13TH INTERNATIONAL GROUSE SYMPOSIUM

4–7 SEPTEMBER 2015 • HILTON REYKJAVIK NORDICA HOTEL, ICELAND

PROGRAM AND ABSTRACTS

ICELANDIC INSTITUTE OF NATURAL HISTORY

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Introduction

It is now 40 years since the World Pheasant Association was created and initiated the first international grouse meeting. The first meetings were held in UK, with the help of people like David Jenkins and Tim Lovel. Only a few Americans showed up early on, Jim Bendell and Fred Zwickel were at the first meeting. Susan Hannon was another early non-European, with experiments on female territoriality that caused ripples throughout many other countries. Germany, Norway, Italy have all hosted the grouse meeting before we went to Fort Collins, Colorado, in 1996. Another hallmark came in 1990 when David Jenkins took the initiative to increase the scientific standard and publish the presentations in peer-reviewed journals. The international broadening has continued. China and Japan have been added as representatives of the Asian continent. Grouse research can be found in most aspects of wildlife ecology, and a Canadian wildlife researcher, experienced in mammalogy, termed the grouse as an honorary mammalian group of species in respect for all the work that had been done.

We know a lot about grouse, and because of all the giants before us, we can continue to ask questions of new aspects of grouse biology. Some of you may have read early classics like *The ruffed grouse; life history, propagation, management* by Bump et al. from 1947, and the *Committee of Inquiry on Grouse Disease The Grouse in Health and in Disease,* Smith, Elder & Co from 1911. Names as Adam Watson and Robert Moss, ITE Banchory, should be familiar, many have read their book on grouse from 2008. The interest on prairie grouse has increased over time, and a recent book on Greater Sage-Grouse edited by S.T. Knick and J.W. Connelly from 2011 is a good source. Ilse Storch should also be recognised in this context. She has made an exceptional effort to make the grouse species visible within IUCN, and not only that; she has also taken on the difficult task as the Editor-in-Chief of Wildlife Biology. She is here at the conference and probably has one or two stories to share! There are many grouse researchers that should be mentioned, but too many to fit in this short introduction. One that should have his name here is the grand old man of Finnish grouse research, Harto Lindén, and also the first editor-in-chief of Wildlife Biology.

Now it is 2015 and we are in Iceland. A fantastic landscape, friendly people, but most of all an interesting grouse species. Whereas almost all bird species in Iceland come from the European continent, the Rock Ptarmigan in Iceland originates from Greenland. This was discovered early, way before genetics, because the grit contents showed that some Ptarmigans had stones that originated not from the volcanic sediments of Iceland but from the rocks of Greenland. True grit! Not only is the Rock Ptarmigan the only grouse species in Iceland, it is also the dominant wild herbivore present! It has shown a regular 10–12 year cycle similar to the snowshoe hare for many, many decades. It has a breeding success that would make any grouse managers envious, 6–8 chicks per pair in autumn every year! A record that will be hard to beat! Three researchers should be put forward here: Finnur Guðmundsson, Arnþór Garðarsson and Olafur Nielsen. Three ecologists that have provided extensive information on the life history of the Icelandic Rock Ptarmigan. The last one has organized this meeting! Thank you Oli! So here we are, representatives of a long tradition and obligation to carry on the work of our predecessors. But not only that – we also have the responsibility of recruiting new grouse researchers and keeping grouse in focus! Not too difficult after reading through the abstracts. This will be fun and interesting!

Tomas Willebrand, chairman scientific programs committee

Dear Conference Delegate:

The Icelandic Institute of Natural History has the honour to host the 13th International Grouse Symposium 2015 in Reykjavík, Iceland. It gives me a great pleasure to welcome you on behalf of the Institute to this important event. We look forward to hosting you throughout the next couple of days and invite you to the reception at Ásmundarsafn on Thursday evening.

The Icelandic Institute of Natural History (IINH) is a public institution under the aegis of the Ministry for the Environment and Natural Resources. The Icelandic Institute of Natural History traces its roots back to 1889 when the Icelandic Natural History Society established a Natural History Museum in Reykjavík. Today, around 50–60 people work at the IINH in Garðabær and Akureyri, carrying out a broad range of research and monitoring tasks. The Institute conducts basic and applied research on the nature of Iceland, with a focus on botany, ecology, taxonomy, geology and zoology. It maintains scientific specimen collections and databases, assembles literature on the natural history of Iceland and operates the Icelandic Bird-Ringing Scheme. The IINH participates in environmental consultant work on sustainable use of natural resources and land development in Iceland and assesses the conservation status of species, habitats and ecosystems. The IINH also provides a range of services for the general public – from scientific outreach programmes to pest identification services.

One species, the Rock Ptarmigan, has long held our interest. Dr. Finnur Guðmundsson (1909–1979) started Ptarmigan research at the IINH in 1963. Dr. Finnur was interested in the enigmatic 10-year population cycle of the Ptarmigan and what factors drive these changes. Ptarmigan work at the IINH has continued more or less un-interrupted since the 1960s. The emphasis has been on the applied side of managing the population and most of the monitoring work on the Ptarmigan in Iceland has been organized and run by the IINH. We have also continued projects that have to do with Gyrfalcon-Ptarmigan relationship. Lately we have initiated research to better understand the relationship between various aspects of Ptarmigan health and their population cycles. This project is a cooperative venture between scientists at the IINH, University of Iceland, University of Akureyri and the Northeast Iceland Nature Centre.

Many grouse populations are under threat and challenged by factors such as habitat destruction, over-harvesting, encroachment and global warming to name a few. Understanding the general dynamics of grouse populations and the nature of the threats they face should be the basis of any management. Therefore meetings like this, where grouse scientists from far and wide gather to present the results of their work, are important. I know that many of you have travelled a great distance to attend this event and I thank you for your time and commitment. I hope you find this conference both useful and stimulating and your visit to Iceland enjoyable.

Lastly but not the least I take this opportunity to pay tribute to the local organizing committee for the excellent preparatory work, it has so successfully undertaken. I thank all the members of the committee for having so generously devoted their time to ensure that we are going to have a stimulating and fruitful conference.

Sincerely,

Jón Gunnar Ottósson, Director General

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Acknowledgments

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Conference organizing committee

Arne Sólmundsson, The Icelandic Hunting Association
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Karl Skírnisson, Laboratory of Parasitology, Keldur, University of Iceland
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Conference organizers

Iceland Travel

Financial Sponsors

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Moderators

Brett Sandercock
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Rocky J. Gutiérrez
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General Information

About Reykjavík

Reykjavík is the capital and largest city of Iceland and a popular tourist destination. It is located in south-western Iceland, on the southern shore of the Faxaflói Bay at 64°08' N and 21°57 W. With a population of around 120,000 (and over 200,000 in the Capital Region), it is the heart of Iceland's cultural, economic and governmental activity.

Reykjavík is believed to be the location of the first permanent settlement in Iceland, which the Norwegian Ingólfur Arnarson is said to have established around AD 870. The ruins of the first farm are preserved as an exhibit and located at Aðalstræti 16, in Reykjavik centre, just north of Lake Tjörnin. Until the 18th century, there was no urban development in Reykjavik. The city was founded in 1786 as an official trading town and grew steadily over the next decades, as it transformed into a regional and later a national centre of commerce, population, and governmental activities. Reykjavík offers all the facilities of a modern city. One of the specialities is the outdoor swimming pools fed by geothermal water. Our foreign conference members are encouraged to get acquainted with the local “bathing” culture. One swimming pool, Laugardalslaugin, is 15 minutes’ walk from the conference venue.

Conference venue

The conference will be held in the auditorium of the ground floor of the Hilton Reykjavik Nordica. The hotel is located on Suðurlandsbraut 2 in Reykjavik. Poster exhibits will be in the hall in front of the lecture hall. Admission to the conference area is open 08:00–19:00. The facilities are non-smoking. The hotel offers free WiFi and dining options are available starting at 07:00 and until 22:00.

The workshop will be held in the Family Zoo in Laugardalur, Reykjavik.

Cell phones

Please silence your cell phone while in the conference rooms. Thank you!

Dining options

Breakfast
Breakfast is on your own.

Lunch
Lunch is included in registration fee and is provided between 12:00 and 13:00 in the hall in front of the lecture hall.

Evening fare
Thursday 3 September, 18:00–20:00. Welcome reception in Ásmundarsafn museum. Vine, bear and soft-drinks, and hors d’oeuvres included in your conference registration fee.

Sunday 6 September, 18:00–23:00. Viðey banquet. The closing “Viðey banquet” is an optional dinner for 100 Euros, and is highly recommended.

Coffee breaks
Coffee is included in your registration fee and will be provided morning and afternoon in the hall in front of the lecture hall.

Special Events

Ásmundarsafn reception

Thursday 3 September, 18:00–20:00
Ásmundarsafn museum was formally opened in 1983 and is dedicated to the works of Ásmundur Sveinsson (1893–1982). Ásmundur was one of the pioneers of Icelandic sculpture, finding inspiration in Icelandic nature and literature. The museum is housed in a unique building, once the artist's home and studio, and which he donated to Reykjavik City along with a large collection of his work. While there are always works by Ásmundur on display, Ásmundarsafn also regularly holds exhibitions of works by other artists, which often tend to have some reference to Ásmundur's art. The museum is surrounded by an elegant sculpture garden, boasting around 30 sculptures by Ásmundur. Ásmundarsafn is within easy walking distance both from the Hilton Nordica and the Family Zoo.

Viðey banquet

Sunday 6 September, 18:00–23:00
The conference celebration dinner is optional for 100 Euros, and is highly recommended. Included in the dinner fee is a bus from Hilton to the harbour, the ferry and a 3 course dinner. The entrée "the ocean and the land" contains Arctic Char, mushrooms and dates, the main dish is fillet of lamb with rusty vegetables and potatoes filled with mushrooms, and the dessert is hot chocolate cake with ice cream. Also included in the dinner are two glasses of wine. Cash bar will be available throughout the evening.

Reykjavik borders the south shores of the bay Kollafjörður. On the bay c. 1 km north of Reykjavik sits Viðey a 1.7 km square island. People have lived on Viðey since the year 900. It was a centre of religious and cultural activity during the period 1225 to 1550 when an Augustinian monastery operated on the island. During the 18th and the 19th century several influential people lived on the island including Skúli Magnússon the founding father of the City of Reykjavik. It was Skúli who built the Viðey House (Viðeyjarstofa), where we will be gathering, during the years 1752–1755. The Viðey House is one of the oldest buildings in Iceland and the first stone house built. Viðey House was inhabited until the 1950s and now houses a restaurant. A village was formed on the east part of the island during the early 20th century but abandoned in 1943. The island is owned by the City of Reykjavik and managed as an out-door recreation area. Connection to the mainland is by a ferry sailing from the harbour Sundahöfn in Reykjavik. Viðey is rich in birdlife and a large number of Common Eiders nest on the island as well as many shorebirds. The sculpture "áfangar" ("mile stones") by the American minimalist sculptor and video artist Richard Serra is on the west end of the island. Another work of art, "The Imagine Peace Tower" conceived by Yoko Ono in memory of John Lennon, is situated on Viðey.

To get to Viðey we will need to catch the ferry at Sundahöfn. A bus will pick us up at the Hilton and take us to Sundahöfn to meet the ferry at 18:00. We will be back to Reykjavik at 23:00.

Workshop

Workshop to expand the use of emerging technology to understand the ecology of avian herbivores in a changing climate

Thursday 3 September 2015, 08:00–17:30
The workshop will be held at the Reykjavik Family Park and Zoo (1.2 km = 15 min walk from Hilton Reykjavik Nordica). The overall objective of the workshop is to share advances in rapid biochemical assays, robotics and remote sensing to better understand, monitor and manage wildlife habitat and behaviour in a changing climate. The workshop will include seminars and hands-on demonstrations to collect, analyse, interpret, and share preliminary data related to monitoring and predicted how wildlife interact with their environment.

The workshop is intended to translate technological advances from basic science to the applied community. The workshop will synthesize how emerging technology is and can be used to monitor and manage wildlife and will foster new international collaborations. Specifically, the workshop will offer discussions between basic scientists and conservation and management agencies to identify how current technology can be modified to meet current and future needs of the organizations responsible for solving threats to wildlife.

The workshop will be chaired by Profs Jennifer S. Forbey (Boise State University), Gail Patricelli (University of California, Davis), and Donna Delparte (Idaho State University). Forbey and Patricelli have used the technology they will demonstrate to understand the behaviour, ecology and conservation of wildlife, including the Greater Sage-Grouse. Delparte has been working with multispectral data acquired through Unmanned Aircraft Systems (UAS) for vegetation mapping, as well as using GIS and geo-tracking to understand bird population dynamics and habitat use. Together, they have assembled a team comprised of masters and doctoral students, postmasters and postdoctoral researchers who developed and use the technology to conduct research at the interface of technology, basic research, and management of wildlife.

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Field trips

Two field trips are offered, a pre-conference trip on 3 September and a post-conference field trip on 8–11 September.

Pre-conference field trip to Mount Esja

3 September 2015, 09:00–16:00
A bus will leave from the conference hotel, Hilton Reykjavik Nordica, at 09:00. The trip will involve a hike up the slopes of Mount Esja and a visit to an estuary. The theme will be Rock Ptarmigan and Ptarmigan habitats and estuary birds. Estimated hiking time is 6–7 hours. The bus will take the group back to Reykjavik and estimated arrival at the Hilton Reykjavik Nordica is between 16:00 and 17:00. The trip will cost 25 Euros and includes bus ride, lunch bag and guide. For the hike you will need hiking boots, rain gear and warm clothing.

Post-conference field trip to North-east Iceland

8 September 08:00 – 11 September 17:25
The trip will start and end at the terminal of the Reykjavik domestic airport. Up in the north-east we will travel using a bus and reside at the Hotel Rauðaskriða. We will visit the heartland of the Ptarmigan and Gyrfalcon in Iceland and observe interesting geology, landscapes and flora. For the trip people have to have good hiking boots, rain gear and warm clothing. The trip will cost 785 Euros. Included in the fee are all travelling costs, plane and bus, and lodging (including breakfast, lunch bag and dinner). Please check at conference registration desk for exact departure times from Reykjavík domestic airport. Note that participants have to get themselves to the airport in the morning of 8 September.

Scientific program

All oral paper sessions will be held in the ground floor auditorium of the Hilton Reykjavik Nordica in Reykjavik, the poster sessions in the hall in front of the auditorium.

Registration
Registration will be at the Hilton Reykjavik Nordica and will open on 08:00 on 3 September before people leave for the field trip at 09:00. During 4–8 September the desk will be open during conference hours.

Submitting oral paper presentations
All oral paper presenters should bring digital copies of their presentations on a memory stick or CD to the registration desk in the hall in front of the auditorium.

Submitting posters
The poster session takes place on 5 September, 17:00–19:00 in the hall in front of the Hilton Reykjavik Nordica auditorium.

Presenters should place their posters by 13:00 on 4 September on the free standing walls provided. Posters will remain posted until the late afternoon on Sunday, 6 September. Mounting material will be provided at the registration desk.

Submission of manuscripts for publication in Wildlife Biology
Those presenting results of their studies at the conference are encouraged to submit a manuscript for publication in a special issue of Wildlife Biology. The submitted manuscripts will go through a normal peer review process according to the standards of Wildlife Biology. The authors should prepare the papers as described in the author guidelines at: http://www.wildlifebiology.org. Wildlife Biology is an open access journal and as such charges a fee of 500 Euros per paper; authors from countries identified as 'low-income economies' may apply for fees being waived (see http://www.wildlifebiology.org/publishing-fees). To submit your paper use Wildlife Biology's manuscript submission site (https://mc.manuscriptcentral.com/wlb). In the submission form, please note that your ms is part of the IGS special issue. The deadline for manuscript submission is 1 February 2016.

Program at a Glance

Thursday 3 September

Hilton Nordica Reykjavik

08:00 – 09:00	Registration desk open

Family Zoo

08:00 – 17:30	Workshop

Mnt. Esja

09:00 – 17:00	Pre-conference field trip

Ásmundursalur

18:00 – 20:00	Welcome Reception of Conference Delegates

Friday 4 September

08:15 – 08:30	Welcome and opening address
08:30 – 10:00	Scientific Program
10:00 – 10:20	Coffee Break
10:20 – 12:00	Scientific Program
12:00 – 13:00	Lunch Break
13:00 – 15:00	Scientific Program
15:00 – 15:20	Coffee Break
15:20 – 18:00	Scientific Program

Saturday 5 September

08:00 – 08:05	Announcements
08:05 – 10:00	Scientific Program
10:00 – 10:20	Coffee Break
10:20 – 12:00	Scientific Program
12:00 – 13:00	Lunch Break
13:00 – 15:00	Scientific Program
15:00 – 15:20	Coffee Break
15:20 – 17:00	Scientific Program
17:00 – 19:00	Poster Session

Sunday 6 September

08:15 – 08:20	Announcements
08:20 – 10:00	Scientific Program
10:00 – 10:20	Coffee Break
10:20 – 12:00	Scientific Program
12:00 – 13:00	Lunch
13:00 – 15:00	Scientific Program
15:00 – 15:20	Coffee Break
15:20 – 16:20	Scientific Program
18:00 – 23:00	Banquet at Viðey

Monday 7 September

08:15 – 08:20	Announcements
08:20 – 10:00	Scientific Program
10:00 – 10:20	Coffee Break
10:20 – 12:00	Scientific Program
12:00 – 13:00	Lunch Break
13:00 – 15:00	Scientific Program
15:00 – 15:20	Coffee Break
15:20 – 17:00	Scientific Program

Scientific Program Schedule

The Conference is located in the first floor auditorium of the Hilton Nordica Reykjavik

Thursday 3 September

Hilton Nordica Reykjavík

08:00 – 09:00 Registration desk open

Family Zoo

08:00 – 17:30 Workshop

Mnt. Esja

09:00 – 17:00 Pre-conference field trip

Ásmundarsalur

18:00 – 20:00 Welcome Reception of Conference Delegates

Friday 4 September

Welcome and Introductions

08:15 – 08:20 **Jón Gunnar Ottósson,** director IINH
Welcome

08:20 – 08:30 **Sigrún Magnúsdóttir,** Minister for the Environment and Natural Resources
Opening address

Moderator: Brett Sandercock

Plenary Lecture

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08:30 – 09:00	**Ólafur K. Nielsen** Rock Ptarmigan studies in Iceland	401

Population Ecology

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Moderator: Ilse Storch

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Moderator: Øyvind Steifetten		Abstract No.
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Population Ecology

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MODERATOR: EVA FUGLEI

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HEALTH

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MODERATOR: JACOB HÖGLUND

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Genetics, Phylogeny

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Management, Conservation

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Management, Conservation

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Management, Conservation

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Abstracts

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Abstract No. 401

Rock Ptarmigan studies in Iceland

Ólafur K. Nielsen (1)

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The Rock Ptarmigan (*Lagopus muta*) is the only grouse found in Iceland. The Icelandic population belongs to the Nearctic *rupestris*-group. Most likely Ptarmigan from Greenland colonized the island at some point during the Pleistocene. The Ptarmigan is the dominant wild vertebrate herbivore and a keystone species in the Icelandic dryland ecosystem. The Ptarmigan population has shown 10-year cycles in numbers with up to 20-fold difference in densities between high and low years. The presentation will give a historic account of Ptarmigan research in Iceland. Most of the research activity has been focused on the population dynamics and the possible role of behaviour and trophic interactions (plant-herbivore, predator-prey, and parasite-host) in driving the population cycle. Also there have been some studies on the phylogeny and genetics of the population. Ptarmigan have been harvested since the time of the settlement in late 9th century, first for subsistence, market hunting was important in the early 20th century but now only sport hunting is practised. The population is monitored intensively (population size, mortality rates, harvest rates) and harvest decisions are based on the results of the monitoring program.

Abstract No. 402

Monitoring habitat supply and effects of climate change on habitat suitability and configuration for coastal alpine ptarmigan in North America

Kathy Martin (1,2), Michelle Jackson (1), and Sarah Gergel (1)

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White-tailed Ptarmigan reside at low and variable densities in alpine ecosystems with little population monitoring throughout their distribution. On Vancouver Island, ptarmigan were first recorded in 1905, declared a sub-species in 1939 (*Lagopus leucura saxatilis*), listed as vulnerable in 1992, and the first field surveys began in 1995. Opportunistic "citizen science" observations submitted by hikers in remote alpine regions can be valuable, as coverage can be extensive compared to scientific field surveys. We compared the performance of 5 statistical modelling approaches and an ensemble model to predict habitat supply for Vancouver Island White-tailed Ptarmigan based on 2 datasets; field data from radio-telemetry and call-playbacks on 28 mountains, and citizen science observations submitted by hikers for 90 mountains. Predictions of suitable habitat for Vancouver Island varied from 370–1,039 km^2 based on field surveys and 404–1,354 km^2 using public observations. Models using both data sets showed comparable accuracy. We then combined data sets using a Random Forest model to predict suitable summer habitat for ptarmigan under current and future climates using 3 general circulation models and 2 greenhouse gas concentration scenarios. Ptarmigan summer habitat is predicted to decline on average by 56% by the 2080s under the low greenhouse gas scenario and 74% under the high scenario. Habitat patches are predicted to become more fragmented, with a 52–79% reduction in mean patch size; all climate change models and greenhouse gas scenarios depicted near total loss of all patches >1 km^2. Patch size appears to influence ptarmigan survival as under current conditions, smaller patches have lower and more variable survival. Whether ptarmigan will persist in their increasingly fragmented habitat will depend on their ability to move through a more heterogeneous landscape, utilize smaller breeding and winter areas, and survive increasingly variable climate extremes.

Abstract No. 403

Identification of a suitable habitat and study of the habitat selection of Rock Ptarmigan in the northern part of Japan

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(2) Graduate School of Science and Technology, Niigata University, Japan

In 2012, Ministry of the Environment changed the conservation status of the Japanese Rock Ptarmigan (*Lagopus muta japonica*) from "Vulnerable" to "Endangered", owing to decline in the population of this species over its entire range. The population in Mt. Hiuchi, which is the northernmost and smallest population in Japan, is the most endangered, along with the population in the South Alps. Identifying a suitable habitat and the environmental variables that affect habitat selection of the Rock Ptarmigan is crucial for the conservation of this species. Using location data in the breeding season during 2009–13 in Mt. Hiuchi, and during 2012–13 in the northern part of North Alps, ecological niche modelling was performed by using MaxEnt to detect a suitable habitat for Rock Ptarmigan and to evaluate niche segregation between two sites (Mt. Hiuchi and North Alps). Three models were constructed: All available location data for the Rock Ptarmigan, the location data of only the Mt. Hiuchi population, and the location data of only the North Alps population. Using a deductive approach and based on expert knowledge, we examined the following environmental variables related to the habitat selection of this species: Japanese stone (JS) pine zone, wetlands, artificial zone, cultivated land, low-height (LH) grassland, high-height (HH) grassland, elevation, slope, and undulations. Among these, elevation, LH grassland and JS pine zone were identified to be a variable between 2 study sites. Not only the physiographic restriction factor, but refuges such as LH grassland and JS pine zone were also important. The evaluation of niche segregation indicated that the Rock Ptarmigan from Mt. Hiuchi preferred LH grassland, whereas the Rock Ptarmigan from North Alps preferred JS pine zone. Our results suggest that the Rock Ptarmigans from the 2 study sites exhibit specialized habitat selection depending on the environmental variables at each site.

Abstract No. 404

Assessing forest grouse habitat using LiDAR remote sensing: the potential of the new technology for grouse research

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Forest habitat structure and composition are major predictors for suitable grouse habitat at the local and regional scale. However, area-wide information about habitat characteristics is rare and has so far limited the development of range-wide distribution models for species that are responsive to forest structure. LiDAR is an emerging remote sensing technology that provides fine-scaled information about vertical vegetation and habitat structure over large areas. The method offers novel opportunities to study habitat quality for forest grouse species at the landscape scale. We used nation-wide occupancy data of Capercaillie (*Tetrao urogallus*) and Hazel Grouse (*Bonasa bonasia*) with the aim to compare the performance of field- and LiDAR-based species distribution models. Both models performed well, however combining the predictor variables even improved the model accuracy for the two forest grouse species. While field variables mainly quantified food resources and compositional characteristics of the ground and shrub layer, LiDAR technology provided valuable complementary 3D information on vegetation heterogeneity. We conclude that LiDAR bridges that gap between precise, locally restricted field-variables and coarse digital land cover information and allows for the area-wide assessment of forest structural variables. They have the potential to significantly improve the accuracy of habitat models which will inform wildlife managers about the distribution and development of suitable forest grouse habitat.

Abstract No. 405

Habitat associations of the Sierra Sooty Grouse include elements of old forest

James Bland (1)

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Seasonal habitats of the Sierra Sooty Grouse (*Dendragapus fuliginosus sierrae*) were assessed at patch- and micro-scales near Pinecrest, in the Sierra Nevada Mountains of California, at locations acquired by radiotelemetry, auditory surveys, nest searches, and incidental brood detections. Patch-scale habitat associations were analysed with Maxent suitability models, micro-scale habitat associations were assessed by comparing detection sites with systematically sampled sites, and the use of large trees was assessed from faecal accumulations under song-post trees. The environmental variables that best distinguished five seasonal habitats (male breeding, nesting, brooding, postbreeding, and wintering) were elevation, slope, aspect, canopy patchiness, tree diameter, abundance of large trees, height and cover of shrubs and herbaceous plants, and abundance of logs and coarse woody debris. Both sexes were associated with two variables considered characteristic of old forest: large trees (>62 cm d.b.h.) and logs. Breeding males selected trees that averaged 97.9 cm d.b.h. for territorial songposts, and were negatively associated with harvested forest. In winter, there was a positive association with harvested forest at the patch scale, but at the micro-scale there continued to be a positive association with large trees. The Sooty Grouse has frequently been described as an early-successional species, but in the Sierra Nevada Mountains it is strongly associated with elements of old forest, particularly in breeding and wintering seasons.

Abstract No. 406

Functional relationships among Lesser Prairie-Chicken survival, habitat type, and landscape fragmentation

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Declines in Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) populations have been linked to large- scale ecological drivers, such as land use change, loss of natural fire, and change in grazing regimes. All of these drivers have the potential to affect annual survival estimates. Understanding how large scale processes affect Lesser Prairie-Chicken survival can advise how best to manage for this species of conservation concern in the future. Individual female Prairie-Chicken were trapped on leks across three different ecoregions in Kansas and Colorado and outfitted with either a 22-g rump-mounted GPS satellite transmitter or a 15-g VHF transmitter. Lifetime ranges were estimated using Brownian bridge movement models or kernel density estimators for satellite and VHF transmitters, respectively. Landscape fragmentation metrics were calculated within each individual range. Fine-scale habitat characteristics were measured at randomly selected bird-use locations. Functional relationships among annual adult female survival, landscape fragmentation, and average microhabitat characteristics were derived using Program Mark. Annual survival was estimated using encounter-specific habitat covariates in Andersen-Gill models. While annual survival directly mirrored the drought trends in Kansas, survival did not differ among sites, despite differences in landscape level fragmentation. These relationships will be crucial for the development of an ideal landscape design for Lesser Prairie-Chickens across their range within Kansas and Colorado, and have the possibility for being extrapolated across the entire species range.

Abstract No. 407

A spatially explicit hierarchical approach to identify seasonal habitats for Gunnison Sage-Grouse

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Gunnison Sage-Grouse (*Centrocercus minimus*) is considered a threatened species under the Endangered Species Act, due to range contractions, loss of habitat, and population declines. Careful management is therefore required to ensure that suitable habitat is maintained, particularly because much of the species' current distribution is faced with exurban development pressures. We assessed hierarchical habitat selection patterns of Gunnison Basin Sage-Grouse population across three life stages (nesting, late-summer, and winter) and at multiple spatial scales, using logistic regression-based resource selection functions. Models were selected using Information Criterion (Akaike or Bayesian) and predictive surfaces were generated using model averaged relative probabilities. Landscape-scale factors such as percent cover of sagebrush and density of roads had the strongest influence on resource selection across all life stages. Crucial habitat identified by landscape models for each life stage was used to define the spatial extent for patch-scale modelling efforts. Resource selection at the patch scale was again influenced by local characteristics of sagebrush, but other effects, such as proximity to residential development and high traffic volume roads, and mean habitat productivity, also played a role. Our models accurately predicted independent use locations across all three life stages. The unique hierarchical structure of our models more accurately captures the nested nature of habitat selection, and allowed for increased discrimination within larger landscapes of suitable habitat. Identified crucial habitats had strong overlap across all three life stages. We illustrate how these models can be used for conservation planning and initial assessments of connectivity to prioritize management efforts.

Abstract No. 408

Landscapes as a moderator of thermal extremes for Greater Prairie-Chicken

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(3) Utah State University, Department of Wildland Resources, 5230 Old Main Hill, Logan, Utah 84322, USA

We examined thermal properties of habitat for Greater Prairie-Chickens (*Tympanuchus cupido*) in a landscape characterized by heterogeneous fire and grazing. We examined operative temperature at varying scales relevant to grouse and used historic and forecasted climate data to estimate thermal stress on breeding grouse. We found that heterogeneous grasslands have high thermal variability with operative temperature ranging as much as 23°C across the landscape. Grouse exhibited strong selection for cooler thermal environments as nest sites were as much as 8 °C cooler than the surrounding landscape, and fine-scale differences in thermal environments was nearly 4 °C cooler than sites within 2 m of nests. Additionally, forecasted climate scenarios indicate grouse will experience 2–4 times the number of hours above thermal stress thresholds, implying that mitigation efforts may be needed. Overall, these data suggest variation in grassland structure resulting from the fire-grazing interaction may be important in moderating thermal environments and suggests that understanding heterogeneity is critical for conserving imperilled wildlife as climate change forecasts predict greater thermal extremes.

Abstract No. 409

Size and stability as market characteristics of Sage-Grouse leks

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Leks can be viewed as biological markets in which males and females negotiate to determine the outcome of courtship interactions. The make-up of players in the market, both number and composition, may strongly influence how courtship proceeds and the eventual distribution of mating success. Lek size, i.e. the number of males in the market, can be measured at both daily and seasonal scales, and the relationship between these time scales, which we term 'lek stability,' may also be important but has received little attention. We examined patterns of male attendance and mating success across four Greater Sage-Grouse leks (14 total lek-years) in central Wyoming, USA. When only considering lek size and mating success (both total and per capita), we found a quadratic relationship with highest copulation rate in moderate-sized leks; this same pattern was obtained when lek size and lek stability were both included in the model. Copulations were more frequently interrupted on smaller and less stable leks. There was also a trend for smaller and more stable leks to be slightly more advanced in median copulation date. We conclude that measuring lek size alone is insufficient for understanding variation among leks in the number or distribution of matings in this species. Future work will examine the process of mate searching and courtship on leks with differing market environments, and explore the factors causing variation in male attendance patterns. Leks have exceptional potential as model systems to understand the interaction between individual tactics and population processes in biological marketplaces.

Abstract No. 410

Male Sage-Grouse invest more courtship effort in higher-value partners: an experimental test with a robotic female

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Females in lekking species are known for being extremely choosy about their mates, but the possibility that males may also exercise choice has received less study. Males may make choices in how they allocate their limited time and energy on the lek, favouring females of higher reproductive value, such as females more likely to consent to copulation. To evaluate this hypothesis in Greater Sage-Grouse (*Centrocercus urophasianus*), we manipulated the social context of courtship using a robotic female capable of mimicking behaviours indicating the likelihood of an eventual mating. We sampled display effort for 52 males across three leks in two experimental treatments (robot showing either interested or uninterested behaviours) and in the presence or absence of live females. We developed a hidden Markov model that estimates two parameters characterizing male courtship effort: (1) the probability males continue a display bout and (2) the display rates of males within bouts. We found that males courting a high-value female had a higher probability of continuing a bout as well as a higher rate of display. Males that allocated more display effort toward a high-value partner also had greater mating success, suggesting that both high display intensity and responsiveness to female behaviours are important components of successful courtship. These results suggest that sexual selection in lekking species may favour choosy males as well as choosy females.

Abstract No. 411

Is male investment important for the fitness of female Chinese Grouse (*Tetrastes sewerzowi*)?

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In some monogamous avian species, males invest more time in vigilance than females, especially during the pre-incubation period. As behaviours are energetically costly, there is a trade-off between vigilance and feeding. Male vigilance can be regarded as a direct male investment for female mate and may benefit the female by reducing the danger of predation, increasing her probability of survival, and allowing more time for her to forage to obtain resources for egg production and incubation. Vigilance can also enable the paired male to prevent extrapair copulation attempts by the other males. In this study, we documented the proportion of time spent in vigilance and feeding by Chinese Grouse (*Tetrastes sewerzowi*) with their mates and alone during the pre-incubation period, and then estimated male investment under more severe predation pressures through predator calls playback. Our results indicated that paired males would spend more time in vigilance than unpaired males and paired females. Chinese Grouse would also alter their activity budgets in response to different social context and an experimental encounter with an important predator. Male vigilance behaviour allowed females to spend more time in foraging. We can therefore conclude that male investment through vigilance behaviour should play an important role in promoting the survival and reproduction success of females. The proportion of time allocated for vigilance by males and foraging by females during the pre-incubation period was the highest recorded among monogamous grouse species, perhaps because Chinese Grouse is the smallest grouse species and has the highest relative reproductive investment.

Abstract No. 412

Looking into the past – the reaction of three grouse species to climate change over the last million years

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Tracking past population fluctuations over time scales of thousands of years can give insight into the response of species to climate change. We have applied the Pairwise Sequentially Markovian Coalescent (PSMC) model on the genomes of three widely distributed grouse species (Aves; subfamily Tetraoninae); the Black Grouse, the Willow Grouse and the Rock Ptarmigan. These species differ in their habitat requirements and are thus expected to differ in their reaction to the prevailing climatic conditions. The method allowed us to track their effective population (Ne) size beyond 1 million years, revealing i) the Black Grouse had a strikingly low Ne prior the last ice age, ii) the early Pleistocene cooling (~3–0.8 mya) favoured the Willow Grouse and Rock Ptarmigan proliferation while decreasing the Ne of the Black Grouse, iii) this proliferation lasted until around the last interglacial (~130 kya) after which the Ne of Willow Grouse and Rock Ptarmigan declined and iv) that all three species reacted differently to the last glacial maximum (LGM) – Black Grouse increased already prior to it, Rock Ptarmigan experienced a severe bottleneck and Willow Grouse was maintained at a large population size. The contrasting dynamics during the LGM most likely reveal the local population dynamics within Western Europe in all three species. Overall, our results provide an empirical example of how species with different habitat requirements react differently to large changes in climate as well as the overall usefulness of the PSMC method.

Abstract No. 413

Population monitoring of the Svalbard Rock Ptamigan

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The Svalbard Rock Ptarmigan (*Lagopus muta hyperborea*) is endemic to Svalbard (Norway) and Franz Josef Land (Russia) and is the only terrestrial bird residing in the high-Arctic archipelago of Svalbard (74–81 °N, 10–35 °E; 62,700 km^2). Svalbard holds an exceptionally simple terrestrial food web lacking small mammals and specialist predators. Here we summarize results on Svalbard Rock Ptarmigan population dynamics and spatial ecology based on data from a long-term monitoring program using both field surveys and hunting statistics. We particularly discuss the implications of climate change effects on ptarmigan population ecology. We have monitored the Svalbard Rock Ptarmigan population annually since 2000 and estimated the pre-breeding population in April by surveying calling territorial males using a point transect sampling design. We used site occupancy data from survey to develop statistical habitat models predicting spatial distribution of suitable breeding habitats in Svalbard. We have also compiled a dataset from the 1980s to analyse how Ptarmigan populations respond demographically (age, gender and body mass) to hunting mortality. Finally we have used hunting statistic data (year-to-year variation in bag size) to analyse impacts of rain-on snow events in winter on the Svalbard Rock Ptarmigan population growth rate. The population density of the Svalbard Rock Ptarmigan is low (1–4 males per km^2) with little temporal variation. Only 3% of the land areas are predicted to have suitable breeding habitats. Experimental removal of ptarmigan in spring had no effect on breeding density, indicating presence of floaters in the population. Increased rain-on-snow events, encapsulating the tundra vegetation in ice and blocking food resources, were negatively impacting the Svalbard Rock Ptarmigan population growth rates. Despite low breeding population densities, the Svalbard Rock Ptarmigan seems resilient to harvesting, due to floaters in the population. However, the spatially limited breeding habitats and the restricted food choice of chicks in the breeding season makes the Svalbard Rock Ptarmigan vulnerable to climate change.

Abstract No. 414

Population reconstruction model for the Rock Ptarmigan in NE-Iceland

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The Rock Ptarmigan (*Lagopus muta*) is found all over Iceland but has the highest density in the north-eastern part of Iceland. It is a popular game bird but in 2003 the hunting regulation was changed. The aim of this study was to build a population reconstruction model for the Rock Ptarmigan in NE-Iceland from 1998 to 2012. The model estimates the population size, recruitment, natural survival and hunting mortality simultaneously. Different variations of the model were compared using the Akaike information criteria. The model that fitted the data best had estimates of the total abundance at the beginning of the hunting season highest 153,000 birds in 1998 and lowest 38,000 birds in 2002. The natural survival of adult Rock Ptarmigans was assumed to be density dependent and ranged from 36 to 65%. The survival of the juveniles was taken as a constant and was estimated to have been 19%. A changepoint was included in the model to account for a change in the hunting mortality that could have occurred with change in the hunting regulation. Before 2003 the hunting mortality was modelled as a function of ptarmigan density and ranged from 32 to 54%. After the hunting ban, the hunting mortality was modelled as a function of the number of hunters and ranged from 11 to 17%. This model indicates that changes in the hunting regulation did have an effect in reducing the hunting mortality and also affecting the harvest strategies of the hunters.

Abstract No. 415

Temporal trends in Fennoscandian Capercaillie and Black Grouse reproductive output

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Black Grouse (*Tetrao tetrix*) and Capercaillie (*T. urogallus*) are sympatric forest dwelling grouse traditionally perceived as contrasting species in regards to their preference along the forest successional continuum. Nonetheless, parallel declines in populations of both species have been linked to development of modern forestry and change of land-use. In general, populations are limited by top-down or bottom-up processes such as predation, food availability or habitat loss. For such long-term trends it is hard to isolate any single effects causing the declines and direct effects of i.e. forestry are thus hard to detect. However, if carrying capacity is limited, reproductive output per female grouse will not necessarily be symptomatic. To investigate reproductive output of boreal forest grouse we undertook a meta-analysis approach and collected previously published studies as well as "grey literature" adding to new unpublished data on nest success, brood frequency and chicks per female in Capercaillie and Black Grouse covering Fennoscandia. By the use of generalized additive mixed models (GAMM) we show that through a period of 80 years all parameters describing reproductive success in these two species have decreased. Furthermore, by use of bootstrapping methods we show that there is more variation in nest success and brood frequencies in the last half of the period covered by the data and vice versa for chicks per female. We hypothesize that regulation of reproduction in Capercaillie and Black Grouse underwent a shift from an artificial predator-free environment to an increase in carrying capacity for small and medium-sized predators as well as reduced persecution by man.

Abstract No. 416

Multi-fate nest predation in Black Grouse and Capercaillie and effects of habitat

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Population declines have been reported across the distribution range of both Capercaillie (*Tetrao urogallus*) and Black Grouse (*Tetrao tetrix*) the past 60 years and the declines have been attributed to the expansion of modern silviculture. Although large-scale effects of silviculture might be hard to detect, change in land use (i.e. change in silviculture practices) and the subsequent alteration of habitat might generate indirect effects affecting Capercaillie and Black Grouse viability on different scales. Studies investigating survival in active nests are scarce and effects of habitat on nest predation is ambiguous. Furthermore, composition and quantity of nest predators is lacking. To assess effects of habitat on cause-specific nest predation in Capercaillie and Black Grouse we analysed 224 Capercaillie and 60 Black Grouse nests in a multi-fate Markov chain nest failure models framework at nest-site and home-range scale. We found home-range scale covariates to best explain nest failure in both Capercaillie and Black Grouse. Furthermore, Pine Marten (*Martes martes*) was more important than Red Fox (*Vulpes vulpes*) thus explaining more of the variation in nest failure. Finally, Marten track indices the previous winter was the best performing home-range covariate. Our results indicate that physical configuration of nest site and home range in general is irrelevant explaining nest predation in forest grouse and that predator species composition and density is the main factor regulating nest success in Capercaillie and Black Grouse.

Abstract No. 417

The trapping release hypothesis

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The Alternative Prey Hypothesis has formed the basis for much of the theory of the small game fluctuations in Scandinavia. The 3–4 year vole fluctuations strongly affect natality and survival of generalist predators as Red Fox (*Vulpes vulpes*) and Pine Martens (*Martes martes*), which greatly affect their predation on alternative prey. It has been assumed that the absence of large carnivores as Wolf (*Canis lupus*), Wolverine (*Gulo gulo*) and Lynx (*Lynx lynx*) caused by the persecution of man in the late 19th century made it possible for the smaller generalist predators to expand. In this talk, we question if the recent increase in Red Fox can be sufficiently explained by the lack of large carnivores. Rather we suggest that the interaction with humans and Red Fox has been as important as the interaction with large predators. From Neolithic times, furs from Northern regions have been a traded commodity. In periods and regions, people paid taxes in furs, and furs were used as a unit of value. In other periods and regions, people have regarded furbearers as a pest. During the last half of the 19th and the first decades of the 20th century, in the Palearctic and Nearctic world, furbearers were heavily persecuted to reduce predation on livestock and game. Still furbearers effecting the small game community are persecuted on scattered hunting estates, and sometimes to reduce competition with or predation on red listed species. Most furs now come from fur farms. The great picture is that trapping of small furbearers is terminated and their populations are mainly limited by their food base. We hypothize that small predators have been released from trapping and hunting and that small game populations only occasionally will reach densities previously reported.

Abstract No. 418

Black Grouse population changes in boreal forests of Eurasia

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(13) Russian Research Institute of Game Management and Fur Farming, Kirov, Russia
(14) Pinezhsky State Nature Reserve, Arhangel region, Russia
(15) Nature Reserve "Kivach", Karelia, Russia
(16) Nature Reserve "Bryansk Forest", Bryansk region, Russia
(17) Kostomuksha Nature Reserve, Karelia, Russia

We have studied Black Grouse population abundance and its dynamics in large regions of North-Europe and Urals' taiga (Finland, Russian Karelia, Murmansk, Arhangel, Kirov and Komi regions and). The data is based on Winter Track Counts (WTC, Priklonski, 1973), where all grouse sightings are recorded. We also studied the longterm Black Grouse abundance changes in Russian and Belarus Natural Reserves (by "Chronical of Natural" Programme, including summer counts of forest grouses): Pinezhsky, Pechoro-Ilychskiy, National Park "Mechera", Nature Reserve "Kivach", "Bryansk Forest", Kostomuksha Nature Reserve Volzhsko-Kamsky National Nature Biosphere Reserve and Visimskiy State Nature Reserves. The highest and most stable abundances of Black Grouse were recorded from East Fennoscandia (Karelia – 3.6 birds per 10 km; Finland – 4.4, coefficient of variation – 12% and 27%, respectively), whereas in the Murmansk and Arkhangelsk Regions and Komi republic, e.g. the species abundance indices were 0.5, 2.5 and 1.1 birds per 10 km, respectively. The "Peak" and minimal abundance years do not concur in different regions of north-European taiga. In Komi in the period from 2001 to 2013, the number of the Black Grouse declined twice, in Arhangel in the period 30 years – decreased fivefold. In Tatarstan Republic (Volzhsko-Kamsky National Nature Biosphere Reserve) after 1980 abundance decreased rapidly and at last 10 tears – disappeared. In Central Siberia BG are small in numbers and rare. The data suggest Black Grouse abundance varies significantly across Northern Eurasia and among years. One may presume there are some factors acting in different directions: towards convergence and towards divergence of the trends.

Abstract No. 419

Survival estimates from ring recovery of Icelandic Rock Ptarmigan *Lagopus muta*

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Survival probability is one of the most essential parameter for understanding population dynamics, and often varies with sex and age. The Rock Ptarmigan in Iceland is the only grouse species and the most abundant wild herbivore. Historically, it has shown multiannual cycles of 10–12 years. Presently, survival estimates are based on counts and changes in age ratio from autumn to spring. In addition, there have been local short-term estimates of mortality and survival from radio-collared birds. From these estimates and survey data, we have learnt that the population has a declining trend. Here we present results on survival estimates from 86 years' ring recovery data of 9000 ptarmigans in Iceland. We assumed an open population according to the Cormack-Jolly-Seber model and used Bayesian analysis approach. Our results show that average annual survival of yearling (both sex pooled) was 11 % whereas adult had 39 %. The average annual survival rate of the population (all ages and sexes pooled) in year 1927–1960 was 18 %, and it increased to 24 % within 1961–1980, until it decreased to 16 % after 1981–2013. The survival probability in the decrease phase was lower than increase phase as we expected i.e. 9 % and 17 %, respectively. The quality of the dataset and the timespan of study give us a confidence to say that the results of these analyses represent reliable estimate as it encapsulated about 4 full cycles of the population.

Abstract No. 420

Nest survival and reproductive phenology of White-tailed Ptarmigan at three breeding sites in Colorado, USA

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Understanding the demographic parameters that are most responsive to climate variation is important to predict future population dynamics and viability of species. Long-term research on White-tailed Ptarmigan (*Lagopus leucura*) in Colorado indicates annual variation in winter climate has small effects on breeding-age survival, yet spring warming is strongly correlated with progressively earlier breeding over the past four decades. However, the consequences of earlier breeding are not known. A three-year study using telemetry was initiated in Colorado, USA in 2013 to assess the breeding success of White-tailed Ptarmigan and how it relates to timing of ptarmigan nest initiation and availability of food resources. Three sites were selected for nest monitoring, including two in the Front Range (Mt. Evans [ME] and Rocky Mountain National Park [RM]) and one in the San Juan Range (Mesa Seco) of the Rocky Mountains. We monitored 74 nests from 54 hens in 2013 and 2014. Mean nest initiation was earlier at Mesa Seco (14 June ± 10 days) compared to the Front Range sites at ME (16 June ± 12 days) and RM (19 June ± 10 days), but variation in date of nest initiation was insignificant among sites. Daily nest survival was greatest at Mesa Seco (S = 0.993, SE = 0.005), followed by RM (S = 0.977, SE = 0.006) and ME (S = 0.973, SE = 0.007). Daily nest survival was positively related to hen age, negatively related to nest age, and unrelated to timing of nest initiation. Daily nest survival was equivalent during both years even though timing of nesting was later in 2014 due to higher spring snowpack. We are currently incorporating measures of food abundance into nest and brood-survival models to further understand the roles plant and insect phenology play in annual fecundity.

Abstract No. 421

Fecundity may be limiting Ruffed Grouse in the southern Appalachians

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Relatively low fecundity may be responsible for lower Ruffed Grouse (*Bonasa umbellus*) populations in the southern Appalachians compared to those in more northern areas of the species' range. Nutritional stress imposed by poor-quality habitat and greater nest predation have been cited as negative influences on reproduction in the region. We monitored 56 female grouse via radiotelemetry during the reproductive season in the Appalachian Mountains of North Carolina, USA, 1999–2004, to measure reproductive success and evaluate cover used for nesting. Nests (n = 44) were located to determine fate and habitat characteristics. Nesting rate (78%) was lower than many reports, and mean first nest clutch size of 10.1 eggs was less than that reported in the Great Lakes states, but was within the range reported in the central and southern Appalachians. Mayfield estimated nest survival was 0.83 (+ 0.084 SE) and the proportion of successful nests was 81%, which is among the greatest reported. Only 11% of females (1 of 9) re-nested following an initial nest failure, and overall hen success was only 61%. Females nested in various forest types with 86% occurring in stands >40 years old. Vegetation and topographic characteristics at nests did not differ from paired, random sites. Cover for nesting was not limiting. Increased nutrition during winter and early spring made available through increased forest management (regeneration harvests and improvement cuts) should lead to improved female physical condition and an increased nesting rate and overall hen success.

Abstract No. 422

Effects of wildfire and climate on population growth rates and trajectories for Greater Sage-Grouse in the Great Basin of North America

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Greater Sage-Grouse (*Centrocercus urophasianus*) are an obligate sagebrush species that has declined concomitantly with the loss and fragmentation of sagebrush ecosystems across most of its geographical range. Hence, the species is currently listed as a candidate for federal protection under the U.S. Endangered Species Act. Increasing wildfire frequency and changing climate are frequently identified as two environmental drivers that contribute to the decline of sage-grouse populations, yet few studies have rigorously quantified their effects on sage-grouse across broad spatial scales and long time periods. We conducted an extensive analysis of wildfire and climatic effects on sage-grouse population growth derived from 30 years of lek-count data collected across the entire hydrological Great Basin of western North America. Annual (1984–2013) patterns of wildfire were determined from remotely sensed 30-m imagery using Monitoring Trends and Burn Severity methods, and variation in precipitation and temperature was determined from locally downscaled climate models. After accounting for consistent density-dependent effects, population growth rates declined with increasing area burned within 5-km of lek and decreasing distance to nearest fire, while increasing seasonal temperatures appeared to influence growth rates more than variation in precipitation. Underlying soil conditions also contribute strongly to variation in sagebrush ecosystem resilience to disturbance and resistance to plant community changes (R&R), so we modelled differences in post-fire recovery time (i.e., return to sagebrush) across three spatially explicit R&R classes. Our model projects that all low R&R sagebrush habitat that comprises the majority of the Great Basin will have burned by ~2090 (± 25 yrs). These patterns illustrate how sage-grouse persistence may be compromised as sagebrush ecosystems become more impacted by a warmer climate and increasingly invaded by annual grasses that accelerate fire frequency and destroy Sage-Grouse habitat. Some of this information is preliminary and subject to revision. It is being provided to meet the need for timely best science.

Abstract No. 423

Emerging effects of energy-related infrastructure on Greater Sage-Grouse nesting ecology

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Energy-related infrastructure within sagebrush ecosystems can influence predator-prey interactions and demography of species of conservation concern. Specifically, the growing number of transmission lines and other tall structures associated with increased demand for wind, solar, and geothermal energy is increasing the abundance of generalist predators and negatively affecting population vital rates of their prey. Here, we present a synthesis of ongoing and past studies that describe direct and indirect effects of these landscape changes on predator-prey dynamics between Common Ravens (*Corvus corax*) and Greater Sage-Grouse (*Centrocercus urophasianus*), a species of conservation concern in western North America. The individual studies were carried out over a 10-year period and consisted of extensive raven surveys within sagebrush ecosystems, radio-tracking of female Sage-Grouse at multiple study sites, and intensive nest monitoring of Sage-Grouse using video recording systems. Our topics include: 1) Common Ravens identified as the most frequent predator of Sage-Grouse nests using advanced nest video-monitoring systems, 2) Sage-Grouse nest survival decreasing as a function of reduced concealment and increased Raven abundance, 3) nest initiation timing effects on predation rates of Sage-Grouse nests, 4) proximity to power lines and other energy structures and the proportions of non-native vegetation predicting the probability of occurrence by Ravens, and 5) a preliminary analyses that indicates a significant positive relation between grouse nest survival and distance to anthropogenic feature. Within nesting habitat of Sage-Grouse, factors that contribute to the expansion of Ravens may present an ongoing challenge for Greater Sage-Grouse conservation and management. Some of this information is preliminary and subject to revision. It is being provided to meet the need for timely best science.

Abstract No. 501

Long-term studies of Red Grouse

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The Red Grouse has been studied since the 1950s in a combination of long-term demographic studies and replicated individual- and population-level manipulations. The main focus of this work has been to try and understand the causes of population cycles in Red Grouse, and in particular the relative importance of intrinsic (behaviour) and extrinsic (climate, food limitation and parasite) mechanisms. In this talk I will summarise these studies and discuss their impact on the field of population ecology, with a particular focus on the role of parasites, intrinsic mechanisms and the impact of multiple, interacting mechanisms. I will end by considering the outstanding questions that remain to be tested.

Abstract No. 502

Red Grouse and raptors – 23 years of monitoring at Langholm Moor, Scotland

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Large parts of uplands habitat in the UK are managed for shooting of Red Grouse *Lagopus lagopus scoticus*. However, the conflict between commercial grouse moor management and the conservation of legally protected raptors, particularly the hen harrier, is one of the most challenging conservation issues in the UK. Langholm Moor, a grouse moor in south-west Scotland, has been in the focus of research trying to resolve these conflicts since 1992. Between 1992 and 1996 numbers of breeding hen harriers and peregrines increased, and raptor predation was shown to remove large proportions of both adult grouse and chicks, thus reducing autumn grouse abundance by 50% within a single breeding season. As raptor predation prevented the recovery of grouse densities, shooting was no longer viable and grouse moor management ceased in 1999. The resulting abandonment of heather burning and predator control (2000–2007), accompanied by an intensification in sheep grazing, lead to further declines not only in the abundance of grouse, but also of harriers, waders and habitat quality, and a significant reduction in breeding success of both harriers and grouse. Since 2008, the Langholm Moor Demonstration Project aims to re-establish Langholm Moor as a driven grouse moor while maintaining a viable population of hen harriers by resuming habitat management and predator control. To mitigate the impact of harriers on grouse chicks, all harrier broods are provided with diversionary food from hatching to fledging. By 2014, both hen harrier numbers and their breeding success had increased significantly, however, grouse and waders have not recovered as expected. Predation by raptors seems to be a major contributor to grouse mortality year-round, and we will discuss the relative impact of different raptor species and how other factors such as habitat or abundance of alternative prey might influence predation patterns.

Abstract No. 503

What life history trait do have a great effect on the population dynamics in Japanese Rock Ptarmigan?

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The knowledge of the life history trait that influence population growth is crucial information to conduct effective measure for conservation and management of endangered species. Although matrix model and sensitivity analysis are often used to evaluate the importance of several life history traits, there are few studies evaluate the consistency between the life history trait that show high sensitivity or elasticity in matrix model and ones having high relevance with actual change of population in alpine ptarmigan. In this study, the life history trait that influence population dynamics in Japanese Rock Ptarmigan which is the southernmost sub-species was evaluated by two methods; correlation analysis between the variation of territory number (from t to t+1) and life history trait in one years before (at time t) and matrix model based on the data through the studying period. The filed survey was conducted closed population on isolated mountain called Mt. Norikura from 2001 to 2014. Complete data set, that is, the change of territory number and 6 demographic parameters including clutch size and continuous survival from eggs to adult were estimated from 2008 to 2013. Japanese Rock Ptarmigan had lower young productivity and higher adult survival rate than other populations of Rock Ptarmigan and related species. The correlation between 6 demographic parameters and the variation of territory number was the highest in chick survival. The survival rate from hatch until one years old (including chick survival) also had the highest sensitivity by matrix model. On the other hand, elasticity was the highest in the adult survival rate. However, the parameter with the highest elasticity in certain matrix was affected by the value of survival rate from hatch until 1 year old. This result indicates that the value of chick survival determines on relative importance of adult survival to population dynamics.

Abstract No. 504

Population viability analysis of Wyoming Greater Sage-Grouse

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Greater Sage-Grouse (Sage-Grouse; *Centrocercus urophasianus*) populations occupy 56% of their historic range in North America. However, Wyoming remain a stronghold for Sage-Grouse, representing approximately 37% of species' current distribution. Research indicates widespread population-level declines have occurred due to habitat loss and fragmentation caused by agricultural conversion, energy development, urbanization, wildfires, invasive species, and woodland encroachment. Consequently, Sage-Grouse were petitioned for listing under the U.S. Endangered Species Act, with a ruling due September 30, 2015. With these concerns, we investigated trends for Wyoming Sage-Grouse populations. We developed three hierarchical scales of lek clusters using a minimal spanning tree algorithm informed from Sage-Grouse habitat surrogates and distances between lek locations. We then used population viability analysis (PVA) and tested several density-independent and dependent models within each cluster to account for migration between leks. With each model and within each cluster, lek count data (Wyoming Game and Fish Department) were used in the PVA after averaging the number of peak male counts per lek and per year. Counts were limited to those collected from 1993 to 2014, during March 1–May 31, and 30 minutes pre-sunrise to 90 minutes post-sunrise. The density-independent model resulted in lambda values (finite rate of population growth) of 0.98 statewide and <1.0 for four out of six cluster at the most course geographic scale (range: 0.97–1.03), <1.0 for 24 of 31 clusters at the medium scale (range: 0.90–1.09), and <1.0 for 14 of 21 clusters at the finest scale (range: 0.90–1.05). The density-dependent models reflected similar trends. Results indicate population declines during the study period. Clusters will allow managers to target populations that are in greatest need of conservation attention, based on our PVA and current and future threats on the landscape.

Abstract No. 505

Evaluating Vital-Rate Contributions to Greater Sage-Grouse Population Dynamics to Inform Conservation

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Population life cycle models that identify key demographic vital rates can optimize species conservation efforts. We used a long-term data set of radio-marked Greater Sage-Grouse *Centrocercus urophasianus*, an umbrella species in the sagebrush biome, to determine population dynamics that most influence population change for a tetraonid of conservation concern. Thus, policy makers and land managers may proceed with more certainty in management actions that improve populations and this ecosystem. We used data over a 12-year period from 180 females constituting 276 annual survival histories (after second year [ASY] females = 136; second year [SY] females = 140), to estimate temporal process (co)variation in vital rates and performed both prospective and retrospective perturbation analysis of a life cycle model. To evaluate our population model we compared estimates of the finite population growth rate (λ) from annual female-based matrices to estimates of λ from male-based lek counts. Our population demonstrated stability during the study period, with a mean λ not different from 1.0. Post-fledging (ASY, SY, and juvenile) survival contributed most to observed past variation in λ and had the greatest potential to change λ in the future, indicating these vital rates were important determinants of Sage-Grouse population dynamics. When sampling variation was removed, nest initiation and success variance was much reduced through time, suggesting these vital rates were buffered against environmental stochasticity despite their lower sensitivity and elasticity values, contradicting the theory of demographic buffering. Long-term demographic studies can provide increased certainty of the role of conservation actions in ameliorating species conservation threats. Our results suggest that current Sage-Grouse conservation efforts may need re-evaluation. There exists a pattern of short-term studies focusing primarily on drivers of nesting success. Only by considering the species' entire life-cycle, and possibly individual populations, can scientists determine critical vital rates for management. When we compared annual λ's from female-based and male-based data we found similar values and fluctuations, therefore providing evidence that spring lek counts of males were a valid index to population change and vital rate estimates from radio-marked individuals can be unbiased and used for assessing population change.

Abstract No. 506

Greater Sage-Grouse survival, reproduction, and habitat use following large-scale fire

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Of the seven North American grouse species, the Greater Sage-Grouse (*Centrocercus urophasianus*) is of particular conservation concern. A federal listing under the US Endangered Species Act is currently pending, and the species is already listed as endangered in Canada. Large scale wildfires may severely degrade Sage-Grouse habitat at the scale of multiple home-ranges, and the prevalence of such fires has been increasing across the range of the species for at least 30 years. Because Sage-Grouse exhibit strong site fidelity they may be susceptible to population level declines following large-scale habitat disturbance. However no published research has been conducted on the short term response of Sage-Grouse to large scale wildfire. We are investigating life history parameters and habitat selection of Sage-Grouse within an 187,000 ha fire, which burned in south-eastern Oregon, USA, during August, 2012. We captured 66 female Sage-Grouse within the fire perimeter and fitted them with GPS transmitters during 2013 and 2014. We used an information-theoretic approach to model daily nest survival and monthly survival of females during this period. We observed unusually low survival and reproduction, as well as unexpected patterns of nest habitat selection. Female survival during the first year post-fire was 31%. Nest survival increased from 20.6% during 2013 to 31.4% during 2014, and the effects of both nesting chronology and nest habitat composition varied between years. On average 21% of nests were located in burnt habitat each year, however apparent success of nests in burnt habitat increased from 20% to 83% between 2013 and 2014. We collected 51,616 Sage-Grouse locations during the study, of which 84% occurred within the boundary of the Holloway fire. Sage-Grouse are attempting to exist and reproduce within fire degraded habitat, and preliminary evidence suggests that survival and reproductive effort is improving as habitat within the fire affected area regenerates.

Abstract No. 507

Integration of genetic and demographic data to assess relative risk in animals with continuous distributions

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The identification and demographic assessment of biologically meaningful populations is fundamental to species' ecology and management. Although genetic tools are used frequently to identify populations, studies often do not incorporate demographic data to understand their respective population trends. As part of a multi-agency effort, we collected feather samples from Greater Sage-Grouse (*Centrocercus urophasianus*) leks from across their range (≈ 175,000 km²) in Wyoming and amplified DNA at 14 microsatellite loci for 1,761 samples. Subsequently, we assessed population structure in unrelated individuals (n = 872) by integrating results from multiple Bayesian clustering approaches (STRUCTURE, TESS, GENELAND) and used the defined boundaries to inform our assessment of long-term population trends and lek activity over the period of 1995 to 2013. Overall, we identified 4 unique genetic clusters in Wyoming and estimation of migration rates and consideration of isolation by distance (IBD) suggested demographic independence (< 10% immigration) for the 2 northern clusters. The southern clusters were not demographically independent and likely the result of IBD. We found that trends for the northwest population were statistically different from the other 3 genetic clusters over the 19 years and that northeast and southwest populations demonstrated a general trend of increasing proportion of inactive leks over time. Population change from 1996–2012 suggested positive population change in the southern populations and negative, or neutral, change in the northern populations. We suggest that Sage-Grouse populations in northern Wyoming are at greater risk than the southern population due to smaller census and effective population sizes and higher variability within populations. Our research is an example of the first step to incorporating genetic and demographic data and presents a novel approach for integration across multiple popular clustering algorithms.

Abstract No. 508

Intensive monitoring of short-term and cumulative effects of ski tourism on a Black Grouse population in a small winter recreation area

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The intensification of mountain sport activities on the Alps represents an increasing threat for the conservation of Black Grouse (*Tetrao tetrix*). During winter the Black Grouse has a fine-tuned energetic balance to cope with the weather conditions and the scarcity of food resources and human disturbance can determine costly energetic expenditures, physiological stress responses and consequently it can contribute to the decline of the populations. During winter 2014/2015 we monitored a Black Grouse population in Gran Paradiso National Park (Western Italian Alps). Our aim was to investigate the human-generated stress in a small winter recreation area and the variation of it during the course of the ski season. We established different routes, starting radially from the ski lifts that we walked regularly during the ski season. We collected approximately 450 droppings of free-ranging grouses from snow burrows. We mapped each of them with gps coordinates then we measured the distance from the nearest ski run, ski lift and snowshoes track. We investigated the effects of winter tourism on grouses on two levels, evaluating the spatial distribution of individuals as function of the skiers load and evaluating the physiological stress response, by measuring faecal concentration of corticosterone metabolites (%CM) in each sample through a black grouse-validated enzyme immunoassay, as function of the skiers load and the distance from the ski lifts. During the presentation we will show some preliminary results with the temporal variation of stress and spatial distribution on different temporal scales and in different periods of the ski season, corresponding to different loads of skiers.

Abstract No. 509

Have parasite-induced cycles in Red Grouse stopped and if so what next?

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Red Grouse *Lagopus lagopus scotica* shooting is a primary land-use in the British uplands, where gamekeepers manage habitat, predators and grouse parasites. On most moors in northern England grouse exhibited 4–5 year cycles in abundance. Experimental manipulations of the parasitic worm *Trichostrongylus tenuis* involving incorporating an anthelminthic drug into grit consumed by grouse identified worms as a cause of cycles through reducing grouse survival. Widespread use of this medicated grit as part of grouse management has dampened cycles, but not prevented them. Following a change in medicated grit formulation, together with a novel tray-based delivery system, in 2007, no obvious cycles have occurred, despite predicted crashes in 2009, and 2013–14. This apparent cessation in cycling was consistent amongst grouse at 25 long-term study sites in northern England. Since 2007, annual examination of parasites in shot grouse has shown two orders of magnitude fewer worms, i.e. from thousands per bird to now tens, less between-year variation in parasite abundance and, whereas before 2007 all grouse had worms, from 2008 onwards 51% (range 30–75%) did not. Hitherto, worms limited grouse densities, but in their virtual absence, mean grouse densities in July increased from 160 birds km^{-2} (2001–07) to 310 (2008–14). Elevated grouse densities have brought new problems. In 2010 the parasitic protozoan *Cryptosporidium baileyi* was diagnosed in grouse, resulting in respiratory cryptosporidiosis. By 2013, infection had spread to grouse on 50% of English grouse moors, with a mean 5% prevalence (range 1–9%). Survival rates in infected birds halved and breeding success reduced by 60%. However mean July grouse densities reached a further peak of 360 grouse km^{-2} in 2014. We discuss the implications of these extraordinarily high densities on grouse health and the wider environment.

Abstract No. 510

The role of chronic stress in birds in natural populations

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Chronic activation of the stress axis is caused by long-term uncontrollable and/or unpredictable factors in the environment. One implicit assumption that occurs in the literature is that birds and mammals are interchangeable in terms of their response to stressors, i.e. birds are essentially mammals with wings and thus the findings that apply to mammals have relevance to birds and *vise versa*. The evolutionary line of descent that led to birds and mammals diverged over 300 million years ago and may have caused the two to differ in terms of how they handle chronic stress. Alternatively the ecological problems they face that are likely to cause chronic stress (social conflict, food limitation, and predation) are similar and thus similarity in their stress response is to be expected. I will make four points in this talk. First, though most stressors are experienced as acutely and thus have no long lasting effect, chronic stress does occur in some birds species because of their specific ecological situations. Second, if the experience of being chronic stressed occurs, it does so because it is adaptive and predictive of the future. Third, the life histories and longevities of birds are such that, relative to mammals, the condition of being chronically stressed is less common in birds. Fourth, none of this applies recent anthropogenic stressors which are outside their evolutionary history, and thus the experience of being chronically stressed in birds is much more common now.

Abstract No. 511

Ecological and chemical factors influencing parasite loads in Sage-Grouse

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Herbivores are challenged with finding high quality food from available plants. Herbivores attempt to consume sufficient nutrients while avoiding plant secondary metabolites (PSMs) that act as potentially toxic chemical defences. PSMs often have adverse physiological effects on consumers, but such effects may be dose-dependent. For example, PSMs that are toxic at high doses can have therapeutic effects against parasites at low doses. We hypothesized that intake of PSMs that are not absorbed (i.e. excreted unchanged) will reduce intestinal parasite loads in vertebrate herbivores. Alternatively, because absorbed PSMs can compromise energy budgets and immune function, we hypothesized that intake of PSMs will increase parasite loads. To test these hypotheses, we analysed PSMs in sagebrush consumed, faecal excretion of PSMs, exposure to PSMs, and parasite loads in Greater Sage-Grouse (*Centrocercus urophasianus*) consuming sagebrush during the winter. We used gas chromatography to quantify PSMs in sagebrush and faecal samples. We used a colorimetric assay to quantify glucuronic acid (a detoxification conjugate) as a proxy of exposure to PSMs. We used the McMaster egg counting technique to quantify parasite loads of a Tapeworm (*Raillietina centrocerci*). We compared parasite loads among sites, seasons, and sexes of birds, as well as how parasites related to PSMs in food, excreted PSMs, and glucuronic acid output. There was a significant difference in parasite loads among different sites throughout southern Idaho and a trend for lower parasite loads in winter than in fall, and lower parasites loads in females than males. Animals excreting high monoterpenes have a low glucuronic acid loads exhibited high parasite loads. Therefore, exposure to PSMs may decrease immune function and allow endoparasites to persist. The interactions between PSMs and parasite loads may have profound ecological consequences because parasite loads and PSMs can both decrease body condition, fitness or mating success in free-ranging wildlife.

Abstract No. 512

Parasites of the Rock Ptarmigan *Lagopus muta* in Iceland

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The parasite fauna of the Rock Ptarmigan (*Lagopus muta*) in North-east Iceland has been studied since 2006. This is part of a larger research project on health and population change of the ptarmigan. The birds are collected in early October and the annual sample are 100 birds (age ratio ad:juv 40:60). For the period 2006–2014 we have parasite data for 908 birds (541 juv and 367 ad). Quantification of protozoans in this material is complete and also quantification for helminths and ectoparasites except for the 2014 birds. Seventeen parasite species have been identified, including 7 endoparasites and 10 ectoparasites. The endoparasites are: the protozoans *Eimeria muta* and *Eimeria rjupa*; the heterokontophyt Blastocystis sp.; the nematodes *Capillaria caudinflata* and *Trichostrongylus tenuis*; the cestode *Passerilepis serpentulus* and *tetrathyridium* (larval stage) of the Fox Tapeworm *Mesocestoides canislagopodis*. The ectoparasites are: the astigmatan feather mites *Tetraolichus lagopi*, *Metamicrolichus islandicus*, *Myialges borealis* and *Strelkoviacarus holoaspis*; the prostigmatan quill mite *Mironovia lagopus*; the ischnocerid feather lice *Goniodes lagopi* and *Lagopoecus affinis* and the amblycerid *Amyrsidea lagopi*; the flea *Ceratophyllus garei*; and the louse fly *Ornithomya chloropus*. Seven of these parasites (the eimerids, the astigmatan and the prostigmatan mites) were new to science, four further species (the heterokontophyt, the cestodes, the amblycerid) represent new host records. Analysis on age and sex-related infection prevalence, and intensities of the different parasites, and how this relates to population change, is in progress. The main results include significant changes in parasite measures among years, also juveniles carry more parasites than adults, and adult males less than adult females.

Abstract No. 513

Details on the parasite community of Icelandic Rock Ptarmigan and their potential impact on population dynamics

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The population density of Icelandic Rock Ptarmigan fluctuates in multiannual cycles with peak numbers c. every 10 years. How the ptarmigan parasite community acts and how parasites relate to ptarmigan age, body condition, and population density has been investigated in this study. The study is part of a PhD and embedded in the Ptarmigan Health Project that has been running since 2006. From 2006 to 2012 in early October, we collected 632 ptarmigan in northeast Iceland. Out of those, 630 (99.7 %) birds were infected with at least one parasite species, 616 (98 %) with ectoparasites and 536 (85 %) with endoparasites. The main factors associated with variation in the parasite community were host age and time. Juvenile birds carried overall more parasites than adults and there were distinct fluctuations in the course of the years of this study. Ptarmigan population density was associated with the coccidian parasites *E. muta* and *E. rjupa* in juvenile birds. Annual aggregation levels of these eimerids fluctuated inversely with prevalence, with lows at prevalence peaks and vice versa, and both prevalence and aggregation tracked ptarmigan population density with a 1.5 year time lag. This time lag can partly be explained by the host specificity of the eimerids and their persistence in and transmission through the environment (in faces) from one year to the next. Further, ptarmigan body condition was negatively affected at high intensities of *E. muta* and *E. rjupa* marginally, an indication for their pathogenicity. Our findings indicate that *E. muta* and *E. rjupa* conveying a negative impact on body condition in juvenile birds could act to destabilize ptarmigan population dynamics in Iceland. How the population parameters ptarmigan survival and fecundity are affected by parasites is under investigation. A likely alternative is that sub-lethal parasitism may act synergistically with predation and other factors to destabilize the ptarmigan population.

Abstract No. 514

Grouse-directed bioprospecting: A novel ecosystem service of sustaining healthy grouse populations and their habitats

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As human demands for natural resources increase, there is greater need to demonstrate the economic benefits of conserving biodiversity. Bioprospecting for new drugs from nature is one such economic benefit of maintaining biodiversity. Natural products have a long and successful history in combating pests and diseases in humans and in the agricultural industry. We hypothesize that the chemical arms race between grouse and their winter food source provides a co-evolving natural experiment occurring over millennia that has generated diverse and effective sources of drugs yet to be discovered for human benefit. We used the foraging behaviour (i.e. plant selection or avoidance) of Greater Sage-Grouse (*Centrocercus urophasianus*) and other herbivores that specialize on sagebrush (*Artemisia spp.*) in winter as a natural bioassay to direct us to plants with biologically active chemicals. We found that chemicals in sagebrush avoided by most herbivores are generally cytotoxic. We also found that herbivores specializing on sagebrush have several mechanisms of resistance to the toxic consequences of ingested plant chemicals. In addition, plants avoided by specialist herbivores had chemicals that inhibited mechanisms of chemical resistance and therefore could inhibit mechanisms drug resistance in agents of human diseases and in agricultural pests. Conserving the foraging behaviour of diverse species of grouse and the chemical diversity in their forage offers a unique ecosystem service of directing the discovery of new drugs. Although the obvious economic value of grouse-directed bioprospecting includes the commercial development of drugs, these benefits are often slow and rare outcomes. Therefore, our project focuses on the immediate ecosystem services of 1) multidisciplinary training of personnel in the countries that maintain grouse and 2) using outreach and ecotourism to convey to the public how local chemical diversity and sustainable harvesting of grouse can benefit human health and local economic development.

Abstract No. 515

Genetic diversity of White-tailed Ptarmigan *Lagopus leucura* in its peripheral range in New Mexico

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The White-tailed Ptarmigan (*Lagopus leucura*) is the only ptarmigan species endemic to North America. It was thought that White-tailed Ptarmigan had become extirpated from the very southern extent of its distribution in New Mexico, USA, and therefore birds from Colorado were translocated there in 1981. Survey efforts from 2007–2012 have shown that White-tailed Ptarmigan exist in at least three areas in New Mexico, albeit separated by distances of 40–60 km. We genotyped White-tailed Ptarmigan feathers collected in 2010 and 2012 from the Wheeler Peak, Pecos Wilderness, and the Vermejo Park Ranch areas to provide the first genetic analysis of this peripheral portion of the range. Our analyses revealed statistically significant genetic structure between and among these areas (overall Fst = 0.103) and significant and relatively high structure within the samples (Fis = 0.259). Gene diversity and allelic richness was highest in the Pecos Wilderness Area, where the translocation took place in 1981. Based on our evaluation of the genetic data, we surmise that the White-tailed Ptarmigan in New Mexico consists of only a few clustered family groups. Assessment of the genetic impact of the translocation effort of White-tailed Ptarmigan into New Mexico will next require comparisons with donor populations in Colorado. Hands-on management and monitoring of population sizes and genetic diversity will be critical lest the White-tailed Ptarmigan be extirpated from its southern outpost in New Mexico.

Abstract No. 516

What can population genomics tell us about ptarmigans?

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Population genomics is the large-scale comparison of DNA sequences among individuals in populations that studies genome wide effects to improve our understanding of phylogenetic history and demography of a population. Comparative genomics can provide an important comprehensive view of the relative importance of mutation, recombination, natural selection, and genetic drift in evolution in natural populations. Comparison of genomes of grouse can be useful to trace traits like adaptations to cold environments and behaviour associated with elaborate courtship. We have whole genome sequenced (WGS) the Rock Ptarmigan (*Lagopus muta*) and the Willow Ptarmigan (*Lagopus lagopus*) with next generation sequencing (NGS) Illumina technology, and assembled draft genomes using the annotated chicken (*Gallus gallus*) genome as a reference. We have also successfully performed genotype by sequencing (GBS) on a number of birds using the ddRAD method and mapped the variation to chromosomal locations and inferred adaptive evolution for these two ptarmigan species from the genome. Population genomics is becoming an exciting venue for the identification of genes and genomic regions involved in, for example, fitness-related traits and speciation.

Abstract No. 517

Red Grouse (*Lagopus lagopus scotica*) in Ireland and Scotland: Adaptive genetic differentiation and implications for conservation

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The key to understand the processes shaping genetic structure, such as local adaptation and dispersal, is to study the spatial distribution of genetic diversity among populations. However, these patterns may differ according to the applied genetic markers, as neutral markers reflect random genetic drift, whereas adaptive markers also reflect selection. In combination, neutral and adaptive markers allow us to assess the relative roles of drift and selection in shaping population structure. From a conservation perspective, this is essential for conservation priorities and the identification of management units. We here study genetic variation among Red Grouse from Ireland and Scotland. While Irish Red Grouse populations are fragmented and have been drastically declining, Red Grouse are abundant in Scotland. It has been therefore proposed to restock the Irish populations with Scottish individuals. We ask whether Red Grouse from Ireland and Scotland show significant divergence in adaptive genetic variation. If so, they should be recognized as separated evolutionary lineages for conservation purposes. For our study we use two different sets of genetic markers: we study adaptive genetic variation at three genes of the major histocompatibility complex (MHC) and neutral genetic variation at 257 single nucleotide polymorphisms (SNPs). We find significant population differentiation among Irish and Scottish Red Grouse at both neutral SNP markers (FST = 0.084) and adaptive MHC genes (FST = 0.116; 0.090; 0.104). Differentiation at one MHC gene was significantly higher than at the neutral markers, suggesting that selection plays an important role in shaping MHC variation, in addition to genetic drift. We speculate that the observed differentiation at adaptive genes might be due to local adaptation to different parasite regimes. These findings have strong conservation implications and we advise against the introduction of Scottish Red Grouse to supplement Irish populations.

Abstract No. 518

Whole genome sequence analysis reveals evolutionary history of extinct Heath Hen

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The Heath Hen (*Tympanuchus cupido cupido*) was extinct on the mainland USA by 1870, and by 1890, only 200 individuals survived on Martha's Vineyard, an island ~6.5 km off the coast of Massachusetts. For the next forty years, efforts were made to prevent its extinction, but the population never exceeded 2000 individuals, with reproduction ceasing after 1924. The last living Heath Hen was observed on 11 March 1932. Despite tremendous effort to prevent its extinction, the Heath Hen's demise was due to multiple factors including habitat loss, over-exploitation, disease, and fire. Recent research in "de-extinction" has stimulated interest in the Heath Hen as a candidate species, but its validity as a candidate requires first resolving uncertainty about its demographic history and most recent common ancestry. Mitochondrial sequence data suggests that the Heath Hen is as divergent from its conspecific, the Greater Prairie-Chicken (*T. c. pinnatus*) as it is from the Lesser Prairie-Chicken (*T. pallidicinctus*) and Sharp-tailed Grouse (*T. phasianellus*), two morphologically and behaviourally distinct prairie grouse species. A recent study investigating the phylogenetic relationships among extant prairie grouse identified sex-biased introgression among species depending on marker type (mtDNA, autosomal, and Z-linked) suggesting that sexual selection has played an important role maintaining species boundaries in areas of sympatry in the Midwestern US and Canada. Here we use whole genome analysis to investigate the evolutionary history of the Heath Hen with samples collected from both the mainland and Martha's Vineyard. Species tree analyses will be conducted using genomic sequence data from all extant prairie grouse species including the critically endangered Attwater's Prairie-Chicken (*T. c. attwateri*). These results will be useful for assessing the distinctiveness of the Heath Hen and provide insight on both genomic and demographic factors that may have contributed to its extirpation.

Abstract No. 519

Identifying sagebrush species and sub-species through near infrared spectrophotometry

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Herbivores are extremely sensitive to the chemical composition of their food sources. Composition can vary significantly among species, sub-species, and populations of plants. Variation in the phytochemistry of sagebrush (*Artemisia spp.*) has been shown to influence foraging behaviour and habitat selection by a number of vertebrate herbivores including Greater Sage-Grouse (*Centrocercus urophasianus*). Our goals were to identify spatial and taxonomic variation in the chemical composition of sagebrush and assess the potential for near infrared (NIR) spectrometry to detect that variation. We analysed phytochemistry and spectral data of sagebrush known to vary in palatability for Sage-Grouse. We used standard chemical assays to quantify crude protein, monoterpenes, and total phenolics among species, sub-species and populations of sagebrush growing across the landscape and in a common garden. We used a portable NIR spectrophotometer to collect spectral data from these same plants. Spectral data were used to develop indices capable of differentiating species and subspecies. Our results demonstrate that NIR is capable of identifying variation in phytochemistry of sagebrush and therefore palatability of forage for herbivores. Scaling up collection of NIR spectra with other remote sensing platforms (e.g. unmanned aerial vehicles, fixed wing aircraft) will allow researchers to better map the distribution of plants that provide quality cover and food for ongoing conservation and management of threatened species.

Abstract No. 520

Acoustic active space of Rock Ptarmigan songs

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In animal communication, the "active space" refers to the distance over which a signal can be perceived by a receiver, and is usually studied in unidirectional way. However, natural communication networks are often complex and imply several receivers. As constraints of sound propagation are different according to direction, the notion of "active space" need to be extended. Here we investigated the 2D-active space of Rock Ptarmigan (*Lagopus muta, Gallinaceae*) songs, using propagation experiments and GIS sound propagation modelling. Ptarmigans vocalizations were recorded in the French Alpine and Pyrenean populations. They were broadcast within several directions and recorded at 1, 25, 50, 100, 200, 300, 400 and 600 m under different weather conditions. The direction- and weather- dependent degradation of the propagated signals was assessed by the analyses of the signal-to-noise ratio and of temporal and spectral correlations. Rock Ptarmigans produce short songs containing three pulse trains. These vocalizations didn't express the same degradation pattern under the different weather conditions and within the different directions tested. A software-based approach was used to build the 2D-active space of the signals in each case. The knowledge of the 2D-active space of an acoustic signal may help to understand in a more realistic way the complex natural communication networks. It can also be applied to the monitoring of species like Rock Ptarmigan, which are counted at sampling points by human acoustic detection, enabling managers to know the area covered by the songs. Moreover, the active spaces of specific pieces of information encoded in a signal, such as vocal individuality or motivation, could be similarly investigated.

Abstract No. 521

New field tools to diagnostic Black Grouse habitat in French Alps

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In the Alps, Black Grouse is exposed to several threats such as brood habitat damaging due to unsuitable farming practices or/and increase of human disturbance through winter sports. In order to develop black grouse-friendly practices we developed two field tools to diagnostic their summer and winter habitat. The first occurred during summer and consist in a description of brood habitat based on vegetation characteristics (e.g. field cover, presence/absence of specific plants) within 1 ha-unit. From this diagnostic a spatial representation of the habitat quality is provided which can support decision making for field management (e.g. alpine meadows or heath-lands restoration by control of domestic stocks or by mechanical means). In the winter diagnostic, two stages are needed. The first consist in mapping leisure activities by recording all different ski tracks noticed during winter. The second stage occurs in spring, during snow melt, and consists in mapping winter distribution of Black Grouse through signs of presence such as winter droppings. Combining information from these two stages, allow us to identify and locate disturbance issues for implementation of winter refuges.

Abstract No. 522

Habitat suitability for Hazel Grouse on the Western Alps and definition of ecological corridors network between Italy and France using circuit theory

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The Hazel Grouse (*Bonasa bonasia*) is listed as Least Concern in Italy, Near Threatened in Switzerland and Vulnerable in France. On the Italian Western Alps the species has disappeared from the end of XIX century. In France, in an area close to the Italian border the Hazel Grouse is present and in recent expansion, therefore the individuation of areas that act as ecological corridors for the connection with the French areal of the species is a key factor for the conservation of it, in particular because of its low dispersal rate. Habitat suitability models represent one of the most useful tools in wildlife management, particularly when models can be used to provide spatially explicit tools as distribution maps and to design a connectivity network. We used presence data of the species to individuate the potential distribution and the most suitable areas on both sides of the border. Subsequently we implemented a connectivity model applying the electrical circuit theory to individuate the best ecological corridors between suitable areas, in particular the connections between protected areas. As result we obtained information on more levels. The habitat suitability model provided information about the habitat variables that positively or negatively affect the probability of presence of the species, therefore the habitat suitability. The application of the model to the alpine territory between Italy and France allowed us to predict the potential distribution of the species. Finally the circuit model allowed us to individuate the best ecological corridors between suitable areas.

Abstract No. 523

A comparative study of White-tailed Ptarmigan densities and survival from monitored populations in Montana and Colorado

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The White-tailed Ptarmigan (*Lagopus leucura*) is an alpine-endemic species occurring in western North America thought to be highly vulnerable to climate warming. Populations are not expected to react equally across a species' range as they are impacted by a variety of factors external to climate. We analysed time-series data on density and survival of two Colorado populations and one Montana population to assess if temporal trends differ between populations in the southern range and the northern core range. Breeding densities were estimated by surveying study areas and broadcasting male territorial calls to locate birds in the spring and summer. Individual markings were used identify birds and to construct encounter histories for survival analysis. At Logan Pass, Montana, breeding densities continuously declined over the periods 1958–1962 (mean = 9.52 birds km^{-2}), 1995–1998 (mean = 5.18 birds km^{-2}), and 2011–2014 (mean = 4.41 birds km^{-2}). Survival generally declined over the same periods: 1958–1962 (males = 0.78, females = 0.65), 1995–1998 (males = 0.80, females = 0.53), and 2011–2014 (males = 0.50, females = 0.36). At Mt. Evans, Colorado, there was a marginally insignificant increase of breeding density ($P = 0.05$; mean = 6.64 birds km^{-2}) but no change in survival (males = 0.64, females = 0.56) from 1968–2012. At Rocky Mountain National Park, Colorado, densities declined significantly ($P < 0.01$; mean = 8.57 birds km^{-2}), but survival did not change (males = 0.76; females = 0.62) from 1968–2000. Our results provide evidence for differing population dynamics among three ptarmigan populations in habitats that are relatively undisturbed from humans. Potential mechanisms underlying these differences include habitat effects of climate change and habitat alteration from ungulates as each population has experienced varying levels and forms of disturbance.

Abstract No. 524

Seasonal survival and causes-specific mortality of Rock Ptarmigan *Lagopus muta* at the southern margins of its distribution range

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There are now compelling evidences that Rock Ptarmigan numbers have declined during the last decades at the southern margins of its distribution range. Such a decline may be induced by low survival, a fundamental component of grouse population dynamics and understanding the mechanisms that affect survival is important for their conservation. We investigated survival rates and cause-specific mortality of Rock Ptarmigan in the French Alps and Pyrenees from 2000 to 2014. We radio-monitored 227 individual Rock Ptarmigan on two study areas, and reported 121 cases of mortality classified into five categories: raptor or mammalian predation, undetermined predation, other causes (climatic events, disease, collision), and unknown causes. Data were analysed on a monthly basis using multi-event Capture-Recapture models using E-surge. The model structure allowed estimating both survival probabilities and cause-specific mortality proportions. We tested the effects of age, sex, season, year and site on survival and cause-specific mortality. The best model (lowest AIC) explaining the variations in survival probabilities included the additive effects of sex, season and site. No yearly variations were detected on survival probabilities except a marginal positive trend in winter survival. For all sex and age classes, monthly survival probabilities (Ψ) were lower in the Alps than in the Pyrenees and in both areas, the seasonal survival rates ranked as follows: Ψwinter > Ψautumn > Ψbreeding . In all areas and seasons, the survival rates of adult males were greater than those of adult females and the survival rates of juveniles in autumn and winter were slightly lower than that of adults. In the Pyrenees, predation by raptors was the main cause of death (54%) of adults and juveniles both during the breeding and dispersal periods while in the Alps the causes of death were more balanced. Although the survival estimates reported in this study are among the highest known for this species, we discussed whether this survivorship may allow the long-term persistence of these southern populations of Rock Ptarmigan.

Abstract No. 525

Brood survival of Chinese Grouse at Lianhuashan, Gansu, China

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The low survival rate of chicks has been proposed as an important factor on variability of Chinese Grouse (*Tetrastes sewerzowi*) population at Lianhuashan, Gansu, China. Using proportional hazard regression model (COX model) we estimated the effects of mean egg volumes and hatching dates on brood survival. We tracked females with broods from hatching to brood break up in brood rearing period, 2010–2012. Brood survival was used as dependent variable. Totally 1142 brood day was obtained from 29 hens with broods in all three years. Mean brood survival length of life was 33.4±33.7 (SE) days. Broods survived to 10, 30, and 50 days post hatching was 0.65±0.09, 0.55±0.09 and 0.41±0.09, respectively. 0.38±0.09 of broods survived until brood break up in fall. Model regression results indicated egg volume (β=0.048±0.07, P=0.496) and hatching date (β=0.217±0.26, P=0.404) had no effect on brood survival of Chinese Grouse. More researches on this subject are needed in future to improve breeding success of Chinese Grouse.

Abstract No. 526

Timing of incubation breaks and predation risk for nesting Greater Prairie-Chickens

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Nest attendance behaviour is a critical but understudied component of avian ecology that can influence nest survival and productivity. Birds that provide uniparental care during incubation and brood-rearing must balance benefits of potential reproductive success with the costs of physiological requirements and predation risk. We used video cameras to monitor nest attendance behaviour of female Greater Prairie-Chickens (*Tympanuchus cupido*) in northcentral Kansas, USA. The primary objective of our study was to determine whether timing of incubation breaks was driven by physiological requirements of females or predation pressure. We predicted that breaks would not coincide with predator activity if break timing was driven by predation pressure. Our nest attendance analyses included 5,904 hours of video footage from 25 nests during 2010 and 2011. Females exhibited high incubation constancy (% of 24-hour period spent incubating a nest; ~95%) and typically took two ~40-minute breaks per day: one break 1–3 hours after sunrise and a second break during the 2-hour period before sunset. We documented 24 nest depredation events from a total of 33 nests. Mesocarnivores were responsible for 75% (18 of 24) of nest depredations, 21% (5 of 24) were by snakes, and none were by avian predators. A majority of nest losses (75%) occurred during crepuscular or overnight hours. Coyotes (*Canis latrans*, n = 9) were the most common nest predator and also killed two incubating females. Timing of incubation breaks did not coincide with avoidance of predator activity in our study system. We conclude that the bimodal pattern of incubation breaks observed in most grouse species is likely driven by physiological requirements of the female rather than predation pressure. Female Greater Prairie-Chickens appear to prioritize their own metabolic needs and future reproductive potential over current nest survival.

Abstract No. 527

Minimum sampling effort to achieve reliable population size estimation in Capercaillies (*Tetrao urogallus*): a pilot study

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In the frame of the Grouse Action Plan in the Ain department (France), the Réserve Naturelle Nationale de la Haute Chaîne du Jura (RNNHC) and the Office National de la Chasse et de la Faune sauvage (ONCFS-CNERA) are in charge to establish the monitoring of Capercaillies (*Tetrao urogallus*). First, a pilot study (this poster) is conducted to define a sampling scheme that could be applied in a second step to the entire department. This program could later be extended to other parts of the Capercaillie distribution range in the Jura Mountains (France and Switzerland). The selected site for the pilot study covers an area of 380 hectares and hosts a Capercaillie population of medium density. Seven agents followed linear transects spaced every 40 meters (28 transects) to collect Capercaillie droppings. A first sampling was performed on fresh snow, when droppings accumulated over less than 5–6 days are visible. A second sampling was conducted on melting snow when older droppings are visible. Female wintering sites were found at higher elevation than those of males. As a consequence of the strict sampling design (linear transects), several direct and indirect evidence of female presence were found in zones identified as unsuitable for Capercaillie and that agents would have avoided if given the choice. Our results suggest that wintering habitats of females is likely to be overlooked during prospections. This methodological bias may explain the lower detectability of females reported in several studies. We can already conclude that linear transects are a valuable method to monitor Capercaillie populations. Genetic analyses of the droppings collected during the two occasions will provide valuable information on the density of Capercaillie. Simulations will be conducted to determine the minimum sampling effort required to achieve reliable estimates of the number of individuals.

Abstract No. 528

Estimating population size and trend of Capercaillie at mountain range scale using Bayesian statistics

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A recent French action plan about Capercaillie required a reliable estimation of the population size and trend for the Pyrenean population, distributed on 5125 km². We designed a sampling strategy and modelling in a database of the 575 known leks (known to have been active during the 30 last years), separating that were known to be still active (AKL), and that where we did not know if they were still active (UKL). Some additional leks were unknown (UL). We hierarchically structured the mountain range at 4 scales: the entire French Pyrenees, 6 bioclimatic regions, 25 smaller natural regions, and 85 natural units (habitat patches) (NU). Within each bioclimatic region, we drew a sample of NU, where we counted the number of cocks in all the AKL and on a random sample of the UKL of the NU. The number of cocks on unknown leks was estimated superposing a 2×2 km grid to the each sampled NU, and sampling 5 grid cells per NU. We prospected a part of them, looking for leks, and mapping the prospected areas. We then estimated the population size at the various scales with a Bayesian hierarchical model mimicking the hierarchical structure of our data. The detection probability of an unknown lek was tested on the field. We accounted for the imperfect detection of cocks during counting with a mixture model which was possible thanks to the repeated counts carried out in some leks. The field monitoring needs 2 years, which enabled the estimation of the number of cocks on the known and unknown leks, at the 4 spatial levels. The model accounted for the temporal autocorrelation in the number of cocks, which allowed obtaining more precise estimates. The 80% credible intervals are narrow enough at the 3 higher spatial scales to enable the definition of a sound conservation policy.

Abstract No. 529

Comparison of autumn food habits of Rock Ptarmigan *Lagopus muta* in North-east Iceland from 2006 to 2014

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A fundamental part in understanding herbivore-plant interaction is knowing the food selection of the herbivore. Our study is a part of a long-term research program on health and population change of the Rock Ptarmigan in Iceland that started in 2006. Annually 100 birds collected in the first week of October are analysed (age ratio ad:juv 40:60, sex ratio for juv 50:50). We had food data (crops with vegetation) for 680 birds 2006–2014. The food from each crop was separated according to species and parts (12 types were recognized) and oven-dried to a constant weight. Dry mass was used to describe importance. Our research questions were: (1) what species and parts are the birds feeding on; and (2) is there a difference with respect to age of the birds, location (here altitude) and year. A total of 80+ species were identified but some few species dominated including *Dryas octopetala*, *Empetrum nigrum*, *Betula nana*, *Vaccinium myrtillus*, *Vaccinium uliginosum* and *Salix herbacea*. Important plant parts were fruits, shoots with buds, catkins, seeds and leaves. To study changes in diet we used a MANOVA and reduced the number of species to 6 groups and plant parts to 5 groups. Difference in diet, both with respect to species and parts consumed, depended on year and altitude but not on age.

Abstract No. 530

The prevalence of calcium oxalate crystals in kidneys of Rock Ptarmigan in North-east Iceland 2006–2014

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A long-term study on the health and population change of the Icelandic Rock Ptarmigan (*Lagopus muta*) began in 2006. In the first week of October each year, 100 ptarmigan (60 adults, 40 juveniles) are collected in North-east Iceland for the project. One of the factors measured is the occurrence of calcium oxalate crystals in kidneys. The ptarmigan acquire the oxalate from feed. Data for the years 2006–2014 was used to address the question how prevalence of calcium oxalate crystals relates to the age of the birds, the sampling year and the population cycle of the ptarmigan? A total of 834 kidney samples were analysed (juveniles: 246 males and 247 females; adults: 203 males and 138 females). Calcium oxalate crystals were quite prevalent among the ptarmigan (21%). It is not known from which plant species the birds acquire the oxalate. There was no age or sex related difference but a highly significant year difference (range 5–48%) and year*age interaction. There was no obvious relation between prevalence of oxalate crystals and ptarmigan population size. The lack of difference between the two age classes is interesting. This suggests that either: (a) birds with kidney crystals suffer higher mortality rates than unaffected birds; or (b) birds with crystals are able to get rid of them.

Abstract No. 531

Are feather holes of Rock Ptarmigan associated with amblyceran chewing lice?

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Feather holes in wings and rectrices have traditionally been suggested to be feeding traces of chewing lice (mallophagans). Here we test the hypothesis that feather holes are related with amblyceran mallophagans in particular. We studied mallophagan infestations and holes in tail feathers of 537 ptarmigan collected in early October 2007–2012 in northeast Iceland. Tails of 80 birds (15 %) had feather holes, and for mallophagans 377 birds (71 %) had *Goniodes lagopi*, 270 (51%) *Lagopoecus affinis*, and 69 (13 %) *Amyrsidea lagopi*. The prevalence of feather holes and *A. lagopi* did not differ, but the two other mallophagans were much more prevalent than the feather holes. Intensities of feather holes and *A. lagopi* were significantly positively associated; this held for the combined sample and the individual years. The two other mallophagans did not show such a relationship with feather holes. Holes were mainly found on the innermost tail feathers, and most were located in the distal part of each feather. Amblyceran mallophagans, such as *A. lagopi*, are known to feed among other on host blood drawn by biting pin feathers whereas ischnoceran mallophagans, such as *G. lagopi* and *L. affinis*, are mainly keratin feeders. Based on the observed relationships, characteristics of the feather holes, morphology of *A. lagopi* mouth parts, and known feeding habits of amblycerans, we conclude that feather holes observed in Rock Ptarmigan may have various origins, but most probably to do with the feeding activity of *A. lagopi* during the pin feather stage which is a novel finding for the grouse family and the genus Amyrsidea.

Abstract No. 532

Grit, Gizzard, Gut and Grouse – a study of the Icelandic Rock Ptarmigan (*Lagopus muta*)

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The Rock Ptarmigan (*Lagopus muta*) is a popular game-bird in Iceland and the population has historically shown cycles with a 10 year period. The ptarmigan feed on digestively resistant diet which is grinded in the gizzard with help of grit the birds ingest. The aim of this study was to: 1) investigate the grit characteristic (number, weight and morphology), gizzard mass and gut length of the Rock Ptarmigan in Iceland; and 2) test if there was inter-annual variation of the grit characteristic, gizzard mass and gut length; and 3) test if there were differences between sex and age classes of the birds. Further, the inter-annual variations, if present, were compared to the changes in the ptarmigan population density. The ptarmigans were collected during the first week of October 2006–2013. The number of grit and their weight was analysed for each bird along with the morphology parameters: size, ruggedness and roundness. Significant difference between the sex and age of the bird was detected for some of the grit variables and for the gizzard mass and gut length. Significant inter-annual variation was detected for all the grit variables. There was also a change in gizzard mass and gut length between years. These changes in the grit variables and in the size of the gizzard mass and gut length may reflect changes in the quality of the food the ptarmigans were consuming between the years. It is possible that these changes in the food affect the population changes.

Abstract No. 533

The epilogue of Holuhraun eruption – Fluoride accumulation in Rock Ptarmigan

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Iceland has many active volcanos. This fact has become more vivid to the inhabitants during the last few years with some major eruption events taking place. The last major eruption was at Holuhraun in the Central Highlands, starting on 29 August 2014 and ending on 27 February 2015. We all recognise the hazard of the immediate effect of volcanic eruption, but what is the long term effect on the wildlife? Many chemicals are released into the surroundings during a volcanic eruption, on solid and/or gaseous form. Some are toxic, while others are harmless. One of the toxic contaminants released is fluoride. When consumed by animals, the fluoride ion gets settled in bones and other calcium containing structures. In the case of long term high fluoride consumption, accumulation of fluoride in bones causes fluorosis. The main symptom of fluorosis is fragile and brittle bones, the bones may thicken and accumulation of bone tissue occurs. These symptoms may have serious effects on the survival of species dependent upon high tensile strength and low mass bones for flying. The presented project is focused on fluoride poisoning of Rock Ptarmigan in Iceland. Juvenile birds (c. 3 months old) were studied. We measured the fluoride content in radius and ulna in 23 juvenile ptarmigan from the east part of the country (Fljótsdalhérað) and 25 juveniles from the north-east part (Myvatn area). The birds were collected in the 1st week of October c. 35 days after the start of the Holuhraun eruption. During this first 35 days of the eruption the gas clouds from the volcano had mainly drifted to the east and the north-east had been little effected. There was a highly significant difference in concentrations of fluorine among the two groups. The birds from Fljótsdalshérað had an average of 929 mg F/g bone tissue (standard deviation 405 mg F/g) while the birds from Mývatn had an average of 362 mg F/g bone tissue (standard deviation 135 mg F/g). Little is known on the effect of fluoride concentration in bird bone tissue, or the tolerance of birds for fluoride pollution. This research is the first to address fluoride accumulation in Rock Ptarmigan.

Abstract No. 534

Bacterial microbiota of Rock Ptarmigan in Iceland

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The role of the microbiota in health and physiology of vertebrate hosts is an exciting area in microbial ecology. Birds harbour both pathogenic and non-pathogenic bacteria which may affect health and fitness. In this preliminary study we characterized bacteria from feathers and ceca of birds obtained from the ongoing longitudinal study "Rock Ptarmigan health and population change". Bacterial colonies were selected from nonselective aerobic and anaerobic cultures, as well as selective and enrichment cultures. Analysis of 16S rRNA gene sequences in conjunction with biochemical identifications revealed dozens of strains. A total of 48 strains were successfully sequenced among which 24 are distinct species. Thirteen isolates of feather degrading bacteria (*Bacillus* sp.) showed keratinase activity in a simple assay to determine keratin degradation in vitro. The ceca hosted various bacterial strains including *Bacillus* and *Micrococcus*. Microbial biodiversity in Rock Ptarmigan cannot be fully covered by cultivation methods. Therefore a more complete study needs to be carried out using metagenomics, that will also enable us to correlate microbiota with health parameters and its impact on the birds.

Abstract No. 535

Corticosterone derivatives in Rock Ptarmigan faecal material

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Corticosterone (CS) is one of the main metabolic hormones of birds and important for their health. The basic blood level concentration of CS has both a seasonal and a diurnal cycle. CS increases during periods of exercise and stress and this is added on top of the basic level. Normal stress response is important for the general health of the bird but long lasting exercise and stress can have negative effects. CS levels have been measured in Rock Ptarmigan in Iceland to study stress levels. This is part of a long-term research on Ptarmigan health and birds for this project are collected once a year in early October. It was not possible to draw blood from the birds for analysis therefore faecal material from the rectum was used. Metabolic derivatives of CS in faecal material were measured using antibodies and quantified as ng CS/g faecal material. This is thought to reflect CS production during the last few hours before the bird was collected. Samples for 2007–2011 have been analysed. The analysis shows that the concentration of CS in faecal material changed significantly between years and among sexes, age was not important. The concentrations were highest in 2008 and lowest in 2011. Males had higher levels than females. There were no relations between CS levels and either body condition or fat reserves.

Abstract No. 536

Comparative genomics and ddRAD: genotype – phenotype correlation in Rock and Willow Ptarmigans.

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Single nucleotide polymorphism (SNP) genotyping by double digestion restriction-site associated next generation DNA sequencing (ddRAD-seq) is a powerful approach to identify and genotype a large number of genetic markers. We use the ddRAD method for constructing a high-density genetic map aligned with our draft genomes for studying the genetic architecture of complex traits in Rock Ptarmigan (*Lagopus muta*). The study material was obtained from an ongoing longitudinal Rock Ptarmigan monitoring project in North-east Iceland. The Icelandic Rock Ptarmigan population cycles multi-annually, with peak numbers approximately 10 years apart where the difference in abundance between low and high numbers is 3–10 fold. For each bird the following set of data is collected; age, sex, food, anatomical measurements, body condition, activity of the immune system, activity of the fat gland and state of the plumage, stress levels and parasite load. Our preliminary results from ddRAD proof to be promising to investigate the relationships among functional genomic variation, ecological, and physiological parameters. We will also use ddRAD to carry out comparative genomics on different populations of Rock Ptarmigan and Willow Ptarmigan (L*agopus lagopus*) species.

Abstract No. 537

Characterization of the complete mitochondrial genomes of Rock Ptarmigan and Willow Ptarmigan

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We have fully sequenced and annotated the mitogenomes of the Icelandic rock ptarmigan (*Lagopus muta*) and the Willow Ptarmigan (*Lagopus lagopus*). The mitogenomes were obtained from a whole genome next generation sequencing with 70 fold coverage, using Illumina HiSeqTM 2000 sequencing system, followed by genome assembly carried out by CLC Main Genomic Workbench. The mitogenome sequences were further confirmed in selected areas by PCR and Sanger sequencing. The genomes of both species show great similarities in size and gene order, also when compared to other grouse. The genomes are 16.688 bp (*L. muta*) and 16.678 bp (*L. lagopus*) in size. Both genomes harbour a non-coding control region (D-loop), 13 protein coding genes (PCGs), 2 rRNA genes and 22 tRNA genes which is identical to most vertebrates. The longest PCG is ND4 whereas the shortest is ATP8. All genes are encoded on the +strand of the genome except for ND3 and eight tRNA genes.

Abstract No. 538

Reintroduction of the Capercaillie (*Tetrao urogallus*) from Wisła Forest District: genetic assessments of captive and reintroduced populations

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The aim of the study was a genetic characteristics of captive Capercaillie (*Tetrao urogallus*) population in Capercaillie Breeding Centre in Wisła Forestry District (CBC-WFD) as well as analysis of genetic diversity and population genetic structure of reintroduced wild grouse population in Bory Dolnośląskie Forestry (BDF). 58 individuals from CBC-WFD along with 81 faeces samples collected in BDF were analysed. A polymorphism of nine microsatellite loci and a fragment of mitochondrial Control Region (CR) were estimated. Genetic population structure was determined for wild and concatenated wild and captive populations as well as phylogenetic relationships between captive and reintroduced individuals with *T. urogallus* from other European countries were revealed. Microsatellite average allele number (NA) and expected heterozygosity (HE) were higher in captive population (NA: 6.3 vs. 5.3; HE: 0.755 vs. 0.675) and both populations were characterized by excess of heterozygotes. CR amplification revealed presence of six mtDNA haplotypes in Bory Dolnośląskie Forest and seven among captive founder population – in total, nine different mtDNA haplotypes were present. All mtDNA haplotypes presented in our study were located on the phylogenetic tree inside Eurasian clade. Population genetic structure analysis revealed presence of three distinct genetic clusters – one composed of individuals from Belarussian lineage and two among Western Carpathian individuals. Both analysed populations – reintroduced and captive, presented high level of genetic diversity, which implicates its high genetic potential and is a positive sign for their survival and the preservation of biodiversity. The experiment was supported financially by National Research Centre, NN 311 081040; participation in the conference by Wroclaw Centre of Biotechnology, program "The Leading National Research Centre (KNOW) of Wroclaw University of Environmental and Life Sciences for the years 2014–2018".

Abstract No. 539

Genetic drift, population structure and admixture in a reintroduced Capercaillie (*Tetrao urogallus*) population

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In 1976, the Parc National des Cévennes started a captive breeding program with the aim of reintroducing Capercaillie (*Tetrao urogallus*) in the Cevennes Mountains, whose species disappeared in XVIIth century, owing to total forest destruction. Following habitat restoration during the XXth century, 597 young hand reared birds were released from 1978–1994, enabling the establishment of a population of roughly 60 individual on the Montagne du Bougès and the Mont Lozère. These birds were a mixture of central European and Pyrenean clades. The released population declined from the outset until 2002. The release of 43 birds from an Austrian breeding station between 2002 and 2005 had little effect on the demography of the sub-population due to the low survival rate of these birds. Since the extinction of the sub-population on the Mont Bougès, in 2005 the only remaining sub-population is that on the Mont Lozère, which hosts approximately 50 individuals. We'll use samples collected in 2014 to estimate the level of genetic diversity and infer the genetic structure of the Mont Lozère sub-population. The second step will be to use reference population from the Pyrenees (*T. u. aquitanicus*) and from the Vosges/Alps (*T. u . major*) to quantify the contribution of the two subspecies to the allelic diversity of the extant Cevennes Capercaillie population. Samples are available for several founder individuals, and this will allow us to quantify the loss of genetic diversity since the population was released. The result of this study will be used to guide future management actions and in particular to decide on the suitability to reinforcing the population which has proved an efficient way of rescuing grouse populations.

Abstract No. 540

Capercaillie (*Tetrao urogallus*) recovery programme in the Bory Dolnośląskie Forest, south-western Poland

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In 2009–2014, 131 young Capercaillies (75 cocks and 56 hens) from Polish breeding centres were released in the Ruszów Forest District. Birds from the Kadzidłowo were reared using "born to be free" method. The adaptation were carried out in a special area (18 ha) where the Capercaillies were protected from terrestrial predators by fladry line and electric fence. 60% of birds were monitored by radiotelemetry. First month after release were survived by 87% of birds (97% of cocks and 80% of hens). In the first year, the mean survivability was 176 days (n=47) (cocks - 218, hens - 114). The better survival of "born to be free" birds results from the presence of mother in the place of release, significantly reducing migrations and mortality of young birds. The chief cause of mortality (74.5%, n=47) was predation, particularly by Northern Goshawk (*Accipiter gentilis L.*) (48.6%) responsible for as much as 68.4% of hen mortality. In cocks, the most essential factor (50%) was predation by Fox *Vulpes vulpes*. The living area of birds (100% MCP – Minimum Convex Polygon) is 1190 km² whereas in the last two years of the programme – 210 km². Since 2012 reproduction has been observed in nature. The key activity was the reduction of predators over the area of c. 840 km², as well as catching and translocating Goshawks. Auxiliary measures included the evaluation and improvement of habitat and education. The programme is co-financed by the European Commission under the project "Active protection of lowland populations of Capercaillie in the Bory Dolnośląskie Forest and Augustowska Primeval Forest" (LIFE11 NAT/PL/428).

Abstract No. 541

The effect of captive kept Capercaillie (*Tetrao urogallus L.*) stimulation method on semen quality

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Semen quality plays a crucial role in successful artificial insemination and creation of avian germ cells cryobank. It depends on many factors and semen collection method is one of them. Ejaculates were collected from 14 Capercaillie (*Tetrao urogallus L.*) kept in Capercaillie Aviary Breeding Center in Wisla Forestry, four time a week (with two day interval, and changing the order of stimulation), by dorso-abdominal massage and male stimulation by Capercaillie dummy female. During stimulation, the males' reactions were noted. In freshly collected ejaculates the following parameters were evaluated: volume, sperm concentration, motility and morphology. Out of 14 examined males, nine expressed positive reactions (completed with ejaculation) to both methods. With the dummy female method, the extreme behaviour of males was observed: the immediate, or after 30 seconds mounting on dummy and mating attempts (83.3% responses), frightening or aggression (16.7% responses). In case of massage method 91.9% of collections ended with ejaculation within 30 sec. The remaining attempts (8.1%) failed. Except sperm concentration (432.4 x 10^6 ml^{-1} ±314.8 with dummy female and 614.5 x 10^6 ml^{-1} ±429.5 for massage method), the collection method had no significant effect on the average values of sperm quality. So, both methods can be recommended for semen collection from Capercaillie however, significant ($P<0.05$) differences between individuals in reaction and semen quality were observed. The experiment was supported financially by National Research Centre, NN 311 081040; participation in the conference by Wroclaw Centre of Biotechnology, program "The Leading National Research Centre (KNOW) of Wroclaw University of Environmental and Life Sciences for the years 2014–2018".

Abstract No. 542

Potential distribution and effects of climate change on the Siberian Spruce Grouse

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The Siberian Spruce Grouse (*Falcipennis falcipennis*) is an endemic grouse restrictively distributed in eastern Siberian forest of Russia. In China, there were two former locations within the Xiaoxinganling Mountain, however, it was believed to be extinct as no evidence for its presence for more than 60 years. The bird is listed as threatened due to restricted total population size with ongoing declines, habitat loss, exploitation, and fragmentation. In this paper, we used the Maximum EntroPy Model (MaxEnt) to analyse the potential distribution of the bird, combined with 20 environmental factors. The total size of most suitable habitat for this grouse is about 102,321 km² with 2,667 km² in China. The accuracy of the model (AUC) is 0.905, and altitude, vegetation type and annual average temperature are the most important factors affecting the potential distribution of the bird. We also used BCC-CSM1-1 and GISS-E2-R models to predict the effects of climate change on the future range of this bird with two scenarios of RCP4.5 and RCP 8.5. The model suggests that the distribution range would decrease for 19.73% and 35.99% in 2050s and 2080s, with the geometrical center of the distribution range moving eastward. So the climate change would affect the Siberian Grouse seriously and we should keep making census of this bird and pay more attention on its conservation.

Abstract No. 543

Integrating habitat quality and spatial distribution assessments with extinction risk in high elevation forest of China

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Habitat loss and degradation are serious problems for wildlife population and biodiversity around the globe, while these effect and evaluation on high elevation population viability has seldom tested, we applied a resource selection function (RSF) model and a spatially explicit population viability analysis (PVA) model for the globally threated Chinese Grouse (*Tetrastes sewerzowi*) in a fragmented landscape in eastern border of Tibetan Plateau. We used these models to analyse habitat suitability, explore population monitoring protocols, and predict demographic trends to identify the conservation policy options that may best enhance population viability. Our RSF model yielded an estimate of 1,218 Chinese Grouse with greater densities occurring in lower, flatter areas with moderate forest cover. Our PVA model suggests that similar to lowland species, the population is highly sensitive to demographic parameters and the unsuitability of the surrounding landscape, and that small increases in the mortality of chicks or dispersing individuals could lead to extinction. We further suggest that enhanced connectivity, particularly among patches with large carrying capacities would be specifically helpful to ensure population viability.

Abstract No. 544

Prioritize conservation actions using a habitat model able to explain abundance of Capercaillie at large scale

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Because an action plan was started in 2012 at national level for the Capercaillie, we need a method in order to prioritize the conservation actions. Because the Pyrenees host 90% of the french populations and a subspecies very distinct from all others, we focalized on this mountain where 715 leks are mapped in our data basis, including 373 where the number of cocks was recorded during the last 4 years, which are used in this study. In order to prioritize the actions to reduce the limiting factors (habitat quality, disturbances, non natural mortality), we need first a suitable habitat model explaining the local abundance of Capercaillie at large scale. Because the mean spacing between neighbouring leks is 1400m, we measured some variables in 700m radius circle surrounding each 373 leks: the canopy cover, divided in 4 classes, the good brood habitats, and the parts of forest used by the birds in winter. We performed different analysis showing that the low and moderate and canopy cover are very well associated with the brood and wintering habitats. These 3 variables are positively correlated with the number of cock/lek, and explain more than 30% of the local variations in number of cock/lek. Because a habitat model based on canopy cover is relevant at large scale, we can now introduce other variables in the analysis. Amongst possible variables, we are collecting dataset about some well- limiting factors well identified by the literature, as forestry roads and paths, leisure areas, length of fences and dangerous cable, density index of red deer and wild boar. They will be crossed with the habitat model in order to evaluate their respective contribution in the local number of cocks/lek.

Abstract No. 545

Disturbance susceptibility of grouse: assessing the role of hunting

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Human disturbance can affect the behaviour and the physical condition of wildlife and may show in altered habitat use, shorter flight initiation distances, increased vigilance and stress hormone levels. Also grouse species have been shown to alter their behaviour in response to disturbances such as recreational activities. Thus, human disturbance has become a much discussed threat to wildlife. According to risk-disturbance theory (Frid & Dill 2002, Beale & Monaghan 2004) perceived predation risk is a major explanation for variation in the responses of wildlife, including grouse (Storch 2013), to encounters with humans. Thus, hunting by humans can be expected to be a major factor influencing the disturbance susceptibility of wildlife. To address these ideas, I develop a cooperative research project aimed at exploring the effect of hunting on the responses of grouse to humans. Grouse are excellent study species because they are found in many different environments. Combining empirical and experimental approaches, the project will test the hypothesis that grouse populations with a long and intense history of human hunting will show higher disturbance susceptibility as compared to populations that have never experienced much human persecution. As indicators of disturbance susceptibility flight initiation distance and stress hormone levels can be used and confounding variables such as habitat, season and hunting method will be taken into account. In my poster I will outline how the project will be implemented and in how far its results can be of use for the understanding and management of human disturbance of grouse.

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Abstract No. 546

Assumption and conditions of the Project LIFE11 NAT/PL/428 "Active protection of lowland population of the Capercaillie in the Bory Dolnośląskie Forest and Augustowska Primeval Forest"

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At the beginning of the 20th century, about 2500 Capercaillies lived in Poland; at present, the total population is estimated at ca. 380–500. In 2012, the European Commission approved the project "Active protection of lowland populations of Capercaillie (*Tetrao ruogallus L.*) in the Bory Dolnośląskie Forest and Augustowska Primeval Forest" for financing in 2012–2018 (LIFE11 NAT/PL/428). The overarching objective of the project is to restore two vestigial lowland populations of Capercaillie by: (1) Releasing 280–365 birds from Polish breeding farms and translocation 60–80 of wild birds; (2) Telemetric, traditional, genetic, and veterinary monitoring; (3) Reducing numbers of mammalian predators; (4) Improving and monitoring the living habitat of Capercaillies; (5) Reducing anthropogenic impact; (6) Environmental education and promotion. The project will be implemented chiefly in areas managed by the State Forest (810km² and 714km²) and is a challenging task in delivering an effective protection of endangered species in commercial forests. The implementation of the project will ensure protection and increase the numbers in two out of three Polish lowland populations of Capercaillie, which can result in an overall increase in the numbers of this species in Poland by 25–30%. The telemetric measurements used should provide data on survival and reproduction of birds bred by different methods and those translocated, and to evaluate their suitability in re-introduction. The effectiveness of various methods of monitoring and limiting the numbers of mammalian predators, as well as results of measures undertaken to improve the quality of habitats will be verified. Another effect of the programme will be the increased ecological awareness and knowledge of Capercaillie as well as of the Natura 2000 network among local communities. Experience gained during the project can then be used in the conservation of Capercaillie in other Member States of the European Union.

Abstract No. 547

Necklace-style radio transmitters associated with changes in courtship vocalizations of male Sage-Grouse

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Radio transmitters are used widely to track individual animals and monitor survival and habitat use. A fundamental assumption of radio telemetry is that transmitters are attached to a representative sample from the population, and that transmitters do not influence behaviours of marked individuals. However, transmitters can influence energy budgets, flight initiation and lek attendance in some species. These impacts may be mitigated by alternative attachment methods. Therefore, it is important to design attachment methods that minimize impacts to wildlife, especially when tracking sensitive species. Greater Sage-Grouse (*Centrocercus urophasianus*), a species of concern, have been tracked for decades using both rump-mounted and necklace-style transmitters. Necklace-style transmitters have detrimental effects on male lek attendance and survival in some areas. However, the behavioural effects of tracking devices on lek-attending males have not received adequate attention. We used spectrographic analysis of audio recordings to evaluate the effects of necklace-style radio transmitters (hereafter, collars) on the strut vocalizations of male Sage-Grouse. Males with collars had significantly lower maximum frequency of the primary whistle, higher minimum frequency of the primary whistle, a shorter whistle duration, and shorter duration of the second coo than males without collars. In addition, collared males produced vocalizations with lower maximum whistle frequencies than birds throughout the geographic range of Sage-Grouse. These results suggest that some collared males may have difficulty producing normal vocalizations during breeding. We are currently evaluating the impact of collars on strut rate of these same males, as this measure of display effort is a consistent correlate of reproductive success in this species. The impact of our observed changes in vocalization on fitness of collared males is undetermined. However, our results suggest that management agencies should consider both the direct (survival) and indirect (vocalization and strut rate) effects of tracking devices as a potential consequence of monitoring wildlife.

Abstract No. 548

Induction of behaviour leading nestlings and practical possibilities of using this phenomenon in the "born to be free" method

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Some years ago it was accidentally found that in forest grouse females (Black Grouse *Lyrurus tetrix*, Capercaillie *Tetrao urogallus*, Hazel Grouse *Bonasa bonasia* and ruffed grouse *Bonasa umbellus*) the instinct of leading nestlings can be induced without hatching eggs in both captive and wild females. Such behaviour can be created in a relatively short time (one to ten hours) by nestlings' voice stimulation. Similar results also occur when nestlings' voices that differ from their own species are used; e.g. in Black Grouse using Capercaillie, or even domestic chicks' voices. In monogamous species e.g. genus *Bonasa*, this stimulation can be obtained in both females and males and can be induced outside their reproductive seasons; e.g. in Black Grouse females, in October. The study of this mechanism can be of practical significance in breeding and reintroduction programs, particularly in the "born to be free" method, where the mother plays a very significant role. Induction leading behaviour was used in Kadzidłowo in order to obtain more Black Grouse, Capercaillie and Hazel Grouse mothers. Moreover, it can be used in wild females to improve results of translocation in order to get birds which in the future would make nests at the place of release. This phenomenon should also be explained according to its physiology.

Abstract No. 549

Preliminary results of wild Capercaillies translocation from Sweden to the Bory Dolnośląskie Forest, south-western Poland

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In order to increase numbers and genetic diversity in the Capercaillie (*Tetrao urogallus L.*) population restored in the Bory Dolnośląskie Forest, in May 2014, 14 wild hens were caught in the Arvidsjaur region of Sweden. The birds were caught for 3 days by nets thrown from a car driven along forest roads. After veterinarian examination they were placed in aviaries in their natural biotope. The birds were transported to Poland in by plane. All birds were given identification rings, and 12 birds – also telemetric VHF transmitters. In order to pass quarantine and acclimatize to local conditions, the Capercaillies lived 30 days in adaptation aviaries situated in forest. The preliminary outcome of translocation is very promising. The condition of hens was good (body mass 1.8–2.4 kg) and the loss of body mass was minor (6.5% on average). During the stay in quarantine aviaries, 7 hens set up nests, and 3 of them had offspring. No long-distance migrations of translocated wild birds in the initial period following release were noted. Thirty days after releasing the mean living area amounted to 1600±866 hectares (95% CI), whereas the distance from the point of release was 2±0.6 km (95% CI). The first death occurred 6 months after releasing (Fox predation), and the survival of wild hens is significantly higher than females from breeding centres in a comparable period. The results of monitoring confirmed integration of introduced hens with the local populations. At present, eight of translocated hens keep close to display grounds, which creates a major chance for their participation in reproduction. The programme is co-financed by the EU under the project "Active protection of lowland populations of Capercaillie in the Bory Dolnośląskie Forest and Augustowska Primeval Forest" (LIFE11 NAT/PL/428).

Abstract No. 550

Predation risk as a mechanism for effects of a wind energy facility on survival of female Greater Prairie-Chickens (*Tympanuchus cupido pinnatus*) in Nebraska, USA

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Recent development of the wind energy industry in North America has raised concerns about the potential effects of wind power facilities on prairie grouse. But, there is a gap in our knowledge of the mechanisms underlying the indirect effects of facilities on survival of prairie grouse, which limits our ability to make management decisions and direct species conservation strategies. The objective of our study was to investigate the indirect effects of a wind energy facility on the survival of Greater Prairie-Chickens (*Tympanuchus cupido pinnatus*) in the context of predation risk. Between March and July of 2013 and 2014, we investigated spatial variation in predation risk by estimating both mammalian and avian predator occupancy along a 10-km gradient directed away from a wind energy facility in Brown County, Nebraska, USA. We assessed spatial variation in daily survival rates of radio-marked hens along the same gradient. Site occupancy (Ψ) of avian predators was significantly lower within, compared to beyond, 2 km of the wind energy facility (≤2km: Ψ = 0.75, 95% CI = 0.54–0.88; >2 km: Ψ = 1.00, 95% CI = 0.99–1.00). In contrast, mammalian predators only showed weak avoidance behaviour within 0.5 km of the wind energy facility (≤0.5km: Ψ = 0.92, 95% CI = 0.61–0.99; >0.5 km: Ψ = 1.00, 95% CI = 0.99–1.00). Despite influencing the distribution of avian predators, distance to wind turbine had no effect on daily survival of female Greater Prairie-Chickens (βdist = 0.0001, 95% CI = -0.00003–0.00013. The potential for higher survival of prey species near wind turbines underscores the complexity of planning to address potential impacts of wind energy development.

Abstract No. 551

Use of multi-state mark-recapture models to assess Greater Sage-Grouse movements among leks

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Movements among leks by breeding birds are important because they could affect the population's genetic flow, complicate use of lek counts as a population index, and indicate a change in breeding behaviour following a disturbance. We used a Bayesian multi-state mark-recapture model to assess the daily probability of Greater Sage-Grouse (*Centrocercus urophasianus*, hereafter "Sage-Grouse") interlek movements and determine factors influencing movements including Sage-Grouse characteristics, weather, date, and lek characteristics. We fit 145 males with Solar Argos Global Positioning Systems Platform Transmitter Terminals over 4 years in Carbon County, Wyoming. The daily probability of a male Sage-Grouse moving among leks ranged from 0.69% [95% CI: 0.12%, 1.82%] in 2011 to 2.66% [95% CI: 0.70%, 4.54%] in 2013, indicating high daily fidelity for one lek throughout the season, although there was a 12.5% to 80.9% chance a Sage-Grouse would move at least once to another lek throughout the season. Interlek movement probabilities were strongly affected by date, peaking on 6 March. Interlek movements were positively associated with bird mass, sagebrush cover surrounding the lek, and elevation, and negatively associated with higher wind speeds. Interlek movements occurred more frequently than previously reported, and can bias lek counts in early spring as Sage-Grouse move from low to high elevation leks, which reinforces interlek movements as a critical component of lek ecology.

Abstract No. 552

Mapping fearscapes for grouse: high-resolution assessment of concealment from predators using remote sensing

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Grouse population densities are sensitive to predation by raptors and hunters. Vegetation can provide refuge from the risks of predation. As such, resource managers and conservation agencies are in need of effective and rapid methods that can assess the functional role vegetation plays in mitigating the risks of predation. Translating assessments of structural characteristics of cover into measurements of functional refuge can be difficult and resource intensive, particularly at increased spatial and temporal scales. Remote sensing technologies can rapidly measure the distribution and height of plants, and estimate functional concealment and visibility provided by the geometry of nearby vegetation. These emerging technologies offer the joint advantages of being comprehensive and scalable. We used terrestrial laser scanning (TLS) to map functional cover or a "fearscape" for prey. We provide examples of how TLS can be applied to model a changing environment associated with changes in climate or land management practices. In addition, we demonstrate how unmanned aerial systems can be used to expand these "fearscapes" to the landscape scale. Our findings demonstrate how high-resolution remote sensing technologies can revolutionize the way in which habitat quality is assessed and managed for wildlife.

Abstract No. 553

Saturation surveys for Lesser Prairie-Chickens in Oklahoma, USA

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The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) has experienced considerable declines in both population size and range over the past several decades, leading to a decision by the U. S. Fish and Wildlife Service to list the species as "threatened" under the Endangered Species Act in 2014. Although these declines have been evident, precise population estimates have been difficult, and even within their present-day range, portions are unsuitable or the species has been extirpated for various, sometimes unknown, reasons. To gain a better understanding of the current population size and occupied range of the species in Oklahoma, we conducted "saturation surveys" in 2010 and 2011 along accessible roads, composed of 214 survey routes. At each designated stopping point, habitat was assessed as being "suitable", "marginal', or "unsuitable", and listening for leks was conducted at those stops that were assessed as suitable or marginal. A total of 73 leks was located in 2010–2011. We estimate that 75–80% of the occupied range in Oklahoma was sampled. These surveys are being repeated in in 2015 and 2016, with minor modifications, including photo-points that can be compared to future surveys, and will be repeated again every 5 years in accordance to the Lesser Prairie-Lesser Range-Wide Management Plan. This will provide long-term population comparisons as well as document habitat changes. We will compare survey and habitat assessment results from 2010–2011 to the portions surveyed in 2015.

Abstract No. 601

Disturbance of wildlife by outdoor winter recreation: allostatic stress response and altered activity-energy budgets

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Anthropogenic disturbance of wildlife is of growing conservation concern, but we lack comprehensive approaches of its multiple negative effects. We investigated several effects of disturbance by winter outdoor sports on free-ranging alpine Black Grouse by simultaneously measuring their physiological and behavioural responses. We experimentally flushed radio-tagged Black Grouse from their snow burrows, once a day, during several successive days, and quantified their stress hormone levels (corticosterone metabolites in faeces [FCM] collected from individual snow burrows). We also measured feeding time allocation (activity budgets reconstructed from radio-emitted signals) in response to anthropogenic disturbance. Finally, we estimated the related extra energy expenditure that may be incurred: based on activity budgets, energy expenditure was modelled from measures of metabolism obtained from captive birds subjected to different ambient temperatures. The pattern of FCM excretion indicated the existence of a funnelling effect as predicted by the allostatic theory of stress: initial stress hormone concentrations showed a wide inter-individual variation, which decreased during experimental flushing. Individuals with low initial pre-flushing FCM values augmented their concentration while individuals with high initial FCM values lowered it. Experimental disturbance resulted in an extension of feeding duration during the following evening foraging bout, confirming the prediction that Black Grouse must compensate for the extra energy expenditure elicited by human disturbance. Birds with low initial baseline FCM concentrations were those that spent more time foraging. These FCM excretion and foraging patterns suggest that birds with high initial FCM concentrations might have been experiencing a situation of allostatic overload. The energetic model provides quantitative estimates of extra energy expenditure. A longer exposure to ambient temperatures outside the shelter of snow burrows, following disturbance, could increase the daily energy expenditure by more than 10%, depending principally on ambient temperature and duration of exposure. This study confirms the predictions of allostatic theory and, to the best of our knowledge, constitutes the first demonstration of a funnelling effect. It further establishes that winter recreation activities incur costly allostatic behavioural and energetic adjustments, which call for the creation of winter refuge areas together with the implementation of visitor-steering measures for sensitive wildlife.

Abstract No. 602

The first grouse genome: reference assisted assembly, evolutionary implications and future research

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In 2014 we published the first grouse genome: of a male Black Grouse (Wang el al. BMC Genomics 15: e180). This was developed using a reference-guided assembly strategy, meaning that we used the already published chicken genome to assemble our raw reads. We generated 133 Gbp of sequence data by the SOLiD platform and used a combination of de novo assembly and chicken reference genome mapping to assemble the reads into 4572 scaffolds with a total length of 1022 Mb. The draft genome well covers the main chicken chromosomes 1 - 28 and Z which have a total length of 1001 Mb. The draft genome is fragmented, but has a good coverage of the homologous chicken genes. Especially, 33.0% of the coding regions of the homologous genes have more than 90% proportion of their sequences covered. In addition, we identified ~1 M SNPs from the genome and identified 106 genomic regions which had a high nucleotide divergence between Black Grouse and chicken or between Black Grouse and turkey. Here I show how these data can be used to test hypothesis about genome evolution and also point at important future use of this genomic resource useful for research on Black Grouse genetics, conservation and evolution.

Abstract No. 603

Non-invasive genetic monitoring of Capercaillie (*Tetrao urogallus*) in the Vosges Mountains (France)

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In the Vosges Mountains, the Capercaillie (*Tetrao urogallus*) has been undergoing decline in both range and numbers during the past century, from an educated guess of 1100 males in the 1930s, to an estimated 50 males in 2002–2007. The extent species' distribution range is highly fragmented and mainly consists of four protected area covering approximately 6000 ha (6 % of its historical distribution range). The genetic monitoring of Capercaillie was set to quantify dispersal and gene flow among local populations, and to identify source- and sink-local populations. Since 2010, volunteers collected droppings and feathers across the species distribution range. Samples were genotyped at 20 microsatellite loci and an additional locus for molecular sexing. Out of 867 samples collected, 698 (80 %) were successfully genotyped which allowed us to identify 137 individuals. The number of individuals observed per year ranged from 46–85, with a sex ratio generally biased towards males. More than 80 % of the observed movements (= Euclidean distance between two locations where an individuals was observed) occurred within local populations. More males than females moved between local populations separated by distances 2–15 km, whereas the opposite was true for distances up to 33 km. Analyses of the genetic structure confirmed that males are philopatric and that females movements favoured gene flow among local populations. By reconstructing pedigrees, we could show that mating among close relatives is not rare, that juveniles could be recruited locally or disperse to neighbouring local populations and that several individuals moved between neighbouring local populations during the breeding season. In this study, we used non-invasive genetic sampling to better understand the dynamics of a fragmented population of Capercaillie. Our approach allowed us to quantify dispersal and gene flow, to estimate individual breeding success and to monitor juvenile dispersal.

Abstract No. 604

Population genetic structure in the Blue Grouse (*Dendragapus*) complex of North America

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We sampled over 700 individuals, representing 72 populations, of Sooty and Dusky Grouse to determine the pattern of genetic structuring throughout their range. Mitochondrial DNA sequences suggest the existence of four genetically differentiated taxa: sooty grouse along the Pacific Coast; northern and southern forms of the dusky grouse in the Rocky Mountains; and a well-differentiated population restricted to southwestern California. These genetic units roughly correspond to taxa previously recognized on the basis of plumage and behaviour; however, the extent of differentiation of the southern California taxon had not been apparent. In central British Columbia, there appears to be a long, narrow region of secondary contact between sooty grouse and the northern form of Dusky Grouse (*D. obscurus richardsoni*) at scattered higher elevation sites between the more continuous populations in the Coastal Ranges and in the Rocky Mountains. Genetic variation within populations varied greatly: several isolated populations were invariant, while hybrid populations possessed high nucleotide diversity. Although estimates of gene flow were relatively large between most populations within a taxon, there was significant differentiation among populations occupying the isolated mountain ranges of the Great Basin in the western U.S. Some of these latter isolates probably have small population sizes and may be of conservation concern given further climate change.

Abstract No. 605

A hybrid genome assembly for Gunnison Sage-Grouse yields insights into demographic history and genic evolution

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Gunnison Sage-Grouse (*Centrocercus minimus*) is an endemic species of the southwestern United States, where it currently occupies a fraction of its estimated historical range, prompting intensive conservation efforts to support remaining populations. While closely related to its parapatric sister species, Greater Sage-Grouse (*C. urophasianus*), they exhibit marked divergence in courtship behaviours and phenotypes and previous studies of neutral markers variation suggests the taxa are well-differentiated. To better understand the genomic consequences of the species decline, we assembled a high-quality reference genome for *C. minimus* based on a combination of sequence data from both short- and long-read sequencing platforms, integrated using a hybrid assembly approach that leverages the low error rates of short-read data to correct the more error-prone long reads prior to assembly. The resulting reference genome is characterized and used to evaluate patterns of genic evolution and genome structure in comparison to other gallinaceous species. Using pairwise sequentially Markovian coalescent modelling, we assessed evidence for changes in effective population size over time. The results are discussed in relation to landscape changes that may have precipitated contraction of the species range, and the potential for future genome-enabled management applications.

Abstract No. 606

Rangewide genetic analysis of Lesser Prairie-Chicken reveals population structure, range expansion, and possible introgression

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Effective management of Lesser Prairie-Chickens requires information about population connectivity and structure. Populations are declining due to habitat loss and fragmentation. Portions of the historic range, however, have recently been recolonized and even expanded due to the planting and maintenance of Conservation Reserve Program (CRP) fields that provide necessary vegetation structure. It is unknown which source populations are involved in the range expansion, which also has brought Lesser Prairie-Chicken into contact with Greater Prairie-Chicken offering the potential for hybridization and introgression. Our goals were to characterize connectivity and genetic diversity among populations, identify source population(s) of recent range expansion, and determine the level of introgression with Greater Prairie-Chicken. We analysed 240 samples from across the range using 13 microsatellite loci. We identified three or four distinct populations that were largely defined by ecoregion boundaries. The shinnery oak ecoregion harboured a significantly distinct population (FST >0.34) recognized by both STRUCTURE and GENELAND. The sand sagebrush also represented a distinct ecoregion, while the shortgrass/CRP mosaic and mixed grass ecoregions appeared admixed. Genetic diversity was similar among ecoregions and Ne ranged from 142 for the shortgrass/CRP mosaic to 296 in the mixed grass prairie. No recent migration was detected among most ecoregions, except from the mixed grass prairie north into the shortgrass/CRP mosaic (m = 0.207, 95% CI = 0.116–0.298). A STRUCTURE analysis investigating the area of overlap revealed K = 2 corresponding to the two different species. Several hybrids and "pure" individuals from both species appeared mis-assigned or admixed suggesting introgression between the two groups. Further, migration estimates suggest movement from both Lesser and Greater Prairie-Chicken in the Shortgrass/CRP into the hybrid group. As significant structure exists among ecoregions, continued monitoring of diversity within and among ecoregions is warranted. Management actions that promote genetic connectivity and range expansion may be critical to the long term viability of the species.

Abstract No. 607

Conservation status and threats to grouse worldwide: an update

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Ten years have passed since the IUCN Grouse Specialist Group (which is now part of the Galliformes Specialist Group) has assessed conservation status, population trends and threats of all grouse species worldwide. In 2005, based on questionnaire data compiled for the IUCN Grouse Action Plan (Storch 2007), information from most of the >50 countries within the grouse range were analysed in relation to species and geographic distribution. In this presentation, I re-assess the situation based on data from the IUCN Red List of Threatened Species as well as regional red lists, expert opinion, and published work. Even though the situation of the grouse as a sub-family is less critical than that of other Galliformes taxa, the overall situation has not improved since the assessment in 2005. Globally, among the now 20 species of grouse, 13 are considered safe (Least Concern) according to the IUCN Red List of Threatened Species. However, 18 of the 20 species have been reported to show decreasing population trends; only 2 species, Spruce Grouse *Falcipennis canadensis* and Franklin's Grouse *Falcipennis franklinii*, are considered stable. The situation is worst for the prairie grouse: the Gunnison Sage-Grouse *Centrocercus minimus* is listed as Endangered because of low population sizes, restricted range, and ongoing population decline. Similarly, the Greater *Typmanuchus phasianellus* and Lesser *T. pallidicinctus* Prairie Chickens are listed as Vulnerable. Another four species are listed as Near Threatened; these are yet another prairie grouse species, the Greater Sage-Grouse *Centrocercus urophasianus*, and the three species with the smallest distribution ranges, the Caucasian Black Grouse *Tetrao mlokosiewiczi*, the Chinese Grouse *Bonasa sewerzowi* and the Siberian Grouse *Falcipennis falcipennis*. I will summarize threats, population trends and challenges to grouse conservationists worldwide.

Abstract No. 608

Mountain forest grouse under climate change: compensating negative effects by increasing structural richness

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Species in mountain environments are expected to face a high risk of range contractions, if not local extinctions under climate change. Yet, most endothermic species are primarily not affected by physiological constraints, but indirectly by climate-induced changes of habitat quality. Forest grouse largely depend on vegetation composition and structure, deteriorating habitat suitability may thus be mitigated or even compensated by habitat management. We tested this possibility for two grouse species, the Capercaillie (*Tetrao urogallus*) and the Hazel Grouse (*Bonasa bonasia*), which are considered as indicators for complementary forest structural parameters and are of conservation concern in Central European mountain forests. Based on species data and environmental information collected at 300 1km^2-plots distributed across three mountain ranges in Switzerland and southwestern Germany, we investigated (1) how species' distributions as well as local occurrence were explained by climate, landscape, and vegetation, (2) to what extent climate change and climate-induced vegetation changes will affect habitat suitability, and (3) whether these changes could be compensated by adaptive habitat management. Species presence was modelled under current climate, and then extrapolated to the conditions of 2050, assuming the moderate IPCC-scenario A1B. Climate variables contributed significantly to explaining species occurrence. Expected climatic changes, as well as climate-induced vegetation trends, decreased the occurrence probability of both species, particularly of Capercaillie at the low-altitudinal margins of its distribution. These effects could be partly compensated by modifying single vegetation structure elements, but full compensation would only be achieved if several factors were changed in concert. The results illustrate the possibilities and limitations of adaptive species conservation management under climate change.

Abstract No. 609

Sage-Grouse as an umbrella species in northwestern Colorado

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Reduction in sagebrush rangelands has resulted in sagebrush avifauna population declines across western North America, triggering a need to better understand relationships between environmental characteristics and avifauna occurrence. Sage-Grouse may act as an umbrella species to manage for multiple species that rely entirely or partially on sagebrush rangelands, but the efficacy of such approaches is often assumed. Therefore, we surveyed Greater Sage-Grouse [GRSG] and sagebrush songbird habitat use in northwestern Colorado in order to create models of bird occurrence related to multi-scaled environmental features and determine the amount of habitat overlap between Sage-Grouse and three sagebrush-obligate songbirds (Brewer's sparrow [BRSP], sage thrasher [SATH], and sagebrush sparrow [SASP]). During May and June 2013–2014, we conducted standard point count breeding surveys for songbirds and GRSG pellet count surveys within a 10-m radius plot at each songbird point. We then modelled songbird or GRSG occurrence using remotely-sensed data, such as big sagebrush and herbaceous cover, to create generalized linear models and determine correlation in occurrence for GRSG and the three sagebrush-obligate species. Occurrence for GRSG, BRSP, & SATH increased with an increase in big sagebrush cover, but each species responded to a different scale of sagebrush cover and different non-sagebrush predictors. There was a high, positive correlation between GRSG and BRSP and SATH occurrence ($r > 0.75$). Occurrence for SASP increased with moderate amounts of big sagebrush cover, resulting in a negative correlation between predicted GRSG and SASP occurrence ($r < -0.25$). In our study area, GRSG may be an effective umbrella species for some sagebrush-obligate species, but SASP appear to use areas with less shrub cover. Given the potential federal listing of GRSG, land managers and biologists should have an understanding of how managing for GRSG habitat could affect other sagebrush avifauna species.

Abstract No. 610

The role of local working groups in Tetraonid conservation: sage lessons from Sage-Grouse

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Sage-Grouse (*Centrocercus spp.*) are restricted to the sagebrush (*Artemisia spp.*) rangelands of western North America. The distribution and abundance of Sage-Grouse have declined in the last 60 years. Currently, populations exist in only 10 states and 1 Canadian province. These declines have been attributed to anthropogenic land uses that reduced, eliminated, or fragmented sagebrush habitats. Worldwide many of the Tetraonids are experiencing similar fates as a consequence of anthropogenic influences. In 1996, Utah State University Extension, through the Community-Based Conservation Program (CBCP), in partnership with the Utah Governor's Office, federal, state, industry, and private partners began working with stakeholders to organize 11 community-based local Sage-Grouse working groups (LWGs) throughout Utah. The CBCP enhanced information flow and stimulated stakeholder involvement in incentive-based conservation. The CBCP assisted stakeholders in learning more about Sage-Grouse ecology as they implemented strategies to achieve species conservation, and community social and economic objectives. In 2013, the Conservation of Greater Sage-Grouse in Utah (Plan) was published. In February 2015, Utah Governor Gary H. Herbert signed an Executive Order (EO) to fully implement the Plan. The EO specifically credited the CBCP for conducting the baseline research and community involvement essential to building the Plan. Since 1996, the Utah's LWGs and their partners have restored over > 200,000 ha of Sage-Grouse habitat and protected over 94% of the state's Sage-Grouse populations in 11 Sage-Grouse management areas. Annually, the state of Utah has committed over $5 million to implementing LWG identified incentive-based conservation strategies. The success of the program was directly related to the early involvement of local leadership, CBCP facilitation, and access to emerging ecological and sociological research. The CBCP process has translated conservation planning and research to habitat management, and habitat management to population stability. We provide insights into a process for developing similar efforts to conserve other Tetraonids.

Abstract No. 611

Changing arctic ecosystems under a rapidly warming climate: Implications for grouse research

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The state of terrestrial arctic ecosystems, including most components of their biodiversity and ecosystem functions, will be liable drastic changes during the course of the present century since climate warming is projected to become most extreme in the Arctic. In this talk, I first summarize findings of those changes that already have taken place. One profound set of change drivers is altered winter conditions (especially snow parameters/cryosphere) that directly affects the population dynamics of tundra-dwelling herbivores. This changed herbivore population dynamics in turn have cascading impacts on a host of other species in the food web. I will also address ecosystem changes that has been attributed to earlier spring, warmer summers and later fall, all which are likely to affect grouse populations. Finally, I will outline challenges to future research and monitoring pertaining to grouse populations in the high north in an era when climate is likely to change more rapidly than in the past.

Abstract No. 612

Capercaillie Management – from science to practice

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In the Black Forest, Germany, an Action Plan for Capercaillie was implemented in 2008. The steps and difficulties of conversion are presented and the necessities of convincing the different interest groups (land owners, hunters, politicians, tourists, wind power enterprisers). Scientific results are a *conditio sine qua non* in this process of implementation, but they must be transferred in the right way.

Abstract No. 613

The impacts of noise on Greater Sage-Grouse: results and implications for conservation policy

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The impacts of noise pollution on wildlife have been studied less than many other consequences of human activities, but a growing body of literature suggests that noise impacts are significant and may disproportionately affect large-bodied birds such as grouse. We conducted a noise-introduction experiment to examine the impacts of noise from natural gas drilling and vehicle traffic on Greater Sage-Grouse (*Centrocercus urophasianus*). We found that noise was related to significant declines in male attendance at leks (29% decline with drilling noise and 73% decline with vehicle noise, compared to control leks). We also found impacts on individual males who remained at noise-playback leks, with elevated corticosterone metabolites in fecal samples indicating chronic stress, and changes in display behaviour. Taken together, these results suggest that noise can cause avoidance of otherwise suitable habitat and that birds remaining in noisy areas are also impacted by noise. In light of these results, we discuss problems with current noise stipulations and make recommendations for more effective noise management strategies for Sage-Grouse and other noise-sensitive species.

Abstract No. 614

Effects of Juniper encroachment and management on Sage-Grouse space use in southeastern Oregon: a comparison of VHF and GPS marked birds.

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Greater Sage-Grouse (*Centrocercus urophasianus*) have experienced declines due to numerous factors, as a result they are be considered for protection under the Endangered Species Act. One of the main factors thought to be loss and fragmentation of habitat caused by conifer encroachment in the western portion of their distribution. Little research has been conducted to specifically to evaluate the effect. Western Juniper (*Juniperus occidentalis*) distribution in the Great Basin has increased ~10-fold since pre-European settlement, but, although juniper management is becoming more widespread, there is a paucity of data regarding how juniper encroachment and management may actually affect Sage-Grouse. Our goal was to assess specific effects of juniper encroachment and management on space use at multiple spatial scales. We analysed high resolution spatial data of individual juniper trees and tree removal areas in southern Oregon. In 2015, we marked 25 female grouse with PTT/GPS transmitters and 25 females with standard VHF transmitters. We examine space use of these birds as it relates to areas in which trees have been removed since 2012 and areas they have not. This information will be vital in determining how conifer encroachment effects Sage-Grouse populations as well as informing management.

Abstract No. 615

Broad-scale population response of Greater Sage-Grouse (*Centrocercus urophasianus*) to grazing management and precipitation

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Populations of Greater Sage-Grouse (*Centrocercus urophasianus*), an obligate sagebrush (*Artemisia spp.*) species in North America, have declined in recent decades, and they are being considered for listing under the U.S. Endangered Species Act. One land use type implicated in the decline of this species is grazing, as herbaceous cover may be important for Sage-Grouse nesting and brood rearing. However, broader population response to grazing management has yet to be evaluated across large spatial extents. The Bureau of Land Management (BLM) currently oversees grazing on nearly 250,000 km² of sagebrush land, and their records provide a unique opportunity to assess Sage-Grouse response to rangeland management. We used grazing data collected by BLM from 3,414 grazing allotments in the state of Wyoming, USA, to test population response of Sage-Grouse to the timing and intensity of grazing, and interactions with precipitation. We used annual counts of displaying males from 801 lek sites (2004–2014) and modelled population trends using state-space models in a Bayesian framework. Preliminary results indicated a positive response to sagebrush cover, and a positive effect of grazing start date, particularly after drought years, suggesting that Sage-Grouse populations may benefit from delaying grazing until later in the growing season. While these trends remain to be tested at finer scales, our findings may guide future grazing management policies by BLM and other agencies, and suggest the potential for using Sage-Grouse as indicators of sagebrush rangeland health.

Abstract No. 616

Landscape level habitat selection of female Lesser Prairie-Chickens in western Kansas and eastern Colorado

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Grasslands are among the most imperilled habitats worldwide. Thus, all ecological processes within these fragile ecosystems are subject to disturbance and degradation. The deterioration of these ecosystems has jeopardized the status of many wildlife populations dependent on grasslands. This trend is evidenced within the Southern Great Plains of the United States by the decline of the Lesser-Prairie Chicken (*Tympanuchus pallidicinctus*; hereafter LPCH). As a threatened species under the Endangered Species Act, this grassland-obligate grouse is the target of increased conservation activities. We evaluated LPCH habitat selection during breeding and non-breeding periods among varying landscapes across the northern range of the species. Female LPCHs were trapped and fitted with either a 15-g VHF bib-style transmitter or a 22-g model 100 GPS Platform Transmitter Terminal (PTT) using a rump-style harness. Habitat use data within sampled landscapes were quantified using categorical (landcover) and continuous (anthropogenic structures and habitat patch characteristics) variables. Variables separating used and available locations were ranked by employing resource selection functions. Preliminary results indicate that Conservation Reserve Program (CRP) grasslands were selected over other landcover types (grazed lands and cropland). Furthermore, selected habitats were positively correlated with reduced levels of anthropogenic structure and greater patch size. As conservation efforts continue to increase for this imperilled prairie grouse, understanding habitat selection as landscapes change will be important for agencies to direct management actions across differential portions of the species range.

Abstract No. 617

Quantifying threats and evaluating conservation effectiveness for Lesser Prairie-Chickens

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The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) is a species of conservation priority because of long-term population declines and changes in available habitat; primarily type conversion of native prairie to other uses. With large acreages of Conservation Reserve Program (CRP) expiring and new limitations on total acres to be enrolled, in 2010, The Natural Resource Conservation Service (NRCS) initiated its Lesser Prairie-Chicken Initiative (LPCI) to retain these CRP fields as grassland and transform them into working lands. The LPCI was expanded to capitalize on 27 NRCS practices that can assist in addressing other threats to the species for example: woody encroachment, improper livestock grazing, and fence collision risk. We have implemented a 3-tiered approach to assessing the effects of LPCI on LEPC populations. Through these assessments, we are simultaneously using science based targeting tools to quantify the extent of a given threat and determine objectives to adequately reduce the threats. Tools currently under development include: tillage risk (including loss of CRP), fence collision risk, Eastern Red Cedar (*Juniperus virginianus*) encroachment, and Honey Mesquite (*Prosopis glandulosa*) encroachment. Additionally, detailed studies using radio-telemetry are providing insights to the effectiveness of conservation actions to improve habitat through grazing management, prescribed burning, and tree removal. We will illustrate the implementation of these targeting tools in the context of invasive woody species and a framework for meaningful threat reduction.

Abstract No. 701

Captive breeding and raising of Attwater's Prairie-Chickens for release into the wild, with experimental methodologies potentially applicable for breeding other Galliformes

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One of three extant prairie-chickens in the world, Attwater's Prairie-Chicken (APC; *Tympanuchus cupido attwateri*), historically found on the coastal plains of southern Texas and Louisiana, is one of the most endangered birds in North America. Numbers in the wild exist primarily at the Attwater Prairie-Chicken National Wildlife Refuge and vary from approximately 60–200 birds, depending on time of year. Annual post-release survival (0–43%) averages 17–19%, compared to 50% for wild produced prairie-chickens. Teetering on extinction, this bird survives as a result of captive breeding by wildlife parks and zoos and annual releases of offspring, but significant wild population growth has not resulted. Red imported fire ants have adversely impacted insect communities on which APC chicks feed, but viruses, protozoans, and phorid flies parasitic on the ants may provide help. Overall, mass propagation of captive Galliformes has proven to be complicated and difficult, and production of birds that show high survival and significant reproduction in the wild is a challenge. An annual release of larger numbers of high quality young is the goal. Utilizing original as well as a combination of techniques for breeding and managing captive ring-necked pheasants (Beaver's Game Farm), Houbara bustards (Emirates' Center for Wildlife Propagation), and APC (Fossil Rim Wildlife Center; Houston Zoo), the Sutton Avian Research Center is currently building a dedicated facility in Oklahoma focused on breeding APC for release. Experimental methods will include: 1) natural breeding in pairs and trios; 2) breeding of both human imprinted male and female APC; 3) female mate choice of copulating males. Other management methods will include use of "home grown" greens, sprouts, and insects, and hopefully wild grouse "gut flora." Greater Prairie-Chickens (GPC) will serve as surrogates initially to test efficacy of prospective designs and methodology.

Abstract No. 702

Relationships among forest management and Spruce Grouse (*Falcipennis canadensis*) patch occupancy and abundance estimates in the commercially-owned forests of Maine, U.S.A.

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Spruce Grouse (*Falcipennis canadensis)* populations are rare or declining across much of the contiguous United States, especially the Northeast region; however, the species has no official protection status, other than a closed hunting season, within the state of Maine. Commercially managed forests represent > 10 million acres in Maine and forest practices are likely the primary influence on patterns of occupancy and abundance of Spruce Grouse. We studied patterns of patch occupancy across 4 forest harvest treatments during the breeding season (May) in northern Maine from 2012–2014. During each year we conducted sets of three callback surveys in 30 stands representing uncut mature conifer, regenerating clearcuts, pre-commercially thinned stands, and selection harvests. The number of responding grouse was also recorded during each survey. We constructed single season occupancy models with years and stand type entered as groups. We model averaged across all univariate models with AICc scores greater than those of the null model and with significant beta values on the variables of interest. The overall probability of detection was 0.63 (SE 0.068) and the overall probability of occupancy across all stands was 0.70 (SE 0.093). We also used the repeated counts we collected to construct abundance models using a similar approach. Across our study area, individual males had average probability of detection that declined over successive surveys from ~0.27 (SE 0.098) to 0.20 (SE 0.079) and stand-scale abundance of males was ~ 3 individuals (95% CI 0–6). Based upon the covariates included in the models, breeding males in our managed landscape selected for mid-successional, conifer-dominated stands that have experienced intensive forestry practices. Stands with a history of selection harvests and uncut, mature conifer stands had lower occupancy and abundance than managed stands, providing optimism for maintaining populations in intensively managed landscapes.

Abstract No. 703

Effect of burning moorland vegetation on Red Grouse population demographics in northern England

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Burning of moorland vegetation, chiefly Heather (*Calluna vulgaris*), on an 8–20 year rotation is regarded by grouse moor managers to be a key technique in creating a structurally diverse sward, to maximise the number of Red Grouse (*Lagopus lagopus scotica*) available for shooting. However, there is increasing concern that heather burning, particularly on peatland sites, can have detrimental effects on terrestrial and freshwater ecosystems. We examined the effect of burning on heather height structure and on Red Grouse population demographics on deep peat (blanket bog) and shallow peat (heath) moors. Pre- and post-breeding density (grouse km^{-2}) as well as breeding success (ratio of young to old birds surveyed in July) were recorded on 36 moors in four regions of northern England. Within each count area, habitat data (variation in heather height (cm) and proportion of points with evidence of burning (fire frequency)) were collected in 1997 and 2010. Linear mixed models were used to determine how fire frequency affected variation in heather height, as well as grouse density and breeding success, and to compare the effect of fire frequency on blanket bog and heath moors. Fire frequency was found to have a significant positive relationship on variation in heather height, which was greater on heaths than on bogs. Although fire frequency had no effect on pre-breeding grouse density, moors which were burned more frequently had higher breeding success and greater post-breeding densities than those burned less often. Our results provide evidence that burning can positively influence grouse breeding success by creating a more variable vegetation structure, and that this relationship is similar on moors of differing peat depth. We intend that these results will contribute to the development of burning best practice that will minimise environmental impacts on peatland sites whilst improving habitat for moorland birds, including Red Grouse.

Abstract No. 704

Habitat attributes and microsite temperatures influencing habitat selection by White-tailed Ptarmigan in the Rocky Mountains of Colorado, USA

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Global climate change is predicted to threaten alpine regions and their inhabitants, leading to placement of alpine avifauna among the most vulnerable species groups. Identifying the specific habitat requirements of alpine birds is critical to predict how changes in habitat structure will affect alpine avifauna under changing climate regimes. We analysed habitat selection of White-tailed Ptarmigan (*Lagopus leucura*) relative to fine-scale nesting and brood-rearing habitat requirements in two alpine study areas in Colorado, USA. We used a 'use-available' framework to compare nest and brood sites used by radio-collared ptarmigan hens versus available locations in the surrounding landscape. Multiple abiotic and biotic habitat factors were measured at both used and available locations via line transects. Microsite temperature at nesting and brood-rearing areas was measured to test if sites were being selected due to thermoregulatory preferences or constraints. Preliminary results suggest there are temperature differences between used and available nesting locations. Brood-rearing locations demonstrated markedly different temperatures between used and available sites, and between study areas, indicating other habitat factors are driving differences. Alpine regions in Colorado support the largest White-tailed Ptarmigan populations in the lower forty-eight states, and understanding these habitat-species relationships will provide greater insight for ptarmigan under future climates. Other avian species are known to breed and inhabit alpine areas of Colorado, therefore we also discuss certain habitat factors shaping their populations and resource selection. With limited studies relating alpine avifauna and habitat factors influencing their populations, our results provide a current glimpse of the complexity in the intricate and hierarchical interactions of alpine avian species with their environment.

Abstract No. 705

Rock (*Lagopus muta*) and Willow Ptarmigan (*L. lagopus*) management in Alaska

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Ptarmigan management and conservation is among the top priorities for the Small Game Program which is a component of the State Alaska Department of Fish and Game, United States. Little has been done to more thoroughly understand movement and mortality of Rock Ptarmigan (*Lagopus muta*) and Willow Ptarmigan (*L. lagopus*) populations since the early 1970s. Although Alaska has abundant Rock and Willow Ptarmigan populations, areas readily adjacent to the limited road system in the state receive considerable subsistence and recreational hunting pressure. As a result the small game program has been trying to develop a more comprehensive approach to understanding abundance, nesting success, and harvest composition of populations in both heavily and lightly hunted areas. In addition, several ptarmigan research studies have been developed since 2012 in Southcentral and Interior Alaska to better understand mortality, movement, and scale of distribution. In May 2013, we began capturing and radio collaring male and female Rock Ptarmigan in both road accessible and remote portions of a popular and heavily hunted game management unit (GMU 13) located in the Alaska Range of Southcentral Alaska. Radio collared Rock Ptarmigan were relocated twice monthly from August through April to determine fate and location. To date, females have dispersed earlier (September) and further (up to 68 km) from breeding areas than males. All collared birds moved lower in elevation (up to 580 m) beginning in September and continuing through March before moving to higher elevation breeding territories in April. We have also begun to more systematically monitor nesting success and chick recruitment into the hunted population using motion sensitive trail cameras. Beginning in May 2015, a second Rock Ptarmigan study will be initiated in central Interior Alaska to also examine movement, mortality, and nesting success of a similarly heavily hunted population along the Steese Highway.

Abstract No. 706

Sustainable harvest: Reflections on harvest management after nearly two decades of monitoring Willow Grouse in areas open or closed to sport hunting

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Here we present results from monitoring population change in willow grouse populations in seven areas (54–174 km²) since 1996. Six areas consist of three pairwise neighbouring areas that either has been open or closed to hunting since the start of the monitoring. Before 1996, all areas had been open to hunting. We collected data on the number of grouse harvested in each of the areas open to hunting, and numbers of grouse and the per capita chick production by line transects using pointing dogs and estimated through distance sampling. The whole region was closed to hunting in 2009 due to unusually low chick production. Harvest rates in the open areas have varied between 8 and 44%, but we did not find any relationship between harvest mortality and apparent survival (true survival and net dispersal). Comparing the population development in the pairwise areas open and closed to hunting did not indicate any difference caused by harvest mortality. Chick production showed large variation with no pattern between areas, but the difference in adult density between pairwise areas was consistent between years. Adult density tended to be higher in the hunted area in two of the three pairs. We suggest that using harvest rate as a management tool is not sufficient in grouse management, and explore the need to expand both the spatial and temporal scales to understand the effects of harvest.

Abstract No. 707

Changes in hunter management to reduce harvest pressure on Greater Sage-Grouse. 1995–2013

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Hunter harvest has been identified as a potential factor contributing to population decline of Greater Sage-Grouse (*Centrocercus urophasianus*; hereafter "Sage-Grouse"). However, regulated Sage-Grouse hunting has consistently been administered by wildlife agencies throughout western North America. Many peripheral populations have been closed to hunting beginning with closures in the 1950s. To reduce the potential for additive effects, harvest season regulations throughout the range of Sage-Grouse have become more conservative over the past two decades in efforts to lower hunter participation and concomitant numbers of harvested Sage-Grouse. We compiled data on harvest season regulations, and estimated numbers of birds harvested and hunters afield from 11 western U.S. states and 2 Canadian provinces from 1995 to 2013. We summarized change in harvest effort as a function of reductions in legal area to hunt, bag and possession limits, season length, season start date, and hunt type (permit only or general). We compared reductions in open (legal) harvest boundaries and area-weighted average harvest regulations relative to administrative boundaries and Sage-Grouse populations. These comparisons allowed us to assess how change in harvest regulations elicited realized harvest pressure reduction. From 1995 to 2013, there was a 25.4% reduction in administrative harvest boundaries compared to a 12.2% reduction in area open to harvest within 8 km from active Sage-Grouse leks. Corresponding response in area-weighted possession limits and season length decreased 73.0% and 52.3%, respectively, from 1995 to 2013. In conclusion, reduction in harvest regulations implemented in the mid-to-late 1990's were primarily associated with restricting harvest to areas where Sage-Grouse occurred and eliminating harvest of populations exhibiting severe decline. Since 2000, harvest regulations have focused on reducing the potential for additive harvest effects throughout the range of Sage-Grouse.

Abstract No. 708

Greater Sage-Grouse detectability and availability for detection on leks

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All Sage-Grouse are not detected or present during a lek count, which complicates the use of lek counts as an index. Understanding factors that influence detection probabilities and availability for detection allows managers to more accurately estimate the number of Sage-Grouse present on leks. We fit 410 males with transmitters (145 GPS, 265 VHF) and uniquely identifiable leg-bands over 4 years in Carbon County, Wyoming, USA. We counted Sage-Grouse using accepted lek-count protocols on 21 leks and evaluated variables associated with our ability to detect marked males on leks using sightability surveys. We applied detection probabilities to more accurately estimate Sage-Grouse counts on leks. We also examined daily lek attendance probabilities using logistic regression to determine optimal conditions, such as weather or day of year, under which availability for detection is maximized. Detection probabilities were high (mean = 0.87 [95% CL: 0.78, 0.93), but varied among leks from 0.77 (95% CL: 0.58, 0.89) to 0.93 (95% CL: 0.73, 0.98). Detection was highest with lower sagebrush heights and increasing snow cover. Daily attendance, or availability for detection, varied substantially each year from a probability of 0.161±0.118 (mean ± standard error) in 2011 to 0.820±0.045 in 2014 with peak attendance dates ranging from 7 April (2012) to 13 May (2011). Date, time of day, and precipitation were the most influential factors affecting attendance, with attendance decreasing with increasing precipitation. Detection on leks can be maximized by conducting lek counts from one half hour before to one half hour after sunrise, 2 or more days after snow fall, which maximizes both attendance and detection. Three lek counts should be completed per active lek to ensure counts do not occur on days with low attendance, and therefore low availability for detection.

Abstract No. 709

Modelling thresholds to detect effects of disturbance on grouse: matching non-linear models to biological processes

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Grouse are often the subjects of research aimed to evaluate the effects of anthropogenic disturbance on ecosystems. In the United States, prairie grouse have been studied to characterize the need for protective buffer zones to be established around critical habitat in relation to energy development. Therefore, these studies are contingent upon the determination of a distance threshold in the response of grouse to disturbance. To address the gap in our ability to properly assess these distance thresholds, we developed a suite of patterns to describe biological processes relevant to grouse. We matched each pattern with a type of linear or non-linear model hypothesized to describe the resultant patterns: no-effect (intercept-only model; null), continual response along gradient (distance-to-disturbance linear effect), discontinuous, stair-step threshold (discrete distance effect), discontinuous ramped threshold, (distance-to-disturbance, discrete interaction), continuous non-linear threshold (distance-to-disturbance, cubic function). We simulated related patterns of known-fate survival data for grouse nests distributed along a 25-km gradient away from a disturbance to assess the potential for non-linear models to describe biological patterns. When we evaluated the models in a model selection framework, all of our proposed models showed high support (AIC weight > 0.8) to describe their matched process when the sample size of nests was high (n=500). However, at lower sample sizes (n=100) that are more typical of 2-year empirical sampling schemes, it became difficult to determine which biological process was causing differential survival near the disturbance. Our results are relevant to the development of policies regarding buffer zones and siting of energy facilities. We encourage researchers to be cautious about the manner in which threshold responses are described.

Abstract No. 710

Effects of wind power development and rangeland management on Greater Prairie-Chickens

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The objectives of our study were to investigate the effects of wind power, prescribed fires, and grazing intensity on the movements and demographic performance of Greater Prairie-Chickens (*Tympanuchus cupido*). We used a before-after control-impact design to test for potential impacts of energy development on male lek attendance, and movements, reproductive success and survival of females. In a 6-year period, we monitored 23 lek sites, 251 radio-marked females, and 264 nesting attempts. Energy development had a weak effect on lek attendance: probability of lek persistence increased with distance from turbines, and most abandoned leks were <5 km from turbines. Leks in native grasslands with >10 males were stable and had the highest probability of persistence. Females exhibited behavioural avoidance of turbines with increased home range size and less space use near turbines. However, proximity to energy development did not affect nest site selection or nest survival. Instead, the strongest correlate of site selection and survival of ground nests was the available vegetative cover, which was determined by prescribed fire and grazing intensity. Unexpectedly, female survival increased after wind power development, possibly because turbines disrupted foraging by predators during the lekking period. Most demographic losses to prairie chicken populations were due to predation by coyotes and other mesocarnivores. To improve productivity, we have tested the potential benefits of a patch-burn grazing system with rotational fire and grazing. Nesting densities were higher in areas rested from fire and improved nesting cover increased nest survival in two drought years. Patch-burn grazing is a promising technique for rangeland management because it can be applied on private lands used for livestock grazing in Kansas.

Abstract No. 711

Indirect effects of a wind energy facility on the behaviour of Greater Prairie-Chickens (*Tympanuchus cupido pinnatus*) at leks in Nebraska, USA

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Rapid expansion of the wind energy industry in North America has raised concerns about the effects of anthropogenic disturbance on prairie grouse. While efforts have been made to address the effects of wind energy facilities on individual fitness and survival, effects on breeding and non-breeding behaviours at leks near wind turbines has been largely neglected. We investigated the effects of a pre-existing (built in 2005) 36-turbine wind energy facility in Nebraska, USA on the behaviour of Greater Prairie-Chickens (*Tympanuchus cupido pinnatus*) between March and May 2013 using direct behavioural observations. Wind turbine noise has the potential to disrupt acoustic communication and behaviour and the potential to reduce female lek attendance. We predicted that males at lek sites close to the facility would spend more time in agonistic behaviours and less in breeding behaviours. Although we found no effect of the wind energy facility on female lek attendance, males at leks located close to the facility spent less time in non-breeding behaviours than those at leks farther from the facility. Distance to the wind facility had no effect on the amount of time males spent in booming displays, flutter-jumps, or agonistic behaviours. Given that the amount of time spent in breeding behaviours has important fitness consequences, our results have implications for the persistence of this species of conservation concern.

Abstract No. 712

A spatial concept for guiding wind power development in Capercaillie habitats: Underpinning the precautionary principle with evidence

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The precautionary principle is an essential guideline applied in wind power planning. However, due to the inherent component of uncertainty it has been widely criticized for being "unscientific", i.e. hindering wind power developments without sufficient evidence. This criticism calls for methods to guide action in the face of uncertainty. We addressed this challenge using the example of species conservation versus wind farm construction, an expanding development with hypothesized – but unexplored – effect on our model species the Capercaillie (*Tetrao urogallus*). By systematically combining information drawn from population monitoring and spatial modelling with population ecological thresholds we identified areas of different functionality and importance with regard to metapopulation persistence and connectivity. We integrated this information into a spatial concept defining different four area categories with different implications for wind power development. The first category covers the spatial requirements of a minimum viable population, focusing on core areas with reproduction plus the primary "corridors" connecting these habitats. Categories 2 and 3 represent a "safety zone" where turbine construction is not generally banned, but subjected to a thorough evaluation process, whereas the fourth category encompasses all areas neither currently nor potentially relevant for metapopulation processes in the future. Drawing from this example, we strongly advocate making best use of scientific knowledge when defining precautionary measures, if not available on the threat itself, so on the object at risk.

Abstract No. 713

Do transmission lines negatively impact Greater Sage-Grouse in Washington State, USA?

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Greater Sage-Grouse (*Centrocercus urophasianus*) require vast areas of sagebrush-dominated landscapes for their survival. Transmission lines are extremely important anthropogenic features on these landscapes. Not only do transmission lines potentially replace suitable habitat with unsuitable habitat, they also may cause direct mortality through collisions and indirect mortality due to increases in predation and habitat fragmentation. In an ideal situation, it would be possible to conduct research before transmission lines were built and then evaluate the impacts afterward. Because this was not possible in Washington, State, we evaluated the potential impacts using an expert opinion-based spatial model incorporating landscape resistance to evaluate Greater Sage-Grouse movement. We then tested 78 alternate models with alternate resistance values for key landscape features, such as transmission lines. Preliminary results for this effort indicate that transmission lines influence Sage-Grouse movement, gene flow, and lek persistence to a greater degree than originally anticipated in the expert models, and appear to be important determinants of habitat suitability and connectivity. Results from the modelling effort were used in a pilot analysis to assess alternate transmission line pathways between existing substations. The models provided a way to compare the pathways in terms of: (1) increases in cost-weighted distance for connectivity corridors; (2) decreases in quantity of potential nest habitat; (3) alteration in areas of potential impact; and (4) comparison of mitigation scenarios. We believe these tools offer a useful way to evaluate development scenarios.

Abstract No. 714

Population ecology of Greater Sage-Grouse following transmission line construction; results of a 10-year study in Nevada, USA

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Greater Sage-Grouse (*Centrocercus urophasianus*; hereafter 'Sage-Grouse') is a North American species of great conservation concern following widespread declines in distribution and abundance. As with other grouse worldwide, population-level impacts of human infrastructure are a concern for Sage-Grouse conservation. From 2003–2012 we conducted a study of Sage-Grouse population response following construction of a 345 kV power transmission line in Eureka County, Nevada, USA. Our study followed a distance-based design, where we tested the null hypothesis that Sage-Grouse behaviour (e.g. habitat selection), demographics (e.g., adult survival, nest success) and population dynamics (i.e. change in abundance) were constant with respect to distance from the focal transmission line, and all other power lines in our study area. Concurrently, we explored other latent factors likely to affect Sage-Grouse population processes, such as weather, habitat composition, and general Sage-Grouse life history characteristics. During our 10-year study we banded 988 male Sage-Grouse, radio-marked 361 female Sage-Grouse, and monitored 427 nests and 120 broods. We found no evidence that power lines directly affected (i.e. via collision) Sage-Grouse mortality. However, numerous aspects of Sage-Grouse behaviour (e.g. nest site selection) and demographics (e.g. nest survival), as well as overall population growth, were associated indirectly, and to varying degrees, with power lines. These effects were closely linked to concurrent variation in the abundance and/or distribution of common ravens (*Corvus corax*) in our study system. Importantly, these results were only apparent once other latent environmental factors were accounted for. Our results demonstrate that the presence of power lines played a non-trivial role in the population ecology of Sage-Grouse in this complex system.

Abstract No. 715

Impacts of oil and gas development on Greater Sage-Grouse lek attendance in Wyoming, USA

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Sagebrush ecosystems in the United States have experienced significant changes over the last century resulting in an approximately 50% loss, due to grazing, fire, and agricultural, urban, and energy development. The Greater Sage-Grouse (*Centrocercus urophasianus*) is dependent on sagebrush throughout its life history and, therefore, has also experienced large declines in distribution and abundance, resulting in candidacy for listing under the Endangered Species Act. One potential threat to populations is the increase in development associated with oil and natural gas extraction. Wyoming contains approximately 40% of the Sage-Grouse population and has experienced a rapid increase in energy development, with that trend expected to continue. It is important to understand how these changes may impact populations in the future. We used a Bayesian state-space model to estimate the impacts of energy development, habitat, and precipitation on changes in lek attendance of male Sage-Grouse in Wyoming from 1984–2008. We explored these covariates at various scales and time lags to account for demographic and behavioural responses to development. We found annual declines in lek attendance of 6.2% across the state, with regional declines ranging from 3.3% to 13.5%. Well density within 800 m of a lek in the previous year provided the best predictive ability of all energy development metrics and had negative impacts on lek attendance. Sagebrush cover within 6.4 km of a lek had a positive effect and spring precipitation two years prior had a negative effect on changes in lek attendance, though neither were significant. Our findings suggest that Sage-Grouse may experience further declines in Wyoming and across its range as energy development is expected to increase in the future. A combination of restrictions on development, mitigating efforts, and restoration of sagebrush may be necessary to maintain Sage-Grouse throughout their range.

Abstract No. 716

Expanding the range of Black Grouse *Tetrao tetrix* in northern England through translocating wild birds

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Black Grouse were once widespread in England, but have declined over the past 150 years due to habitat changes. In 1998, 773 males remained and following the instigation of conservation measures numbers increased to 1029 in 2006, but range remained stable. Suitable habitats were present on the southern fringe of the range, but expansion was considered limited by the low dispersal capacity of males (0.8 km) compared to females (9.3 km). Accordingly, yearling females were dispersing into areas where there were no males. To stimulate range expansion and establish new leks we started moving males. Release sites were selected which had suitable habitats, generalist predators were controlled and were within the dispersal distance of females. Males were caught at night, fitted with radio-transmitters and hard released. Between 2006 and 2010, 24 males were released at two sites, with a further 45 males released at two new sites between 2011 and 2014. In the first year, three males returned back to their capture locations and subsequently birds were moved a minimum 15 km. No birds were found dead within two weeks of catching. Annual survival rates were consistent with estimates from the core northern England range. Males released into new sites in the first year had home ranges two-fold greater than males moved in subsequent years. Home ranges of adult males were three-fold larger than that of juveniles. Males displayed and established leks, attracting females which bred successfully. Leks established and persisted. In autumn 2014, a cohort of wild females were released to assess whether they would settle, breed and hold males within the release area. In England, between 1998 and 2014 range increased from 37 to 48, 10 km grid squares with two thirds occupied through translocation. Translocation can provide a conservation tool to stimulate range expansion into areas of suitable connected habitat.

Abstract No. 717

Breeding and restitution of Capercaillie (*Tetrao urogallus*) according to the "born to be free" method – a review of recent results and trends for the future

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In this paper the results of restitution of Capercaillies with the innovatory "born to be free" method are presented. Using this method, offspring are reared in a natural biotope. This means that later they do not have to learn how to survive in nature. Six years of research in the Lowland Silesian Forest (Ruszów Inspectorate) showed that the most significant factor was the presence of a mother since the young Capercaillies maintain contact with her until the period of natural dispersion. In addition to the role of mothers, adaptive areas surrounded with electric fences and coloured ribbons are also important. During the first month (in fact the first three months) all released birds survived. To date, 11 restitutions in four places have been carried out. They were as follows: Lowland Silesian Forests (6 years); Augustowska Primeval Forest (2 years); Brandenburgia (2 years) and Piska Primeval Forest – the preliminary experiment in 2014. The method of limiting mezzo predators by not killing adult territorial specimens, but by disturbing their reproduction, is effective. It is important, that the predators do not reproduce in the area where the Capercaillies have been introduced since they "protect" that territory and do not allow other predators to enter. For mammals such as the Fox (*Vulpes vulpes*), Marten (*Martes martes*), Raccoon-dog (*Nyctereus procyonoides*) vasectomy could be carried out. For birds such as the Goshawk (*Accipiter gentiles*), which is very dangerous for females and young Capercaillies, reproduction can be limited by exchanging real eggs with porcelain ones. It seems that the "born to be free" method actively protects Capercaillies based on birds born in captivity. The above mentioned treatment of predators can be more effective than killing them.

Abstract No. 718

An attempt to guard chicks one month after hatching by cage

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Japanese Rock Ptarmigan (*Lagopus muta japonica*) is the southernmost sub-species and isolated on the alpine mountain tops in central Japan. From the population study on Mt. Norikura since 2001, it was cleared that the mortality of juveniles was highest during the first 2 weeks after hatching. The reasons behind the high mortality were predation and exposure by rainy weather after hatching. An attempt to guard chicks from these factors was done on Mt. Norikura in 2013. We prepared three cages (large size : width 270 cm x depth 450 cm x height 150 cm metallic, middle size : 180 cm x 360 cm x 120 cm wooden, small size : 120 cm x 240 cm x 90 cm wooden) and set up them in alpine breeding area. We induced family (a female and her chicks) into the cage without catching. Total three families just after hatching were induced into the three cages. During nice weather conditions in the daytime, each family was take out from the cage and lived freely in the native alpine area. One or two persons accompanied the family to avoid predation. When the weather changed into bad condition the family was induced into the cage. Every night we induced the family into the cage. We would like to show this method by video film. One month later the three families (three females and their 15 chicks) were released safely. No chick died during this attempt. It was shown that this method should be useful for the conservation of Japanese Rock Ptarmigan.

Abstract No. 719

Gunnison Sage-Grouse (*Centrocercus minimus*) translocations: using genetic information to assess translocation success

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Assessment of management efforts for threatened species is essential to achieving appropriate levels of conservation. However, management actions are rarely assessed even though ultimate success can depend on appropriately implementing initial conservation efforts. The range of Gunnison Sage-Grouse (*Centrocercus minimus*) of Colorado and Utah, USA, has been reduced dramatically due to habitat loss and degradation, resulting in isolated populations with low genetic diversity and high genetic structure. The entire species consists of 7 populations, a stronghold found in the Gunnison Basin which supports 85–90% of the species, with smaller satellite populations to the west and a single satellite population to the east of the Gunnison population. In an attempt to augment dwindling population sizes in the satellite populations, Colorado Parks and Wildlife began translocating birds captured in the Gunnison Basin to each of the western satellite populations beginning in 2005. However, the ultimate fate of translocated individuals remains unknown. We are using range-wide genetic samples collected before and after the translocations began, and a set of 24 microsatellite loci to inform the effectiveness of translocations. If the birds from the Gunnison Basin survived and reproduced, as expected, alleles from the Gunnison Basin birds should increase in frequency in the satellite populations. Comparisons of genetic diversity statistics and results from Structure analyses for the samples from before and after translocation began will highlight potential evidence of less differentiation in the satellite populations and an increase in frequency of alleles from the Gunnison Basin. Findings from this study will aid managers in identifying conservation approaches and allocating resources to the most promising conservation and management efforts for a species listed as Threatened under the Endangered Species Act.

Abstract No. 720

Characteristics of wild Capercaillie (*Tetrao urogallus L.*) semen

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The risk of biodiversity depletion in small, closed population maintained *ex situ in vivo* becomes a serious problem; therefore any ways of increasing the genetic diversity are desirable. We tried to collect semen from two wild Capercaillie that lost fear of man, for its further use in artificial insemination of females kept in captivity. The male No 1 lived in the Slovak Tatra Mountain National Park, No 2 in Slovak National Park Great Fatra. Semen was collected by dorso-abdominal massage: twice from male No 1 and once from male No 2. Birds catching and semen collections were supervised by employees of Slovak National Parks. Collected ejaculates were extended with EK diluent, transported at 4 °C to aviary, and then evaluated: volume, sperm concentration and morphology. Male No 1 did not react on man approaching at distance of 5 meters; reduction in this distance awoke attack attempt, what we use to catch him. Male No 2 showed a greater fear and we could catch him after a longer observation. From both males the valuable ejaculates, comparable to those of Capercaillies kept in captivity, were collected: ejaculate volume 60 µl and 20 µl; sperm concentration 154 $x10^6$ ml^{-1} and 70 $x10^6$ ml^{-1}; number of live normal sperm 68.9% and 62.3%, for male No 1 and 2 respectively. Results obtained showed that dorso-abdominal massage is effective for semen collection from wild Capercaillie and quality of ejaculates allows to use them for artificial insemination of females kept aviaries.
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Abstract No. 721

Habitat selection by sympatric, translocated Greater Sage-Grouse and Columbian Sharp-tailed Grouse

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Greater Sage-Grouse (*Centrocercus urophasianus*) and Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*) have declined substantially in much of western North America. Conservation agencies have acquired and restored habitat and augmented grouse populations through translocation. We compared how sympatric, translocated Sage-Grouse and Sharp-tailed Grouse used habitats within their spring–summer home ranges and at nest sites within remnant shrub-steppe surrounded by a matrix of cropland in eastern Washington, USA. Using radiolocations of ≥ 43 birds of each species, we found that Sage-Grouse had larger spring–summer home ranges than Sharp-tailed Grouse, and the composite of home ranges of sharp-tailed grouse was subsumed within that of Sage-Grouse. Across the landscape, the areas of highest predicted intensity of overall use overlapped by > 50% between the grouse species, because both species selected restored fields, areas further from trees and roads/distribution lines, and did not distinguish between 3 levels of shrub cover. However, Sage-Grouse selected less rugged areas. At nest sites, Sage-Grouse selected for greater shrub cover, lower annual forb cover, taller perennial grasses, and areas further from distribution lines, whereas Sharp-tailed Grouse selected for greater perennial grass cover, taller perennial grasses and forbs, and restored fields. These differences resulted in a much lower overlap in areas with high probability of nest site selection (38% overlap within the top quartile, < 10% within the top 5% quantile). Because many western states are highly fragmented by cropland, understanding how populations of species with different life history characteristics coexist within remaining tracts of shrub-steppe at different spatial scales is important for effectively conserving and managing shrub-steppe communities.

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