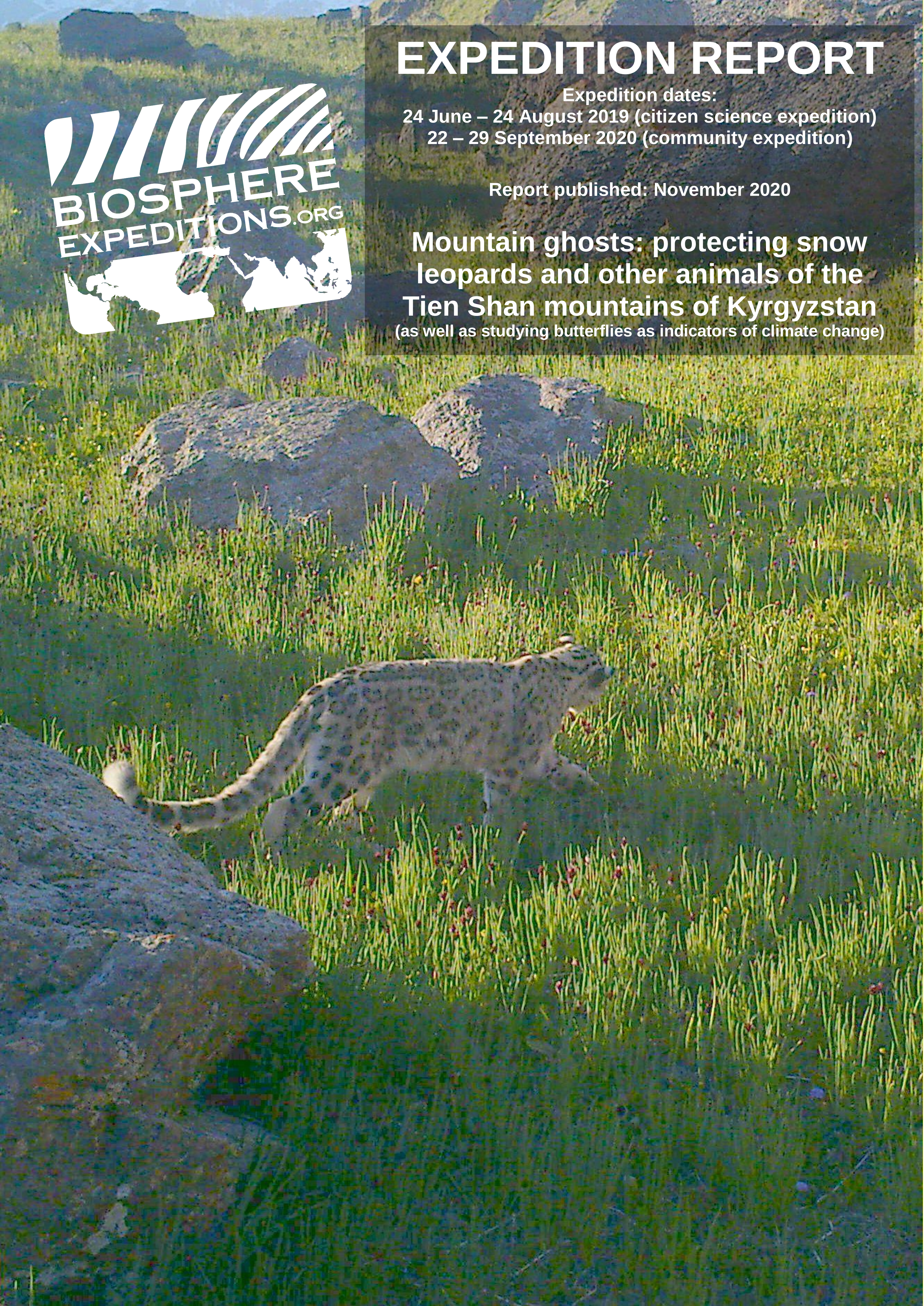
EXPEDITION REPORT

Expedition dates:
24 June – 24 August 2019 (citizen science expedition)
22 – 29 September 2020 (community expedition)

Report published: November 2020

Mountain ghosts: protecting snow leopards and other animals of the Tien Shan mountains of Kyrgyzstan

(as well as studying butterflies as indicators of climate change)



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Matthias Hammer (editor)
Biosphere Expeditions

Abstract

This study was part of a continuing annual citizen science expedition to the Tien Shan Mountains (Kyrgyz Ala Too and Jumgal Too ranges), run by Biosphere Expeditions and NABU for the sixth consecutive year from 24 June to 26 August 2019, with the aim of surveying for snow leopard *Panthera uncia* and its prey species. Using a cell methodology developed for citizen scientist volunteer expeditions, 64 cells of 2x2 km were surveyed and 9 interviews with local people were conducted. Previous expeditions had indicated that snow leopard was present in the survey area and in 2019 the discovery of fresh signs of snow leopard presence, including two camera trap recordings, confirmed the presence of the cat as well as the importance of the study area as snow leopard habitat. The surveys also showed that the area's habitat is varied and capable of sustaining a healthy prey base for the snow leopard. Potential prey species in the area are primarily Siberian ibex, marmot and Himalayan snowcock; in 2019 there was one visual record of argali. Poaching, overgrazing and other disturbances are issues that must be addressed in order to avoid habitat degradation and with it the loss of the snow leopard. Local people are mostly in favour of snow leopard presence and receptive to protecting the area and creation of economic incentives based on intact nature and snow leopard presence, but they have a poor vision on how this could be self-organised. A butterfly study that proposes alpine vs. non-alpine species as indicators of climate change was continued for the fifth year running, and bird and plant inventories were also compiled by the 2019 expedition.

In 2020, when the citizen science expedition had to be cancelled due to the coronavirus pandemic, a community expedition was organised instead from 22 – 29 September 2020. This community expedition included members of the community camera-trapping group instigated by Biosphere Expeditions in 2017 and was run by new local partner Ilbirs Foundation. The community expedition maintained and reset twelve camera traps in the study site to ensure continuous data collection. Camera trap SD cards retrieved during the expedition yielded two snow leopard captures in the same valley. This might be two records of the same individual, but picture quality was too poor to ascertain this. Other camera trap pictures corroborated previous expedition findings of a healthy prey base with records of Siberian ibex, Himalayan snowcock and badger, amongst others. Unconfirmed snow leopard signs (scat, tracks, scrapes) were also detected at three camera trap locations.

Резюме

Исследования, представленные в даной работе – это часть ежегодно проводимых гражданско-научных экспедиций в горах Тянь-Шаня (хребты Кыргыз Ала-Too и Джумгал-Тоо), проводимых Биосферными экспедициями и NABU, в течении шести лет с 2014-2019 годы с целью изучения снежного барса Panthera uncia. В 2019 году с 24 июня по 26 августа с использованием методологии ячеек, разработанных для волонтерских экспедиций гражданских ученых, было обследовано 64 ячейки размером 2x2 км и проведено 9 интервью с местными жителями. Предыдущие экспедиции указывали на присутствие снежного барса в районе исследований, а в 2019 году были обнаружены конкретные и свежие признаки присутствия снежного барса, а также две записи с камер, подтвердивших наличие кошки, а значит, и важность района исследований, как места обитания снежного барса. Исследования также показали, что местообитания снежного барса разнообразны и способны поддерживать здоровую кормовую базу. Потенциальными кормовыми видами в этом районе являются, прежде всего, сибирский горный козел, сурок и гималайская горная индейка, в 2019 году была зафиксирована одна визуальная запись об архаре. Браконьерство, чрезмерный выпас и другие нарушения среды обитания - это проблемы, которые необходимо решить, чтобы избежать деградации местообитаний и потери снежного барса. Местное население, в основном, выступает за присутствие снежного барса и восприимчиво к охране территории и созданию экономических стимулов, основанных на сохранении нетронутой природы и присутствии снежного барса, но у них слабое представление о том, как это может быть самоорганизовано. Исследование бабочек, в котором альпийские и неальпийские виды предлагаются в качестве индикаторов изменения климата, продолжалось в течении пяти лет, и в ходе экспедиции 2019 года были также составлены кадастры птиц и растений.

В 2020 году из-за пандемии коронавируса гражданские научные экспедиции были отменены, вместо них с 22 по 29 сентября 2020 года организовали общественную экспедицию. В ней приняли участие члены общинной группы, работающих с фотоловушками, созданные Биосферными экспедициями еще в 2017 году, а также подключили нового местного партнера – специалистов Фонда Илбирс. Общественная экспедиция переустановила двенадцать фотоловушек на исследуемом участке для обеспечения непрерывного сбора данных. С помощью SD-карт-ловушек, во время экспедиции, было снято два снежных барса в одной и той же долине. Возможно, это две записи одного и того же животного, но качество снимков было слишком низким, чтобы это установить. Другие снимки фотоловушек подтвердили данные предыдущей экспедиции о здоровой добыче, включая записи сибирского горного козла, гималайского снежного петуха и барсука. В трех местах ловушек также были обнаружены неподтвержденные следы снежного барса (скребки, следы, царапины).

Корутунду

Бул изилдөө илбирсти (*Panthera uncia*) жана башка жырткыч түрлөрдү изилдөө максатында, 6 жыл катары менен, 2019-жылдын июнь айынын 24нөн август айынын 26на чейин, Биосфералык экспедиция жана NABU тарабынан жыл сайын өткөрүлүүчү, Тянь-Шань тоолоруна (Кыргыз Ала-Тоо жана Жумгал тоо кыркалары) уюштурулган жарандык илимий экспедициянын уландысынын бир бөлүгү болчу. Жарандык илимпоз ыктыярчылардын экспедициясы үчүн иштелип чыгарылган торчо карта методикасын пайдалануу менен бирге, көлөмү 2x2 км болгон 64 уяча изилденип чыкты жана жергиликтүү тургундардан 9 интервью алынды. Мындан мурдагы экспедициялар изилдене турчу аймакта илбирс бар экендигин көргөзгөн жана 2019 – жылы илбирстин бар экендигинин жаңы белгилери аныкталган, аны менен эле кошо фотокапкандын камерасына жаздырып алынган эки ийгиликтүү видео, илбирстин бар экендигин, ошондой эле илбирстин байырлаган жерлери катары изилденүүчү аймактын маанилүүлүгүн аныктады. Изилдөөлөр, илбирс байыр алган аймак ар түрдүү жана илбирстин азыгы үчүн таза базаны түзүп бергенге жөндөмдүү экенин көргөздү. Бул аймактын потенциалдуу тоют түрү болуп – сибирь тоо эчки-текеси, суур жана гималай улары эсептелинет. 2019 - жылы архар бир жолу визуалдык каттоодон өткөн. Браконьерчилик, малды чектен ашык жайуу жана башка укук бузуулар оор көйгөйлөр болуп эсептелинет, бул көйгөйлөрдү илбирстин жашоо чөйрөсүнүн деградация болуп кетүүсүн жана аны менен кошо эле илбирстин жок болуп кетүүсүн алдын алуу үчүн чечүү зарыл. Жергиликтүү калк жалпысынан илбирстин болуусун туура деп баалашат жана аймакты коргоону жана илбирстин сакталышын, кол тийбеген жаратылыштын негизинде экономикалык стимулдун түзүлүшүн кабыл алууга макул, бирок кантип өз алдынча уюштуруу керек экендиги боюнча маалыматтары аз. Альпылык жана альпылык эмес түрлөрү, климаттын өзгөрүүсүнүн индикатору катары сунушталган көпөлөктөрдү изилдөө бешинчи жылы катары менен улантылган жана ошондой эле экспедициянын жүрүшүндө 2019 – жылы өсүмдүктөрдүн жана канаттуулардын кадастры түзүлгөн.

2020 – жылы коронавирус пандемиясына байланыштуу жарандык илимий экспедиция болбой калгандыктан, анын ордуна 2020-жылдын сентябрь айынын 22нен 29на чейин коомдук экспедиция уюштурулган. Бул коомдук экспедиция өзүнө 2017-жылы «Биосфералык экспедиция» баштап берген видеотартууларды жергиликтүү жамааттык топтун мүчөлөрү менен улантып жана «Илбирс» фонду менен чогуу иштерди камтыган**.** Токтоосуз маалыматтарды топтоону камсыздоо үчүн, коомдук экспедиция колдогон жана изилденип жаткан тиилкеге он эки фотокапканды кайрадан коюп чыккан. Экспедиция учурунда табылган фотокапкандын SD-картасынын жардамы менен бир эле өрөөндө эки илбирс тартылып алынган. Балким бул эки сүрөт бир эле адамдыкы болушу мүмкүн, аны такташ үчүн сүрөттөрдүн сапаты аябай начар болгон. Башка фотокапкандан алынган сүрөттөр мурдагы экспедициянын маалыматтарын далилдеди, анда сибирь тоо-эчкиси, гималай улары жана суурлар тартылып алынган. Ошондой эле фотокапкан коюлган башка үч жерде, илбирстин так ырасталбаган издери аныкталган (издер, тытыктар).

Contents

1. Expedition Review

M. Hammer (editor)
Biosphere Expeditions

1.1. Background

Background information, location conditions and the research area are as per Tytar et al. (2019c). The aim of the expedition was to survey for snow leopard *Panthera uncia* and its prey species. Side projects included community engagement, continuing butterfly and petropglyph studies as well as bird and plant inventories.

1.2. Dates & team

The project ran over a period of two months divided into two 13-day slots, each composed of a team of national and international citizen scientists, a professional scientist and an expedition leader. Group dates were as shown in the team list below.

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of ages, nationalities and backgrounds. They were (in alphabetical order and with country of residence):

24 June – 6 July 2019: Guillaume David (UK), Simone Draeger (Germany), Uwe Draeger (Germany), Lothar Ellenberger (Germany), Michele Gilbert (USA), Christiana Hebel (UAE), Christa Kuehner (Germany), Manfred Kuehner (Germany), David Lane (UK), David Merrie (UK), Tessa Merrie (UK), Stephan Nerge (Germany), Kurt Wanecki (UK).

8 – 20 July 2019: Hilary Adragna (USA), John Adragna (USA), Ismail Asykulov* (Kyrgyzstan), Christa Boersch (Germany), Christina Hoffmann (Germany), Nils Hoffmann (Germany), Angelika Krimmel (Germany), Mark Purrett (UK), Rowan Purrett (UK), Meike Soetebier (Germany), Jochen Tham (Germany), Detlev Wienpahl (Germany).

29 July – 10 August 2019: Ismail Asykulov* (Kyrgyzstan), Geoff Badham (Australia), Marcus Benner (Germany), Lyndal Coates (Australia), Clemens Herche (Germany), Nadja Hundertmark (Germany), Amelia Kaldy (Australia), Gerd Koenig (Germany), Stuart McDonald (UK), Anjum Misbahuddin (UK), Helena Preiss (Germany), Ulf Quentin (Germany), James Robbins (UK) Andreas Truegler (Austria).

12 – 24 August 2019: Dina Bof (Italy), Hubert Gfaeller (Germany), Tom Heffron (Australia), Carolin Mandanna Hurfar (Germany), Petra Loebel (Germany), Eileen Rhein** (USA), Aniek Rooderkerken** (Netherlands), Joerg Ruedenauer (Germany), Dirk Schermutzki (Germany).

*local placement | **press

Also our expedition cook throughout the expedition, Gulia Subanova and, on a rotational basis, members of NABU's anti-poaching patrol Grupa Bars: Zhyrgal Sultanov, Zhenisch Tursuniasov, Bek Seidaliev and Bekbolot Ozgorush uulu, all from Kyrgyzstan.

A medical umbrella, safety and evacuation procedures were in place. There was one medical incident, which required evacuation to Bishkek. The patient has since recovered.

The expedition scientist was Volodymyr Tytar. He was born in 1951 and obtained his Master's Degree in Biology from Kiev State University. At that time he first experienced the Tien Shan mountains and wrote a term paper on the ecology of the brown bear. He then pursued a career as an invertebrate zoologist before shifting towards large mammals and management planning for nature conservation. As well as in Kyrgyzstan, he has worked with Biosphere Expeditions on wolves, vipers and jerboas on the Ukrainian Black Sea coast, on snow leopards in the nearby Altai mountains, and has been involved in surveying and conservation measures throughout his professional life.

The first two groups of the expedition were led by Malika Fettak. Malika is half Algerian, but was born and educated in Germany. She majored in Marketing & Communications and worked for more than a decade in both the creative department, but also in PR & marketing of a publishing company. Her love of nature, travelling and the outdoors (and taking part in a couple of Biosphere expeditions) showed her that a change of direction was in order. Joining Biosphere Expeditions in 2008, she runs the German-speaking operations and the German office and leads expeditions all over the world whenever she can. She has travelled extensively, is multilingual, a qualified off-road driver, diver, outdoor first aider, and a keen sportswoman.

The second two groups of the expedition were led by Amadeus DeKastle, who has been living and working in Kyrgyzstan since 2009. Born in Germany and with a US passport, he holds a Master's degree in entomology from the University of Nebraska. He currently works with NGO Plateau Perspectives in environmental conservation with a number of citizen science research projects. He is also a part-time lecturer at the American University of Central Asia in the Environmental Management Department. In 2014, he found out about Biosphere Expeditions' work in Kyrgyzstan and signed up for a placement. After two years of volunteering with Biosphere Expeditions, he decided to jump in with both feet and joined the team in 2016.

1.3. Partners

NABU (= Naturschutzbund = nature protection alliance), founded in 1899, is one of Germany's oldest and its biggest conservation NGO. In Kyrgyzstan, NABU, in cooperation with the Kyrgyz government, is implementing a programme to conserve the snow leopard through a twin approach of research and the prevention of illegal hunting and trade of the endangered species (see http://nabu.kg/wp/).

The Ilbirs Foundation, founded in 2016, is a Kyrgyz non-profit environmental organization. It carries out educational, charitable, cultural, information, research and other socially useful activities with the aim of improving the natural environment and the conservation of rare and endangered species of animals and plants in Kyrgyzstan.

1.4. Acknowledgements

We are grateful to the expedition participants, who not only dedicated their spare time to helping but also, through their expedition contributions, funded the research. Thank you also to our partner organisations NABU and the Ilbirs Foundation, in particular NABU's Grupa Bars. Thank you also to Almaz Alzhambaev of www.carforrent.kg, the Friends of Biosphere Expeditions and all donors to a fundraising campaign for their support. Finally, thank you to the peer reviewers for helpful comments.

1.5. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Enquires should be addressed to Biosphere Expeditions at the address given on the website.

1.6. Expedition budget

Each team member paid towards expedition costs a contribution of € 2,270 per person per 12-day slot. The contribution covered accommodation and meals, supervision and induction, special research equipment and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., or visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	**€**
Expedition contributions	88,643
Coronavirus appeal fundraiser for the community expedition	3,500
Expenditure	
Expedition base includes all food & services	10,459
Transport includes hire cars, fuel, taxis in Kyrgyzstan	17,877
Equipment and hardware includes research materials & gear etc. purchased internationally & locally	4,034
Staff includes local and Biosphere Expeditions staff salaries and travel expenses	18,432
Administration includes miscellaneous fees & sundries	1,831
Team recruitment Tien Shan as estimated % of annual PR costs for Biosphere Expeditions	9,564
Income – Expenditure	**26,446**
Total percentage spent directly on project	**70%**

2. Monitoring snow leopards and other species on the south side of the Kyrgyz Ala-Too mountain range in the Tien Shan mountains of Kygryzstan

Volodymyr Tytar
I.I Schmalhausen Institute of Zoology of the National Academy of Sciences of Ukraine

2.1. Introduction

Snow leopards (*Panthera uncial*) are an endangered species found in central Asia. Their biology, distribution and its situation in Kyrgyzstan are described in Tytar & Hammer 2015, Tytar et al. 2016, Tytar et al. 2017, Tytar et al. 2018, Tytar et al. 2019c.

The aim of this expedition was to determine if the species was present in the Kyrgyz Ala-Too mountains and evaluate the potential prey base. This year's report focuses on the distribution modelling of marmots, a key prey species.

2.2. Materials and methods

Kyrgyz Ala-Too study site

The Kyrgyz Ala-Too study site and the rationale for running the expedition there are described in Tytar & Hammer 2015, Tytar et al. 2016, Tytar et al. 2017, Tytar et al. 2018, Tytar et al. 2019c.

In 2019 the base camp was located close to the Suusamyr-Kochkor road approximately in the middle of the chosen study area (42.359535ºN, 74.737829ºE, 3,002 m) (Fig. 2.2.2a). From base camp, one-day surveys were conducted in the Kyrgyz Ala-Too and Jumgal Too ranges, which were reached by car and further investigated on foot.

Methods & training of citizen scientist participants

Methods employed, sampling and data analysis techniques, as well as the training of international and local citizen scientist participants were as described in Tytar & Hammer 2015, Tytar et al. 2016, Tytar et al. 2017, Tytar et al. 2018, Tytar et al. 2019c.

Sixty-four cells, each 2 x 2 km in size, located in the southern Kyrgyz Ala-Too Range and neighboring Jumgal Too (Fig. 2.3a) were surveyed for snow leopard and sympatric medium and large-sized mammals and game birds from late June to late August 2019. Surveys were conducted at an average elevation of 3496±30 m asl. Individual survey teams ranged from four to eight citizen scientists and daily search efforts took from four to ten hours, depending largely on weather conditions, distance of the survey site from base camp and complexity of the terrain.

Snow leopard signs searched for during this study included pugmarks (tracks), scrapes, faeces (scat), urination, rock scent spray and observations (including camera trapping).

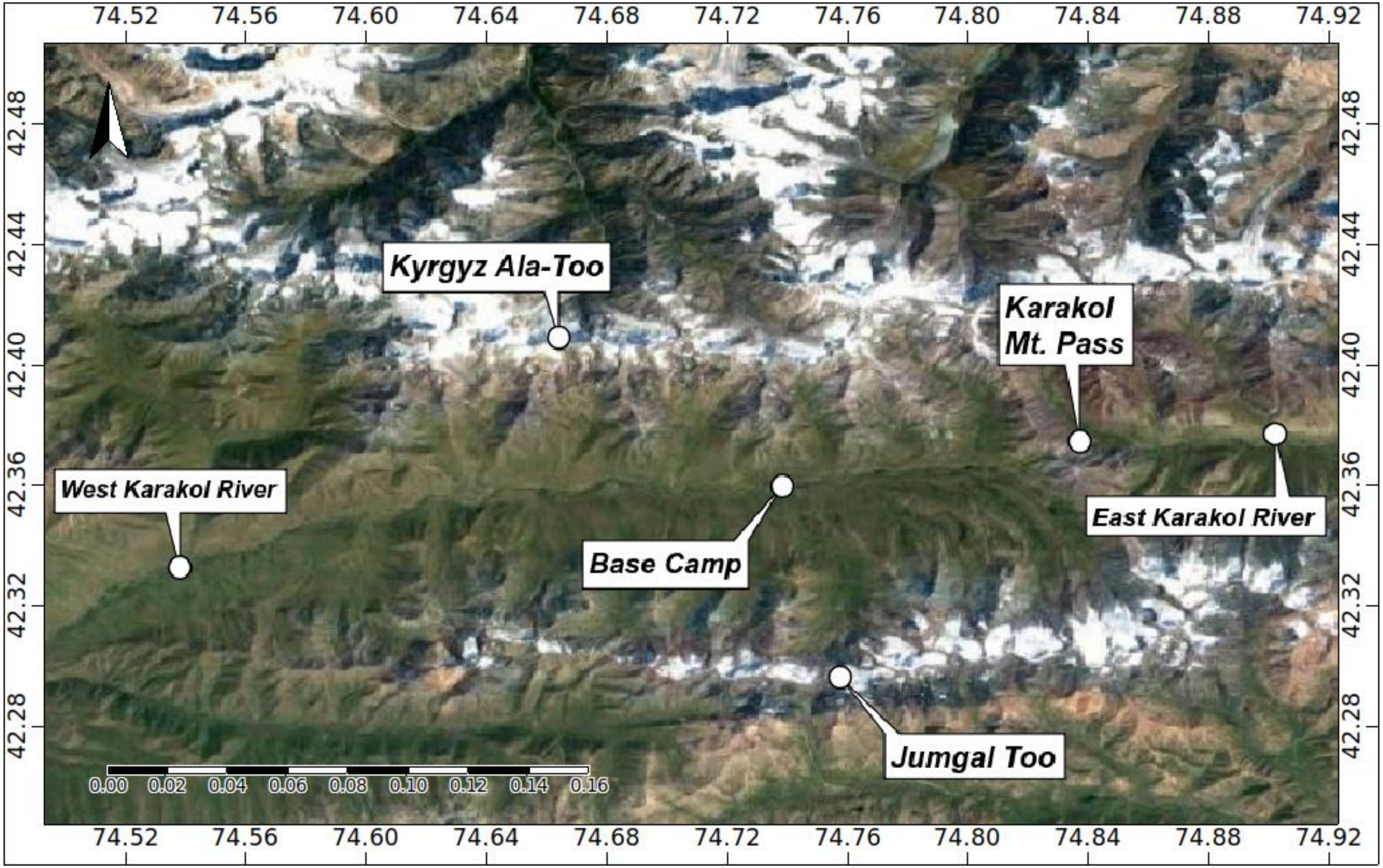


Figure 2.2.2a. Google Earth map of the study area with various locations shown.

Surveying the prey base is another essential component of a snow leopard presence/absence survey. Prey species were surveyed by recording signs and by observation including camera trapping. Prey signs included tracks, faeces, hair/wool, and carcasses/bones. Two groups of prey species are considered: 'primary', consisting of Siberian ibex (*Capra sibirica*) and argali (*Ovis ammon*), and 'secondary' – long-tailed or red marmot (*Marmota caudata*), pika (*Ochotona* sp.), roe deer (*Capreolus capreolus*), hare (*Lepus capensis tolai*) and other small mammals, and game birds (primarily Himalayan snowcock, *Tetraogallus himalayensis*). The same search sites were used for snow leopard and prey surveys.

Evidence of other carnivores (wolf, fox) sharing snow leopard habitat was also recorded.

Understanding factors influencing the existence of the prey resource is a basic requirement and this knowledge can help to focus efforts on protecting the prey species snow leopards rely on and distinguish areas of interest. Because marmots form a part of the diet of the snow leopard, a comprehensive mapping of marmot habitat using an approach called species distribution modeling was used. *MaxEnt* software was used to generate an estimate of habitat suitability and map the distribution of marmots in the study area.

Thirteen Bushnell camera traps were set throughout the study area by the expedition. Two strategies were employed to install the cameras: on in which the field team identified good spots to produce photos of the snow leopard and prey species; secondly, relying on a species distribution model built on previously obtained visual records of Siberian ibex, the main food source for the snow leopard (Tytar et al. 2019a).

After the expedition, these camera traps are maintained by the community monitoring group set up in previous years by the expedition (Tytar et al. 2016, Tytar et al. 2017, Tytar et al. 2018, Tytar et al. 2019c) through the winter of 2019/2020 up to the arrival of the next expedition.

For a general biodiversity assessment of the area, other vertebrate species, including birds (see appendix II) and mammals, as well as plants (see appendix III) were recorded whenever possible following procedures described in Tytar & Hammer 2015, Tytar et al. 2016, Tytar et al. 2017, Tytar et al. 2018, Tytar et al. 2019c.

Interviews were conducted with local people in their villages, settlements and surrounding areas, following procedures described in Tytar & Hammer 2015, Tytar et al. 2016, Tytar et al. 2017, in order to gather local knowledge about the area and record snow leopard sightings, to investigate the level of human/wildlife conflict and to learn about local attitudes to wildlife and natural resources.

In addition to the biological surveys, rock art (petroglyphs) was also recorded in the study area by taking photos and GPS positions of them, as well as describing the scenes depicted. Beyond their value as an aesthetic and historic expression, petroglyphs provide a rich body of information on several different dimensions. For instance, they have been used in studies of climate change and the changing inventories of species (Lenssen-Erz & Heyd 2015). Also establishing a firm link between biodiversity conservation and the conservation of cultural heritage could open new opportunities in preserving the area.

2.3. Results

Around 78% of the cells were sampled once, 22% of the cells were resampled 2 to 13 times, 315 records of animals of interest were made in 63 cells.

2.3.1. Snow leopard presence/absence survey

Snow leopard records made during the 2019 expedition are summarised in Table 2.3.1a (exact GPS locations are omitted for conservation reasons).

Table 2.3.1a. Snow leopard signs recorded by the 2019 expedition.

Date	Elevation (m)	Cell code	Type of record
11 July 2019	3703	AD16	Track and scat
11 July 2019	3657	AD16	Scat
12 July 2019	3606	AG15	Track, Figure 2.3a
12 July 2019	4110	AE16	Tuft of fur (?)
15 July 2019	3512	AF20	Camera trap record, Figure 2.3c
31 July 2019	3653	AD16	Camera trap record, Figure 2.3d
7 August 2019	3643	AD16	Track
7 August 2019	3643	AE20	Track
8 August 2019	3705	AE20	Track, Figure 2.3b
8 August 2019	3723	AE20	Scat

Tracks (pugmarks)

Tracks are more easily found in sand, mud or patches of fine gravel alongside streams and/or melting snow and ice within the habitat of the snow leopard. Snow patches left over from the winter and fresh snow cover were specifically examined for tracks. Out of the 5 pugmark records, 4 were discovered in soft soil and one trail was found in snow.

Figure 2.3.1a. Snow leopard track in snow (12 July 2019, cell AG15).

Figure 2.3.1b. Snow leopard track in mud (8 August 2020, cell AE20).

Scrapes

Scrapes are markings made by the snow leopards with their hind legs in form of little mounds of soil substrate. These can be found in sandy sites (short-lived) and fine gravel (longer-lived). In our study site suitable substrates are usually absent in areas favoured by the snow leopard, where the majority of substrate is broken terrain. No scrapes were recorded in 2019.

Scats

Scats (faeces) can be deposited solitarily or with other scats of varying ages. Scats are most often found in association with scrapes. There is a high risk of misidentification of other species' scats as those of snow leopards and vice versa. Only genetic testing can confirm the species with sufficient confidence. Three scats presumably belonging to the snow leopard were found this year and collected for genetic confirmation.

Urination

Urine can be deposited on scrape piles and is commonly deposited along regular paths or trails. No definite signs of urination were found during the survey period. Lack of trails and difficulty in finding scrapes were a contributing factor.

Scent spray

Snow leopards spray-mark the faces of upright or overhanging boulders and the base of cliffs. Some sites are periodically revisited and re-sprayed (mainly along trails). No scent spray was found during the survey.

Observations (including camera trapping)

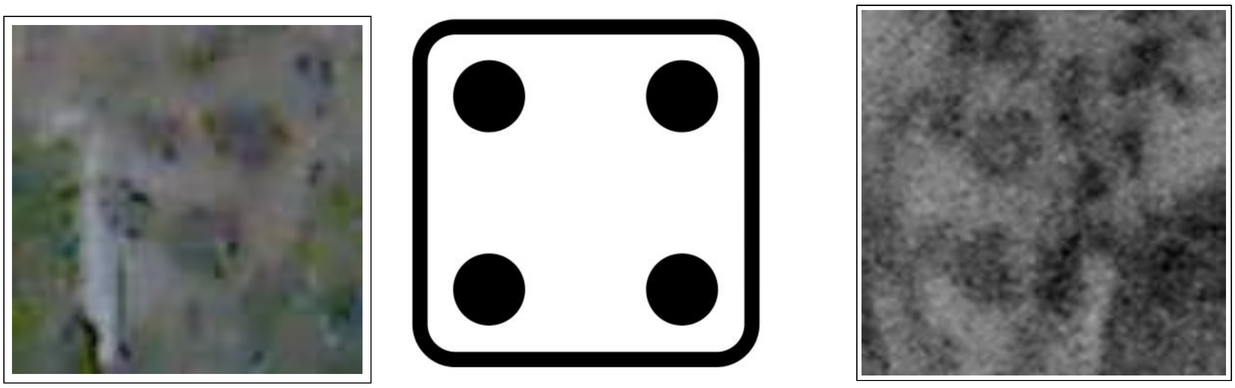
Two clear camera trap records of the snow leopard were taken in the study area during the expedition. One of the records was made in the late evening hours (19:50). The flash was not triggered, so the picture (found amongst 2,610 taken in total by the camera) had to be processed in an image editor (Figure 2.3.1d). Interestingly, this record was made at the lowest altitude (3,512 m) ever recorded for a snow leopard by the expedition in the study area since 2014.

Because the home range size of snow leopards varies widely, up to as much as 400 km^2 (McCarthy 2000), the question arose are these accounts of one and the same animal? Fortunately, in both cases the photographic records produced good images of the forelimbs, the distinct pelage patterns of which are commonly used for individual identification of snow leopards based on rosette/spot pattern definition and variability (Jackson et al. 2005).

The red circles in Figures 2.3.1c and 2.3.1d show spot patterns on the right flank that are clearly different. In addition, in Figure 2.3.1e another obvious difference can be seen between the individuals: in one of them (a) four spots in a dice-like pattern are well defined, which cannot be said about the other individual (b). Our conclusion is that we are most likely dealing with two different animals.

Figure 2.3.1c. Camera trap picture of a snow leopard taken in the evening hours (15 July 2019, cell AF20). Note spot pattern in red circle for comparative purposes.

Figure 2.3.1d. Camera trap picture of a snow leopard taken at night (31 July 2019, cell AD16). Note spot pattern in red circle for comparative purposes.



a b

Figure 2.3.1e. Dice-like spot pattern on upper forelimb of the snow leopard recorded on 15 July 2019 (a) and the corresponding, but not matching pattern in the individual recorded on 31 July 2019 (b).

Threats to snow leopard presence

In the course of the presence/absence survey, an account was taken of human-induced factors considered to threaten snow leopard presence in the area. Grazing activities turn out to be the most common and are widespread, although in the early season, most of the grazing is confined to areas within the larger river valleys, foothills and lower portions of the side valleys. But later on, with the depletion of pastures, herders move their livestock higher up and reach altitudes where they disturb snow leopards and/or their prey. This also increases the risk of depredation, however this year there have been no reports of any attacks of snow leopards on domestic animals.

Many areas suitable for grazing have been abandoned by herders as they are no longer subsidised by the government. We have noticed over the last years that the number of private herders moving in is rising (our estimation is that there could have been a three-fold increase since 2014). This is likely to aggravate the situation.

Occasional horse droppings and car tracks found at higher altitudes indicate sporadic human presence over much of the area. Trekkers crossing remote mountain areas have been recorded too. Other signs of human presence and disturbance included bullet cases, hides, campfires and various items of rubbish left behind by visitors. The last set of signs signs indicate poaching if they cannot be associated with legal hunting.

Usually it is hypothesised that snow leopards largely confine themselves to undisturbed expanses, with less frequent or no use of areas affected by human presence (McCarthy, Chapron 2003). However, for the sake of objectivity, it should be noted that in both cases where camera traps recorded snow leopards human presence and activities were recorded too: in cell AF20 dozens of bulls had been grazing and occasionally attended by herders; cell AD16 had been frequently visited by locals on horseback, accompanied by herding dogs, because a mobile phone signal can be obtained there from a spot just opposite to where the camera trap had been installed. Therefore we propose that human presence, if not overwhelming, is less important as the availability of suitable prey, which the camera trap recorded repeatedly throughout the season, either exactly where the shot of the snow leopard was taken, or closely nearby.

Camera trapping

The installation of the Bushnell camera traps in the study area started on 5 July 2019 and ended on 20 August 2019, when the last traps were retrieved from the field. In summary, cameras were active for a total of 453 trap days. Out of the 13 installed cameras, only two yielded no results. Cameras photographed 28 incidences, depicting two snow leopards, 18 and 8 presences of ibex and snowcock respectively; these numbers and the photographic rates (expressed as photos/100 trap days after O'Brien et al. 2003) are given in Table 2.3.1b.

Table 2.3b. Number of independent photos (capture events) and photographic rates for snow leopard and prey.

Species	Number of photos (events)	Photographic rate
Snow leopard	2	0.44
Siberian ibex	18	3.97
Himalayan snowcock	8	1.77

Prey base survey

Signs of prey species (ibex, argali, marmot, snowcock etc) found during presence/absence surveys using the cell-based methodology were fairly abundant and widespread in a variety of terrains for some species (total of 327 records) (Fig. 2.3.1f). Siberian ibex comprised 33% of these records (18 were made by camera traps, there were nine sightings of the animals, the rest were records of footprints, droppings etc.). There were very few indirect, presumably argali, records, with only one sighting of two young male individuals. Marmots are common at lower elevations (n = 147 = 45%), whereas sign of snowcock presence (n = 45 = 14%) appear at higher altitudes, with recordings made through droppings and feathers (n = 35), camera trap records (n = 8) and direct sightings (n = 2).

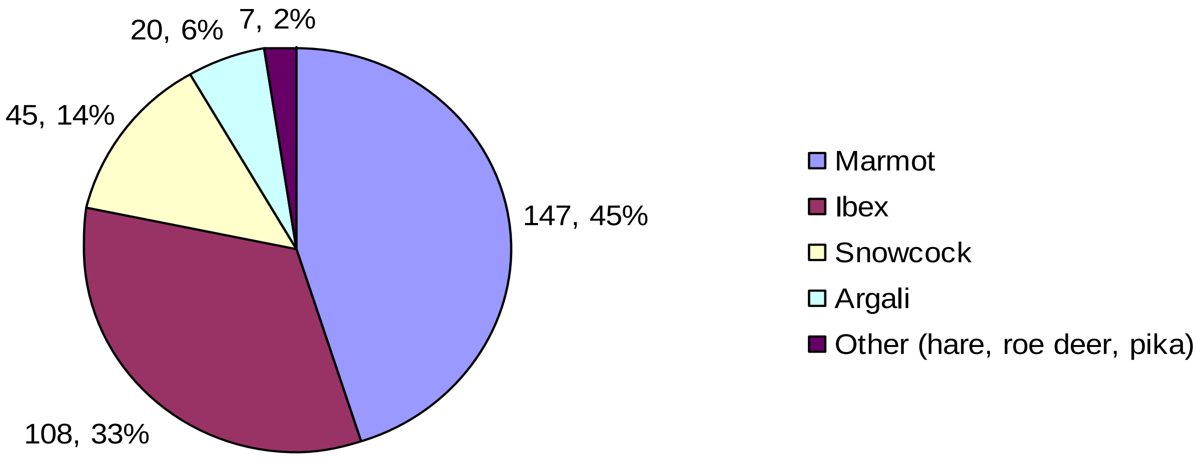


Figure 2.3.1f. Total number and percentages of records of prey species.

2.3.2. Marmot records and distribution modelling

The presence of occupied marmot burrows was recorded using the location (cell) given by a grid with cell size 2 by 2 km,, the code of which was displayed in a GPS. Using cells allows examination of data at a wider scale, so information is collected from different cells that are spread from each other, avoiding data autocorrelation. Environmental factors that may affect the spatial distribution of burrow systems were considered: land surface temperature (LST) in winter and summer, summer normalized difference vegetation index (NDVI), a Digital Elevation Model (DEM), and soil type data (obtained from MODIS website and SoilGrids). The relationship between environmental factors and burrow records was analysed using ecological niche models (*MaxEnt software*) to predict the distributions of marmot burrows. The models performed well with average test AUC values of 0.939 (n = 30; test percentage 30%). The order of variable importance in the models were summer NDVI and DEM, winter LST, summer LST, and soil type. The distribution of the suitable areas was largely (up to 38 % permutation importance) affected by summer NDVI. NDVI is an indicator of the feeding conditions of marmots and most of the records were distributed in areas with NDVI in summer ranging from 0.5 to 0.7. According to the prediction maps (Fig 2.3.2a), suitable marmot habitat (> 0.5 predicted probabilities of occurrence) can occupy up to 40% of the study area. Such prediction maps can be used to direct sampling efforts to areas on the landscape that tend to have greater predicted probabilities of occurrence and accomplish ground validation of snow leopard habitat quality. This research has been published recently by Tytar et al. 2019b.

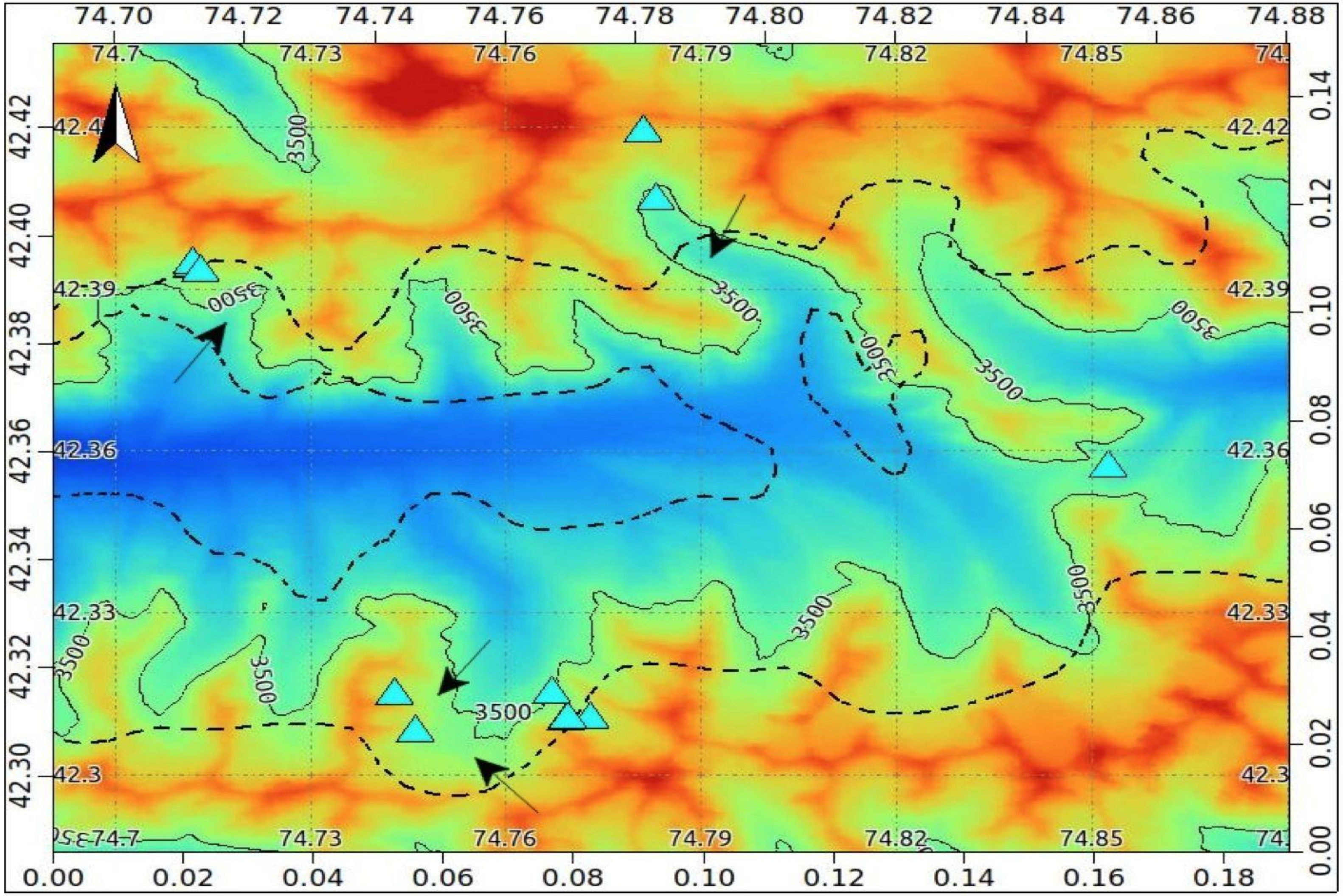


Figure 2.3.2a. Digital elevation map of the Kyrgyz Ala-Too study area (range from red at highest elevation to blue at lowest). The dashed line contours areas of predicted probability of long- tailed marmot occurrence exceeding the 10 percentile training presence threshold value; the solid line contours elevation at 3,500 m; triangles indicate places where records were made of the snow leopard; arrows point to priority conservation areas (map from Tytar et al. 2019b).

2.3.3. Outreach activities and interviews

Nine interviews in different households were conducted within the local community. These activities reached nine adult herders (seven men and two women, aged between 27 and 60+).

In most cases livestock was of a mix of sheep, goats, cows, horses and other domestic animals such as donkeys, some poultry and a number of dogs. In all nine households there were varying numbers of sheep (between 230 and 700 heads) and horses (between 5 and 105), dairy cows (usually around 10, but in one case 360 heads), bulls and yaks (up to 300 and 100, respectively), and goats (up to 150 heads).

In reponse to the question "Have you ever seen a snow leopard and/or sign of a snow leopard?" only one herder said he had seen sign of snow leopard (pugmarks). Others said "no" and they do not know someone who has seen a snow leopard or sign of the animal.

Together these responses evidence the rareness of the species in the area, possibly exacerbated by the elusive character traits assigned to it in local folklore and the fact that herders rarely come into contact with the predator. As in past years, positive responses from local people are few, however, they continue to indicate that snow leopard is present in the surveyed area and confirm its importance as a habitat for the species.

When respondents were asked how they felt about the snow leopard, five reported "liking" the animal (… "*our beauty*"…, …"*they are an important resource for tourism…, … flagship animal for Kyrgyzstan"*); in four attitudes were neutral, adding that snow leopards do not create any problems for them.

When asked about the snow leopard's impact on the area, five repondents were fully in favour of the animal, whereas the others kept neutral. One respondent compared the role of the snow leopard to that of wolves in Yellowstone.

In terms of significance for the country, five repondents considered the species to be beneficial. Interviewees knew the snow leopard is under protection in Kyrgyzstan (the Red Data Book of the Republic was often mentioned) and appreciated the legal protection of the species. From these results, it is clear that there is a good basis in the area for developing nature conservation initiatives and developing community involvement.

None of the interviewees believed that snow leopards can attack humans, nobody has been a witness of such an attack, although some have heard such stories told by somebody else.

In terms of community assessment of human/predator relations, three of the respondents said that snow leopards attack domestic animals when they live nearby, but claimed that this affected only sheep. Once again, the widespread belief (in Asia) was repeated that snow leopards feed exclusively on the blood of their victim: "… *only sucks blood of the sheep…*", and in support of this view " … *the flesh of the*

dead sheep was totally white ...". But the impression from the questioning is that livestock depredation by the snow leopard in the area does not appear to be a major issue, because there "… *are too few*…", etc. As in previous years, much more blame for losses of domestic livestock was put on wolves: "…*wolves attack livestock*…, *wolves kill more than they can eat* ...", which are considered by locals to be the most serious threat to their well-being.
Interviewees had no opinion upon the impact of snow leopards on populations of large or small animals, but were far from considering the snow leopard a threat to populations of prey species, because "…*snow leopards just eat them*…" and "…*the real threat comes from wolves and poaching*".

Most of the interviewees found it a "good thing" if snow leopards attracted more tourists to the region, because this could create more job opportunities and generate alternative means of income. Many would be ready to sell local products (meat, cheese, kumis, felt carpets etc.) and/or develop tourist-based businesses. There is, however, some fear amongst locals that business investment may lead to corruption and spark unfair competition with established travel companies.

Seven of the interviewees were in favour of creating some kind of protected area that could benefit wildlife and solve some of the day-to-day problems they are facing. For instance, the eradication of wolves where a coordinated programme, led by an authority, could be effective. Some of them consider a nature park administration such an authority, which should have a sufficient number of rangers for implementing eradication measures, enforcing hunting rules, etc.

Community camera-trapping group

A community camera-trapping group was initiated in 2017 to extend camera trap surveying in the study area year-round. The nucleus of the group was and is centered around Amantur Tolgartbekov uulu, a NABU employee and expedition ranger at the time, and a native of Don Alysh village on the edge of the study site. Initially Amantur Tolgartbekov uulu helped train two male community members from Don Alysh during the expedition in July 2017 (Figure 2.3.3a).

Training included the use of camera traps and trapping techniques. Further training was subsequently provided by members of NABU and ten Bushnell camera traps were handed over to the community monitors with the task of setting and monitoring the cameras in a number pre-defined areas in the Kyrgyz Ala Too after the 2017 expedition. Although no more snow leopards were captured on camera by the community group over the 2017/18 camera-trapping season, valuable data were collected on the species composition of this high altitude habitat and seasonal movements of animals, particularly Siberian ibex (Table 2.3.3a).

Figure 2.3.3a. Amantur Tolgartbekov uulu (left foreground, kneeling) providing training on camera traps for members of the community monitoring group.

Figure 2.3.3b. Ibex captured by the community group in 2017.

Over the 2018/19 camera-trapping season four community members were involved in camera-trapping with ten camera traps. Unfortunately the photos for that season were lost due to a communications problem, but they did not include snow leopard captures.

Over the 2019/20 camera-trapping season four community members were involved in camera-trapping with twelve camera traps. The highlight of this season were two captures of snow leopard in February 2020 (Figure 2.3.3c), in the same valley, so they may be two captures of the same individual. Picture quality was not good enough to allow for distinguishing between individuals.

When the citizen science expedition, planned for the summer of 2020, had to be cancelled due to the coronavirus pandemic, the community group ran its own week-long community expedition in September 2020 with three community members, supported by two local staff from the Ilbirs Foundation (Figure 2.3.3d), thus ensuring continuous data collection despite the pandemic. The community expedition returned with a wealth of data, including snow leopard sign records (Table 2.3.3a). It also performed camera trap maintenance and adjustment, ready for the 2020/2021 season until the annual citizen science expedition can hopefully return in the summer of 2021.

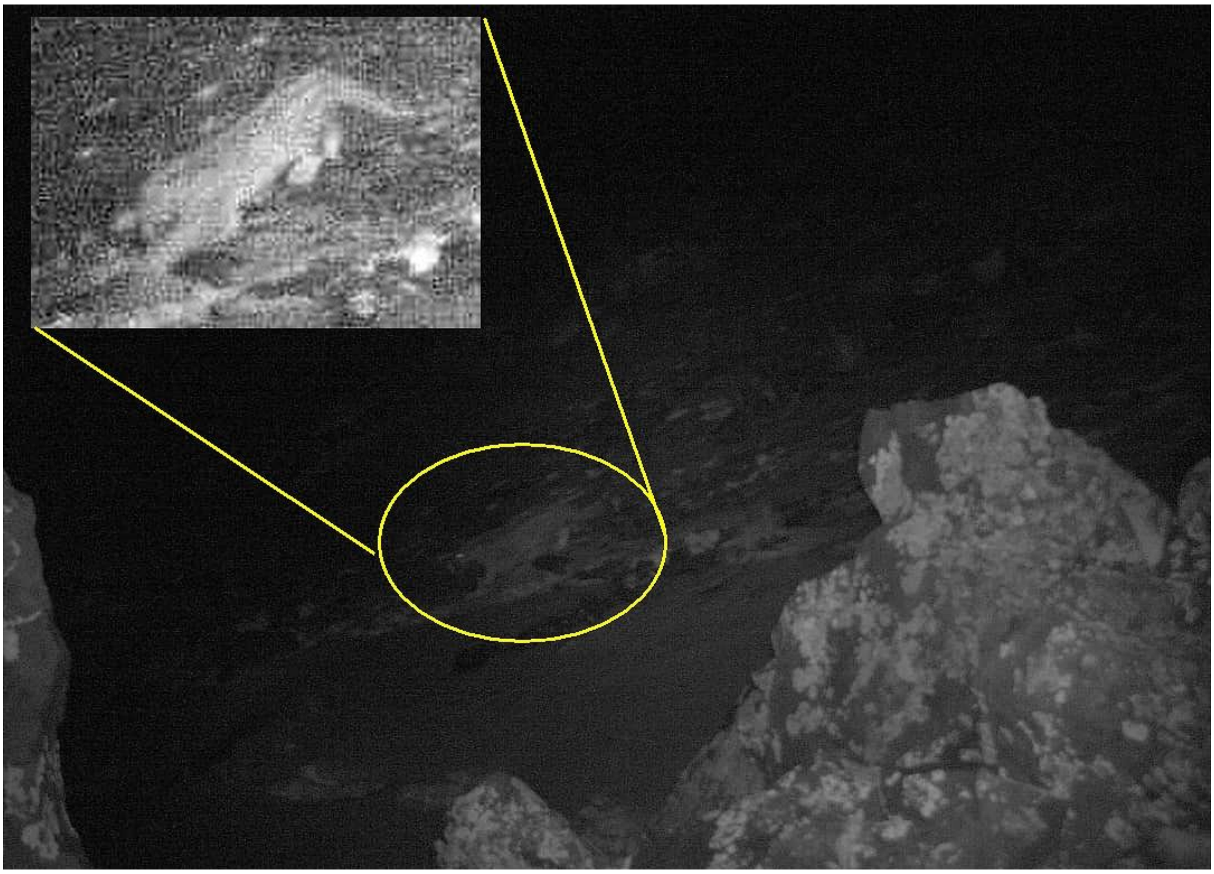


Figure 2.3.3c. Snow leopard caught on camera trap by the community monitoring group in February 2020. The dark image was processed to reveal the animal as shown.

Figure 2.3.3d. Community expedition members in September 2020.
From left to right: Askat Mukabaev, Azamat Abasov, Sagynbek Zhumaliev, Shamil Abdyldaev

Figure 2.3.3e. Example of community camera-trapping result for 2019/2020 season: badger.

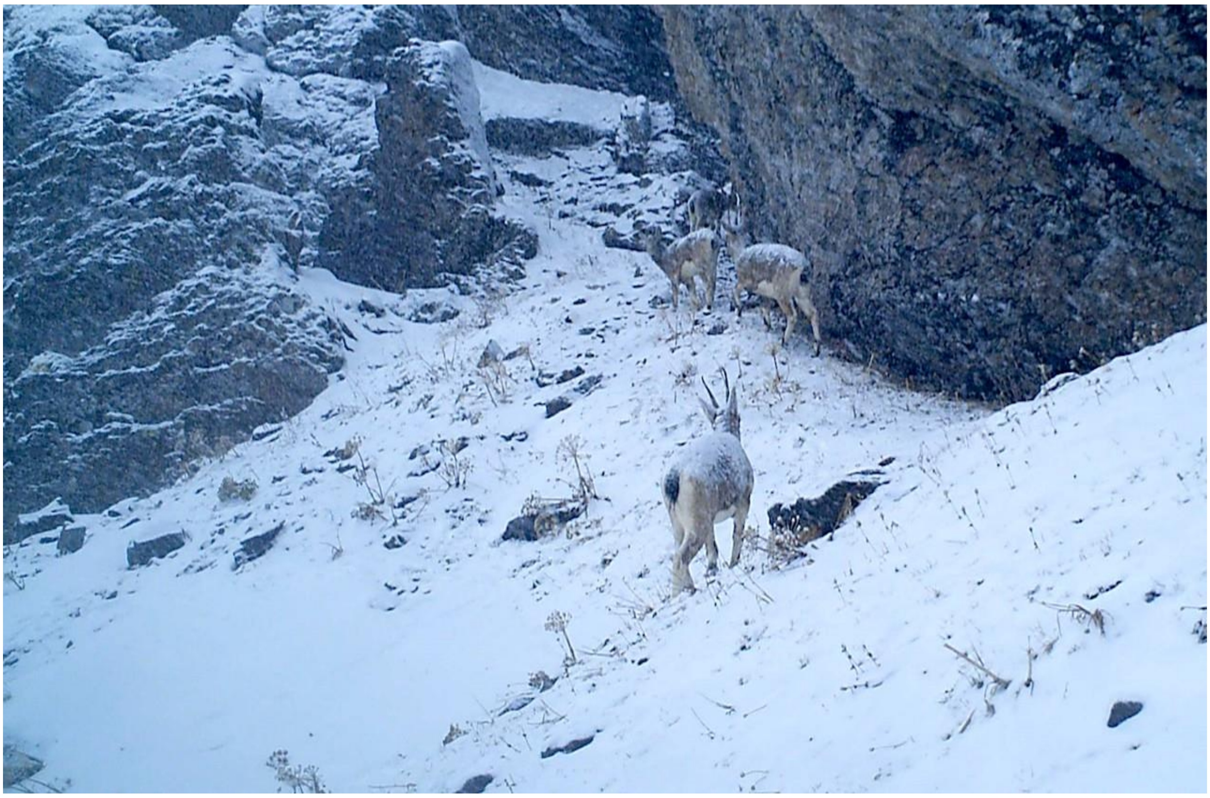


Figure 2.3.3f. Example of community camera-trapping result for 2019/2020 season: ibex.

Figure 2.3.3g. Example of community camera-trapping result for 2019/2020 season: ibex.

Figure 2.3.3h. Example of community camera-trapping result for 2019/2020 season: pika.

Figure 2.3.3i. Example of community camera-trapping result for 2019/2020 season: red fox.

Table 2.3.3a. Results of the community camera-trapping group 2017-2020.

Area	Start and end dates of recording	Number of camera traps	Resulting camera trap nights	Photo capture events (number of recording events, not individuals)	Remarks
			2017/2018 season		
Karakol West	21 Aug 2017 – 17 July 2018	2	371	Siberian ibex 4x Snow cock 5x Stone marten 3x Stoat 3x Mountain hare 1x	The longest active camera period was eleven months. This camera trap at approx. 3,800 m elevation recorded the last appearance of ibex on 10 October 2017 with reappearance on 1 July 2018. Other operating periods range from one to four months
Karakol East	14 Oct 2017 - 6 Dec 2017	8	408	Siberian ibex 11x Stoat 3x Snow cock 1x Stone marten 2x Mountain hare 1x	Camera traps were only in the field for 2 to 3 months each.
			2018/2019 season		
Karakol East & West	Not applicable	10	0	Ten camera traps were set up by a team of four community members in both the East and West Karakol Valleys. Photos lost due to miscommunication, but did not include any snow leopard captures.	
			2019/2020 season		
Karakol West	27 Sept 2019 - 23 Sept 2020	5	1022	Siberian ibex 21x Snow cock 4x Red fox 3x Weasel 2x	Data combine records from the usual camera-trapping season plus the community expedition in September 2020. The community expedition also found three snow leopard scats, three scrapes and two tracks at various camera trap locations. Two camera traps were able to record nearly a full year worth of data.
Karakol East	13 Sept 2019 - 24 Sept 2020	8	1139	Siberian ibex 39x Snow cock 6x Pika 3x Stone marten 2x Snow leopard 2x Badger 1x Red fox 1x	Both Snow leopard captures were from the same valley, so this could potentially be the same individual. These are also the first camera trap records of pika (Figure 2.3.3h) since the beginning of the expedition. One camera was active for eleven months, with the rest recording between four and seven months each. The badger result is shown in Figure 2.3.3e and the red fox in Figure 2.3.3i.

2.3.4. Additional surveys

Evidence of other carnivores sharing snow leopard habitat was also recorded. These included the wolf *Canis lupus* the red fox *Vulpes vulpes* and ermines *Mustela erminea*. Foxes were distributed all over the area, whereas definite wolf signs were found only in three places. Wolves are the major predators in the area, causing losses to domestic livestock, therefore arousing deep concern amongst herders.

Ground surveys have also come across sign of the manul *Octolobus manul*, also called the Pallas's cat, classified as Near Threatened by the IUCN (Ross et al. 2015). The species is also listed in the Red Data Book of Kyrgyzstan (VI category, Near Threatened, NT).

For the first time a record (sighting) has been made of a pika species – the Turkestan red pika *Ochotona rutila*. In contrast with most other pikas, the Turkestan red pika is a quiet species and has no alarm calls and no song vocalisations. It is a rock-dwelling pika, which usually takes shelter in large boulders (Smith, Lissovsky 2016) commonly of moraine origin where, in fact, the animal was spotted.

Camera trap studies commonly record other species besides the ones targeted. Few of these 'collateral' data are ever published. They may, however, provide important information about the biodiversity in the region and documentation of species thought to be locally extinct or absent (McCarthy et al. 2010). During the expedition camera trap records were made of the red fox, badger *Meles leucurus*, stone marten *Martes foina*, listed in the Red Data Book of Kyrgyzstan: VII category, Lower Risk/least concerned - LR/lc, marmot *Marmota caudata*, as well as a number of bird species: commonly the yellow-billed chough *Pyrrhocorax graculus*, Guldenstadt's redstart *Phoenicurus erythrogaster* and accentors *Prunella* spp..

Birds are convenient indicators of biodiversity, at least at larger scales, and as monitors of environmental change (Furness & Greenwood 1993). One reason is that birds have long been popular with naturalists, amateur and professional, and consequently their taxonomy and distributions are well known. Birds, furthermore, play an informational role in attracting public attention to natural habitat (Bibi & Ali 2013). In 2019 the expedition recorded 70 bird species (appendix I). Three - the golden eagle *Aquila chrysaetos*, bearded vulture, *Gypaetus barbatus*, and Egyptian vulture *Neophron percnopterus* - are listed in the Kyrgyz Red Data Book; the Egyptian vulture was recorded for the second time. Ten species were recorded for the first time: Booted eagle *Aquila pennata*, red-fronted rosefinch *Carpodacus puniceus*, little ringed plover *Charadrius dubius*, feral pigeon *Columba livia domestica*, yellowhammer *Emberiza citrinella*, rusty-rumped warbler *Locustella certhiola*, bluethroat *Luscinia svecica*, variable wheatear *Oenanthe picata* morpha *opistholeuca*, greenish warbler *Phylloscopus trochiloides* and brown accentor *Prunella fulvescens*. Using the Bray-Curtis similarity index (Hammer et al. 2001), a comparison of similarities between the species composition of the bird inventory made in 2014, on the one hand, and subsequent inventories made in 2015-2019, on the other, has shown a small amount of variability (coefficient of variation=9.6%). Despite the erratic way bird records are collected, this low variability permits the assumption that the bird community in the study area is in a relatively stable condition, which seems to accord with habitat stability. In general, near two-thirds of the species (62.8±2.66%) found in the area compose a permanent core of the bird fauna and are routinely recorded from year to year.

Expedition participant David Merrie, a keen amateur naturalist and botanist, also completed a plant inventory of the area (see appendix II).

2.3.5. Rock art and burial mound inventory

Participants continued to compile a database of georeferenced records of rock art in the study area (the rationale for this work and previous surveys are in Tytar & Hammer 2015, Tytar et al. 2016, Tytar et al. 2017, Tytar et al. 2018, Tytar et al. 2019c.)

During this expedition, 200 of pieces of rock art were documented, categorised as "animal & man" (180 records) and "writing or symbol" (20), together with five locations of burial mounds (Fig. 2.3.5a).

Recently the database (namely, rock art) has been considered in a publication (Hermann et al. 2020). In summary, the authors concluded: "The repertoire, dominated by animals and particularly by caprines (goats), reflects the pastoral use of the valleys of this region, providing a continuity from the beginning of the Iron Age until nowadays. In spite of successive periods and styles, the imaginary context is basically still the same in the rock art depictions, with caprines, sometimes attacked by wolves, and some isolated hunting scenes. The Turkic period gives more importance to camels, as well as to representations of clan signs, perhaps to mark zones of pasture. In the Soviet era the shepherds continued to represent almost exclusively caprines. However, except for a star and nine Cyrillic inscriptions, the Soviet world does not seem to have influenced the graphic representations".

2.4. Discussion and conclusions

On an expedition such as this, covering large areas of remote, rough and broken terrain, it is difficult to find signs of snow leopard and its primary prey species. Ungulates and carnivores favour higher grounds and are more dispersed during the summer season and snow leopard signs are harder to find.

Anecdotal evidence from local people in 2014 (Tytar & Hammer 2015) indicated that snow leopard was present in the area and confirmed the importance of the study area as a habitat for snow leopard. Subsequent sign surveys (Tytar et al. 2016, Tytar et al. 2017, Tytar et al. 2018, Tytar et al. 2019c) yielded further confirmation of snow leopard presence by discovering a total of 29 snow leopard signs. The 2019 citizen science expedition for the second time recorded snow leopard through camera-trapping. The community expedition in 2020 demonstrated continued snow leopard presence through two snow leopard photo captures in the same valley (perhaps the same individual) and found unconfirmed signs (scats, scrapes, tracks) at three camera trap locations.

Further research is needed to monitor snow leopard numbers and distribution, and to monitor snow leopard prey population trends in the survey area. Presence/absence surveys will need to be repeated in the coming years, using camera traps throughout the year via the help of the community camera-trapping group. These efforts can be guided by modelling exercises, showing places where basic requirements for Siberian ibex and marmots, upon which snow leopards rely, are likely to be met.

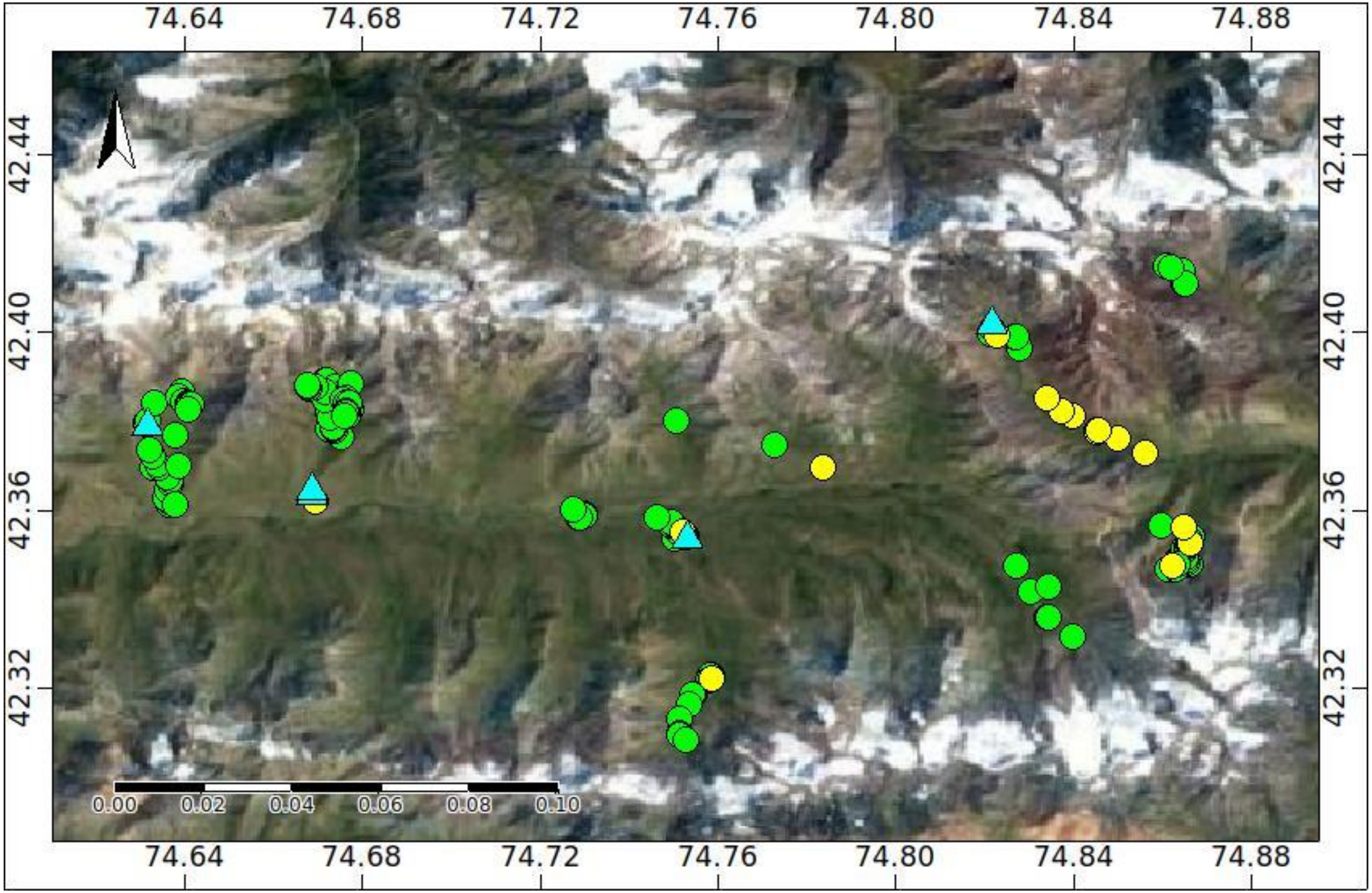


Figure 2.3.5aa. Distribution of rock art and burial mounds in the study area (2019 inventory): green circles – “animal & man”, yellow circles – “writing or symbol”, blue triangles – burial mounds.

With the end of a subsidised socialist economy a slow recovery of wildlife has occurred, but with the current growth of the human population in the country, competition for pasture grounds and development may nullify this positive trend and drive the snow leopard out of the area. Under these circumstances, there is an urgent need for site protection and management through building upon areas which up to now we have prioritised (Tytar et al. 2017, Tytar et al. 2018).

Conservation planning to protect biodiversity can benefit from the results of the modelling: areas with predicted high habitat suitability for the Siberian ibex were in the first place considered for this purpose. Live observations and successful camera trap recordings of ibex in these areas, together with records of snow leopard sign, have identified wildlife areas promising for developing a local network of protected areas. We assume that in the meantime "wildlife sanctuaries" (Kyrgyz terminology "zakaznik") are the most suitable category of protected area in our case. These could become components of a wider ecological corridor connecting the Ala Archa National Park and wildlife areas located further to the east beyond the Karakol Pass. The current Law on Specially Protected Natural Areas (SPNA) defines wildlife corridors, but it is not clear on how establishment of these corridors is to be initiated, who is responsible for managing these areas, and how they are to be managed. Moreover, wildlife sanctuaries are considered exclusively in terms of "game". Therefore there should be serious amendments made to the current law before any effective conservation planning in the area can occur and this should be an important issue for NABU Kyrgyzstan and the Ilbirs Foundation to lobby. In parallel, another option would be to develop a local community-based game management area and consider wildlife needs in the local pasture management planning. The community camera-trapping group may well provide the nucleus and impetus for such efforts, which should be explored further.

Poaching of ibex and related disturbance may be core factors driving animals out of the site, a notion well perceived by local herders. As a priority recognised by NABU staff, improved anti-poaching control could have an immediate impact on halting the decline of prey species and, by inference, snow leopards.

Because some locals feel that an endorsed protected area could benefit wildlife and solve some of the problems they are facing, there is a need more actively to involve the community around this idea and find ways how this could be self-organised, particularly in terms of curbing poaching and implementing fair hunting rules, which would also benefit the local hunters from the communities. Again, the community camera-trapping group as well as the new collaboration with the Ilbirs Foundation may provide the resources and expertise needed for this.

In terms of exploring possibilities of benefiting the local community, snow leopard research and associated activities could be considered as a valuable tourist resource for generating income. The friendly attitude towards the snow leopard expressed by the majority of local people could be the key to the success of both research and community initiatives.

Liaising with local people, who by and large have positive attitudes towards snow leopard presence in the area, will continue to play a key part in the research. Continued dialogue with herders is important, not only to find out what has happened in between expedition periods, but to involve them more fully in the research and in the prevention of poaching. For this purpose community members from the surrounding area were trained in camera trapping techniques in order to extend the study season, have been successful in continuing to monitor camera traps within the Kyrgyz Ala Too between expeditions and ensured continuous data collection through a short community expedition when the annual summer citizen science expedition had to be cancelled in 2020 due to the coronavirus pandemic. It is hoped that the citizen science expedition can return in the summer of 2021.

All these activities should and will continue. They may lead to the establishment of a local community-based NGO, which may manage the area as its own conservation and game management area.

Tasks for future expeditions

Key points of future Biosphere Expeditions snow leopard expedition to the mountains of Kyrgyzstan are:

1. Continue to evaluate and map the current status of snow leopard populations in the Kyrgyz Ala Too range (including the neighboring Jumgal Too), concentrating efforts in areas predicted to be of good habitat suitability for both the snow leopard and its prey.

2. Focus interviews conducted with local people on nature conservation issues, particularly on their vision of how the area could be protected and the role of the local community.

3. Continue to develop relationships with local partners NABU, the Ilbirs Foundation and the community camera-trapping group with a view to providing the impetus and resources for further community-based conservation activities and the creation of a community-based NGO and protected area.

4. Resume citizen science expeditions as soon as possible.

2.5. Literature cited

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3. Butterflies of the west and east Karakol river valleys, Kyrgyzstan, 2019

(Lepidoptera, Diurna)

Amadeus DeKastle
Plateau Perspectives and American University of Central Asia

3.1 Introduction, materials and methods

Rationale and methods of data collection are described in Tytar et al. 2019c. Data were collected by the last expedition group only in the locations shown in Figure 3.1a.

The aims of the study are twofold, first of all to continue collecting information on species distribution and diversity in the region, and secondarily to work out potential elevational shifts in response to climate change.

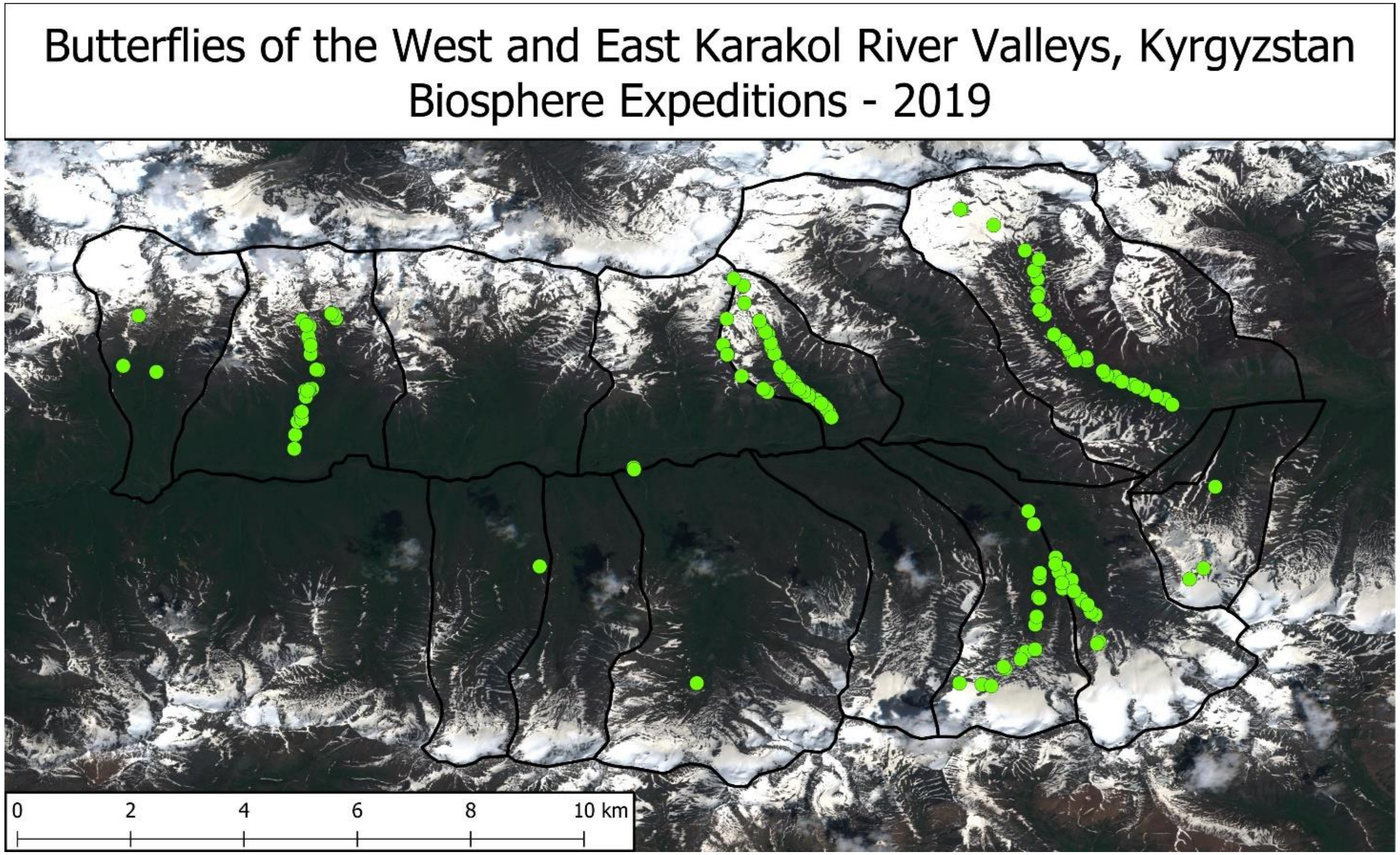


Figure 3.1a. Map of the West and East Karakol river valleys studied with data points for each butterfly observation.

3.2. Results

Twenty-one butterfly species were identified with 162 individual sightings (Table 3.2.a). Some of these species provide new location data absent in previous years' publications (see above). For example, sightings of *Colias cocandica*, *Thymelicus lineola* and *Karanasa kirgisorum* provide new data on distribution of these species, as very few records exist from previous years. In 2017, one species (*Colias cocandica)* had only a single, doubtful sighting (Tytar et al. 2018), in 2018, a positive identification was made showing that the species is in fact present in the study area, albeit in low numbers. In 2019, three more positive identifications were made, increasing our understanding of this butterfly's distribution significantly. Another species, *Vanessa cardui,* had not been seen since 2016, and in 2019 it was the most commonly spotted butterfly out of all 21 species.

Table 3.2a. Butterflies recorded by the expedition.

Family	Scientific name	Common name
Hesperiidae	*Thymelicus lineola*	Essex Skipper
Lycaenidae	*Aricia agestis*	Brown Argus
	Lycaena phlaeus	Small Copper
	Polyommatus icarus	Common Blue
Nymphalidae	*Aglais urticae*	Small Tortoiseshell
	Argynnis aglaja	Dark Green Fritillary
	Boloria generator	-
	Melitaea solona	-
	Vanessa cardui	Painted Lady
Papillionidae	*Papilio machaon*	Old World Swallowtail
	Parnassius mnemosyne	Clouded Apollo
	Parnassius tianschanicus	Large Keeled Apollo
Pieridae	*Colias cocandica*	-
	Colias erate	Pale Clouded Yellow
	Colias thisoa	Menetries' Clouded Yellow
	Pontia callidice	Lofty Bath White
	Pontia daplidice	Bath White
Satyridae	*Coenonympha caeca*	-
	Coenonympha sunbecca	-
	Erebia sokolovi	-
	Karanasa kirgisorum	-

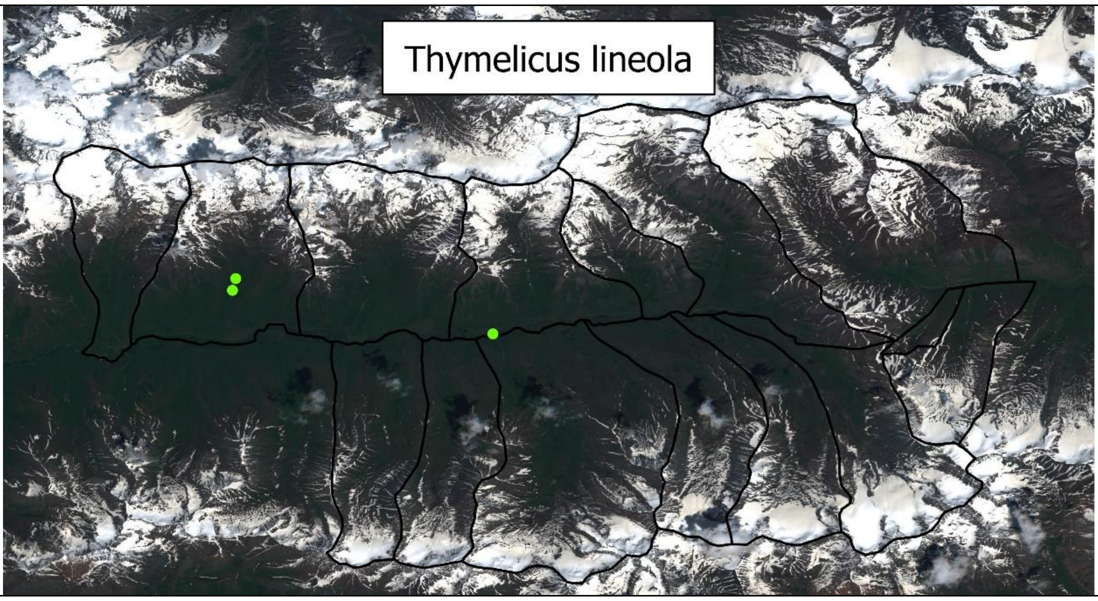
Species profiles

Species profiles include photographs, natural history and distribution maps for each species observed during the expedition. The profile information from the reference material provided below, not from our own data sets. Maps were created using the data collected during the expedition. All photographs and maps are the property of the author (unless otherwise noted) and only permitted for use outside this report with written permission.

Hesperiidae

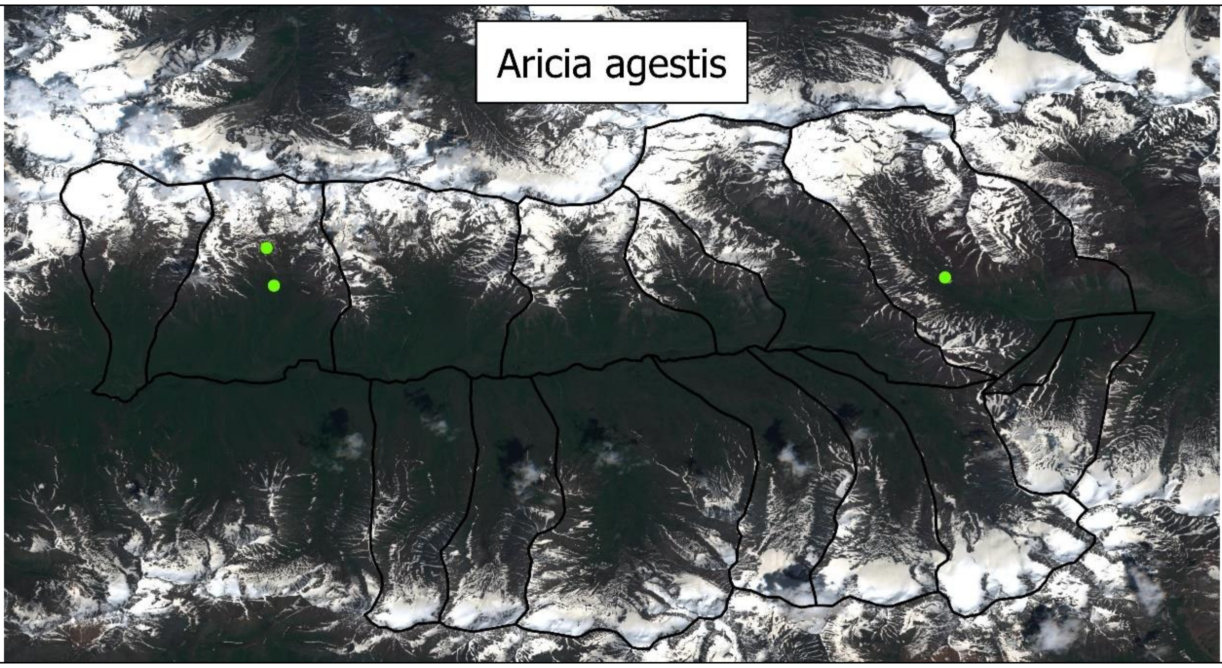
Thymelicus lineola - Essex Skipper			
Flight time	May to August	Elevation (m)	Up to 2600
Habitat	Clay, stony gorges, cultivated areas		
Food plants	*Brachypodium spp.*		
Life cycle	Univoltine and overwinters as an egg		

Photo Courtesy of Gail Hampshire - 2014

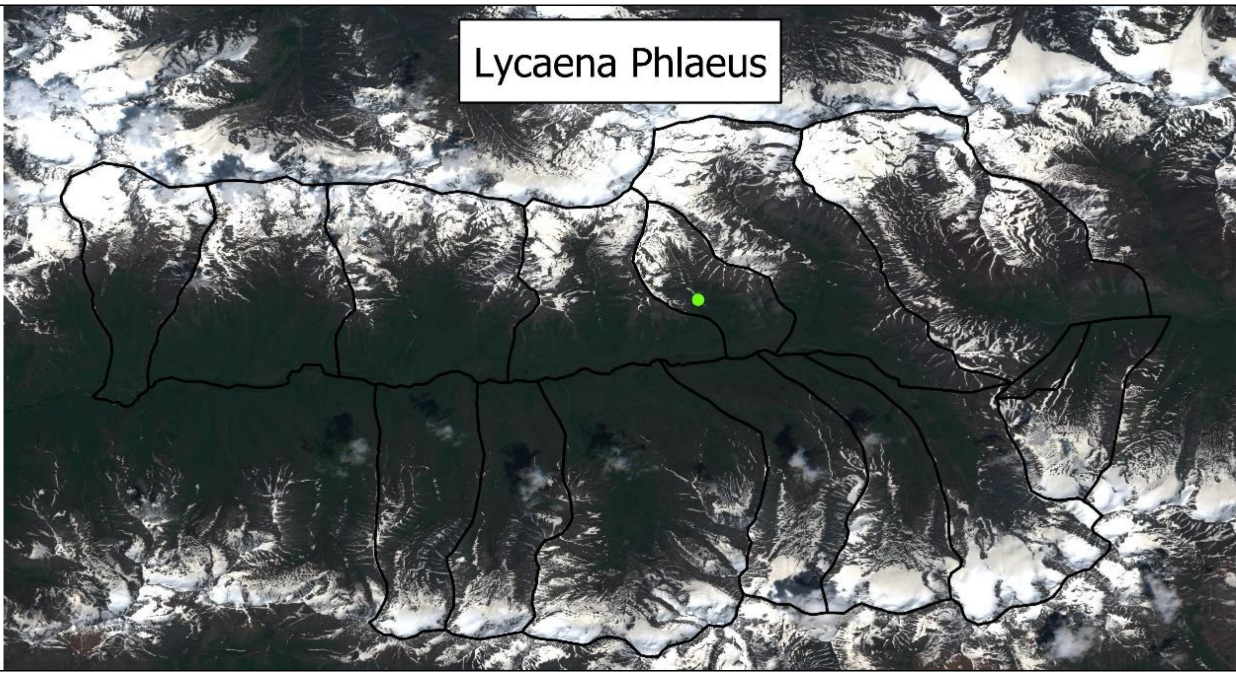


Lycaenidae

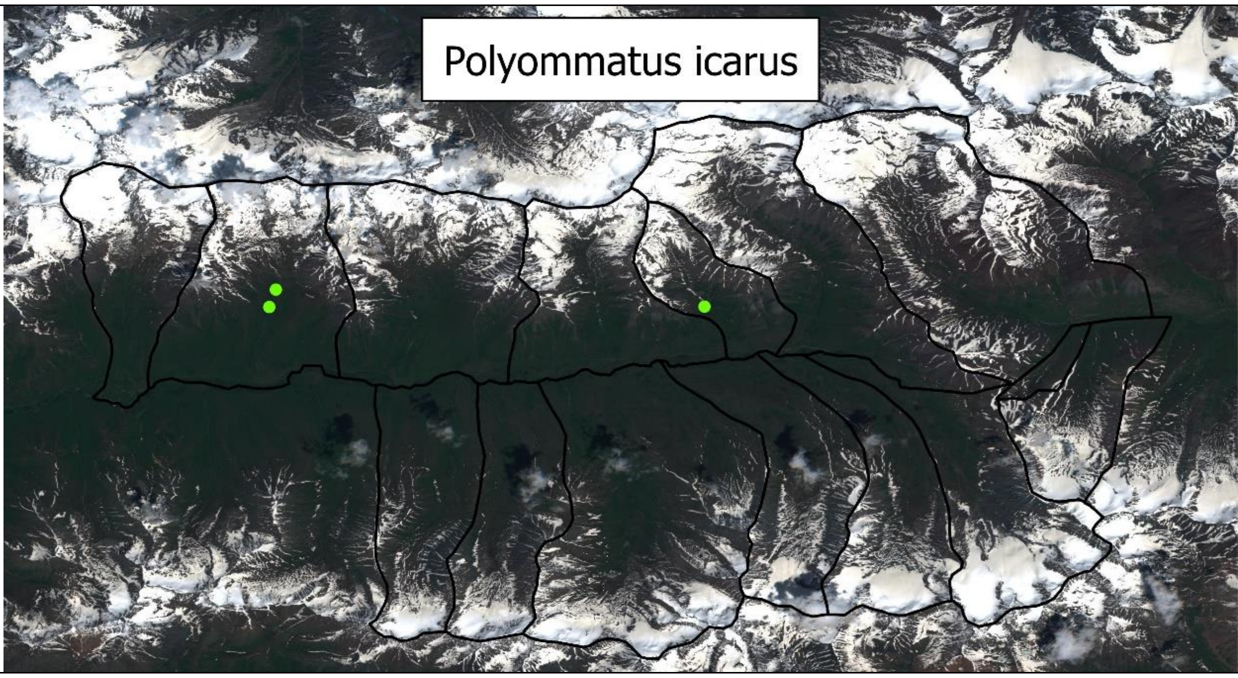
Aricia agestis - Brown Argus			
Flight time	May to September	Elevation (m)	1700-3800
Habitat	Dry meadows or steppe areas		
Food plants	*Erodium spp.* (storksbill) and *Geranium spp.* (cranesbill)		
Life cycle	Eggs are laid singly. Species overwinters as larva and pupates in the spring. Univoltine or bivoltine.		



Lycaena phlaeas - Small Copper			
Flight time	June to August	Elevation (m)	Up to 4500
Habitat	Meadows in lowlands and mountains		
Food plants	*Rumex spp.* (Sorrel)		
Life cycle	Multivoltine. Overwinters as a larva, likely tended by ants.		

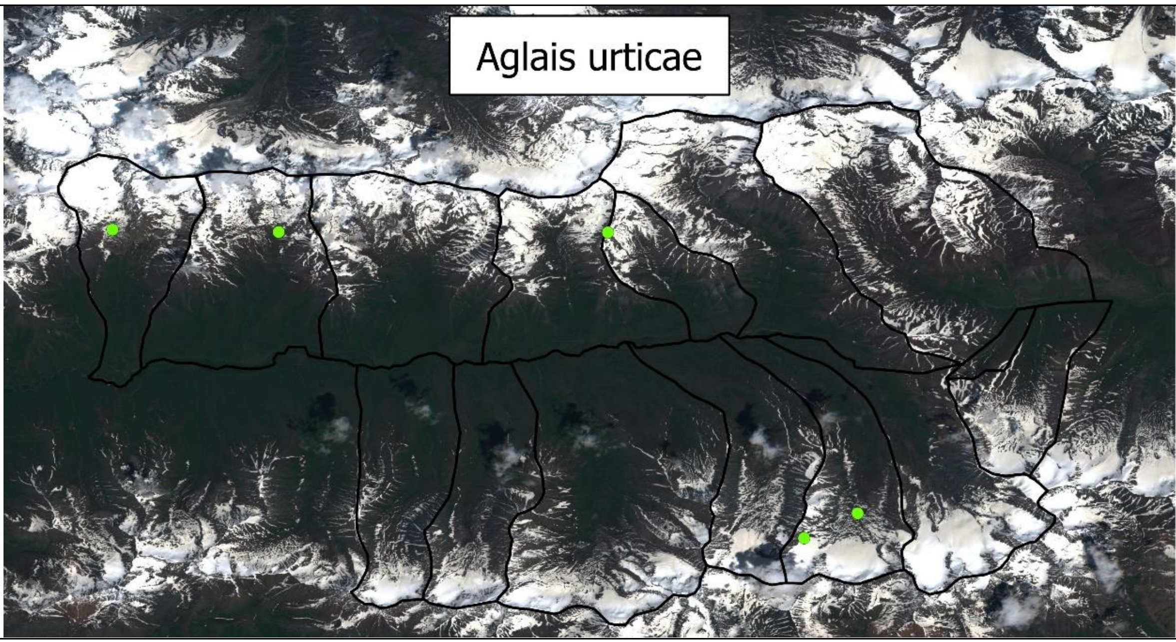


Polyommatus icarus – Common Blue			
Flight time	May to September	Elevation (m)	Up to 3000
Habitat	Grassy meadows, xerophytic slopes and river valleys, mountainous areas		
Food plants	*Medicago spp.* (Burclover), *Onobrychis spp.* (Sainfoin), *Trifolium spp.* (Clover)		
Life cycle	Eggs are laid singly. Species overwinters as larva. Larva is attended to by ants (from the genera *Lasius, Formica, Plagiolepis,* and *Myrmica*) Typically bivoltine.		



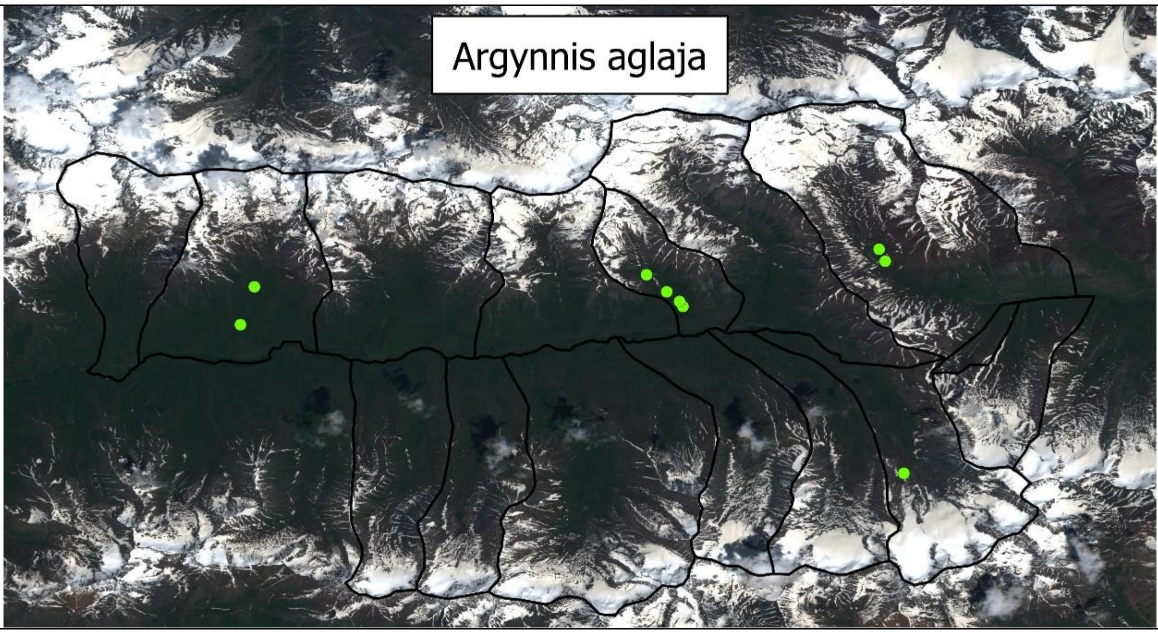
Nymphalidae

Aglais urticae — Small Tortoiseshell			
Flight time	April to September	Elevation (m)	up to 4000
Habitat	Open areas and mountain gorges with a high density of the host plant		
Food plants	*Urtica spp.* (stinging nettle)		
Life cycle	Adults overwinter in a state of hibernation begun around October. They emerge during early spring		

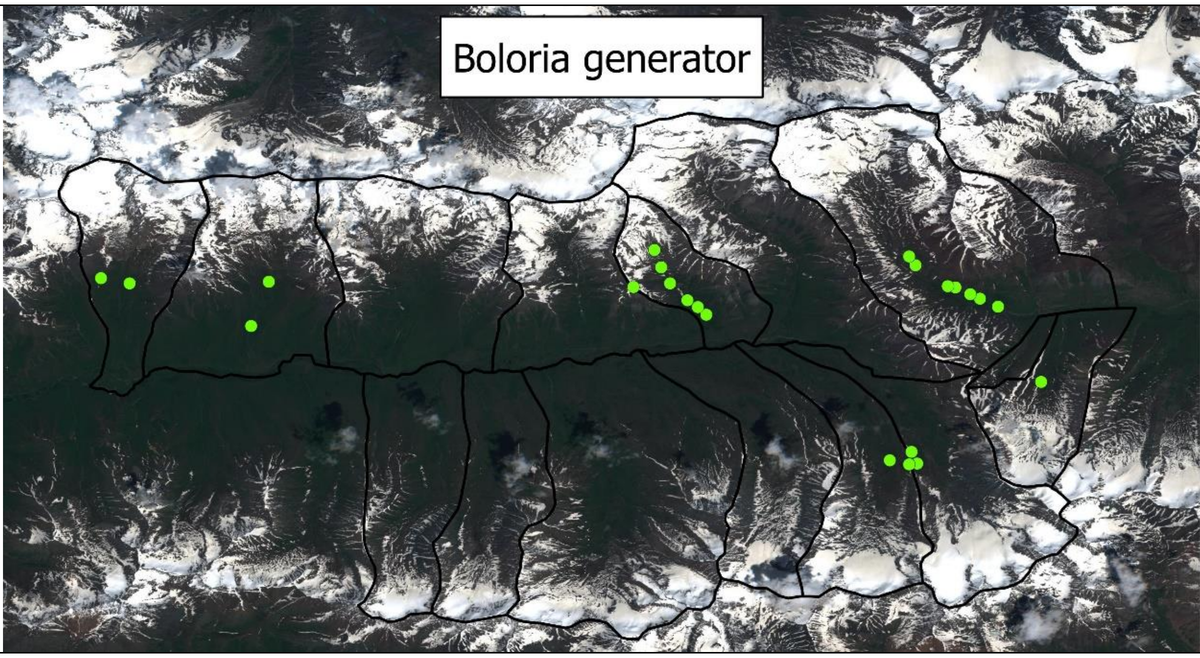


Argynnis aglaja — Dark Green Fritillary			
Flight time	June to August	Elevation (m)	up to 4200
Habitat	Meadow areas in mountainous and subalpine biomes		
Food plants	*Violaceae spp.*(violets) and *Polygonaceae spp.* (buckwheats)		
Life cycle	Species overwinters as a small larva		

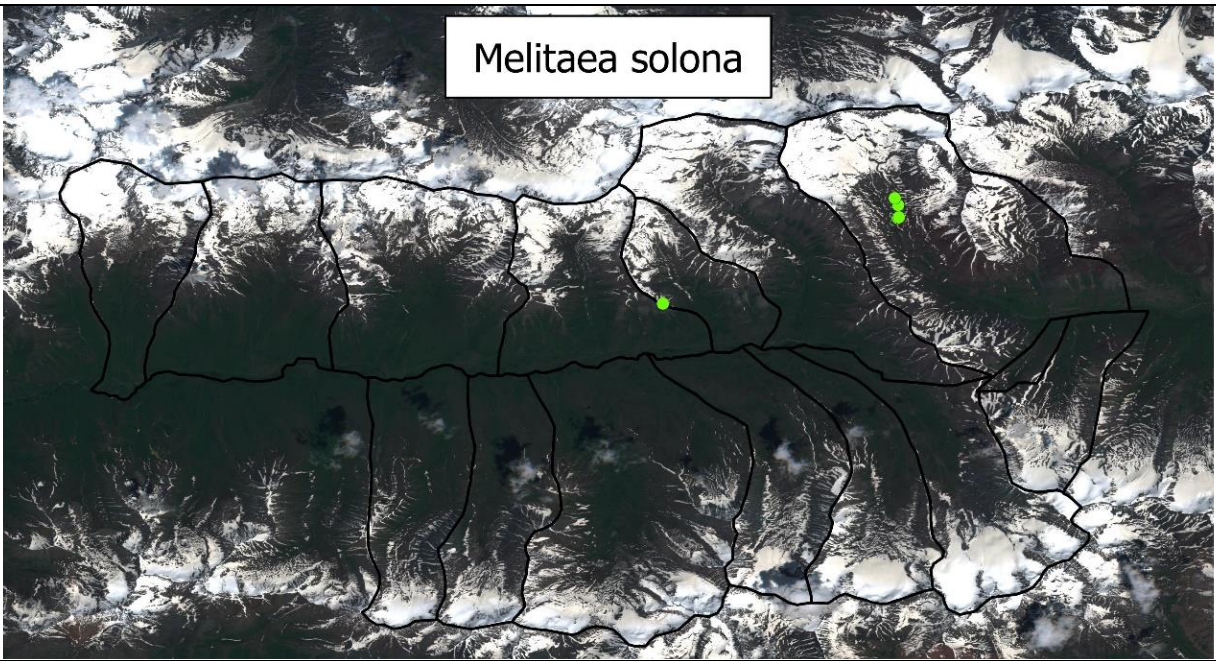
Photo courtesy of Koenraad Bracke - 2016



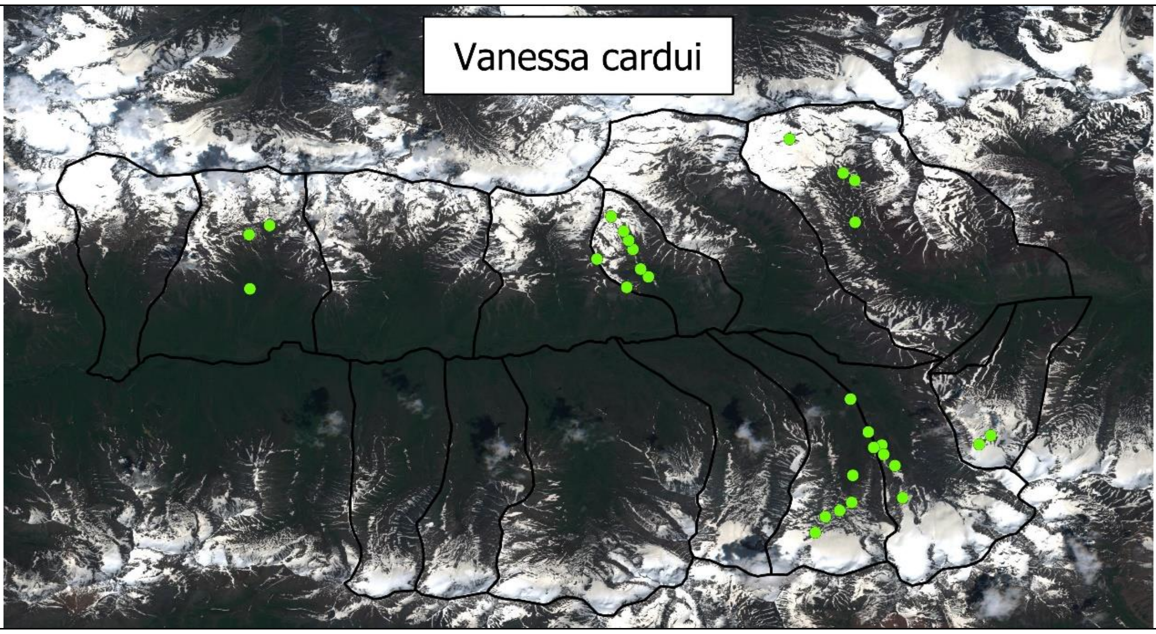
Boloria generator — no common name			
Flight time	July to September	Elevation (m)	2500-4500
Habitat	Moist mountain meadows and stream banks		
Food plants	*Polygonum alpinum* (Alpine Knotweed)		
Life cycle	Nothing mentioned in the literature		



Melitaea solona — no common name			
Flight time	June to July	Elevation (m)	2700-4000
Habitat	Humid alpine meadows		
Food plants	*Pedicularis spp.* (Lousewort)		
Life cycle	Nothing mentioned in the literature		

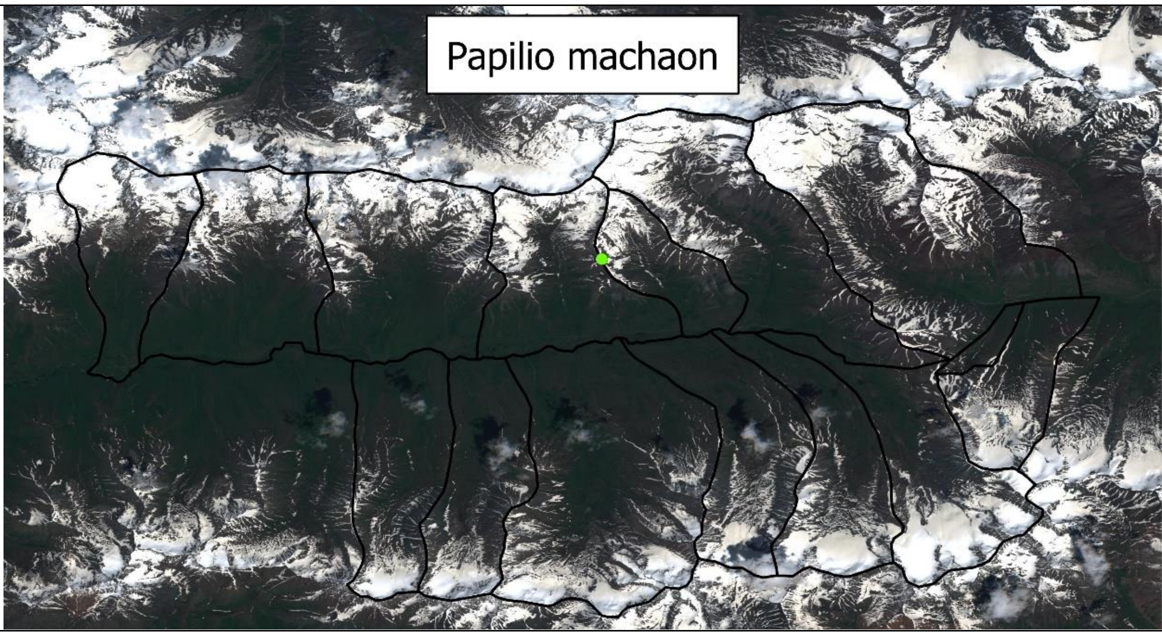


Vanessa cardui — Painted Lady			
Flight time	March to October	Elevation (m)	Up to 3000
Habitat	Open landscapes from deserts to mountains		
Food plants	27 different host plants including *Carduus spp.* (plumeless thistle), *Plantago spp.* (plantain), and *Salvia spp.* (sage)		
Life cycle	Species is migratory, but local reference material suggests that adults may overwinter		

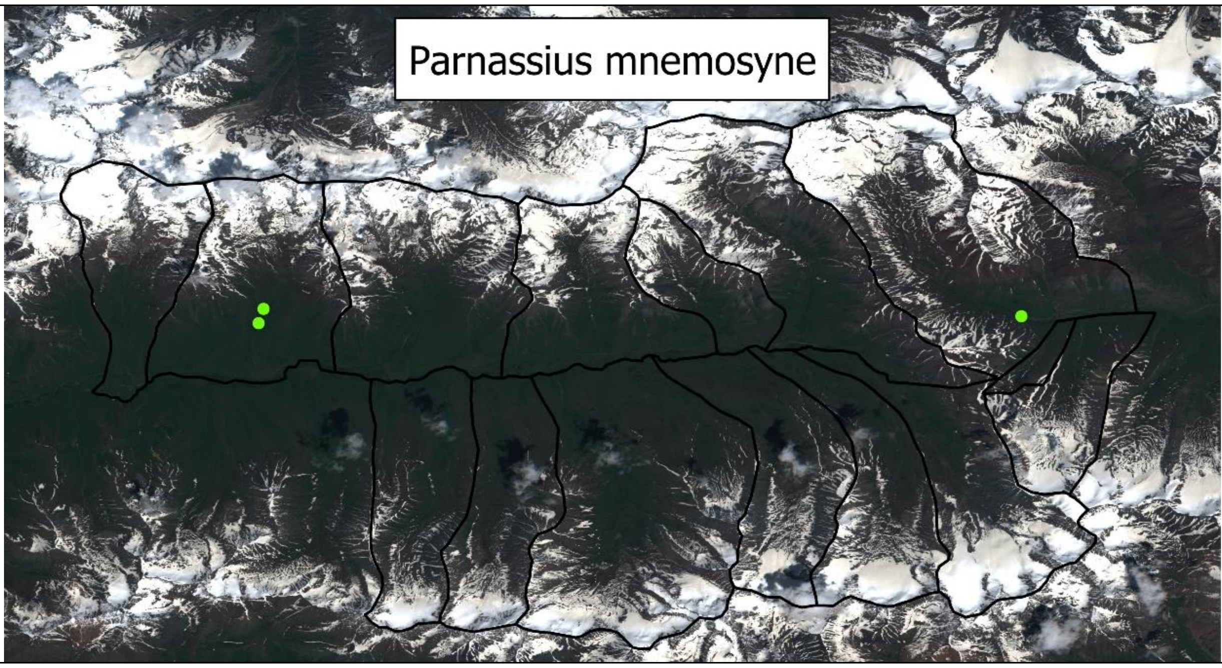


Papilionidae

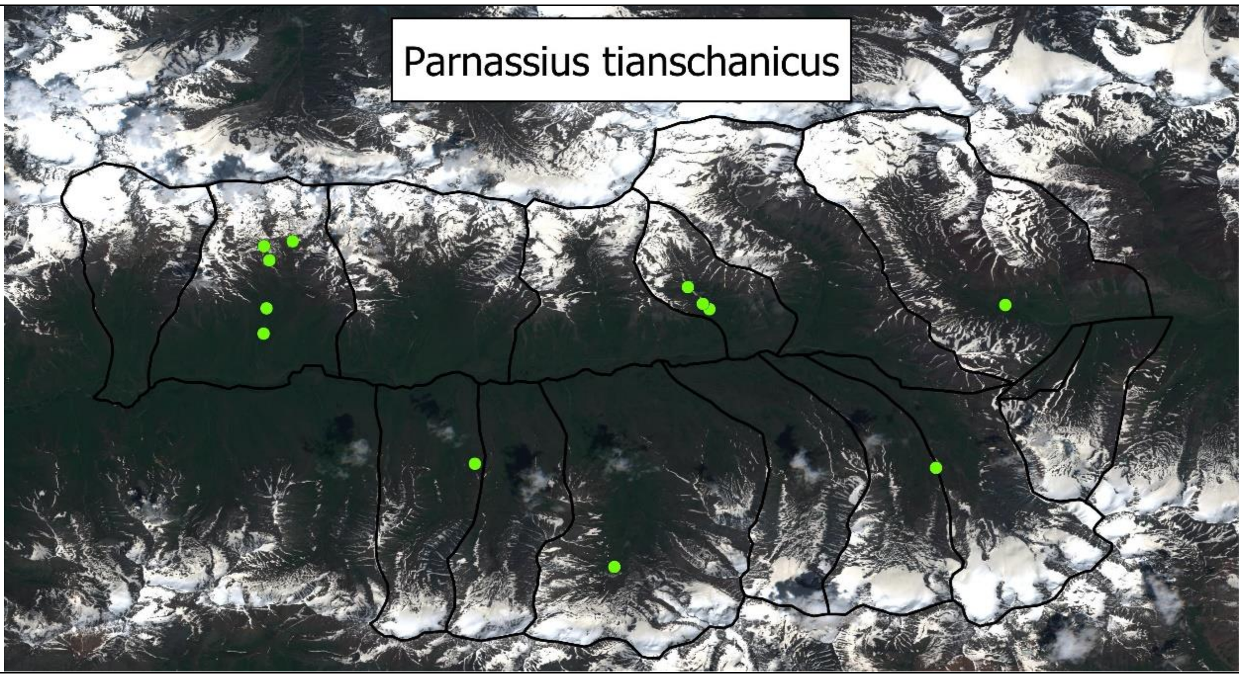
Papilio machaon — Old World Swallowtail			
Flight time	April to November	Elevation (m)	Up to 4000
Habitat	Found in virtually any ecosystem from lowlands to high mountains		
Food plants	*Artemisia spp. (*Wormwood), *Ferula spp., Haplophyllum spp., Prangos spp.*		
Life cycle	Eggs laid singly on host plant. Overwinters as a pupa. Pupal diapause is possible for up to 3 years before adult emergence. Univoltine or bivoltine depending on location.		



Parnassius mnemosyne — Clouded Apollo			
Flight time	May to July	Elevation (m)	1300 - 3000
Habitat	Grassy stepped slopes as well as mountain valleys and river terraces		
Food plants	*Corydalis ledebouriana*, *Corydalis glaucescens*		
Life cycle	Overwinters as an egg		



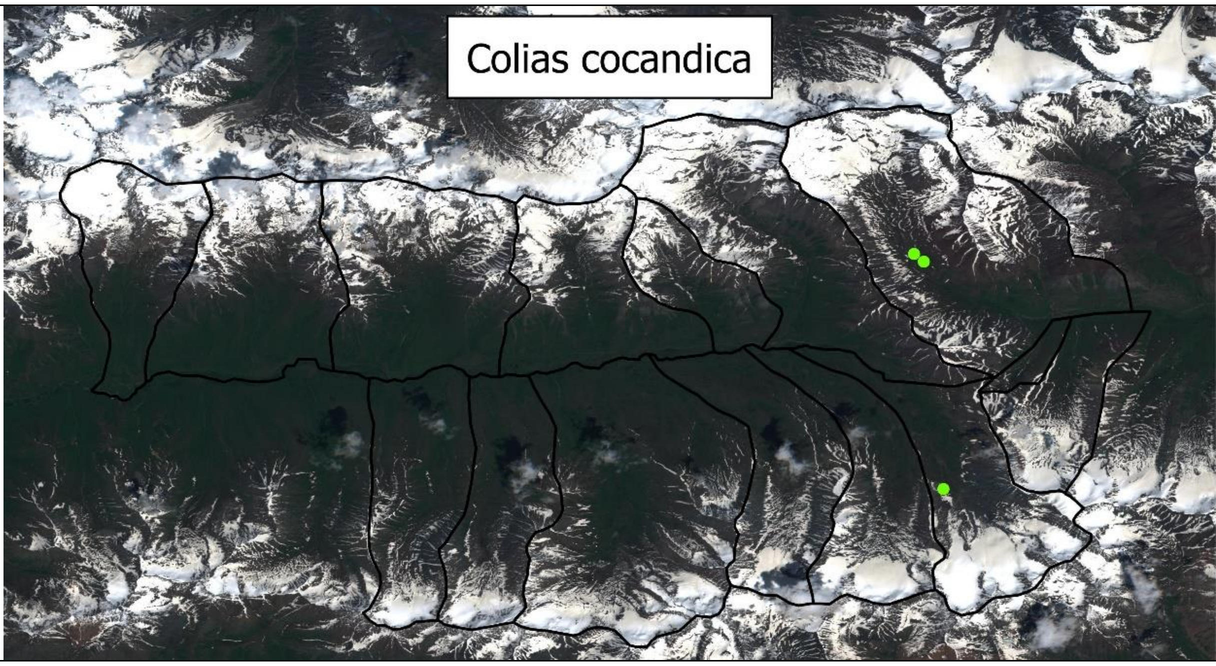
Parnassius tianschanicus — Large Keeled Apollo			
Flight time	May to September	Elevation (m)	1700-3500
Habitat	East and south facing rocky slopes in subalpine and alpine areas		
Food plants	*Rhodiola spp.*, *Sedum ewersii* (Stonecrop), *Sedum hybridum*		
Life cycle	Overwinters as a larva		



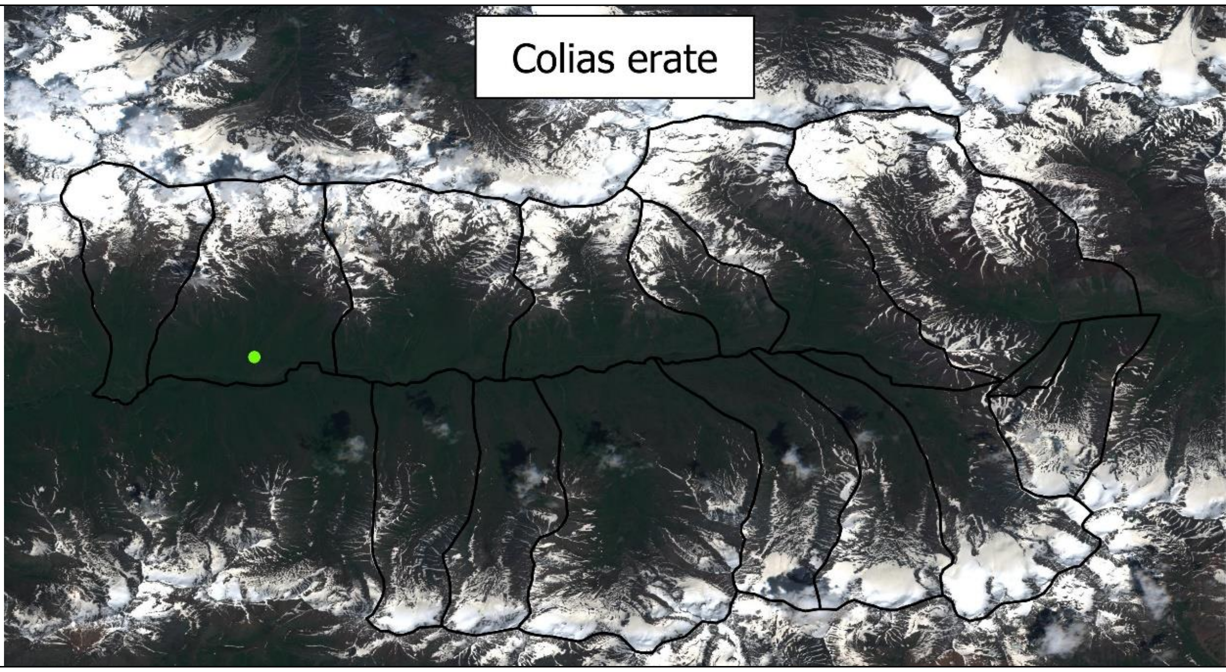
Pieridae

Colias cocandica			
Flight time	June to July	Elevation (m)	3000 - 4500
Habitat	Stoney slopes and mountain meadows		
Food plants	*Astragalus spp.* (milkvetch)		
Life cycle	Overwinters as a second instar larva		

Photo courtesy of Josef Greishuber - 2005

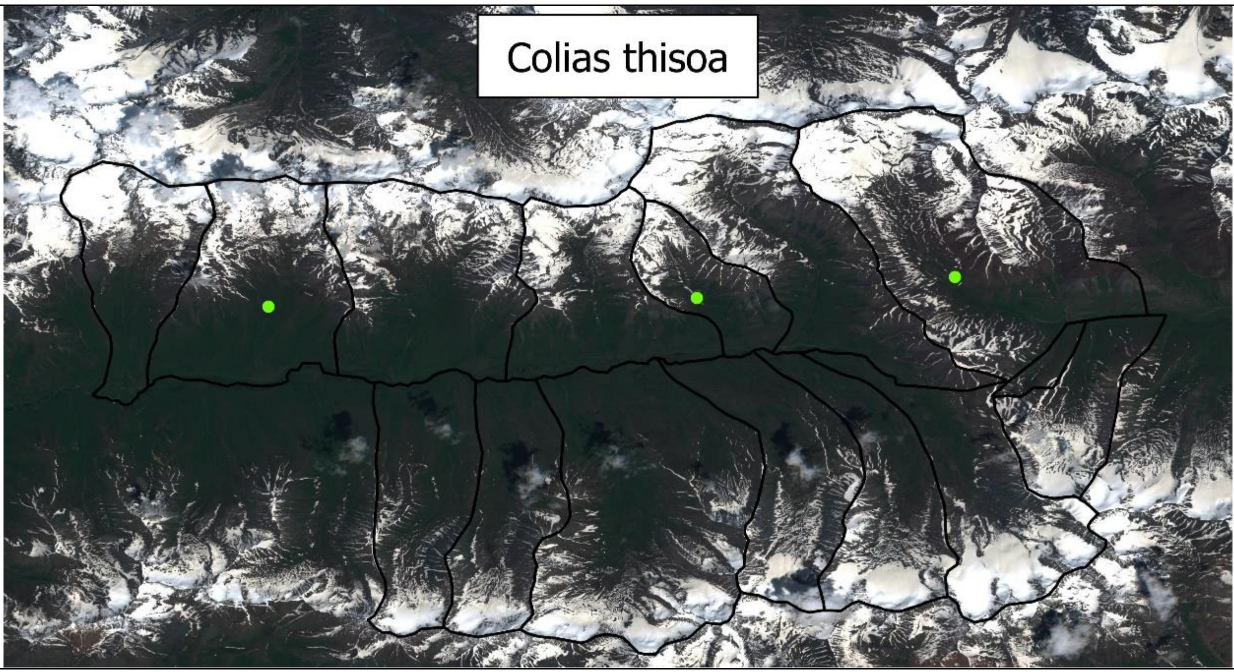


Colias erate — Pale Clouded Yellow			
Flight time	April to October	Elevation (m)	up to 3300
Habitat	Steppes, fields, and mountain meadows		
Food plants	*Onobrychis spp.* (Sainfoin), *Medicago spp.* (Burclover), *Trifolium spp* (Clover), *Trigonella spp* (Fenugreek), *Alhagi spp.* (Camelthorn)		
Life cycle	Bivoltine. Overwinters as either a pupa or larva		

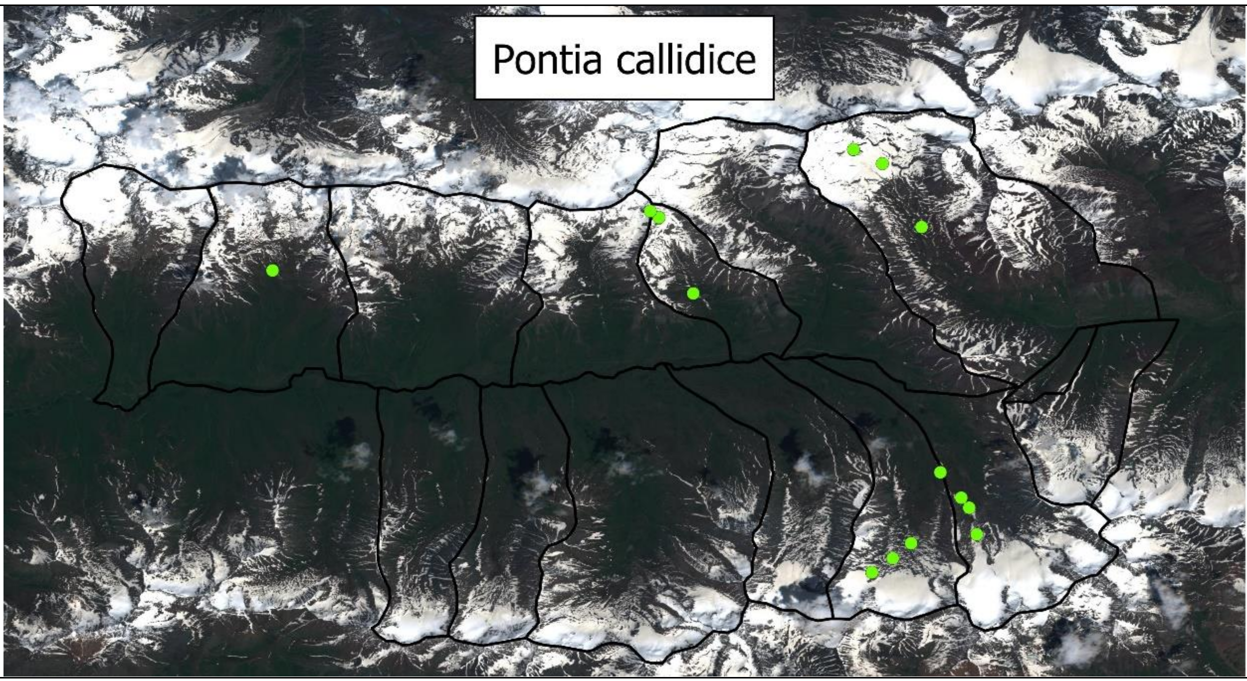


Colias thisoa — Menetries' Clouded Yellow			
Flight time	June to July	Elevation (m)	2000 - 3400
Habitat	Southern and eastern facing steppe slopes		
Food plants	*Astragalus spp.*		
Life cycle	Hibernates as a second instar larva		

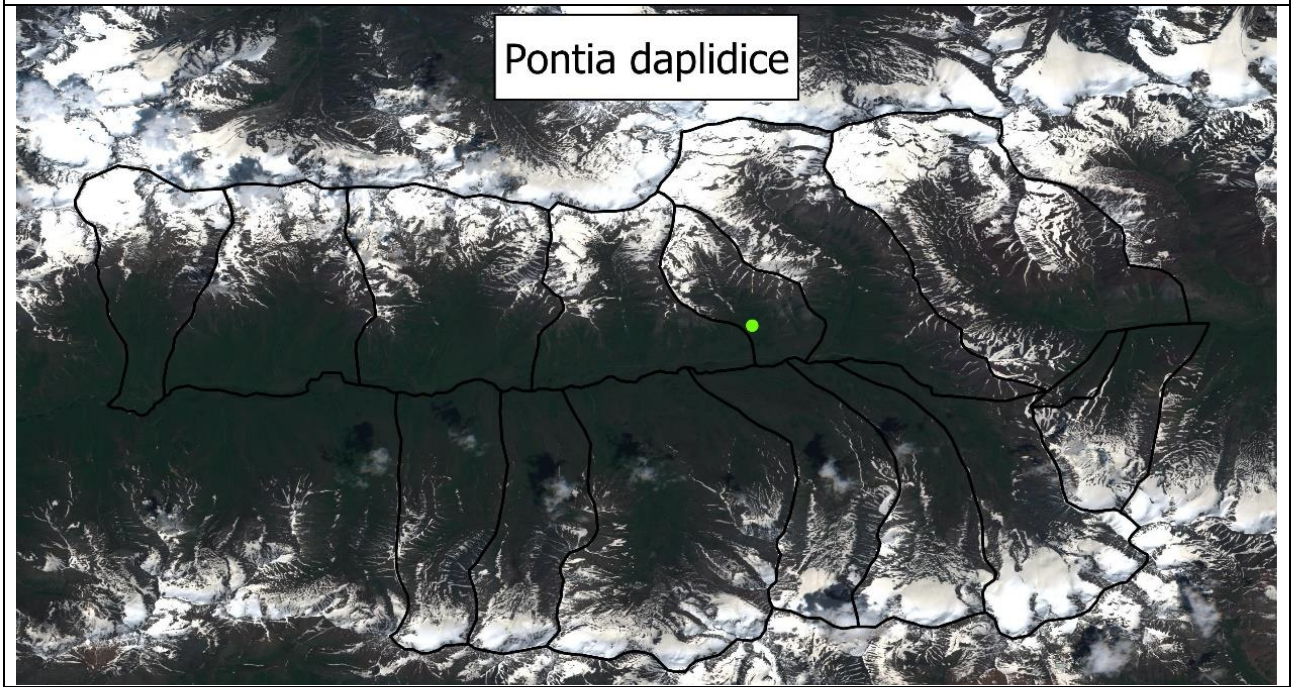
Courtesy of Joseph Greishuber - 2005



Pontia callidice — Lofty Bath White			
Flight time	May to September	Elevation (m)	2000-4500
Habitat	South facing river valleys and steppe slopes		
Food plants	*Brassica spp.* (Cabbage), *Alyssum spp., Arabis spp.* (Rockcress), *Barbarea spp.* (Winter Cress), *Descurainia spp.* (Tansymustard), *Erysimum spp.* (Wallflower), *Sisymbrium spp.* (Rocket), *Thlaspi spp.* (Pennycress), *Draba spp.* (Whitlow-grass), *Lepidium spp.* (Peppercress), *Reseda lutea* (Wild Mignonette), *Orostachys spp.* (Chinese Hat)		
Life cycle	Bivoltine. Second generation hibernates as a pupa.		

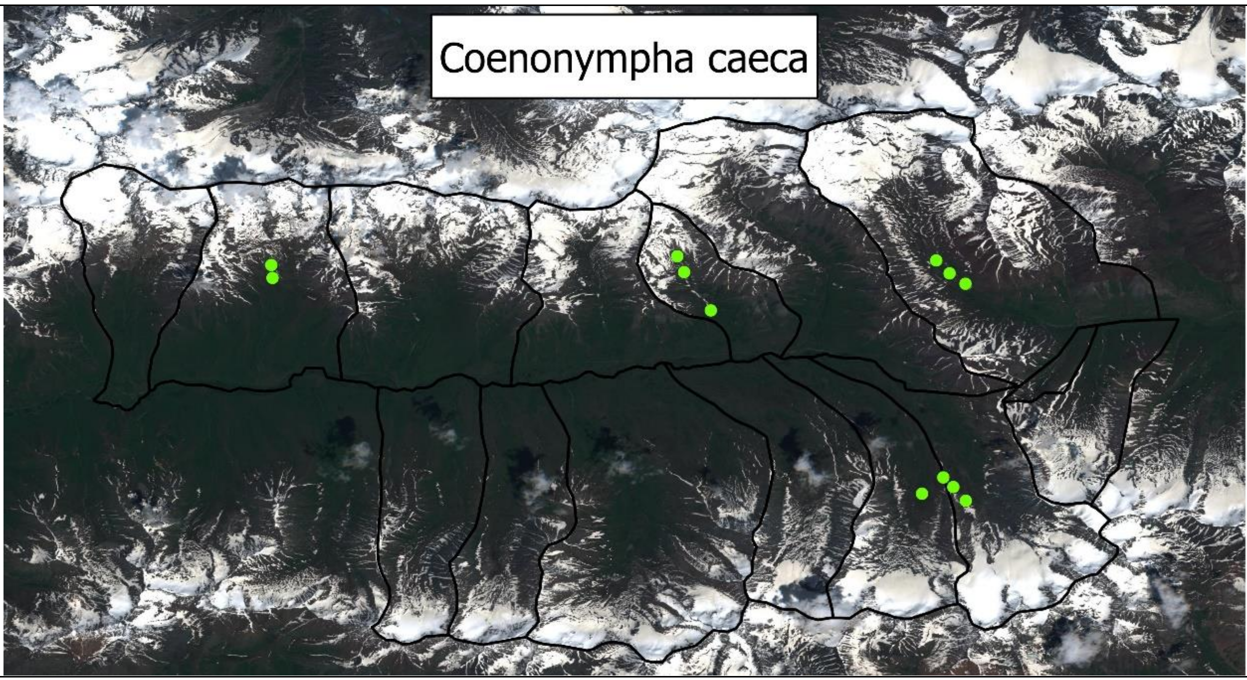


Pontia daplidice — Bath White			
Flight time	April to October	Elevation (m)	500-4000
Habitat	Deserts, steppes, river valleys		
Food plants	*Alyssum spp., Arabis spp.* (Rockcress), *Berteroa spp.* (Hoary Alison), *Erysimum spp.* (Wallflower), *Sisymbrium spp.* (Rocket), *Thlaspi spp.* (Pennycress), *Turritis spp.* (Rockcress), *Reseda lutea* (Wild Mignonette), *Vicia spp.* (Vetch), *Lathyrus spp.* (Sweet Pea), *Pisum spp.* (Pea), *Trifolium spp.* (clover)		
Life cycle	Multivoltine. Overwintering generation does so as a pupa		

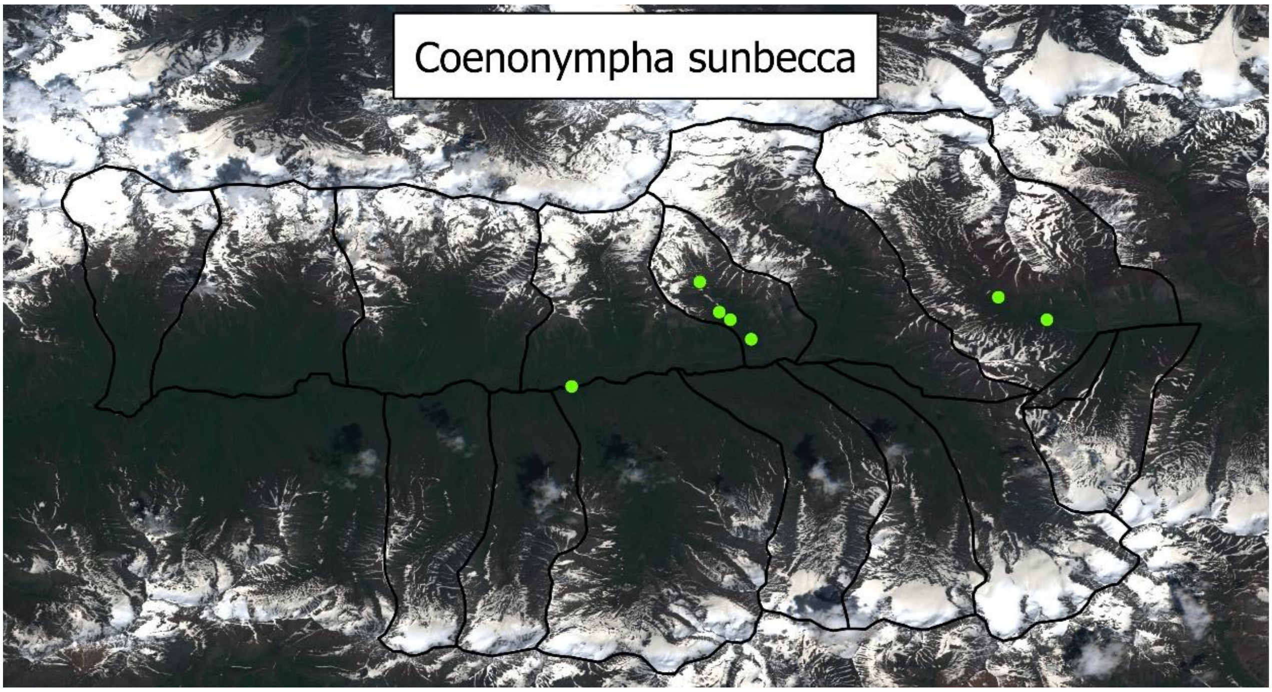


Satyridae

Coenonympha caeca			
Flight time	June to July	Elevation (m)	2000-3500
Habitat	Alpine meadows, stream banks, and stony slopes that face eastward		
Food plants	*Carex spp.* (sedge)		
Life cycle	Nothing mentioned in the literature		

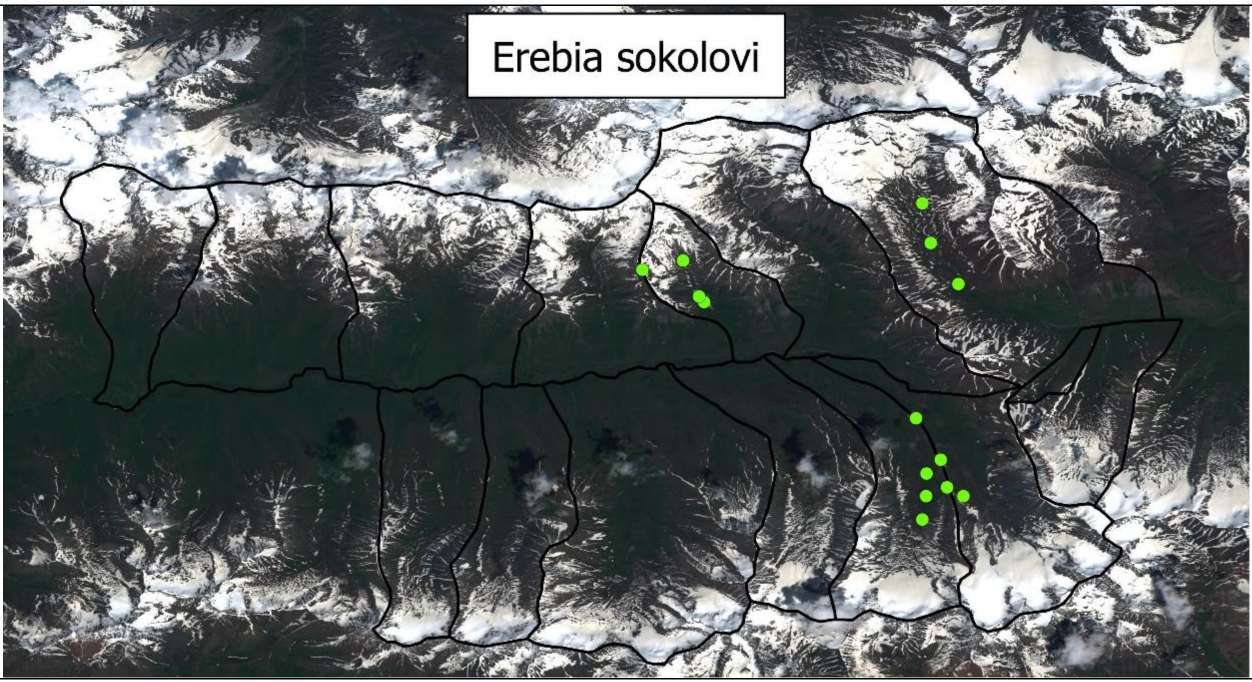


Coenonympha sunbecca			
Flight time	June to August	Elevation (m)	1500-3400
Habitat	Sloped meadows and stream banks		
Food plants	*Poaceae spp.* (grasses)		
Life cycle	Nothing mentioned in the literature		

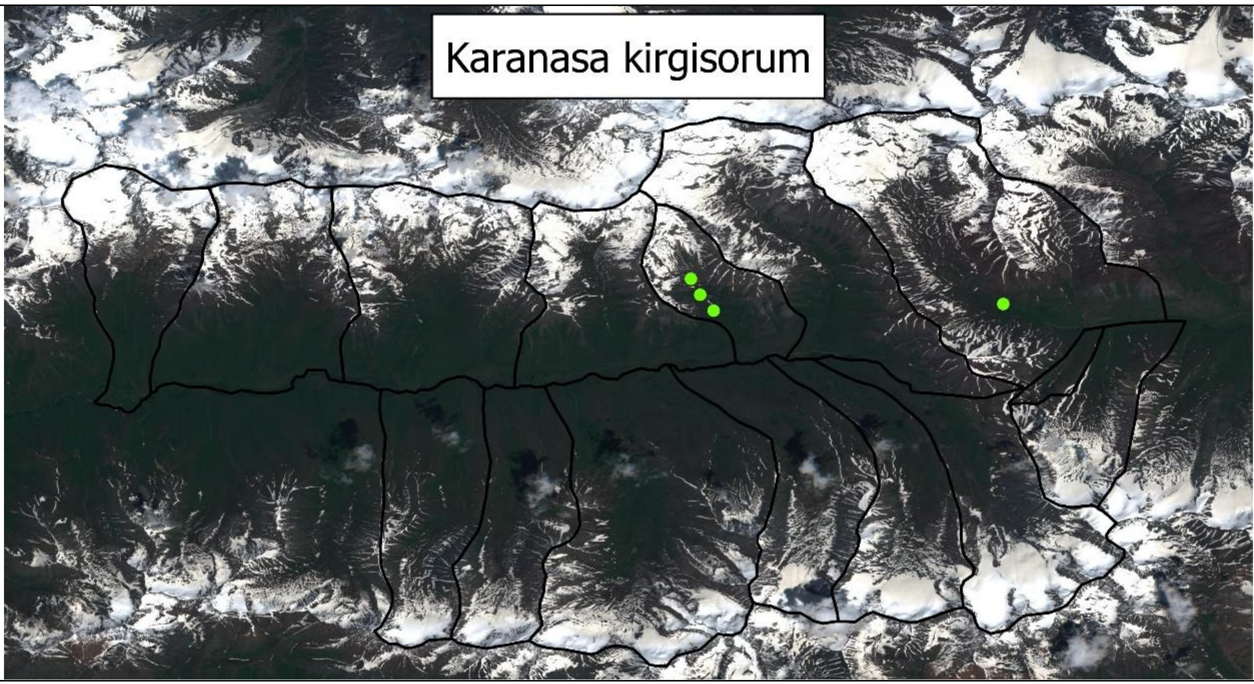


Erebia sokolovi – no common name			
Flight time	July to August	Elevation (m)	3000-3600
Habitat	Meadow slopes in subalpine and alpine areas		
Food plants	*Poaceae* (grasses)		
Life cycle	Nothing mentioned in the literature		

Photo courtesy of Peter Sporrer - 2015



Karanasa kirgisorum			
Flight time	July to August	Elevation (m)	3000-3400
Habitat	Steppe slopes and old scree slopes		
Food plants	*Poaceae* (grasses)		
Life cycle	Nothing mentioned in the literature		



3.3. Discussion and conclusions

The region studied is already alpine in elevation, but there are limits to the elevation that many butterflies can live at. Much of this is due to physiological limitations, but may also be due in part to a variety of environmental factors such as temperature or host plant availability. A simple analysis was done using GIS software to determine the species composition of butterflies living above 3,600 m. This elevation was chosen as it represents the average elevation where the majority of vegetation ceases to survive.

Generally, above this elevation, only lichen, cushion plants and small forbs are able to persist, greatly reducing the availability of host plants to butterflies dependent on certain low-alpine plant species. Sixty-four records of butterflies found above 3,600 meters between the years of 2015 - 2019 are shown in Table 3.3a, more than half of them are from the 2019 season alone.

Table 3.3a. Butterflies recorded above 3,600 meters during the 2015 - 2019 seasons with number of records in brackets.

2015	2016	2017	2018	2019
C. erate (1)	*A. urticae (1)*	*A. urticae* (3)	*A. urticae* (2)	*A. urticae* (3)
C. erubescens (1)	*P. callidice (1)*	*C. erate (1)* *	*C. erate (1)*	*B. generator* (3)
P. callidice (1)	*P. tianschanicus (1)*	*P. callidice* (4)	*P. callidice* (4)	*C. caeca* (2)
		P. delphius (4)	*P. delphius* (2)	*C. sunbecca* (1)
		P. tianschanicus (1)	*P. tianschanicus (1)*	*E. sokolovi* (2)
				K. kirgisorum (1)
				P. machaon (1)
				P. tianschanicus (1)
				P. callidice (7)
				V. cardui (13)

* This record is of a dead specimen found on glacial ice above 4000 meters. It may have been blown up to the glacier and died as a result.

Using data from Tschikolovets (2005) and Toropov and Zhdanko (2006, 2009), elevation profiles for each species (detailed in the above species descriptions) were used to determine if a species was “alpine” or not. An elevation of 3,600 m was used again for consistency. Any species that had an elevation range above 3,600 m was considered alpine. Any species with a range below 3,600 m was not considered alpine (Table 3.3b).

Table 3.3b. A list of alpine butterflies based on their elevation profiles.

Species	Elevation (in meters)	Species	Elevation (in meters)
Aglais urticae	up to 4,000	*Lycaena phlaeas*	up to 4,500
Argynnis aglaja	up to 4,200	*Melitaea solona*	2,700-4,000
Aricia agestis	1,700-3,800	*Papilio machaon*	up to 4,000
Boloria generator	2,500-4,500	*Parnassius delphius*	3,000-4,000
Clossiana erubescens	2,000-3,600	*Pontia callidice*	2,000-4,500
Colias cocandica	3,000-4,500	*Pontia daplidice*	500-4,000
Erebia sokolovi	3,000-3,600		

Using five years of data collection, and although the sample size is rather small (only 10% of the total number of sightings), we should expect that a majority of individuals found above 3,600 m belong to one of the alpine species. And indeed the data show that 61% of all butterfly individuals collected above 3,600 m are in fact alpine species (Figure 3.4a). This means that 39% of individuals found above 3,600 m are outside their established elevation ranges, suggesting that high alpine habitat is becoming favourable to these species.

However, when we inspect the data on a year-by-year-basis (Table 3.3c), we begin to see a slightly different pattern emerge. The data in 2015 and 2016 are very limited, but they do give us some information at least. However, the later years, especially 2019 provide much more data with which we can begin asking new questions.

Table 3.3c: Percentage of alpine species found above 3,600 meters.

2015	2016	2017	2018	2019	Total
2 of 4 IDs	2 of 3 IDs	11 of 13 IDs	8 of 10 IDs	16 of 34 IDs	39 of 64 IDs
50%	66%	86%	80%	47%	61%

One species causing a large amount of skewing of the data is *V. cardui*. According to the species profile, it should only be found up to 3,000m, which already suggests a limited understanding of its distribution in the study area, but 13 out of the 34 specimens identified in 2019 above 3,600 meters are of *V. cardui*. This suggests one of two things: (1) *V. cardui* host plants have moved higher in elevation in response to climate change, thus allowing this species to move up in elevation as well or (2) the initial understanding of the elevation range of *V. cardui* is incorrect, as we have some specimens found even above 3,800 meters, which is significantly more than their expected range of up to 3,000 meters.

Either of these situations suggest that there is more to be learned about this species, its habitat, and distribution in the west and east Karakol river valleys. As was mentioned before, it seems the species is not common on a yearly basis, suggesting that its distribution is typically rather patchy over time due to its migratory habit.

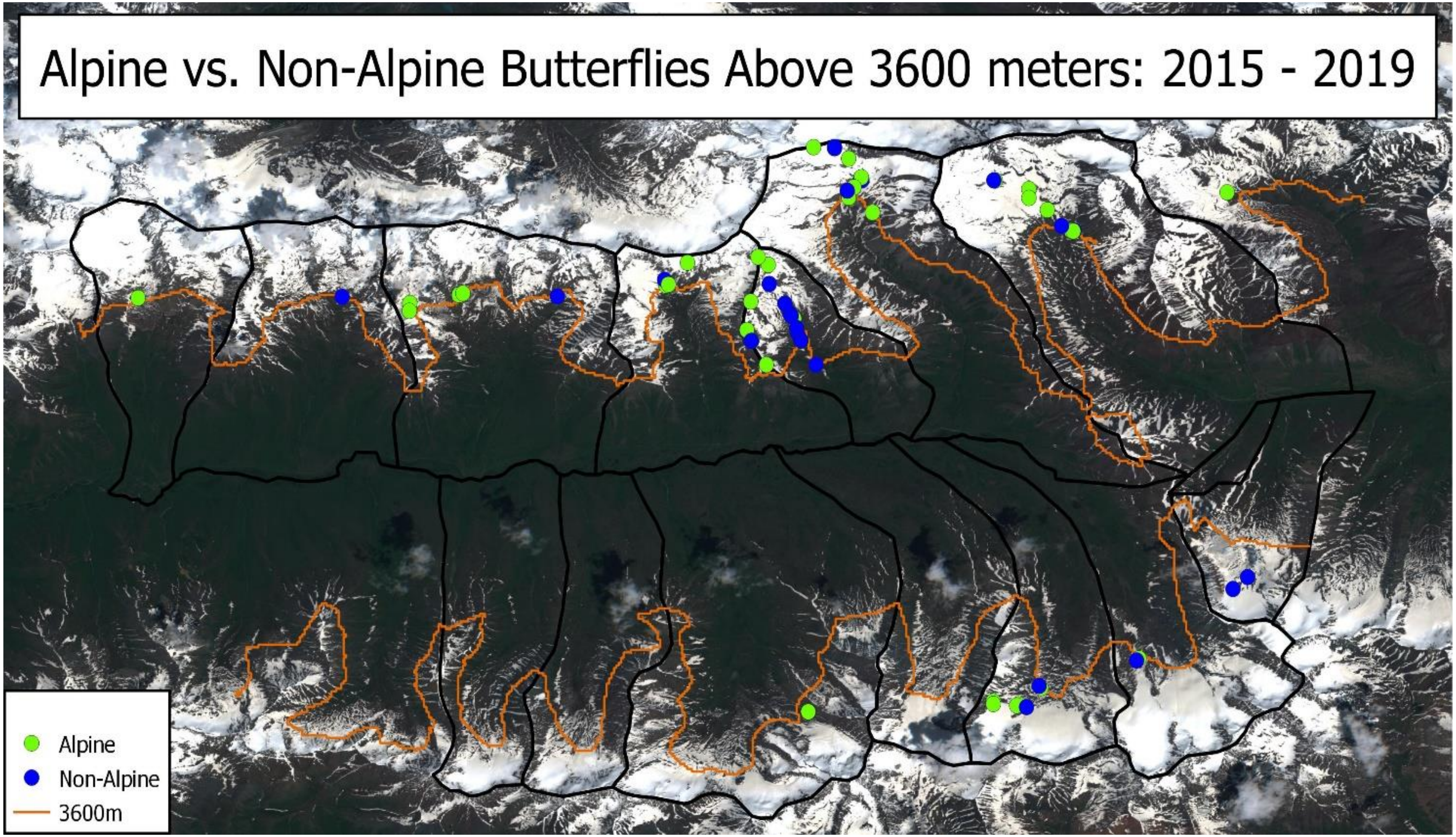


Figure 3.3a. Alpine vs. non-alpine butterflies 2015-2019.

Now, if we decide to take into account that our information regarding the elevation limits of *V. cardui* was incorrect, and we include the species into the list of our alpine species, then our table changes (see Table 3.3d).

Table 3.3d: Percentage of Alpine species found above 3,600 meters.

2015	2016	2017	2018	2019	Total
2 of 4 IDs	2 of 3 IDs	11 of 13 IDs	8 of 10 IDs	29 of 34 IDs	39 of 64 IDs
50%	66%	86%	80%	85%	81%

So, in effect, we have two ways to interpret the data. Either non-inclusive of *V. cardui* or inclusive of it. However, either way we look at these data, we can see that we never have 100% of the butterflies above 3,600 meters being part of the alpine subset. This continues to suggest that the habitat is in fact changing. Climate change is the most obvious factor and if this is so, then further studies should show that the percentage of non-alpine butterflies found above 3,600 m will continue to increase over time as a consequence of climate change in the alpine environment, most specifically, the establishment of host plant populations at higher elevations due to receding glaciers and more favourable growing conditions. Using this model, these two butterfly groups (alpine vs. non-alpine) can be used as indicators of broad changes in the alpine environment due to climate change.

3.4. Literature cited and *resources used

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Appendix I: Bird list compiled by the expedition

Latin name	English name	Русское название
Coturnix coturnix	Commom quail	Обыкновенный перепел
Tetraogallus himalayensis	Himalayan snowcock	Гималайский улар
Tadorna ferruginea	Ruddy shelduck	Огарь
Tadorna tadorna	Common shelduck	Пеганка
*Falco cherrug**	Saker falcon	Балобан
Falco tinnunculus	Common kestrel	Обыкновенная пустельга
Falco columbarius	Merlin	Дербник
Falco subbuteo	Eurasian hobby	Чеглок
*Gypaetus barbatus**	Bearded vulture	Бородач
*Neophron percnopterus**	Egyptian vulture	Обыкновенный стервятник
*Gyps himalayensis**	Himalayan griffon	Кумай
Gyps fulvus	Eurasian griffon	Белоголовый сип
*Aegypius monachus**	Cinereous vulture	Чёрный гриф
Circus cyaneus	Hen harrier	Полевой лунь
Circus pygargus	Montagu's harrier	Луговой лунь
Buteo buteo	Common buzzard	Обыкновенный канюк
Buteo rufinus	Long-legged buzzard	Курганник
*Aquila chrysaetos**	Golden eagle	Беркут
*Aquila heliaca**	Imperial eagle	Могильник
*Aquila pennata**	Booted eagle	Орёл-карлик
Charadrius dubius	Little ringed plover	Малый зуёк
Tringa ochropus	Green sandpiper	Черныш
Actitis hypoleucos	Common sandpiper	Перевозчик
Columba livia domestica	Feral pigeon	Сизый голубь
Cuculus canorus	Common cuckoo	Обыкновенная кукушка
Tachymarptis melba	Alpine swift	Белобрюхий стриж
Upupa epops	Hoopoe	Удод
Pica pica	Magpie	Сорока
Pyrrhocorax pyrrhocorax	Red-billed chough	Клушица
Pyrrhocorax graculus	Yellow-billed chough	Альпийская галка
Corvus frugilegus	Rook	Грач
Corvus corone	Carrion crow	Черная ворона
Corvus corax	Raven	Ворон
Oriolus kundoo	Indian golden oriole	Масковая иволга
Hirundo rustica	Barn swallow	Деревенская ласточка
Delichon urbicum	Northern house martin	Городская ласточка
Alauda arvensis	Eurasian skylark	Полевой жаворонок
Eremophila alpestris	Horned lark	Рогатый жаворонок
*Locustella certhiola***	Rusty-rumped warbler	Певчий сверчок

Latin name	English name	Русское название
Phylloscopus humei	Hume's leaf warbler	Пеночка тусклая
Phylloscopus trochiloides	Greenish warbler	Зелёная пеночка
Acridotheres tristis	Common myna	Обыкновенная майна
Pastor roseus	Rosy starling	Розовый скворец
Monticola saxatilis	Rock thrush	Пестрый каменный дрозд
Luscinia pectoralis	White-tailed rubythroat	Черногрудая красношейка
Luscinia svecica	Bluethroat	Варакушка
Phoenicurus ochruros	Black redstart	Горихвостка-чернушка
Phoenicurus erythrogaster	Guldenstadt's redstart	Краснобрюхая горихвостка
Saxicola torquata	Stonechat	Черноголовый чекан
Oenanthe oenanthe	Northern wheatear	Обыкновенная каменка
Oenanthe isabellina	Isabelline wheatear	Каменка-плясунья
Oenanthe picata m. opistholeuca	Variable wheatear	Чёрная каменка
Montifringilla nivalis	White-winged snowfinch	Снежный вьюрок
Prunella fulvescens	Brown accentor	Бледная завирушка
Prunella collaris	Alpine accentor	Альпийская завирушка
Prunella himalayana	Altai accentor	Гималайская завирушка
Cinclus cinclus	White-throated dipper	Оляпка
Motacilla alba	White wagtail	Белая трясогузка
Motacilla citreola	Citrine wagtail	Желтоголовая трясогузка
Motacilla flava	Yellow wagtail	Жёлтая трясогузка
Motacilla cinerea	Grey wagtail	Горная трясогузка
Anthus campestris	Tawny pipit	Полевой конёк
Anthus spinoletta	Water pipit	Горный конёк
Anthus trivialis	Tree pipit	Лесной конёк
Acanthis cannabina	Linnet	Коноплянка
Leucosticte nemoricola	Plain mountain finch	Гималайский вьюрок
Leucosticte brandti	Brandt's mountain finch	Жемчужный вьюрок
Carpodacus erythrinus	Common rosefinch	Обыкновенная чечевица
Carpodacus severtzovi severtzovi	Spotted great rosefinch	Среднеазиатская большая чечевица
Carpodacus puniceus	Red-fronted rosefinch	Красный вьюрок
Emberiza citrinella	Yellowhammer	Обыкновенная овсянка

*Red Data Book of the Kyrgyz Republic (Шукуров Э.Дж. (гл. ред.) Кыргыз Республикасынын Кызыл китеби / Красная книга Кыргызской Республики 2-е изд. Бишкек: 2006. – 544 стр. – Текст на кырг., рус., англ. яз.).

**unreliable record (distribution outside area, usually below 2,100 m); most likely *L. naevia*, Common grasshopper warbler.

Appendix II: Plant inventory compiled by expedition participant David Merrie with the help of Tessa Merrie. Help with identification was gratefully received from Drs Phil Cribb, Mike Gilbert, Nicholas Hind (Compositae) and Gwil Lewis (legumes), all from Royal Botanic Gardens, Kew.

Polemonium caeruleum (Jacob's ladder or Greek valerian) Kew plant list

Tragopogon spp. (goatsbeard or salsify) Kew plant list

Leontopodium ochroleucum (Edelweiss) Kew plant list

Clematis alpina, var *alba* (Alpine clematis) Kew plant list

*Campanula glomerata (*clustered bellflower *or Dane's blood)* Kew plant list

Salix sp. (willow) Kew plant list

Echium vulgare (viper's bugloss or blueweed) Kew plant list

Hyoscyamus niger (henbane, black henbane or stinking nightshade) Kew Plant list

Phlomis oreophila (sage) Kew plant list

Verbascum sp. (mullein) Kew plant list

Allium sp. (onions, garlic, leeks and others) Kew plant list

Allium atrosanguineum (native onion) Kew plant list

Persicaria sp. (knotweed) Kew plant list

Eritrichium possibly *tianshanicum* (Alpine forget-me-not) Kew plant list

Ferula sp. (fennel) Kew plant list

Clementsia semenovii (unresolved name) [Kew plant list]

Eremurus fuscus (foxtail liliy or desert candle) Kew plant list

Erigeron aurantiacus (daisy family) Kew plant list

A field of *Alchemilla* (lady's mantle) Kew plant list

Gagea bulbifera (a lily) Kew plant list

Gentiana prostrata (pygmy gentian) Kew plant list

Geranium saxatile (a geranium) Kew plant list

Hegemone (white, common name unknown) Kew plant list
Gagea (yellow, yellow star of Behtlehem) Kew plant list

Hegemone lilacina (common name unknown) Kew plant list

Myosotis sp. (forget-me-not) Kew plant list

Ligularia alpigena (leopard plant) Kew plant list

Pedicularis sp. (lousewort) Kew plant list

Myricaria germanica (*tienshanica*) (a tamarisk) Kew plant list

Allium altaicum (yellow flowers in foreground, native onion) Kew plant list

Potentilla hololeuca (a cinquefoil) Kew plant list

Primula algida (a primrose) Kew plant list

Primula algida (a primrose, white variant) Kew plant list

Primula nivalis (snow primrose) Kew plant list

Pulsatilla campanella (a pasque flower or prairie crocus or meadow anemone) Kew plant list

Rheum sp. (a rhubarb) Kew plant list

Trollius altaicus (a buttercup) Kew plant list

Ranunculus rufosepalus (a buttercup) Kew plant list

Schmalhausenia nidulans (a Schmalhausen thistle) Kew plant list

A *Euphorbia* (spurge) Kew plant list

Stellaria sp. (stitchwort or chickweed, in wheel tracks) Kew plant list

Tulipa dasystemon (a tulip) Kew plant list

Tulipa dasystemon (a tulip) Kew plant list and *Gagea bulbifera* (a lily) Kew plant list

Plants of uncertain identification

Astragalus?

Cirsium?

Juniper – type?

Polygala sp.

Pedicularis sp.

Senecioneae, probably *Sinacalia* sp.
either *Sinacalia davidii* or
S.tangutica.

Liamiaceae, possibly *Salvia*

Alchemilla – type?

Angelica brevicaulis?

Astragalus alpinus?

Corydalis tienshanica?

Legume, possibly *Hedysarum*

Dracocephalum ?imberbe

Dracocephalum ?imberbe

Dracocephalum stamineum?

Erigeron sp.

Pedicularis sp.

Geranium sp. & *Myosotis* sp.

White: *Pedicularis* sp. Yellow: *Potentilla*?

Myosotis suavolens?

Lagotis?

Oxytropis?

Oxytropis?

Oxytropis ?glabra

Potentilla?

Pedicularis sp.

Thermopsis sp.

Potentilla hololeuca?

Tanacetum richterioides?

Potentilla hololeuca? or *Papaver croceum*?

Ranunculus?

Rhodiola algida?

Cardueae?

Tulipa, poss *dasystemon*?

Tulipa dasystemon & Gagea bulbifera?

Unknown, poss. *Chorispora* sp.

Unknown, poss *Chorisporа* sp.

Unknown, poss *Chorispora* sp.

Lagotis sp.

Appendix III: Expedition reports, publications, diary & further information

Project updates, reports and publications:
https://www.researchgate.net/project/Kyrgyzstan-Researching-and-protecting-snow-leopards-and-other-animals-of-the-Kyrgyz-Tien-Shan-mountains-through-citizen-science

All expedition reports, including this and previous expedition reports:
https://www.biosphere-expeditions.org/reports

Expedition diary/blog:
https://blog.biosphere-expeditions.org/category/expedition-blogs/tien-shan-2019/ and
https://blog.biosphere-expeditions.org/category/expedition-blogs/tien-shan-2020/

Expedition details, background, pictures, videos, etc.
https://www.biosphere-expeditions.org/tienshan