Wildlife in the Changing Andorran Pyrennes

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LETTER TO VOLUNTEERS

Dear volunteers,

we want to thank you a lot for sharing with us this second year of expeditions in the Pyrenees. After the experience acquired in 2016, our challenge was to improve many things: logistics, social, and scientific. Our main goal is obviously gathering data that can help us answer to the many questions we have, and that working in the Pyrenees can help us answer to; but we also aim at making the expedition an unforgetable experience for you. Helping you be more aware of the dangers that sensitive environments (not only mountains, but mountains in our case) face due to global change; or helping you know a bit about a country, Andorra, that many people do not even know where it is; or just discovering the joy of hiking, are among other non-scientific objectives that we have put to ourselves. You will read in this report that the scientific objectives are 100% accomplished (so, thanks!!), and we believe that we are in a good direction. We hope the non-scientific objectives have also been accomplished. As many Earthwatch Institute projects, this project is very ambitious. The project is also logistically complicated, with many activities carried out each day, under a climate that makes us adapt our plans almost every day, and in a landscape that somedays is too steep for some of us (staff included!!). We want to thank you for your adaptability and for accepting the changes we have had to do at last minute.

Finally, we are quite sure that most of you enjoyed the accommodation (despite having to have dinner a bit too late!). We are very grateful to Hotel Bringué for their collaboration, their willingness to make things work and easy for us, and for their flexibility with our diet requirements ;-). The same way that comments from the volunteers of 2016 let us improve some things in 2017, your comments (both public and private) will help us improve the expeditions for the volunteers that will join us in 2018.

Thanks a lot again for making this adventure possible. We expect to be able to publish the first results of this expedition by the end of next years. Science is slow, yes, but we are very confident that the data coming from this expedition will have a special value both for the scientific community and the decision makers. We hope that having CENMA as our local partners will shorten the distance between science and policy.

Very best wishes from the Pyrenees staff. We hope we meet again.

Wildlife in the Changing Andorran Pyrenees staff.

Jana, Irene, Albert, Guillem, Manel and Bernat

Summary

Globally, it has been an extremely successful year, for various reasons. The most important one is that we have been able to carry out all the activities planned, with the intensity and periodicity that were designed; but it has also been successful because we are starting to discover, looking at this year's data and comparing them with last year's, the great potential of this project to provide powerful results in some years, results that will include many "actors" of the alpine community (from the microbial community to the large ungulates). Having only analysed a small part of our data, we have also some first citations in Andorra of some species (specially mushrooms, but also two insects, but this list will for sure grow), showing the gap of knowledge that exists for this so sensitive environment to global warming.

Goals, Objectives, and Results

Small Mammals

In 2017 we have sampled our 4 plots 3 times, one in June, another one in July and the last one in September. During the two may expeditions we described the vegetation around each of the 36 traps of each plot. In total, we have made a total of 286 captures (re-captures included) of 9 different species: *Elyomis quercinus*, *Apodemus sylvaticus*, *Myodes glareolus*, *Apodemus flavicollis*, *Chionomys nivalis*, *Glis glis*, *Apodemus* sp., *Sorex araneus*, and *Sorex minutus*. The following table summarizes the number of captures per season per species:

Species name	Summer	Autumn	Total
Apodemus flavicollis	10	13	**23**
Apodemus sp.	10		**10**
Apodemus sylvaticus	77	35	**112**
Chionomys nivalis	11		**12**
Eliomys quercinus	35	5	**40**
Glis glis		4	**4**
Myodes glareolus	40	12	**68**
Sorex araneus	8	4	**12**
Sorex minutus		5	**5**

As expected, the two most abundant species captured were the wood mouse (*Apodemus sylvaticus*) and the red vole (*Myodes glareolus*), but it's a bit surprising that we captured more individuals in summer than in autumn (*a priori*, there are more captures in autumn than in summer because of the offspring), but the cold temperatures we had in September (much colder than the average) could explain this. We are currently looking at the differences between 2016 and 2017, and also at differences related to site and elevation (not shown here because we will need more data to obtain robust results)

Microbial Activity

Following the Tea Bag Index (TBI) protocol, we obtain two values: the decomposition rate (k) and the litter stabilisation factor (S). In litter bag studies, decomposition is measured by weight loss of plant material in time. A decomposition curve is often estimated by fitting this weight loss to an exponential decay function with decomposition rate constant k. During decomposition, parts of the labile compounds stabilise and become recalcitrant. This stabilisation depends on environmental

factors and results in a deviation of the actual decomposed fraction (i.e. limit value) from the hydrolysable fraction H. This deviation can therefore be interpreted as the inhibiting effect of environmental conditions on the decomposition of the labile fraction and is referred here to as stabilisation factor S. With the sampling design that we use, we can obtain these two values (k and S) for three periods:

- P1: spring-summer, from the bags buried in May and dug up in July
- P2: summer-autumn, from the bags buried in July and dug up in September
- P1-2: spring-autumn, from the bags buried in May and dug up in September

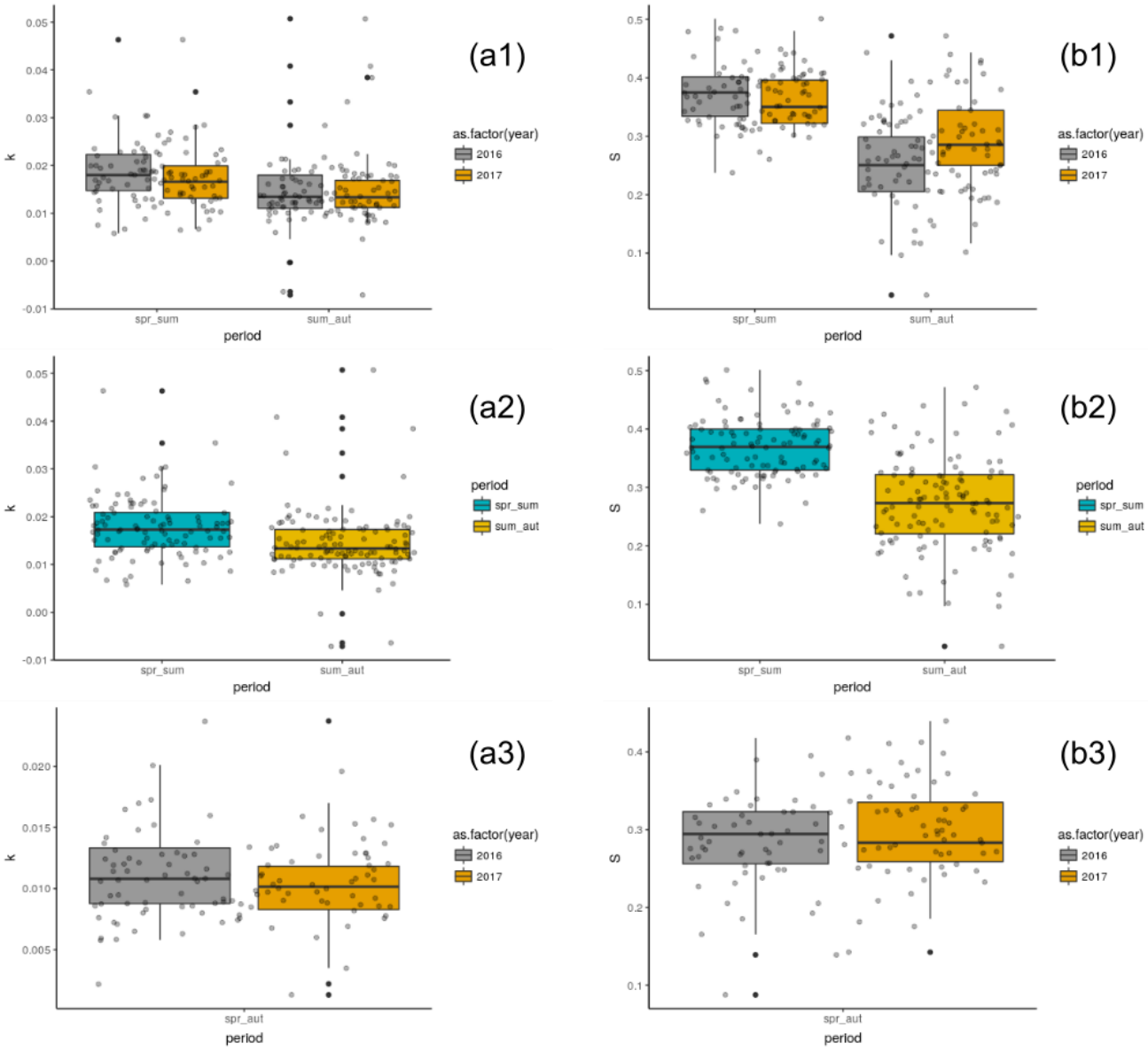

Figure 1. Decomposition rate (k) and litter stabilisation factor (S) at High (HE) and low (LE) elevation for three different periods (spr_sum: spring summer, sum_aut: summer-autumn, and spr_aut: spring-autumn) and in 2016 and 2017

Data obtained show that most decomposition occurred during P1, both in 2016 and 2017 (Figure 1, a1 and a2). Comparing the two years, we can also see that K values were a bit higher in 2016 than in 2017 (Figure 1, a3), although differences are not statistically significant. S values indicate lightly different results: whereas mean 2016 and 2017 values were very similar (Figure 1, b3), differences between periods are more different than with k, being values in P1 higher than those in P2. In this case, differences are statistically significant (specially due to low S values during P2 in 2016, Figure 1, b1). It's still very early to take big conclusions from our results. They basically indicate that most decomposition occurs during spring-early summer, a period with higher water availability and milder temperatures. If global change models are correct, with a decreasing precipitations and higher temperatures, we could expect lower mean annual decomposition rates, with consequences for the whole nutrient cycle.

Bird banding

Bird banding started this year, so we cannot compare the values obtained in 2017 with those of 2016. One of the objectives we had was assessing whether we could obtain enough data (mostly of our two target species, the Coal tit and the Crested tit) to be able to compare the high and the low elevation populations. In total, we have banded 154 birds of 19 different species, with 48 coal tits and 26 crested tits. Although results are not spectacular in numbers, they are good enough to continue with this activity during the next years. Preliminary analyses between the various morphometric measures we took during the handling (gender, reproductive status, weight, fat, muscle, P3 length and wing length), show that differences between the high and the low elevation populations are only significant comparing "fat" of the high and low populations (but only significant for coal tit). As hypothesized, values are higher for the high elevation population. Whether this is a consequence of the lower temperatures at high elevation or of other factors is something we will explore in the close future.

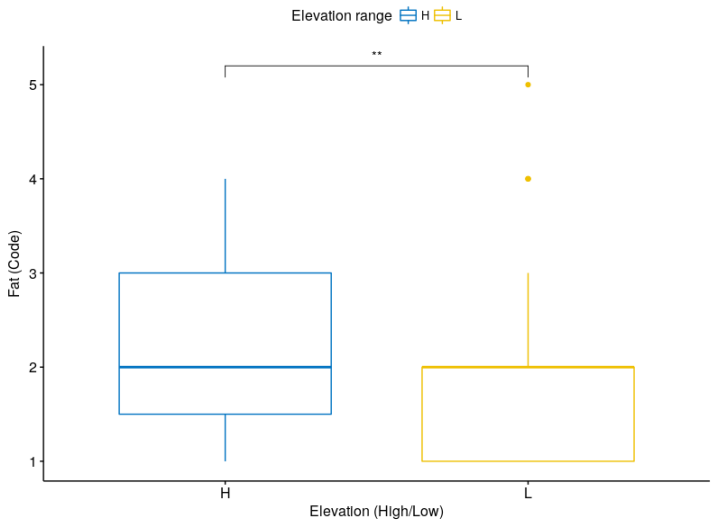

Figure 2. Left: a group of birds captured waiting I their bags to be handled; Right: Fat content of Coal tit (Periparus ater) at high (H) and low (L) elevations.

Nest Boxes

Nest boxes are starting to be used by coal tits and crested tits. In total we have seen 43 chicks in some of our nest boxes, and only 8 of them were crested tits. In addition, we found 8 nest boxes with eggs (totaling 49 eggs, and an average of 6.125 eggs/nest box), and 6 nest boxes with evidence of a nest construction start. This is a good starting point to survey the reproductive response of these two species to global warming. Also, since most chicks were banded, it will be possible to determine how the individuals in these close valleys move as they get adult. With the installation of 50 more nest boxes at low elevation (an activity carried out during the September expeditions), we will be able to see the differences between the high and the low elevation populations, results that will perfectly complement those from "bird banding".

Camera traps

Except for the fact that 6 cameras were stolen just before the September expeditions, and 2 more were stolen before taking them back to the lab in November, it seems that this activity has worked very well ("surviving" cameras without big issues). We are still checking the 178000 pictures taken by the 60 cameras during the whole 2017 (at the moment of writing this report, we have "only" 30000 to look at). Till now, the species we have are the ones we expected (roe deer, chamois, wild boar, red fox, marmot, cow, horse, some martens and birds). There is currently a Master of Sciences student that will do her thesis with some data from the pictures (both from 2016 and 2017), so we expect having some results by September 2018.

Arthropods

In 2017 we prepared a new sampling scheme for invertebrate species, mostly focused on xylophagous coleoptera because of the potential thread they can be for tree species under certain (warmer) temperatures. Three types of traps (flight interception, attraction and Malaise) were installed at low and high elevation in 5 sites. Sampling was carried out every 15 days from late June to September. The identification of samples is still going on, but so far we have identified to family 2815 individuals belonging to 29 different coleopteran families. The three most abundant families are the Curculionidae, the Staphylinidae and the Melyridae. An interesting data is that we found the first record in Andorra (and the second in the Iberian Peninsula) of two species: *Ptinus (Pseudoptinus) auberti* Abeille de Perrin, 1869, and *Ernobius nigrinus*. There is now a note to be sent to a journal to communicate these interesting findings.

Tree Growth

Complementing the 120 dendrometers (digital and analogic) installed at our 12 high elevation sites (10 per site), 60 more were installed in May at 5 low elevation sites (12 per site), to be able to compare tree growth patterns between the two elevations. Unexpectedly, preliminary data vizualizations show that trees at high elevation had a statistically higher value of basal area increment (BAI) than trees at low elevation (Figure 3, left). During some expeditions, we carried out measures to calculate competitive effects from neighbouring trees. The competition index depends on how many trees are closer than 5 meters (the more the trees, the higher the index value) and on their size (the bigger, the higher the index value). When we include the competitive effect to the equation, analyses show that elevation range is not an important (at least significantly) factor affecting the basal area increment anymore, but competition is. Results show, as expected, that the higher the competition, the lower the basal area increment of trees (Figure 3, right). Also as expected, competition index values are, in average, higher at low elevation than at high elevation (not shown here). The main conclusion we can currently extract from these results is that if, as expected, temperatures increase, black pine establishment will increase in the future at high elevations, which will lead to higher competitive effects and so lower growth rates. Precipitation decrease could prevent this effect, but models currently predict a decrease that will likely have a low effect on water availability, at least at high elevations. With these data is more difficult to predict what may happen to the low elevation trees with increasing temperatures. Future analyses of the data from the digital dendrometers may add some interesting information to this (work in progress!).

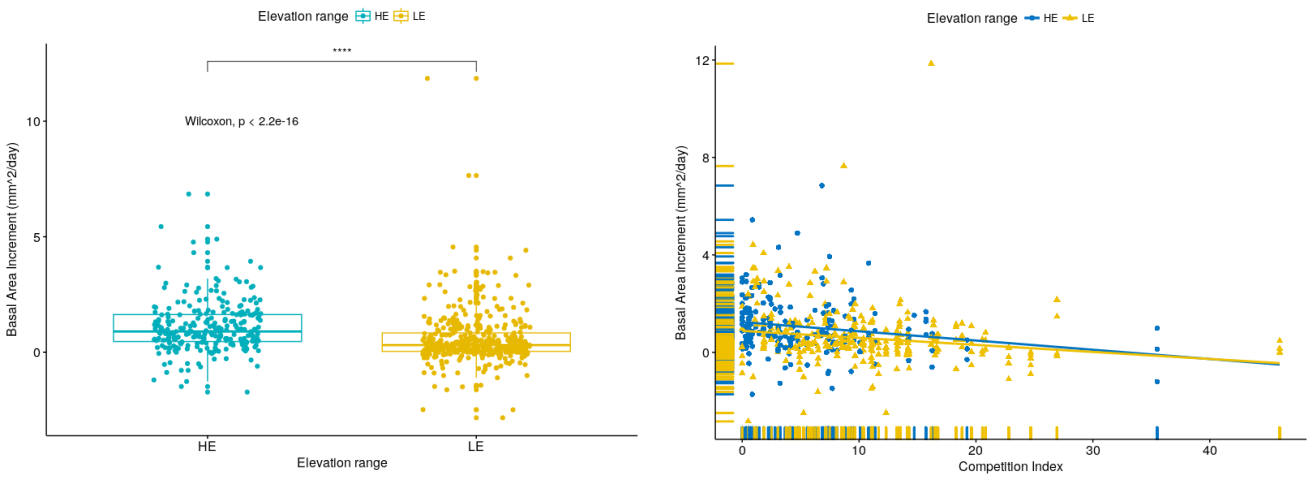

Figure 3. Left: Basal Area Increment values at high (HE) and low (LE) elevation of black pine (Pinus uncinata) in 2017. Right: effect of competition on growth of black pine (Pinus unicnata) at high and low elevation, showing the negative effect of competition on basal area increment

Exclusion Experiment

As planned, all the material to start the herbivore exclusion experiment next year are in place. We have only had a small mishap at the end of the season. The civil services of Andorra made us take out some of the metal stakes because they are in cross-country ski treks and they wanted to be sure that skiers won't get injured with the stakes. Although we had sent all the locations to have the ok from them (and we got it!!), we had to take some of them out. We hope that since the holes are already done, it will be easy and fast to prepare the plots in May.

Mushroom collection

During some expeditions we made casual observations (and collections) of mushrooms in determined sites. Results could not be better. Among the species found (133 in total), 17 are new citations for Andorra, and 31 are new localizations of species in Andorra. The list is, thus, quite long, but the species of special interest are:

- *Cortinarius caperatus* (Pers.) Fr., important because it appears in the Red List of threatened species of Spain.
- *Hygrocybe spadicea* (Scop.) P. Karst., threatened species in Europe, because of the destruction of its habitat.
- *Vibrissea truncorum* (Alb. & Schwein. : Fr.) Fr. Catalogued as NT (Nearly Threatened) in the Red List of Threatened fungi of Midi-Pyrénées, in France.
- *Melanoleuca substrictipes* Kühner. The distribution and abundance of this species is not well known because of the lack of citations.
- *Rhizocybe pruinosa* (P. Kumm.) Vizzini, G. Moreno, P. Alvarado & Consiglio. The distribution and abundance of this species is not well known because the lack of citations.

A paper is being prepared and will be sent to be published in a local journal in 2018.

Snowbed vegetation

Sampling of the two snowbeds that are part of the Pyrenean Network and are in our sites was carried out as expected. Data were sent to CENMA, our local partner and a participant of the network. No summary of the data sent has been sent to us at the moment we write this report.

Project Impacts

1. Increasing Scientific Knowledge

a) Total citizen science research hours

Number of hours per day that volunteers spent collecting data: 5-6

Number of hours per day that volunteers are being trained to collect data: 1-2

Number of hours per day that volunteers spent entering data: 1

Transportation time from accommodation to the field: 10-20 minutes per day

b) Peer-reviewed publications

We just finished our second year, so no papers have been sent to peer-reviewed publications yet.

c) Non-peer reviewed publications:

Two publications are currently being prepared to communicate the new findings (of mushrooms and coleoptera) found during the 2017 expeditions.

d) Books and book chapters

We have not participated in any book or book chapter

e) Presentations:

Bernat Claramunt gave a presentation (attached) about the project during the Pyradapt 2017 (https://pyradapt.wordpress.com/english-version/) meeting that took place in Biarritz (France) in November.

A collaborator of the Museu de Granollers also gave a presentation in the Annual Meeting of the Spanish Association for the Study and Conservation of Mammals (SECEM) (find attached the last slide, file "SECEM.png"). Ignasi Torre, the presenter, used some of our data in an oral presentation entitled "*Una década del seguimiento de micromamíferos comunes (SEMICE): período 2008-2017*" ("A decade of survey of common small mammals (SEMICE): period 2008-2017")

1. Mentoring

a) Graduate students

Student Name	Graduate Degree	Project Title	Anticipated Year of Completion
Jamie Bootwalker	PhD	Seasonal and altitudinal changes of the coleoptera community at high elevation	2020
Inés de la Cueva	MoS	The effect of human presence on ungulates behaviour in the Andorran Pyrenees	2018
Aaron	Degree	Interaction between ungulate species in the French Pyrenees	2018
Marta Prat	MoS	Large mammals responses to anthropic pressure in the French Pyrenees	2019

b) Community outreach

Name of school, organization, or group	Education level	Participants local or non-local	Details on contributions/ activities
La Massana City Council			Coordination with the course of Mycology 2017
École Primaire Fraçaise de la Massana	Primary school	2 groups of 15 + 19 students	Students of the course of Mycology 2017
Societat Catalana de Micologia (Catalan Society of Mycology)	Adult	Two days: 25 + 24	Coordination with the course of Mycology 2017
Museum of Granollers	Adult	On day: 26	Course of small mammals 2016
Ordino City Council			Coordination in the course of small mammal 2016

1. Partnerships

Partner	Support Type(s)[1]	Years of Association (e.g. 2006-present)
Andorra Turisme	Funding	2015-present
Ordino City Council	Funding	2015-present
Meteorological Service of the Andorran Government	Meteorological Data providers	2016-present

[1] Support type options: funding, data, logistics, permits, technical support, collaboration, academic support, cultural support, other (define)

2. Contributions to management plans or policies

Plan/Policy Name	Type[2]	Level of Impact[3]	New or Existing?	Primary goal of plan/policy[4]	Stage of plan/policy[5]	Description of Contribution
Sorteny Natural Park	Restoration of mountain track	Regional	New	Cultural and land conservation	In progress	Shell Better World Program
Arcalís ski resort	Hydro-sowing	Regional	New	Land conservation	In progress	Shell Better World Program

[2.] Type options: agenda, convention, development plan, management plan, policy, or other (define)

[3.] Level of impact options: local, regional, national, international

[4.] Primary goal options: cultural conservation, land conservation, species conservation, natural resource conservation, other

[5.] Stage of plan/policy options: proposed, in progress, adopted, other (define)

3. Conserving natural and sociocultural capital

a) Conservation of taxa

i. List any focal study species that you did not list in your most recent proposal

These are not focal species, but interesting species form the biodiversity point of view because we have provided de first citation in Andorra for all of them.

Species	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source
Hygrocybe spadicea	First citation in Andorra	EN (Endangered) in the Region of Midi-Pyrénées (France)	Red List of Threatened fungi of Midi-Pyrénées
Cortinarius caperatus	First citation in Andorra	Catalogued as Threatened, in Spain and Catalonia	Red List of Spain and Catalonia
Vibrissea truncorum	First citation in Andorra	NT (Nearly Threatened) in the Region of Midi-Pyrénées (France)	Red List of Threatened fungi of Midi-Pyrénées
Melanoleuca substrictipes	First citation in Andorra	DD (Data Deficient) in the Region of Midi-Pyrénées (France)	Red List of Threatened fungi of Midi-Pyrénées
Rhizocybe pruinosa	First citation in Andorra	DD (Data Deficient) in the Region of Midi-Pyrénées (France)	Red List of Threatened fungi of Midi-Pyrénées
Ptinus (Pseudoptinus) auberti Abeille de Perrin, 1869	First citation in Andorra	DD (Data Deficient)	Red List of Species in France
Ernobius nigrinus	First citation in Andorra	DD (Data Deficient)	Red List of Species in France

* Since Andorra has a small territory, we follow the recommendations of the UICN at regional level. For this purpose we take into consideration the Red List of Spain and France.

ii. In the past year, has your project helped conserve or restore populations of species of conservation significance? If so, please describe below.

A couple of activities carried out help protecting species of conservation significance. One of them is our participation in the Pyrenean Snowbed Network, providing data of two snowbeds that are in our study site. The other one has just started this year, in collaboration with the Sorteny Natural Park Office and funded with the Better World programme of Shell; in this case, the aim is to restore a couple of sensitive areas of the Natural Park where visitors walk off-trail and put in danger some plant species of the alpine community (part of them also part of the snowbed community).

b) Conservation of ecosystems

In the past year, has your project helped conserve or restore habitats? If so, please describe below.

Id, point above

c) Ecosystem services

☐Food and water

☐Flood and disease control

☐Spiritual, recreational, and cultural benefits

☐Nutrient cycling

Details:

None of them directly. This project is mostly centered on Biodiversity (an ES that is not in the list).

Research Plan Updates

Report any changes in your research since your last proposal/annual report. For any 'yes' answers, provide details on the change in the 'Details' box.

1) Have you added a new research site or has your research site location changed? ☐**Yes** ☒**No**
2) Has the protected area status of your research site changed? ☐**Yes** ☒**No**
3) Has the conservation status of a species you study changed? ☐**Yes** ☒**No**
4) Have there been any changes in project scientists or field crew? ☐**Yes** ☒**No**

Details – provide more information for any 'yes' answers

Provide details on any changes to your objectives, volunteer tasks, or methods, include reason for the change.

No important changes occurred in the 2017 expeditions, except that we added some nest boxes in our low elevation sites (not planned in the project), to compare high and low elevations reproductive traits of passerine birds from 2018 on.

Acknowledgements

We first want to thank the volunteers and Earthwatch to make this project possible. But we also wish to thank Hotel Bringué to try to make food and accommodation comfortable for all of us, Andorra Turimse and the Ordino City Hall for their collaboration in some logistics, and the Arcalís Ski Resort to be open to carry out any activity that may decrease the environmental footprint of the resort. Finally, we also want to thank Shell(c) for having facilitated employees to participate in some of our expeditions.