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Nº7

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Miguel Ramos Barros

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Peña Castil ice cave
Jesús Sánchez-Bermejo Ramos

Editorial

Since its beginning in 2008, the Global Change Monitoring Programme of the National Parks Network has maintained its long term vision, not only by increasing the number of meteorological stations and national parks involved in climate observation. Monitoring the changes produced as a result of climate change, land use changes, effects of pollutants, introduction of exotic species, etc. is nowadays, on the agendas of all the institutions supporting the programme as well as the sites managers.

This issue of the Global Change Monitoring Programme newsletter is focused on *Picos de Europa* National Park. As a Mountain National Park, it is conditioned by its altitudinal gradient, and its important diversity of habitats and species is a result of the geographic isolation, and other conditioning factors of high altitude areas.

Over time, the harsh conditions of the Cantabrian Mountain have shaped the relationship between the land and its people, who are closely linked and adapted to its environmental circumstances. The uniqueness of its natural heritage and landscapes has led to its protection, with Covadonga Mountain being declared National Park more than a century ago, in 1918. This was the first national park in our country, and one of the first in Europe. Since 1995, the National Park extended its protection over three massifs from the formidable Cantabrian Mountains in *Picos de Europa*.

The Cantabrian mountain range has a sentinel role for the effects of global change, making it possible to detect and quantify evident and foreseeable changes with greater precision; we already know that temperature increase and the decrease in precipitation frequency and abundance can alter phenology, interactions between species, and the structure and functioning of terrestrial ecosystems; that anthropogenic impacts, such as the abandonment of traditional land uses cause changes in the natural environment; that global disturbances are affecting the water systems, accelerating the retreat of glaciers and snowfields and the gradual disappearance of reservoirs of relict ice, and there is an increasing appearance of plagues and emerging diseases, etc.

In this newsletter we present a selection of research projects and monitoring activities undertaken in *Picos de Europa* National Park to date, that show a spectrum of ideas and knowledge about how climate changes and other global and local impacts are being manifested in the mountain range. This information will allow for the implementation of adaptive management measures.

Editorial Board

The role of protected areas in the current scenario of global change

Amparo Mora Cabello de Alba

Biologist, Conservation Department Technician of *Picos de Europa* National Park

Picos de Europa, declared as a National Park, is widely known for its impressive mountain landscapes, with rugged summits that descend to the Cantabrian Sea over a distance of 20km. However, there is an entire community of species that we seldom see, that require a more thorough observation. At first glance, we are also unable to appreciate the enormous footprint left on the parks landscape by its inhabitants. There is evidence of land use since 20.000 BC, such as the prehistoric figures found in Buxu Cave, in Cardes. The beginning of pastoral activity can be traced back to around 4.900-4.500 B.C.., as was revealed in studies by Moreno *et al* (2011) and Niewendam *et al*., (2015) who found evidence of use of fire to create grazing pastures in the area surrounding lake Enol and La Majada around these dates.

The long-term presence of human beings in this territory, since prehistoric times, has not prevented it being one of the most species-rich areas within the Iberian Peninsula and in Europe. *Picos de Europa* is located within the Mediterranean Basin, one of the world's 35-biodiversity hotspots (Mittermeier et al, 2011).

Within the Mediterranean Basin, we are in the Iberian Peninsula, which hosts more than 50% of Europe's plant and vertebrate species (IUCN, 2013) and a high level of endemisms, about 31% for plants and vertebrates (Williams et al, 2000). Some studies have shown that mountain areas are amongst the most diverse in species and rich in endemisms in the Iberian Peninsula (Buira et al, 2017; Rosso et al, 2017).

Within *Picos de Europa* National Park, in an area of 67.455 ha (0.1% of the Ibero-Balearic surface), the number of recorded species correspond to 21% of the Ibero-Balearic vascular flora, 25% of the peninsular lichen flora, 60.6% of the daytime butterflies species of the Peninsula, and 55% of the peninsular mammals. We are undoubtedly in an area of exceptional importance in terms of natural wealth, at a national and european level.

What challenges do we face in this uniquely rich territory? The main global change factors that are at operating in *Picos de Europa* are climate change and rural abandonment.

In terms of warming of the climatic system, its effects are becoming more evident year upon year on the Park´s ecosystems. In the North of the Peninsula, an increase in temperatures and a decrease in precipitationare expected. It is also likely that heat waves will become more frequent, last longer, and that extreme precipitation events will become more intense and frequent. These changes are already being observed, even though we don't have a long term data set.

Majada de Gumartini, in Cangas de Onís, on the path to the Lakes, where Covadonga and Antonio Fernández still make Gamoneu del Puerto cheese during the summer.

There is a clear decrease in the number of days in which snow cover protects the systems from the ice effect during winter; the advance in the start of the breeding season of many species; the increase in the number of days of physiological activity of many species; the decrease in the quantity of water in aquatic environments and the increase of the infectious activity of certain fungi (Clare et al, 2016), among other impacts.

As to rural abandonment, its effects on ecosystems are also clear. Without the direct action of people or their livestock, the agroecosystems that have been maintained over centuries, and with which many wild species have co-evolved will naturally regress towards a state of woodland. The encroachment of scrub affects the entire territory and is very evident in hay meadows and grazing meadows, which quickly lose their open character without the necessary cutting or grazing pressure.

Since 1950, 50% of the human population in *Picos de Europa* has been lost in successive waves, especially in the post-war period and in the 60s.The process continues. At the same time, the dissociation between the land and the economy is broadening-.

Only 30% of the working population is dedicated to livestock. Communal natural resources, such as mountain pastures are, for the most part, no longer in production, but being abandoned. Instead, the majority of the working population (56.82 %) works in the service sector. These figures are even more extreme in the county towns; For example, In Cangas de Onís, where 43% of the inhabitants of the *Picos* are concentrated, the service sector accounts for 78.54% of the working population, and livestock farming only 10.67%. With the abandonment of the land, economic resources are lost, an enormous cultural legacy is lost (irreplaceable knowledge about the land use) and in addition, biodiversity is lost.

Susana Marquínez, environmental agent, monitoring amphibians in the Charca de la Rasa from Pandecarmen. Macizo Occidental summits in the background.

The example of mountaine hay meadows, a habitat of community interest, which has been studied in great detail during recent years as part of the Interreg Sudoe SOS Praderas project (2016-2019), reflects this issue very well. Hay meadows, a part of the traditional way of keeping livestock, are meadows in which the grass is left ungrazed throughout the summer months (whilst the animals feed in the higher pastures), and is later cut at the end of summer, dried and stored as food for the livestock.

These herbaceous meadows, which are cut once or twice per year and organically fertilised, are host to extraordinary amounts of biodiversity. In transects of less than 1km length, 126 plant species (9.6% of the Park´s flora) and almost 91 butterfly species (33% of the ibero-balearic species) have been recordedup to 70% of this habitat has been lost between 1956 and 2017 (García et al, 2017). Rural abandonment, shifts in the economic activity and changes in livestock farming practices are behind these changes.

What is the role of the National Park in this environmental and socio-economic situation? Undoubtedly, the globalisation of environmental problems and the current economic crisis scenario, have added a new dimension to conservation policies. Previous approaches to the conservation of wild and pristine natural ecosystems, free from human inhabitants and human intervention are no longer logical; now that scientific evidence shows that there has in fact been a long coexistence of humans and many wild species in Europe, resulting in adaptations to the human-managed landscapes, making the conservation of pristine areas almost impossible. Climate change is now affecting all corners of the planet.

The current trend is a move towards an integrated management approach, where the inhabitants are part of the ecosystems, emphasising the importance of cultural aspects and of sustainable development institutions, as well as the relationship between human society and nature.

This was the case made by the IPBES (The Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services) on May 6th 2019. The Spanish state forms part of the IPBES and it is also sponsored by the UNEP (United Nations Environmental Programme). The IPBES published a preview of their Global Assessment on Biodiversity and Ecosystem Services, which highlights the five main factors of change that impact nature. Factors were ranked in order of importance as follows: Sea and land use change; direct exploitation of organisms; Climate change; Pollution and exotic invasive species. They state that it has been demonstrated that the loss of biodiversity is not just an environmental issue, but is also a development, economy and security issue, as well as a moral and social.

Within the protected areas, we need to adapt our systems and face a new role as areas for monitoring, adaptation and raising awareness about climate change; whilst at the same time, they are economic incentives for the sustainable development of our land. As long as the social, economic and environmental challenges – inextrincably linked- facing our territories are tackled, our work will continue to be meaningful.

Common midwife toad (Alytes obstetricans) laying eggs in water. This species is suffering significant decreases, which places it on the brink of extinction in some parts of our territory due to the occurrence of two diseases, the chytridiomycosis and a ranavirus. The expansion of these diseases is linked to global factors, which are impossible to tackle at a protected site scale.

Monitoring network infrastructure

Three national parks join the Global Change Monitoring Programme

National Parks, as biodiversity reservoirs, highly representative of the natural system to which they belong to and with a low human impact, among other things, are ideal sites to identify and characterise changes as well as for determining future climatic trends.

The Spanish Office for Climate Change (OECC), the State Meteorological Agency (AEMET), the Biodiversity Foundation (FB) and the National Parks Autonomous Agency (OAPN), have been developing the Global Change Monitoring Programme in National Parks (RSCG) since 2008, with the objective of creating an observation network that enables the evaluation and monitoring of the impacts that may take place in the National Park Network as a consequence of global change.

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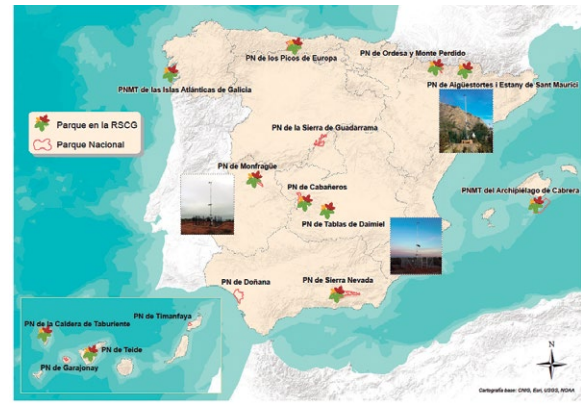
At the end of 2018, the national park weather station network was expanded with funds from PIMA-Adapta (Environmental development Plan for Global Change Adaptation) from OECC. Three new stations were installed, adding three national parks to the project:

Within the Tablas de Daimiel National Park, a weather station called "La Duquesa" has been set up at 607m of altitude; in Monfragüe National Park, "La Serrana" station in the town of Serradilla at 482 m, and in Aigüestortes i Estany de Sant Maurici National Park, the station "Estany de Llebreta" at 1.620 m in Vall de Boí .

As with the other Network´s weather stations, they are automatic stations that register data from essential climate variables following the criteria of the Global Climate Observing System (GCOS).

With the incorporation of these three stations, the number of weather stations in the network increased to 32, located in 11 national parks. They will help us understand the scope of climatic risks, as well as designing appropriate adaptation measures in line with the global change phenomenon in our national parks.



Research

Global change monitoring in aquatic ecosystems of *Picos de Europa* National Park

M. Álvarez-Cabria, F.J. Peñas, M. Sáinz-Bariáin, E. Estévez, A.M. González-Ferreras, I. Pérez-Silos, A. Goldenberg, M. Hoang, C. Rocha-Pompeu, A. Silió-Calzada, J.M. Álvarez-Martínez & J. Barquín.

Environmental Hydraulics Institute of the University of Cantabria (IHCantabria).

Since 2012, the Environmental Hydraulics Institute of the University of Cantabria (IHCantabria) has set up and run an aquatic ecosystems monitoring network in *Picos de Europa* National Park (PNPE), thanks to the support of the Biodiversity Foundation, the PNPE Interautonomic Consortium, National Parks Autonomous Agency (OAPN), and the National I+D+i , in various funding calls.

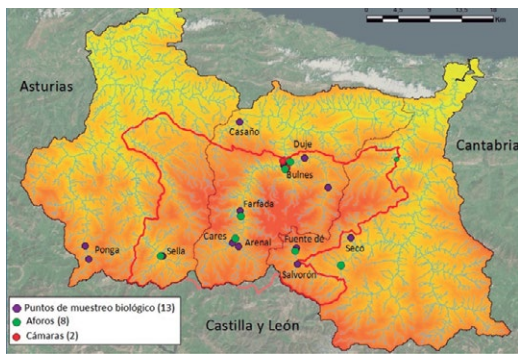
Monitoring network infrastructure

The PNPE river network has been characterised by 8 gauges, 2 terrestrial cameras and 13 sampling points (Fig. 1). The gauges take a measure of water depth and temperature every 30 minutes, while the terrestrial cameras capture images (5 per day) to characterise the phenology of different ecological processes.

For the characterisation of the biological component, the aquatic ecosystem monitoring network of PNPE has taken water samples, invertebrate and fish communities' samples and measures of the fluvial metabolism (primary production and ecosystem respiration) in the summer period, from 13 stretches of the river network, during the years 2012-2018. Furthermore, in 2018 the environmental DNA technique (Edna) was used to sample and improve the characterisation of aquatic biodiversity. This technique was applied to the 13 points that were samples, as well as diverse lakes and springs of the PNPE. The 13 points of the sampling network (Fig.1) are located within the 3 most affected stretches by organic spills: river Duje stretch (downstream of Tielve river), river Cares stretch in Valdeón and the lower stretch of the Bulnes river. Also at the source of Duje and Arenal rivers, both of them being affected by erosion and runoff.

Moreover, five additional control stretches, with similar environmental characteristics have been sampled, but without any relevant effects (rivers Casaño, Salvorón, Seco, Sella and Ponga). A spring affected by organic spills was also included (Fuente Dé) and two control points (Farfada and the source of the river Ponga). All data generated by this monitoring network are freely available and in quasi-real-time at: http://picoseuropa.ihcantabria.com.

Figure 1. Location of the biological stations (13), the gauges (8) and the cameras (2) that are part of the aquatic ecosystems monitoring network of PNPE. The red line marks the Park´s boundary.



Most relevant results

Currently there is a continuous data set of 7 years (2012-2018), however the objective is to be able to construct a greater data set to be able to identify global change effects in the medium-long term (>10 years). To date, results have enabled us to determine the efficiency of the spatial design used and of the structural and functional indicators for monitoring mountain river ecosystems (Estevez et al., 2017). They have also allowed for the analysis of the dynamics of biological populations in relation to the described issues, and to obserrve how riparian forest conservation is key to buffer the effects of human activities.

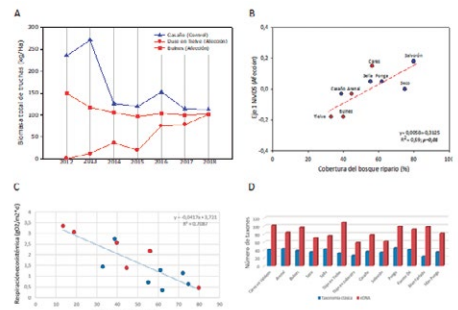
A notable finding among the observed results is the recovery of the populations of brown trout (*Salmo trutta*), following the cessation of purine dumping that took place in the town of Tielve in 2013. The temporal data series of trout density and biomass reveals the dynamics of the population recovery within this stretch of river after dumping was stopped, until it reached the values described in Bulnes river stretch, which is of similar typology and also affected by organic effluents, but to a lesser extent (Fig. 2A). In 2018, the trout's biomass in both stretches almost reached the values obtained in the Casaño river (with no relevant problems and with the same typology).

Another result to mention is the importance of the riparian forest for the suitable conservation of montane rivers. It has been observed that the stretches that maintain a well-structured riparian forest, with a higher amount of cover over the river, the macroinvertebrate communities are significantly better conserved (Fig. 2B).

Similarly, it has been observed that the stretches (affected and control) with higher riparian forest density show ecosystem respiration and primary production values lower than the stretches with less riparian cover (Fig. 2C), this is likely due to the direct effect of temperature and solar incidence, which favours the development of primary producer communities.

Finally, the eDNA technique, used for the first time by the PNPE in 2018, has allowed the identification of 85 invertebrate taxa (on average) per sampling point, compared to the 36 identified by traditional techniques (Fig. 2D). Molecular techniques allow the identification of species from groups that are not traditionally determined in monitoring programmes of continental waters, such as mites, oligochaetes, nematodes and chironomids. Similarly, they allow a higher level of detail to be obtained in some insect genera with a great species-diversity (e.g. Simulium or Leuctra) and understanding diversity patterns within these ecosystems, as well as the factors that determine them.

Figure 2. A) Trout biomass evolution in river stretches of Casaño (control), Duje and Bulnes (affected) during the period of 2012-2018. B) Correlation between riparian forest density and an impact axis (red points are affected and blue points, control); C) Correlation with Ecosystem respiration. D) Number of taxons identified in the summer of 2018 in the 10 rivers and 3 springs using traditional techniques (blue bars) and with eDNA (red bars).



Research

Monitoring of amphibian populations in *Picos de Europa* National Park

Jaime Bosch Pérez

National Museum of Natural Sciences (MNCN-CSIC)

Amphibians are the most threatened group of vertebrates, with multiple factors that threaten their survival, even in protected areas. In the last two decades, the concern about the alarming deterioration of the natural environment has been overtaken by two more serious threats to these organisms: the proliferation of emerging diseases, and climate change. The first of these new threats is directly related to human activity (for example, mass tourism), while the effects of climate change are more pronounced in areas of High Mountain. Therefore, these two aspects of global change could have a combined effect on amphibians of *Picos de Europa* National Park.

The two most common emerging amphibian diseases in the world (the chytridiomycosis, produced by an Asian fungus, and the ranavirosis, that usually spreads to the natural environment by the uncontrolled introduction of fish), are already occurring in a number of amphibian populations in *Picos*, causing declines of greater than 90% in the common midwife toad and Alpine newt. With respect to climate change, although we are still assessing the extent of its influence on the amphibian population trends in *Picos*, we predict that it will be important, taking into consideration similar analysis carried out in *Sierra de Guadarrama* National Park.

For these reasons, following the first amphibian mortalities in 2015 caused by emerging diseases, we initiated an amphibian-monitoring programme with the exceptional support of the technical staff and the parks 'wardens.

Park staff carrying out amphibian surveys. Photo credit: Amparo Mora y Jaime Boch

This programme has produced a 12-year time series, which allows us to see the trends of almost 30 populations of 8 of the most abundant amphibian species. The effort and enthusiasm of the staff from the park involved in the monitoring programme have been exemplary, and the knowledge we currently have around the amphibians of *Picos* is considerably greater than when we began the programme.

Unfortunately, the outcomes of the monitoring programme are not very promising. Our results suggest that, while only one of the populations has increased in abundance during the study, 40% show an overall negative trend (Fig. 1). As expected, the preliminary assessments also show a consistent negative relationship between the amphibian populations in *Picos* and the presence of one or both of the previously described pathogens.

Figure 1. Population trends of common midwife toad (*Alytes obstetricans*) in four Park locations (solid line, real larvae abundance data; dotted line, modelled curve).

Unfortunately, controlling these diseases in the environment is a nearly impossible task in the present day. In case it were possible to prevent future occurrences, or they were to diminish in a natural way, we have analysed the genetic structure of the populations most affected.

This information would be essential to implement a potential reintroduction programme to enable the return of the amphibians to some of the most affected mountain lakes. We have also recently developed lab treatments for infected individuals that could be useful in the future, for example, for treating particular species and specific age-groups that have been identified as largely responsible for the occurrence of new infectious cases in different lakes. In any case, it is worth remembering that, when dealing with an infectious disease, one of the main priorities to tackle them is to control their spread.

It is fundamental that visitors are aware of the issue, and for this reason we have produced boards, leaflets to inform them about it and good practices to prevent transmission. Mass influx of tourists to some of the highly infected sites such as *Lloroza* wells or *Ercina* lake, and unregulated access to water and even amphibians, poses a very high risk of transmission, not only between amphibian populations in the park or nearby areas, but also to the countries of international visitors.

Finally, the presence of species which predate amphibian also has a notable effect on some populations of Picos, such as the case of the Alpine newt in Ercina lake. The formerly abundant population has been greatly diminished by the high predation pressure caused by crabs, which are supposedly indigenous to the Iberian Peninsula; however, its natural presence remains difficult to explain in *Covadonga* lakes.

The conservation of amphibians in a global change scenario, which includes an increased number of visitors demanding increasingly larger spaces for recreational activities, and travelling greater distances is without doubt a difficult challenge. However, we cannot conform to a landscape, dotted with mountain lakes if they are without their indigenous amphibian populations, which were found there long before it was declared the first national park of Spain.

Research

Effect of the use of livestock veterinary medicine compounds on the diversity and the state of the ecosystem in *Picos de Europa* National Park.

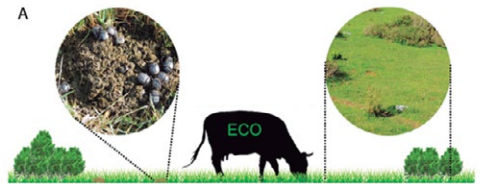
José R. Verdú Faraco
I.U.I. CIBIO, University of Alicante

In recent decades, the increasing use of agrochemical and veterinary medicine compounds is causing a loss of diversity in our ecosystems due to population declines and sometimes local extinction of species. There could be serious consequences as a result of the reduction in coprophagous beetle (dung beetle) populations. The results obtained by our research team demonstrate the high toxicity of ivermectin, even at very low concentrations, being 6 times more toxic than other less used compounds such as moxidectin.

Taking into account that the action of this insect group is crucial for improving soil fertility by the recycling the dung of large herbivores, keeping areas available for grazing, preventing the proliferation of many plagues of diptera, and decreasing the greenhouse gas emission rate, the true effect of the indiscriminate use of veterinary medicinal products (VMP) may be underestimated (Fig. 1).

The answers to this issue are particularly relevant in National Parks, where traditional livestock farming has been crucial in shaping and maintaining landscapes with all of their biodiversity. The *Principado de Asturias*, and particularly *Picos de Europa* National Park, are clear examples of traditional livestock farming, where the interaction between grazing and coprophagous fauna should be analysed whilst considering a broad range of historical situations.

Figure 1. Effects of livestock farming types on the functional diversity of the system under two potential scenarios in the study area:
A) Ecological livestock farming without use of ivermectine (IVM);
B) Livestock farming with annual ivermectine preventive treatments



In this sense, during 2017 and 2018, within the framework of the CGL2015-68207-R project, a study was carried out on the effect of VMP use on the diversity of coprophagous beetles and subsequently on the ecosystem services this arthropod group provides. In the case of *Picos de Europa* National Park, two areas were selected, the *Vega de Enol* and surroundings, characterised as an area with continued and relatively high use of VMP, and the surroundings of *Tresviso* and *Sotres* as an area with less frequent and relatively moderate use of VMP.

The results obtained reveal that coprophagous beetle diversity is lower in locations where there is greater use of VMP (Table 1).

Table1. List of coprophagous beetle species observed in *Picos de Europa* National Park during the current study.

Especies	Vega de Enol	Sotres-Tresviso
Acrossusdepressus (Kugelann, 1792)		*
Acrossusrufipes (Linnaeus, 1758)		*
Agrilinusconstans(Duftschmid, 1805)	*	*
Aphodiusfimetarius(Linnaeus, 1758)	*	*
Bodilopsis rufa (Moll, 1782)		*
Colobopteruserraticus(Linnaeus, 1758)	*	*
Esymuspusillus(Herbst, 1789)	*	*
Otophorushaemorrhoidalis (Linnaeus, 1758)	*	*
Rhodaphodiusfoetens (Fabricius, 1787)		*
Teuchestesfossor (Linnaeus, 1758)	*	*
Euoniticellusfulvus(Goeze, 1777)	*	*
Onthophagus (Onthophagus) taurus (Schreber, 1759)	*	*
*Onthophagus (Palaeonthophagus) joannae*Goljan, 1953		*
Onthophagus (Palaeonthophagus) similis (Scriba, 1790)	*	*
Onthophagus (Palaeonthophagus)stylocerus		*
Geotrupesstercorarius(Linnaeus, 1758)	*	*
Trypocoprispyrenaeus(Charpentier, 1825)		*
Total	10	17

Vega de Enol presents low numbers of coprophagous beetle species, which has already resulted in a large amount of non-decomposed dung (Fig. 2). Due to low species diversity and abundance, the removal rates of dung are virtually zero in the first three days of exposure. Therefore, this effect of low diversity ultimately results in a situation where there is an accumulation of excrements on the surface, which produces the negative effects described in figure1.

With respect to greenhouse gas emission, as was expected, the emission of methane by livestock dung was much higher in *Vega de Enol* than in *Sotres-Tresviso* (0.1 g m^{-2} day^{-1} and 0.01 g m^{-2} day^{-1}, respectively after 72 hours of exposure).

This fact illustrates that the burial process of excrement and the uptake of nutrients into the soil carried out by coprophagous beetles is not taking place in an efficient manner.

Figure 2. Accumulation of livestock excrements in *Vega de Enol*. It shows the dung is completely dry without any coprophagous beetle activity (Credits: J.R. Verdú; July 2018).

In conclusion, we find ourselves in an alarming situation if we think that some VMP, such as the ivermectine, is widely used and in a preventive manner by most livestock veterinarians and farmers in Europe, and other parts of the world since 1985. It is not surprising that after 30 years of indiscriminate use of these VMPs, we are witnessing a continued decline in the biodiversity of farmland systems, even those within the national parks of Spain.

This decline in biodiversity forces us to ask ourselves the same questions that the celebrated Rachel Carson asked herself in her best-seller *"Silent Spring"* after studying the devastating effect of DDT and other chemical products. Is something being done? Can something be done? Can I do something?

Ongoing projects within the framework of the Global Change Monitoring Programme in national parks

The table shows the research projects framed under the Global Change Monitoring Programme in 2019.

PROJECT	INSTITUTION	NATIONAL PARK	FUNDING SOURCE
DYNAMICS OF MONTANE BIODIVERSITY. SPECIES AND HABITAT MONITORING NETWORK TO ASSESS THE EFFECTS OF GLOBAL CHANGE.	SPANISH NATIONAL RESEARCH COUNCIL (CSIC)	**ORDESA Y MONTE PERDIDO**	**OAPN**
MONITOR-EA PROJECT. MONITROING GLOBAL CHANGE EFFECTS IN AQUATIC ECOSYSTEMS OF *PICOS DE EUROPA* NATIONAL PARK. *** Finalised in February 2019.**	UNIVERSITY OF CANTABRIA (UC)	***PICOS DE EUROPA***	**FB**
SCRIPT PROJECT. MONITORING AND MODELLING OF GLOBAL CHANGE EFFECTS IN *PICOS DE EUROPA* RIVERS.	UNIVERSITY OF CANTABRIA (UC)	***PICOS DE EUROPA***	**FB**
APLINEDIVING PROJECT. VULNERABILITY AND ADAPTATION OF AQUATIC ENDEMISMS TO CLIMATE CHANGE IN SIERRA NEVADA.	UNIVERSITY OF SEVILLE	**SIERRA NEVADA**	**FB –PIMA Adapta**
QUMATURE PROJECT. VULNERABILITY AND RESILIENCE OF MATURE MEDITERRANEAN QUERCUS FORESTS IN PROTECTED AREAS UNDER DIFFERENT CLIMATE AND MANAGEMENT SCENARIOS.	NATIONAL INSTITUTE FOR AGRICULTURAL AND FOOD RESEARCH AND TECHNOLOGY (INIA)	**MONFRAGÜE AND CABAÑEROS**	**FB –PIMA Adapta**
IIMPACTS AND MITIGATION OF GLOBAL WARMING EFFECTS ON ECOSYSTEM SERVICES PROVIDED BY COPROPHAGOUS BEETLES OF MONTANE MEADOWS.	UNIVERSITY OF ALCALÁ DE HENARES	**SIERRA NEVADA**	**FB –PIMA Adapta**

Fire salamander on beech leaf litter.

Outreach activities

Volunteer activities for the study and monitoring of alpine birds

Miguel de Gabriel Hernando
Iberian Ringing Group

Birds of high-mountain, or alpine birds, are the undisputed protagonists of the landscape of *Picos de Europa*, where they find their last sanctuary in an increasingly warm world. Examples of such species include: the yellow-billed chough, the alpine sparrow, the alpine accentor or the wallcreeper, all of which are adapted to rough terrain and cold climates, with ecologies and behaviours as specialised as they are unknown.

For this reason, more than fifteen years ago, the Iberian Ringing Group first proposed a study in *Picos de Europa* that would shed light on the ecological peculiarities and the conservation status of this group of birds. This task that was no easy one, given the harsh working conditions imposed by the environment in which they live.


Photo by Antonio López Orta

The volunteer program of the National Parks Autonomous Agency was a unique opportunity to launch this project, providing it with funding and allowing the incorporation of volunteers whose work has been essential. Since then, we have received more than two hundred participants from all provinces and seventeen different countries.

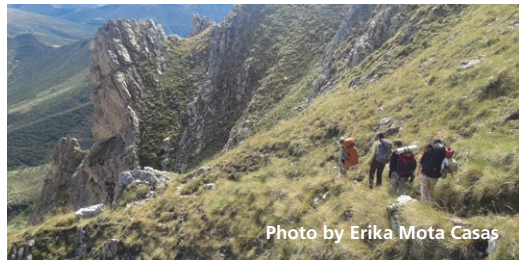


Photo by Erika Mota Casas

Despite getting up before dawn, getting cold, roasting in the sun, or climbing endless slopes, the vast majority of those who have accompanied us are willing to come back for more. The truth is that simply spending two weeks surrounded by the breath-taking landscape of the park is a unique experience that leaves few indifferent. Moreover, the participants are, and feel as though they are making a valuable contribution to a scientific study, that is revealing more every day about the ins and outs of high mountain ecosystems, and exploring previously unknown information about how they function.

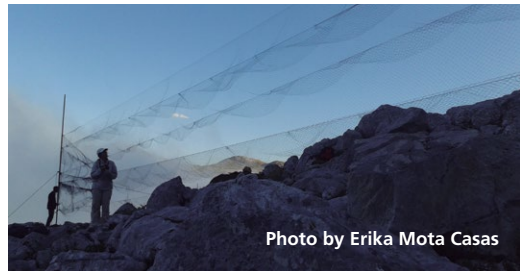


Photo by Erika Mota Casas

The study combines monitoring and study-based activities, which allow the participants to put into practice the most widespread methods of bird surveying in their daily routines: transects and point counts, the search for and monitoring of nests, and scientific ringing. In all these years, we have made great progress in what we know about the distribution, movements, demography, reproductive ecology and habitat selection. In addition to obtaining information to assess the effects of climate change on bird populations and other organisms adapted to this environment.

Thanks to all of you who have made it possible!

Recuperation of abandoned mountain hay meadows and final seminar of the Interreg SUDOE SOS Praderas project

Amparo Mora Cabello de Alba
Biologist, Conservation Department Technician of *Picos de Europa* National Park

The mountain hay meadows, agroecosystems maintained by the age-old actions of humans, are disappearing throughout Europe. And with them, the high level of biodiversity associated. They are part of an extensive traditional grazing system used in mountains regions. Mountain hay meadows are plots of grass which are not grazed by cattle during the spring and summer, whilst the animals are in high mountain pastures and mountain passes.

Swallowtail butterfly (*Iphiclides podalirius*) in hay meadows of Güembres (*Soto de Sajambre, León*).

The grass that grows during those months, it is cut at the end of the summer, dried and stored as feed for the cattle during the winter. This minimal management, which allows for the maintenance of open grassland areas and that limits competition between plant species, has resulted in a very high level of plant diversity, which is associated with a high diversity of insects, especially butterflies.

They are included among the European priority habitats, and the EU Biodiversity Strategy recognises their poor conservation status. The main cause of their disappearance are the changes of land management: intensification of the management where the relief allows easy access; and abandonment, in mountainous or humid areas, without forgetting the urban pressure in plots closest to urban areas.

The Interreg SUDOE SOS Praderas project (www.sospraderas.eu), of which *Picos de Europa* National Park is a beneficiary, aims to promote the sustainable management of hay meadows to favour their conservation. The beneficiaries of the Interreg SUDOE SOS Praderas project are: University of Oviedo (project coordinator), *Picos de Europa* National Park, National Institute of Agricultural and Veterinary Research (Portugal), Polytechnic Institute of Bragança (Portugal), Semillas Silvestres SL , Government of Aragon, and Conservatoire Botanique des Pyrénées et Pyrénées Ariégoises (France). The project aims to stop the loss of its associated biodiversity through increasing its value, proper management, the implementation of agro-environmental subsidies, and the commercialisation of new products (seed mixtures). Through these actions, farmers, businessmen of the seed sector, and the population in general will benefit through the conservation of this shared heritage.

On the 6th of June 2019, the final workshop of the project will take place in public in Oviedo, in which the main issues affecting hay meadows in mountain areas of Southwestern Europe will be presented; experiences in the field of conservation, management and use of hay meadows, and results from the SOS Praderas project

SOS Praderas team with Nicolás Bada, livestock farmer, in Pandébano hay meadows. From left to right: Laura García, Nicolás Bada and Tomás E.Díaz.

The manager's perspective

Interview with Borja Palacios Alberti

Biologist, Conservation Department Technician of *Picos de Europa* National Park

How valuable is it for management and research within *Picos de Europa* National Park that the park participates in the Global Change Monitoring Programme?

Any management measure should be based on scientific knowledge and solid information, therefore the collection and the quality of the data is one of the main concerns of those who manage protected areas. A manager values the data of a widely distributed Monitoring Network that measures appropriate variables and that works over time. These data will provide the manager with reliable information in order to make decisions. As users of the Global Change Monitoring Programme, it is essential that the maintenance of the weather stations is guaranteed and free access to the data granted.

In *Picos de Europa*, in addition to the network of weather stations, which is currently owned by AEMET, and which provides a definitive boost for its maintenance, a network of automatic gauges that characterise the habitat is installed in 10 sections of river of the National Park, giving information about their hydrological conditions and quantifying the observed changes. It is known as the Network for Monitoring of Conservation State of High Mountain Rivers (RECORAM), overseen by the Environmental Hydraulics Institute of the University of Cantabria.

The works carried out by the park staff are also of great importance for the monitoring global change in the park, as they collect essential information for both the daily and future management of this protected area.

What are the most obvious effects of global change, and in particular climate change, on the health of natural systems and species of the park?

For centuries, *Picos de Europa* was intensively used by livestock farmers that settled in both high and low mountain passes in many small settlements (Shepard's huts and cabins), where they spent most of the year. This intense farming activity has shaped the landscape and affected some species in that they were reduced to minimal populations, such as the wolf, other species became extinct (such as the indigenous wild goat). The abandonment of these settlements and the reduction in grazing over the last 40 years is causing the most significant changes in *Picos de Europa*. The immediate response of the ecosystem was an increase in forest density, a shift from subalpine meadows to shrubby areas, and the loss of hundreds of hectares of grassland that was once used for feeding cattle; biodiversity gems, both in terms of vegetation (subalpine flora) and fauna (especially entomofauna). In parallel, the ungulates (wild boar and especially deer) and their main predator (the wolf), have undergone a significant increase.

With regard to species diversity, in my opinion, we will have to decide on what type of National Park we want; if it is the one resulting from the eco-social changes and the current loss of biodiversity, or one that intends to conserve the richness that is created by traditional human practices, linked to higher biodiversity… or finally, divide the park into zones where both situations are at play.

What species, habitats, systems and ecological processes do you consider to be most vulnerable to climate change in *Picos de Europa*? What management tools do you consider the most appropriate to tackle the challenge of climate change?

The generalist species will always have more chances to adapt to changes than specialists, which depend on a more limited ecological niche.

According to the result of the monitoring that is carried out in *Picos de Europa*, the vertebrates most affected by environmental changes belong to the class *Amphibia* (all species), and some species from the class *Aves* (such as the capercaillie). This tetraonid seems to have suffered more from changes in land use of the mountain over the last 50-60 years than from climate change.

Almost 50% of the bird species in *Picos* are alpine or subalpine. Since 2003, the Iberian Ringing Group (GIA) has been monitoring this bird community, which can serve as an indicator of environmental changes, and be of great help in the planning of management measures.

In my opinion, continuing with the traditional land use of the mountain, especially those linked to sheep farming, could be an effective tool to face the challenge of change. However, decision-making involves a more global and regional scale, or at minimum, at the scale of the Cantabrian Mountain Range.

Regarding flora species, following the methodical and flawless monitoring, mapping, and revisions of flora undertaken since 2000 by botanists from University of León, Oviedo and Santander, together with the Atlantic Botanic Garden of Gijón and the coordination of the National Park, the main management tool would be the Conservation Programme of vascular plants of *Picos de Europa*, which sets out the most appropriate conservation measures for endangered flora.

Which topics require a deeper understanding in order to improve the scientific knowledge on global change impacts in *Picos de Europa*?

Firstly, the research undertaken in *Picos de Europa* would have to be made known, and in this sense the publication and distribution of a summary of research activity carried out under the Global Change Monitoring Programme of National Parks will be very useful for the manager.

From there, in my opinion, we should study in depth and deal with topics at the local scale. Climate change and its consequences cannot be simplified to image of a Polar bear, far from our home, wandering around the Artic, but to the small changes already happening around us, which could be better understood and tackled with a simple solution at the local scale.

What are the most relevant monitoring parameters of climate change for the management of the park?

The ones directly derived from monitoring activities of populations and communities that can act as indicators. This work is being undertaken by national park staff (technicians, wardens, volunteers…) and by researchers that have been working in the area for years: monitoring of rainfall and temperature, monitoring of herbivory on blueberries, breeding trends of large raptors, monitoring trends in alpine flora, monitoring trends in hay meadows, monitoring of alpine and subalpine birds, Lepidoptera populations, wild ungulates…All of these activities are essential to detect changes (or not), or conservation problems.

How should the politics of protected areas be adapted to the effects of Climate Change?

To adapt and/or face up to processes of change (global, climatic…), we should commit to Sustainable Development (Editorial Newsletter Issue nº 5), and in this sense it might work well to look back and analyse the footprint left by early inhabitants of the current areas before they were declared as protected. Many traditional land uses and exploitations (others not traditional) brought richness to these areas, so let´s give them another try.

And of course, increase budget for projects referred to as "climate change" or "global change" or "greenhouse effect".

The researcher's perspective

Interview with Alfredo González Nicieza
Researcher at University of Oviedo

How valuable for management and research is the integration of *Picos de Europa* NP into the Global Change Monitoring Network, and in particular, the installation and maintenance of weather stations in the park?

Picos de Europa NP is the only one that encompasses montane ecosystems in the Atlantic region of the Iberian Peninsula. These are two key aspects, as montane ecosystems are among those that appear to be most affected, and the Atlantic region (particularly the Cantabrian Range) could suffer from a process of 'Mediterranisation'.

The monitoring of climate change and its effects on populations, communities and ecosystems is essential to predict future trends and states, and to have the advantage of anticipation when applying buffer measures.

Can conclusions be drawn about the effects of climate change on the park›s characteristic ecosystems?

In cases where long-term data sets exist (at least 30-40 years), most likely yes. For example, in the Pyrenees, it is already known for a fact that there is an altitudinal displacement of different plant formations. The problem here is the availability of regularly recorded information over extended periods, for different units of interest (for example, populations: size or genetic diversity; communities: composition and abundance of species; ecosystems: duration of the hydro period in temporary wetlands, flow of water and physical-chemical parameters in rivers, duration of the period of snow cover in reference habitats). As far as I know, this type of solid information is not available for most vertebrate groups.

What components of global change (climate change, land use changes, pollution, biological invasions ...) are most relevant in *Picos de Europa*?

If we consider the last 25 years, I would say the land use changes have been relatively subtle. A large part of the park's territory is used for livestock farming, which depending on the area, can be of moderate to intense use. In order to perceive such a large change, perhaps we have to look back to the times when herds of goats and sheep were more abundant, and exerted a greater level of control on shrub growth (this niche has been partially occupied by brush cutters).

Therefore, I do not think the change of land use is as relevant as the use of land in itself. I would put the focus on the issue of forest regeneration in some very specific areas (e.g. Monte de Pome). Pollution would also be a threat of little relevance in the park, affecting only some specific locations and this threat will tend to diminish. However, we could also discuss other types of pollution, such as visual and noise pollution, but they too are equally manageable and infrequent. I believe the measures adopted over the past years have been effective.

By process of elimination, the factors that should be focused on would be climate change and invasive species. Aside from emerging pathogens, there are currently no serious problems associated with the presence of invasive species in *Picos de Europa*, apart from specific cases in some mountain lagoons, which may be serious at a local level. However, I believe that this should be a major concern, as we cannot ignore the possibility that the effects of climate change may cause mountain habitats to become suitable for invasive species, which are already widely distributed in the Cantabrian region.

Which topics require a deeper understanding in order to improve the scientific knowledge on global change impacts in *Picos de Europa*?

I suppose that there are a lot of options, but one would be the intensification of the data recording through micro stations to cover a greater variety of habitats and, especially microhabitats. This information would be really valuable if incorporated into the predictive models of occupation (species distribution models) in combination with data on physiological requirements of organisms (physiological niche models). The survival of organisms and the persistence of populations depends on the use of microhabitats, where the microclimatic conditions are often different from those recorded in the main stations. The high environmental heterogeneity of mountain environments makes this type of information indispensable.

What are the most evident signs of climate change in Pico de Europa?

As signs, perhaps the most evident would be the decrease of permanent snow caps. I don't know if there are historical records of the maximum altitudinal limits of beech forest, birch forest, and shrub, because this would surely allow us to know definitively (if you can exclude the land management effect).

What species, habitats, systems and ecological processes are considered more vulnerable to climate change in the national park? What measures of monitoring or adaptive management should be prioritised?

Wetlands are environments especially sensitive to climate change, especially montane wetlands. In addition, aquatic environments seem especially sensitive to biological invasions, and within the vertebrates, amphibians are the most threatened group. This may be an opinion biased by my work, but other systems or processes that I recognise as being affected are not affected to the same extent by climate change, as they are by other factors (e.g., blocking of forest regeneration).

I believe that in addition to a sustained monitoring of the abundances of those species that are in a situation of greater vulnerability, or may be in the near future, the predictions of future distribution of the species provided by niche models may help us to assess risks in a more objective way. It would also be interesting to implement a genetic-diversity monitoring program for some populations.

Regarding the actions and management measures in sensitive systems, the first measure would be not to act before having a good knowledge of the system. When a measure is implemented, its effects should be monitored and necessary corrective measures implemented, or even revert the action if it is deemed necessary.

Fencing of wetlands for conservation purposes can be a good example of adjustable actions. Shallow wetlands are largely maintained as we see them thanks to the patterns of disturbance caused by herbivores through the consumption of biomass and the effects of trampling. It has been shown that when we block these disturbances ecological succession advances, the ponds fill up, and in the end we are left with a much less aquatic environment. It is the same effect that occurs in a river when the flow is regulated to avoid rises in water level: the absence of disturbance leads to a completely different community.

Can you suggest a few of the key indicators of impacts and ecosystem vulnerability in *Picos de Europa*?

I think that, as in other fields (e.g. water quality assessments and conservation status of river ecosystems), the presence and abundance of sensitive species can be the most effective key indicator. The genetic diversity of these species can be another a good indicator, especially in the long-term.

Parameters of change

Caves of *Picos de Europa*: from their history to their potential as a historic archive of climate and environmental change.



Montserrat Jiménez Sánchez, Geology Department of the University of Oviedo

Daniel Ballesteros, UMR 6266-IDEES from University of Rouen-Normandie and CNRS

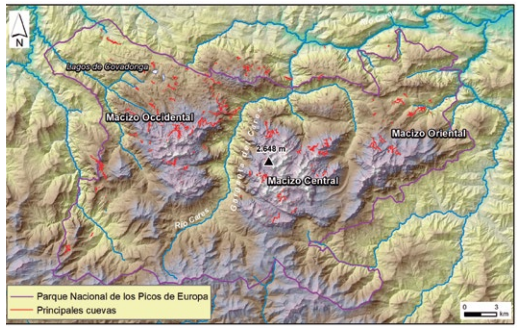
Diego J. Álvarez-Lao, Geology Department of the University of Oviedo

Among the most unique terrains on Earth are those derived from the action of the karst processes, in which the solubility of rocks and other factors, such as climatic and environmental factors, condition the evolution of a landscape, in which water dissolves the rock both in surface and in its depths. This way, very special environments are formed in which the surface landscape, with sinkholes and limestone pavement, is as important as the underground, with caves and chasms.

The caves are sensitive to the climatic and environmental processes that occur in the karst environment, but at the same time they are restricted environments, which makes them historical records of climatic and environmental changes occurring at a local, regional or global level. Among the records present in the caves, there are: speleothems, detrital sediments, ice, archaeological remains, and paleontological remains (fauna, pollen). All of which have a climatic and environmental meaning that can be deciphered using multidisciplinary methods, but they also have the peculiarity that in many cases they can be assigned an age through geochronological methods.

Picos de Europa National Park has a virtually unknown underground heritage that includes 3,700 caves documented by speleologists, which all together have more than 420 km of underground passages, and reach up to 18.9 km in length and 1,589 m of depth. These include 14% of the deepest chasms in the world (Fig. 1). In addition to granting the Park its unique landscape, the different processes that have shaped the karst of the area have allowed the conservation of different records in the cavities, such as speleothems, lakes and underground river sediments, ice and paleontological remains in cavities, including the geomorphological configuration of the caves themselves, which reveals periods of history that can be related to climatic and environmental changes.

Figure 1. Location of the main karst caves of *Picos de Europa* National Park and its surroundings, discovered during speleological explorations. The location of the cavities is in red and the limits of the Park in purple tones.



The geomorphological studies place the origin of karst cavities dating back more than two million years, when the main rivers in the area had already begun to develop gorges, canyons and mountain passes. The dissolution of the limestone in its depths facilitated the formation of underground ducts filled with water that would constitute the primitive caves. As the surface rivers deepened in their bed, the same occurred in the underground water flows, leaving the initial ducts and creating new ones at a lower altitude.

Between them, wells and underground canyons of up to 300 m deep were formed. The Uranium-series dating of speleothems has allowed us to know the ages of some of them, reaching over 350,000 years old. Combining this data with detailed geomorphological information, we have come to know that the caves were filled by sediments from underground rivers and by speleothems between 220,000 and 145,000 years ago.

Later, between 125,000 and 45,000 years ago, these sedimentary fillings were mostly eroded, while temporary lakes and detrital sedimentation were formed in some caves (Fig. 2). This period coincided with the existence of glaciers, whose melting waters fed the karst aquifer.

Figure 2. Detrital deposits of 60,000 of over years old in Cueva del Hayéu'l Osu, thought to be the result of the presence of surface glaciers.

On the other hand, *Picos de Europa* caves conserve more than 30 paleontological sites discovered by different speleological groups. Seven of these deposits have been the subject of a recent research contract (FUO-300-17) funded by the Inter-autonomous Consortium of *Picos de Europa* National Park.

The fauna (especially large herbivores, carnivores and micromammals) constitutes an important climatic indicator, since the different species reflect the environmental conditions of that time. The discovery of fauna associated with warm or cold climates, or adapted to forests, meadows or rocky areas allows us to accurately establish the occurrence of periods with different climatic and environmental features. To date, we have recovered almost 2,000 bone remains from bovids and ursids up to 36,000 years of age (Fig. 3). The main reason for fauna entering the caves was due to accidental falls into the chasms, which formed mortal traps. The paleoclimatic and environmental significance of these will be soon revealed.

In short, the caves of *Picos de Europa* National Park constitute an inexhaustible source of climatic and environmental data, which will continue to accumulate in them over the next millennia, and which have just begun to be studied. Its high potential as a record of climate and environmental change undoubtedly reinforces the value of the heritage of this unique protected site.

Figure 3. 34,000 years old bone remains of chamois (Rupicapra pyrenaica) in Cueva del Hayéu'l Osu.

Long-term monitoring of butterflies in *Picos de Europa* National Park

Amparo Mora Cabello de Alba
Biologist, Conservation Department Technician of *Picos de Europa* National Park

Picos de Europa National Park hosts 137 diurnal butterflies' species, 60% of the 226 species in the Iberian-balearic region. However, the area occupied by the park only represents 0.1% of the total territory of the Iberian Peninsula and Balearic islands. Undoubtedly, *Picos de Europa* is a hotspot or an area of high diversity of diurnal butterflies.

Picos de Europa is also among the richest areas for diurnal lepidoptera in Europe. The last European Red List of Butterflies reveals that the highest diversity is located in the mountains of Southern Europe. *Picos de Europa* National Park hosts a quarter of the European species (28, 4%).

Amongst the factors that might explain the high species diversity in such a confined area as *Picos de Europa* is the fact that it stands at a crossroads (located in the Cantabrian Range, receives Atlantic influences from the West, and Mediterranean from the South and Southeast), and the large altitudinal gradient (80-2640 m) that is possesses allows the existence of a great variety of habitats. Both factors have resulted in that this area has become a refuge for a number of species during the Tertiary and Quaternary climatic fluctuations.

Lycaena virgaureae.

Butterflies are key indicator species that can reveal information about state of conservation of an ecosystem. They have short life cycles and thus react quickly to environmental changes. Their limited dispersal ability, larval food plant specialisation, and close-reliance on the weather and climate, make many butterfly species sensitive to even the most subtle of changes.

2013 marked the start of the long-term monitoring scheme of diurnal butterfly in Picos, our methodology was based on the standard methodology used by the organisation Butterfly Conservation in the UK. It involves regularly waking transects of a given length, which pass through a variety of habitats. In 2014, we joined a nationwide monitoring network at the Spanish BMS level, which includes the rest of National Parks, and other organisations, such as: Doñana Biological Station, Universidad Autónoma de Madrid, Rey Juan Carlos, Granada University and other associations.

The butterfly monitoring team in *Picos* is formed by wardens, nature guides, technicians and some volunteers. We have nine transects in place. Some outstanding data has been collected, such as the presence of 92 butterfly species in less than 1 km, more species than in UK and Ireland together! The value of the data increases with every year that we are able to continue with this task, and it will be of great importance in the future to assess the global change effects (changes in land use and climate change).

Boloria selene, in the hay meadows of Pandébano (Cabrales, Asturias). Mountain: Western and Central Massifs of *Picos de Europa* from the highlands of Valdeón (Valdeón, León).

Alicia García, Park guide, undertaking a transect for butterfly monitoring.

Recovery of the bearded vulture in *Picos de Europa* National Park

Concepción Gálvez Marquínez
Bearded Vulture Conservation Foundation

The bearded vulture (*Gypaetus barbatus*) is a magnificent bone-eating vulture, considered one of the most endangered species of the European Union. In our country, it is included in the Spanish Catalogue of Threatened Species as "Endangered".

In Spain, the short-term and medium-term survival of this species seems to be affected by several factors: its reduced population size, which does not exceed 900 individuals within the entire Spanish state; its restricted range, confined to the Pyrenees mountain range; its slow reproductive rate, and the difficulty in successful colonisation of new territories. These factors make the Pyrenean population the last genetic reservoir of Bearded vultures in Europe, vulnerable to stochastic and demographic events.

In 2002, the Bearded Vulture Conservation Foundation (FCQ) started their Reintroduction Programme in *Picos de Europa*. A project based on the cooperation between the National Parks of Ordesa and Monte Perdido, and *Picos de Europa*, in keeping with the strategic lines that govern the National Parks Network: the conservation of these sites and their biodiversity, the improvement of the scientific knowledge and the promotion of a social awareness of conservation. In addition to the National Parks Network, several other entities participate and co-finance the project, including: the European Commission, the Government of Aragón and the Ministry for the Ecological Transition through the Biodiversity Foundation.

GOAL OF THE PROJECT: To facilitate the long-term occupancy of the species in *Picos de Europa*/Cantabrian mountain range, that will make possible the creation and establishment of a metapopulation that allows the movement and exchange of individuals through the Iberian- Cantabrian corridor with the Pyrenean population. This way, amplifying the species distribution area and helping to reduce the risk of extinction. The creation of biological corridors is one of the principles that inspired the establishment of the Natura 2000 Network.

ACTIONS DEVELOPED: The FCQ has consolidated a methodology that involves a series of actions year after year, following the life cycle of the species.

1. Improve adult reproduction and survival rate in Pyrenees: through supplementary feeding of bearded vultures between October and February in the breeding territories considered to be of high risk in terms of reproductive failure within the Aragonese Pyrenees.

2. Recovery of embryos from below-average production rate nests in the Pyrenees: rescue of live newly-hatched chicks and non-hatched embryos from nests in a situation of high risk. The rescues are carried out by Agents for the Protection of Nature of the Government of Aragon. Following the rescue protocol, the embryos are transferred to the facilities of the Breeding Centre in Human Isolation (CRIAH), Pastriz (Zaragoza).

Photo by Javier Gil Vaquero/ F.C.Q.

3. Application the assisted breeding protocol at the Breeding centre for Bearded Vultures in Human Isolation, Zaragoza: once the incubation process finishes and the egg hatches, the hatched individuals are raised through behavioural learning by natural imprinting, since the handling is done in isolation of humans: any interaction made with the chicks is done with a puppet that exactly mimics an adult bearded vulture.

4. Behavioural learning by natural imprinting in Ordesa and Monte Perdido National Park (PNOMP): Once the chicks complete their first stages of life, they are transferred to the hacking platform (rearing in the field) in PNOMP, where the behavioural learning phase takes place as they continue to develop. Chicks in the rearing phase are kept in enclosures, where they are able to observe bearded vultures and other scavengers such us Griffon vultures or Egyptian vultures in the wild, as they approach the supplementary feeding station located in front of their hacking platform. In this way, the chicks learn about intra- and inter-specific behaviour and behaviours that that will be essential for their future survival in the wild.

5. Release of individuals in *Picos de Europa* National Park (PNPE) using hacking: Once the behavioural learning phase has passed, the individuals are transferred to PNPE for around 30 days prior to their definitive release, where they are housed in similar enclosures to those in Ordesa; before they eventually become part of the wild stock of bearded vultures. Before release they are ringed and a tag is fitted to their wings so they can be recognised from distance, as well as being equipped with satellite trackers. The monitoring of bearded vultures in the wild is done through direct observation, in combination with computer software that shows the movements of satellite-tracked individuals.

6. Maintenance of supplementary feeding stations for scavengers. Distribution of animal remains (category 3) from livestock slaughter houses. This helps individual to establish a territory and to facilitate their socialisation with other individuals.

RESULTS: Between 2010 and 2018, 24 individuals have been released in *Picos de Europa* National Park. Currently, 18 individuals have survived and remain within the park. There has been proof of the first pair to attempt breeding in the park in 60 years.

The project has allowed the cooperative work between two protected sites from the National Parks Network to be shown and encouraged the preservation of the ecosystem services provided by carrion-eating birds.

Feeding with the puppet. Javier Gil Vaquero (FCQ)

Rain containing heavy metals in Covadonga Lakes

Jorge Pey Betrán
Researcher ARAID at Pyrenean Institute of Ecology – Spanish National Research Council (CSIC)

High mountain areas are host to unique ecosystems that are currently threatened due to changes in the atmospheric circulation patterns, the increase of extreme weather events, or the impact of pollution.

Picos de Europa National Park (PNPE) possesses a plethora of sites that are well renowned for their natural beauty, many of which are also epicentres of biodiversity. The Cantabrian Range, that is a central feature of this centenary park, forms a natural geographic boundary that forces the humid winds arriving from the sea over its slopes, resulting in heavy rainfall in the affected areas.

The progress of our society, in many cases, brings with it the pollution of water, soil and the atmosphere. The surroundings of PNPE are host to diverse human activities that contribute, to a greater or lesser extent, to the degradation of the air quality with nitrogen and sulphur oxides or heavy metals. Many of these pollutants are removed from the atmosphere thanks to the rain, depositing them close to the place where they were generated, or even further away. Although the deposition of atmospheric pollutants takes place around the globe, the phenomenon in the surroundings of Lake Enol is much more severe than was previously thought.

Thanks to the DONAIRE Project (CGL2015-68993-R) we are monitoring the atmospheric pollution transported by the rain in the surroundings of Lake Enol. Due to its location, it is exposed to humid winds from the sea, which carry pollutants from North-western Iberia. We have observed since the beginning is that the deposition of heavy metals such us cadmium, lead and zinc is much higher than what is registered in heavy polluted urban areas. We have found that most of the heavy metals are in a soluble phase, so their bioaccessibility is much higher. The association of heavy metals that we have observed has an obvious industrial origin and shows how the industries, despite being located far from the PNPE, still cause great effects on the park. The results that we have found compel us to keep monitoring the situation to raise awareness of the problem, and to be able to verify in the near future the impact of environmental improvements that should be adopted.

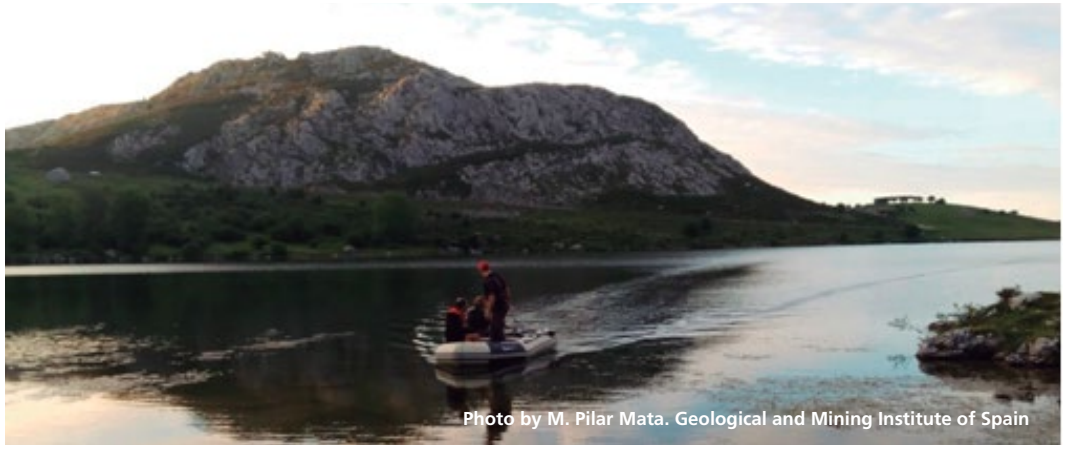


Photo by M. Pilar Mata. Geological and Mining Institute of Spain

Consequences of atmospheric deposition of nitrogen and phosphorus in vegetation communities and soil microbiota in high mountain systems.

Cristina Armas Kulik
Spanish National Research Council
Experimental Station of Arid Zones, Almeria.

Global change threatens biodiversity and ecosystem functioning, one of the main drivers being the increasing atmospheric deposition of nitrogen (N). It is expected that by 2050, nitrogen deposition will double, for this reason it is imperative that we better understand how it alters the ecosystem processes. Phosphorus (P) is a limiting nutrient that may soon increase by atmospheric deposition. Both N and P are essential for plant and microbial productivity, but the ecosystem functioning depends not only on their availability, but also on their stoichiometry, closely linked to biochemical processes that control key ecosystem aspects.

This project, funded by the National Parks Autonomous Agency (OAPN), addresses the influence of atmospheric deposition of N and P on soil and plant communities in four Spanish high mountain ecosystems that extend across a gradient of latitude and aridity in Teide National Park, Sierra Nevada, Sierra de Guadarrama and *Picos de Europa*. In 2016, we started experimental manipulations to simulate deposition scenarios with a factorial design of N and P addition, to study their effect on soil and plan communities. In parallel, we estimated the wet N and P deposition and measured the inorganic N and P production in situ, the plant growth, and the activity and abundance of soil microbiota. Preliminary results of the project show the wet deposition of N and P during the study were low in all of the parks.

In the outermost parks (Teide and *Picos de Europa*), both the dominant shrub species and grasses of the *Poaceae* family increased in growth mainly with the addition of N, however this effect was variable throughout the different years of the study. This increase in productivity may result in changes in species dominance, which in the case of the mixed grassland and shrub habitat studied in *Picos de Europa* National Park, may favour the expansion of the dominant shrub (*Genista obtusiramea*) and *Poaceae* grasses over other dicotyledonous plants of the meadow. In the remaining parks, patterns were more complex and sensitive to the addition of P.

We are now analysing the microorganisms' abundance and soil activity, namely its respiration and enzymatic activity, as well as the potential relationships and synergies among all the response variables measured in these ecosystems. However, it is important to highlight that just two monitoring seasons may not appropriately reflect the organisms response to atmospheric nutrient deposition, nor capture its variability. It would be convenient to continue with this monitoring to be able to predict how these unique ecosystems may be affected if nutrient deposition in the environment is maintained or increases.

Plot in *Picos de Europa*

News

Jous Project registers record temperatures in *Picos de Europa* National Park (PNPE)

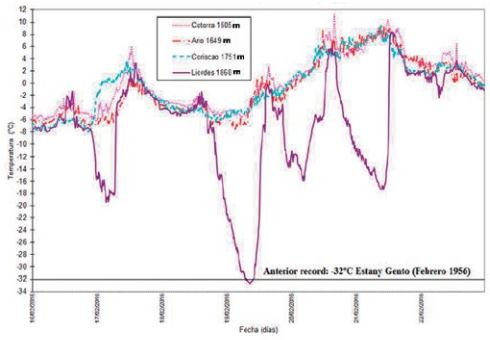
Miguel Iglesias González
Jous Project team member


Vega de Liordes during the summer of 2016

The Jous project was founded is 2010 thanks to a group of enthusiasts of: mountaineering, meteorology, and the cold, coming from all over Spain. Despite the Iberian Peninsula not being famous for its low temperatures, it was known that in mountain areas with certain geomorphologies, such as terrain depressions with almost no vegetation and highly exposed to the elements, temperatures can reach below -20°C. During 2010, several enthusiasts noticed that the "Jous" or glaciokarst depressions, characteristic of *Picos de Europa*, meet those conditions. Moreover, they are large, exceeding 1800 m above sea level, with considerably higher levels of snowfall when compared to other mountains of the Peninsula.

With the support of a data logger temperature sensor in a protective case/hut located at Jou Santu during the winter 2010-2011, some preliminary data were collected. Temperatures were registered that reached lows of -27°C. From that moment, we realised the great potential that *Picos de Europa* has for monitoring extreme cold temperatures, and the Jous project began. (https://proyectojouspicos.wordpress.com)

Driven by enthusiasts that contribute their own economic resources, together with the invaluable support of *Picos de Europa* National Park, during the winter of 2011-2012 the study of pools of cold air in the Jous of *Picos de Europa* began. The efforts are focused around the monitoring of a number of spaces, such as: Jou Santum Comeya, Jou del Infanzon and the great beasts of the cold, Hoyos Sengros and la Vega de Liordes. On clear nights with no wind and fresh snow, the loss of heat from the ground causes extreme cooling of the circulated air, which increases in density and descends upon the slopes, accumulating in the Jous, generating extreme temperatures: - 30,6°C on December 2013 in Hoyos Sengros, a record-breaking temperature for this month in Spain, or -32,7°C on February 19th 2016 in Vega d Liordes, within the range of absolute minimum temperatures recorded in the Iberian Peninsula. This winter, with the installation of a meteorological station connected to the network in Vega de Liordes (data available in cazatormentas/estacion/?Id=79), the evolution of this phenomenon, that is capable of causing lows of -35 °C, can be followed live.



Temperatures in La Vega de Liordes stations and in the other three stations that belong to the Global Change Monitoring Programme in the national park; the absolute minimum, -32, 7°C, is registered in Vega de Liordes.

Publications

LOPINGA. Butterfly monitoring newsletter in *Picos de Europa*

The third issue of the magazine "Lopinga, Butterfly monitoring newsletter in *Picos de Europa*" has been published, prepared by the Conservation department of the National Park to promote the exceptional richness of the Lepidoptera of this protected site.

The National Park participates in the BSM-Spain Network (Butterfly Monitoring Scheme-Spain), which includes a number of institutions involved in the monitoring of butterflies in Spain and contributes to the production of indicators for the European Environmental Agency.

https://www.miteco.gob.es/es/red-parques-nacionales/nuestros-parques/picos-europa/lopinga-2018_tcm30-496423.pdf

Summary of the health of the Fauna of Montaña de Covadonga and *Picos de Europa* National Parks, 1992 - 2017

Coinciding with the first Centenary of the declaration of Covandonga´s Mountain National Park, which gave way to the declaration of the current *Picos de Europa* National Park in 1995, this document has been published to compile the systematic work carried out from 1992 until 2017. Twenty-five years of monitoring in various fields, mainly within the fields of health of wild and domestic fauna in the National Park.

Among other aspects, the book details information about: sarcoptic mange in chamois which reached the National Park in the last decade, monitoring of wildlife poisoning events, monitoring of the white-clawed crayfish population, research on zoonotic diseases in ticks, blue tongue disease, bees, and of course, it covers the year to year monitoring of the livestock censuses, with a description of the mountains that are used by the public in each of the districts that form part of the protected area, and the health state of domestic animals (livestock) that access to the National Park due to their close relationship with wild animals.

We point out that one of the book´s notable features is the concise analysis of more than 190 interviews with farmers that graze their livestock in the National Park's interior.

Publications

Impacts, vulnerability and adaptation to climate change in extensive livestock production systems in Spain

The main objective of this report is to present a summary of the current level of knowledge and point out a number of techniques and livestock management practices in line with the new climate scenarios, as well as some climate change adaptation measures.

In the report, 22 recommendations have been selected for adaptation to climate change in extensive livestock farming and grazing systems, split into four groups related to the management of plant formations, animal management, management of livestock use and other socioeconomic aspects.

All of them take into account the intimate relationship between livestock grazing and the modification of meadows and grazing systems under the influence of climate change: the forecasted changes predict modifications to the phenology, composition and production of grazing land, as well as animal welfare; at the same time, the adaptation measures, especially linked to animal husbandry can modify the climate change effects on the vegetation, and consequently the quality of life of the animals themselves.

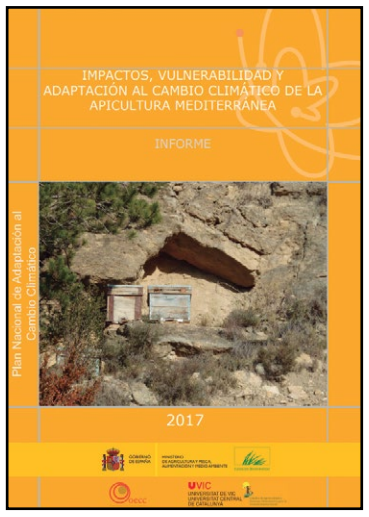
https://www.miteco.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/informe_ganaderia_extensiva_tcm30-435573.pdf

Impacts, vulnerability and adaptation to climate change in Mediterranean beekeeping

The evidence increasingly shows the importance of pollinating insects for life and wellbeing, not only for biodiversity conservation, but also for a sustainable economy. In parallel, with concerns about the current and future consequences of climate change growing, so too does the need to better understand the vulnerability of bees and impacts on beekeeping.

The current study intends to characterise the vulnerability of the Mediterranean beekeeping sector to climate change in a context of global change, determine the adaptation practices and strategies that are being put in place, and propose future lines of work based around the necessities that have been identified in the sector.

https://www.adaptecca.es/sites/default/files/documentos/informe_apicultura_mediterranea_tcm30-435572.pdf

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