EXPEDITION REPORT

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

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Abstract

This study was part of an expedition to the Tien Shan Mountains (Kyrgyz Ala-Too and Jumgal Too ranges), run by Biosphere Expeditions and NABU from 11 July to 27 August 2016 with the aim of surveying for snow leopard (*Uncia uncia*) and its prey species. Using a cell methodology developed by Biosphere Expeditions for citizen scientist volunteer expeditions, 46 cells of 2x2 km were surveyed and 15 interviews with local people were conducted. Twenty butterfly species not previously known to occur in the area were also recorded. Previous expeditions indicated that snow leopard was present in the survey area. In 2016 the discovery of fresh signs of snow leopard presence confirmed the importance of the study area as a habitat for the predator. The surveys also showed that the area's habitat is sufficiently varied and capable of sustaining a healthy prey base for the snow leopard. Potential prey species are Siberian ibex, marmot and snowcock; in 2016 there was only one occasional record of argali. Sufficient location data on Siberian ibex enabled its distribution to be modelled against climatic and topographic variables, as well as variables derived from remote sensing. It is hoped that cell selection guided by the modelling exercise will increase the chance to record both the Siberian ibex and the snow leopard on future expeditions. Poaching, overgrazing and other disturbances are serious issues that must be addressed in order to avoid habitat degradation and with it the loss of the snow leopard. On the other hand, local people are in favour of snow leopard presence and receptive to creating economic incentives based on intact nature and snow leopard presence. To that end, Biosphere Expeditions and NABU will continue with the annual research expeditions to the area, seeking to conduct further surveys and involving local people in this, as well as the search for economic benefits and incentives to maintaining habitat health, and with it snow leopard presence.

Резюме

Настоящее исследование является частью экспедиции в горах Тянь-Шаня (Кыргыз Ала-Тоо и Джумгал Тоо), организованной Биосферной экспедицией совместно с НАБУ с 11 июля по 27 августа 2016 года, с целью выявления снежного барса и оценки его потенциальной кормовой базы. Применив методику координатной сетки на карте, разработанной Биосферной экспедицией для проведения научно-практического исследования совместно с волонтерами, было исследовано 46 полигонов (размером 2x2 км) и был проведено 15 опросов у местных жителей. Получен также список 20 видов дневных бабочек, ранее не отмеченных в данном регионе. Опросы местного населения и факты нападения на скот подтвердили присутствие снежных барсов в окрестностях. В 2016 г. удалось обнаружить свежие следы пребывания снежного барса. Таким образом, получено подтверждение значимость региона для обитания этого хищника. Исследования показали, что изученная область обладает значительным биоразнообразием и имеется достаточная кормовая база для снежного барса (горные козлы, сурки, улары); аргали в этом году отмечены только один раз. Наблюдения по горному козлу позволили с учетом ряда факторов окружающей среды промоделировать его распространение в регионе. Предсказанные моделью благоприятные для вида территории приблизительно совпали с теми, где были обнаружены следы пребывания барса. Браконьерство, уничтожение растительного покрова и другие нарушения являются серьезной проблемой, способствуют локальному вымиранию барса и ухудшают среду его обитания. С другой стороны, отношение местного населения к этой кошке положительное. В связи с этим, Биосферная экспедиция и NABU продолжат исследования с целью определения численности диких животных; совместно с населением будут осуществлен поиск путей сохранения снежного барса как вида с учетом экономических факторов.

Резюме

Биосфералык экспедиция менен НАБУ нун Тянь-Шань (Кыргыз Ала-Тоо жана Жумгал Тоо) кыркаларында, 2016-жылдын 11-июлунан 27-августуна чейинки аралыкта уюштурулган экспедициясынын максаты, илбирс жана анын тоют базасысынын аталган аймакта бар экендигин аныктоо болуп саналат. Биосфералык экспедиция тарабынан иштелип чыккан картада координаттык торчо методикасын колдонуу менен ыктыярчылардын жардамы аркылуу 46 полигон (аймагы 2х2км) жана жергиликтүү тургундар арасында 15 жолу сурамжылоо иштери жүргүзүлдү. Андан сырткары мурда аныктала элек күндүзгү көпөлөктөрдүн 20 түрү аныкталды. Жергиликтүү тургундарды сурамжылоо иштери, жана ошондой эле үй-жандыктарына болгон кол салуу учурлары, бул аймакта илбирстин байырлай тургандыгын далилдеди. 2016-жылы илбирстин жаңы издери табылды. Алынган далилдердин негизинде, илбирс үчүн бул аймак маанилүү экендиги такталды. Изилдөөлөр көрсөткөндөй, изилденген аймак биотүрдүүлүгү жагынан жогору, илбирстин тоют базасы болгон (эчки-теке, суур, улар) жетиштүү санда. Тоо эчкилерине жүргүзгөн байкоолор аркылуу, жаратылыштагы кээ бир факторлорду эске алуу менен, аталган жандыктын бул аймакта таралышынын модели түзүлдү. Түзүлгөн моделдин негизинде, илбирстин изи табылган аймактын чектеш экенин аныкталды. Браконьерчилик жана жайыттардын начарлашы илбирстин санынын азайып жатышынын бирден-бир себептери болуп саналат. Жакшы жагы жергиликтүү элдин бул жандыкка болгон мамилеси канааттандыраарлык экендигинде. Биосфералык экспедиция менен НАБУ жапайы жандыктардын санын аныктоо максатында изилдөөлөрдү уланта бермекчи; жергиликтүү калк менен биргеликте экономикалык факторлорду эске алуу менен, илбирсти сактап калуу жолдору ишке ашырылат.

Zusammenfassung

Diese Studie war Teil einer Expedition in das Tien-Shan-Gebirge Kirgisiens (Ala-Too und Jumgal-Too Bergketten), durchgeführt von Biosphere Expeditions und dem NABU vom 11. Juli bis 27. August 2016 mit dem Ziel ein Gutachten über den Schneeleoparden (*Uncia uncia*) und dessen Beutetiere zu erstellen. Als Basis diente eine von Biosphere Expeditions entwickelte Zellenmethodik für Forschungsexpeditionen mit Bürgerwissenschaftlern, bei der 46 Zellen von 2x2 km Größe untersucht und 15 Interviews mit der einheimischen Bevölkerung durchgeführt wurden. Außerdem wurde eine Liste von 20 in der Region vorkommenden Schmetterlingsarten erstellt. Daten, die von vorangegangenen Expeditionen gesammelt wurden, gaben Hinweise darauf, dass der Schneeleopard im Studiengebiet vorkommt. Die Expedition 2016 fand frische Schneeleopardenspuren und bestätigt somit das Vorkommen der Art im Studiengebiet. Die Forschungen zeigten auch, dass das Habitat im Studiengebiet variabel genug ist und gute Voraussetzungen für eine gesunde Beutetierpopulation vorliegen. Potenzielle Beutetiere sind der sibirische Steinbock, das Murmeltier und die Schneehenne; außerdem wurde ein Anzeichen auf Argali-Bergschafe gefunden. Es gab es genug Steinbock-Positionsdaten, um Verbreitungsmodelle der Art in Relation zu Klima und Topographie entwickeln zu können. Basierend auf diesen Modellen sollten weitere Expeditionen weitere Anzeichen auf Steinbock und Schneeleopard finden. Wilderei, Überweidung und andere negative Einflüsse bleiben ernstzunehmende Störfaktoren, die angegangen werden müssen, um eine Verödung des Lebensraumes und das damit einhergehende Verschwinden des Schneeleoparden zu verhindern. Die Akzeptanz des Schneeleoparden bei der einheimischen Bevölkerung ist hoch und die Menschen sind sehr empfänglich dafür, ökonomische Massnahmen zu kreieren und umzusetzen, die auf beidem basieren: Einer intakten Natur und dem Schneeleopard in freier Wildbahn. Biosphere Expeditions und der NABU werden die alljährlichen Expeditionen ins Studiengebiet weiterführen, mit dem Ziel noch mehr Daten zu sammeln, die lokale Bevölkerung einzubeziehen und nach wirtschaftlichem Nutzen, sowie Massnahmen zu suchen, die einen intakten Lebensraum und damit einhergehend das Vorkommen von Schneeleoparden sichern.

Contents

Please note: Each expedition report is written as a stand-alone document that can be read without having to refer back to previous reports. As such, much of this and other sections, which remain valid and relevant, are a repetition from previous reports, copied here to provide the reader with an uninterrupted flow of argument and rationale.

1. Expedition Review

M. Hammer (editor)
Biosphere Expeditions

1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (biological or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This project report deals with an expedition to the Tien Shan mountains of Kyrgyzstan (Kyrgyz Ala-Too Range) that ran from 11 July to 27 August 2016 with the aim of surveying snow leopards as well as their prey species such as argali (a mountain sheep) and the Central Asian ibex. The expedition also surveyed other animals such as marmots, birds, and small mammals, and worked with the local anti-poaching patrol “группы барс” (snow leopard group “Grupa Bars”) and other local people on capacity-building and incentive creation projects.

Little is known about the status and distribution of the globally endangered snow leopard in the area, or about its interaction with prey animals such as the Tien Shan argali and Central Asian ibex, and its reliance on smaller prey such as marmots, ground squirrels and game birds. Biosphere Expeditions will provide vital data on these issues, which can then be used in the formulation of management and protection plans. The expedition also worked with locals in an effort to build capacity, educate and involve local people in snow leopard conservation and generate income through responsible tourism activities.

1.2. Research area

Kyrgyzstan is a country located in Central Asia and often referred to as the "Switzerland of Central Asia". Landlocked and mountainous, Kyrgyzstan is bordered by Kazakhstan to the north, Uzbekistan to the west, Tajikistan to the southwest and China to the east. Its capital and largest city is Bishkek. Kyrgyzstan is further from the sea than any other country in the world and all its rivers flow into closed drainage systems, which do not reach the sea. The mountainous region of the Tien Shan covers over 80% of the country, with the remainder made up of valleys and basins. The highest peak is Jengish Chokusu (Pik Pobedy) at 7,439 m and more than half of the country is above 2,500 metres. Steppe and alpine vegetation dominate the landscape; glaciers and permanent snow cover over 3% of the country’s total area. The climate in Kyrgyzstan is continental with a small amount of rainfall.

The Kyrgyz Ala-Too (Кыргыз Ала-Тоосу, also Kyrgyz Alatau, Kyrgyz Range) is a large range in the northern Tien Shan mountains. The range is situated just south of the capital city of Bishkek and the views from the city itself are stunning and form a backdrop unlike any other in the world. The Kyrgyz Ala-Too Range stretches for a total length of 454 km from the west end of Issyk-Kul to the town of Taraz in Kazakhstan. It runs in an east-west direction, separating into the Chuy, Kochkor, Suusamyr and Talas valleys. The western part of Kyrgyz Ala-Too serves as a natural border between Kyrgyzstan and Kazakhstan. The range's highest mountain is Alamyudyun Peak at 4,855 m.

Figure 1.2a. Map and flag of Kyrgyzstan with study site.

An overview of Biosphere Expeditions' research sites, assembly points, base camp and office locations can be found at Google Maps.

The mountains are divided by several river valleys and there is a great variety of landscape. There are hollows with semi-desert areas, alpine peaks, narrow river canyons and broad valleys, highland tundra and deep natural limestone gorges, open steppes, permanent snow and glaciers, tracts of forest, as well as a multitude of lakes, wild rivers and waterfalls. Forests of larch, cedar, spruce and pine (but very few deciduous trees) cover more than half of the mountain territory.

There are many threatened animal and plant species present in the area, a great number of them endemic, with a recent count showing at least 70 threatened mammal, 376 bird, 44 fish and over 3,000 insect species.

The Kyrgyz people are descendants of several different nomadic Turkish ethnic groups in Central Asia and were first mentioned in writing in 201 BC. Kyrgyzstan is one of the active members of the Turkic Council and the TÜRKSOY community. Kyrgyzstan's history is one of Turkish and Mongol, and more recently Soviet and Russian domination. Independence from the Soviet Union was declared on 31 August 1991 and Kyrgyzstan became, and has stayed, a unitary parliamentary republic.

1.3. Dates

The project ran over a period of two months divided into three 12-day slots, each composed of a team of international research assistants, scientists and an expedition leader. Slot dates were:

11 - 23 July **|** 1 - 13 August **|** 15 - 27 August 2016

Team members could join for multiple slots (within the periods specified).

1.4. Local conditions & support

Expedition base

The expedition team worked from a mobile base camp, set up in various valleys on the southern side of Kyrgyz Ala-Too (see Fig 2.2.3b). Base camp consisted of an assortment of dome, mess and kitchen, as well as shower tents, and a yurt (see Fig. 1.4a). All meals were prepared by the expedition cook; breakfast and dinner were provided at base and a lunch pack was supplied for each day spent in the field.

Figure 1.4a. Base camp with kitchen and mess tunnel tents, a yurt and dome tents for participants. Shower and toilet tents are outside the frame. There is also an expedition lorry for transporting base camp, and the expedition 4x4 vehicles.

Weather

The local climate is temperate continental with short, hot summers (during which the expedition took place) and prolonged, cold winters. Winter temperatures range from -9°C to -45°C, summer temperatures from +11°C to +35°C during the day. Base camp was in the mountains at an altitude of 3,000 m and as such the weather was very variable. In July/August wind and rain showers occurred frequently and higher up the wind could be accompanied by a snowfall. Sunny days were in the minority.

Field communications

The expedition had a satellite phone for emergency communications. There were also hand-held radios for groups working close together. There was generally no mobile phone network. The expedition leader posted a diary with multimedia content on Wordpress and excerpts of this were mirrored on Biosphere Expeditions' social media sites such as Facebook and Google+.

Transport & vehicles

Team members made their own way to Bishkek. From there onwards and back to Bishkek all transport was provided for the expedition team. A variety of 4x4 vehicles were rented from Almaz Alzhambaev of www.carforrent.kg. Local partner NABU also provided a 4x4 vehicle and a lorry (see Figure 1.4a). Horses were rented from local people as necessary.

Medical support and incidences

The expedition leaders were trained first aiders and the expedition carried a comprehensive medical kit. Further medical support was provided by the Public Foundation "Rescue in the mountains of Kyrgyzstan", small district hospitals in the town of Suusamyr (about 40 km from camp 1) and Kochkor (about 40 km from camp 2), a large hospital in Kara-Balta and large public hospitals and private clinics in Bishkek (about 140 km and 200 km from camp respectively). Safety and emergency procedures were in place and invoked once for a case of acute abdominal pain, which cleared without any ill effects for the patient following a visit to Bishkek.

All team members were required to carry adequate travel insurance covering emergency medical evacuation and repatriation.

1.5. Expedition scientist

Volodymyr Tytar was born in 1951 and his Master's Degree in Biology is 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 Ukraine Black Sea coast, and on snow leopards in the nearby Altai mountains, and has been involved in surveying and conservation measures throughout his professional life.

1.6. Expedition leaders

Malika Fettak (groups 1 & 2) 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.

Phil Markey (group 3) was born and educated in the UK, but spent most of his adult life living in the tropics of various countries. Phil's academic background is in both biology and geology and he works as a botanist specialising primarily in palms, bananas and cycads, but also gymnosperms, pteridophyta and other prehistoric plants. Phil is also a mountain leader trained in expedition logistics, catering, mechanics and survival skills, fluent in Mandarin Chinese and an experienced 4x4 and 8x8 off-road driver. During his three decades of expedition travel throughout the world, Phil has been lucky enough to have seen and studied many of the world's rarest and most endangered animals and plants in their natural environments.

1.7. Expedition team

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

11 – 23 July 2016: Amadeus DeKastle* (Kyrgyzstan), Dietmar Denger (press) (Germany), Michael Krause (Germany), Aigerim Kumondorova* (Kyrgyzstan), Amanda Maier (Australia), Carola Neumann (Germany).

1 – 13 August 2016: Fedor Broekhoven (the Netherlands), Starr Edge (USA), Gerald Fischer (USA), Roland Fischer (Germany), Neil Goodall (UK), Cedric John Hardwick (UK), Bernd Kannenberg (Germany), Hunter Listwin (USA), Ruth Mackay (Australia), Jake Sadoff (USA), Raymond Wilkinson (France), Rahat Yusubalieva* (Kyrgyzstan), Fiona Zeiner (Austria).

15 – 27 August 2016: Trevor Clarke (UK), Manuela Forster (Germany), Kenny Fung (USA), Hunter Listwin (USA), Deborah Oskamp (Germany), Tristan Quapp (Canada), Mary Quapp (Canada), David Quapp (Canada), Laura Tedstone (UK), Nicola Woodward (UK), Miyana Yoshino (Japan), Rahat Yusubalieva* (Kyrgyzstan), Nigel Zaman (Belgium).

Also our expedition cook throughout the expedition, Emma Alimbekova, and, on a rotational basis, members of NABU's anti-poaching patrol Grupa Bars: Schailoobek Tezektschiev, Aman Talgartbek Uulu and Bekbolot Ozgorush Uulu, all from Kyrgyzstan.

*Placement kindly supported by the Friends of Biosphere Expeditions and a GlobalGiving crowdfunding campaign.

1.8. Partners

On this expedition our main partner was the German conservation organization NABU (NABU; Naturschutzbund; nature protection alliance). Founded in 1899, NABU is one of the oldest and largest environment associations in Germany. The association encompasses more than 450,000 members and sponsors, who commit themselves to the conservation of threatened habitats, flora and fauna, and to climate protection and energy policy. In Kyrgyzstan, NABU, in cooperation with the Kyrgyz government, is implementing a program 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/).

1.9. 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 organisation, the Naturschutzbund (NABU; nature protection alliance), in particular the Grupa Bars (see section 1.7. for details), as well as Tolkunbek Asykulov and NABU's Bishkek office staff, Boris Tichomirow, Hanna Pfüller and Britta Hennig. A big thank you also to Almaz Alzhambaev of www.carforrent.kg, who has helped us very much over and above the call of duty. Thank you also for John Soos for kindly revising our community questionnaire. Biosphere Expeditions would also like to thank members of the Friends of Biosphere Expeditions and all donors to a fundraising campaign for their support.

1.10. 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.

1.11. Expedition budget

Each team member paid towards expedition costs a contribution of £1,940 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	52,744
Expenditure	
Expedition base includes all food & services	5,586
Transport includes hire cars, fuel, taxis in Kyrgyzstan	9,287
Equipment and hardware includes research materials & gear etc. purchased internationally & locally	4,117
Staff includes local and Biosphere Expeditions staff salaries and travel expenses	9,844
Administration includes miscellaneous fees & sundries	1,248
Team recruitment Tien Shan as estimated % of annual PR costs for Biosphere Expeditions	6,430
Income – Expenditure	**16,232**
Total percentage spent directly on project	**69%**

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 (2016)

Volodymyr Tytar
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2.1. Introduction

2.1.1. Background on the snow leopard

The snow leopard is a member of the *Felidae* subfamily *Pantherinae,* on the basis of morphology and behaviour. There has been and still is much controversy over the genus of the snow leopard. Taxonomically, the snow leopard has been classified as *Uncia uncia* since the early 1930s (Wozencraft, 2005). Based on genotyping studies, the cat has been considered a member of the genus *Panthera* since 2008 (Jackson et al. 2008, Janecka 2008).

Snow leopards are found in twelve countries across Central Asia (China, Bhutan, Nepal, India, Pakistan, Afghanistan, Tajikistan, Uzbekistan, Kyrgyzstan, Kazakhstan, Russia and Mongolia) (Fig.2.1.1a). China contains as much as 60% of the snow leopard's potential habitat.

Figure 2.1.1a. Part of the snow leopard's range (brown) and range countries (map © 2009 Snow Leopard Trust). Expedition study site in black ellipse.

Inaccessible and difficult terrain, along with the secretive nature of this rare cat, helps to account for the fact that large parts of its range have yet to be surveyed. Between 4,500 and 7,350 snow leopards are thought to occur within a total potential habitat area of 1,835,000 km^2 (McCarthy & Chapron 2003). Snow leopards are generally solitary creatures, and mating usually occurs between late January and mid–March, with one to five cubs being born after a gestation period of 93 to 110 days, generally in June or July (Sunquist & Sunquist 2002). Snow leopards are closely associated with the alpine and subalpine ecological zones, preferring broken, rocky terrain with vegetation that is dominated by shrubs or grasses (McCarthy & Chapron 2003).

The home range of five snow leopards in prime habitat in Nepal varied from 12 to 39 km^2, with substantial overlap between individuals and sexes (Jackson & Ahlbom 1988). In Mongolia, where food resources may be scarcer, home ranges of both males and females exceeded 400 km^2 (McCarthy & Chapron 2003). Snow leopards are opportunistic predators capable of killing prey up to three times their own weight (Mcdonald & Loveridge 2010). They will also take small prey such as marmot (*Marmota sp.*) or chukar partridge (*Alectoris sp.*). In general, their most commonly taken prey consists of wild sheep and goats (including blue sheep, Asian ibex, markhor and argali) (Lyngdoh et al. 2014). Adult snow leopards kill a large prey animal every 10-15 days, and remain on the kill for an average of three to days, but sometimes up to a week (McCarthy 2000). Predation on livestock can be significant, which often results in retribution killing by herders (McCarthy & Chapron 2003).

Snow leopards are listed as Endangered on the IUCN Red List. Currently the species does not meet the standards of Critically Endangered, but populations are projected to decline by 50% or more over the next three generations. This is due to potential levels of exploitation (trade in pelts/bones and conflict with livestock), to declining suitable habitat, extent of occurrence, and finally due to quality of habitat (prey depletion) (McCarthy & Chapron 2003). They appear in Appendix I of both CITES and the Convention on Conservation of Migratory Species of Wild Animals (CMS). Snow leopards are protected nationally over most of their range. However, in some countries the relevant legislation may not always be very effective.

2.1.2. The snow leopard in Kyrgyzstan

Kyrgyzstan was once home to the species' second largest population in the world (Anon. 2013). In the 1970s and 1980s, the trapping and export of wild animals was officially organized by the Soviet national zoo authority. Kyrgyzstan supplied approximately 40 snow leopards annually, which the central office in Moscow sold to zoos worldwide for USD 50 per animal (Anon. 2013). With the end of the Soviet Union, many official wildlife trappers were put out of work. Today, because of the high prices snow leopard parts earn on the black market, snow leopards have been poached heavily since Kyrgyzstan gained independence from the Soviet Union in 1991 (Dexel 2002).

In Kyrgyzstan (representing around 4% of the snow leopard home range, Table 2.1.2a), numbers declined from an estimated 600–700 individuals in the late 1980s (Koshkarev 1989) to 150–200 individuals by 2000 (Koshkarev & Vyrypaev 2000), putting the species at high risk of extinction in the country. More recent population estimates are closer to 350-400 for the whole country (Davletbakov et al. 2016).

Table 2.1.2a. Potential Habitat Area (in square kilometres) for snow leopard across its range in Central Asia (after Hunter & Jackson 1997).

Country	Total potential habitat (estimated occupied habitat)	Good	Fair	Percent protected
All Countries	**3,024,728**	549,706	2,475,022	6.0
Kyrgyzstan	**126,162 (105,000)**	32,783	93,379	1.1

Across the snow leopard's range, gaining a more accurate picture of snow leopard distribution and identifying 'hotspots' is a critical conservation need. Over most of the range, it is uncertain where the species occurs (McCarthy & Chapron 2003). This emphasises the need for snow leopard surveys and distribution mapping, the results of which will help to identify areas for conservation.

Secondly, there is a need for a better understanding of prey species distributions and populations. As with snow leopards themselves, the distribution and abundance of the cat's prey is poorly documented over much of the range. Baseline population estimates should be gained for this purpose. This will allow long-term trend monitoring to begin of both snow leopards and their prey.

Thirdly, an important issue is the evaluation of the attitudes and lifestyles of local communities, who share the snow leopard's habitat, in order to promote the coordinated development between continue snow leopard existence and local production and living.

Recently these needs have been incorporated into a new international effort to save the snow leopard and conserve high-mountain ecosystems, the Global Snow Leopard & Ecosystem Protection Programme (GSLEP), which mirrors to the commitments of the Bishkek Declaration adopted by twelve snow leopard home range countries at the Global Snow Leopard Forum in 2013. Under GSLEP, portfolios of national activities have been designed and are expected to be implemented with the support from international and national partners.

2.1.3. Background on Kyrgyzstan (based on Farrington 2005)

Mountains - With the exception of a few, small, lowland areas on the Kazakh Steppe and in the Ferghana Valley, Kyrgyz territory is entirely comprised of the ranges, valleys and plateaus of the Tien Shan and Pamir-Alai Ranges, with 94 percent of the nation's territory being higher than 1,000 m in elevation, and 40 percent above 3,000 m. The nation has two peaks that exceed 7,000 m in elevation. The highest peak in the Tien Shan, Peak Pobeda (Kyrgyz: Jengish Chokusu, Chinese: Tuomuer Feng), has an elevation of 7,439 m, and is located in the Central Tian Shan on eastern Kyrgyzstan's shared border with China. It is only exceeded in height by the peaks of the Himalaya mountain belt, the Tibetan Plateau, and the Pamirs of Tajikistan. Kyrgyzstan's second highest mountain is Peak Lenin, elevation 7,134 m, which is located in the Trans-Alai Range of the northern Pamirs on Kyrgyzstan's international border with Tajikistan. The Tien Shan itself is the longest mountain range in Asia north of the Tibetan Plateau, with a length of about 2,400 km that stretches from the outskirts of Tashkent, Uzbekistan to eastern Xinjiang, China. The bulk of the range is almost evenly split between Kyrgyzstan and China, and at its widest point in central Kyrgyzstan the Tien Shan is roughly 275 km in width and comprised of six closely spaced, parallel ranges, all exceeding 4,000 m in height.

The mountains of the Tien Shan are composed mainly of crystalline and sedimentary rocks of the Paleozoic Era (i.e. about 540–250 million years ago). The basins that lie between the mountains are filled with younger sediments that were formed chiefly by the erosive action of the area's rivers. A new stage of development began about 25 million years ago and has continued to the present time, characterised by sudden movements of the Earth's crust. Loose fragments of rock have slid into the valleys and formed accumulations. Subsequently, glaciers produced moraines comprising boulder-rich sediments in the mountains, while gravel (sediment deposited by water) and loess (sediment deposited by wind) accumulated in the valleys.

Glaciers, lakes and rivers - The Kyrgyz Tien Shan together with the Pamirs of Tajikistan play a crucial role as the primary water catchments for almost all of former Soviet Central Asia, as well as for large parts of western Xinjiang, and are the sources of the two largest rivers flowing to the depleted Aral Sea, the Syr Darya and the Amu Darya. Thus these ranges permit large populations to exist in the arid region and are of key importance to the national economies of the region, which are heavily dependent on irrigation-intensive agricultural systems.

Glacier cover in Kyrgyzstan is extensive, with a total area of 8,170 km^2 or approximately four percent of national territory covered. "Permanent" snowfields cover still more of Kyrgyzstan's highlands. Snow and glacier melt are an extremely important part of the hydrological cycle in the Tien Shan, with glacier melt alone accounting for, on average, about ten percent of flow from mountain streams, which can increase to twenty percent during time of drought. The most extensive ice fields in Kyrgyzstan are found around the Pobeda-Peak Khan-Tengri massif, which extends into Kazakhstan and Xinjiang and includes more than 1,200 glaciers with a total area spanning the three countries of 4320 km^2. In Kyrgyzstan, the single longest glacier in these icefields is the Engilchek Glacier, which is some 50 km in length. However, between 1935 and 1985 Kyrgyzstan's glaciers lost anywhere from five to twenty-seven percent of their mass due to global warming, which has resulted in a rise in temperatures of about 0.5ºC over the last 60 years.

Kyrgyzstan's four largest natural lakes are Lake Issyk-Kul, Lakes Song-Kul and Chatyr-Kul in Naryn Province, and Lake Sary-Chelek in Jalalabad Province. All four lakes are important summer nesting grounds for migratory waterfowl and Lake Issyk-Kul, which does not freeze in winter, is also an important wintering ground for a number of waterfowl species (Ter-Ghazaryan & Heinen 2006). In addition to these four lakes there are numerous smaller mountain lakes scattered throughout Kyrgyzstan, including a number of moraine lakes that form at high altitude in areas experiencing glacial retreat (Fig. 2.1.3a).

The most important rivers, which have all, or portions, of their headwaters lying within Kyrgyz territory are those of the Syr Darya, Amu Darya, Tarim, Chu, and Talas Rivers, none of which reach the world's oceans. The Syr Darya and Amu Darya are the life-blood of the agricultural economies of Turkmenistan, Uzbekistan and western Kazakhstan, and the misuse of these has led to the present Aral Sea crisis (Micklin 2007). The Naryn River is the longest and most important river in Kyrgyzstan and is one of two rivers originating on Kyrgyz territory that join in the Ferghana Valley of Uzbekistan to form the Syr Darya, the other being the Kara Darya, which originates in Osh Province.

The Naryn gathers high in the tundra bogs of the Ak-Shirak Range, at an elevation of about 3,800 m, from where its source waters flow only a few kilometres before being immediately impounded by the Kumtor Gold Mine reservoir. The river then proceeds to flow roughly 600 km to Uzbekistan, filling three major reservoirs en route that are the source of much of Kyrgyzstan's electricity.

Figure 2.1.3a. Moraine lake within the study site (42.419207°N, 74.779487°E, 3,884 m).

Climate

The country's climate is influenced chiefly by the mountains, Kyrgyzstan's position near the middle of the Eurasian landmass, and the absence of any body of water large enough to influence weather patterns. These factors create a distinctly continental climate that has significant local variations. Although the mountains tend to collect clouds and block sunlight (reducing some narrow valleys at certain times of the year to no more than three or four hours of sunlight per day), the country is generally sunny, receiving as much as 2,900 hours of sunlight per year in some areas. The same conditions also affect temperatures, which can vary significantly from place to place. In January the warmest average temperature (−4°C) occurs around the southern city of Osh, and around Lake Issyk-Kul, which has a volume of 1.7 km^3, and does not freeze in winter. Indeed, its name means "hot lake" in Kyrgyz. The coldest temperatures are in mountain valleys. There, readings can fall to −30°C or lower; the record is −53.6°C.

The average temperature for July is similarly variable, from 27°C in the Fergana Valley, where the record high is 44°C, to a low of −10°C on the highest mountain peaks. Precipitation varies from 2,000 mm per year in the mountains above the Fergana Valley to less than 100 mm per year on the west bank of Lake Issyk-Kul.

Ecosystems, flora and fauna

The Tien Shan, with its extensive ice fields and hundreds of rushing rivers and streams, forms a well-watered ecological island of mountain meadows, forests and lakes in the arid heart of Asia, being bound to the south by the vast Taklamakan Desert of Xinjiang, and to the north by the dry steppes of Kazakhstan. The geologic history of the Tien Shan is one of rapid uplift forming multiple parallel ranges (Bullen et al. 2003). These geologic processes have led to the formation of a large number of long, roughly parallel valleys with wide altitudinal variation. One result of this geologic history has been the formation of numerous, closely spaced, and extremely varied microclimates. These microclimates in turn have led to the formation of a large number of remarkably diverse ecosystems that occur over a relatively small area, and include a number of relict ecosystems that have survived in mountain valleys as the Tien Shan has become more geographically isolated with the increasing aridity of the surrounding region (Agakhanyantz 1978).

According to the Global Land Cover Database (GLC) 2000 (Fritz et al. 2003), nine land cover types are distinguished in Kyrgyzstan (Table 2.1.3a; Fig. 2.1.3b). The most common type is "Herbaceous Cover, closed-open", which covers almost half of the country. Next are "Bare Areas" and areas with "Sparse herbaceous or sparse shrub cover" and "Snow and Ice". Other types, including cultivated and managed areas, croplands, human infrastructure etc., comprise only around 10% of the land cover.

Table 2.1.3a. Land cover types in Kyrgyzstan according to GLC 2000.

GLC2000 land cover type	%
Herbaceous cover, closed-open	46.7
Bare areas	23.9
Sparse herbaceous or sparse shrub cover	9.1
Snow and Ice	9.0
Cultivated and managed areas	4.1
Water bodies	3.4
Tree cover, broadleaved, deciduous, open	2.5
Mosaic: Cropland / shrub and/or grass cover	1.2
Artificial surfaces and associated areas	0.002

The Tien Shan forms an ecological bridge that loosely connects the mountain ranges of South Asia, including the Himalaya, Pamir and Hindu Kush, with the remote, Inner Asian ranges of Mongolia and Siberia, most notably the Altai and Sayan Ranges. As a consequence of this geographic positioning and the increasingly arid environment of the surrounding region, the Tien Shan serves as an important corridor for the movement and dispersal of mountain-dwelling species between the ranges of Inner and South Asia, and is a meeting place for flora and fauna representatives of Central Asia, Inner Asia, Tibet, South Asia, and even East Asia, Europe, and the Mediterranean (Daviesson & Fet 2001, Agakhanyantz 1978, Schaller 1998). Thus, the combination of the Kyrgyz Republic's geographic positioning, numerous microclimates, and variety of relict ecosystems, has endowed the country with remarkable species diversity. There are 563 vertebrate species (Table 2.1.3b) and over 10,000 invertebrate species that have so far been identified in Kyrgyzstan. Notable vertebrate species include the snow leopard (*Uncia uncia*), argali (*Ovis ammon*), Pallas's cat (*Felis manul*), and the Himalayan griffon (*Gyps himalayensis*). The four mammals endemic to the region are the Tien Shan striped field mouse (*Apodemus agrarius tianschanicus*), Tien Shan brown bear (*Ursus arctos isabellinus*), Menzbier's marmot (*Marmota menzbieri*) and the Tien Shan ground squirrel (*Spermophilus relictus*) (Daviesson & Fet 2001). Thus far, 3,786 higher plants and 3,676 lower plants have been identified in Kyrgyzstan, including more than 200 endemic plant species and 200 species of medicinal plants (Daviesson & Fet 2001).

Table 2.1.3b. Vertebrate species Identified in Kyrgyzstan by taxa (Daviesson & Fet 2001).

Taxa	Number of species in Kyrgyzstan	Number of species endemic to Kyrgyzstan	Number of species in the Kyrgyz Red Data Book of Threatened Species	Number of species on the IUCN Red Data Lists.
Fish	**75**	**12**	**6**	**1**
Amphibians	**4**	**2**	**3**	**-**
Reptiles	**33**	**2**	**5**	**3**
Birds	**368**	**-**	**35**	**8**
Mammals	**83**	**4**	**15**	**4**
TOTALS	**563**	**21**	**64**	**16**

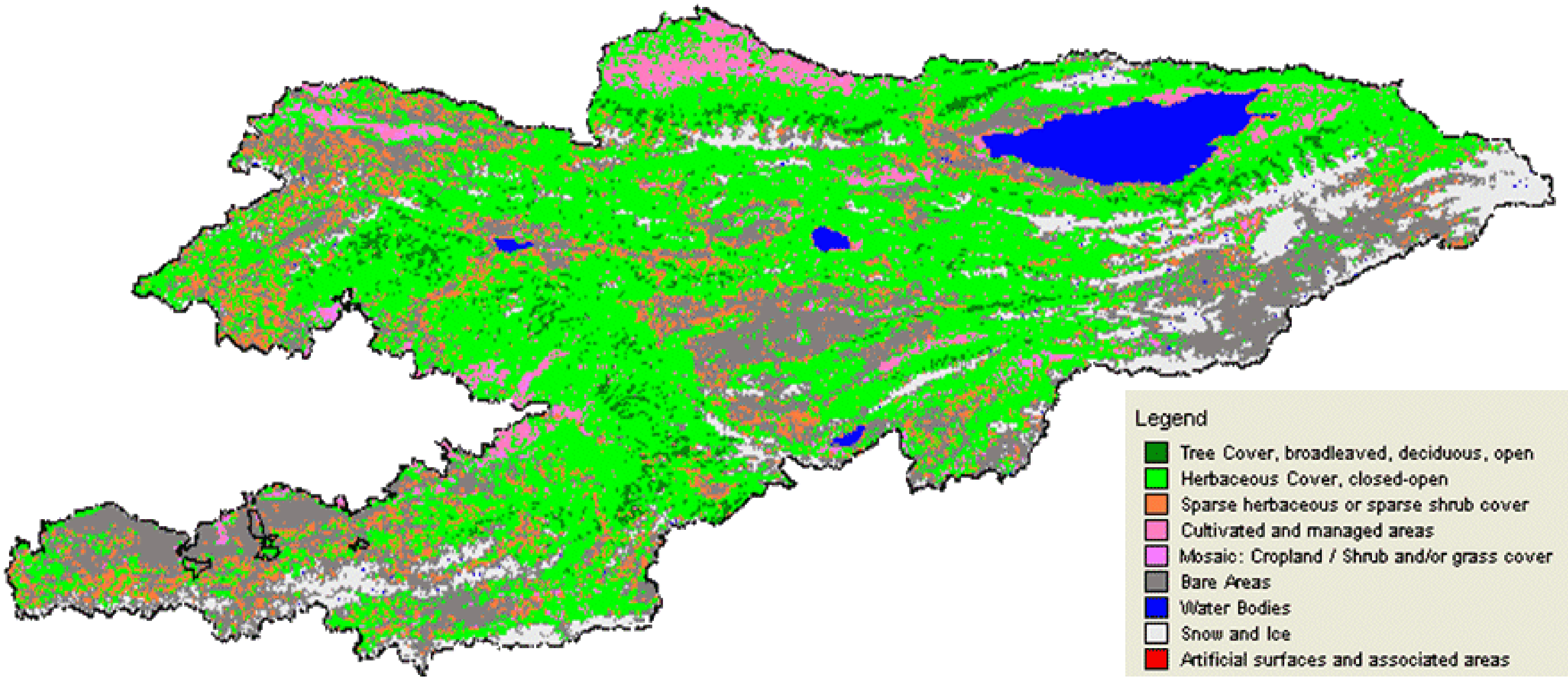

Figure 2.1.3b. GLC2000 land cover types in Kyrgyzstan.

Economy

During the Soviet era, the principal industries of Kyrgyzstan were the production of wool and meat, uranium and tin mining, some textile factories and industrial production. With independence in 1991, all of these industries collapsed and most people were forced into self-employed subsistence occupations, such as being small farmers and livestock owners, or small traders shuttling back and forth between China, Kazakhstan and Russia. Few new industries have emerged in Kyrgyzstan, although the country has been opened to international mining investment, and the Canadian-owned Kumtor Gold Mine, one of the world's largest, now accounts for about 20 percent of Kyrgyz GDP.

Figure 2.1.3.c. Typical Kyrgyz yurt of a livestock owner (42.379765°N, 74.942040°E, 2,958 m).

The foundation of cultural identity amongst ethnic Kyrgyz lies in the ancient practice of nomadic pastoralism, which has persisted on the grasslands of Inner Asia for several millennia. Prior to collectivisation in the late 1920s, Kyrgyz herders followed a four pasture annual migration cycle, from winter pastures in lowland valleys to summer pastures in mountain highlands, with intermediate pastures being occupied in spring and autumn. The Kyrgyz had no permanent settlements prior to the arrival of the Russians and dwelled year round in yurts, the portable round felt tent found throughout Central Asia (Fig. 2.1.3c). While all but a few Soviet era herding collectives have long since been disbanded, each year thousands of herding families continue to migrate with their livestock between their home villages and summer pastures in the high mountains, where they remain for several months.

Environmental issues

Kyrgyzstan has been spared many of the enormous environmental problems faced by its Central Asian neighbours and the economic downturn of the early 1990s reduced some of the more serious effects of industrial and agricultural policy. Nevertheless, Kyrgyzstan faces serious environmental problems. Among global environmental issues presently on the agenda in Kyrgyzstan are global climate change, ozone layer depletion, desertification, and biodiversity loss.

Related to global climate change in Kyrgyzstan is the problem of deglaciation. A study commissioned by the UNDP projects glacier area loss in Kyrgyzstan in the range of 52 to 70% in the first half of the 21st century and a total of 70 to 86% by the end of the century (UNDP 2009).

In terms of biological diversity, Kyrgyzstan holds a prominent place worldwide. It possesses around 1% of all known species, while its area makes up only 0.13% of the world's land mass. According to the national Biodiversity Strategy and Action Plan (Kyrgyz Republic…1998), the threats to biodiversity are related to anthropogenic activity and include habitat loss and alteration, fragmentation of natural communities due to overuse, over-harvesting, direct mortality, introduction of non-native species, environmental pollution, and climate change. In Kyrgyzstan today, at least ten percent of the nation's vertebrate species are endangered (Table 2.1.3b). Among the higher plants, 71 species are considered to be threatened.

In the highlands of Kyrgyzstan, many species have been pushed to the brink of local extinction since the onset of the economic crisis of the 1990s, which hit rural areas particularly hard. Disbandment of agricultural collectives left entire villages without state support. In efforts to generate cash incomes or simply survive, many Kyrgyz turned to hunting, including the widespread poaching of endangered species, which resulted in a severe reduction of wild animal populations. Poaching has had an alarming impact on protected species such as the snow leopard, which was formerly found throughout Kyrgyzstan, and in the mid-1980s had an estimated population of 1,200–1,400 animals (Koshkarev 1988). However, independence in 1991 was followed by the mass impoverishment of rural populations and one result of this period of turmoil has been a general breakdown of law enforcement measures concerning wildlife and protected areas. By 1996 the estimated population of snow leopards had fallen by half or more to 650, as animals were trapped for fur and sale of parts for traditional Chinese medicine, while live cubs were sold to private zoos. In 2003, it was estimated that as few as 150 snow leopards remained in Kyrgyzstan (Vorobeev & van der Ven 2003).

While the number of sheep in Kyrgyzstan has fallen dramatically since independence, loss of habitat and species diversity due to overgrazing remains a severe problem in Kyrgyzstan. In 1994 the size of livestock herds averaged twice the carrying capacity of pasturage land, continuing the serious overgrazing problem and consequent soil erosion that began when the herds were at their peak in the late 1980s. Overgrazing has resulted in widespread erosion, landslides, proliferation of unpalatable plant species and an overall reduction in pasture productivity (Fitzherbert 2000).

Figure. 2.1.3d. Livestock on high mountain pastures (42.365335^{o}N, 74.756501^{o}E, 3,061 m).

While these developments adversely affect domestic animals residing on these lands, they also affect wild animals, particularly grazing animals, and lead to an overall reduction of wild plant species that are the preferred forage of both wild and domestic animals. In addition, uncertain land tenure and financial insecurity have caused many private farmers to concentrate their wealth in the traditional form - livestock - thus subjecting new land to the overgrazing problem.

The Tien Shan mountains

The Tien Shan mountains are the largest mountain range in Asia in surface area, with a length of 2,800 km and a maximum width of 800 km, and with a total of 40 peaks over 6,000 m. They stretch across several countries and much of the system lies in the territory of Kyrgyzstan. Extending over 2,800 km from the Chatkal range just east of Tashkent to Urumchi, (beyond which it rises again as the Bogdo Ola Range), the Tien Shan mountains are usually described as being divided into northern, western, eastern, central and inner ranges and most of them exhibit typical “alpine” features. The range is made up of sedimentary, metamorphic and igneous rocks.

Kyrgyz Ala-Too

The Kyrgyz Ala-Too (Kyrgyz: Кыргыз Ала-Тоосу, also Kyrgyz Alatau, or Kyrgyz Range) is a large range in the north Tien Shan (Figures 2.1.3a and 2.2.2a). It stretches for a total length of 454 km from the west-end of Lake Issyk-Kul to the town of Taraz in Kazakhstan. It runs in an east-westerly direction, separating Chuy Valley from Kochkor Valley, Suusamyr Valley and Talas Valley. The Talas Ala-Too Range adjoins the Kyrgyz Ala-Too near the Töö Ashuu Pass. The western part of Kyrgyz Ala-Too serves as a natural border between Kyrgyzstan and Kazakhstan.

2.2. Materials and methods

2.2.1. Kyryz Ala-Too study site

By a joint decision of NABU and Biosphere Expeditions, the Kyrgyz Ala-Too mountain range was chosen for snow leopard inventory and habitat research for several reasons including:

(1) The area in recent times has been poorly surveyed for snow leopard. Previous research of the area (Koshkarev 1989, see Table 2.2.1a) has suggested the suitability of the Kyrygz Ala-Too for sustaining snow leopards. However, more evidence is needed before coming to a final conclusion.

Table 2.2.1a. Numbers, density and area occupied by the snow leopard in various parts of the Tien Shan (excerpt from Koshkarev 1989). Ala-Archa is within the Kyrygz Ala-Too range.

Range, river catchment area	Number of individuals	Average density (per 100 km^2)	Occupied area (in km^2)
Aksu	12-14	2.51	517.5
Sokoluk	6-8	3.25	215.6
Ala-Archa	7-9	2.40	333.5
Issyk-Ata	5-6	3.25	169.0

(2) A map study suggested that the area may be an important corridor for snow leopard dispersal between the Talas Ala-Too Range (western Tien Shan) and ranges located in the Issyk-Kul basin. According to a draft design of an ecological network for Kyrgyzstan led by a prominent Kyrgyz biologist E.M. Shukurov "it supports habitats and migration routes of many wild animals (the snow leopard, black vulture, bearded vulture, hawk-type raptors, lynx, wild boar, Siberian ibex, Himalayan snowcock) as well as juniper and spruce forests that need protection".

(3) The habitat is high in biodiversity, supporting a range of prey species and other carnivores.

(4) The area lacks proper protection and is threatened by a growing economic interest; as quoted in Shukorov's draft design: "*geographically, the zone is located in the Chuy Oblast, which is the most populous province nationwide (over 1.5 million people). The proximity to the capital city of Bishkek makes the zone more vulnerable, because of heavy recreation pressure from city dwellers visiting the nearest national park, mountaineer camps, zakaznik reserves, ski resorts, thermal springs, etc. The anthropogenic impact on natural ecosystems is especially pronounced in summer, as domestic cattle (over 100,000 heads of cattle, over 250,000 of sheep and goats) are put to pasture of the Kyrgyz Ala-Too*".

Shukorov quotes the commonest violations of land use as: "*unsystematic cattle grazing, illegal hunting and forest felling*". However, there is a potential here for establishing protected areas and several proposals have been made in Shukurov's draft that could favour wildlife and benefit local residents.

2.2.2. Research area and timing of survey

Surveys concentrated on the south side of Kyryz Ala-Too, away from the main cities on the northern slopes. Suusamyr valley, a high steppe plateau (2,200 m), was the expedition's main access route into the southern valleys. Although only some 160 km from Bishkek, Suusamyr valley is also one of the more remote and rarely visited regions of Kyrgyzstan, which was one of the reasons for selecting this option. The valley's population of about 6,000, is mainly Kyrgyz. In Soviet times the valley was one of the major sheep breeding areas in the country. Up to four million sheep a year were driven over the mountain passes in spring to graze on the grasses of the steppe. Today, in the summer, people still live in yurts and graze sheep and horses. The valley's main settlement, the village of Suusamyr, is also the one that gives the valley its name. The village lies at the eastern edge of the plain, about 15 km east of the main Bishkek-Osh road. From here, there is a route following the course of the West Karakol river at the southern foot of the Kyrgyz Ala-Too, up to the Karakol pass (Fig. 2.2.2a) and leading further to the town of Kochkor.

The surroundings are very sparsely populated – there are virtually no permanent settlements in the valley. In summer, people occupy the jailoos (high mountain pastures) right up to the Karakol pass itself – grazing horses, cows, goats and sheep.

For reasons of safety, accessibility and convenience, the expedition base camp was located close to the Suusamyr-Kochkor road near to the middle of the planned study area (42.359535^{o}N, 74.737829^{o}E, 3,002 m). From the base camp mostly one-day surveys, but also some two-day/one-night surveys were conducted to various portions of the Kyrgyz Ala-Too Range and to the neighbouring Jumgal Too Range on the opposite side of the West Karakol river.

Snow leopard surveys are best undertaken when weather permits travel within the proposed survey area, when animals are most actively marking and when signs are most long-lived. These conditions rarely coincide, so trade-offs have to be made between logistical factors and biological ones. Logistics and team recruitment factors by and large determined the survey period for this study. On the one hand, summer is a difficult time to find snow leopard signs: marking activity is low, human disturbance is high and livestock grazing can soon obliterate signs.

Suitability of tracking substrate is also poor (tracking is much easier in snow). Weather conditions also tend to be unpredictable and contribute to sign erosion and eradication, as rain erodes signs very rapidly.

On the other hand, recruiting for a summer expedition is much more realistic, logistics are not nearly as prohibitive as in winter and, most importantly for this study, human presence can be a valuable source of information, especially in the absence of other baseline data.

Figure 2.2.2a. Karakol mountain pass in June (42.356682°N, 74.847872°E, 3452 m).

2.2.3. Research methods

Survey routes followed river valleys and landform edges wherever possible. Research focused on areas considered the most important habitat for snow leopard and prey, and with the lowest levels of human disturbance. Distant survey sites were accessed by car. Ground surveys were conducted on foot.

Snow leopard presence can be detected by sign, i.e. pugmarks (tracks), scrapes, faeces (scat), urination and rock scent spray. These signs tend to be left in relatively predictable places. For example, scrapes tend to be left at the base of cliffs, beside large boulders, on knolls and promontories, at bends in trails, or along other well-defined landform edges (Koshkarev 1984, Mallon 1988, Schaller et al. 1987, Jackson & Ahlborn 1988). These factors are important when deciding where to survey.

Surveying the prey base is another essential component of a snow leopard presence/absence survey. Argali (*Ovis ammon*) and ibex (*Capra sibirica*) are considered the main prey species in the area and their range closely parallels that of the snow leopard. Prey species were surveyed by recording signs and by observation. Prey signs included tracks, faeces, hair/wool, and carcasses/bones. Prey species were divided into 'primary' (ibex and argali) and 'secondary' (roe deer (*Capreolus capreolus*), marmot (*Marmota baibacina*), pika (*Ochotona* sp.), hare (*Lepus capensis tolai*), wild boar (*Sus scrofa*) and game birds). The same search sites were used for snow leopard and for prey surveys.

The prospective study site encompasses an area of 122 x 38 km within the Kyrgyz Ala-Too Range, with additional surveys conducted in the Jumgal Too Range. The area was divided into 2 x 2 km cells and surveying followed the methodology manual developed for volunteer expeditions by Mazzolli & Hammer (2013).

GIS and mapping

The main reference maps used were Soviet military topographic maps created between 1950-1980 at a scale of 1:100 000 and 1:200 000. A GIF image of the area was imported and geo-referenced into the GIS freeware program TrackMaker (www.gpstm.com). A grid of 2 x 2 km cells, of which a fraction was actually surveyed, covering the study area was uploaded into the expedition's GPS units (Garmin etrex 20 and 30) to aid navigation and data collection. Grid data was in Universal Transverse Mercator projection, covering zone 43 N and datum WGS 84 (Fig. 2.2.3a).

Using GIS freeware programs DIVA-GIS 7.5 (www.diva-gis.org/), QGIS 2.6.1 (www.qgis.org) and SAGA GIS (www.saga-gis.org), grid cells were polygonised, their centroids were found and hexagon buffers were created around them. These shapefiles were then used in the subsequent analysis of collected data (Fig. 2.2.3b).

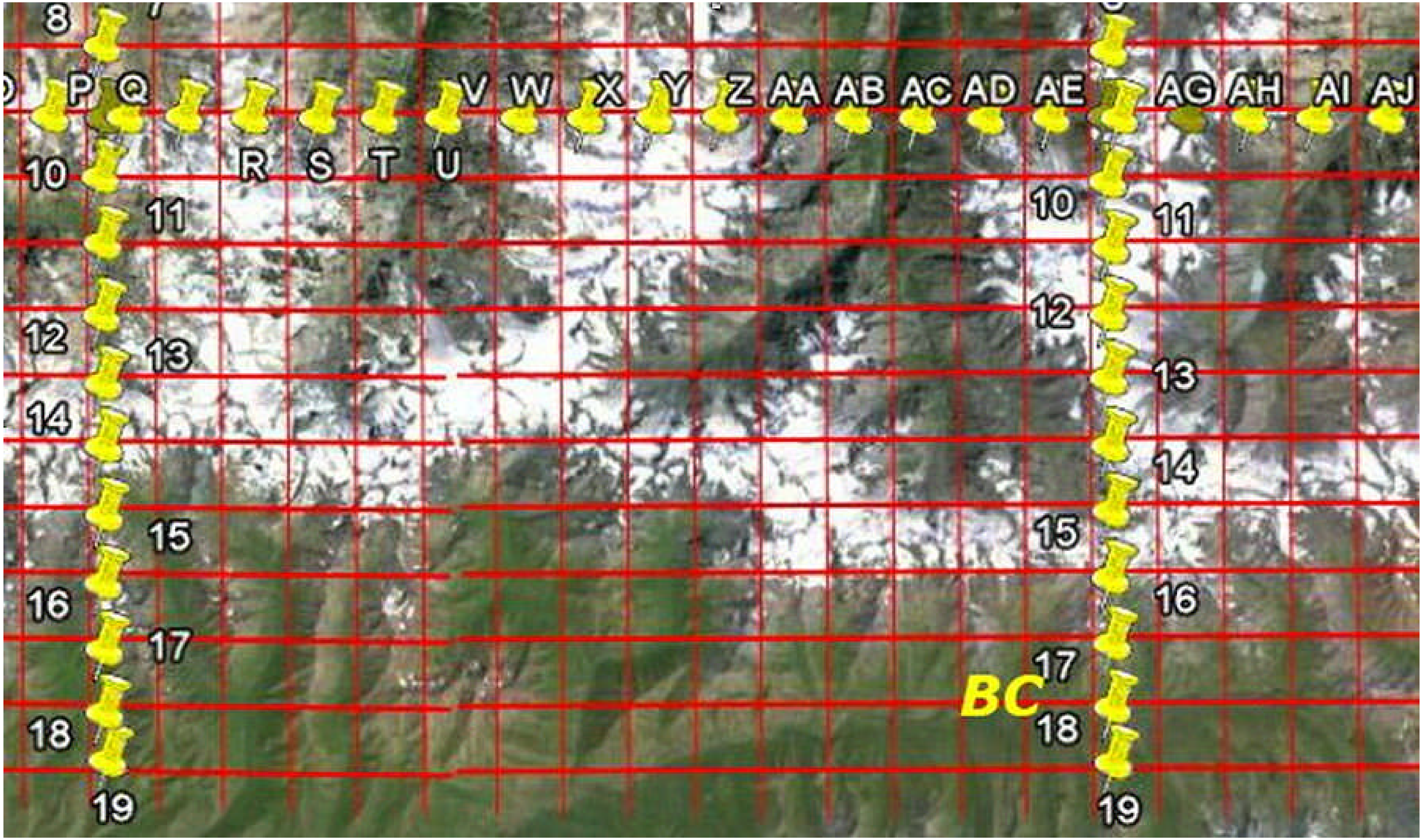

Figure 2.2.3a. Fragment of the map of the study area and grid of 2 x 2 km cells, shown as a Google Earth file (*.kml). Red = gridlines (tracks). Yellow pins = waypoints with cell codes, BC = base camp (located in cell AE18).

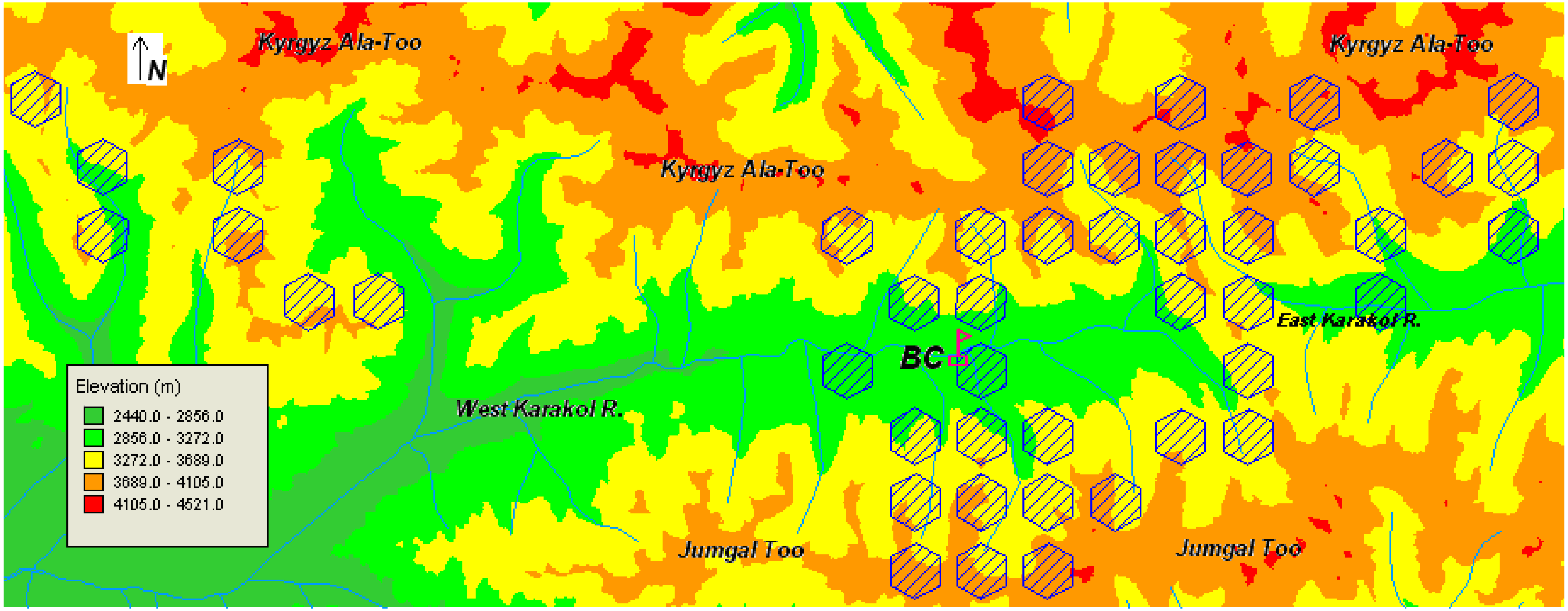

Figure 2.2.3b. The 2 x 2 km cells sampled and found to contain data in the planned research area (for convenience of computer processing in GIS the 'square' cells are represented by hexagons, which share the same centroids, i.e. "average" position of all the points in the shape). BC – base camp (42.359535ºN, 74.737829ºE, 3,002 m).

2.2.4. Training of expedition participants

In this study, data collection was performed by volunteers with no previous knowledge of wildlife research and conservation, except those given during the initial stages of a short-duration expedition. Training included an introduction to snow leopard conservation issues, the role of NABU and Biosphere Expeditions in the snow leopard survey and the methods of recording presence of species using GPS and datasheets. For these purposes various handouts were produced, including an 18 page illustrated Expedition Field Guide.

Before participants were split into small groups to perform their various research tasks, an introductory survey on the first day was performed as part of the training process. During this survey, tracks and scats of known species were shown.

To reduce identification errors, participants were instructed to bring scats to base camp whenever they were unable to identify the species. They were also briefed on how to take photos of tracks for identification later at base. The large surveying team recruited by Biosphere Expeditions helped to cover a substantial geographical area in a short time, meaning that the chances of finding snow leopard and other wildlife sign were maximized.

2.2.5. Sampling of target species

Following the presence/absence method in the field manual developed by Mazzolli & Hammer (2013), the presence of prey species and large carnivores was recorded using the general location given by a cell code. Once a species or its signs were found in a given cell, it was scored as containing the species.

In cases of snow leopard sign, GPS records were taken at the spot. Siberian ibex sightings were mapped where possible, using a GPS receiver, physical map and a SILVA compass in order to record more precisely their location, rather than just recording the given cell code alone.

There is a need to cover large areas so that the survey can better represent the snow leopard and potential prey populations. For this reason, teams usually covered two or more 2 x 2 km cells during the daily surveys.

Nineteen digital Bushnell camera traps were set throughout the study area. Two kinds of strategies were employed to install the cameras:

- one in which the field team perceived a good spot to produce photos of the snow leopard and species associated with snow leopard habitat;

- the other based on the species distribution modelling exercise performed on previously obtained visual records of the Siberian ibex, the main food source for the snow leopard.

In the first case the selection of ‘good spots’ was guided by field experience and intuition, whereas in the second it was presumed that areas of predicted probability of Siberian ibex occurrence >0.6 (i.e. 60%) represented areas of prime interest. The results of preliminary modelling based on previous knowledge gained by the expedition show that these areas include heads and surrounding ridges of the streams Ayu-Ter and Kuyke-Bulak, ridges in between and surrounding Chon-Chikan and Chaartash streams, upper parts and surrounding ridges of the Choloktor stream, as well as an area stretching between the upper reaches of Issyk-Ata and the neighboring Kara-Tor stream. In the south, modeling indicates ridges surrounding the upper reaches of Kashka-Tor stream as a priority area.

Other species, including birds, mammals and butterflies etc., were recorded whenever possible.

2.2.6. Species records and distribution modeling for Siberian ibex

Statistical models were used to explore the response of individual species to land cover, topography, land use, bioclimatic features etc. (Guisan & Zimmermann 2000). Because of their importance for both science and management, habitat models have been used to predict occurrence and abundance patterns for many species (Elith et al. 2006).

Taking into account the importance of Siberian ibex for sustaining snow leopards (Lyngdoh et al. 2014), the objective was set to map the habitat quality of this key prey species in the study area for both research and potential conservation purposes, as well as the need for generalising our view on the distribution of Siberian ibex in the study area by incorporating fresh data. Together the data consisted of 95 georeferenced records of direct observations of ibex.

Environmental & bioclimatic data

To relate the occurrence records of ibex with abiotic conditions, we downloaded 19 bioclimatic variables for the current climate at a 30 arc second resolution and WGS84 projection (Hijmans et al. 2005). These variables represent annual trends, seasonality and extreme or limiting environmental factors (e.g. temperature of the coldest and warmest months, and precipitation of the wet and dry quarters). Temperature has long been recognised as an important environmental factor in ecosystems with regard to its pivotal role over biological (development, growth and reproduction), chemical and physical properties. Precipitation regimes and variation of precipitation events have broad effects on ecosystem productivity, habitat structure and ultimately on species distribution.

For the study region of the Kyrgyz Ala-Too, scientific data on a range of environmental resources (other than bioclimatic) are limited, which hinders sustainable management and nature conservation.

The need for updated information has long been recognised and stimulated the use of earth data using remote sensing techniques, which has become a universal and familiar instrument for assessing natural resources (Philipson & Lindell 2003). Information from low-altitude satellite sensors and remote sensing offers can reveal patterns and processes related to rangeland condition in the area. The multi-temporal and multi-spectral data acquired by various satellite sensors are used to identify, map and monitor rangelands, and to derive specific environmental variables. A Landsat 8 satellite image was used (path 151/row 31), taken on 11 July 2015, available from the U.S. Geological Survey georeferenced GeoTIFF files at 30 m resolution via https://libra.developmentseed.org. This image encompassing the study area was selected because of minimum cloud coverage (1.42%). Candidate predictor variables were extracted from the Landsat image. Although raw Landsat bands can convey habitat information (e.g. open water is easily differentiated from vegetation in infrared bands), derived variables can be better predictors than raw ones (Wintle et al. 2005).

Variables found as most suitable to predict the ecological niche within the landscape include Tasselled Cap Transformation and the Normalized Difference Vegetation Index (NDVI), a numeric indictor that uses red and near-infrared wavelengths of the electromagnetic spectrum to study the characteristics of the vegetation (Lahoz-Monfort et al. 2010). It is one of the most commonly used vegetation indexes to measure and monitor vegetation cover.

Tasselled Cap Transformations, originally developed to understand changes in agricultural lands, generate three orthogonal bands from the six-band Landsat composite (Huang et al. 2002). The three generated bands represent measurements of brightness (band 1, dominated by surface soils), greenness (band 2, dominated by vegetation) and wetness (band 3, includes interactions of soil, vegetation and moisture patterns) (Kauth & Thomas 1976). Greeness and NDVI are correlated (r=0.988, p<0.05), therefore only NDVI was considered.

A digital elevation model (DEM) was used as input for capturing topographic variables. The DEM was aggregated from the 30 seconds (~30 m) NASA Shuttle Radar Topography Mission (SRTM) DEM. A number of terrain features were extracted, which characterise the habitat from different perspectives:

- *Slope* is the steepness or the degree of incline of a surface.

- *Aspect* is the orientation of slope. The direction a slope faces with respect to the sun (aspect) has a profound influence on vegetation, snowpack and construction. The expedition split aspect into two components: eastness = sin(aspect) and northness = cos(aspect) These indices of northness and eastness provide continuous measures (−1 to +1) describing orientation. Northness will take values close to 1 if the aspect is generally northward, close to -1 if the aspect is southward, and close to 0 if the aspect is either east or west. Eastness behaves similarly, except that values close to 1 represent east-facing slopes (Olaya 2009).

- *Topographic ruggedness index (TRI)*. TRI was developed to express the amount of elevation difference between adjacent cells of a DEM.

- *Topographic wetness index (TWI)* is an index that’s capable of predicting areas susceptible to saturated land surfaces. The index is a function of both the slope and the upstream contributing area (Beven & Kirkby 1979).It represents a simple, biologically meaningful description of how topographic characteristics, such as slope and surface curvature, may affect habitat suitability.

- *Landforms*. The classification has ten classes; high ridges, midslope ridges, upland drainage, upper slopes, open slopes, plains, valleys, local ridges, midslope drainage and streams. Natural habitats of plants, erosion potential and solar radiation are directly related to landform patterns and the relative position to with a landform (Blaszczynski 1997).

- *Wind exposition index (WEI)*. WEI was developed to characterise how exposed areas are to potential winds with respect to the surrounding topography.

These features create a "landscape of risk", in which herbivores have to trade off between resource acquisition (e.g. foraging in high quality habitats, finding mates) and predator avoidance (Schweiger et al. 2015). Ruggedness and a variety of landforms may create a potential for ibex, as good climbers, to find protection from bad weather conditions and the possibility to overview large areas in predominantly rocky terrain with steep slopes.

The resolution or grain of Landsat images and the DEM is finer than the accuracy by which ibex presence in the field can be recorded (usually the animals are seen far away) and considerably less than the mean area explored daily by individual Ibexes; for this reason all of the environmental layers considered were rescaled to a 30 arc second resolution (~ 1 km).

The System for Automated Geoscientific (SAGA) GIS software (v. 2.2.7) was used for the preliminary data processing and extracting (clipping) images for the study area. SAGA is a Free Open Source Software (FOSS) and its analytical and operational capabilities cover geostatistics, terrain analysis, image processing, georeferencing and various tools for vector and raster data manipulation (Conrad 2006). Final results were processed and visualized in DIVA-GIS 7.5 and QGIS 2.6, free computer programs for mapping and geographic data analysis. Both are complementary.

Statistical modeling

Factor analysis in Statistica 10 Portable was used to examine the contributions and the main patterns of inter-correlation among the potential environmental variables. Principal component (PC) was used as the extraction method. By rotating the factors, a factor solution was found that is equal to that obtained in the initial extraction, but which has the simplest interpretation, and for this purpose the Varimax normalized type of rotation was applied. Usually a solution that explains 75–80% of the variance is considered sufficient.

Maxent distribution model

The freely available version 3.3.3k of the Maxent software (Phillips et al. 2006) was used to generate an estimate of probability of presence of the species that varies from 0 to 1, with 0 being the lowest and 1 the highest probability. The default settings of Maxent (regularisation parameter 1, autofeatures) were used in this study. We ran models with 20 bootstrap replicates, which are summarised in Maxent as raster outputs of the minimum, maximum, average and median of the estimates of the probability of presence. We considered the maximum estimate output to be most appropriate in our case, because animals in general choose the habitat that best fits its needs.

Model performance was assessed using the average AUC (area under the receiver operating curve) score to compare model performance. AUC values >0.9 are considered to have “very good”, >0.8 “good” and >0.7 “useful” discrimination abilities (Swets 1988). The logistic output format was used, because it is easily interpretable with logistic suitability values ranging from 0 (lowest suitability) to 1 (highest suitability). The logistic probabilities provide a relative indication of the likelihood of occurrence of the species, but they do not define predicted occurrence in the binary presence/absence manner typically required by managers. Better interpretation is possible in most cases by defining thresholds of habitat suitability. Therefore, arbitrary thresholds were applied to the logistic output of each model, restricting the predicted probability of occurrence to values above zero, >0.4, >0.5, >0.6 and >0.7. Final versions of maps were considered were generalised raster outputs by using the inverse distance weighted interpolation technique realized in SAGA GIS.

Maxent also performs a jackknife analysis as a built-in option, in order to determine which of the environmental variables has a significant influence on distribution patterns. The jackknife test measures variable importance and evaluates the relative strengths of each predictor variable (Yost et al. 2008). It tests the gain of a model based solely on each environmental variable as well as the loss or gain when the same variable is excluded from the model. The greater the loss or gain due to a variable being excluded from the full model, the more important that variable is in constructing the final model surface.

Usually, researchers calculate correlation coefficients (e.g. Pearson coefficient) to avoid correlated variables and to reduce the effects of multi-colinearity in their models. However, from this type of analysis, ecologically relevant variables could be excluded. Burnham and Anderson (1998) have shown that applying correlation analysis in order to find a significant set of predictor variables will most probably expose false correlations. Fortunately, Maxent is able to incorporate complex dependencies between predictor variables and even in the presence of correlated variables, non-linearity, bimodality, etc. Maxent performs better than most other modelling methods (Elith et al. 2011), though no single modelling method is thought to have the complete truth. Thus, all covariates were retained for the final model

2.2.7. Outreach activities

Involvement of the local communities through interviews and talks was an important part of the expedition. Time was spent with local people in their villages, settlements and surrounding areas, 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 (see Appendix II: field interviews datasheet). Participants recorded data gathered during interviews. The NABU staff together with local placements provided invaluable help in communicating with local people.

2.2.8. Petroglyphs - rock art

Petroglyphs are one of the earliest expressions of abstract thinking and are considered a hallmark of humanity. Beyond their value as an aesthetic expression, petroglyphs provide a rich body of information on several different dimensions. They may shed light on the dynamic histories of human populations and the patterns of their migrations and interactions. Petroglyphs have been used in studies of climate change and the changing inventories of species (Lenssen-Erz & Heyd 2015).

A large number of petroglyphs (pictures drawn or etched onto stones) were found in the study site. These petroglyphs left on rocks can provide evidence of the way of life and the environment of times gone by when there was no system of writing. Kyrgyzstan boasts a very large number of petroglyphs and recent mapping of sites showed that petroglyphs are found all over the country. It may be that some of the locations found during the expedition were previously unknown.

An important theme in rock art research around the world is the acknowledgement of the role that the images play in the landscape. More recently, field surveys in Central Asia have begun to map out the distribution of rock art scenes and archaeological sites that has made possible the generation of archaeological landscapes, which plot the features onto maps and topographic contour models (Rozwadowski & Lymer 2015). The concept of landscape is also important to ideas of cultural heritage and within the past few years rock art sites have started to be considered as valuable tourist resources; "cultural landscapes", important to the respective Central Asian republic in which they reside.

2.3. Results

Forty six cells of 2 x 2 km in size over an 18 x 48 km area located in the southern Kyrgyz Ala-Too Range (Fig. 2.2.3b) were surveyed for snow leopard and sympatric medium and large-sized mammals and game birds during a 6-week period in July-August 2016. Surveys were conducted at an average elevation of 3,622 m (ranging from 3,157 to 4,116 m). Some cells were resampled a number of times. Individual survey teams ranged from four to eight volunteers and daily search efforts took from five to ten hours.

In terms of the Global Land Cover 2000 Project (GLC 2000), a harmonised land cover database over the whole globe, seven land cover categories can be distinguished in the study area (Fig. 2.3a). Amongst these, areas of “herbaceous cover, closed-open”, “bare” areas and areas covered with “snow and ice” are prevailing, occupying 48%, 16% and 30% of the area covered in the survey respectively (Fig. 2.3a). GLC 2000 makes use of the VEGA 2000 dataset: a dataset of 14 months of pre-processed daily global data acquired by the VEGETATION instrument on board the SPOT 4 satellite (Fritz et al. 2003).

Herbaceous cover, closed-open (according to GLC 2000 classification). Stands of *Phlomoides oreophila*.

Sparse herbaceous or sparse shrub cover (according to GLC 2000 classification).
Cushions of *Thylacospermum caespitosum*.

Cultivated and managed areas (according to GLC 2000 classification).

Bare areas (according to GLC 2000 classification).


Water bodies (according to GLC 2000 classification).


Snow and ice (according to GLC 2000 classification).

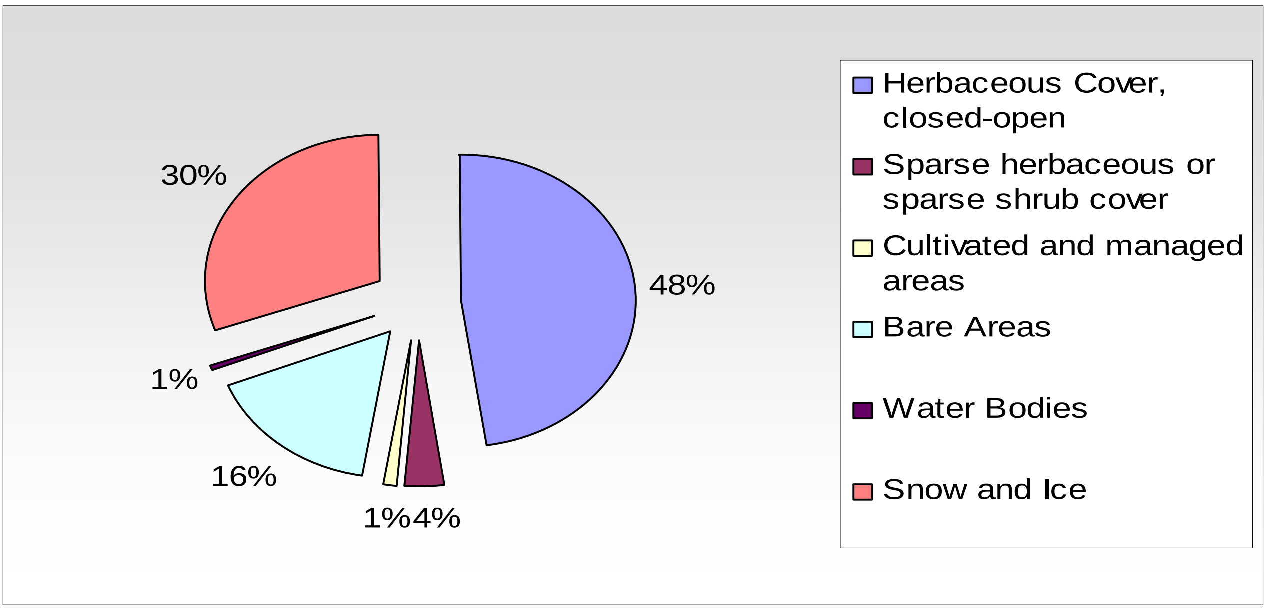

Figure 2.3a. Types of GLC 2000 land cover categories found in the study area and their percentages.

2.3.1. Snow leopard presence/absence survey

Snow leopard signs searched for during this study included: pugmarks (or a pattern of pugmarks coming together to form a line of pugmarks known as a "trail"), scrapes, faeces (scat), urination, rock scent spray and direct observation (i.e. camera trapping), potential kills of prey, as well as oral statements of snow leopard presence made by local people (see below in 2.3.6).

Snow leopard records are summarised in Table 2.3.1a and Fig. 2.3.4a.

Table 2.3.1a. Snow leopard records made by the 2016 expedition.

No.	Date	Location (area)	GPS location	Elevation (m)	Cell	Notes
1	14 Jul	Issyk-Ata	N 42.40633^o E 74.78306^o	3465	AG15	Unclear pugmarks in snow
2	15 Jul	Kashka Tor	N 42.31492^o E 74.74303^o	3620	AE20	Trail following ibex
3	21 Jul	Don Jalamysh	N 42.36693^o E 74.49947^o	3775	U17	Pugmarks in muddy soil
4	4 Aug	Issyk-Ata	N 42.41903^o E 74.78106^o	3829	AF14	Trail of one animal crossing snow fields on the way up to the Issyk-Ata pass
5	11 Aug	Kashka Tor	N 42.31037^o E 74.77297^o	3562	AF20	Pugmarks in soft soil, scat, one scrape
6	17 Aug	Kashka Tor	-	-	AF20	Same place as visited on 11 August; several pugmarks discovered
7	25 Aug	Kashka Tor	N 42.31041^o E 74.76936^o	3560	AF20	Approximately the same place; more pugmarks discovered, snow leopard kill of ibex found

Pugmarks

These are most easily found in sandy places, muddy areas or patches of fine gravel. They are usually present at lower elevations, away from preferred snow leopard terrain, but may also be found alongside streams and/or melting snow and ice within the snow leopard's habitat. Snow patches left over from the winter and fresh snow cover were specifically examined for tracks. Out of seven pugmark records, five were discovered in soft soil and two were found in snow. Pugmarks made in soft soil (Fig. 2.3.1a) are usually identified with confidence, whereas those made in snow do cast some doubts as they melt and become indistinct.

Figure 2.3.1a. Snow leopard pugmarks (42.31037^{o} N, 74.77297^{o} E, 3,562 m).

Scrapes

These can be found in sandy sites (short-lived) and fine gravel (longer-lived). Unfortunately, suitable substrates are not present in most of the survey area favoured by snow leopard, where the majority of substrate is broken terrain. Potential suitable substrate is also subject to livestock grazing and rainfall. Occasional snowfall throughout much of the survey period also reduced the possibility of finding scrapes. All in all this means that only fresh scrapes are likely to be found. One such scrape of possible snow leopard origin was found in the Kashka Tor area in cell AF20 (Fig. 2.3.1b).

Figure 2.3.1b. Presumed snow leopard scrape (42.31037° N, 74.77297° E, 3,562 m).
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Faeces

Faeces can be long-lived in areas with little rainfall and minimal insect activity, but on this occasion the survey area was subject to high rainfall and intense insect activity. Grasshoppers and ground beetles, for instance, were found at all but the highest elevations and are voracious consumers of faecal matter. Faeces can be deposited solitarily or with other scats of varying ages. Faeces are most often found in association with scrapes. Only one set of faeces was recorded together with the scrape shown above.

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 leopard's often mark the faces of upright or overhanging boulders and the base of cliffs. Some sites are periodically revisited and re-sprayed (mainly along trails). The majority of spray sites will have one or more scrapes within a distance of a few meters. No scent spray was found during the survey.

Kills of snow leopard prey

One snow leopard kill of an ibex was discovered on 25 August 2016 in cell AF20, where snow leopard activity had been recorded previously (Fig. 2.3.1c).

Figure 2.3.1c. Siberian ibex killed by a snow leopard.
Top: head and neck of the animal, note the intact nasal portion and eye socket.
Bottom: flaps of skin of the animal remains.

Camera trap photos

Cameras set in cell AF20 (where there had been recent sign of snow leopard presence) recorded increased activity of red foxes (*Vulpes vulpes*) between 18 and 24 August, which, as concluded later, were attracted by a fresh ibex carcass. All of the records obtained were taken from a distance exclusively at night between 20:59 and 00:41, meaning the videos and photos are almost entirely black and figures indistinct. However, in the the videoplayer VLC 2.0.6 Twoflower, there is an option to inverse colours and thereby get a better view of the moving animal.

Some doubtful records were dismissed by comparing series of videos and photos taken by cameras set to the "hybrid" mode. This highlights the need for setting in the future the camera traps consistently to this mode.

The "snow leopard" record described in the expedition diary had to be dismissed. The camera trap photo shot (Fig. 2.3.1d) taken alone was erroneously considered to be one of a snow leopard.

Figure 2.3.1d. Presumed snow leopard photo (photo EK000011).

The confusion became clear later on when a series of records were analysed from the same camera, which was placed facing a nearby stream. Before making the record EK000011 a fox, clearly identifiable from photos EK000009 and EK000010 (Fig. 2.3.1e) taken within one second from each other, was recorded heading towards the stream and the ibex carcass, located on the far side of the stream.

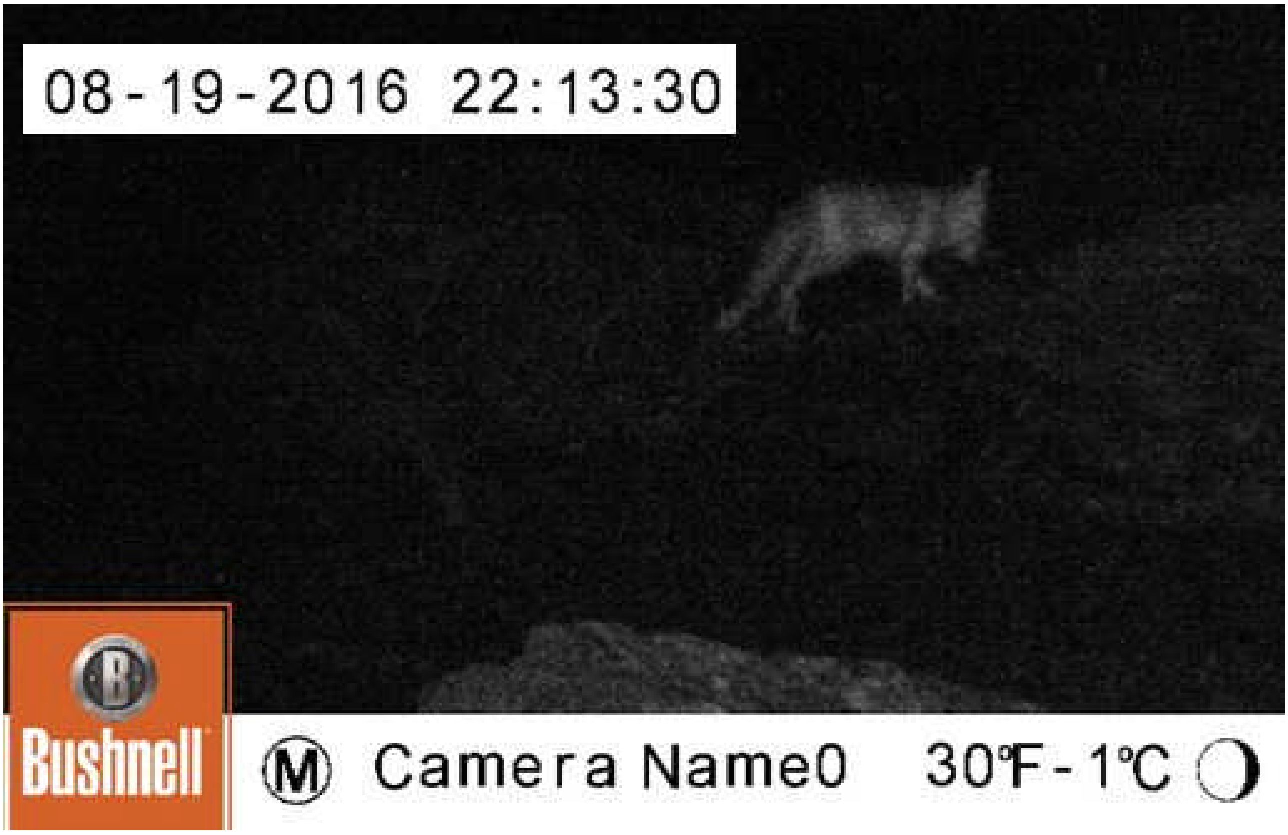

Figure 2.3.13. The "snow leopard" is actually a fox (photo EK000009 above, EK000010 below).

EK000011, recorded another second later, then shows the rear of the animal only, which was misidentified as snow leopard due to the shape of its tail and the “spots” on its coat, which were actually just an effect of the graininess of the picture due to the very dark lighting conditions. The slender snow-leopard-like tail that does not look like a more bushy fox tail could be due to the fact that the animal was wet (it was raining when the picture was taken).

Whatever the case, this illustrates how easily one can be fooled by a single, unclear night photo.

2.3.2. Threats to snow leopard presence

In 2016 several yurts appeared in the upper reaches of the Suusamyr valley in proximity of the Karakol Pass. In previous years these areas would have been ignored as the pasture grounds lower down in the valley are far richer, but perhaps the competition to occupy them is increasing.

Occasional horse droppings and car tracks found at higher altitudes indicate sporadic human presence over most of the area. Other signs of human presence and disturbance included bullet cases, hides, campfires and various items of rubbish left behind by visitors. In 2016 more trekkers crossing remote mountain areas (for instance, the Issyk-Ata Pass, upper reaches of Kara Tor etc.) have been recorded.

2.3.3. Prey base survey

The prey base survey revealed the presence of Siberian ibex, argali, marmots and Himalayan snowcock in the study site.

The maps below (Figs. 2.3.3a – d) display the cells (represented by filled hexagons) in which species were found.

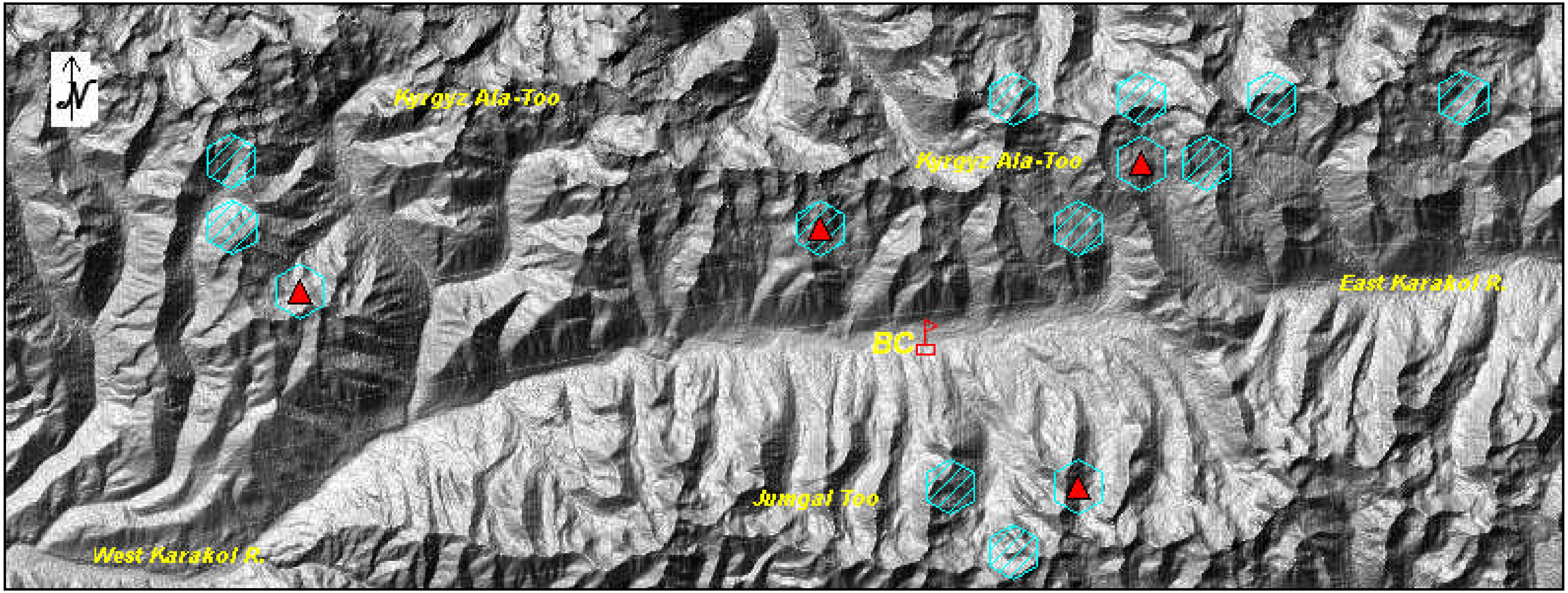

Figure 2.3.3a. Map showing the distribution of Siberian ibex. Recording methods are direct observation (n=11, hatched cells) and camera traps (n=4). In cell AC16 independent records were made of both types. Red triangles indicate cells where camera traps were placed and successfully took pictures of ibex. BC = base camp.

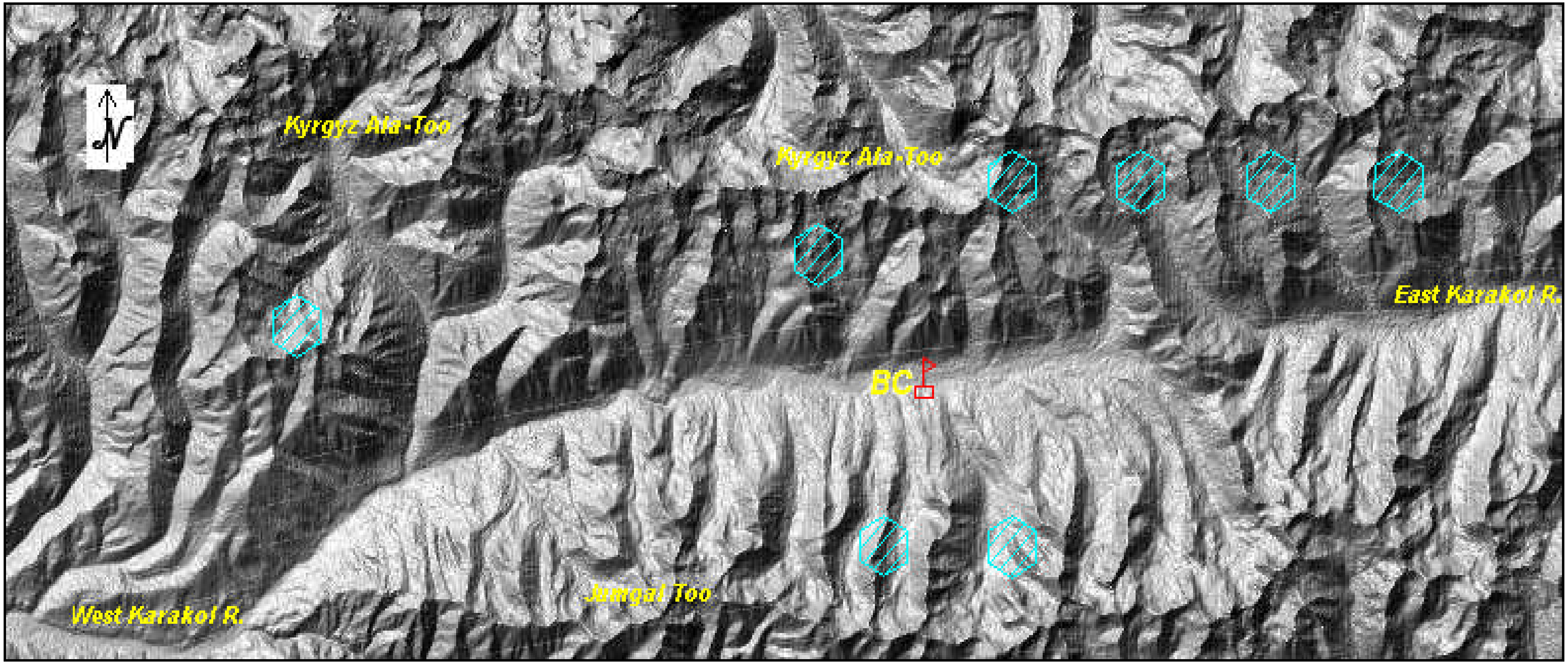

Figure 2.3.3b. Map showing the distribution of Siberian ibex (recording methods: track, scat and other, n=8). BC = base camp.

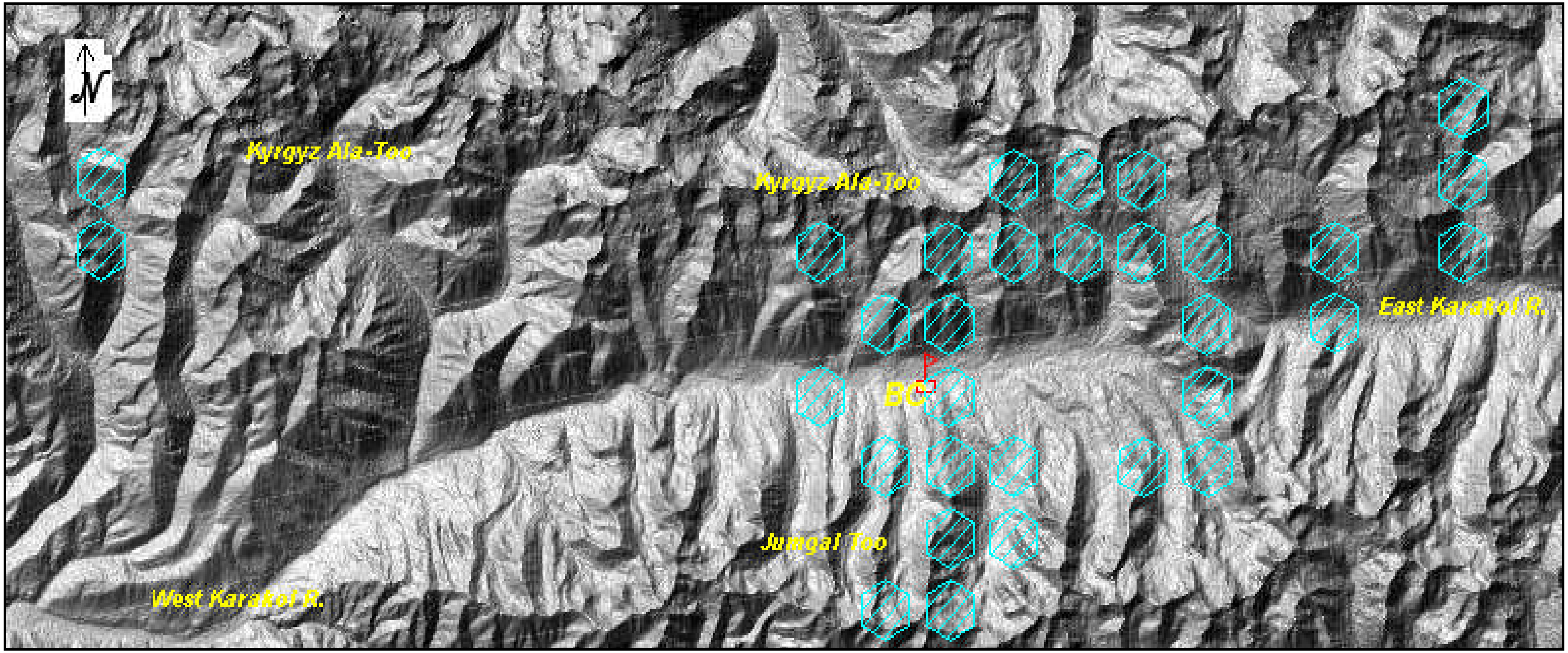

Figure 2.3.3c. Map showing the distribution of marmot (recording methods: all, n=31). BC = base camp.

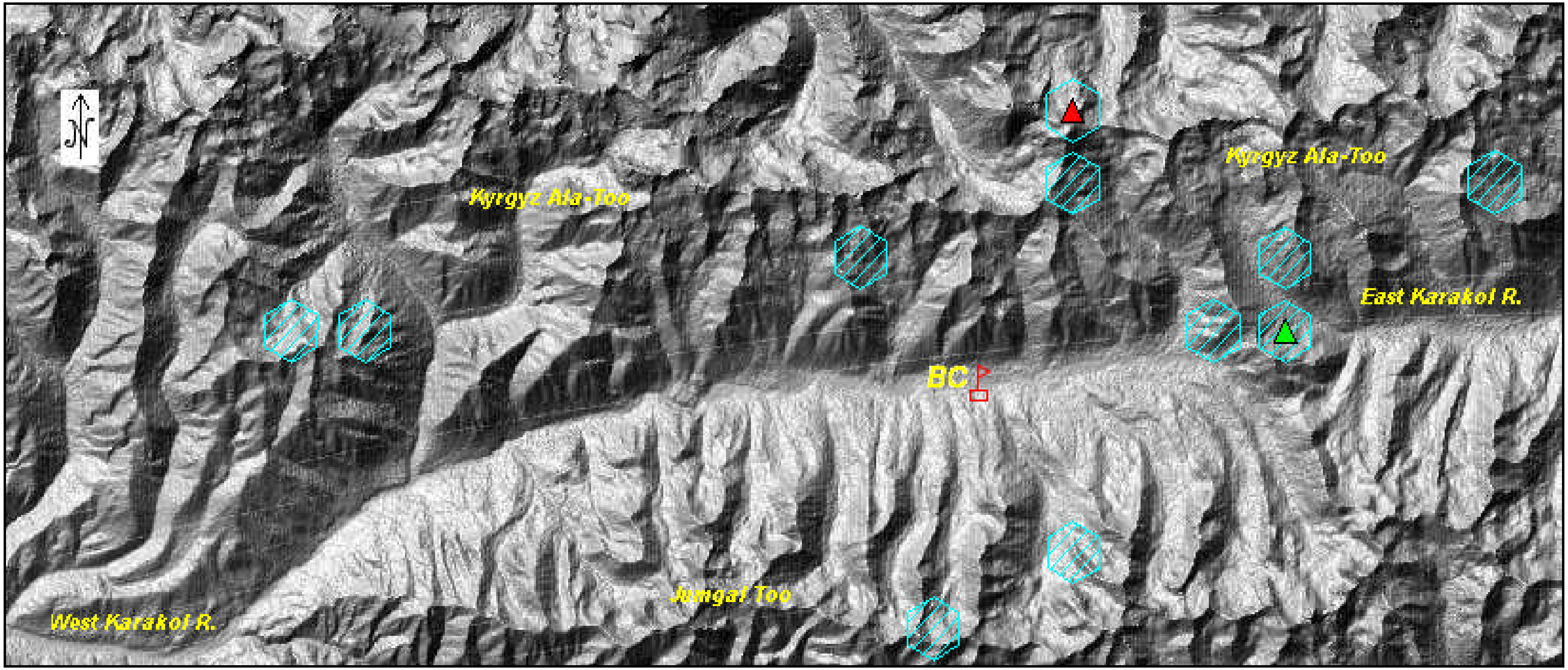

Figure 2.3.3d. Map showing the distribution of the snow cock (recording methods: scat and other, including camera trap records, n=11); green triangle indicates cell AI17 where 2 male argali were observed. BC = base camp.

2.3.4. Siberian ibex distribution modelling

Principal component (PC) analysis was used to analyse the niche of Siberian ibex in the study area. The set of available environmental and bioclimatic data described in section 2.2.6 was used to capture various aspects of ibex ecology and environmental requirements of the species.

The first three PCs accounted for close to 80% of the variance in the data set. The first component (PC1) explained around 47% of the total variance. This component reveals a strong positive correlation with temperature-related variables, particularly *bio1* (Annual Mean Temperature) and not surprisingly – with the Normalised Difference Vegetation Index (NDVI) (these are correlated, r=0.844, p<0.05); on the contrary, PC1 is negatively correlated with elevation and associated topographic features such as, for instance, the wind exposure index and *bio18* (Precipitation of Warmest Quarter). PC2 (~23% of the total variance), on the other hand, reveals strong (mainly positive) correlation with precipitation-related variables, notably with *bio19* (Precipitation of Coldest Quarter), a factor totally independent from elevation or any topographic features. PC3 (~8% of the total variance) is associated solely with topographic features, particularly slope (positively correlated with the terrain ruggedness index and inversely with the terrain wetness index).

In terms of building an appropriate distribution model, the jackknife test of variable importance indicated that *bio12* (Annual Precipitation) was the most important predictor variable when used in isolation, while NDVI demonstrated the highest decrease when it was omitted from the model. *Bio12* and NDVI also provided the highest percent contribution to the overall model, 19.5% and 17.4%, respectively.

From the 20 Maxent model runs, the average AUC was 0.911, with little variation in the area under curve (AUC) between runs (SD=0.014), which indicates “very good” discrimination abilities (Swets 1988). As the AUC test compares predicted contribution with the raw point data from the field surveys, a value of 0.911 is a good fit of model to reality. The averaged output from these 20 model runs is shown in Fig. 2.3.4a, depicting areas of predicted probability of Siberian ibex occurrence: low (between 0.4 and 0.5), medium (between 0.5 and 0.6), high (between 0.6 and 0.7) and excellent (above 0.7).

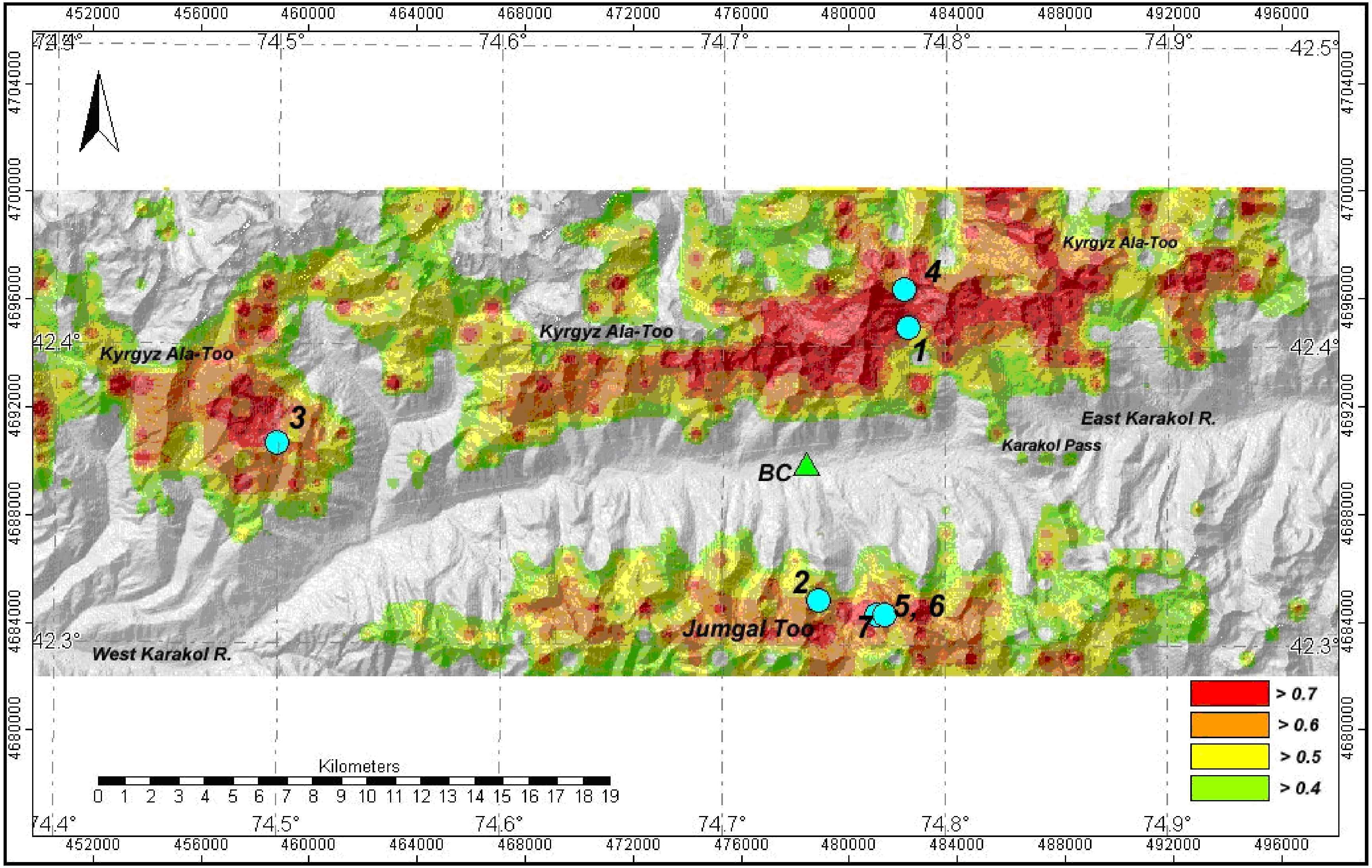

Figure 2.3.4a. Map of predicted habitat suitability for Siberian ibex and locations in which snow leopard recordings (turquoise circles) were made by the 2016 expedition. *BC* (base camp) – green triangle; area of low predicted habitat suitability (green), medium (yellow), high (orange), excellent (red). Numbers as in Table 2.3.1a.

2.3.5. Outreach activities and interviews

Fifteen interviews in different households were conducted within the local community. These activities reached adult herders: twelve men (aged between 26 and 64), and three women (all aged around 50).

In most cases livestock consisted of a mix of sheep, goats, cows, horses and other domestic animals such as donkeys and some poultry. In all 15 households there were varying numbers of sheep (between 200 and 500 heads) and horses (from 30 to 200); a smaller number of households (eleven) kept cows (from 1 to 80), and goats were present in six households in indefinite numbers.

The response to the question "Have you ever seen a snow leopard and/or sign of a snow leopard?" was in 37% of the cases negative (Fig. 2.3.5a). In addition, 17% of interviewees said they did not know anyone who has seen a snow leopard or a sign of the animal. Amongst these was a herder who has been grazing his livestock in the area for five consecutive years. Together these negative responses (totalling 54%) are evidence of the relative rareness of the species in the area, likely to be exacerbated by its elusive character. Positive responses are fewer and most of these records (with only one exception) date back to five years or even some decades ago. These occurred mainly outside the research area or their location is unknown, but interestingly one of such records made 25 years ago concerns the Kashka Tor site, where a full record of the snow leopard was confirmed this year. The single recent sighting of a snow leopard was claimed to be made in the area in June. However, the location of this record was left unclear. Nevertheless, evidence from local people indicated that snow leopard was present in the surveyed area and confirmed the importance of the study area as a habitat for snow leopard.

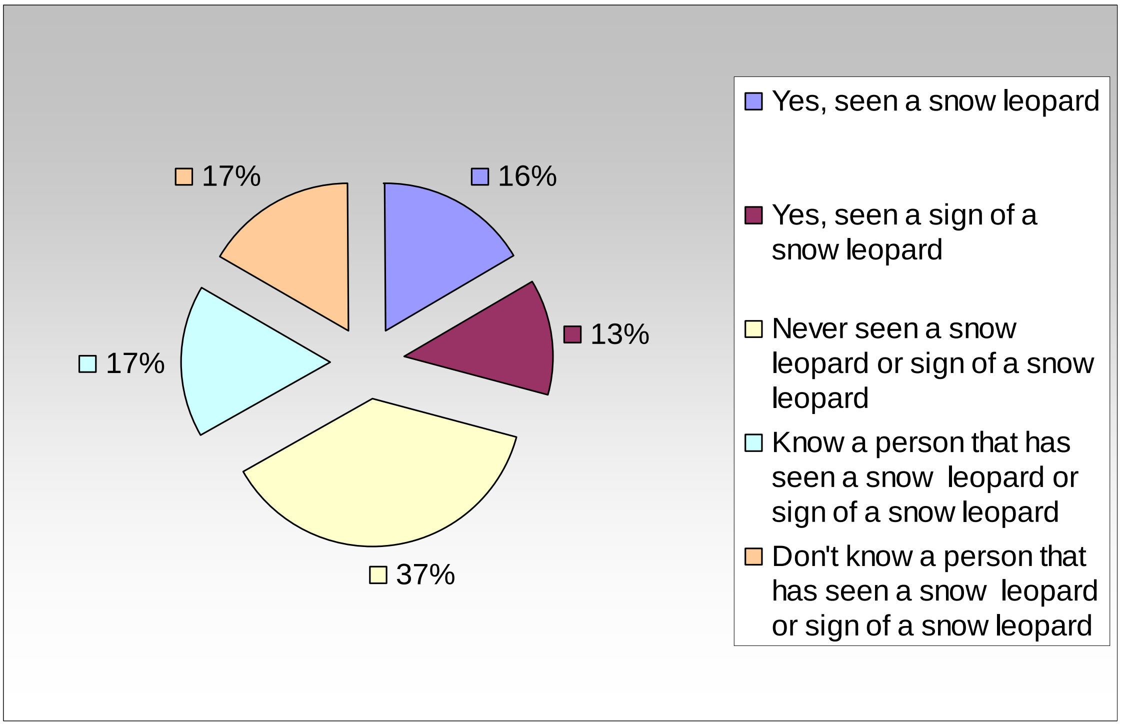

Figure 2.3.5a. Summary of outreach activities and interview responses.

When respondents were asked how they feel about the snow leopard, almost 100% reported "liking" the animal (… "*our beauty*"…). The same occurred when asked about the snow leopard's impact on the area and significance for the country, with almost 100% responding that the species was beneficial to the area and good for the country. Almost all of the interviewees knew that the snow leopard is under protection in Kyrgyzstan (the Red Data Book of the Kyrgyz Republic was mentioned twice) and appreciated the legal protection of the species. From these results, it is clear that there is a solid basis for developing nature conservation initiatives and launching community involvement.

In terms of community assessment of human/predator relations, eleven out of fifteen (73%) respondents said that snow leopards attack domestic animals when they live nearby (Table 2.3.5a), but three of them considered that this happens only rarely. Interestingly, only two herders had witnessed snow leopard attacks on their own livestock, whereas three had heard of such attacks happening elsewhere. In general, livestock depredation by the snow leopard does not appear to be a major issue, because there "… *are too few*…", "… *snow leopards live at high altitudes…*", "… *domestic animals rarely go to the elevation, where snow leopards are* …", "… *happens when livestock is far away and left unattended by the herder* …". As in previous years, there were complaints concerning wolves: "…*wolves attack livestock*…", which are considered by locals to be the most serious threat in terms of livestock depredation.

About a half of the interviewees agreed that snow leopards can reduce populations of ibex and argali, whereas the other half had an opposite opinion (Table 2.3.5a). In this case it is not quite clear whether the respondents distinguished between "*reduce* populations of ibex and argali" and "*feed* on populations of ibex and argali". Those considering that snow leopards cannot reduce populations of ibex and argali argued that there are "… *still many ibex…*" or "… *there are not many snow leopards in the area for them to have a significant impact on ibex numbers* …". The perception of interviewees who agreed that snow leopards can reduce populations of ibex and argali was far from seeing the snow leopard as a threat to the populations of the prey species, because "…*snow leopards just kill for food, not like wolves*…", meaning that their demand is low. Besides this, there is a belief that snow leopards "… *take weak animals, act like sanitisers* …", "… *regulate numbers of prey…*", "… *keep the balance of nature…*". Wolves, in contrast to snow leopards, are considered to be a much more serious threat to ibex and argali numbers, alongside the impact of illegal hunting and poaching.

In two explicit cases the common and widespread myth in Central Asia was repeated that snow leopards feed exclusively on the blood of their prey: "… *only sucks blood of the victim…*" and "… *the meat of the victim is white, because the snow leopard has sucked out the blood…*". This myth probably originated because of the puncture marks created when the leopard suffocates its prey, but, according to Andrews (2002), it has great symbolism. The blood of anything is its life force. In many societies there existed the belief that what one ate, one became. An animal that only took the blood and not the flesh may indicate great discrimination, so that only the powers and life force of the prey are assumed and not its weakness.

Three quarters of the respondents consider snow leopards have no impact on small animals (such as marmots and snowcock), because they believe that they are not a part of the diet of the predator. Reasons may be that "… *they live at different elevations*…" or "…*marmots most of their lifetime are hibernating*…".

Table 2.3.5a. Community assessment of the impact of snow leopards on wildlife and human/predator relations.

	Yes	No	Don't know
Do snow leopards reduce the number of large game animals such as ibex or argali?	6	7	0
Do snow leopards reduce the number of small animals such as marmots and snowcock in the area?	3	9	0
In areas where snow leopards live near livestock, do they feed on domestic animals?	11	4	0
Do snow leopards attack people?	0	11	0
If snow leopards attack people, are these attacks more frequent in places where snow leopards live near people?	0	3	4

None of the interviewees believed that snow leopards attack humans, and none had ever witnessed such an attack, although some have heard such stories told by somebody else.

The majority of 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 in the area. Many would be ready to sell local products (meat, cheese, kumis, felt carpets etc.) and/or develop tourist-based businesses, emphasising the need to "… *employ local guides*…". Unfortunately, there is a fear amongst locals that business investments may lead to corruption and spark unfair competition with established travel companies.

2.3.6. Additional surveys

Evidence of other carnivores sharing snow leopard habitat was also recorded. These included the wolf (*Canis lupus*) and the red fox (*Vulpes vulpes*). Fox signs were found all over the area, whereas wolf signs were found in fewer places. Wolf is the major predator currently preying on domestic livestock in the area and tends to be met around seasonal settlements in the jailoo. Herders were found to be deeply concerned about livestock losses to wolf depredation. This combined with the perception that wolves are an increasing threat to the economic well-being of local communities contributed to the government policy of paying a substantial bounty for killing wolves (Hazell 2001). The Kyrgyz government spends up to 1 million Kyrgyzstani soms (approx. £12,000) annually in support of eradication measures. These measures (mass raids on wolves, shooting, etc.) pose a threat to the snow leopard and/or the primary prey species. One such raid was accomplished in the study area during the expedition, restricting surveys heading towards the Jumgal Too Range for several days. Besides this, there is a high potential for conflicts between the wolf and the snow leopard, especially when the diversity of profitable, large prey is low (Jumabay-Uulu et al. 2014, Wang et al. 2014).

Capturing images of the target species through camera-trap studies commonly records numerous additional species, although much of this extraneous data has been historically marginalised and rarely published. It may, however, provide important information about the biodiversity in the region, including differences between areas, efficacy of protected areas, and documentation of species thought to be locally extinct (McCarthy et al. 2010). Unfortunately, no camera trap photos of argali were recorded during the 2016 expedition, although one direct sighting was made. Besides Siberian ibex, camera traps recorded red foxes, badgers (*Meles meles*), stone marten (*Martes foina*), marmots (*Marmota baibacina*), as well as a number of bird species (in addition to the Himalayan snowcock); these were the red-billed chough, Guldenstadt's redstart and the Alpine accentor, once even a Bearded vulture.

Birds are convenient indicators of biodiversity 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 better known than for any other comparable group of animals. This year joint efforts of the teams came up with a list of 63 bird species (Appendix I). For three there are doubts about their proper identification. Eight are listed in the Kyrgyz Red Data Book.

Figure 2.3.6a. The common noctule (*Nyctalus noctula*), found at base camp.

An interesting find was made at base camp (at 3,000 m) of a bat species (*Nyctalus noctula*). This occurred on 23 August 2016, at a time when this species usually migrates to places where they will hibernate. According to the IUCN account of the species (Csorba & Hutson 2016), the upper elevation limit of the noctule is 1,900 m. The expedition's finding considerably raises this limit.

2.3.7. Petroglyphs – rock art

In addition to the biological surveys, the expedition team continued to compile an extensive database, consisting of 312 georeferenced records of rock art in the study area, grouped into clusters (Fig. 2.3.7b).

The biggest cluster, consisting of dozens of pieces of rock art, occupies the upper reaches of the West Karakol River, particularly the tributary Sary-Kol, which the expedition team named the “Sary-Kol Petroglyph Site” (Fig. 2.3.7a). A second area rich in rock art is the Chon-Chikan site, which has been more closely explored this year and new georeferenced locations have been added. At this stage of exploration both these sites seem to comprise the most outstanding features of the “cultural landscape”.

Figure 2.3.7a. General view of the “Sary-Kol Petroglyph Site” with petroglyphs in the foreground depicting ibexes and a hunting scene.

Rock drawings here appear to have been made in two ancient artistic styles. The first technique was silhouette or shadow, typical of many ancient pictures. Blows were made with a metallic or stone instrument to take out the entire surface of the rock nearly 2 mm deep inside the silhouette. Some pictures were beaten by blunt tools, which removed only a thin layer of varnish, and this is typical of later periods. Another technique used tools with sharp edges and frequent blows, producing a deep line engraved in the rock.

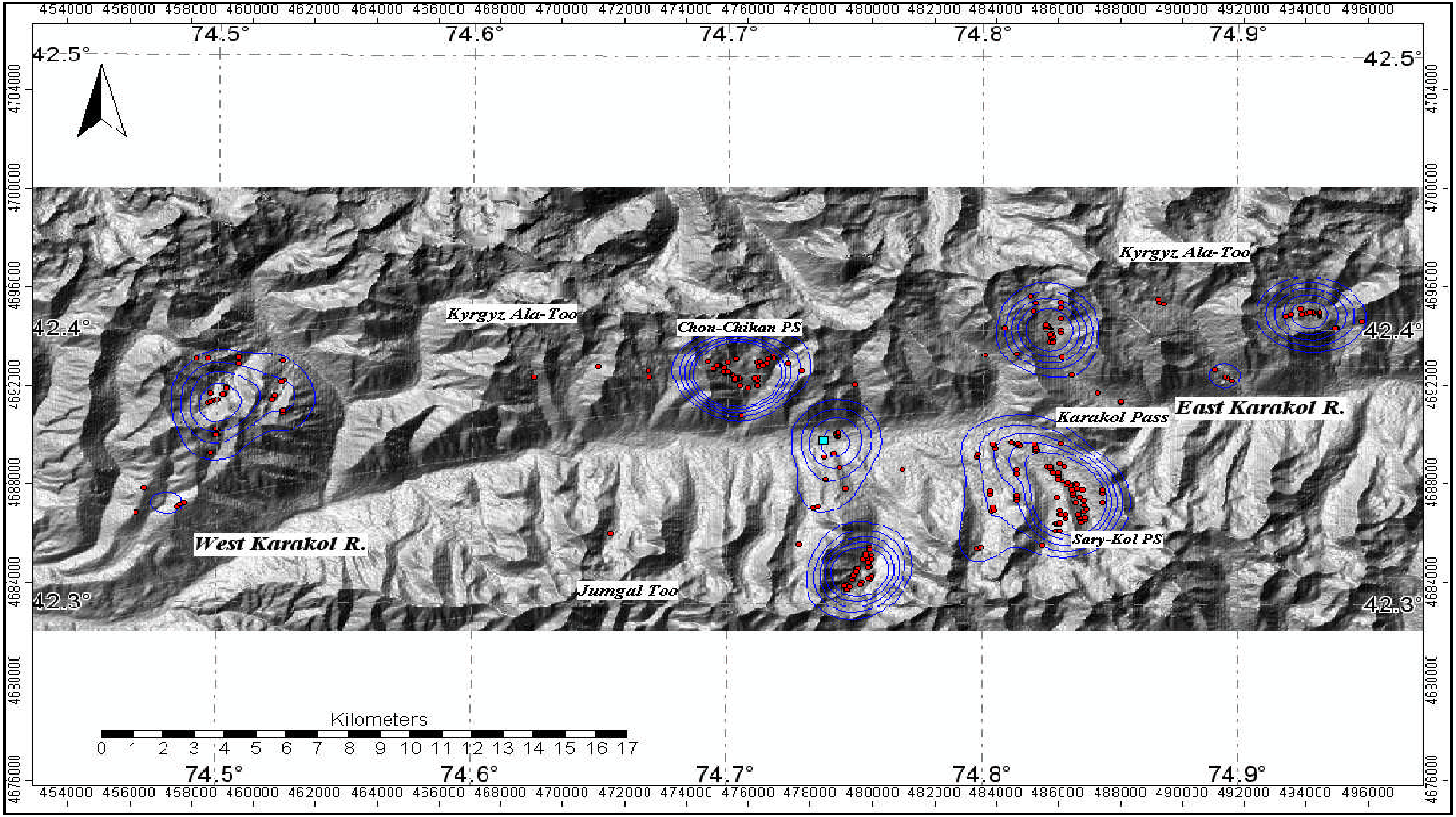

Figure 2.3.7b. Petroglyph sites in the study area: distribution (red circles – point data, turquoise square – base camp); Sary-Kol PS ("Sary-Kol Petroglyph Site"), Chon-Chikan PS ("Chon-Chikan Petroglyph Site").

The total number of registered rock art sites in Kyrgyzstan is still unclear, as reports by specialists show different figures. The State Register of Historical and Cultural Sites of Kyrgyzstan includes 23 locations that have status of national significance; in addition, some are on the List of Sites of Local Importance (Abdykanova 2014).

The majority of the petroglyphs represent ibexes. The depiction of ibexes in the ancient arts may involve a variety of meanings, of which the most common concerns prowess, which is seen as a symbol of masculinity, power, abundance, fertility and long life (Karimi 2007). Other drawings represent human and animal figures, including hunting scenes. Some of these figures depict, for instance, red deer – a species which has disappeared from the study area.

Canids are recognisable by fairly short legs, short, upright pointed ears and long tails, but are difficult to identify with accuracy. Straight tails might be indicative of dogs or wolves. Carnivores with a long curved tail (approximately of the same length as the body of the creature) could be snow leopards, though the leg lengths look inappropriate (Fig. 2.3.7c).

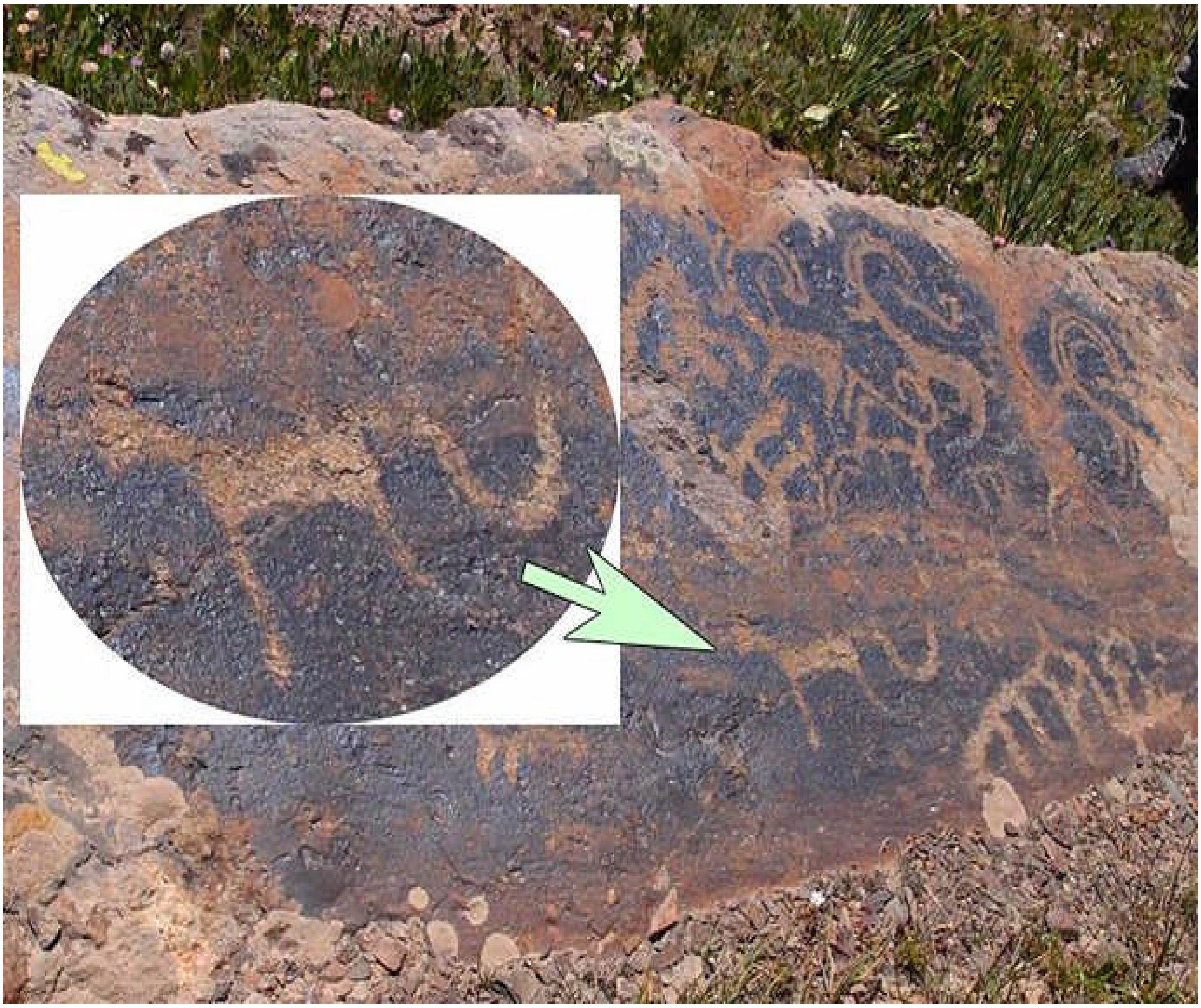

Figure 2.3.7c. The creature with a long curved tail could be a snow leopard.

2.4. Discussion and conclusions

This expedition season was highlighted by finding a snow leopard kill of an ibex. According to V. Gudkov (Гудков 2007), snow leopard kills are rarely discovered and difficult to identify in the field because numerous scavengers, including red foxes, wolves, vultures etc., can significantly complicate the initial pattern. As V. Gudkov states, characteristic features of a snow leopard kill are (a) in the skull, the victim's nasal bones and eye sockets remain intact and (b) around the skeleton one can always find large flaps of skin. Later on scavengers can distort this pattern. Wolves, for instance, crush the nasal cavity and eye sockets of the dead animal, tear the flaps of skin into pieces and eat them. In our case features mentioned by V. Gudkov are clearly in place. In addition, snow leopard tracks found near to the kill provide sufficient evidence to conclude that the kill was made by a snow leopard.

Signs of prey species during presence/absence surveys were found to be fairly abundant and widespread in a variety of terrains for some species. Numerous records were made of Siberian ibex (34.9%), whereas argali (1.2%) were far less abundant in the study area (only one fortunate sighting made from a vehicle on 10 August of two males crossing the Karakol Pass, cell AI17). Marmots are common at lower elevations (51.2%), whereas indications of snowcock presence (11.6%) appear at higher altitudes (these are mainly droppings left over from the winter season).

The presence of a species depends upon the specific environmental conditions that enable it to survive and reproduce (Marzluff & Ewing 2001). Understanding the factors influencing its existence is a basic requirement for the assessment of the species distribution and for devising efficient species conservation strategies (Wein 2002). This knowledge helps to focus efforts on protecting the prey species that snow leopards rely on the most. Among the various tools used in conservation planning to protect biodiversity, species distribution models (SDMs), (also known as climate envelope models, habitat suitability models and ecological niche models), provide a way to identify the potential habitat of a species in an ecoregion. Applications of such models have increased exponentially since 2007 (for an overview see Research Fronts 2014).

Using the SDM approach, the expedition made an attempt to predict and map areas with high probability of Siberian ibex occurrence (Fig. 2.3.4a) for a practical purpose, regardless of the role of individual predictors. As mentioned, four cells (AC16, AG15, AH15 and AF20) were selected in the first place for installing camera traps and undertaking routine surveys. These were chosen as it was hypothesised in last year's report (Tytar et al., 2016) that these cells should hold highly suitable habitat for the ibex and therefore could attract the snow leopard.

In 2016 we had in fact tested this hypothesis. In three of these cells (AC16, AF20 and AH15) ibex recordings were made (including successful camera trap records) and in two (AG15 and AF20) there was evidence of snow leopard presence, especially in AF20 (the upper portion of Kashka-Tor) where numerous pugmarks, a scrape and eventually a recent snow leopard kill were discovered. In five other cells (U17, AD16, AE21, AF14 and AF15), which were selected on an opportunistic basis, two held evidence of snow leopard presence (pugmarks U17 and AF14), and three of ibex (successful camera trap records in cell U17); two cells (AD16 and AE21) yielded no records at all.

Although there is as yet no substantial statistical justification, cell selection guided by the modelling exercise appears to perform better and raises chances for recording both the Siberian ibex and the snow leopard. However, this is not always the case and exceptions include, for instance, cells AD16 and AE21 with no records. One reason could be strong human presence, an issue not accounted for in the model. Nevertheless, we consider that future studies can benefit from predictions generated by the maximum entropy model. In this respect a revised map designed by adding fresh point data on ibex occurrence from 2016 (Fig. 2.4a) can be used for planning corresponding routes and camera trap locations in the following field season.

Conservation planning to protect biodiversity can also draw benefits from the results of the modelling. Areas with predicted habitat suitability for ibex exceeding 0.7 (i.e. 70%) should be considered for this purpose. Maps in Fig. 2.3.4a and Fig. 2.4a point out where surveys have to be conducted in the first place. Taking into account successful camera trap recordings of ibex, good conservation areas could be the upper Kashka-Tor (AF20 and adjacent cells), Chon-Chikan (AC16 and adjacent cells) and Kara-Tor (AH15 and adjacent cells). In terms of historical significance, the Chon-Chikan area may have the additional potential for being declared a protected "cultural heritage site". However, this would require appropriate justification from professionals. The same would apply to the "Sary-Kol Petroglyph site".

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, when much of the snow cover, especially in the second half of the summer, has melted away. Ungulates and carnivores favour higher grounds and are more dispersed during the summer season, and snow leopard signs are harder to find. Prolonged snow cover in July of 2016 considerably raised the efficacy of the research, resulting in the discovery of fresh signs (pugmarks) of snow leopard presence.

Evidence from local people, gathered by previous expeditions (Tytar & Hammer 2015; Tytar et al. 2016) indicated that snow leopard was present in the surveyed area. In addition, since the beginning of Biosphere Expeditions' research there has been a growing understanding of the importance of the study area as a habitat for the snow leopard. For instance, cell AF20 was highlighted for snow leopard presence, where a foal had been allegedly attacked and mutilated, but not killed, by a predator. Four camera traps set near the attack location yielded no results, though did record presence of ibex. Subsequent sign surveys in this cell yielded further confirmation of snow leopard presence by discovering pugmarks, faeces, a presumed scrape and recent remains of an ibex preyed upon by a snow leopard. Unfortunately, there were no clear records of the snow leopard through camera-trapping.

The expedition has also shown that the habitat in the study area (and beyond) is sufficiently varied and capable of sustaining a healthy prey base for the snow leopard, particularly of Siberian ibex. Unfortunately, numbers of argali in the area are too low for the snow leopard to be dependent on this particular prey species. Only twice (in 2014 and 2015) has the expedition recorded sporadic occurrence of argali in the study area (Tytar & Hammer 2014, Tytar & Hammer 2015).

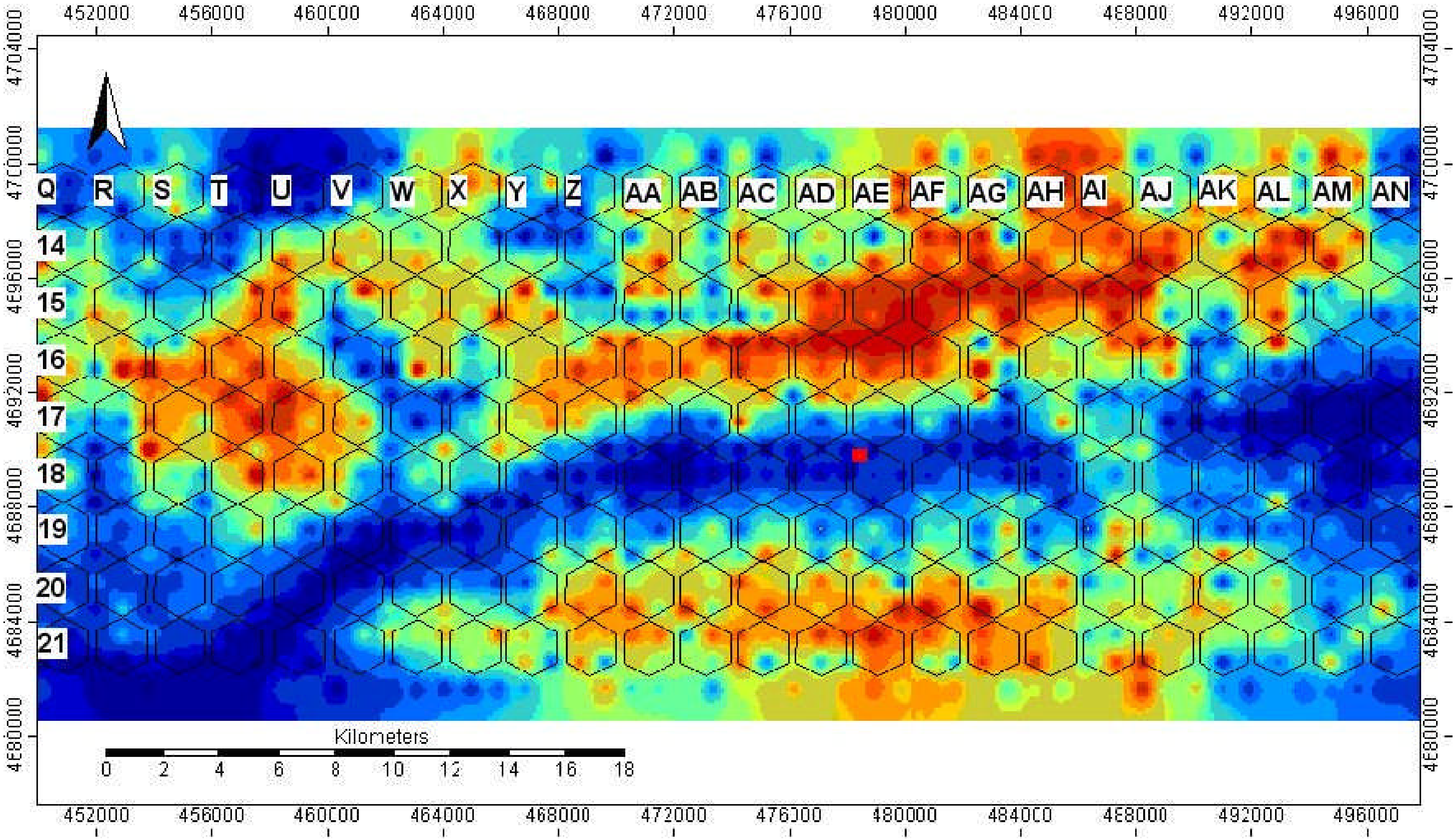

Figure 2.4a. Map for planning survey routes and camera trap locations:
highest probability Siberian ibex areas are coloured in shades of red, lowest in shades of blue; red square – base camp.

The developing relationship between the predator and prey species could be very fragile, so any decline in the prey species may drive the snow leopard out of the area. Indeed, poaching (both in the past and today) and growing disturbance may be the main factors for driving animals out of the site, a notion perceived as well by local stakeholders.

As a priority recognised by NABU staff, improved anti-poaching control together with a temporary ban on hunting could have an immediate impact on halting the decline of prey species and, by inference, snow leopards.

Overgrazing by livestock is also a significant problem.

Further research is needed to confirm snow leopard presence and to monitor snow leopard and prey population trends in the survey area. Presence/absence surveys will need to be repeated in the coming years, using camera traps from the very beginning of the survey. Finding a trail and/or relic scrape(s) is a high priority. If either of these can be found, remote camera-trapping would be enhanced as a survey tool. These efforts can be guided by modelling exercises as above, showing places where basic requirements for Siberian ibex, upon which snow leopards rely the most, are met to a significant degree.

With the collapse of the Soviet Union much of the area under study was abandoned by nomadic herders and henceforth a slow recovery of wildlife has occurred. However, the current growth of the population in the country, increasing 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 research (population and life history parameters, threats), site protection and management through developing justifications for a local network of nature conservation areas.

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 (for instance, maintenance of the camera traps) and to explore possibilities of benefiting the local community, for instance, rock art sites which now are becoming considered as a valuable tourist resource, could be a source of income. The friendly attitude towards the snow leopard expressed by the majority of local people could be the key to the success of such initiatives.

Recommendations for the 2017 expedition:

- Concentrate surveys on high probability Siberian ibex areas as derived by modelling and indicated on the corresponding map (Fig. 2.4a).

- In addition to using the cell methodology adopted by Biosphere Expeditions for volunteer expeditions, expedition participants and the scientist should take into account any kind of point data (in the first place of primary prey species, Siberian ibex and argali, especially sightings) for modelling, research design and planning purposes.

- If available, advantage must be taken of prolonged snow cover for detecting snow leopard presence (keeping in mind safety precautions).

- As soon as the reducing snow depth will allow access to areas of interest, explore and install camera traps in the upper Kashka-Tor (AF20 and adjacent cells), Chon-Chikan (AC16 and adjacent cells), Kara-Tor (AH15 and adjacent cells), as well as other areas of high habitat suitability for ibex (Fig. 2.4a).

- Set camera traps to the "hybrid" mode.

- Continue to build relationships with herders and interview people to gather local knowledge about the area and recordings of recent snow leopard presence. Working with NABU's Grupa Bars, local people should be identified and trained as community patrols to gather evidence of snow leopard presence when the expedition is not in situ. A grant from the Nando and Elsa Peretti Foundation has been secured by Biosphere Expeditions to help achieve this and to equip community patrols with camera traps.

- Build local capacity by training the next generation of snow leopard conservationists. Five local students with an interest in nature and wildlife conservation will be selected, on a competitive basis, to take part in the 2017 research expedition, thereby building capacity by training the next generation of snow leopard conservationists. Successful candidates will have to write up reports and hold at least two talks – one to the public and one to their peer group – about the experience. They will also be required to write a public blog. A grant from the Nando and Elsa Peretti Foundation has been secured by Biosphere Expeditions to help achieve this.

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3. Butterflies of the West Karakol River Valley, Kyrgyzstan, 2016

(Lepidoptera, Diurna)

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Plateau Perspectives and American University of Central Asia

3.1 Introduction

Although the West Karakol River Valley is only 7-8 hours away by car from Bishkek, the capital city of Kyrgyzstan, this region is very poorly studied in regards to its ecology. Information on butterfly distributions in this region is lacking in most currently available resources. The summer of 2015 was the first time efforts were made to study the butterfly ecology in this region. As a result, the data presented within provides a lot of new information that enhances our understanding of the distribution of many of these butterflies.

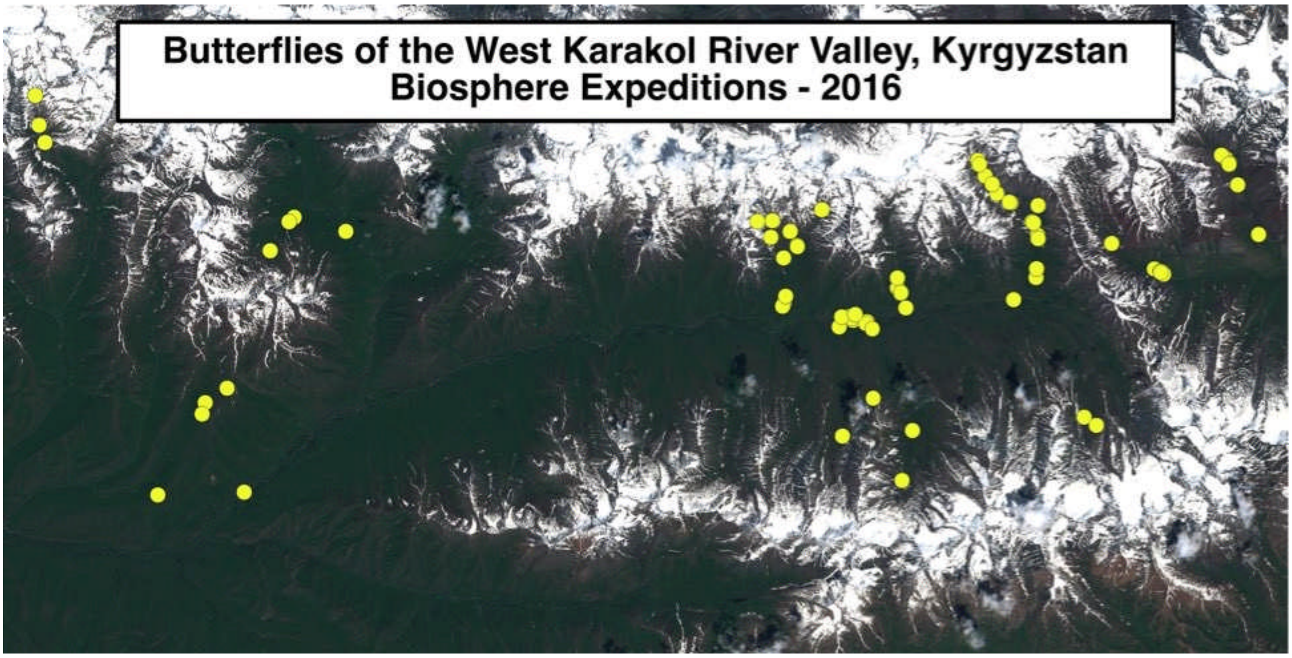


Figure 3.1a. Map of the West Karakol River Valley area studied with data points for each butterfly observation.

3.2. Materials and methods

Data were collected during the Biosphere Expeditions project during the summer of 2016 in July and August. Citizen scientists from around the world were present during three 12-day trips that the expedition took place over. Although the main duties of the expedition were not related to butterfly identification and distribution mapping, efforts were made by many members of the expedition to catalogue the butterflies seen. This was done through the use of a smartphone application called "Butterflies of Kyrgyzstan" developed by the author. The app essentially functions as a field guide, but allows users to submit valuable location and image data.

3.3. Results

In all, 20 species were identified with 77 individual sightings. The numbers were exactly the same last year, although the species composition is much different. Some species that were rare last year were found in abundance this year, while others sighted last year were not found at all. Some of these species provide new location data that was absent in our study last year, and in any other publications.

Table 3.3a. Butterflies of the West Karakol River Valley, Kyrgyzstan, July - August 2016.

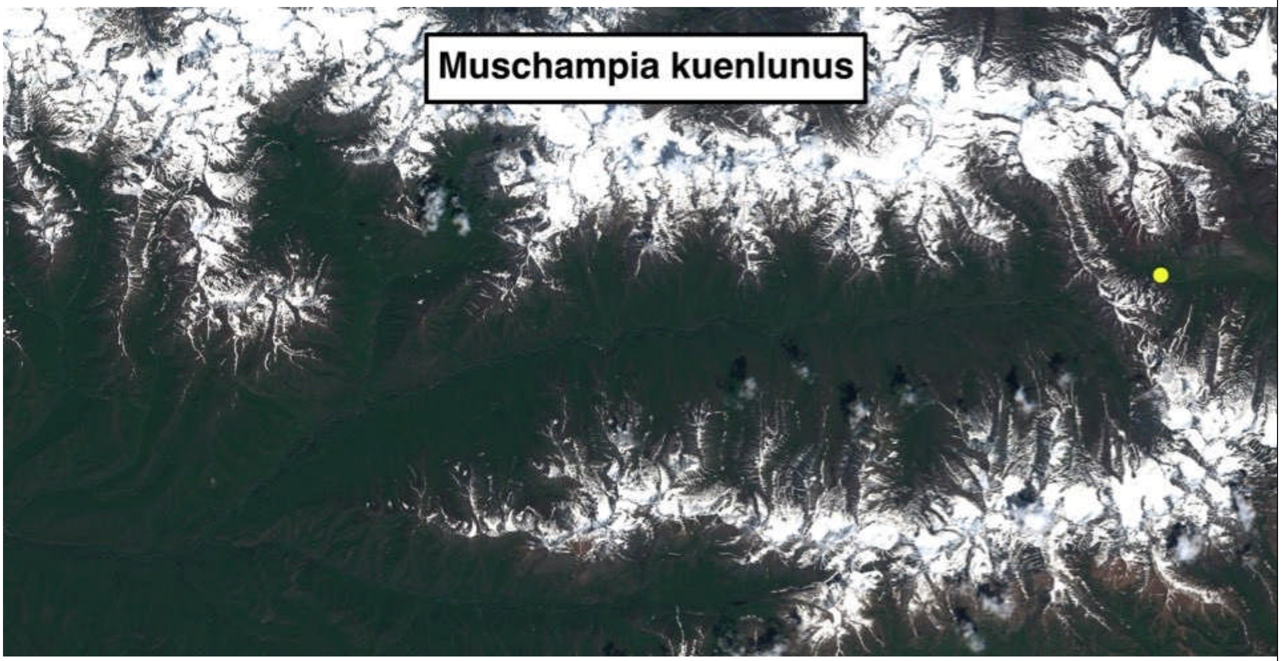
Family	Scientific Name	Common Name
Hesperiidae	*Muschampia kuenlunus*	No Common Name (NCN)
	Pyrgus alpina	NCN
Lycaenidae	*Aricia agestis*	Brown Argus
	Cuppido buddhista	Buddhist Blue
Nymphalidae	*Aglais urticae*	Small Tortoiseshell
	Argynnis aglaja	Dark Green Fritillary
	Boloria generator	NCN
	Clossiana erubescens	NCN
	Vanessa cardui	Red Admiral
Papillionidae	*Parnassius delphius*	Banded Apollo
	Parnassius tianschanicus	Large Keeled Apollo
Pieridae	*Colias cocandica*	NCN
	Colias erate	Pale Clouded Yellow
	Pieris bryoniae	Dark Veined White
	Pontia callidice	Lofty Bath White
	Pontia daplidice	Bath White
Satyridae	*Coenonympha caeca*	NCN
	Coenonympha sunbecca	NCN
	Erebia mopsos	NCN
	Erebia sokolovi	NCN

Species profiles

Species profiles include photographs, natural history and distribution maps for each species observed during the expedition. Please note that all photographs and maps are the property of the owner (unless otherwise indicated) and only permitted for use outside this report with proper permission.

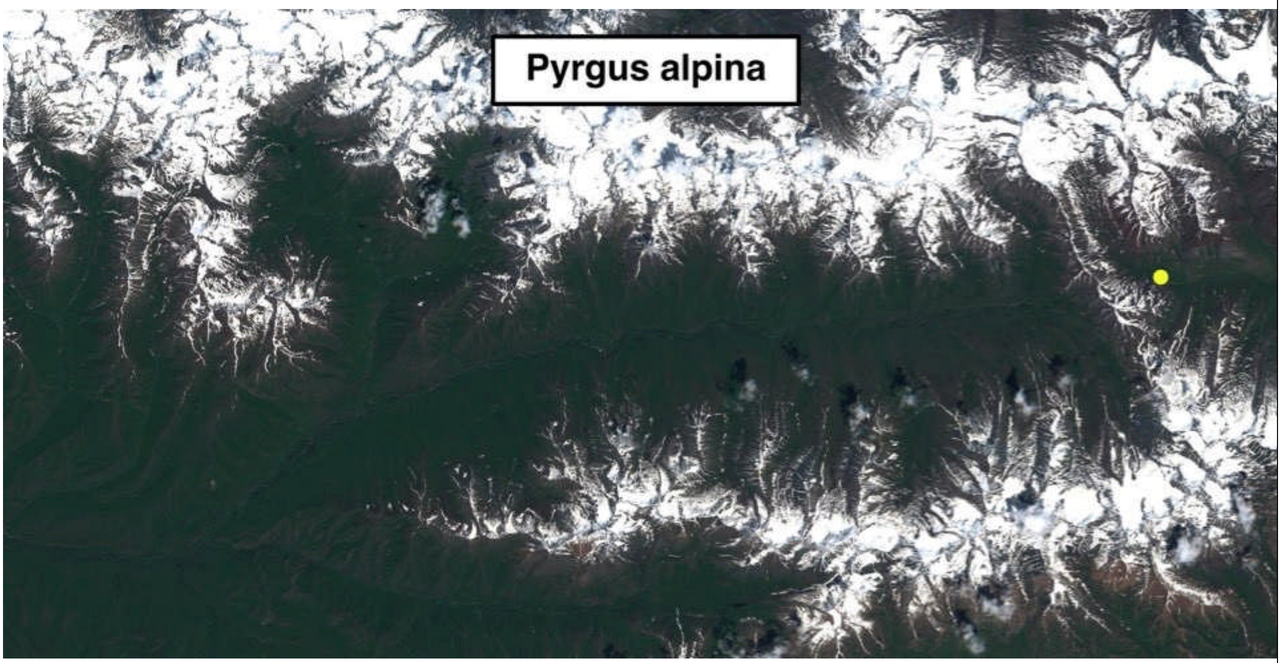
Hesperiidae

Muschampia kuenlunus			
Flight time	June to August	Elevation (m)	1500-3300
Habitat	Meadows and steppes		
Food plants	*N/A*		
Life cycle	Univoltine		



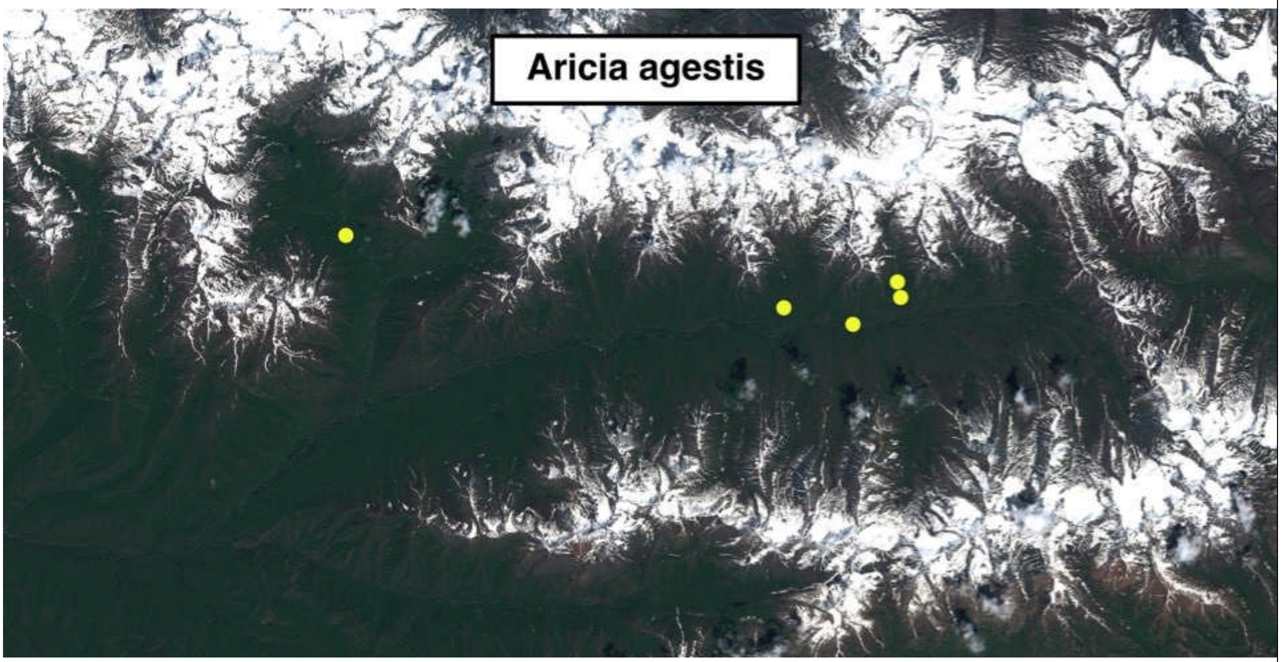
Pyrgus alpina			
Flight time	May to early July	Elevation (m)	1000-3000
Habitat	Forest clearings, mountainous meadows, steppes		
Food plants	*Potentilla spp.*(cinquefoil) and *Rosa spp.* (wild rose)		
Life cycle	Eggs laid singly on host plant. Species overwinters as an egg. Likely		

Plate courtesy of Charles Oberthur - 1904

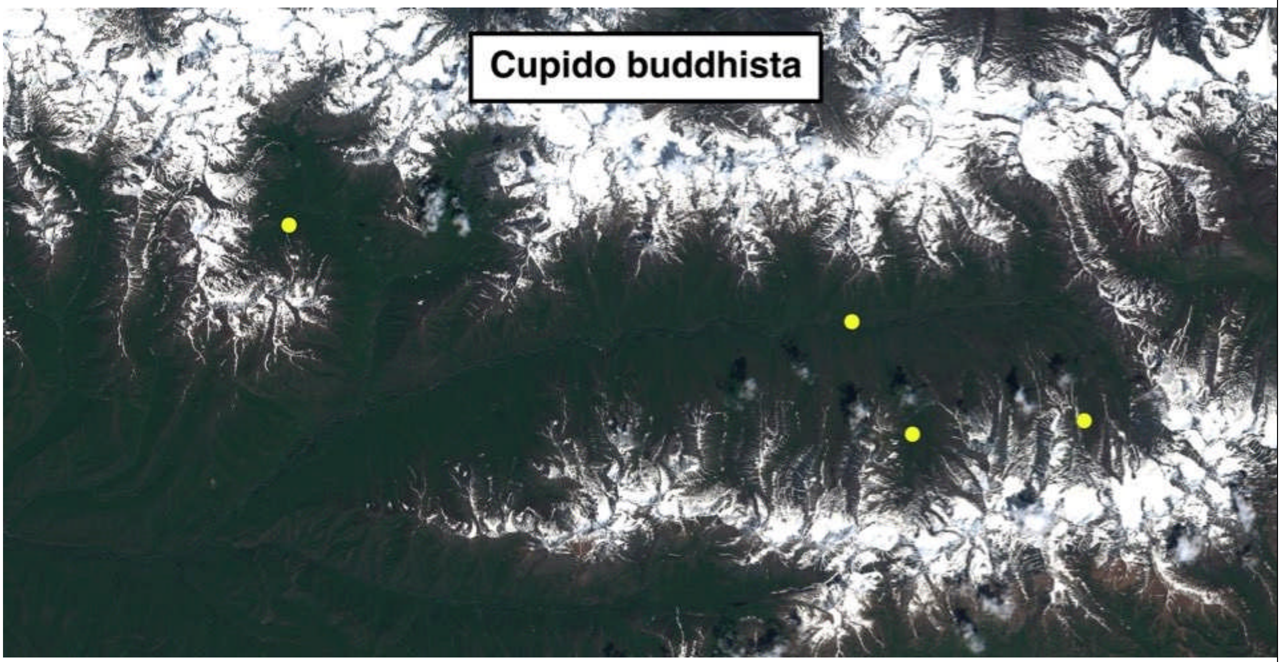


Lycaenidae

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		

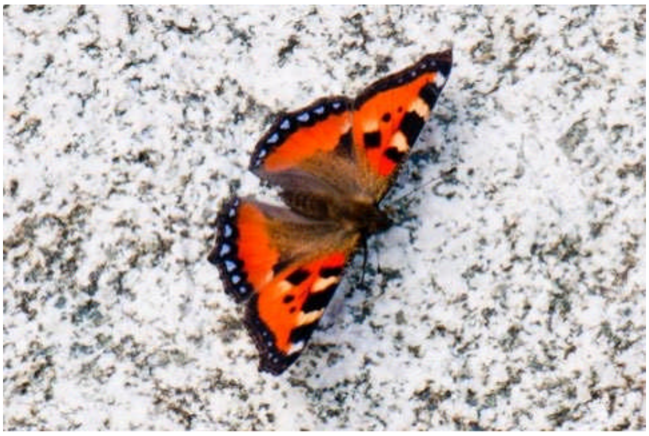


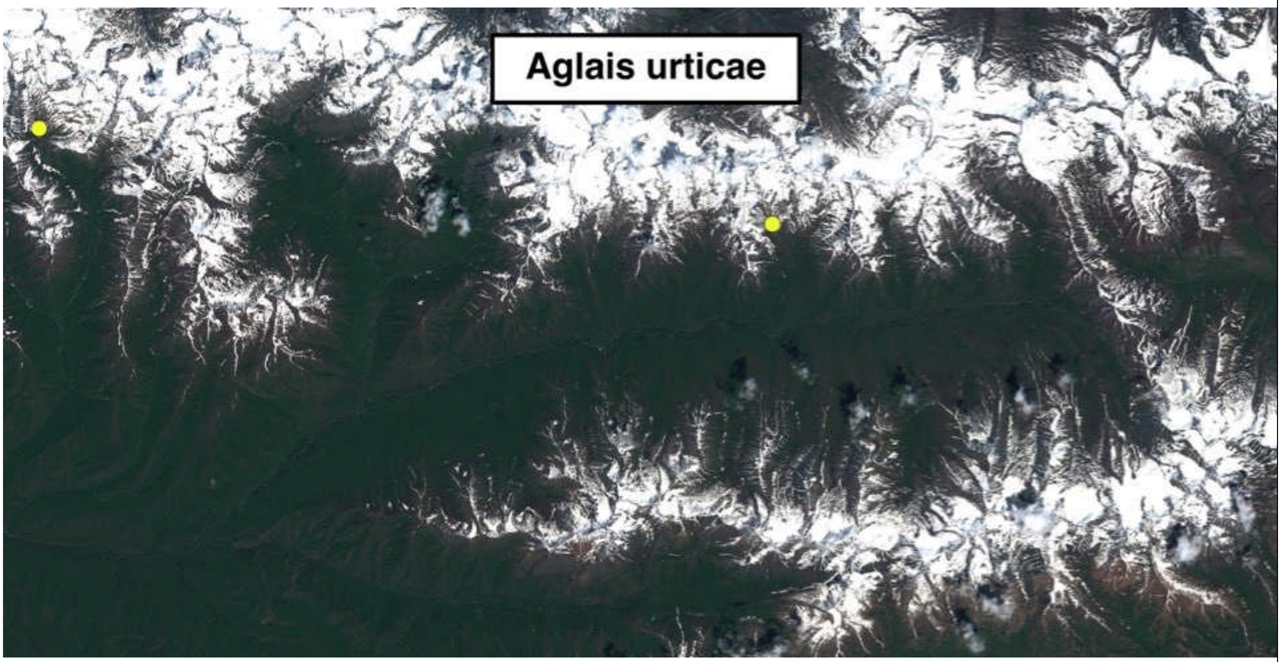
Cupido buddhista — Buddhist Blue			
Flight time	June to September	Elevation (m)	2300-3400
Habitat	Alpine biomes with lots of herbaceous plants		
Food plants	*Oxytropis spp.* (locoweed)		
Life cycle	N/A		



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		

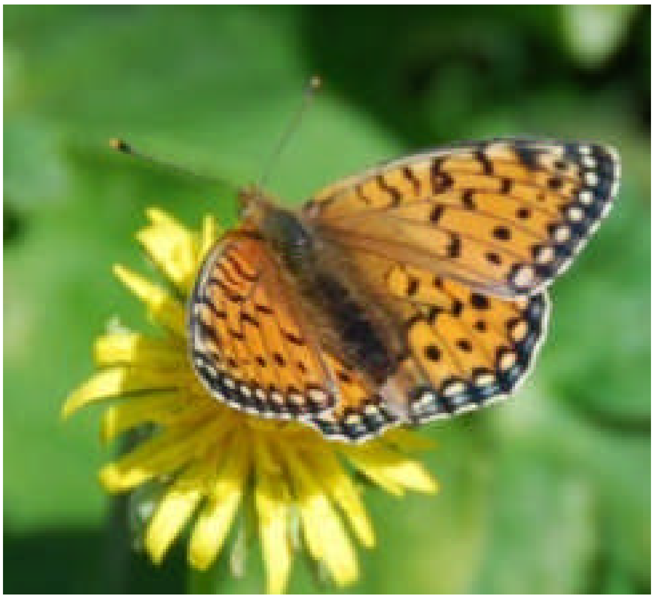
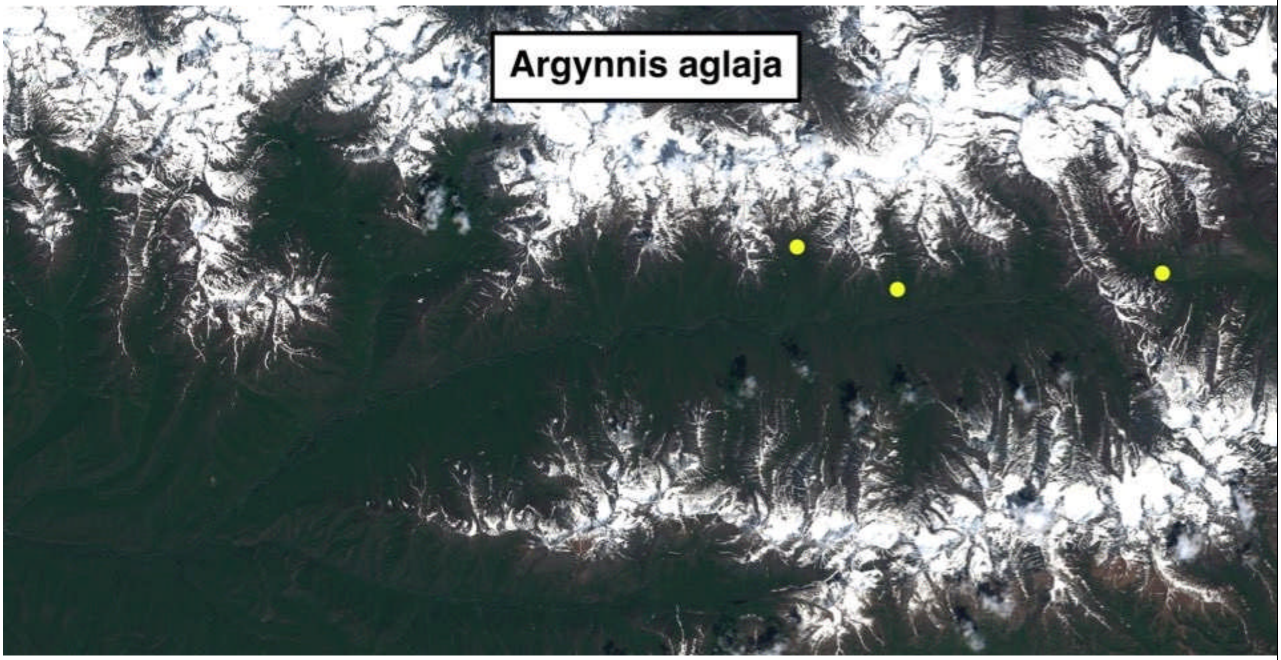
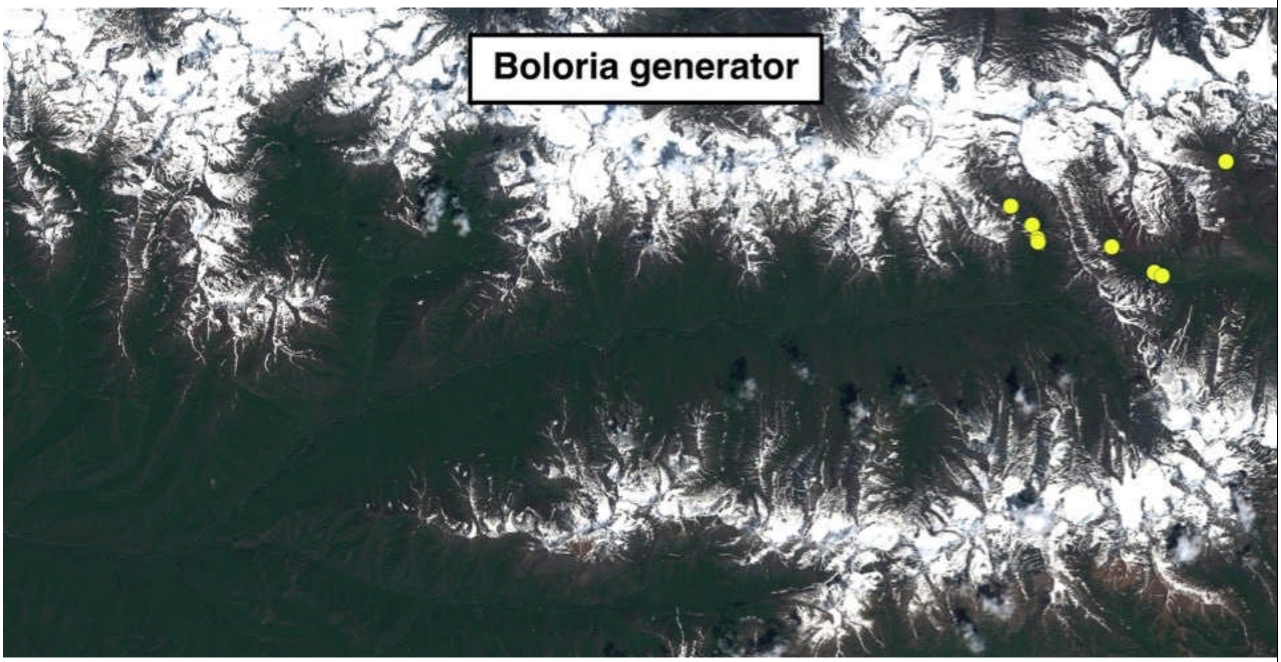


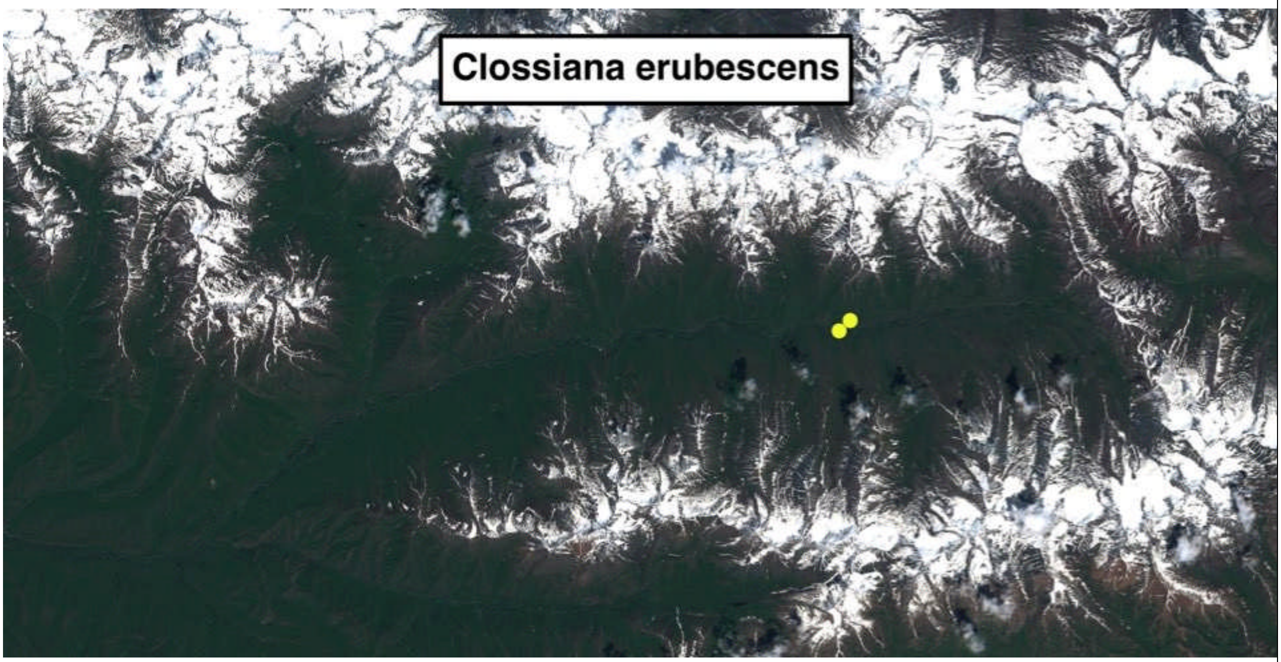
Photo courtesy of Koenraad Bracke - 2016



Boloria generator			
Flight time	July to September	Elevation (m)	2500-4500
Habitat	Moist mountain meadows and stream banks		
Food plants	*Polygonum alpinum* (Alpine Knotweed)		
Life cycle	N/A		

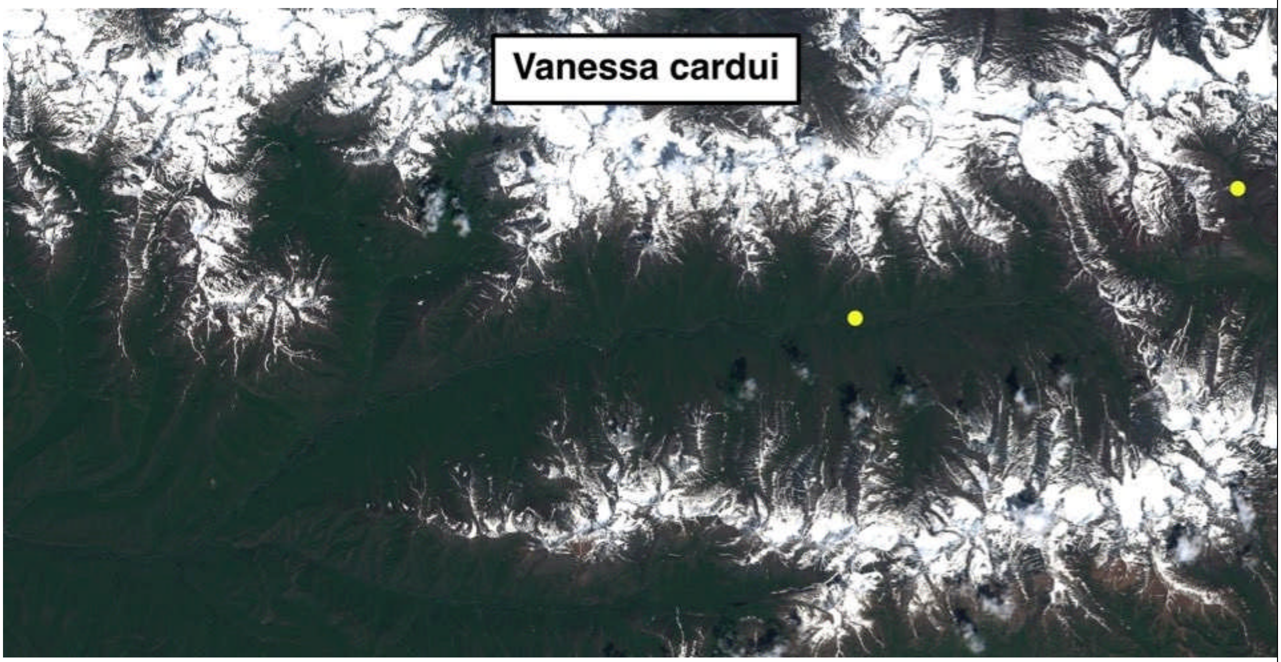


Clossiana erubescens			
Flight time	June to August	Elevation (m)	2000-3600
Habitat	Mountain meadows and stream valleys		
Food plants	*Violaceae* (violets and pansies)		
Life cycle	N/A		



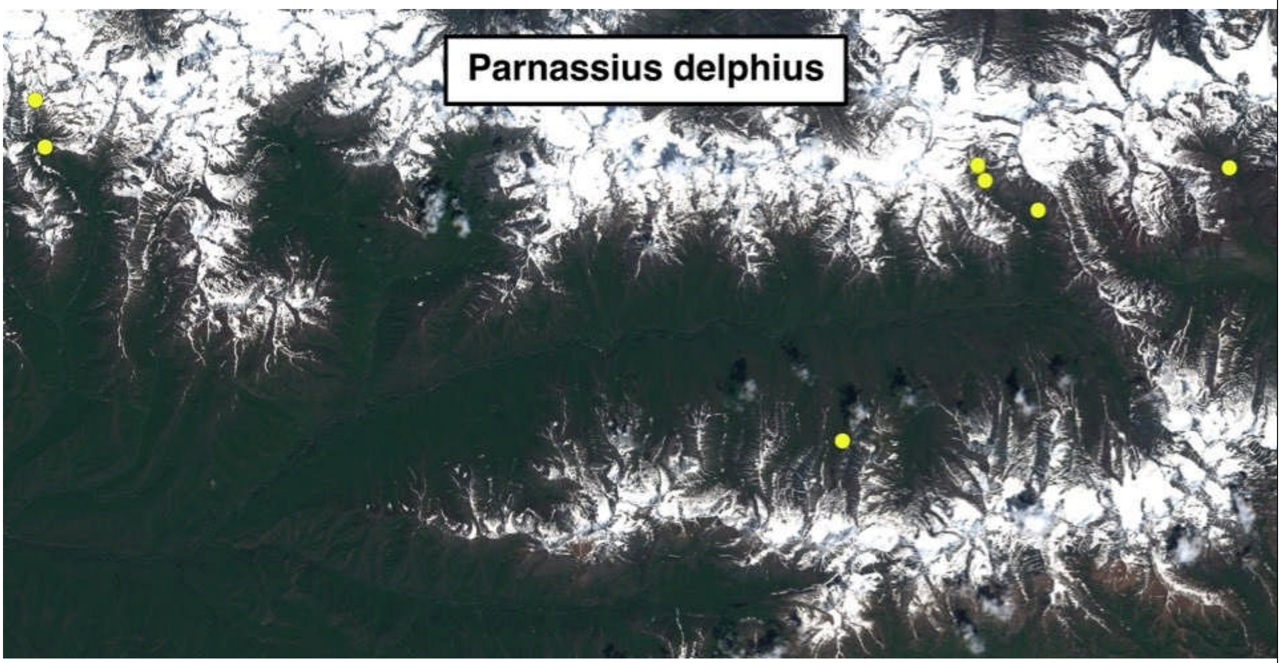
Vanessa cardui — Red Admiral			
Flight time	March to October	Elevation (m)	up to 3000
Habitat	Open landscapes from deserts to mountains		
Food plants	27 different host plants including *Carduus spp.* (plumeless thistle), *Plantago spp.* (plantain), and *Salvia spp.* (sage)		
Life cycle	Species overwinters as an adult		



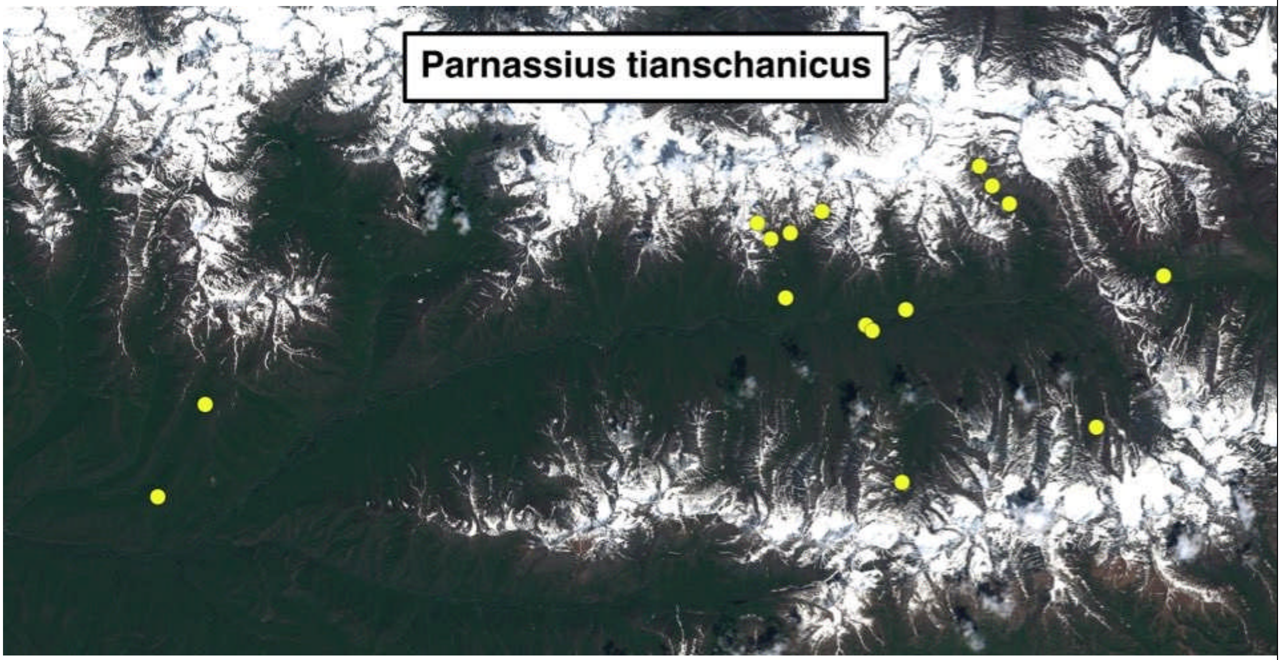


Papilionidae

Parnassius delphius — Banded Apollo			
Flight time	June to July	Elevation (m)	3000-4000
Habitat	Western facing rocky slopes, scree fields,and mountain meadows		
Food plants	*Cysticorydalis fedtschenkoana*, *Corydalis tenella* (Discreet Corydalis), *Corydalis gortschakovi*		
Life cycle	Follows a 2 year life cycle. Initially overwinters as an egg hatching in spring. Larvae feed for 1 year then overwinter as pupae the second winter		



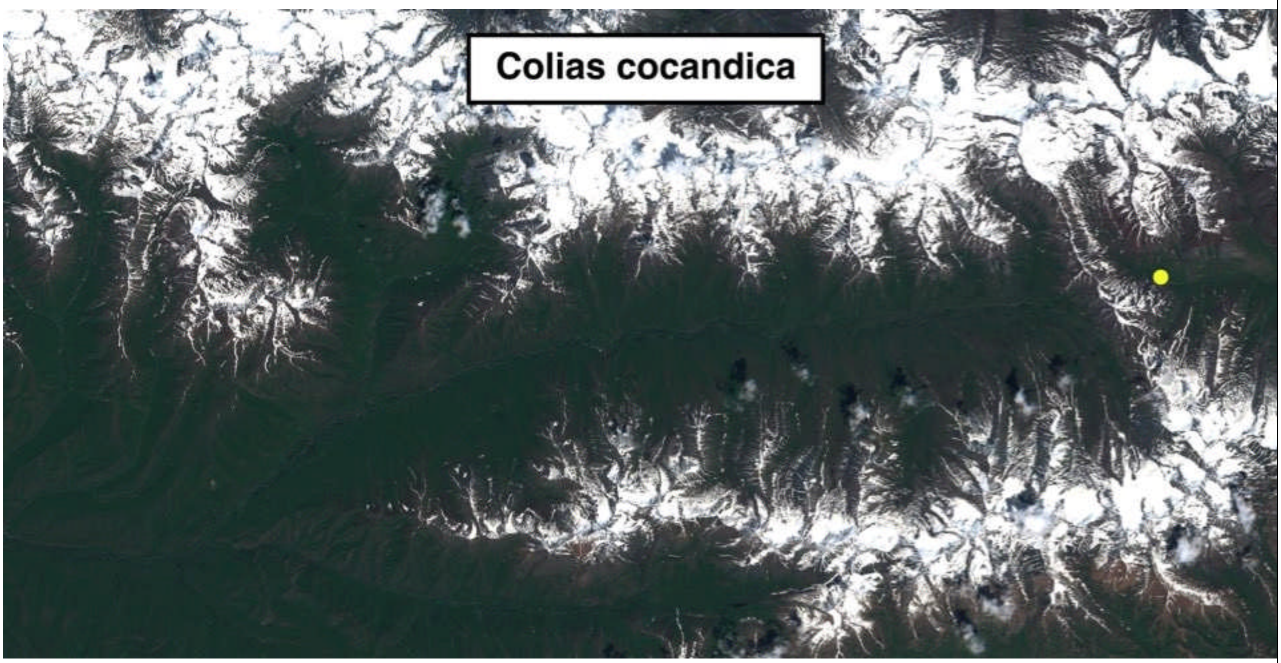
Parnassius tianschanicus — Large Keeled Apollo			
Flight time	May to September	Elevation (m)	1700-3500
Habitat	East and south facing rocky slopes in subalpine and alpine areas		
Food plants	*Rhodiola spp.*, *Sedum ewersii* (Stonecrop), *Sedum hybridum*		
Life cycle	Overwinters as a larva		



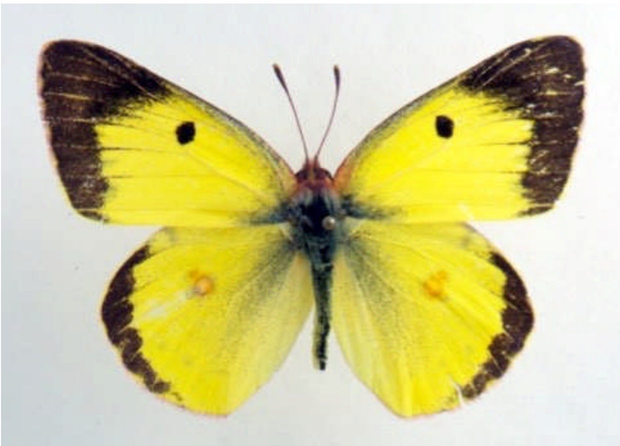
Pieridae

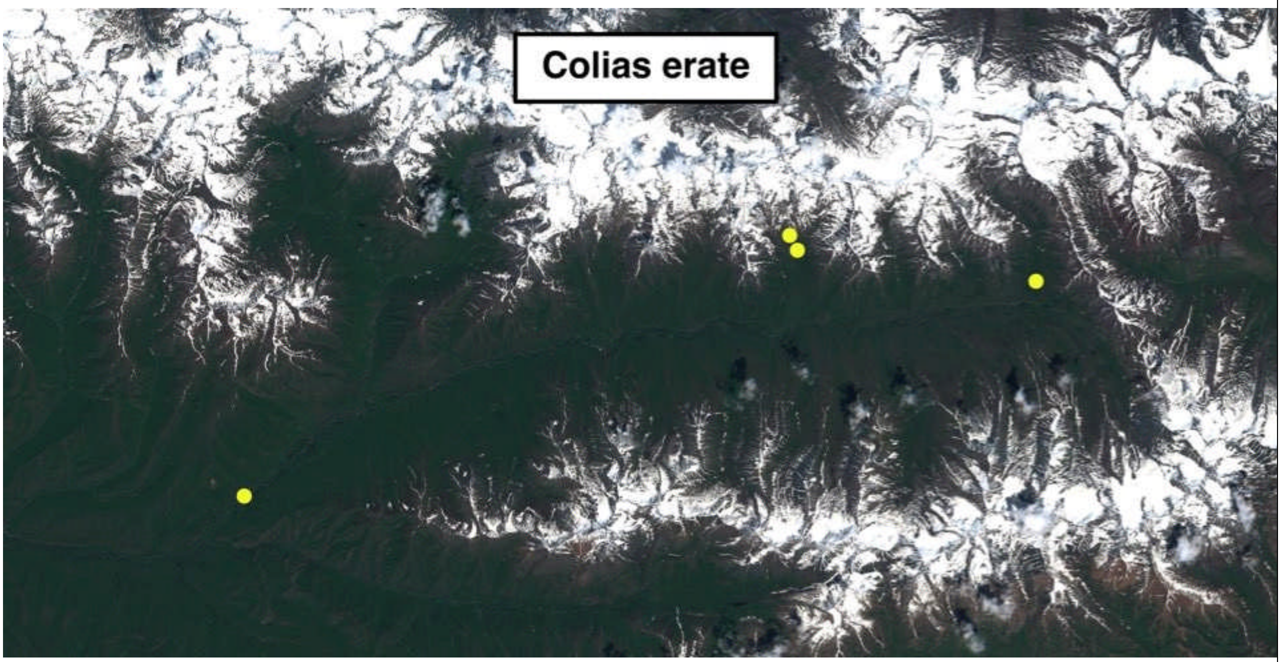
Colias cocandica			
Flight time	June to July	Elevation (m)	3000 - 4500
Habitat	Stoney slopes and mountain meadows		
Food plants	*Astragalus spp.* (milkvetch)		
Life cycle	Overwinters as a second instar larva		

Photo courtesy of Josef Greishuber - 2005

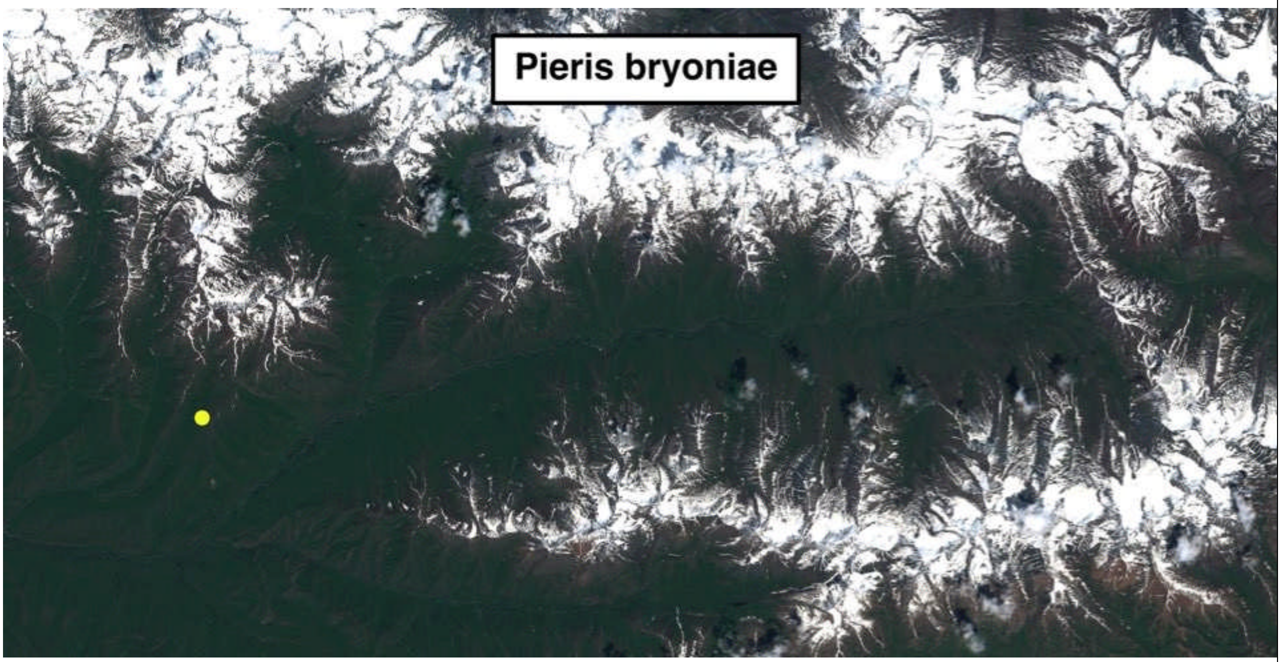


Colias erate — Pale Clouded Yellow			
Flight time	April to October	Elevation (m)	up to 3300
Habitat	Steppes, fields, and mountain meadows		
Food plants	*Onobrychis spp.* (Sainfoin), *Medicago spp.* (Burclover), *Trifolium spp* (Clover), *Trigonella spp* (Fenugreek), *Alhagi spp.* (Camelthorn)		
Life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

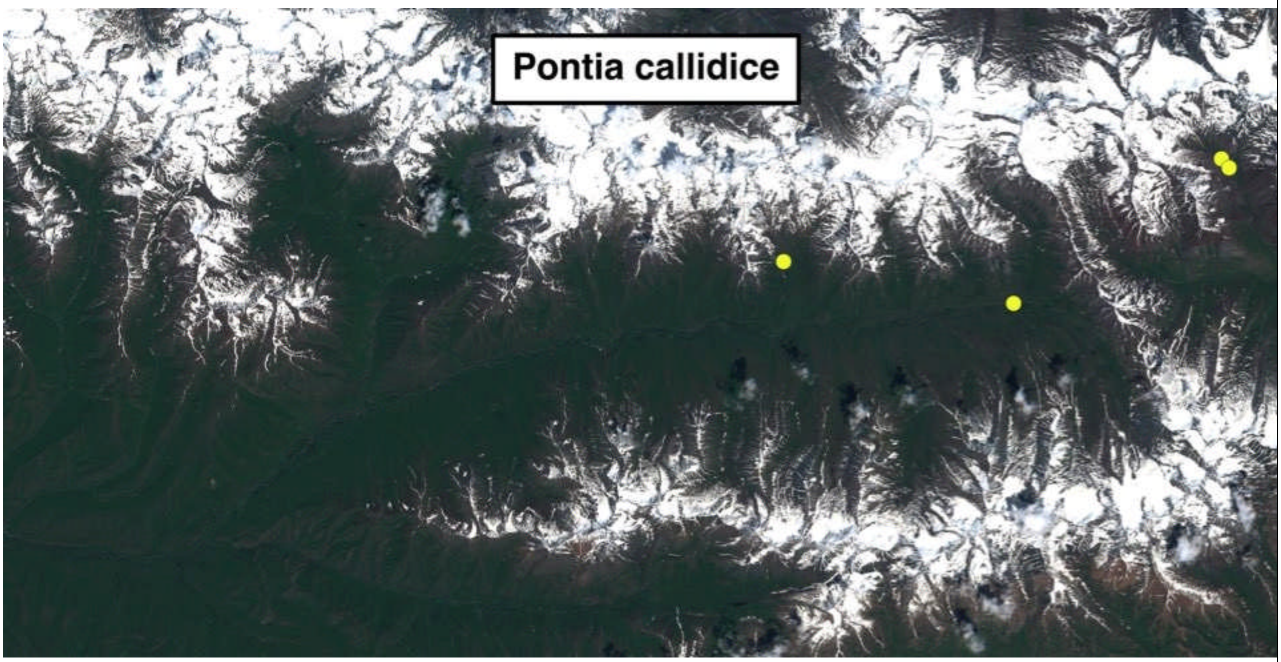




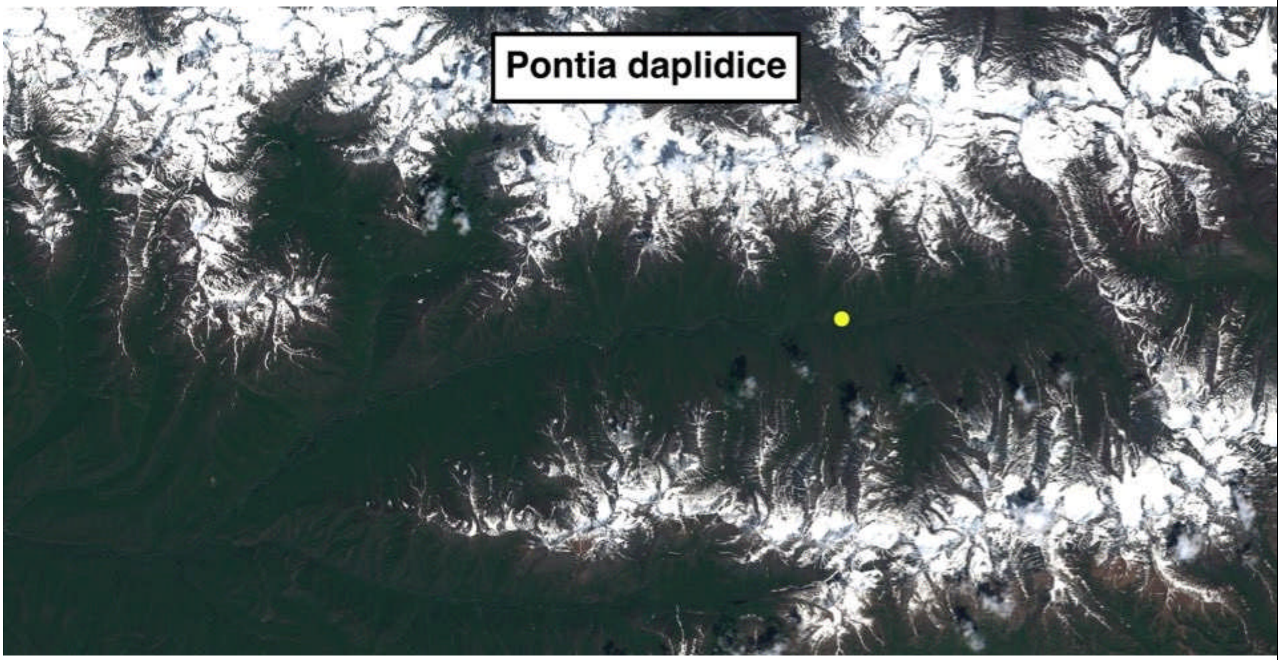
Pieris bryoniae — Dark Veined White			
Flight time	June to July	Elevation (m)	up to 2700
Habitat	Damp foothills and meadows		
Food plants	*Thlaspi spp.* (Pennycress)		
Life cycle	Overwinters as a pupa		



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		

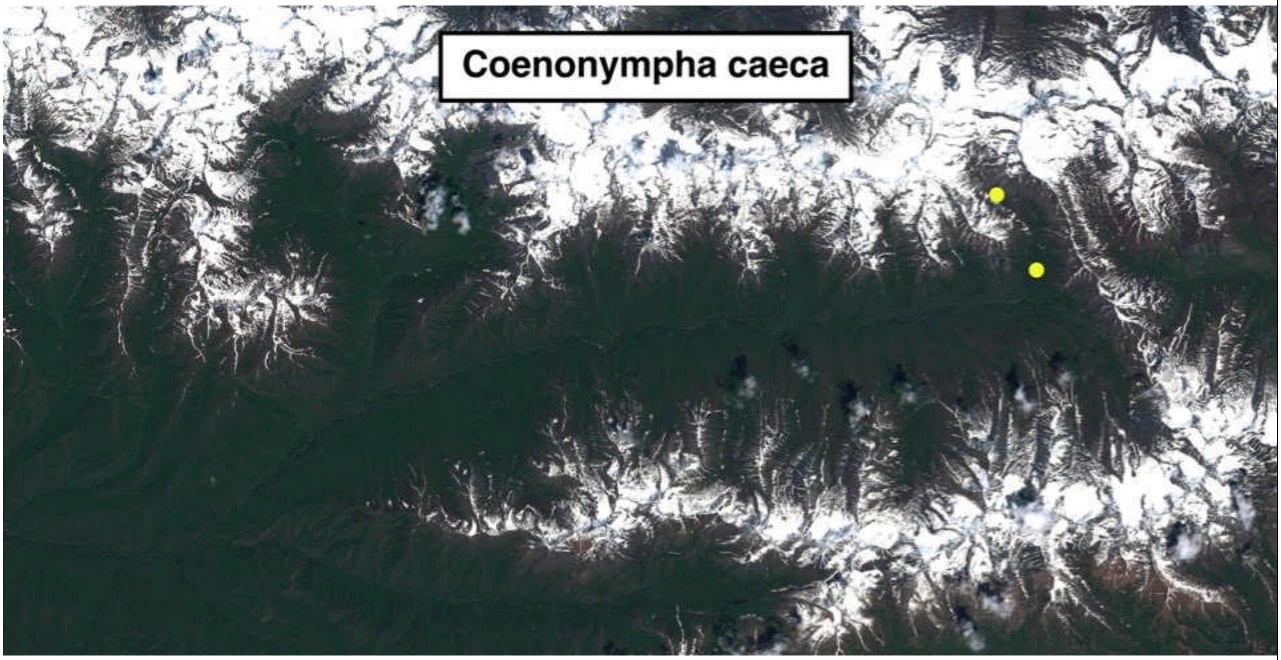


Pontia daplidice — Bath White			
Flight time	April to October	Elevation (m)	500-4000
Habitat	Deserts, steppes, river valleys		
Food plants	*Alyssum spp., Arabis spp.* (Rockcress), *Berteroa spp.* (Hoary Alison), *Erysimum spp.* (Wallflower), *Sisymbrium spp.* (Rocket), *Thlaspi spp* (Pennycress), *Turritis 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		

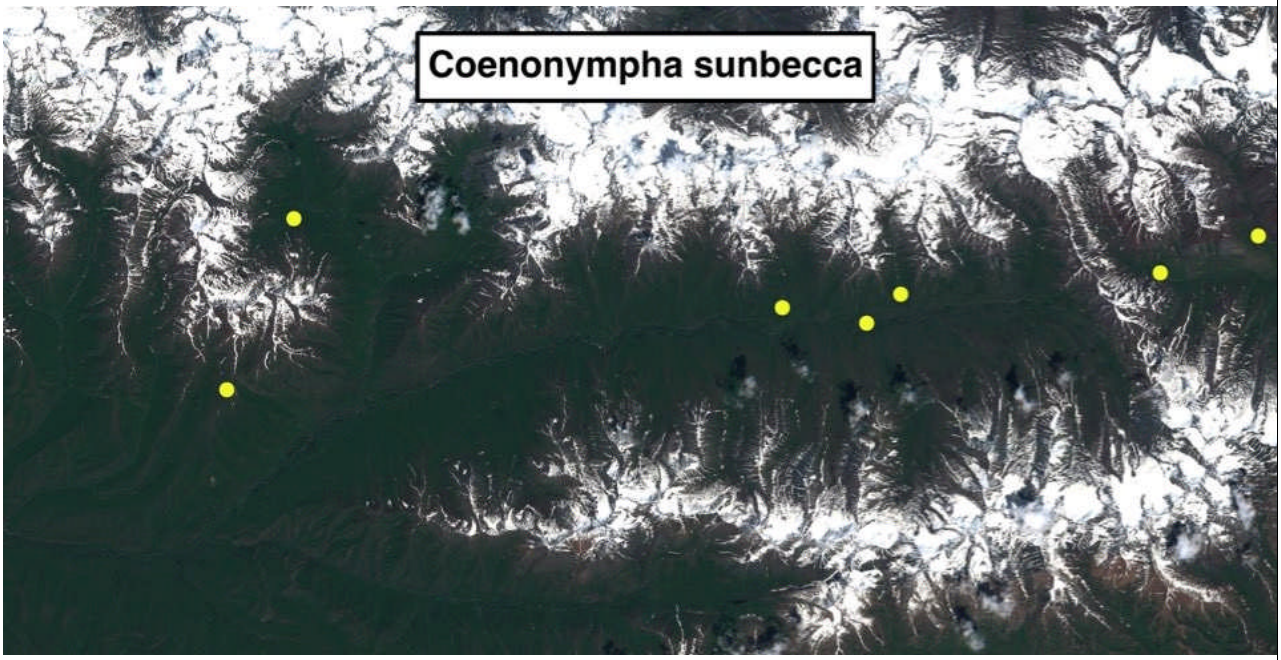


Satyridae

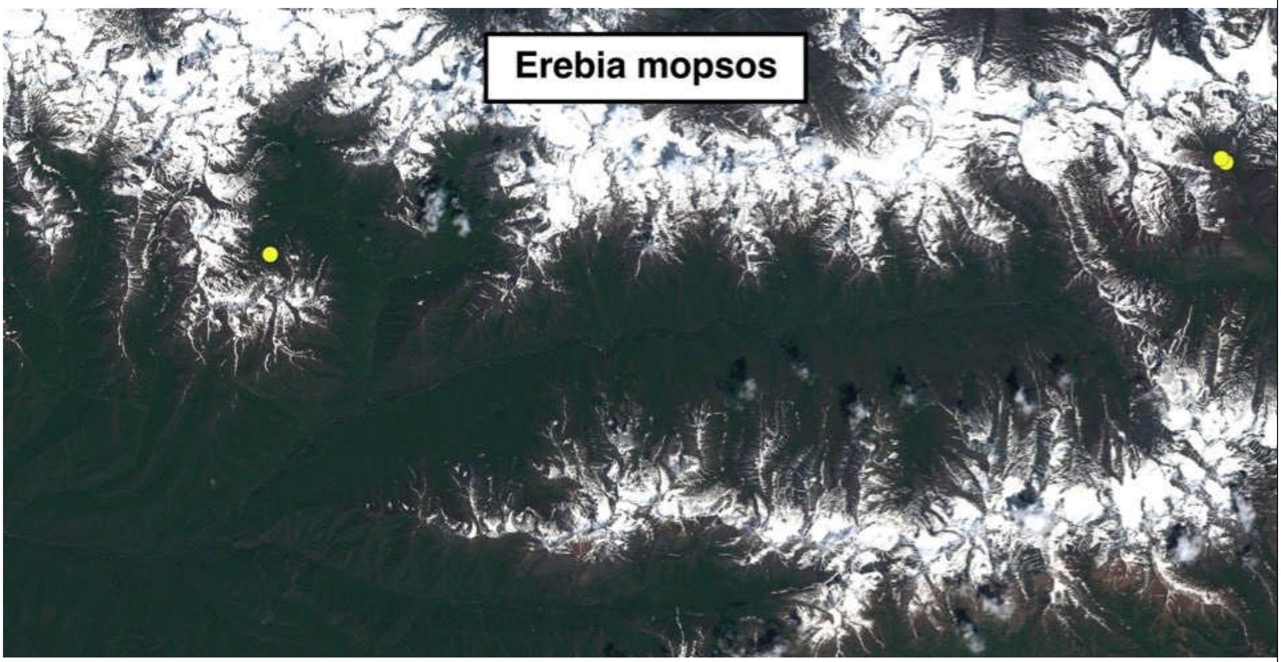
Coenonympha caeca			
Flight time	June to July	Elevation (m)	2000-3500
Habitat	Alpine meadows, stream banks, and stoney slopes that face eastward		
Food plants	*Carex spp.* (Sedge)		
Life cycle	N/A		



Coenonympha sunbecca			
Flight time	June to August	Elevation (m)	1500-3400
Habitat	Sloped meadows and stream banks		
Food plants	Poaceae (Grasses)		
Life cycle	N/A		

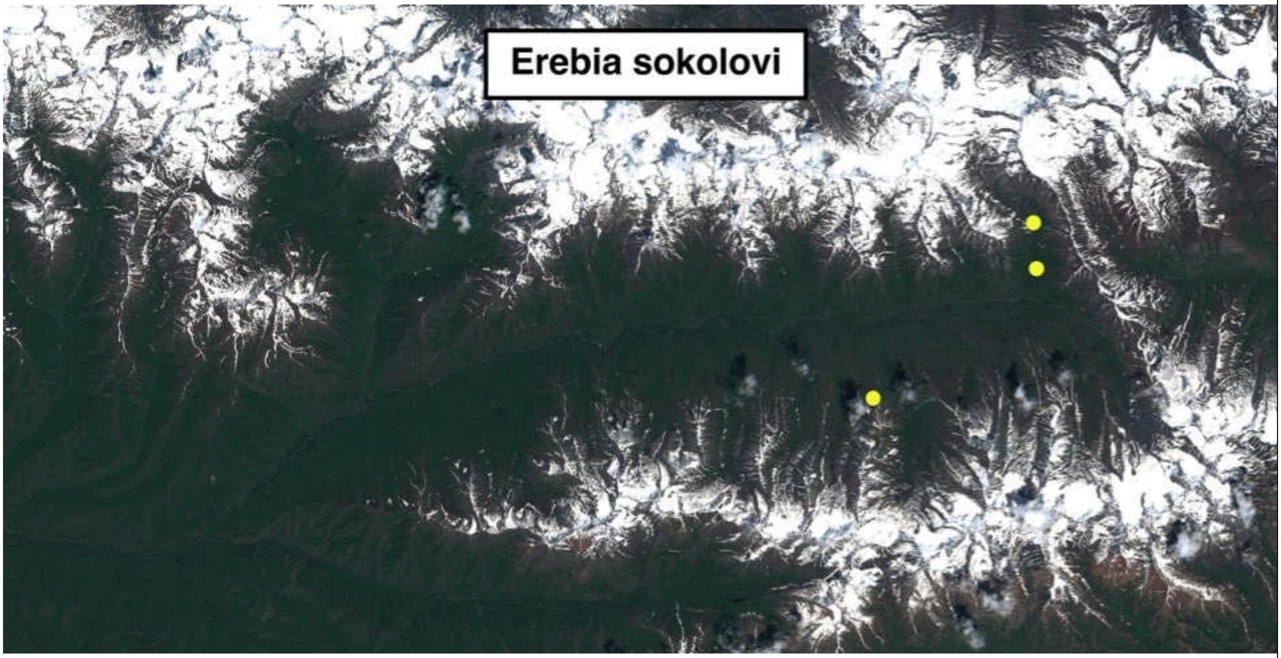


Erebia mopsos			
Flight time	June to July	Elevation (m)	2800-3500
Habitat	Meadow slopes in subalpine and alpine areas		
Food plants	*Festuca spp.* (Fescue)		
Life cycle	N/A		



Erebia sokolovi			
Flight time	July to August	Elevation (m)	3000-3600
Habitat	Meadow slopes in subalpine and alpine areas		
Food plants	Poaceae (Grasses)		
Life cycle	N/A		

Photo courtesy of Peter Sporrer - 2015



3.4. Discussion and conclusions

The region studied is already alpine in elevation, but there are limits to the elevation at which many butterflies can live. This could be due to a variety of environmental factors such as temperature or host plant availability. A simple analysis was carried out using GIS software in order to determine the species composition of butterflies living above 3500 meters. Of the 26 different species encountered from 2015 - 2016, only 8 were found at elevations above 3,500 metres. In 2015 there were nine sightings of seven different species above 3,500 m: *P. tianschanicus* (three individuals), *P. machaon, C. erate, B. generator, P. callidice, A. urticae,* and *C. erubescens* each with one individual. 2016 saw ten sightings of three different species above 3500 m: *P. delphius* (five individuals), *P. tianschanicus* (four individuals), and *C. erate* (one individual). Although the sample size is rather small, the data presented shows that over the course of two years of research, 68.4% of all butterfly individuals collected above 3500 meters are members of the *Parnassius* genus. It is therefore hypothesised that, in future surveys, at least half of all butterflies encountered over 3500 meters are likely to be *Parnassius sp.* This hypothesis seems likely as *Parnassius sp.* are generally considered to be the “alpine” butterflies of the region.

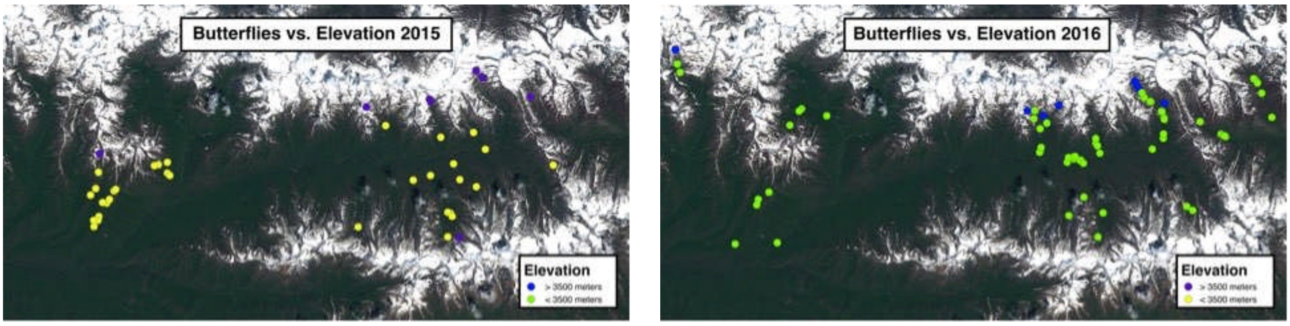


Figure 3.4a. Butterflies vs. Elevation: 2015 and 2016.

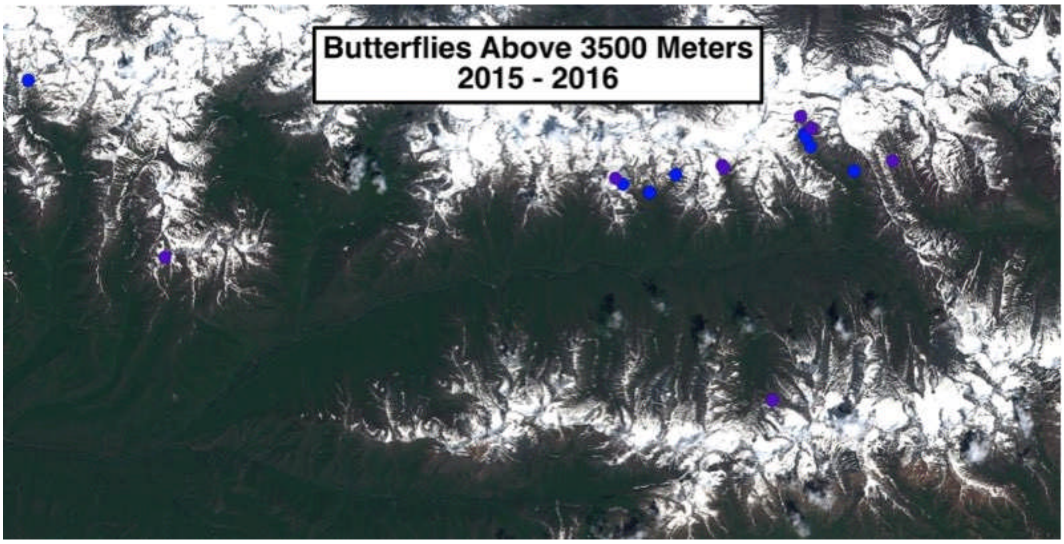


Figure 3.4b. All butterflies encountered above 3500 meters: 2015 – 2016.

Recommendations for 2017

- The 2017 expedition should begin using a newly updated version of the smartphone citizen science app now known as “Lapis Guides”. A new iPhone version will be available in June 2017.

- A clearer understanding by expedition participants of the sub-project of collecting information on the observations of butterflies will increase the number of sightings and should thereby should also increase the number of species observed. As such, the author will conduct training for participants and staff during each expedition group.

- Testing of the hypothesis that at least half of all butterflies above 3500 meters are from the Parnassius genus. This can easily be done using the smartphone application mentioned above.

- Further research to determine specific habitat locations for Parnassius sp. within these high alpine elevations. This could include host plant data collection to be cross-referenced with NDVI satellite images for future GIS modelling.

3.5. Literature cited

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Appendix I: List of bird species recorded during the 2016 expedition.

Latin name	English name	Русское название	RDB*
Acridotheres tristis	Common myna	Обыкновенная майна	
Actitis hypoleucos	Common sandpiper	Перевозчик	
Alauda arvensis	Eurasian skylark	Полевой жаворонок	
Alcedo atthis	Common kingfisher	Обыкновенный зимородок	
Anas clypeata	Northern shoveler	Широконоска	
Anas platyrhynchos	Mallard	Кряква	
Anthus trivialis	Tree pipit	Лесной конёк	
Anthus campestris	Tawny pipit	Полевой конёк	
Apus apus	Common swift	Чёрный стриж	
Aquila chrysaetos	Golden eagle	Беркут	+
Buteo buteo	Common buzzard	Обыкновенный канюк	
Buteo rufinus	Long-legged buzzard	Курганник	
Calliope pectoralis	Himalayan rubythroat	Черногрудая красношейка	
Carpodacus erythrinus	Common rosefinch	Обыкновенная чечевица	
Carpodacus rubicilla severtzovi	Spotted great rosefinch	Среднеазиатская большая чечевица	
Ciconia nigra	Black stork	Чёрный аист	+
Cinclus cinclus	Dipper	Белобрюхая оляпка	
Circus cyaneus (?)	Hen harrier	Полевой лунь	
Columba rupestris	Hill pigeon	Скалистый голубь	
Corvus corax	Raven	Ворон	
Corvus corone	Carrion crow	Черная ворона	
Corvus frugilegus	Rook	Грач	
Corvus monedula	Eurasian jackdaw	Галка	
Coturnix coturnix	Commom quail	Обыкновенный перепел	
Cuculus canorus	Common cuckoo	Обыкновенная кукушка	
Delichon urbicum	Northern house martin	Городская ласточка	
Eremophila alpestris	Horned lark	Рогатый жаворонок	
Falco cherrug	Saker falcon	Балобан	+
Falco naumanni	Lesser kestrel	Степная пустельга	+
Falco peregrinus (?)	Peregrine falcon	Сапсан	+
Falco subbuteo	Hobby	Чеглок	
Falco tinnunculus	Common kestrel	Обыкновенная пустельга	
Gypaetus barbatus	Bearded vulture	Бородач	+

Gyps fulvus (?)	Eurasian griffon	Белоголовый сип	+
Gyps himalayensis	Himalayan griffon	Кумай	+
Lagopus muta	Rock ptarmigan	Тундряная куропатка	
Leucosticte brandti	Brandt's mountain finch	Жемчужный вьюрок	
Leucosticte nemoricola	Plain mountain finch	Гималайский вьюрок	
Milvus migrans	Black kite	Черный коршун	
Monticola saxatilis	Rock thrush	Пестрый каменный дрозд	
Montifringilla nivalis	White-winged snowfinch	Снежный вьюрок	
Motacilla alba	White wagtail	Белая трясогузка	
Motacilla cinerea	Grey wagtail	Горная трясогу́зка	
Motacilla citreola	Citrine wagtail	Желтоголовая трясогузка	
Motacilla flava	Yellow wagtail	Жёлтая трясогузка	
Oenanthe isabellina	Isabelline wheatear	Ка́менка-плясунья	
Oenanthe oenanthe	Northern wheatear	Обыкновенная каменка	
Passer montanus	Eurasian tree sparrow	Полевой воробей	
Phoenicurus erythrogaster	Guldenstadt's redstart	Краснобрюхая горихвостка	
Phoenicurus ochruros	Black redstart	Горихвостка-чернушка	
Pica pica	Magpie	Сорока	
Prunella collaris	Alpine accentor	Альпийская завирушка	
Pyrrhocorax graculus	Alpine chough	Альпийская галка	
Pyrrhocorax pyrrhocorax	Red-billed chough	Клушица	
Saxicola torquata	Stonechat	Черноголовый чекан	
Sturnus vulgaris	Common starling	Обыкновенный скворец	
Sylvia communis	Common whitethroat	Серая славка	
Tadorna ferruginea	Ruddy shelduck	Огарь	
Tetraogallus himalayensis	Himalayan snowcock	Гималайский улар	
Tichodroma muraria	Wall creeper	Стенолаз	
Tringa ochropus	Green sandpiper	Черныш	
Upupa epops	Hoopoe	Удод	

* 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.).

Appendix II: Field interview datasheet as used by the expedition

FIELD DATASHEET: INTERVIEWS

You will be visiting local people to find out about their knowledge, beliefs and attitudes about snow leopards. This is also an opportunity to obtain information about their observations of wildlife. Snow leopard conservation is, to a significant degree, dependent on the understanding that people have about the snow leopard and of their relationship to the animal. This interview is an opportunity to gain a better understanding of the interactions between snow leopards and the Kyrgyz people.

Interviews are to be conducted in an informal, conversational style. In order to establish rapport and help create a relaxed atmosphere, begin by introducing yourself and state that you are interested in learning about what local people think and feel about snow leopards in this area. Emphasise that there are no right or wrong answers, and that you are simply interested in hearing about their ideas and experiences with snow leopards.

Prior to the interview, ask if there are any questions. Once their questions are answered, start the process with, “Is it alright for us to proceed?” Explain that you will be referring to this questionnaire as we go along in order to make sure that everyone is asked the same questions.

INTERVIEW CONDUCTED BY		DATE OF INTERVIEW	

PERSONAL INFORMATION ABOUT THE INTERVIEWEE

Name		Age	
Place of residence (name of community)		Place of birth (region)	
Occupation		Sex	

	Sheep	Goats	Cows	Horses	Other
If you work with livestock, what kind of animals and how many? (many is optional)					

INFORMATION ABOUT SNOW LEOPARDS

I would like to ask you some questions about snow leopards	YES, seen a snow leopard (ask question A below)	YES, seen signs of a snow leopard (ask question B below)	NO, never seen a snow leopard or signs of a snow leopard	YES, do you know a person that has seen a snow leopard or signs of a snow leopard	NO, do you know a person that has seen a snow leopard or signs of a snow leopard

Question A: If you saw a snow leopard, can you tell me about that please.	When did you see it?	Where did you see it?	What was it doing?	How do you feel about having seen a snow leopard? Excited	Not excited

Question B: If you saw signs of a snow leopard, such as tracks in the snow for example (but not an actual snow leopard)	What did you see?	When did you see it?	Where did you see this?	How do you feel about having seen sign of a snow leopard? Excited	Not excited

What impact do you think the presence of snow leopards has on the area	Beneficial	Detrimental	In your view are they good or bad for the country?	Good	Bad

Can you tell me a little more about the impact that snow leopards have on Kyrgyzstan?	

Can you tell me how you feel about snow leopards in general?	

Do you like, dislike or feel neutral about snow leopards?	Like	Dislike	Neither

Do snow leopards attack people?	Yes	No	Don't know

If yes, what makes snow leopard attacks on people?	

If snow leopards attack people, are these attacks more frequent in places where snow leopards live near people?	Yes	No	Don't know

How many snow leopards are there in Kyrgyzstan?	Enter estimate	Don't know

Are snow leopards protected in Kyrgyzstan?	Yes	No	Don't know

In your opinion, should snow leopards be legally protected in Kyrgyzstan?	Yes	No	Don't know

Can you tell me more about that?	

THE EFFECT OF SNOW LEOPARDS ON OTHER ANIMALS

Do snow leopards reduce the number of <u>large game animals</u> such as ibex or argali sheep in this area?	Yes	No	Don't know

If yes, how do snow leopards reduce the numbers of large animals?	

If no, why do you think snow leopards do not reduce the number of large animals?	

Do snow leopards reduce the number of small animals such as marmots and snowcock in the area?

Yes	No	Don't know

If yes, how do snow leopards reduce the numbers of small animals?	
If no, why do you think snow leopards do not reduce the number of small animals?	

In areas where snow leopards live near livestock, do they feed on domestic animals?

Yes	No	Don't know

If yes, can you tell me more about that?	

SNOW LEOPARDS AND TOURISM

If snow leopards attracted more tourists to this region, would this be a good thing or a bad thing?

Good	Bad	Don't know

What are your thoughts about how snow leopards might influence tourism?	

ADDITIONAL COMMENTS

Before we end our meeting, I wonder if you have anything else that you might want to tell me about snow leopards that we didn't discuss so far?	

Thank you very much for taking the time to explain your thoughts and feelings about snow leopards. Your answers to these questions will be useful in helping us understand how people and snow leopards can harmoniously coexist in this country.

Appendix III: Expedition diary and reports

A multimedia expedition diary is available on https://biosphereexpeditions.wordpress.com/category/expedition-blogs/tien-shan-2016/

All expedition reports, including this and previous expedition reports, are available on www.biosphere-expeditions.org/reports.