Abandonment of hay meadows and its implications for butterfly conservation in Picos de Europa National Park (Northwest Spain)

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Picos de Europa National Park, a diversity hotspot for butterflies

Parnassius apollo (protected by Habitats Directive)

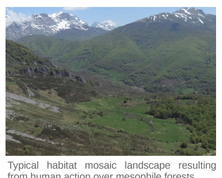
Agriades pyrenaicus (Iberian endemic)

Euphydryas aurinia (protected by Habitats Directive)

Phengaris nausithous (protected by Habitats Directive)

Calcareous high mountain landscape

Aricia morronensis (Iberian endemic)



Typical habitat mosaic landscape resulting from human action over mesophile forests

Erebia palarica (Iberian endemic)

High mountain pastures

Picos de Europa National Park, northwest Spain, is a biodiversity hotspot for butterflies, harbouring 137 butterfly species (28,4 and 60,6% of the European and Iberian Peninsula butterfly fauna, respectively). The park is also home to 5 endangered butterfly species and 3 Iberian endemics.

Its wide altitudinal range (80-2640 m); contrasting climates (Atlantic in the north and warm temperate in the south slopes); role as glacial refugium [1]; inaccessibility and a long history of sustainable human use, account for this huge diversity.

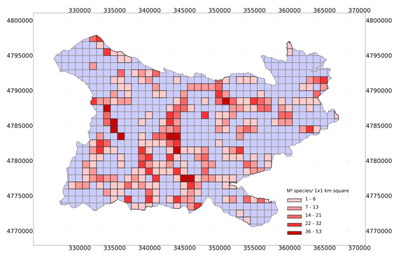


Fig. 1. Map of Picos de Europa NP showing the number of butterfly species across the park in a 1km x 1km grid resolution. ETRS89 UTM zone 30, axis 5 km grids. Violet represents areas without data (database in progress).

Butterfly diversity at landscape scale

Fig. 1 shows the spatial distribution of butterfly species richness across the whole NP, with hotspot areas in the central and southern regions. This pattern can be explained by two main factors: elevation and warmed local climates.

The number of species rises evenly with elevation, reaches its maximum between 900-1000 m, and then decreases to the lowest value above 2000 m (Fig. 2). A similar pattern has been reported for plant richness in the park [2].

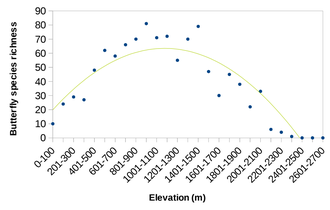


Fig. 2. Number of butterfly species by 100 m elevation bands (R^2=0,85; F=64,37, df=2,21; p<0,001).

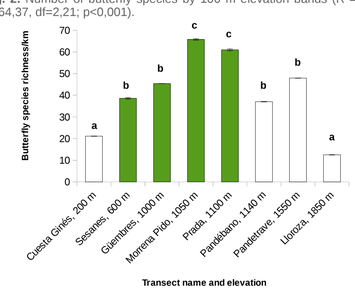


Fig. 3. Number of butterfly species (mean ± SE) per km in each transect. Habitat mosaics with hay meadows are showed in green (F=49,09; df=7,22; p<0,001; letters indicate significant differences at p<0,005).

Butterfly diversity at local scale

Butterfly transects carried out at several localities since 2013 (Table 1), as part of the Spanish Butterfly Monitoring Scheme [4], revealed that mosaics containing hay meadows and located at mid-elevations (around 1.000 m), are the most important areas for butterfly species richness (Fig.3) and abundance (Fig.4).

Up to 91 different species have been counted in a single lineal transect in the course of butterfly monitoring schemes (Table 1). This figure means that we can find 33% of Iberian butterfly species in as little as 1-km transect.

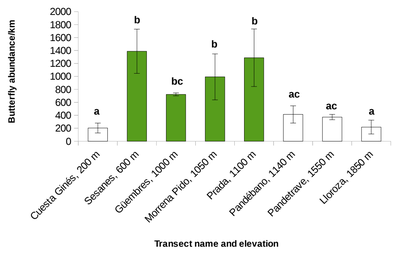


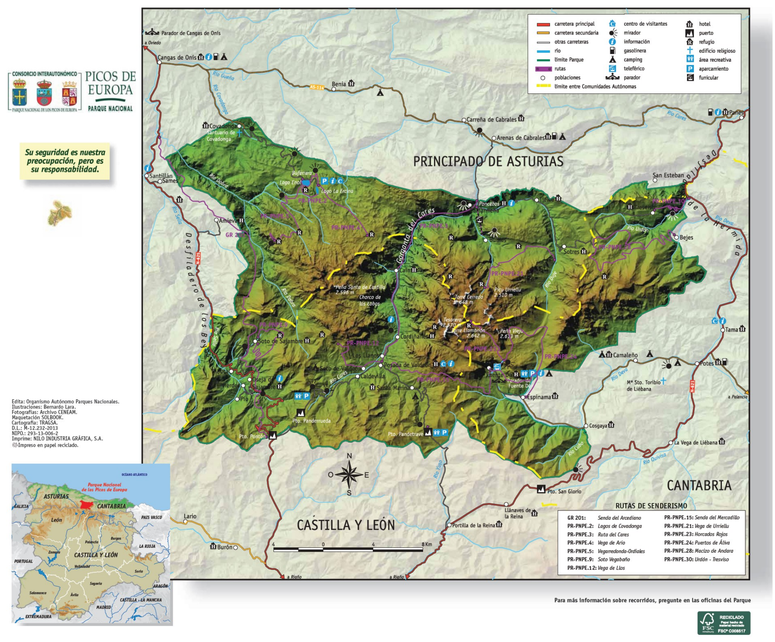
Fig. 4. Butterfly abundance (mean ± SE) per km in each transect. Habitat mosaics with hay meadows are showed in green (F=19,59; df=7,22; p<0,001; letters indicate significant differences at p<0,005).

Table 1. Details of the butterfly transects set up as part of the Spanish Butterfly Monitoring Scheme in Picos de Europa National Park (in orange, transects with habitat mosaics with hay meadows).

Monitoring Transect	Vegetation (EUNIS)	Altitude (m)	Years	Transect lenght (m)	Species richness/km	Key species
Urdón	Mosaic: Basic and ultrabasic inland cliffs. Pyreneo-Cantabrian cushion heaths. Calciphile western Mediterranean oak matorral. Pyreneo-Cantabrian [Quercus]-[Fraxinus] forests. Grasslands and lands dominated by forbs, mosses and lichens.	150	2015-2016	920	47,82	*Laesopis roboris, Limenitis camilla, Satyrium w-album.*
Cuesta Ginés	Cantabro-Pyrenean [Erica mackaiana-Erica cinerea] heaths	200	2013-2016	1421	21,11	*Minois dryas, Arethusana arethusa, Coenonympha dorus*
Sesanes	Mosaic: Atlantic hay meadows. Pyreneo-Cantabrian [Quercus]-[Fraxinus] forests. Meso and eutrophic Quercus, Carpinus, Fraxinus, Acer, Tilia, Ulmus and related woodland. Spanish [Quercus faginea] forests.	600	2013-2016	1697	38,59	*Favonius quercus, Thecla betulae, Pieris mannii*
Güembres	Mosaic: Atlantic hay meadows. Cantabrian (Quercus pyrenaica) forests. Cantabro-Pyrenean [Erica vagans]-[Erica cinerea] heaths	1000	2014-2016	1409	45,42	*Carterocephalus palaemon, Boloria selene*
Morrena Pido	Mosaic: Pyreneo-Cantabrian [Quercus]-[Fraxinus] forests. Pyreneo-Cantabrian cushion-heaths. Atlantic hay meadows.	1050	2013-2016	996	65,76	*Boloria pales, Galucopsyche alexis, Hipparchia statilinus, Kanetisa circe*
Prada	Mosaic: Atlantic hay meadows. Bramble thickets. Atlantic and subatlantic hazel thickets. Pyreneo-Cantabrian cushion-heaths.	1100	2013-2016	1123	60,99	*Argynnis pandora, Carcharodus flocciferus, Kanetisa circe, Melanargia russiae, Pyrgus carthami.*
Pandébano	Atlantic hay meadows	1140	2013-2016	992	37,05	*Euphydryas aurinia, Lycaena hippothoe, Scolitantides baton.*
Pandetrave	Mosaic: Northwestern Iberian [Genista florida] fields. Permanent mesotrophic pastures and aftermath-grazed meadows. Iberian montane [Nardus stricta] swards.	1550	2013-2016	992	47,95	*Erebia palarica, Argynnis adippe, Parnassius apollo, Pyrgus carthami.*
Lloroza	Mosaic: Iberian montana [Nardus stricta] swards. Pyreneo-Cantabrian cushion heaths. Limestone pavements.	1850	2014-2016	1399	12,51	*Agriades pyrenaicus, Aricia morronensis, Erebia cassioides, Erebia lefebvrei, Parnassius apollo.*

References:

[1] Buira et al, 2017. *Biodiversity Conservation*, 26: 479; [2] Alonso Felpete et al, 2011. *Catálogo Florístico del PN Picos de Europa.* Ayto. Gijón; [4] observa.ebd.csic.es/web/seguimientomariposas; [5] Van Swaay & Warren, 2006. *Journal of Insect Conservation*, 10: 5; [6] Romo et al, 2007. *Animal Biodiversity and Conservation*, 30: 1; [7] Van Swaay et al, 2010. *European Red List of Butterflies*. Publications Office of the EU; [8] Meyer, 1996. and *Environment*, 79. P. 145; [9] Van Swaay & Warren, 1999. Red Data Book of European Butterflies (*Rhopalocera*). *Nature and Environment*, 99.

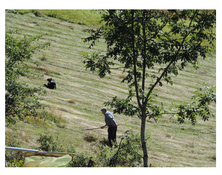


Interreg Sudoe SOS Praderas project

We are opened to collaboration with other institutions in future projects about hay meadows conservation; agroecosystems and nature conservation; and sustainable development inside natural protected areas.

The challenge

Hay meadows, agroecosystems maintained by human action, are dissappearing all across Europe. They are priority European habitats (6510 and 6520) and the European Biodiversity Strategy recognises its deficient conservation status and the need for actions to restore them.



Santiago González, 80 years old farmer, mowing in Güembres (Sajambre, León, 12/08/2016)

Picos de Europa hay meadows status

- Mesic, nutrient-rich hay meadows (phytosociological alliance *Arhenaterion elatioris*)
- Hold 169 plants (10% of the whole flora in the park), despite occupying only 3% of the total area [7].
- 30% loss between 2000 and 2010 [8] and rate of loss doubled in the period 2010-2017 [9].
- Loss linked to rural abandonment: lack of management results in scrub and forest colonisation.
- Likely affecting the populations of many species of plants, butterflies and other insects.

SOS Praderas study sites (northern Portugal, northern Spain and southern France)

SOS Praderas main objective

The main aim of the project is to develop a cost effective management of hay meadows through:

1. Valuing them as places of natural and cultural heritage.
2. Getting CAP grants to traditional management practices
3. Developing a new market product: hay meadows native seed mixtures.

Interreg SUDOE SOS Praderas project factsheet

Actions under SOS Praderas

SOS Praderas is structured in several task groups, according to five main objectives:

- Assessing the **conservation status of hay meadows in southwestern Europe (GT1)**.
- Creating a **cooperation network among Natura 2000 area managers to enhance hay meadow conservation (GT3).**
- **Stimulating CAP grants to maintain hay meadows (GT4)**.
- **Conserving hay meadow seeds in germoplasm banks** besides **characterising seeds and fruits (GT2 and GT5)**.
- Producing **a new market product, hay meadows native seed mixtures (GT6 and GT7)**, that would suppose an extra income for local farmers.

More information at: www.sospraderas.eu

Mora, A. & Bueno, A., 2018. Going backwards to look to the future: Traditional meadow management modernization for cost effectiveness and nature conservation. Project Interreg Sudoe SOS Praderas tries new approaches towards hay meadow conservation. *Bulletin of the Eurasian Dry Grassland Group*, 36. Pp.: 42-44. DOI: 10.21570/EDGG.Bull.36.42-44

The territory

Peña Santa de Castilla, 2,596 m

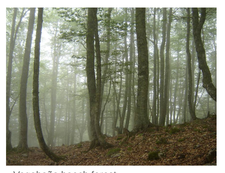
Iphiclides podalirius on a hay meadow.

Campanula and Hieracium growing in calcarean fissures.

Boloria selene on a hay meadow.

Brown bear (*Ursus arctos*) footprint.

Saxifraga oppositifolia, high mountain boreo-alpine vegetation



Vegabaño beech forest.

Chamois (*Rupricapra pyrenaica*)

Calcarean caves with stalactites.

- Within the Cantabrian Mountain Range (northwest Spain). Surface: 67.455 ha.
- First national park declared in Spain, in 1918.
- Biggest limestone formation of Atlantic Europe.
- General climate is temperate Atlantic with localised areas of submediterranean climate.
- One of Iberian endemism hotspots (21% of Iberian vascular flora; 25% of Iberian lichens; 60,6% of Iberian butterflies; 33% of Iberian vertebrates); refugium area during the last glaciation.
- Emblematic species as brown bear (*Ursus arctos*), atlantic salmon (*Salmo salar*) or wolves (*Canis lupus signatus*).
- Rich cultural heritage: inhabited since prehistoric times (20,000 BC) and managed by sepherding cultures since 6,500 BC.

How is the SOS Praderas project benefiting butterflies?

Lopinga achine, Woodland Brown.

Brachypodium grass, typical of *Lopinga achine* habitat.

Forest clearing, mowed till recent years. Typical habitat for *Lopinga achine*, with a defined border between the grassland and the forest.

Lopinga achine (Woodland Brown) depends on hay meadows for its persistence

Lopinga achine, is included in Habitats Directive as a priority species and it is considered Vulnerable in the European Red List of Butterflies [7]. Picos de Europa hold 7 out of the only 9 known Iberian populations. Four new populations have been discovered by the National Park Rangers since 2010 and it is likely that more populations are to be discovered. The species is hard to monitor due to its short flying period (1 month) and its low local density.

Across Europe, the traditional management of maintaining clearings in forested areas (i.e. hay meadows, tracks, etc.) provided a good habitat for the species. Currently, the species is under threat due to rural abandonment and forest encroachment, which are the main determinants of local extinctions [8,9].

At Picos de Europa National Park, all the populations are found in areas with hay meadows embedded in a matrix of deciduous Pyreneo-Cantabrian forest of *Quercus* and *Fraxinus* (Table 2).

Table 2. Details of the 7 *Lopinga achine* populations in Picos de Europa National Park.

Population	Angón	Baenu	Llorgosu	Monte Corona	El Cuadro	Trea	Collado Hoja
Área (m²)	450	80,331	100	212,947	100	23,162	32,498
Orientation	E	N	NW	NE-E	NE	NE	NE
Altitude (m)	700	711-974	855	550	750	950-1050	820
Vegetation	Pyreneo-Cantabrian [*Quercus*]-[*Fraxinus*] forest with Atlantic hay meadows.						
Max. N.° individuals observed	12	30	1	20	1	12	15

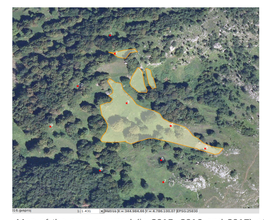
Interreg Sudoe SOS Praderas project recovers abandoned hay meadows within _Lopinga achine_ habitat

Since 2015, Picos de Europa NP has been mowing abandoned hay meadows in two areas where *Lopinga achine* is present, as part of SOS Praderas project. Twenty-two meadows have been mowned, with a total surface of 6,5 ha.

A connectivity analysis of the restored meadows is planned for this summer (2018) in order to create corridors to facilitate butterfly movements among meadows. Butterfly monitoring will be carried out in restored meadows and in nearby abandoned ones to assess the success of conservation actions in terms of butterfly richness and abundace.

Lopinga achine is used as the umbrella species: studying and protecting this species will indirectly protect many other butterflies and other insects that rely on traditional hay meadows management.

Félix Rojo (NP ranger) supervising mowing works at Prada meadows.



Map of the area mowned (in 2015, 2016 and 2017) at the *Lopinga achine*'s El Cuadro population.

Map of the area mowned (in 2015, 2016 and 2017) at the *Lopinga achine*'s Monte Corona population.