

# RECOVERY PLAN FOR THE SIERRA NEVADA BLUE

*Polyommatus (Plebicula) golgus*



Butterfly Conservation Europe



# SPECIES RECOVERY PLAN FOR THE SIERRA NEVADA BLUE *Polyommatus (Plebicula) golgus*

Miguel L. Munguira<sup>1,2</sup>, Sara Castro<sup>1</sup>, José Miguel Barea-Azcón<sup>3</sup>, Javier Olivares<sup>4</sup> & Svetlana Miteva<sup>2</sup>

1. Universidad Autónoma de Madrid
2. Butterfly Conservation Europe
3. Agencia de Medio Ambiente y Agua, Andalusia
4. IES Vega de Atarfe, Granada

Butterfly Conservation Europe  
P.O. Box 506, NL-6700 AM Wageningen  
Telephone: +31-317-467320  
Email: [info@bc-europe.eu](mailto:info@bc-europe.eu)  
Homepage: [www.bc-europe.eu](http://www.bc-europe.eu)



This project is implemented in cooperation with :

Universidad Autónoma de Madrid  
Facultad de Ciencias, Departamento de Biología  
Cantoblanco, 28049-Madrid  
Telephone: +34-91-4978282  
Email: [munguira@uam.es](mailto:munguira@uam.es)  
Homepage: [www.uam.es](http://www.uam.es)



Dutch Butterfly Conservation / De Vlinderstichting  
Postbus 506, 6700 AM Wageningen  
Telephone: 0317-467346  
Email: [info@vlinderstichting.nl](mailto:info@vlinderstichting.nl)  
Homepage: [www.vlinderstichting.nl](http://www.vlinderstichting.nl)



Parque Nacional y Parque Natural de Sierra Nevada  
Ctra. Antigua de Sierra Nevada, Km. 7  
18071 Pinos Genil (Granada)  
Telephone: +34- 958 980 238  
Fax: 958 026 310  
E-mail: [pn.snevada.cma@juntadeandalucia.es](mailto:pn.snevada.cma@juntadeandalucia.es)



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## Keywords:

Threats, conservation, Spain, endemic species, endangered species.

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## Contents

INTRODUCTION	7
IDENTIFICATION	8
IMMATURE STAGES	9
TAXONOMY	10
DISTRIBUTION	11
HABITAT	12
BIOLOGY	15
POPULATION	16
CONSERVATION	18
THREATS	20
SPECIES ACTION PLAN	22
LEGAL PROTECTION	22
CONSERVATION MEASURES	22
RESEARCH	28
PUBLIC AWARENESS	29
ACKNOWLEDGEMENTS AND LITERATURE	30



## Introduction

This document presents a summary of all the information available for *Polyommatus golgus* and the results of the field studies carried out during the field seasons of 2012, 2013 and 2014. It includes also unpublished data from the authors and collaborators.

Species Recovery Plans (SRPs) are documents which bring together relevant information about a given endangered species, present an analysis of the threats that the species is facing, and list actions needed to reverse these threatening factors. If successful these actions will help protect the species from extinction and greatly improve its conservation status. SRPs are vital tools for the conservation of highly threatened animal and plant species. However, in Spain, recovery plans have never been produced for species of the Lepidoptera order, and therefore one of the aims of this document is to fill this gap and provide for the first time guidance for the conservation of threatened endemic butterflies.

The Species Recovery Plans are part of the Species Recovery Program of Butterfly Conservation Europe. The work on *Polyommatus golgus* has received the financial support from MAVA Fondation pour la Nature within a project to produce a SRP for the endangered endemic species living in Spain: *Euchloe bazae*, *Agriades zullichi*, *Polyommatus golgus* and *Polyommatus violeetae*.

The production of this SRP involved three steps. First, we gathered all the information available for the species in the form of scientific papers, distribution records and chapters of Red Data Books or reports. Second, fieldwork was planned to visit most of the habitats of the species and record information on the threats and the ecology of the species. Finally, we discussed possible conservation actions with conservation experts and landscape managers during a workshop in 2013 and visited relevant National and Natural Parks, in which we developed measures with park officials. During the fieldwork, the following data were recorded for each population of the species: name of the locality, date, geographic coordinates, altitude, geological substrate, number of adults on transect counts, larval food plant density, aspect, threats and vegetation type. Photographs were also made from all the places where the presence of the butterfly was detected and from any relevant habitat feature.

The document is divided into three main sections. The first section summarizes the available information for the species and shows new data gathered during the project. A second section deals with information that is relevant for the conservation of the species, particularly an analysis of the threats that have been mentioned for the species and those that were detected during fieldwork. The final section explains in detail the specific actions that are proposed for an improvement of the species' conservation status. At the end of the document there is a comprehensive list of references.



## Identification

### Wing morphology

The length of the forewing is 11 to 16 mm.

The upperside of the wings of the **male** is of a bright blue colour (Fig. 1), with marginal spots in the hindwings and a black marginal line present in subspecies *golgus*, and of a light sky blue, without marginal spots in the hindwings and the black marginal line poorly noticeable in subspecies *sagratrox*.

The underside of the male wing is brownish-grey. On the forewing it has six to seven postdiscal spots and those of the E1 and E2 spaces are lined with the long discal spot. The marginal marks are slightly pronounced.

In the hindwing there are from eleven to thirteen spots: two to four basal, one discal and from seven to eight postdiscal. The discal spot is triangular and is almost without black scales in its centre, making the white area of the spot quite wide. Submarginal lunules are of pale orange colour, they are variable in number and size and close to them are noticeable black marginal spots.

The **female** has a dark brown upperside (lighter in subspecies *sagratrox*), with a submarginal lunule on the forewing in some individuals and from two to four orange lunules in the hindwing. The underside (Fig. 1) is light yellowish brown, with marginal dots and a variable number of orange submarginal lunules.



Figure 1. Male of *Polyommatus golgus golgus* from Sierra Nevada, Granada (left, photo J Olivares). Female *P. golgus sagratrox* in Sierra de la Sagra, Granada (right, photo JP Cancela).

### Genitalia

The male genitalia show a thin furca and vinculum, labides with internal lobe and brachia ending in a slightly pronounced hook. These characteristics are similar to *Polyommatus dorylas*, therefore the male genitalia are not distinctive. The female genitalia have an elongated hypostema and the henia is funnel shaped, less sclerotized and with an oval genital plate.



## Immature stages

**THE EGG** has a diameter of about 0.56 mm. It is pale green when laid and turns to white later. The *micropylar* rosette has five or six rounded cells. In the transition area there are some cells with rough walls, with four or five sides. The tubercle-aeropyle area has rounded and short tubercles and irregular cells of quadrate or pentagon form (Fig. 2).

**THE FIRST** of the five larval instars is yellowish, turning later to light green with a black head. This colour is cryptic with the leaves of the food plant. It has long dorsal and lateral white setae (Fig. 3), which help it to remain unnoticed. Two pore cupola organs and two club-shaped subdorsal setae appear in each abdominal segment. The cuticle surface is rough, with a honeycomb framework.

**THE LARVA OF THE THIRD INSTAR** is also green, but the amount of setae blurs the colour. These setae are of three types, long and thorny, short and thorny, and hydroid, the latter surrounding the dorsal nectary organ (Newcomer's gland), which is functional. The green dorsal stripe is very clear in this instar and a lateral line also appears, white at the beginning and yellowish-green at the end of the instar.

**FOURTH AND FIFTH LARVAL INSTARS** have more setae and they are stronger, especially in the dorsal and lateral areas. Also short and curved setae can be seen in the dorsum. In the area surrounding the Newcomer's gland, around the spiracles and sparsely scattered in the rest of the body there are pore cupola organs; they are flat and with several marginal teeth. Tentacles are situated in both sides of the eighth abdominal segment. The final length of the larvae is 12.0-12.5 mm, and the colour is bright green (Fig. 4). Surrounding the Newcomer's gland there are setae with spatula-shaped ending and hydroid setae in the gland's lips.

**THE PUPA** has a length between 8.5 and 10.3 mm. Head, thorax and wing areas are dark green while the rest is brownish-yellow. As time goes by, the dark green fades and the entire chrysalis has a similar colour. It has numerous toothed setae with rounded ending, that are specially abundant in the spiracle areas, where there are also pore cupola organs, hydroid setae and cupuliform sensillae. In the abdomen there is a dark and broken line and two subdorsal rows of spots, one in each side of the abdomen. All these patterns get reduced when the pupal stage is ending. The surface of the cremaster area is covered with fine spines. The pupal cuticle is rough, irregular, with domed structures. The pupa has a stridulatory organ, formed by tubercles and teeth.

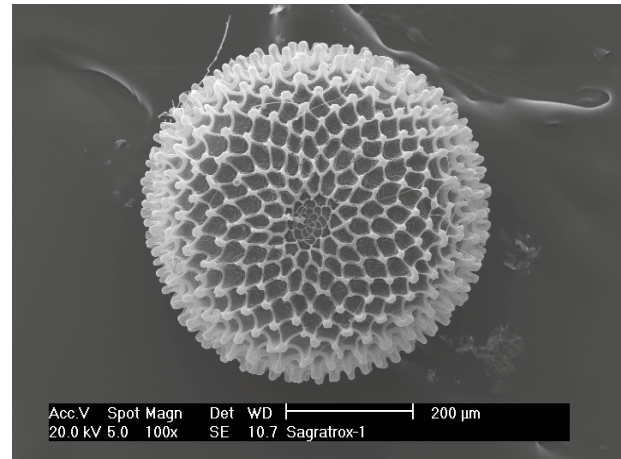


Figure 2. Scanning electron microscope photograph of the egg of *Polyommatus golgus*. Scale bar 0.2 mm (photo ML Munguira & J Martín).

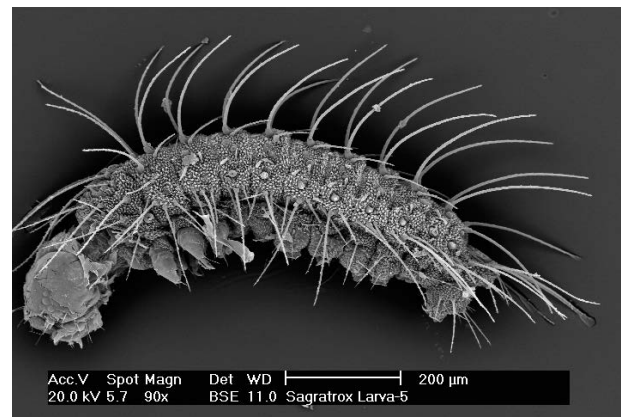


Figure 3. Scanning electron microscope photograph of the first instar larva of *Polyommatus golgus*. The dorsal and lateral setae are clearly visible. Scale bar 0.2 mm (photo ML Munguira).



Figure 4. Fifth larval instar of *Polyommatus golgus* feeding on its larval food plant, *Anthyllis vulneraria* in Sierra Nevada (Granada province, photo ML Munguira).

## Taxonomy

Common name: Sierra Nevada Blue or Niña de Sierra Nevada

Latin name: *Polyommatus (Plebicula) golgus* (Hübner, 1813)

Phylum: Arthropoda

Class: Insecta

Order: Lepidoptera

Family: Lycaenidae

De Lesse (1960) stated that the chromosome number of the species ( $n = \text{ca. } 131\text{-}134$ ) is lower than in the closely related *P. dorylas* ( $n = \text{ca. } 147\text{-}151$ ). It has therefore been considered a distinct species since then, and this criterion has been followed by Manley & Allcard (1970) and Gómez Bustillo & Fernández-Rubio (1974). Recently, molecular studies based on mitochondrial COI and nuclear ITS2 sequences (Wiemers et al. 2010) confirm the specific status of *P. golgus* and include the species within the genus *Polyommatus* and subgenus *Plebicula*.

Two subspecies have been described:

- *P. golgus golgus* (Hübner, 1813) from Sierra Nevada.
- *P. golgus sagratrox* Aistleitner, 1985 from the rest of the species distribution range (Fig. 5).

Some authors (see Gil-T. 2013) consider that this subspecies should be given specific status.



Figure 5. Male of *Polyommatus golgus sagratrox*, Guillimona, Granada (photo J Olivares).

## Distribution

The species is endemic to the Iberian Peninsula, and is only present in Sierra Nevada (Granada and Almería provinces), Sierra de Cazorla (Jaén province), Sierra Seca, Sierra Guillimona and La Sagra (north of Granada province). The species is present in 14 UTM squares (10 x 10 km, Fig. 5). During fieldwork we confirmed the presence and visited populations from six of these squares in Sierra Nevada, Cazorla, Guillimona and La Sagra.

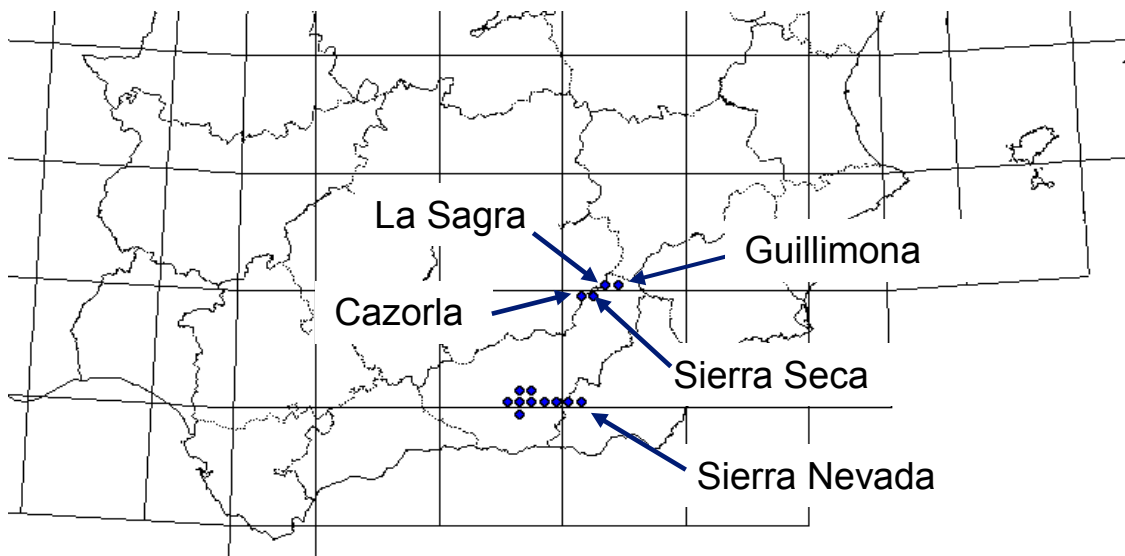


Figure 6. Distribution of *Polyommatus golgus*. Southern populations: Sierra Nevada. Northern populations: Sierra de Cazorla, Sierra Seca, Sierra Guillimona and La Sagra. Dots represent the presence of the species in 10 x 10 km UTM (Universal Transverse Mercator) squares.



### Habitat description

The two subspecies of *Polyommatus golgus* live in rather different habitats. Subspecies *golgus* lives in Sierra Nevada at altitudes ranging from 2,150 to 2,750 m in our samples, although it has been recorded at up to 3,100 m by other authors. All the recorded populations of this subspecies are in north facing slopes or in the summits of the sierra, a fact that probably suggests the preference of more humid habitats in this area. The distribution of this species becomes isolated to the oriental side of the mountain range, where conditions are significantly more arid. The habitat of this subspecies belongs to the Genisto baeticae - *Juniperetum nanae* (oromediterranean) and *Erigeronto frigidum* - *Festucetum clementei* (crioromediterranean) plant communities. These vegetation formations are dominated by dwarf junipers, Genista shrubs and grasses (Fig. 7). Rock substrate consists on schist that locally can show a high proportion of quartz.

The habitats are also characterized by the recent periglacial activity, with some glacial events during the little Ice-Age, a period of intense cooling that finished in 1850, and which left traces of periglacial activity at Sierra Nevada (Gómez-Ortiz et al. 2014). The resulting landscapes are actually dominated by great valleys separated by long slopes that elapse perpendicularly from the central axis of the mountain range. The oro and crioromediterranean habitats where the species lives are included under the Habitats Directive Annex 1 (92/43/CEE) as Habitats of Community Interest: Oro-Iberian *Festuca indigesta* grasslands (code 6160) and Mountain *Cytisus purgans* formations (code 5120). The Directive requires the designation of Special Areas of Conservation (SACs) for this habitat, a fact that was fulfilled by the inclusion of this habitat and the designation of Sierra Nevada as SAC in 2012. However, in 2014, Spain reported to the EU that the “overall assessment of conservation status” is bad (U2) for this habitat.

*P. golgus* habitat at Sierra Nevada remains under the snow for at least half of the year. Snow cover provides protection against extreme cold and windy conditions and plays an important role in the water supply and humidity conditions of these ecosystems. These conditions are essential for this species and for other endemic and endangered plants and insects that live in the area.



Figure 7. Habitat of *Polyommatus golgus golgus* in El Veleta, Sierra Nevada (Granada Province). Dwarf junipers and low vegetation grow over schist substrate (photo ML Munguira).



Figure 8. Habitat of *Polyommatus golgus sagratrox* in Empanadas, Sierra Cazorla (Jaén Province). Vegetation is dominated by cushion shrubs of *Erinacea anthyllis* over dolomite substrate (photo ML Munguira).

The northern populations of the subspecies *sagratrox* live in four nearby sierras on clearings of *Pinus nigra* woodlands and at higher elevation on cushion shrub communities with *Erinacea anthyllis* (Fig. 8). Altitudes in our samples were: in La Sagra between 1,800 m and 2,381 m, in Sierra Guillimona at an average of 1,847m and in Sierra de Cazorla at 2,055 m. Vegetation is within the Betic oromediterranean stage and the plant communities belong to the *Daphno oleoidi* - *Pineto sylvestris* series. Substrates are limestone, marl-limestone and dolomite.

## Habitat model

Using the 127 coordinates of locations of *Polyommatus golgus* obtained in 2010-2014, a potential distribution model was obtained with the MaxEnt software (Phillips et al. 2006). The model searches, with the use of several variables, the areas that share characteristics from the variables that match with the known distribution of the species. The environmental predictors used for the model were selected from 45 variables that included topographic, hydrologic, climatic, landscape structure, and teledetection variables. 115 locations of *P. golgus* were used to perform the model and 12 to test it. The resulting model was transformed to binary using the 10 percentile training presence threshold that represents the favourable area for a 90% of presence records.

The model obtained showed a high predictive capacity, with AUC (Area Under the ROC Curve) values of 0.94. The threshold used to convert the model from continuous to binary (10 percentile training presence of MaxEnt) was of 0.43. A total of 822 fragments were identified as potential habitat for the species. The total area of the polygons was 10,297 ha, with an average extension of polygons of 12.5 ha (range 0.1-2990 ha). There were eight predominantly climatic variables that contributed to the model performance, and among them the minimum summer and maximum winter temperature contributed respectively with 44% and 31% to the model. The model gives as favourable temperature conditions the summer average values from 11.5 to 24.5°C, and winter averages from -2.5 to 4.3°C. This is coincident with the mountain character of the habitat of *P. golgus*, which has lower temperatures than surrounding areas. These areas are also exposed to high solar radiation and have high rainfall when compared with the regional average (700-900 mm). Under this scenario, it is expected that the predicted rise in temperatures of between 2.7 and 7°C from present to 2100 (Benito et al. 2011) will produce a displacement to higher areas of the lower range limits of the species and eventually the extinction of some of the populations living on peaks (especially Sierra Seca and Empanadas, Fig. 9).



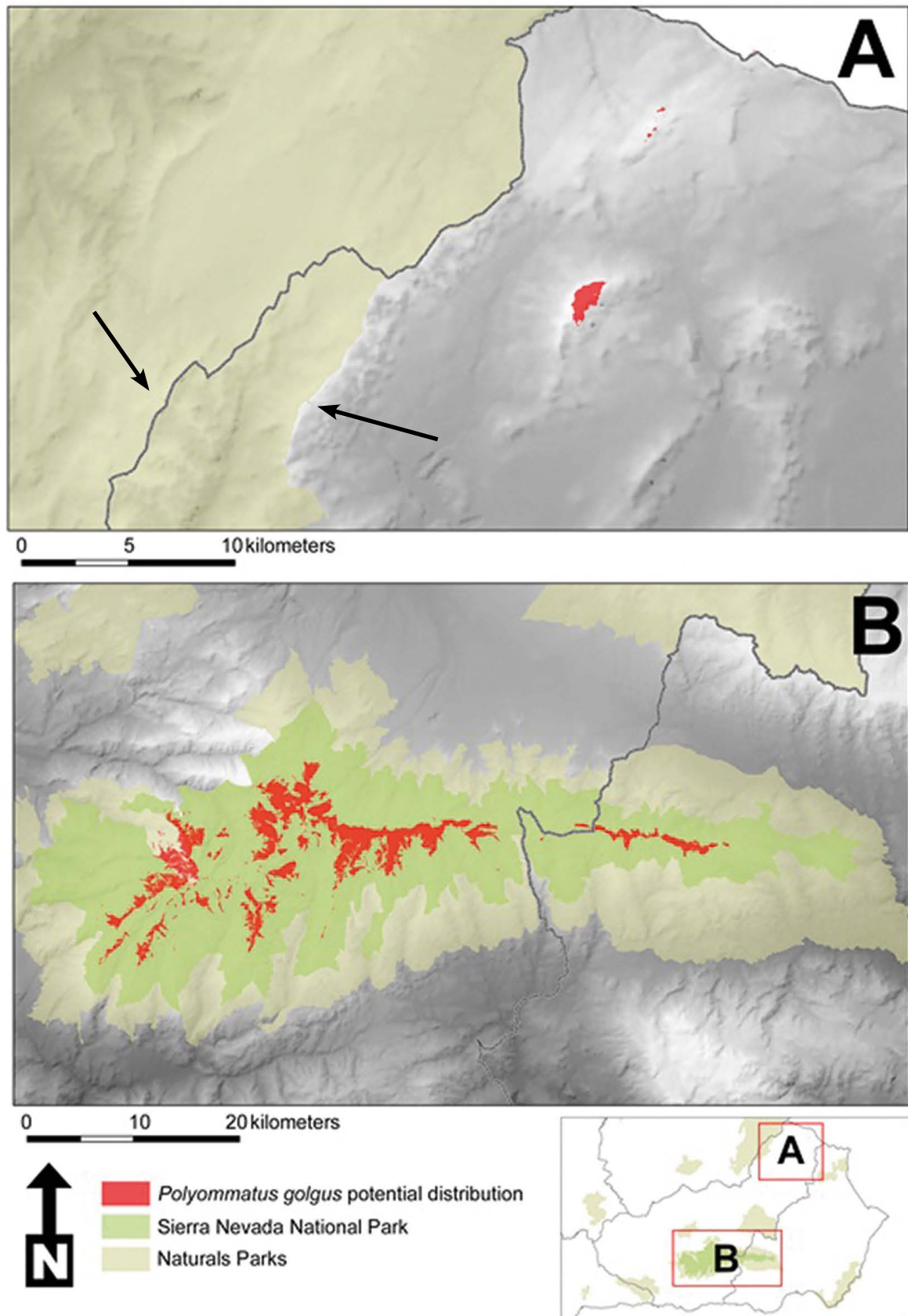


Figure 9. Potential distribution of *Polyommatus golgus* (red areas) in Sierra Nevada and in the northeastern Granada Province (SE Spain). The area of Sierra Nevada National Park (dark green) and the Natural Parks (light green) are also represented. Arrows point out the populations of Empanadas, Sierra de Cazorla (left) and Sierra Seca (right).



## Biology

**PHENOLOGY AND BEHAVIOUR:** *Polyommatus golgus* is a univoltine species, with adults flying in July, although some individuals can be seen in June. Males exhibit both perching and patrolling behaviour. Perching males wait, sitting on perches, for the appearance of the females. The locations of these perches do not contain high accumulations of food plants or flowers, so the females attend these areas just for mating. Males defend mating territories, flying after intruding butterflies and returning to their perches. This kind of behaviour can be classified as a lek system (Munguira, 1989). On the other hand, patrolling males fly over areas of suitable habitat searching for females and fight with competing males.

**Adult NECTAR SOURCES** include *Arenaria tetraquetra*, *Hieracium pilosella*, *Jasione crispa*, *Sedum album*, *Dorycnium pentaphyllum*, *Silene rupestris* and *Thymus serpylloides*, whose flowers are abundant during the flight period.

**OVIPOSITION** takes place in July. The female lays its eggs one by one on the upperside of the curled leaves of the perennial larval host plant *Anthyllis vulneraria* (Fig. 10). The female often alights and rests with its wings outstretched to regulate its body temperature, which often gets lower because of the wind.

**LARVA:** the first instar larva hatches at the end of July. The first three larval instars are partly endophyte, and the caterpillar makes a hole in the epidermis of the leaves and inserts the head with the help of its extensible neck, to feed on the parenchyma. They overwinter as third instar larva. During the fourth and fifth larval instars, they feed on the flowers and young leaves. The last larval instars are tended by ants of the species *Tapinoma nigerrimum* and *Lasius niger*, which often have their nests near the food plant.

**PUPATION** occurs in June and it takes place in the ground, close to the host plant. Natural enemies are unknown in the populations from Sierra Nevada, but in La Sagra larvae are attacked by hymenopteran parasitoids of an indeterminate species.



Figure 10. Mating pair of *Polyommatus golgus* on the larval food plant, *Anthyllis vulneraria*, in Sierra Nevada, Granada Province (photo JM Barea-Azcón).

## Population

Population numbers have been estimated using the transect method on fixed routes of around 1 km. When the studied habitat had a length of less than 1 km, a shorter distance was recorded and the results extrapolated to 1 km. The average for all the counts made in the different years was 20.5 adults per km (calculated from 19 samples). Fig. 11 shows the average of counts in the populations that were sampled in the years 2012 and 2013. The two years in which population densities were estimated showed different values: 17 adults/km for 2012 (twelve samples) and 28 adults/km for 2013 (six samples). In 2014 we only studied the population of Empanadas, Sierra of Cazorla, with 15 adults/km. The differences between estimates in 2012 and 2013 are probably the effect of different climatic conditions in the two years. 2012 was a year with a very dry and extremely hot spring that was probably negative for larval survival and consequently might have reduced adult numbers.

We cannot infer adult population sizes from these data, but the order of magnitude of populations would range from hundreds of individuals in the smallest populations (e.g. Guillimona or El Buitre, where the habitat of the species is restricted to a very small area), to tens of thousands in the largest (Río San Juan), where the habitat occupied by the species is extensive. Numbers obtained in transect counts are quite typical of mountain species from the Mediterranean area and are also very similar to estimates obtained for the other mountain species during the present project (*Agriades zullichi* and *Polyommatus violetae*).

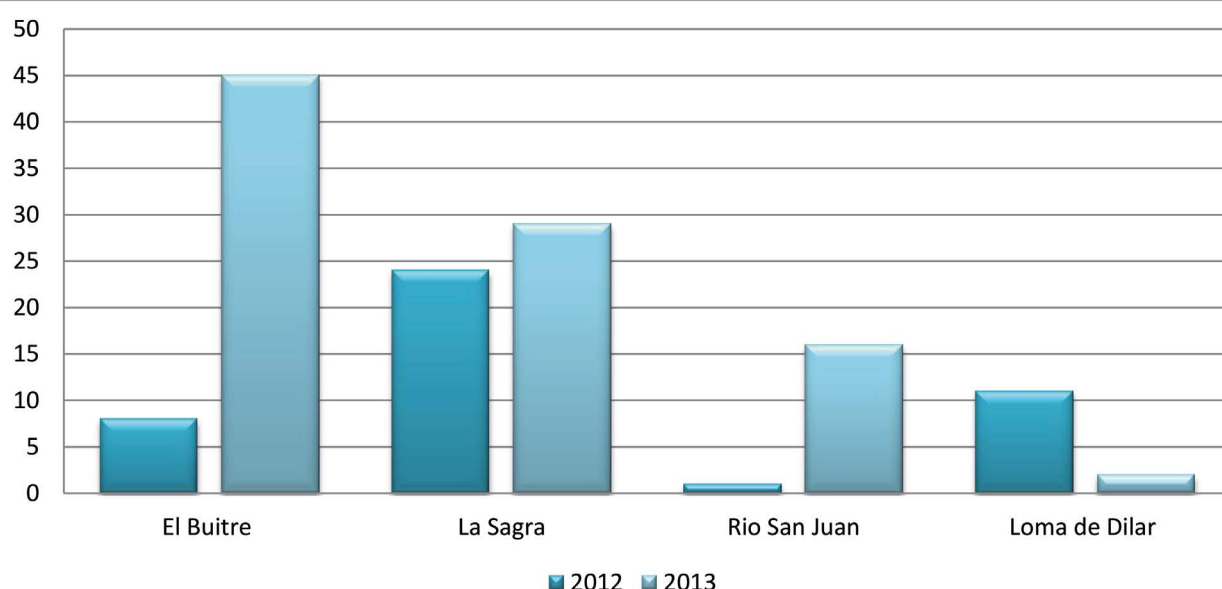


Figure 11. Adult estimates of *Polyommatus golgus* obtained from 1 km linear transects in 2012 and 2013. Average values were calculated when there were different samples from the same locality and year.

A comparison of the density of the larval food plant, *Anthyllis vulneraria* (measured as the number of plants in 100 m<sup>2</sup> quadrats) and the adult density showed that these parameters were not correlated in the few areas where both data were available (correlation coefficient,  $r = -0.026$ , Number of sites = 5, Fig. 12). Although the sample is small, this indicates that adult density is not dependent on larval food plant density, given that the food plant abundance reaches a certain threshold. Plant densities, measured as the number of plants in 10x10 m quadrats ranged from 77 to 384, with an average of 158 plants, which means that the average hectare of habitat has 15,800 plants. Plant densities also showed a wider range of variation than adult numbers (Fig. 12).

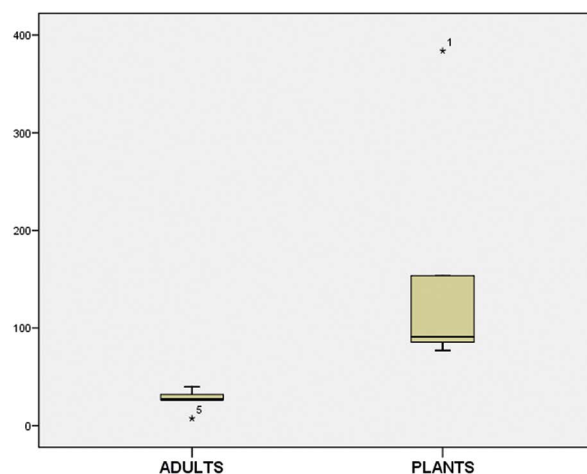


Figure 12. Box plot of the estimates of adult numbers of *Polyommatus golgus* and of the larval food plant density, *Anthyllis vulneraria*. Plant estimates were measured in 100 m<sup>2</sup> plots and were available, together with adult estimates, only for five locations.

In the population of Hoya de la Mora in Sierra Nevada, the Butterfly Monitoring Scheme of the National Park has been recording *P. golgus* numbers since 2008. The results are shown in Fig. 13 where adult counts are standardized for a length of 100 m. Although trend estimates would need longer time series, it is evident from these data that the population shows strong fluctuations. Changes in population numbers can also be confirmed by the different estimates obtained in the two sampling years from most of the populations that are shown in Fig. 11.

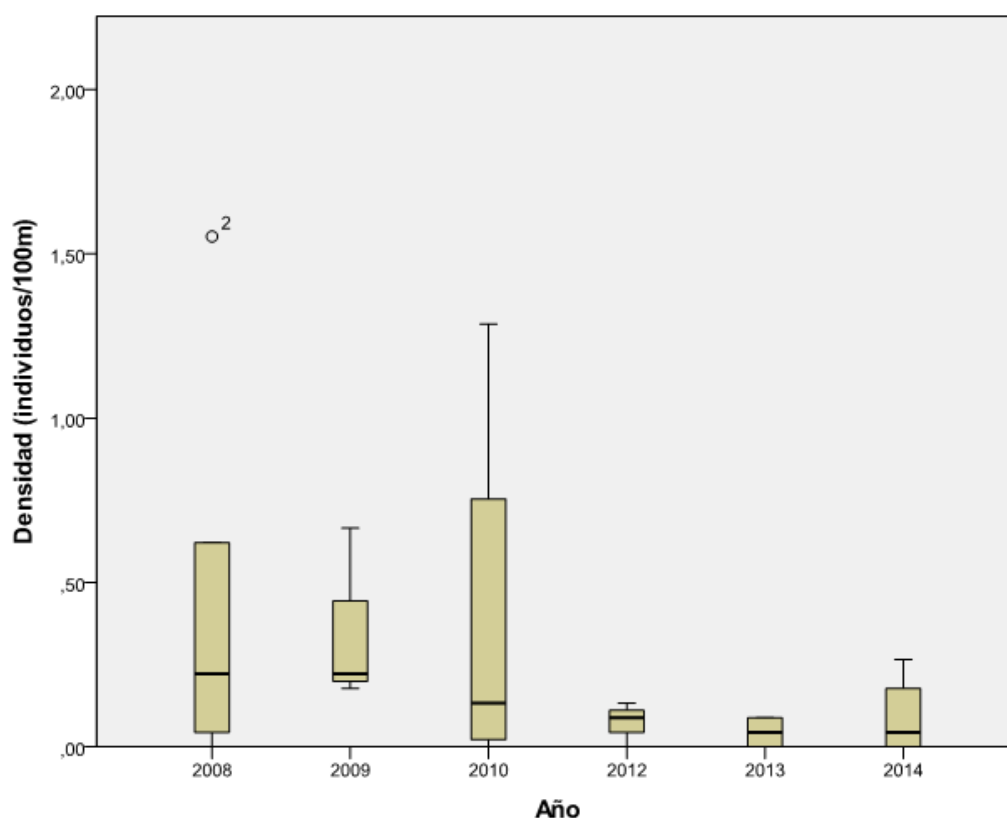


Figure 13. Box plots of the estimates of adult numbers (Densidad) of *Polyommatus golgus* from Sierra Nevada Butterfly Monitoring Scheme in the location of Hoya de la Mora. Adult numbers per 100 m are given for average values, range and standard deviation in each year (Año) of the scheme. In the year 2011 the population was not recorded.

## Conservation

### Legal protection

*Polyommatus golgus* is included in the Annex II of the Bern Convention (1982) and in the Annexes II and IV of the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora or shortly the Habitats Directive. The name used in these annexes is *Plebicula golgus*.

Spain recognizes the importance of the species by including it in the:

Spanish List of Threatened Species (Catálogo Español de Especies Amenazadas) (2011): listed as endangered (EN).

Spanish Catalogue of Threatened Species (Catálogo Nacional de Especies Amenazadas) (2000): EN.

Andalusian Catalogue of Threatened Species (Catálogo Andaluz de Especies Amenazadas) (2012): EN.

### Protected areas

There are five main areas in Spain where the species is present and they are all legally protected.

The species habitat in Sierra Nevada is part of a Biosphere Reserve, a Natural Park, a National Park (Sierra Nevada, declared in 1999), a Natura 2000 site (ES6140004). The management plan of the Park is available at the following link: [www.juntadeandalucia.es](http://www.juntadeandalucia.es)

The populations in Sierra de la Sagra and Guillimona are in a Natura 2000 site (Sierras del Nordeste, ES6140005). The management plan of the site is not available neither in preparation.

The population in Empanadas is within a Natural Park: Parque Natural de las Sierras de Cazorla, Segura y las Villas. This area is also a Biosphere Reserve and a Natura 2000 site (ES0000035). The management plan of the site is not available neither in preparation.

The population in Sierra Seca is also within a Natural Park: Parque Natural Sierra de Castril, which is also a Natura 2000 site (ES6140002). The management plan of the site is available at the following link: [www.juntadeandalucia.es](http://www.juntadeandalucia.es)

All the sites, except the ES6140005 Sierras del Nordeste, are declared under the Birds and the Habitats Directives. Sierras del Nordeste is only under the Habitats Directive.

## Conservation status

The species has been listed in the following Red Data Books and Endangered Species Lists:

Spanish national and regional Red Lists:

- Spanish Atlas of Endangered Invertebrates (Atlas de los Invertebrados Amenazados de España, 2009): EN B2ac (i, ii).
- Red Data Book of Andalusian Invertebrates (Libro Rojo de los Invertebrados de Andalucía, 2008): EN B2ac (i, ii).
- Red Data Book of the Spanish Invertebrates (Libro Rojo de los Invertebrados Españoles, 2006): EN B2ac (i, ii).
- Revision of the Red Data Book of Iberian Lepidoptera (Revisión del libro rojo de los lepidópteros ibéricos, 1985): EN.
- Red Data Book of Iberian Lepidoptera (Libro rojo de los Lepidópteros ibéricos, 1976): Endemism (END).

International Red Lists:

- The IUCN Red List of Threatened Species: VU D2.
- European Red List of Butterflies (2010): VU.
- Red Data Book of European Butterflies (1999): Species of European Conservation Concern (SPEC 4a).

## Threats

In the literature the species is mentioned to be threatened by urban development in Sierra Nevada (waste accumulation, roads, footpaths, buildings and extension of the ski station), trampling in Sierra Nevada, overgrazing and collecting in La Sagra and Guillimona, and the fact that not all the populations were within protected areas. Non-specific threats such as climate change and a restricted distribution range have also been mentioned by some authors. Indeed the fragmented and small distribution area makes it more sensitive to adverse changes that may affect its survival.

The threats detected during the fieldwork of the current project are shown in Fig. 14 and Table 1. Numbers in the figure show the percentage in which each threat was found in relation to the total records in the visited locations. In the following sections these are discussed for each one of the main areas where the butterfly lives.

*Table 1. Threats detected during fieldwork on the different locations that were studied during the project in the years 2012-2014. Data were compiled from the different years of sampling.*

LOCATION	UTM COORDINATE	ALTITUDE (m)	THREATS
RÍO SAN JUAN	30SVG60	2,152	Food plant scarce, drought
VELETA	30SVG60	2,648	Grazing, a road crosses the area, trampling, ski resort
LOMA DE DÍLAR	30SVG60	2,725	None
PICO ATALAYA	30SVG70	2,713	None
LOMA DE LOS CUARTOS	30SVG70	2,679	None
LAVADEROS DE LA REINA	30SVG70	2,632	None
EL BUITRE	30SWG10	2,420	Overgrazing
EMPANADAS	30SWG19	2,041	Grazing
LA SAGRA	30SWH30	1,817-2,364	Food plant scarce, trampling
SIERRA DE GUILLIMONA	30SWH40	1,838	Overgrazing

In **SIERRA NEVADA**, the main threat to the populations in El Veleta (one of the ten studied locations, Table 1) is habitat destruction caused by urban development related to winter sports infrastructure. In 1995, during the enlargement of the ski resort, the course of Monachil River was diverted, artificial snow cannons were installed and terrain irregularities were levelled out in areas where the species previously lived. These actions destroyed the habitat of part of the population living on El Veleta western slope. The enlargement of the ski station goes together with other environmental impacts such as water pollution, waste accumulation or nitrogen deposition. Other threats detected in Sierra Nevada were trampling of the species habitat caused by tourists using alternative footpaths in an area that supports a high number of visitors; extensive grazing concentrated in some areas, and the negative effect caused by drought on the food plants in years with low rainfall values (2012 was one of these years and low population numbers are probably related to this fact). Extensive grazing and overgrazing, reported respectively in the populations of El Veleta and El Buitre (20% of all the studied sites), can pose a problem to some populations in the case that it changes to more intensive practices. Moreover, grazing is not necessary to keep the habitat of the species open nor is favourable for a good quality of the habitat. All these reasons were considered by experts when classifying grazing as a threatening factor.

The populations of **LA SAGRA** are mainly threatened by trampling, but this effect is limited to the considerable network of footpaths near the summit of the mountain, which damage around 1% of the total habitat of the butterfly in this sierra. Drought in years of low rainfall may also have a limited effect upon its larval food plant. Finally, extensive grazing takes place in the area where the species lives, but during fieldwork this activity was not observed. However, there is evidence that grazing occurs in the area, thus intensifying the grazing regimes might be a problem, especially because grazing is not necessary to keep the good habitat quality for the butterfly.



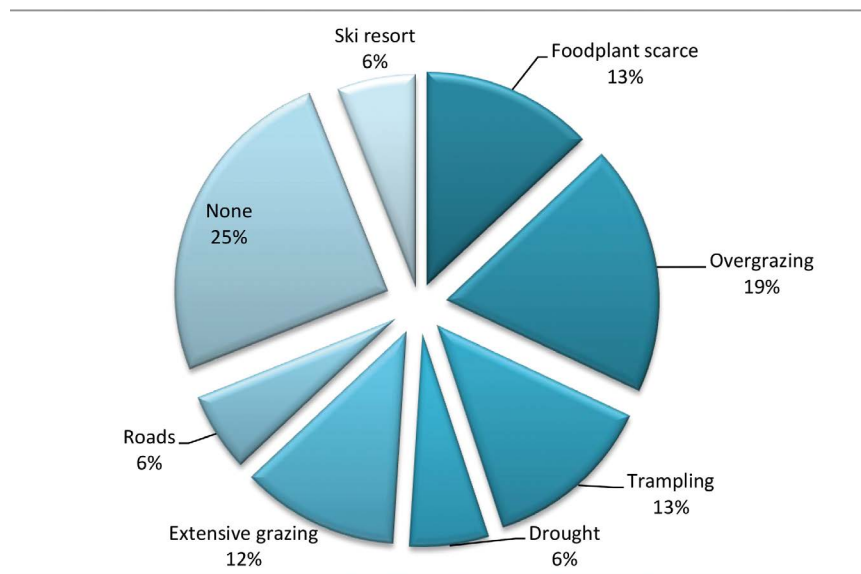


Figure 14. Threats detected during fieldwork on the habitat of *Polyommatus golgus*. Numbers represent the percentage in which each threat was detected in relation to the total number of records for the visited localities. Populations with no evident threatening factors are treated as "none".

In **SIERRA DE GULLIMONA** overgrazing is the chief threat detected during fieldwork. Adults of the species were recorded only in the extensively grazed areas and in the surrounding heavily grazed areas, the butterfly was not observed.

The population of Empanadas in the **SIERRA DE CAZORLA** is subject to extensive grazing by sheep and goats. The threat for this population would be that the grazing regime increases, but the Natural Park officers are already aware of the potential problem and will control the situation.

The impact of climate change on the habitats is the main problem the species is already facing. Some of the observed consequences of this change are drought, increased temperature and reduction of snow coverage. If these impacts of climate change continue, the range of the species would be displaced to higher areas where the habitat might not be suitable. For the populations living on the highest areas of the mountains these changes would mean their extinction. For all the other populations, the climate change impact would mean a substantial reduction of the area occupied by the population. This threat is not reflected in our data, because registering its impact on a local scale requires longer time series of field data.

## Species action plan

This chapter discusses the possible actions, which, if conducted, will significantly improve the survival chances of the species. In each chapter we discuss the actions that are necessary and describe them for the different areas in which the species is found (see “distribution”). The actions have been discussed with officials and directors of the parks (National and Natural Parks) where the species is present and with relevant personnel from the Junta de Andalucía, responsible for the conservation of the species at the regional level.

It is essential to monitor the populations of the species, as mentioned for some of the following specific actions, because the effectiveness of the proposed measures would only be evident if the butterfly population trends are positive. In general, the conservation actions are related to the habitat. The main goal is to avoid negative interventions or reduce their impact to a minimum. Some precautionary measures are also mentioned in the following sections.

Although mentioned in the literature for the populations of La Sagra and Guillimona (Barea-Azcón et al. 2008), collection of specimens has not proved to be considered of enough importance as a threat for the species. This illegal practice is controlled by the local police and can be subject to strong fines and prosecution. Poachers can always have some effect on very small populations, but population experts generally do not regard this as important for the conservation of butterfly species.

### Legal protection

The species is already legally protected under the Habitats Directive and listed in the Spanish and Andalusian Catalogue of endangered species.

All its populations are within protected areas that are also Natura 2000 sites: the National Park of Sierra Nevada, two Natural Parks (Sierra Castril and Sierra de Cazorla, Segura y las Villas) and the Natura 2000 site covering La Sagra and Sierra Guillimona (Sierras del Nordeste). Unfortunately, the field studies made during the last three years, showed some threats acting on some of the sites.

The population of Sierra de la Sagra needs some special attention. First, the area is included in the High Peaks Recovery and Conservation Plan in Andalusia (Plan de Recuperación y Conservación de Especies de Altas Cumbres de Andalucía), which actions would be a benefit for this area. Second, due to the remarkable natural values of this sierra, there is an initiative to improve its conservation status, by establishing a Natural Park. This is being promoted by José María Irurita, a conservation expert from the Regional Government in Andalusia (Junta de Andalucía). The establishment of a Natural Park could also be beneficial for the species because this area hosts a large population of *Polyommatus golgus* and one of the best populations of *P. violetae*. As a rule, the presence of *P. golgus* requires special attention when designing the borders of the new park and the elaboration of the management plans for both the new and the already existing protected area in Sierra de la Sagra.

Action: declare La Sagra as a Natural Park.

Priority: **High** (but will not be implemented immediately).

### Conservation measures

The following are management measures for the conservation of the species suggested in relation to the main threats for *Polyommatus golgus*. For each threat actions are suggested for the different areas in which they were detected and the priority of the action and funding bodies are specified. The main actions that are proposed for the species recovery are:

- Recover traditional footpaths and close shortcuts to prevent trampling.
- Prevent new developments and restore damaged habitats in the Veleta area of Sierra Nevada.
- Build exclusion fences in Sierra Nevada to study the effect of grazing upon the butterfly populations.
- Prevent the effects of climate change.

- Conduct research on the genetics, population trends and the possibility of captive breeding.
- Raise public awareness by producing information leaflets and panels in the main areas where the species lives.

## TRAMPLING BY PARK VISITORS

Trampling has effect on the habitat of *Polyommatus golgus* and has been mentioned as a threat in two areas: Sierra Nevada and La Sagra.

National Park authorities in Sierra Nevada are already trying to recover traditional footpaths and close shortcuts in the Mulhacén area, and we suggest that this action should be extended to the Veleta area. A road crosses the slopes of El Veleta, but park visitors cross the butterfly habitat using shorter alternatives (Fig. 15). BC Europe, together with Sierra Nevada National Park, will produce and place information panels in the area to inform and invite the visitors to take part in species conservation by simply using the road instead. Panels will be both close to the habitat and in the Visitor Centres of the National Park. Wardens of the Park will be informed and can give guidance on the correct behaviour in the park while taking visitors with the bus that drives to the highest areas of El Veleta.

In La Sagra population this problem is limited to the summit of the mountain, where there are several alternative footpaths. In this population an information panel will also invite visitors to use the main path to protect the good quality of the habitat of the species.

We consider the priority of these measures of **high** importance and the information panels will be financed by BC Europe within the present project.

## URBAN DEVELOPMENT

The construction of the ski resort on the habitat of *P. golgus* in Sierra Nevada has indeed reduced the suitable area for the species in the slopes of the Veleta peak (Fig. 16). The demand to extend the ski resort is still taking place, although park authorities are always against new developments which will only extend the damage. In agreement with the park experts we recommend avoiding new developments of touristic infrastructures (hotels and lodges, car parks, ski tracks) on the area of the actual ski resort or in the neighbouring valleys where the species is also present.



Figure 15. Touristic walking paths on El Veleta, crossing the habitat of *Polyommatus golgus* (photo ML Munguira).



This action is of very **high** priority for the conservation of the species, it does not need financial support as it is a precautionary measure of which National Park managers are perfectly aware, and they have an important role in the decisions that are taken regarding this topic.

Also, in Sierra Nevada it would be important to restore areas that have been destroyed by urban development, favouring the regeneration of the native vegetation and removing damaging infrastructures from the habitat of the species.

This action is considered of **medium** priority, but would not be easy to be implemented until financial support is achieved. Restoring a damaged habitat is expensive and long-term project, requiring significant investments needed for experts specialized in vegetation and landscape recovery, equipment and materials. This measure would be more applicable in areas, close to those where the species still lives and where the impact of the ski resort has been less damaging, promoting and facilitating natural expansion.



*Figure 16. The habitat of *Polyommatus golgus* in El Veleta damaged by ski tracks in Sierra Nevada National Park (photo ML Munguira).*

## OVERGRAZING AND OCCASIONAL GRAZING

Two exclusion fences have been planned, together with the Sierra Nevada National Park authorities, as an experimental action for the protection of the habitat of *Polyommatus golgus* and *Agriades zullichi*. These fences will be located one in the Veleta area and one close to El Picón de Geres. Monitoring of these two species is needed to determine if this action is beneficial and could be extended to other areas where grazing can pose a problem. The officials from Sierra Nevada National Park find this measure feasible and will start to plan it in the year 2015. They will also provide financial support and advice on the technical aspects.

The priority of this action is **high**, because it will provide valuable information for the management of the species in the future.

During the fieldwork, the effect of grazing in Sierra de Guillimona area was registered (Fig. 17). Although the effect of grazing upon the populations of *P. golgus* has not been directly proven, it would be important to keep the livestock pressure under control in the future. The High Peaks Recovery and Conservation Plan in Andalusia (Plan de Recuperación y Conservación de Especies de Altas Cumbres de Andalucía) can act as a legal framework for actions regulating this threat because, in its point 4.1.2., it deals with the negative effect of overgrazing and natural herbivores, and supports sustainable extensive grazing.

In the other two main areas where the species lives (Cazorla and La Sagra), overgrazing is probably not a very important threat. Since they are within protected areas, we will inform the local land managers on the potential dangers of overgrazing in the habitat of the species. According to the data from the Junta de Andalucía the overall level of livestock grazing over the parks is low. Therefore, the main action related with this threat is to prevent heavy grazing, particularly in the specific areas where this could be damaging to the habitat of the butterfly.

The priority of this action is **high**, but financial support for the High Peaks Recovery and Conservation Plan has not been allocated, so unfortunately a firm control of grazing regimes would not be implemented in the near future.

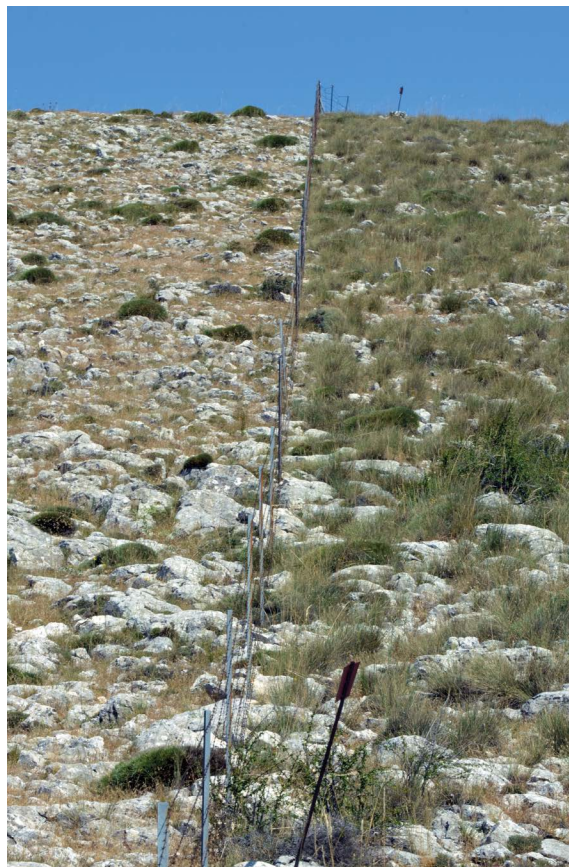


Figure 17. Effect of cattle grazing in Sierra Guillimona (Granada Province) close to the habitat of *Polyommatus golgus*. Grazing on the left side of the picture considerably reduces the vegetation cover (photo E García-Barros).



## CLIMATE CHANGE

In the literature (e.g. Munguira et al. 2009) climate change is considered to be one of the main threats for the species in the long term. The effect of this change would displace populations to higher elevations in mountain areas (Fig. 18). The main consequence of this threat would be a reduction of the area where the species lives as the whole population would be forced to move to high areas. For *P. golgus* this can be especially dramatic because some of its populations in Sierra Nevada are already on the summit of the mountains (Fig. 19), as well as the population in Sierra Guillimona and the Empanadas in Sierra de Cazorla (Fig. 8). Climate change would eventually cause the extinction of these populations.

It is difficult or rather impossible to compensate the negative effect of climate change with locally limited measures as the actions needed are of a global character. However, conservation NGOs and environment agencies should lobby for a more effective reduction of greenhouse gas emissions so that national governments and international agencies could in the near future reverse the practices that are causing this problem.

The priority of these measures is **high**, because if the predictions of climatic scenarios become true we would inevitably lose a high percentage of the populations of the species and substantially reduce the range of the larger populations.



Figure 18. The approximate limits of the *Polyommatus golgus* population on the summit of La Sagra (black line) and the reducing effect the climate change might have (photo ML Munguira).



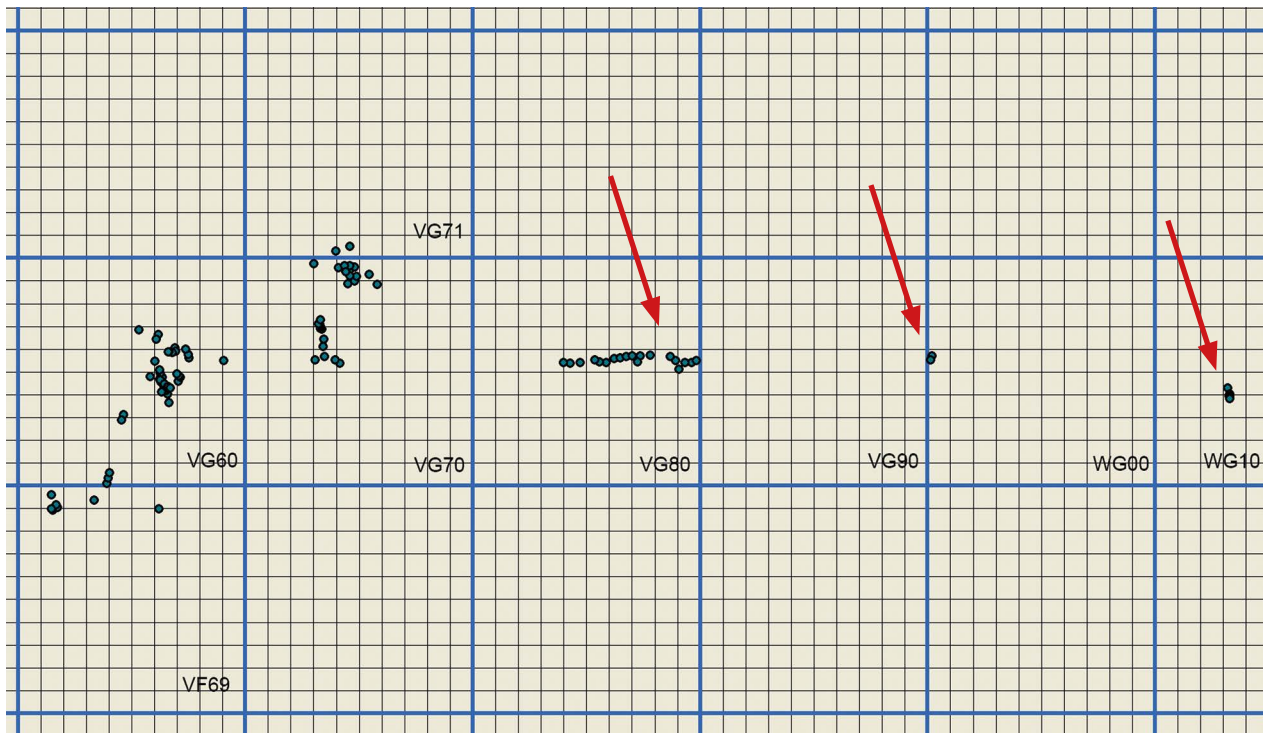


Figure 19. The populations of *Polyommatus golgus* that live on the summit of peaks in Sierra Nevada (arrows). Dots represent the presence of the species taken from GPS readings (JM Barea-Azcón, unpublished data).

## Research

### Adult censuses

As a minimum, adult censuses using the transect method should be carried out in each one of the five main areas where the species lives. Censuses are currently been made in Sierra Nevada population (see Fig. 13), and could be easily implemented in Sierra de Cazorla, where just two annual visits would be necessary. These counts could be carried out by the people participating in the monitoring scheme of Sierra Nevada (that has been active for six years already) and from officers from the Cazorla Natural Park that will be starting a monitoring scheme in 2015. Censuses are also suggested for La Sagra population, but these would probably not be easy to implement until it becomes a Natural Park.

Priority of this action is **high** because it will register changes in the populations, which might be a result of a success of conservation measures and/or of possible effects of threats.

### Plant records

Locations with the butterfly food plant should be compiled and studied for the presence of *P. golgus*. This would provide information about the micro distribution of the species and, in the case of absence of the butterfly, spot areas where action should be taken to favour the presence of the species.

### Captive breeding

This would be an interesting research topic that would secure, if successful, live specimens for population reinforcements. The abundance of larval food plants should also be taken into account when considering reinforcements. Local scientists and amateurs have the knowledge to carry out this research program, but additional funding would be necessary.

The priority of this action is **low**, because a captive breeding program is not urgent taking into account the actual situation of the species.

### Genetic studies

The genetics of the northern populations of Granada and Jaén should be investigated. They have only recently been assigned to the species and this should be tested through more studies in the future. The genetic differences of the five areas in which the populations of the species are split should also be studied to ascertain if they should be considered as different conservation units. This is also an action of **low** priority.

## Public awareness

People who visit the parks and protected areas are usually nature lovers. General information and ideas about the protection of the species for visitors could encourage the involvement of the public and eventually gain their support for the conservation actions.

- Information leaflets will be produced during 2015 with information about the importance of the species and its conservation. Actions taking place to help the recovery of the species would be specified. The leaflets will use non-technical language and show pictures of the species and its habitat. Leaflets would be available at the Information Centres of the parks of Sierra Nevada, Sierra de Castril and Sierra de Cazorla, Segura y las Villas. They will be produced both in English and Spanish. This action is of **high** priority and will be implemented as part of this project.
- Publish information on websites. A digital version of the leaflets will also be produced and distributed widely to amateur and scientific organizations (butterfly conservation organizations, entomological societies and park webpages). The priority is **intermediate** and the time of application will continue in the following years, also in order to share the news on the developments and the lessons learned.
- Produce and place information panels in Sierra Nevada, La Sagra, and Sierra de Cazorla, with information about the importance of the species and its conservation. Panels will contain general information on the importance of the butterfly fauna in each area, the main threats the species face and what the park visitors can do about. This action is considered of **high** priority and will be implemented during 2015.
- Guided butterfly tours should be supported in Sierra de Cazorla and Sierra Nevada parks. Such activities would encourage the interest of visitors in these insects, and give information about endemic and endangered species and the need for their conservation. The specialized information presented during these tours will provide added value to the visits to these parks.
- Power Point presentations could be available for training courses that usually take place in protected areas for the personnel working in them. They would include information on the species already gathered during this project and will be available to the park officers. Priority of this action is **low**.
- Media releases (newspapers) with contents related to the recovery of *Polyommatus golgus*, have already taken place during the project and would indeed be produced at its end and in the future. Priority is **intermediate** and this action will take place throughout the long term.

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Sierra Nevada constitutes an excellent natural laboratory for studies on the climate change effects on biodiversity, but also on the impact of the management activities in a climate change scenario.

Sierra Nevada National and Natural Park works in a monitoring program aimed to track the global change effects on the ecological and socio-economical systems of this emblematic mountain range. This monitoring program is part of the Sierra Nevada Global Change Observatory. One of the main biological indicators in this program are the butterfly communities, giving special attention to endemic and endangered species as Zulleich's Blue. The more important threatening factor for this species is the climate change. Tracking its effects is of major concern in order to improve the habitat management.

Recently, the Andalusia Government approved the High Summits Species Recovery and Conservation Plan (Acuerdo de 13 de marzo de 2012, del Consejo de Gobierno). This Plan has a legal consideration and targets the species included in the Andalusian Endangered Species Act. Sierra Nevada Blue is one of these species together with other insects like the butterflies Zulleich's Blue and the Andalusian Anomalous Blue, the bush cricket *Baetica ustulata* and the ant *Rossomyrmex minuchae*, as well as many mountain specific plant species. This Plan aims to establish an appropriate framework for the development of an effective conservation strategy, taking into account key concepts as Global Change, adaptive management, traditional mountain land uses and public awareness.

Lay-out: René Manger, Gloria Angelova

Back cover photo: Enrique García-Bárros

Front cover photo: José Miguel Barea-Azcón