>				x	xx____	_x_			
<i>Hesperia comma</i>									
<i>Ochlodes sylvanus</i>									__x_
<i>Spialia sertorius</i> (Hoffmannsegg, 1804)							x__		
<i>Thymelicus lineola</i> (Ochsenheimer, 1808)								x	_x____
<i>Thymelicus sylvestris</i> (Poda, 1761)									_x____
<b>Total spp. for period</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>5</b>	<b>18</b>	<b>11</b>	<b>7</b>	<b>13</b>	<b>25</b>
<b>Total spp. for month</b>	<b>0</b>		<b>3</b>		<b>20</b>		<b>16</b>		<b>28</b>

Table 3 (2/4). Summary of butterfly species recorded and observed in the study area in II-VI.2012. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 (Table 2). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	July 1-15(9) <sup>1</sup>	July 16-31(8)	Aug 1-15(4)	Aug 16-31(4)	Sept 1-15(3)	Sept 16-30(2)	Oct (0)	Nov 1-15(2)	Nov 16-30(1)
<b>PAPILIONIDAE</b>									
<i>Iphiclides podalirius</i>	_x_x_								
<i>Zerynthia polyxena</i> (Denis et Schiffermüller, 1775) <sup>2</sup>									
<b>PIERIDAE</b>									
<i>Anthocharis cardamines</i>									
<i>Pieris mannii</i>		_x__X			__x	_x			
<i>Pieris napi</i>									
<i>Pieris rapae</i>	__x_xx			_x_		_x			
<i>Pieris</i> sp.		_x_x_							
<i>Leptidea sinapis</i>		_x__x							
<i>Colias alfacariensis</i> Ribbe, 1905	_x__				x__				
<i>Colias croceus</i>					__x	_x		Xx	
<i>Colias</i> sp.				_x__					
<i>Gonepteryx rhamni</i>									
<b>LYCAENIDAE</b>									
<i>Favonius quercus</i>	_x__	_x__	_x__						
<i>Satyrium ilicis</i>	_x__								
<i>Callophrys rubi</i> (Linnaeus, 1758)									
<i>Lycaena phlaeas</i>		__xx							
<i>Leptotes pirithous</i> (Linnaeus, 1767)						_x			
<i>Cacyreus marshalli</i>			__x	x__	_x_				
<i>Celastrina argiolus</i> (Linnaeus, 1758)	_x__	_xxxx	x_x_						
<i>Cupido alcetas</i> (Hoffmannsegg, 1804)	_x__	_x__x							
<i>Scolitantides orion</i> (Pallas, 1771)									
<i>Plebejus argus</i>	_X_Xx	Xx xXxx	_X_			_X			
<i>Plebejus argyrognomon</i>	_x__								
<i>Polyommatus bellargus</i>		__x_	_xx_	_xXx	X_				
<i>Polyommatus icarus</i>	_x__	_x_x_x	_Xx	xx_x	x_X	_X			
<i>Polyommatus</i> sp.						x_			
<b>RIODINIDAE</b>									
<i>Hamearis lucina</i>	_x__	_x__x							
<b>NYMPHALIDAE</b>									
<i>Libythea celtis</i> (Laicharting, 1782)								x_	
<i>Vanessa atalanta</i>					__x	_x		x_	
<i>Vanessa cardui</i>	x__								
<i>Nymphalis polychloros</i> (Linnaeus, 1758)									

Table 3 (3/4). Summary of butterfly species recorded and observed in the study area in VII-XI.2012. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 (Table 2). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	July 1-15(9) <sup>1</sup>	July 16-31(8)	Aug 1-15(4)	Aug 16-31(4)	Sept 1-15(3)	Sept 16-30(2)	Oct (0)	Nov 1-15(2)	Nov 16-30(1)
<i>Polygonia c-album</i> (Linnaeus, 1758)									
<i>Limenitis reducta</i>	_x_	_x_x_			x_x				
<i>Melitaea athalia</i> (Rottemburg, 1775)			_x_						
<i>Melitaea aurelia</i>		__x							
<i>Melitaea cinxia</i> (Linnaeus, 1758)									
<i>Melitaea didyma</i>			__x_	x__					
<i>Melitaea trivialis</i> (Denis et Schiffmüller, 1775)									
<i>Euphydryas aurinia</i>									
<i>Issoria lathonia</i>	_x_								
<i>Argynnis paphia</i>	xx_x_					_x			
<i>Boloria dia</i>	_x_		_x_						
<i>Brenthis daphne</i> (Bergsträsser, 1780)									
<i>Brenthis hecate</i>	__x_								
<i>Melanargia galathea procida</i>	__xxXX__								
<i>Minois dryas</i>		_x_	xxx_	x__	x_				
<i>Brintesia circe</i>	_x_x_	_x_	_x_		x_x				
<i>Arethusana arethusa</i>			_Xxx	xx_					
<i>Hipparchia fagi</i>	_x_	_X_	xx_						
<i>Hipparchia statilinus</i> (Hufnagel, 1766)			_x_	_x_	x_				
<i>Hipparchia semele</i>						_X			
<i>Lasiommata maera</i>			_x_x	_xx	X_				
<i>Lasiommata megera</i> (Linnaeus, 1767)	x__								
<i>Pararge aegeria</i>	_x_		_x_						
<i>Pyronia tithonus</i>		x__xxxx	xxx_						
<i>Maniola jurtina</i>	x_xxx_	_x__xx_	__xx	XXx_	x_x	_X			
<i>Coenonympha arcania</i>	x_x_								
<i>Coenonympha oedippus</i> (Fabricius 1787)	__xx_								
<i>Coenonympha pamphilus</i>	_x_	_x_	_xx_	_x	X_x	xx			
<b>HESPERIIDAE</b>									
<i>Carcharodus alceae</i> (Esper, 1780)									
<i>Erynnis tages</i>	_x_								
<i>Hesperia comma</i>				Xx_	X_				
<i>Ochlodes sylvanus</i>	xx_xx_x_			x__					
<i>Spialia sertorius</i> (Hoffmannsegg, 1804)									
<i>Thymelicus lineola</i> (Ochsenheimer, 1808)									
<i>Thymelicus sylvestris</i> (Poda, 1761)	_x_								
<b>Total spp. for period</b>	<b>29</b>	<b>19</b>	<b>19</b>	<b>14</b>	<b>16</b>	<b>11</b>	<b>–</b>	<b>3</b>	<b>0</b>
<b>Total spp. for month</b>		<b>37</b>		<b>23</b>		<b>21</b>	<b>–</b>		<b>3</b>

Table 3 (4/4). Summary of butterfly species recorded and observed in the study area in VII-XI.2012. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 (Table 2). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

TOTAL SPECIES 70	Feb 16-28(1) <sup>1</sup>	March 1-15(1)	March 16-31(1)	April 1-15(2)	April 16-30(8)	May 1-15(5)	May 16-31(3)	June 1-15(6)	June 16-30(4)	July 1-15(5)
<b>PAPILIONIDAE</b>										
<i>Iphiclides podalirius</i>					_x_oo	xO_xo	o_x	__o__		oXxXx
<i>Papilio machaon</i>										__o
<b>PIERIDAE</b>										
<i>Anthocharis cardamines</i>					__xx__	x__				
<i>Aporia crataegi</i>							__x	xOxxoo		_x__
<i>Pieris brassicae</i> (Linnaeus, 1758)										__o_
<i>Pieris mannii</i>								__x	__x_	__Xxo_
<i>Pieris napi</i>						__x				__x
<i>Pieris rapae</i>					x_xxo_	xo__	__o			__X
<i>Pieris</i> sp.						__o_		__ox_o		
<i>Pontia edusa</i> (Fabricius, 1777)										
<i>Leptidea sinapis</i>					_oo_ox	x_xox	__xx		__xx	__x_x
<i>Colias alfacariensis</i>										__o_x
<i>Colias croceus</i>							o_x	__ooo		oxx_o
<i>Colias</i> sp.										
<i>Gonepteryx rhamni</i>		o			__x__	oo__		__o_		
<b>LYCAENIDAE</b>										
<i>Favonius quercus</i>										
<i>Satyrium ilicis</i>								__xxXx	o_xx	_x__
<i>Callophrys rubi</i>						x__				
<i>Lycaena phlaeas</i>					__x_	_o__				
<i>Cacyreus marshalli</i>										__o__
<i>Celastrina argiolus</i>					_x__				__xx	__xxx
<i>Cupido alcetas</i>									__x	
<i>Scolitantides orion</i>								__x__	__x_	
<i>Aricia agestis</i> (Denis et Schiffermüller, 1775)										__xx
<i>Plebejus argus</i>						_ox_	oXx	X_XxX	__xX	
<i>Plebejus argyronomon</i>										__X
<i>Plebejus</i> sp.										
<i>Cyaniris semiargus</i> (Rottemburg, 1775)						__x				
<i>Polyommatus bellargus</i>							__Xx	_oxxx_	o_xx	
<i>Polyommatus daphnis</i> (Denis et Schiffermüller, 1775)										
<i>Polyommatus icarus</i>							__xx	x_xX_x		__xxx
<i>Polyommatus</i> sp.								__x	__x	__x_

Table 4 (1/6). Summary of butterfly species recorded and observed in the study area in II-15.VII.2013. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 or 2012 (Tables 2 and 3). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	Feb 16-28(1) <sup>1</sup>	March 1-15(1)	March 16-31(1)	April 1-15(2)	April 16-30(8)	May 1-15(5)	May 16-31(3)	June 1-15(6)	June 16-30(4)	July 1-15(5)
<b>RIODINIDAE</b>										
<i>Hamearis lucina</i>					_X_	oo_X				
<b>NYMPHALIDAE</b>										
<i>Libythea celtis</i>					_x_	o_		_x_	o_	
<i>Vanessa atalanta</i>					_o_			_o_o_		_x_oo
<i>Vanessa cardui</i>								_x_		_xx_
<i>Agalais io</i> (Linnaeus, 1758)						_x_				
<i>Aglais urticae</i> (Linnaeus, 1758)					_o	x_	_x_			
<i>Nymphalis antiopa</i> (Linnaeus, 1758)										
<i>Nymphalis polychloros</i>		X		x_	x_					
<i>Polygonia c-album</i>						_o_			_x_	
<i>Limenitis reducta</i>						_x_	_x_	_xxx	_o_	_o_
<i>Melitaea athalia</i>								_xx_	_x_	
<i>Melitaea cinxia</i>							_xX			
<i>Melitaea didyma</i>								_x_x_	_xx	_x_x_
<i>Melitaea trivia</i>								_x_		
<i>Euphydryas aurinia</i>						_x_x_	_xx			
<i>Issoria lathonia</i>										_x_
<i>Argynnis paphia</i>									_x_	
<i>Argynnis niobe</i> (Linnaeus, 1758)								_x_		
<i>Argynnis</i> sp.										
<i>Boloria dia</i>					_x_					
<i>Brenthis daphne</i>								_x_	_xx	_x_
<i>Melanarga galathea procida</i>								_Xxx	_XX	oxXxX
<i>Minois dryas</i>										
<i>Brintesia circe</i>									_oX	_xxxX
<i>Arethusana arethusa</i>										
<i>Hipparchia fagi</i>										_x_
<i>Hipparchia semele</i>										_x_
<i>Lasiommata maera</i>							_xx	xoXXxx	_xx	
<i>Lasiommata megera</i>					_x	x_x_				o_xxX
<i>Pararge aegeria</i>					x_xx_oo_	x_	o_	_xx	_x	_x
<i>Pyronia tithonus</i>										
<i>Maniola jurtina</i>							_xX	x_Xxxx	_XX	_xXxo
<i>Coenonympha arcania</i>							_xx	x_XxXx	o_xx	o_xo
<i>Coenonympha pamphilus</i>						_x_X	_Xx	x_xxxx	_xx	_xx_x

Table 4 (2/6). Summary of butterfly species recorded and observed in the study area in II-15.VII.2013. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month (or June/July period). <sup>2</sup> Author provided only for those species not recorded in 2011 or 2012 (Tables 2 and 3). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	Feb 16-28(1) <sup>1</sup>	March 1-15(1)	March 16-31(1)	April 1-15(2)	April 16-30(8)	May 1-15(5)	May 16-31(3)	June 1-15(6)	June 16-30(4)	July 1-15(5)
<b>HESPERIIDAE</b>										
<i>Carcharodus floccifera</i> (Zeller, 1847)										
<i>Erynnis tages</i>						xox_x	o__			__o
<i>Hesperia comma</i>										
<i>Ochlodes sylvanus</i>								__xx__	__xX	oXxxx
<i>Pyrgus amERICANUS</i> (Oberthür, 1910)										
<i>Pyrgus malvoides</i> (Elwes et Edwards, 1897)										
<i>Spialia sertorius</i>								__x__		
<i>Thymelicus lineola</i>								__Xxx	__x__	
<i>Thymelicus sylvestris</i>									__xx	
<b>Total spp. for period</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>16</b>	<b>22</b>	<b>18</b>	<b>30</b>	<b>26</b>	<b>33</b>
<b>Total spp. for month</b>	<b>0</b>		<b>2</b>		<b>16</b>		<b>30</b>		<b>37</b>	

Table 4 (3/6). Summary of butterfly species recorded and observed in the study area in II-15.VII.2013. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 or 2012 (Tables 2 and 3). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	July 16-31(7) <sup>1</sup>	Aug 1-15(1)	Aug 16-31(3)	Sept 1-15(2)	Sept 16-30(2)	Oct 1-15(3)	Oct 16-31(1)	Nov 1-15(2)	Nov 16-30(2)	Dec 1-15(2)
<b>PAPILIONIDAE</b>										
<i>Iphiclides podalirius</i>	oX_Xx_x									
<i>Papilio machaon</i>	__X__		_x_	o						
<b>PIERIDAE</b>										
<i>Anthocharis cardamines</i>										
<i>Aporia crataegi</i>										
<i>Pieris brassicae</i> (Linnaeus, 1758)										
<i>Pieris mannii</i>	_xxxx_x	o			_x					
<i>Pieris napi</i>	_x__			_x						
<i>Pieris rapae</i>		o		x_						
<i>Pieris</i> sp.	o__		oox	_o	o_	__o	o			
<i>Pontia edusa</i> (Fabricius, 1777)			__x	_o	o_					
<i>Leptidea sinapis</i>	__xx__		x_x	x_	_o					
<i>Colias alfacariensis</i>	_x_x_									

Table 4 (4/6). Summary of butterfly species recorded and observed in the study area in 16.VII-XII.2013. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month (or June/July period). <sup>2</sup> Author provided only for those species not recorded in 2011 or 2012 (Tables 2 and 3). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	July 16-31(7) <sup>1</sup>	Aug 1-15(1)	Aug 16-31(3)	Sept 1-15(2)	Sept 16-30(2)	Oct 1-15(3)	Oct 16-31(1)	Nov 1-15(2)	Nov 16-30(2)	Dec 1-15(2)
<b>PIERIDAE</b>										
<i>Colias croceus</i>				xx			x	xo	x	o
<i>Colias</i> sp.	_x_									
<i>Gonepteryx rhamni</i>	_x_									
<b>LYCAENIDAE</b>										
<i>Favonius quercus</i>	o__									
<i>Satyrium ilicis</i>										
<i>Callophrys rubi</i>										
<i>Lycaena phlaeas</i>	_x_			x_		_o		x_		
<i>Cacyreus marshalli</i>			_x_						x	
<i>Celastrina argiolus</i>		o	xx_	x_						
<i>Cupido alcetas</i>										
<i>Scolitantides orion</i>										
<i>Aricia agestis</i> (Denis et Schiffmüller, 1775)	_X_	o	x_x	x_						
<i>Plebejus argus</i>	_x_XxXx	o	xxX					_o		
<i>Plebejus argyronomon</i>	__X_		_x							
<i>Plebejus</i> sp.	__x									
<i>Cyaniris semiargus</i> (Rottemburg, 1775)										
<i>Polyommatus bellargus</i>		o	XXX	Xx	_x					
<i>Polyommatus daphnis</i> (Denis et Schiffmüller, 1775)	_x_									
<i>Polyommatus icarus</i>	_XXx		XXX	Xx	_x	_x	x			
<i>Polyommatus</i> sp.										
<b>RIODINIDAE</b>										
<i>Hamearis lucina</i>	o_x_									
<b>NYMPHALIDAE</b>										
<i>Libythea celtis</i>									x	
<i>Vanessa atalanta</i>	_x_		x_o		o_	oxx	x	xo	X	o
<i>Vanessa cardui</i>										
<i>Agalais io</i> (Linnaeus, 1758)										
<i>Aglais urticae</i> (Linnaeus, 1758)			xx_							
<i>Nymphalis antiopa</i> (Linnaeus, 1758)	_o_									
<i>Nymphalis polychloros</i>										
<i>Polygonia c-album</i>										
<i>Limnitis reducta</i>	oo_xx_x	o	xxx	_x	ox	_x				
<i>Melitaea athalia</i>										

Table 4 (5/6). Summary of butterfly species recorded and observed in the study area in 16.VII-XII.2013. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 or 2012 (Tables 2 and 3). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.

Species	July 16-31(7) <sup>1</sup>	Aug 1-15(1)	Aug 16-31(3)	Sept 1-15(2)	Sept 16-30(2)	Oct 1-15(3)	Oct 16-31(1)	Nov 1-15(2)	Nov 16-30(2)	Dec 1-15(2)
<i>Melitaea cinxia</i>										
<i>Melitaea didyma</i>			x_x	x_						
<i>Melitaea trivia</i>										
<i>Euphydryas aurinia</i>										
<i>Issoria lathonia</i>	_o_x_						x			
<i>Argynnis paphia</i>	__ox			xo						
<i>Argynnis niobe</i> (Linnaeus, 1758)										
<i>Argynnis</i> sp.			_o_							
<i>Boloria dia</i>			__x							
<i>Brenthis daphne</i>										
<i>Melanarga galathea procida</i>	ox_xx_									
<i>Minois dryas</i>			xxx	x_	_x					
<i>Brintesia circe</i>	ox_xx_x		xx_	x_	_x					
<i>Arethusana arethusa</i>			XxX							
<i>Hipparchia fagi</i>	__x		Xox	Xx	ox					
<i>Hipparchia semele</i>				xx	_X	x_x				
<i>Lasiommata maera</i>			_x	xX	_X					
<i>Lasiommata megera</i>	__xx_		xxX	x_	_x					
<i>Pararge aegeria</i>	_x__		xxx	xx	oX	o_o	x			
<i>Pyronia tithonus</i>	__Xx_	o	x_x	x_						
<i>Maniola jurtina</i>		o	xxX	xX						
<i>Coenonympha arcania</i>	__o__									
<i>Coenonympha pamphilus</i>	__xx_x		XXX	Xx	_x	_xx	x			
<b>HESPERIIDAE</b>										
<i>Carcharodus floccifera</i> (Zeller, 1847)	__x									
<i>Erynnis tages</i>	_xXXx_		_x_							
<i>Hesperia comma</i>			XXX	xX	_x					
<i>Ochlodes sylvanus</i>	ooxXx_									
<i>Pyrgus amicanus</i> (Oberthür, 1910)	__x		_x		ox					
<i>Pyrgus malvoides</i> (Elwes et Edwards, 1897)	__o__		_x	x_						
<i>Spialia sertorius</i>										
<i>Thymelicus lineola</i>										
<i>Thymelicus sylvestris</i>	_x_									
<b>Total spp. for period</b>	<b>37</b>	<b>9</b>	<b>31</b>	<b>27</b>	<b>18</b>	<b>8</b>	<b>7</b>	<b>4</b>	<b>4</b>	<b>2</b>
<b>Total spp. for month</b>	<b>50</b>		<b>33</b>		<b>30</b>		<b>10</b>		<b>6</b>	<b>2</b>

Table 4 (6/6). Summary of butterfly species recorded and observed in the study area in 16.VII-XII.2013. Legend: <sup>1</sup> Figures in brackets indicate no. of sampling sessions per month. <sup>2</sup> Author provided only for those species not recorded in 2011 or 2012 (Tables 2 and 3). x = Either one or two individuals photographed during a sampling session; X = 3 or more individuals photographed during a sampling session; o = Observed (but not photographed) during a sampling session; \_ (or blank) = Neither photographed nor observed during a sampling session.



Among the species not recorded by Carrara (1926) is *C. marshalli*, a South African species introduced into Italy in 1997 via horticultural trade in its host plant, *Pelargonium* (Balletto et al., 2005). *C. marshalli* has been recorded from nearby Udine and Tarcento as well as Slovenia since 2008 (Bernardinelli, 2008; Verovnik et al., 2011b) and thus is likely to have arrived in the province of Trieste around the same time.

Some 13 European countries, including France, Germany, the Netherlands, Sweden and the UK, are implementing butterfly recording schemes in attempts to build long-term data sets on species abundance. To date, however, Italy is not among these countries (van Swaay et al., 2012a, Butterfly Conservation Europe: <http://www.bc-europe.eu/index.php?id=339>, accessed 14 March 2014). Such schemes, which also record abundance, are valuable for detecting population changes over the long-term, including those influenced by climate change (Roy & Sparks, 2000; Roy et al., 2001; Warren et al., 2001; Stefanescu et al., 2003). However, a case has also been made for recording schemes that measure presence rather than abundance (Casner et al., 2014), as is the case in the current study (although some inferences on abundance can perhaps be made based on repeated sightings over a short time period). This study has also identified several species-rich 1 km transects that could be used as standard transects in a regular recording scheme for the area as per current guidelines (van Swaay et al., 2012a).

Among the 79 species recorded in this survey, some 14 are of conservation concern either in the region or more widely in Europe (Tables 5 and 6). Of particular note are *E. aurinia* and *C. oedippus*. In the case of *E. aurinia*, a number of individuals were recorded in each of the three years of the survey, indicating a stable, healthy population, even if it did not cover the whole of the survey area. While *C. oedippus* was recorded only in 2012, several individuals were found, indicating a relatively small but potentially healthy population that appears, however, to be isolated from any other local populations. Both species were found in patches of rough vegetation and field margins of the cultivated area close to Malchina. It can also be noted that neither species was recorded from the Trieste area in the early 20th century (Carrara, 1926). Targeted surveys timed to coincide with peak flight periods of these two species and across a wider area than the areas identified by the author in this survey would

provide useful additional information on the importance of the location for these two species.

These two species are also among the 34 species considered by van Swaay & Warren (2006) when developing a list of Prime Butterfly Areas (PBAs) for conservation priority in Europe. When selecting their 431 PBAs, van Swaay & Warren (2006) took into account two types of area: discrete sites that support one or more target species; and wider areas (such as mountain ranges or valley systems) where a target species occurs as scattered populations that may well be connected as a single metapopulation. Indeed, a possible *C. oedippus* metapopulation has been recorded at sites around Komen, some 8 km from Malchina across the border in Slovenia (Čelik & Verovnik, 2010). In Italy, *C. oedippus* is known from around 100 sites, although many are considered under threat, mostly by natural reforestation (Bonelli et al., 2010). Further studies in and around the survey area would also help to confirm if other species recorded only rarely in the area were part of other significant metapopulations.

Given the presence of both *E. aurinia* and *C. oedippus* in the survey area, the area of the Triestine karst around Malchina could be considered for possible inclusion as a PBA. This would add to the cluster of PBAs already identified in the Friuli Venezia Giulia/Slovenia/Istria region. The fact that the area also harbours a number of other species at risk regionally, including strong populations of *L. celtis*, *B. circe*, *Ar. arethusa*, *H. fagi* and *C. arcania*, as well as populations of other species such as *H. statilinus* and *Pyronia tithonus* (Tables 2, 3, 4, and 6) adds to the value of the area.

Species	European (EU25) status	EU27 status <sup>1</sup>
<i>Scolitantides orion</i>	LC	NT
<i>Melitaea aurelia</i>	NT	LC
<i>Melitaea trivia</i>	LC	NT
<i>Argynnis niobe</i>	LC	NT
<i>Hipparchia statilinus</i>	NT	NT
<i>Coenonympha oedippus</i>	EN	LC
<i>Carcharodus floccifera</i>	NT	LC

Table 5. European-level conservation status of endangered and threatened butterfly species recorded in the survey area (from van Swaay et al., 2010 and 2012b). LC = Least concern; NT = Near threatened; EN = Endangered. <sup>1</sup> EU27 includes also Bulgaria and Romania

As a designated Natura 2000 site (see Natura Network Viewer: <http://natura2000.eea.europa.eu/#>), much of the survey area is theoretically protected from development. In practice, however, the ongoing abandonment of agricultural fields and succession to more overgrown/wooded areas (Poldini, 1989) or other threats such as construction of new housing continue to erode suitable butterfly habitats. As mentioned earlier, the abandonment of agricultural land and/or changing habitat management affects many of Europe's threatened butterfly species, while other important threats include climate change, increased frequency and intensity of fires and tourism development (van Swaay et al., 2010). Indeed, in 2012, several areas close to the survey area were affected by fire (Tosques, 2012a; 2012b).

Habitat loss is, however, regarded as the greatest threat to butterflies. Van Swaay & Warren (2006), for example, highlight that even species targeted for conservation are declining not only within PBAs, but also within protected areas. Likewise, in the UK, Warren et al. (2001) demonstrated that, despite the positive effects of climate change on range expansion, for three-quarters of 46 species considered, these gains were outweighed by the negative effects of habitat loss.

Van Swaay & Warren (2006) conclude that legislation alone is not enough to maintain threatened populations, but that practical conservation measures are also urgently needed. Such measures should include sound habitat management of key sites allied with sympathetic management of surrounding areas, such as the continuation of traditional agriculture and forestry practices. They also recommend that populations of target species are monitored and that research is conducted to identify appropriate habitat management techniques - with appropriate financial support. In contrast, Navarro & Pereira (2012) argue that 'rewilding' (defined as "the passive management of ecological succession with the goal of restoring natural ecosystem processes and reducing human control of landscapes") of abandoned farmland should be considered as a possible land management option in Europe, particularly on marginal areas. However, they also recognize that such passive forest regeneration will cause some species to decline in abundance while others would increase, i.e. there would be both 'winner' and 'loser' species.

In the survey area considered here, the greatest

Species	Status in Triveneto region	Comments re: area surveyed <sup>1</sup>
<i>Zerynthia polyxena</i>	Very local, EN, protected at EU level	One individual photographed in 2012
<i>Callophrys rubi</i>	LR but in decline	Rare. Recorded once in 2012 and once in 2013
<i>Libythea celtis</i>	Scarce, VU	Good local populations
<i>Nymphalis antiopa</i>	DD/EN - population at lower altitudes EN	One individual observed in 2013
<i>Melitaea trivia</i>	VU, protected in FVG <sup>2</sup>	Never common. Recorded twice in 2012 and once in 2013
<i>Euphydryas aurinia</i>	NT, protected in FVG at EU level	Reasonable population localized to parts of survey area
<i>Brenthis hecate</i>	VU	Very rare. Recorded twice in 2012 only
<i>Brintesia circe</i>	EN, threatened, very local	Good local population
<i>Arethusana arethusa</i>	NT, protected in FVG	Good local population
<i>Hipparchia fagi</i>	VU, locally common, EN in Alto Adige	Good local population
<i>Hipparchia statilinus</i>	DD/LR, can be locally common	A few individuals recorded in 2012 only
<i>Pyronia tithonus</i>	Very local distribution, VU/EN	Found regularly, but never more than one or two individuals
<i>Coenonympha arcania</i>	LR/NT, common - populations in hill/mountain areas of FVG less threatened	Good local population
<i>Coenonympha oedippus</i>	VU, protected at EU level	A few individuals recorded in 2012 only
<i>Pyrgus amoricanus</i>	NT, only local populations	Recorded intermittently in 2013 only

Table 6. Triveneto-level conservation status of protected, endangered, threatened and vulnerable butterfly species recorded in the survey area (from Paolucci, 2010). LR = Lower risk; NT = Near threatened; VU = Vulnerable; EN = Endangered; DD = Data deficient. <sup>1</sup> For additional details, refer to Tables 2, 3 and 4. <sup>2</sup>FVG = Friuli Venezia Giulia

threat to local butterfly populations and diversity of species remains the natural reforestation that is ongoing since the decline of grazing in the area. Similar effects are occurring to local bird communities, with specialist grassland species such as the rock partridge *Alectoris graeca* (Meisner, 1804), grey partridge *Perdix perdix* (Linnaeus, 1758) and ortolan bunting (*Emberiza hortulana* Linnaeus, 1758) having gone locally extinct, populations of skylark (*Alauda arvensis* Linnaeus, 1758) and tawny pipit *Anthus campestris* (Linnaeus, 1758) under threat, and numbers of corn bunting (*Emberiza calandra* Linnaeus, 1758), red-backed shrike (*Lanius collurio* Linnaeus, 1758) and nightjar (*Caprimulgus europaeus* Linnaeus, 1758) much reduced. Concomitantly there have been increases in species frequenting scrub and woodland, such as the nightingale, blackcap, blackbird, chaffinch and melodious warbler (Parodi, 1999). However, exactly which type of management practices are most suited for maintaining both faunal and floral diversity in the area, is unknown.

Based on research in Germany on a comparable grassland site with shallow soil in a warm, dry temperate climate, Romermann et al. (2009) concluded that neither mowing nor various mulching regimes properly conserved the structure of wildflower populations developed over many years of grazing in species-rich semi-natural grasslands. However, they did recommend mulching twice per year, as this generated the most similar floristic and functional plant community compared to the original grazing regime.

In contrast, regarding the conservation of another endangered grassland-specialist insect species, *Saga pedo* (Pallas, 1771) (Orthoptera, Tettigoniidae) that is also present in the survey area (Fontana & Cussigh, 1996; author's observations), from their studies in the Czech Republic, Holuša et al. (2013) recommended either extensive rotational grazing or using scythes to cut grass in a traditional way to maintain open areas of natural grassland. Alternatively, partial machine mowing (one-third to one-half of specific areas) each September could be considered.

Unfortunately it is more than likely that the current situation of abandonment and neglect of once grazed and cultivated areas is likely to continue in the survey area for the foreseeable future. Similarly, Bonelli et al. (2010), discussing the conservation of *C. oedippus* populations across Italy, note that natural reforestation is best prevented by developing suitable, but costly, management plans, "which for the moment remain only on paper, in the best of cases."

The same is likely true for large parts of the Triestine karst, despite the undoubted conservation value for butterfly species, as reported here.

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