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From the Editor

It has been difficult to get people writing for this issue. We would like to encourage all of you to consider submitting notes or articles for the next issue, so we can continue providing noteworthy news to fellow grouse researchers and enthusiasts around the world. But we have got some very interesting contributions. As many of you remember a workshop was held the day before the start of the conference in Iceland in 2015. In this issue an overview of this Workshop on how to expand the use of emerging technology to understand the ecology of grouse in a changing climate is published. The overall objective was to translate technological advances in remote sensing, rapid biochemical assays, and robotics to resource managers for improved understanding, monitoring, and management of wildlife habitat and behavior in a changing climate. Use of camera traps to record activity on sage-grouse leks in Wyoming is also found in this issue. A short note from a project in progress dealing with the impact of wind turbines on capercaillie is also published. Information on a new book on grouse from Paul A. Johnsgard dealing with the ecology, reproductive biology, and social behavior of all ten of the extant North American grouse species is found. This entire book can be downloaded at no cost to the reader. And as usual Don Wolfe has done a great job with the recent grouse literature.

At the last conference in Iceland in 2015 we decided to have an editorial board to help getting contributions from their part of the world. We discussed this with different people and asked some if they were willing to do this job. Claude Novoa, Office National de la Chasse et de la Faune Sauvage, France, Leslie Robb, WA 98813, USA, Yasuyuki Nagano, International Nature and Outdoor Activities College, Japan and Yua-Hua Sun, Institute of Zoology, Chinese Academy of Sciences, China agreed to be on this editorial board, and will assure that the Grouse News continues to improve.

In 2017 The 33rd International Union of Game Biologists Congress - 14th Perdix Symposium will be held from the 22nd to the 25th August 2017 in Montpellier, France. The 14th Perdix Symposium will be a special session of the IUGB Congress. In 2018 the 14th IGS will be arranged in Utah, USA. More information on this will come later.

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From the Chair of the Grouse Group

Dear Grousers

When the next IUCN quadrennium 2017-2020 will begin on 1 January, 2017, the Galliformes Specialist Group (GSG) will have two new Co-Chairs: Simon Dowell and John Carroll (see News from the GSG, page 6). While I personally welcome this outcome, I also regret that there were no candidates from among the grousers for the positions of Chair or Co-Chair of the Galliformes SG.

But perhaps this is not too surprising. The network of grouse researchers and conservationists that already existed - although informally - before the founding of the IUCN Grouse Specialist Group in 1993, has always had some life of its own. This network was kept together by a core group of grouse researchers and their PhD students and post-docs, who happened to continue studying grouse throughout their careers. The network was renewed and tightened every three years at the International Grouse Symposia, which always had the feel of a family meeting. In between, personal friendships and the newsletter Grouse News kept the grousers in contact. For the functioning of this professional network, the formal status as an IUCN Specialist Group was of minor importance. One reason was in the well-established personal linkages among the grousers, and another in the fact that most grousers (and their study species) resided in countries of Europe and North America with strong governmental institutions and mechanisms for species conservation. In such countries, the SGs of the IUCN are arguably less urgently needed than in other parts of the world and for other Galliformes taxa.

From discussions with many of you, I take it that the grousers are wishing to maintain their own "grousy identity", regardless of what their formal status within IUCN and the GSG might be. Still, because the Grouse Group has been by far the largest group within the GSG, and for the visibility of grouse in the conservation world, it would be advantageous to maintain a strong sub-group within the Galliformes SG, and make use of the strength of the IUCN for the conservation of the grouse, whenever needed.

As the new Co-Chairs of the GSG, it is up to Simon and John to decide how to build and sub-structure the new GSG, and I think that it is important that they are completely free in their considerations. We should therefore consider the Grouse Group as a formal sub-group of the GSG dissolved from the end of the year. The new GSG Co-Chairs will decide about future structures. Myself, I am willing to continue serving as a GSG member, but otherwise, will keep out of decisions on the GSG’s future operation.

Finally: thanks to all of you for trust and support in my many years as Chair of the Grouse SG, and later, of the Grouse Group within the GSG. Keep on grousing!

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NEWS FROM GALLIFORMES SG

The process of finding a new leadership for the GSG is now complete. The SSC Steering Committee approved the appointment of two new Co-Chairs, with effect from the IUCN World Conservation Congress in September.

The new Co-Chairs are to be Simon Dowell, Science Director at Chester Zoo (UK) and John Carroll, Director of the School of Natural Resources at the University of Nebraska (USA). Many of you will remember that in the early 1990's Simon became the founding Chair of the former SG for Partridges, Quails and Francolins, and that John later succeeded him. They have both remained substantially involved in Galliformes research and conservation ever since, and between them have amassed a great deal of experience in Europe, Asia, Africa and the Americas.

We (and all our species!) are indeed fortunate that, despite their senior professional positions, Simon and John have still felt able to commit themselves to the task ahead for the GSG's future. More details on the transition process, and a joint message from the Co-Chairs elect, were published in the 12th issue of the GSG’s newsletter G@llinformed, which was distributed in August, 2016.

Ilse and Pete would like to thank Jon Paul Rodrigues (Deputy Chair of SSC) and Rachel Roberts (SSC Chairs Office) for excellent guidance on how best to conduct this leadership succession process. Four members of our Co-Chairs’ Advisory Board (Rahul Kaul, Phil McGowan, Jeff Thompson & Tommaso Savini) kindly offered to serve as the Chair Nominations Panel. They made the recommendation that has now been formally approved. We are confident that we will be leaving the GSG in very capable hands when we formally hand over GSG leadership to Simon and John at the end of the year.

It has been a privilege for us to serve as the GSG Co-Chairs, and we thank you for providing so much information and advice whenever we asked for it. We are especially grateful to the members of our Advisory Board. We could not have represented the GSG and the plight of all threatened Galliformes species without the support of the GSG membership. Personally, we will remain involved in research on and conservation of Galliformes, but it is now time for us to hand over responsibility for leading the GSG. So we wish Simon Dowell and John Carroll every success in leading us all into an increasingly threatened global future, but in the expectation of further inspirational outcomes for the good of our species.

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RESEARCH REPORTS

Overview of a Workshop to Expand the Use of Emerging Technology to Understand the Ecology of Grouse in a Changing Climate
Jennifer Forbey, Gail Patricelli, Donna Delparle, Alan Krakauer, Peter Olsoy, Marcella Fremgen, Jordan Nobler, Nancy Glenn, Lucas Spaete, Bryce Richardson, Lisa Shipley and Jessica Mitchell

We held a workshop related to the use of emerging technology to understand the ecology of grouse on 03 September 2015 from 08:00 to 17:30 at the Reykjavik Family Park and Zoo, Reykjavik, Iceland as part of the 13th International Grouse Symposium. Our overall objective was to translate technological advances in remote sensing, rapid biochemical assays, and robotics to resource managers for improved understanding, monitoring, and management of wildlife habitat and behavior in a changing climate. The workshop included seminars and hands-on demonstrations of equipment used to collect, analyze, interpret, and share data related to monitoring and predicting how grouse interact with their environment. Professors Jennifer S. Forbey (Boise State University), Gail Patricelli (University of California, Davis), and Donna Delparle (Idaho State University) chaired the workshop, which was funded by a grant from the U.S. National Science Foundation. Sessions in the workshop were led by a team of faculty, students, and researchers who developed and routinely use the technology to conduct research at the interface of basic research and wildlife management. Through Grouse News, we hope to distribute the information related to several types of emerging technology to the wider community and grouse researchers specifically. For each technology type, we offer a list of equipment used, an overview of the technology, and examples of how the technology is used in different systems. We encourage researchers and wildlife managers to contact the users of the technologies listed here if they have additional questions.

TECHNOLOGY #1: UNMANNED AIRCRAFT SYSTEMS (UAS) TO ASSESS HABITAT COMPOSITION
UAS contacts: Donna Delparle, delparle@isu.edu, Idaho State University; and Peter Olsoy, peter.olsoy@wsu.edu, Washington State University

Equipment Details
Instrument: Quad copter Unmanned Aircraft Systems (UAS, Figure 1)
Flight time: 20-35 min
Sensors: RGB Olympus PG, Tetracam ADC Micro, Rikola Hyperspectral sensor, InfraredCamerasInc thermal camera
Power: Electric, 2 to 4 LiPo batteries at 5 cell, 6000-10000 mAh
Autopilot System: 3D Robotics Pixhawk
Controller: FR Sky Taranis X9D
GPS navigation: 3D Robotics GPS survey grade for image acquisition
Other equipment required: Laptop, battery charging station, 4+ ground targets AND/OR mounted survey grade GPS
Software: Mission Planner (data collection and flight planning), Pix4D, Agisoft Photoscan, Enoxosaic (data processing, data export).

Introduction
The use of UASs for conservation management and wildlife research applications is growing in popularity. Here are typical steps in planning your UAS activities:

Figure 1. Donna Delparle flying Quad copter Unmanned Aircraft Systems (upper left) in sagebrush steppe ecosystem with hyperspectral camera to differentiate species of sagebrush (Artemesia spp.) in Idaho, USA.
• Identify the research question or conservation management problem for a selected study area or region
• Select the appropriate sensor(s) to address the problem
• Select an appropriate UAS system – a multirotor platform or fixed wing UAS that is capable of carrying the required sensor and covering the study area
• Pre-plan your flight mission(s) in accordance with weather conditions, time of year and if repeat flights are required. Obtain necessary permits and approvals well in advance
• Fly your mission in compliance with safety regulations, national airspace requirements and with qualified personnel
• Perform in-field QA/QC to confirm data is being collected to standards and meets research objectives
• Data processing can be conducted post collection:
  o GPS differential correction can be performed real-time or post processed
  o Images collected during flight are typically stitched together using photogrammetry (structure from motion) processing software such as Pix4D
  o A digital surface model (DSM) can be generated
  o Multispectral/Hyperspectral data mosaics can be generated
• Analysis/Visualization: Further metrics can be calculated for model input and visualization

Application of UAS
UAS have been used for wildlife surveys, habitat assessments, animal tracking, and monitoring poaching activities.

Example 1: Quantification of vegetation structure and biomass
URL: http://dx.doi.org/10.1016/j.rse.2016.05.019
Summary: UAS was used to measure fine-scale vegetation structure and estimate biomass and carbon storage in a dryland ecosystem.

Example 2: Estimating prairie dog colony populations with Unmanned Aircraft Systems for black-footed ferret reintroduction
Source: Delparte D, T Stone, K Bly, M Tracy, R Behrendt, M Belt, E McCaffery (in prep).
URL: N/A
Summary: UAS surveys were flown over prairie dog colonies in north central Montana to determine population size and density in support of black-footed ferret reintroduction efforts. Object-oriented feature extraction analysis was utilized to automatically extract and count prairie dog burrows to compare with field observations. Each colony was further characterized based on vegetation composition and population density.

Example 3: Wildlife Tracking with UAS
URL: http://dx.doi.org/10.1109/MASS.2014.48
Summary: This is an example of a low cost system to facilitate VHF tracking from signals originating from a wildlife tracking collar.

Other Applications and Reviews:


**Resources:**

**TECHNOLOGY #2: TERRESTRIAL LASER SCANNING (TLS) TO ASSESS HABITAT STRUCTURE**

**TLS contacts:** Nancy Glenn, nancyglenn@boisestate.edu, Boise State University, Lucas Spaete, lucasspaete@boisestate.edu, Boise State University and Peter Olsoy, peter.olsoy@wsu.edu, Washington State University

**Equipment Details**
Instrument: Riegl VZ-1000
- Near-infrared laser (operated at 1550nm wavelength)
- Can collect data at a distance of up to 1400m (range)
- Beam width: ~2mm at 10m range, increasing 30mm per 100m distance
- Field of View: 100° x 360°
- Measurement Rate: 29,000 – 122,000 measurements/sec
- At 100 m distance, Accuracy: 8mm, Precision: 5mm

Other equipment required: Laptop, tripod, digital camera, 3+ targets OR mounted RTK GPS

Software: RiSCAN Pro (data collection, post-processing, data export), BCAL Lidar Tools (height filtering and further post-processing of LAS files; [https://bcal.boisestate.edu/tools/lidar](https://bcal.boisestate.edu/tools/lidar))


**Introduction**
Terrestrial laser scanning (TLS) is a ground-based, active imaging method that rapidly acquires dense 3D point clouds of object surfaces by laser range-finding (Figure 2). How it works:
- A laser pulse leaves the scanner, hits an object, and then returns to the sensor. This is done tens of thousands of times per second
- The location of the point in space is calculated by knowing the angle at which the laser left the scanner and precisely measuring the time-of-flight
- Results in a 3D point cloud with millions of points
- The point cloud can be analyzed directly or can be processed to create continuous rasters:
  - A digital elevation model (DEM) of the bare earth surface is created with the ground subset (i.e., ground elevation above sea level)
A canopy height model (CHM) is calculated with the vegetation subset (i.e., range of vegetation heights from 0 cm and up)

A digital surface model (DSM) may be calculated using all points (ground + vegetation)

- From the point cloud, vegetation metrics such as height and height variability can be calculated for model input (e.g., random forest or multiple linear regression)

**Application of TLS**

TLS is expanding the options for mapping habitat features across the landscape by not only addressing existing mismatches in scales between ground and aerial, but also allowing for greater flexibility in modeling and predicting habitat changes to test a broad range of hypotheses. The TLS point cloud is very dense (~100–1000 pts/m²), but usually only covers a small area (~0.01–1 km²), which makes it ideal for projects that require greater detail at smaller geographic scales.

**Example 1: Predicting concealment for prey**


**URL:** [http://dx.doi.org/10.1093/biosci/biu189](http://dx.doi.org/10.1093/biosci/biu189)

**Summary:** A TLS was used to estimate horizontal concealment and visibility across a range of scales and from a range of vantage points representing predator sightlines. TLS was found to be highly correlated with field measures of habitat cover ($R^2 = 0.85$).

**Example 2: Capturing 3D vegetation structure**


**URL:** [http://dx.doi.org/10.1016/j.ecolind.2015.10.034](http://dx.doi.org/10.1016/j.ecolind.2015.10.034)

**Summary:** Leaf Area Index (LAI) was estimated from TLS scans using structural variables such as height, canopy cover, and volume for 42 Wyoming big sagebrush across three different collection sites in the Snake River Plain. Strong predictors of LAI included canopy cover ($r^2 = 0.73$) and shrub volume ($r^2 = 0.76$). The convex hull method of estimating shrub volume and compared favorably to point-intercept sampling ($r^2 = 0.78$), a field-based method used in rangelands.

**Example 3: Monitoring nests for wildlife**


**URL:** [http://dx.doi.org/10.5038/1827-806X.44.2.8](http://dx.doi.org/10.5038/1827-806X.44.2.8)
Summary: A TLS was used to scan a cave in Borneo to count and distinguish between swiftlet nests and bats. Nests were undercounted by only 1.5% compared to manual photo counts, while bat counts had an error of 15%.

Other Applications and Reviews:
Vierling KT, LA Vierling, J Müller. 2013. Spinning a laser web: predicting spider distributions using LiDAR. *Ecological Applications* 21:577–588. [http://dx.doi.org/10.1890/09-2155.1](http://dx.doi.org/10.1890/09-2155.1)

**TECHNOLOGY #3: SPECTORADIOMETER FOR ASSESSING ORGANIC COMPOUNDS**

Spectroradiometer contacts: Nancy Glenn, nancyglen@boisestate.edu, Boise State University; Jennifer Forbey, jenniferforbey@boisestate.edu, Boise State University; and Jessica Mitchell, mitchelljj@appstate.edu, Appalachian State University

Equipment Details
*ASD FieldSpec® HandHeld 2*
- Wavelength range: 325 nm – 1075 nm
- Accuracy: ±1 nm
- Resolution: <3 nm at 700 nm
- Field of view: 25° (fore optics are available)
- Weight: 1.2 kg
- Battery life: 2 (alkaline)-5 hours (lithium)
- Internal memory: up to 2,000 individual spectrum files

Software: RS² (instrument optimization and control), FieldSpec HH2 (data export and organization), ViewSpec Pro (data processing and analysis)

More information: ASD FieldSpec® HandHeld 2 Manual [http://support.asdi.com/Products/Products.aspx](http://support.asdi.com/Products/Products.aspx)

Introduction
The HandHeld 2 is a portable spectrometer that measures reflected light between the wavelengths of 325 nm – 1075 nm. This range includes much of the visible and near infrared (NIR) portions of the electromagnetic spectrum (Figure 3). Light reflected from the target passes through an internal diffraction grating and its intensity is measured along the entire wavelength range of the instrument. By adjusting the integration time (i.e., sensitivity) of the instrument, and calibrating reflection to a known standard, investigators can measure a target’s reflectance. Reflectance is defined as the proportion of light reflected from an object to the light striking an object:
Figure 3. Example of spectral fingerprints (% reflectance over different wavelengths +/- 95% confidence intervals) for conifers (green) versus deciduous (black with blue CI) plants scanned by participants in the field with the HandHeld 2 during the Technology Workshop in Iceland.

\[
\text{Reflectance (R)} = \frac{\text{Reflected Light (R_s)}}{\text{Incident Light (I)}}
\]

This reflectance is a characteristic of the object being measured and is independent of light conditions. Entire or partial reflectance spectra can be compared to known standards to estimate specific compounds (e.g. plant protein, Mitchell et al. 2012) or correlated with measurements of interest (e.g. animal intake, Moore et al. 2010).

Application of spectroradiometer technology
Near infrared spectrometry has been applied to disciplines including ecological, geological, agricultural, and hydrologic investigations. Portable, field-based units have been used to ground truth data collected by airborne or space-borne sensors (e.g., differentiate taxonomic groups, Figure 4), assess soil and crop characteristics in agricultural settings, determine properties of snow and ice, and measure photosynthetic productivity of vegetation.

Example 1: Quantifying nutritional content
URL: doi:10.1016/j.jaridenv.2016.07.003
Summary: The capacity of near-infrared reflectance spectroscopy (NIRS) to measure and monitor the dietary quality of sagebrush was evaluated using a scanning monochromator (NIRSystems Model 5000, FOSS North America). Calibration equations were developed for crude protein (CP), dry matter digestibility (DMD), 1,8-cineole (cineole), and total polyphenolics. The coefficients of determination (r^2) were 0.93 for CP, 0.83 for DMD, 0.64 for cineole, and 0.64 for total polyphenolics.

Example 2: Mapping plant palatability
Summary: NIR spectral characteristics were correlated with an animals’ willingness to consume specific plants in feeding trials. These characteristics were then mapped over a landscape and used to predict the landscape’s palatability and habitat use.

Example 3: Identifying bacteria-carrying mosquitoes
URL: http://dx.doi.org/10.1371/journal.pntd.0004759
Summary: Reflection spectra from laboratory-reared mosquitoes were used to identify spectral signatures characteristic of infection with *Wolbachia* bacteria. Single scans (3 seconds) of live mosquitoes were consequently able to identify infected individuals with up to 96% accuracy.
Other Applications and Reviews


TECHNOLOGY #4: E-NOSE FOR DETECTING VOLATILES

**E-Nose contacts:** Bryce Richardson, brichardson.fs@gmail.com, USDA Forest Service; Marcella Fremgen, marcella.fremgen@westeralum.org, Bird Conservancy of the Rockies; and Jennifer Forbey, jenniferforbey@boisestate.edu, Boise State University

**Equipment:** Cyranose 320 with PCNose+ Version 10.11 software

**Website:** [http://www.sensigent.com/products/cyranose.html](http://www.sensigent.com/products/cyranose.html)

**Introduction**

The Cyranose 320 is an electronic nose that is used to compare chemical vapors. The “electronic nose” (or, e-nose) is trained to recognize chemical vapor classes, which are used as standards to analyze unknown samples. The Cyranose 320 compares the unknown samples to the “smell library” in its memory and provides a qualitative assessment of the chemical vapors associated with the sample.

Electronic noses can be trained to identify a wide variety of compounds, but first the instrument must be exposed to the compounds before identifying unknowns by following these steps:

1. Develop a “smell library” using at least ten samples for each substance
2. Samples in the “smell library” must be cross-validated to ensure that the e-nose recognizes and correctly classifies substances
3. Unknown samples can then be compared to the smell library to see how similar the sample is to known substances (to identify substances)

Chemical measurements are produced when the 32-sensor NoseChip recognizes differences in resistance (voltage decreases) produced by interactions with the headspace gases. Each sensor is unique, and therefore responds differently for vapors, creating a chemical fingerprint, or “smell print” for vapors. The patterns produced by sensors are analyzed using principal components analysis (PCA) for pattern recognition.

**Application of E-nose technology**

The Cyranose 320 has primarily been developed for and used in medical and environmental monitoring applications. Some examples include breath-based diagnosis of diseases, pathogen identification, pneumonia diagnosis, air quality monitoring, and food quality testing. See links on the Cyranose 320 website for more detailed information about these uses:

Example 1: Disease diagnosis
URL: http://jcm.asm.org/content/43/4/1745.short
Summary: The e-nose was used to evaluate whether both cattle and badgers tested positive for infections with Mycobacterium bovis (tuberculosis), thereby providing wildlife managers with a rapid, cost-effective, and relatively non-invasive test. The e-nose had 100% accuracy for detections in both species, negating the need for destructive sampling. The e-nose could be used to diagnose other wildlife health issues, especially for species of concern where destructive sampling is a common detection method.

Example 2: Evaluating food quality
Summary: The e-nose was used to classify fruits as immature, mature, or over-mature using volatile organic compounds. The classification was validated using destructive sampling (puncture strength, starch index). The classification accuracy was 83%. The e-nose could be used to evaluate wildlife forage.

Example 3: Evaluating diet selection
Source: Unpublished work, Marcella Fremgen (Bird Conservancy of the Rockies) and Jennifer Forbey (Boise State University).
URL: N/A
Summary: The e-nose was trained to identify sagebrush species present at different field sites in Idaho. After cross-validation, the e-nose was tested to be sure it recognized new samples of each plant species. Finally, fecal pellets were tested to see if the e-nose could recognize which sagebrush species were consumed by sage-grouse at that site. This method can be compared to monoterpene profiles produced from gas chromatography for both plants and fecal pellets, which can be used to identify diet, but is costly and time-consuming. The classification accuracy for identifying each sagebrush species (n=2) was 100% at each site (n=2). Classification of fecal pellets from each site was less accurate (with about 50% success at each site for 10 samples per site) for determining which plants were consumed at a foraging patch, compared to analysis using gas chromatography. This study could be extended to diet selection studies for other species, and costs could be compared between monoterpene analysis using gas chromatography and e-nose.

Other Applications

TECHNOLOGY #5: ADVANCED TELEMETRY SYSTEM

Telemetry contacts: Alan Krakauer, ahkrakauer@ucdavis.edu, University of California, Davis; and Gail Patricelli, gpatrick@ucdavis.edu, University of California, Davis

Equipment:
- Encounternet Master Node
- Encounternet Base Stations (Solar & Conventional)
- Encounternet Solar Tag

Website: http://encounternet.net/

Introduction: While animal telemetry has long been a critical tool for wildlife biologists, traditional VHF transmitters have some limitations for collecting large volumes of high-resolution data. A variety of new
transmitter designs, including those that couple GPS logging with other types of sensors, provide powerful opportunities to study how secretive animals such as grouse move through and interact with their environment.

One advanced telemetry system, the Encounternet system, was first developed for automated remote study of animal social networks. Lightweight Encounternet tags can detect and log the proximity of other tags and exchange copies of their previous encounter logs. Encounternet engineers have broadened the capabilities of the tags into modular platforms that can potentially support a range of sensor types. The system also includes autonomous logging base stations (solar or battery powered) and a master node that serves as a Yagi antenna interface between the tags and base stations and a laptop running Pymaster, the Encounternet software. Advanced biotelemetry systems such as Encounternet represent unparalleled tools for studies of animal behavior and ecology. They can provide fine-grained information on activity and space use necessary to leverage the detailed maps of food quality and risk generated by other exciting conservation techniques, such as those discussed at this workshop.

Application of Encounternet Technology:
Encounternet animal tracking systems were first developed for proximity logging applications, such as measuring social networks, lek attendance by females, or nest-box visits by cavity-nesting birds.

Example 1: Greater Sage-grouse behavior monitoring
Source: Unpublished work, Alan Krakauer, Gail Patricelli, Amy Dirksen and Orr Spiegel (UC Davis).
Summary: Our studies of Greater Sage-grouse Centrocercus urophasianus employ Encounternet tags that log GPS and 3-axis accelerometer data. The GPS tag provides data on landscape use and spatial movement away from the lek. The accelerometer data provides information on animal posture and body movement, thereby allowing us to determine what an animal was doing when using a particular area. The combination of these data sources allows us to link maps of bird activity with measurements of forage and habitat quality detailed in the other workshop stations. We can examine how off-lek activities relate to on-lek behaviors observed by video and audio monitoring and experiments with the robotic females. In sum, we gain a much more robust understanding of foraging ecology in a difficult-to-observe organism, and have an exciting opportunity to study, at the level of individuals, the feedbacks between on-lek courtship effort and off-lek behavior. Data-rich telemetry systems such as Encounternet sensor tags typically operates on higher frequency radio signals than traditional VHF radiotelemetry, resulting in a reduced range, especially for animals close to the ground such as grouse. We place base stations and master nodes on leks, where males are reliably found. Interacting with tags during non-lekking seasons could be challenging unless the birds are predictable in their movements.

Example 2: Mate selection
Summary: Examines the utility of an advanced telemetry system for automated monitoring of a tropical lekking species. The system (small autonomous receivers and lightweight Encounternet tags) was able to detect simulated visits of transmitter-equipped females to male display territories where automated receivers had been placed. Moreover, distance vs. signal strength relationships were derived in order to estimate tag-receiver distances, and was capable of differentiating simulated visits to display perches versus nearby branches only 5m away. This demonstrates the potential to provide flexible, automated, and prolonged monitoring which could lead to greatly increase the spatial and temporal scope of social or ecological interactions.

Example 3: Social interactions
URL: doi:10.1016/j.anbehav.2014.09.029
Summary: Describes the utility of an advanced telemetry network for simultaneously monitoring the movement and interactions of a population of small songbird. The system (another Encounternet system) featured close to 100 autonomous receivers deployed throughout the breeding grounds; the pattern of detection for each transmitter could be used to determine the location of many birds over long periods of time with high temporal resolution. This study leveraged these locations to identify events in which two
males interacted with each other in close proximity. This dataset of interactions was then used to construct the males’ social network.

**Other Applications and Reviews**


**Resources:**

*Additional Analysis Software*


Animal Tracker and MoveBank, [http://www.orn.mpg.de/animal_tracker](http://www.orn.mpg.de/animal_tracker)

Tracklab GPS Analysis, [http://www.biotrack.co.uk/tracklab-gps-analysis.php#s4](http://www.biotrack.co.uk/tracklab-gps-analysis.php#s4)

*Alternative Hardware Vendors*


UvABiTS, [http://www.uva-bits.nl/system/](http://www.uva-bits.nl/system/)

**TECHNOLOGY #6: BIOMIMETIC ROBOT**

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**Equipment Details:** Custom made robotic female sage-grouse

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**Introduction:** Biomimetic robots can be a powerful tool for eliciting behaviors, studying behavioral interactions, and approaching free-living animals for data collection. We have used robotic female sage-grouse (fembots) in playback experiments for all of these purposes (Figure 4). Playback experiments involve playing simulated or recorded behaviors back to other animals to elicit a response. The classical playback experiment involves playing a recorded song to a territorial male bird to learn the function (i.e. “meaning”) of the song or measure the responsiveness of the target male. We use the robot as a 3D interactive playback of female behavioral signals and cues, allowing us to learn the function of female behaviors during courtship and measure male responsiveness to these signals in a controlled fashion. The robot also allows us to collect courtship display data on all males on the lek, including peripheral or juvenile males that are difficult to observe courting females (because real females avoid them). This allows us to study how male behavior—the quality of male displays and the responsiveness to female signals—relates to male fitness (measured as mating success), and thus how selection acts on male behaviors.

The robotic females have been especially powerful in combination with other technologies. For example, we have been using the Encounternet radio-tracking system to measure male foraging success and collect samples for analysis of diet quality using near infrared (NIR) spectrometry; we can then relate these measures to male display effort measured during controlled courtships with the fembots and to observations of male mating success. This allows us to examine links between ecology, off-lek foraging
behaviors, foraging success, display behaviors and fitness. In future work, we will examine how male behaviors relate to the topography and vegetation cover on and around the lek using data collected with Unmanned Aerial Systems, LiDAR and Terrestrial Laser Scanning.

Applications of Biomimetic Robotics:

**Example 1:** Breeding behavior


**URL:** doi: 10.1093/beheco/arp155

**Summary:** Examines tradeoffs in male sage-grouse courtship between display quantity (strut rate) and acoustic quality, and how males may tactically adjust their displays to avoid such tradeoffs. Used controlled approaches of the robotic female sage-grouse to experimentally induce changes in male display rate, and measure consequent changes in quality. Found that unsuccessful (non-mating) males face a tradeoff between quantity and quality, whereas successful males appear to tactically allocate their limited display energy by responding to female behaviors.

**Example 2:** Breeding selection


**URL:** http://dx.doi.org/10.1642/AUK-14-63.1

**Summary:** Examines variation among male sage-grouse in a non-vocal sound, the “swish”, produced during courtship displays when males rub their wing feathers across highly-modified feathers on their chests. Used controlled approaches of the robotic female sage-grouse to experimentally induce courtship in males. Found significant variation among males in these sounds, but no relationship between the acoustic features of the sound and male mating success.

**Other Applications and Reviews:**


**Resources:**

Futaba remote controller systems:

Tank kit for chassis:
Taxidermy body form for robot:
http://www.mckenziesp.com/GBF17-P4878.aspx
Camera for robot:
http://www.veho-muvi.com/muvi_product/muvi-pro-micro/

Acknowledgements
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Use of camera traps to record activity on sage-grouse leks

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Abstract

In-person counts of sage-grouse at leks are vital for informed sage-grouse management, but conducting these counts can be logistically difficult. Camera traps (i.e. automated trail or wildlife cameras) have been used in conjunction with numerous studies of wildlife species, but rarely on grouse leks. In a pilot study, we deployed five camera traps at known leks in central Wyoming over an approximately 10-day span. These cameras successfully captured images of sage-grouse using both ambient illumination and with the aid of built-in infrared flash. Grouse were visible almost every evening at all leks, and less commonly around midnight and after. We conclude that camera traps can be an effective tool when used in a targeted manner for documenting the presence of birds at leks. Further research is needed to develop methodology to achieve counts that are comparable to in person counts by human observers. Additionally, the frequent evening lek attendance we observed could indicate the occurrence of critical breeding behaviors at this time; therefore, future efforts to control disturbance at sage-grouse leks may need to consider at dusk activity as well as dawn.

Introduction

Grouse biologists use a variety of techniques to assess the health and trajectory of populations including monitoring the fates of nests and broods, collecting wings from hunters, and pellet counts (Connelly et al. 2003). Among the most important measures are visual in-person counts of males at traditional lek sites (Patterson 1952). Typically, these are conducted by experienced observers who visit around or shortly after dawn to record the maximum number of visible males and females. Although the goal of lek counts is to get as close to a true census of the local population of males as possible, individual grouse can vary in their detectability based on factors such as topography and cover (Walsh et al. 2004, Fremgen et al. 2016). Additionally, remote leks can be difficult to access, a fact that is compounded by the need to conduct multiple counts each season (Fedy and Aldridge 2011).

Given these challenges, grousse biologists are embracing new technologies to supplement in-person lek counts. For example, infrared imaging may be able to improve aerial counts at leks (Gillette et al. 2015). Autonomous recording units have also been used to detect based on sound the presence of sage-grouse (Beatrix Prieto Diaz, pers. comm.) and other grouse species (Venier et al. 2012), and have been used to estimate colony size in other bird species (Borker et al. 2014, Oppel et al. 2014). Genetic identification based on DNA from feathers has also been used in some cases (Bird et al. 2013). Camera traps (i.e. automated trail or wildlife cameras) have been used in several studies of sage-grouse, but primarily to document nest fate (Holloran and Anderson 2003, Coates and Delehanty 2008). While camera traps have been used to count lekking males in other grouse species (Gregersen and Gregersen 2014), they have not yet received widespread use for sage-grouse. We could find no published reports of their use for lek monitoring on this species, although researchers have used them occasionally to document occupancy (Joel Nicholson, pers. comm.; Brian Maxfield, pers. comm.) or for education and outreach purposes (Nature_Conservancy 2016).

Our goal is to demonstrate the utility of camera traps for documenting the presence of sage-grouse at leks. We were particularly interested in determining patterns in the evening and at night. Although lek activities at these times have been documented, few studies have systematically recorded lek activity outside of the traditional dawn period (Hartzler 1972, Jenni and Hartzler 1978).

Methods

This study took place in the Government Draw area approximately 30km from Lander, Fremont County, Wyoming. The primary landholder in this locality is the U.S. Bureau of Land Management. The site contains multiple known leks, and is the site of ongoing studies of sage-grouse behavior and ecology (e.g., Krakauer et al. 2009, Patricelli and Krakauer 2010, Blickley et al. 2012a, Blickley et al. 2012b, Koch et al. 2015). Cameras were deployed from 20 April through 01 May 2016, with the full moon occurring on 21 April, 2016.

The cameras (n = 5; HyperFire models HC500 and HC600; Reconyx, Holmen, WI) were deployed one each on five separate leks. These models automatically fire an infrared flash in low light conditions. The cameras were set to capture a single photo using the time-lapse surveillance mode (photos every 5 or 15 minutes), starting at 1800H, and operating through the night until either 0600H or 1000H, depending on the lek. We chose this mode rather than the motion sensor mode because the motion sensor requires significant lateral movement to trigger an image capture event, which we believed might bias
image capture towards the periods of highest activity and attendance. Time-lapse has been used in other studies (e.g., Gregersen and Gregersen 2014), and we did not test the motion sensor mode in this study.

Cameras were affixed to ~59 cm long survey stakes using bolts drilled through the top of the stake approximately 6 cm from the top (Figure 1). We observe very little human presence at these leks during the sage-grouse breeding season; researchers working on more accessible leks may wish to lock cameras to a more firmly anchored support in order to deter theft. Each stake was placed approximately 5-15 m from an area in which males were observed during prior morning counts at the lek. While our camera placement was guided by these observations, we believe one could use cues of high-use territories—clusters of fresh fecal pellets and ceacal casts—to determine likely targets for the camera. Some refinement of camera placement was needed even with our advanced scouting. In 2 cases, the camera had to be repositioned to improve the view, and in another case the stake was knocked over by unknown wildlife.

Figure 1. Image of the camera support used in this study. We have deployed small survey stakes on leks to facilitate territory mapping and to hold microphones as part of microphone arrays, and have observed no negative impacts over 10 years of observations.

Research was carried out under Wyoming Department of Game and Fish permit no. 405 and University of California Davis Institutional Animal Care and Use Committee no. 18080.

**Results**

We placed camera traps on five known leks, and successfully captured images of sage-grouse on all five leks (Figure 2, 3). Male sage-grouse were present in both the morning and evening on all five leks. Males were often present in the first frames of evening recording (i.e., 1800 h), suggesting they likely arrived earlier. Attendance in the evening typically extended for approximately 1 hour after dark, except for around the full moon (21 April 2016) when it lasted for much of the night. Most photos showed males in display.

Figure 2. Examples of images of greater sage-grouse captured. The top panel shows several males in display under bright late-afternoon sun (1900 h). The bottom panel shows 2 males courting a hen at 0325 h.
Figure 3. Summary of greater sage-grouse detections across five leks—three letter lek codes along the top indicate data for that lek. Blue symbols indicate photographs in which the camera-trap’s on-board flash fired (i.e., night), orange symbols indicate images using only natural light. The gray shaded areas represent times each camera was off and no photos were taken. Photos in which at least one male was found in display posture are indicated by a (+) symbol; circular points indicate exclusively rest, foraging, or other behaviors. Phenomena of interest include consistent evening attendance even before the sun set and relatively rare attendance in the middle of the night (heavy nocturnal attendance mostly around 22 April and 23 April). Additionally, note the late morning attendance on 24 April at GUS, LAV, and MNT that occurred with no dawn attendance, likely due to a weather event that limited more typical attendance patterns.

Discussion
We observed fairly synchronous patterns of frequent evening and night lek attendance at all five leks. This result is perhaps not unexpected given the nocturnal observations of birds on leks reported previously (Hartzler 1972, Jenni and Hartzler 1978), but was nonetheless surprising for us despite more than a decade of intensive work at these leks. We had occasionally encountered male sage-grouse on leks between 0100 and 0400, particularly during brighter lunar phases, and we often arrived at leks predawn to find males already in attendance, but had only rarely found sage-grouse on leks before midnight during our occasional visits in the late afternoon and evening.

The relative synchrony in evening and night attendance across leks suggests that attendance patterns could be driven in part by responsiveness to large-scale variation in environmental factors such as weather or lunar phase and not exclusively to local factors such as stochastic encounters between males and females near the lek outside of the ‘standard’ morning activity window. Further study is needed to
characterize these factors. Even without understanding all the mechanisms governing daily attendance patterns, it is worth noting the high frequency with which males attended leks around dusk and into late morning (see also Hartzler 1972, Jenni and Hartzler 1978). If these patterns are found in other populations as well, it suggests that guidelines for reducing disruptions at leks should extend beyond morning lekking periods to cover additional times around dusk and later into the morning.

Given how frequently our cameras were able to successfully photograph sage-grouse, we believe that camera traps may be an important tool for assessing lek activity. Once the cameras are aimed and provided field assistance, J. Forbey provided advice and numerous recording units of Centrocercus urophasianus. PLoS ONE—s expensive than manned overflights of leks, although they do require at least two in-person visits to set up and then collect the units (although these visits can occur at any time during the day). In-person counts are likely to remain the standard survey method given the flexibility in timing and the ability to collect additional data, but they require early morning access to each lek. It is noteworthy than on one morning (24 April) during our study, our cameras detected birds arriving at multiple leks at close to 10AM after being absent all morning. This is well after most in-person counts would have concluded and therefore an in-person count would have resulted in no birds detected on that day.

In conclusion, camera traps exhibit great potential to aid sage-grouse managers in determining whether a lek is occupied and in characterizing daily patterns of attendance. This information can help managers more efficiently allocate observers to leks that are occupied and reduce morning visits to unoccupied leks. It is unlikely that the methods we describe in this study—close targeting of specific display areas—could provide complete counts of males at all but the smallest, most open leks. But camera traps could be combined with alternative techniques for complete counts, such as different equipment (e.g. video cameras, higher resolution still cameras) or in-person observations, to collect a combination of quantitative counts and attendance patterns for sage-grouse and other lekking grouse species.

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References


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Project in progress: the impact of wind turbines on Capercaillie
Joy Coppes

In *Grouse News* 45 we introduced a research project studying the effects of wind turbine construction on Capercaillie (*Tetrao urogallus*). Although we are collecting field data since 2012, officially our project started July 2014. In this five year project (until 2019), we are applying a before-after-control-impact (BACI) design and several methods to study the effects of wind turbine construction on Capercaillie.

During the first years of the project data was mainly collected in areas before wind turbines were constructed and control areas. We selected areas were wind turbines were planned to be constructed within the next years and for each wind power area a reference area without wind turbines was selected. In several of our study areas it became clear wind turbines would likely not be constructed within our study period, resulting in a reduction of number of study areas. Currently there are several study areas with a before-after-control-impact design in Germany (N=2) and Austria (N=3). In Sweden a wind park is studied with an after-control study design since no data is available from before the wind park was constructed.

In this study we apply several methods mainly focusing on the indirect effect (i.e. disturbance / displacement) caused by wind turbines. Our study methods range from habitat analysis and searching for indirect Capercaillie signs (i.e. feathers, droppings) to genetic analysis and analyzing stress hormones in droppings. In the Swedish study area the main focus is on using GPS telemetry to assess the effects of wind turbines on capercaillie behavior and on measuring reproductive success using wildlife detection dogs to study the effect of the turbines on the reproduction. There are few records of grouse colliding with wind turbines; unfortunately these are generally not well documented. We hope to get more detailed documented cases to gain insight into the effects and scale of collisions with wind turbines. Due to the BACI study design, we do not expect results before the end of 2019. We are still open for more collaborations or new study areas to include in this study. For more information on the project partners, study methods or grouse collisions feel free to contact me or visit our website: [www.capercaillie-windpower.com](http://www.capercaillie-windpower.com).

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NEW BOOKS

The North American Grouse, their biology and behavior
New book on grouse from Paul A. Johnsgard.

In 1983 Paul Johnsgard published a book on *The grouse of the World* dealing with biology and distribution of the different species. This year he has written a book of the North American grouse species.

Abstract
The ten currently recognized species of grouse in North America have played an important role in America’s history, from the famous but ill-fated heath hen, a primary source of meat for the earliest New England immigrants, to the ruffed grouse, currently one of the most abundant and sought after upland game birds in more than 40 states and provinces. This book summarizes the ecology, reproductive biology, and social behavior of all ten of the extant North American grouse species. It also describes the current status of grouse populations, some of which are perilously close to extinction. The social behavior of grouse is of special biological interest because among these ten species there is a complete mating system spectrum, from seasonally monogamous pair-bonding to highly promiscuous mating patterns. The latter group illustrates the strong structural and behavioral effects of sexual selection resulting from nonmonogamous mating. These influences reach a peak in the development by some grouse species of engaging in mating “leks,” arena-like competitions performed by males while attempting to attract fertile females, and also provide opportunities for females to select optimum mating partners. These sexual competitions also promote strong differences evolving in sexual signaling behaviors (“displays”) among closely related species. Nevertheless, a relatively high incidence of mating errors and resulting hybridization often occurs in spite of these marked behavioral differences. In addition to a text of 101,000 words, the book includes 16 range maps, 37 line drawings, and 38 photographs by the author, as well as nearly 1,400 literature citations.

CONFERENCES

The 33rd International Union of Game Biologists Congress - 14th Perdix Symposium

Dear colleagues

We are glad to remind you that the 33rd IUGB congress will be held from the 22nd to the 25th August 2017 in Montpellier, France. The 14th Perdix Symposium will also be hosted as a special session. Many workshops will be proposed as well.

We kindly invite you to submit an abstract (http://iugb2017.com/submit/) to present your last research works. Don’t miss the December 31st deadline!

For more information, please visit our website at http://iugb2017.com/

STAY TUNED:

We look forward to your proposals and to seeing you in Montpellier next August!

Best regards,
The 33rd IUGB Organizing Committee

iugb2017@gmail.com

Summary of talks on grouse for 3 conferences
Mike Schroeder and Leslie Robb

The biennial Sage and Columbian Sharp-tailed Grouse Workshop

The biennial Sage and Columbian Sharp-tailed Grouse Workshop was held in Lander, Wyoming during 13–17 June 2016. This was the 30th meeting of this group. The workshop included 177 attendees and 90 presentations on greater sage-grouse, Gunnison sage-grouse and sharp-tailed grouse. Those who attended this meeting are going to remember this meeting for the spectacular fieldtrip to some of the best remaining sage-grouse habitat in North America. This fieldtrip was further enhanced by the presence of Haven Wiley, who conducted behavioral work on sage-grouse in the area. His publication of observations of sage-grouse behavior in Scientific America was a seminal work in the world of grouse. The organizer of the conference Tom Christianson (Wyoming Game and Fish Department) was able to put current observations of grouse into a historical context that was extremely instructive to all those who attended. The following is a list of talks with the senior author listed.

Geophagy and movement of greater sage-grouse in the Upper Green River drainage (Bryan Bedrosian)

Attendance, stability, and the distribution of matings on greater sage-grouse leks (Gail Patricelli)

Reproductive state leads to habitat partitioning in female greater sage-grouse with implications for survival (Kurt Smith)

Late summer habitat as a limiting factor for fitness in greater sage-grouse (Phillip Street)

Reproductive costs for female greater sage-grouse in northern Nevada and southern Oregon (Tessa Behnke)

Survival of translocated sharp-tailed grouse: temporal threshold and age effects (Steven Mathews)

Augmentation of Columbian sharp-tailed grouse populations in Washington (Michael Schroeder)

Gunnison sage-grouse translocations: using genetic information to assess genetic implications of translocations (Shawna Zimmerman)
The oxymoron of treating sagebrush for sage-grouse: long-term response to brooding habitat management in Utah (David Dahlgren)

Detecting and counting prairie grouse with high resolution cooled infrared and high definition video camera from aerial platforms (John Romero)

Applying ecological site concepts to assess greater sage-grouse habitat suitability in southeastern Montana (Nathan Wojcik)

Predicting landscape vegetation from microhabitat measurements (Aaron Pratt)

Spatially explicit modeling of annual and seasonal habitat for greater sage-grouse in Nevada and northeastern California (Brianne Brussee)

Using resilience and resistance concepts to develop a strategic approach for managing threats to sagebrush ecosystems and Gunnison and greater sage-grouse in their eastern range (Tom Christiansen)

Effects of mowing and herbicide treatments on the nutritional quality of sagebrush in central Wyoming (Jason LeVan)

Effects of livestock grazing practices on greater sage-grouse nest survival (Seth Dettenmaier)

Evaluation of population monitoring strategies for greater sage-grouse in northwest Colorado: genetic mark-recapture as an alternative to traditional lek counts (Jessica Brauch)

Hierarchical clustering of greater sage-grouse leks: a method to inform long-term monitoring of population persistence, sinks and sources (Michael O’Donnell)

Multi-scale statewide Wyoming greater sage-grouse population viability analysis based on nested lek clusters (David Edmunds)

Sage-grouse management in the genomics age: insights into local genetic adaptation and population differentiation (Kevin Oh)

Assessing range-wide genetic connectivity in greater sage-grouse using genetic techniques (Steve Knick)

Using population and landscape genetics to assess connectivity of greater sage-grouse across Wyoming (Brad Fedy)

Greater sage-grouse hierarchical population structure and genetic diversity across the northeastern range: a comparison to contemporary landscapes and management boundaries (Todd Cross)

The range-wide network of priority areas: implications for long-term conservation of greater sage-grouse from graph theory (Steve Knick)

Using public grazing records to model sage-grouse population trends (Adrian Monroe)

The influence of rest-rotation grazing and long-term grazing termination on the abundance and diversity of food arthropods of greater sage-grouse in central Montana (Hayes Goosey)

Effects of spring-season cattle grazing on greater sage-grouse (Courtney Conway)

Fitness consequences of migration strategy and seasonal habitat protections for greater sage-grouse (Jonathan Dinkins)

Incubation recess movements of greater sage-grouse in Nevada (Jonathan Dudko)

Influence of transmission line construction on winter sage-grouse habitat use in southern Utah (Erika Hansen)

Partnering to provide data to implement the sage-grouse habitat assessment framework (Vicki Herren)

Short-term response of greater sage-grouse to habitat treatments in Wyoming big sagebrush (Jason LeVan)

Encounters with pinyon-juniper Influence riskier movements in greater sage-grouse across the Great Basin (Brian Prochazka)

Double brooding observed in a Columbian sharp-tailed grouse in Idaho (Matt Proett)

Space and resource use of shrub-steppe habitat by common ravens at the Yakima Training Center, Yakima, WA (Brandon Rossi)
Identification of Columbian sharp-tailed grouse lek sites in south central Wyoming (Kurt Smith)
Modeling survival using radio telemetry data when detection is not perfect due to collar failure and sampling constraints (Phillip Street)
Sage-grouse as umbrella species in northwestern Colorado (Jennifer Timmer)
Robert Patterson’s Dry Sandy Lek #31 -- 20 and 65 years later (Haven Wiley)
Applying ecological site concepts to assess greater sage-grouse habitat suitability in southeastern Montana (Nate Wojcik)
CyberTracker: paperless data collecting and management for field research (Brandon Flack)
Accelerated cycle of wildfire and invasive grass negatively impact sage-grouse populations in the sagebrush sea of the Great Basin (Peter Coates)
Seasonal movements, site fidelity and resource selection of greater sage-grouse following large scale wildfire (Lee Foster)
Reducing cropland conversion risk to sage-grouse through strategic conservation of working rangelands (Joe Smith)
Influence of human activities and environmental change on greater sage-grouse population trends: hunter harvest, anthropogenic development, fire and weather (Jonathan Dinkins)
The effects of a wind energy development on a greater sage-grouse population (Chad LeBeau)
The influence of wind energy development on nesting ecology of Columbian sharp-tailed grouse in eastern Idaho (Matt Proett)
Predicting greater sage-grouse nest sites using guideline-based micro-habitat indicies (David Musil)
Validating landscape disturbance models for the greater sage-grouse in Colorado (Amy Pocewitz)
Rage in the sage: Identifying potential Gunnison sage-grouse lek sites using spatially explicit modeling (Douglas Ouren)
Greater sage-grouse responses to climate change and future energy development in Wyoming (Cameron Aldridge)
Importance of regional variation in conservation planning and defining thresholds for a declining species: a range-wide example of the greater sage-grouse (Kevin Doherty)
CyberTracker: paperless data collecting and management for field research (Brandon Flack)
Conserving migratory mule deer through the umbrella of sage-grouse (Holly Copeland)
Extending conifer removal and landscape protection strategies from sage-grouse to songbirds, a range-wide assessment (Jason Tack)
Factors influencing timing of greater sage-grouse migration (Aaron Pratt)
Predators, predator management, and sage-grouse: a review (Michael Conover)
Resource denial as a means to reduce avian predation of greater-sage-grouse (Robert Lewis)
The role of local working groups in sage-grouse conservation in Utah: policy and management (Terry Messmer)
Public lands and private waters: scarce mesic resources structure land tenure and sage-grouse distributions (Jeremy Maestas)
Temporal-dampening and period-shifting in the range-wide cyclic dynamics of greater sage-grouse (Brad Fedy)
Streamlining sage-grouse environmental regulation through a GIS-enabled web application (Nicholas Graf)
Wyoming sage-grouse core areas: influences on energy development and male sage-grouse lek attendance (Scott Gamo)
Effectiveness of landscape management practices for landscape species: are core areas working to protect sage-grouse? (Emma Spence)
The combined influence of landscape management, core areas and local habitat structure on sage-grouse conservation across Wyoming (Emma Spence)

Effectiveness of core area conservation metrics for sage-grouse: can we identify disturbance thresholds? (Jeffrey Beck)

Pinyon and juniper encroachment into sagebrush ecosystems impacts distribution and survival of greater sage-grouse (Mark Ricca)

Translating conservation actions through spatial modeling: Gunnison sage-grouse response to conifer removal (Jacob Hennig)

Greater sage-grouse resource selection drives reproductive fitness in conifer removal system (Charles Sandford)

Short-term response of sage-grouse to landscape scale conifer removal in the northern Great Basin (John Severson)

The 3rd North American Congress for Conservation Biology
The 3rd North American Congress for Conservation Biology was held in Madison, Wisconsin during 17–20 July 2016. The conference attendance was more than 1000 individuals from the United States, Canada, and other countries. Andrew Gregory and Emma Spence of Bowling Green State University organized a symposium titled “Impacts of anthropogenic habitat modification associated with agriculture and energy development on prairie-chicken”. The symposium primarily dealt with management problems and directions for greater sage-grouse and greater and lesser prairie-chickens in rapidly changing political and ecological environments. The following is a list of talks.

Impacts of a human disturbance on greater prairie chickens (Emma Spence, Andrew Gregory, Breanna Powers, and Brenda Groskinsky)

Effectiveness of Wyoming’s core area protections for greater sage-grouse winter concentration areas (Jeffrey Beck, Jonathan Dinkins, Kurt Smith, Kirstie Lawson, and Aaron Pratt)

A policy analysis of greater sage-grouse protection plans in Wyoming, Montana and Oregon (Andrew Kear, Emma Spence, and Andrew Gregory)

Do transmission lines negatively impact greater sage-grouse In Washington State, USA? (Michael Schroeder)

Greater sage-grouse responses to climate change and future energy development in Wyoming (Julie Heinrichs, Michael O’Donnell, Cameron Aldridge, Steve Garman, Collin Homer, and Nathan Schumaker)

Influence of sound on nesting ecology of the lesser-prairie chicken (Tom Lipp)

Conservation planning for lesser prairie-chickens among reproductive and survivorship landscapes of varying anthropogenic influence (Dan Sullins, David Haukos, John Kraft, Joseph Lautenbach, Jonathan Lautenbach, Reid Plumb, Smantha Robinson, and Beth Ross)

Lesser prairie-chicken space use response to anthropogenic structures among landscapes (Reid Plumb, Joseph Lautenbach, Samantha Robinson, John Kraft, Dan Sullins, Jonathan Lautenbach, David Haukos, Virginia Winder, James Pitman, Christian Hagen, and David Dahlgren)

The Wildlife Society 23rd annual conference
On 15–19 October 2016, The Wildlife Society held its 23rd annual conference in Raleigh, North Carolina, USA. The conference was attended by approximately 1,900 individuals including researchers, biologists, managers, administrators, and students from universities, government agencies, non-governmental organizations, and others. The Wildlife Society and their flagship journal, “The Journal of Wildlife Management” have historically provided great opportunities for exchanging and presenting ideas about grouse. Although this legacy dates back to the origins of The Wildlife Society, the 2016 conference was one of the most significant gatherings of grouse researchers outside of the grouse-specific meetings. For example, there was a special symposium titled “Ecology and conservation of North American forest grouse: past, present, and future” that had an accompanying poster session. There were also numerous talks and posters on grouse that were part of other sessions. A total of 38 papers and posters on grouse
were presented. In a striking departure from recent trends, only 7 of the 38 presentations dealt with sage-grouse. A list of the presentations follows.

Multi-species benefits under the umbrella of sage grouse (David Naugle)

Expansion on western rangelands: prairie grouse as focal species for strategic ecosystem restoration (Jeremy Maestas, David Naugle, and Christian Hagen)

Satisfying the quilt work of habitat needs of the lesser prairie-chicken: the role of patch-burn grazing (Jonathan Lautenbach, David Haukos, and Christian Hagen)

Are larger pastures and sparser herds the way to manage grassland birds? A case-study of the lesser prairie-chicken (John Kraft, David Haukos, Christina Hagen, and Jim Pitman).

Ruffed grouse drumming log preferences near Tomahawk, Wisconsin (Jeffrey Williams, Holly North, Samuel Lau, Benjamin Tjepkes, and Jason Riddle)

Spatial and Temporal Trends in Density and Site-Occupancy of Ruffed Grouse in Maine (Kelsey Sullivan, Erik Blomberg, Marie Martin, and Amanda Demusz)

Dusky Grouse Ecology and Management in Utah (Skyler Y. Farnsworth, David K. Dahlgren, and Eric T. Thacker)

Effect of Forest Structure on Nest Site Selection by Spruce Grouse across Two Spatial Scales (N. Scott Parkhill, Joel M. Tebbenkamp, Stephen W. Dunham, Daniel J. Harrison, and Erik J. Blomberg)

Summer Habitat Selection by Non-Reproductive Ruffed Grouse in Maine (Joelle Mangelinckx, Erik J. Blomberg, Samantha Davis, Brad Allen, and Kelsey Sullivan)

Seasonal Survival and Harvest Rates of Ruffed Grouse in Central Maine, USA (Samantha Davis, Erik Blomberg, Joelle Mangelinckx, Brad Allen, and Kelsey Sullivan)

Trap and Transfer of Spruce Grouse from Maine and Ontario into New York to Boost Local Populations and Help Maintain Long-Term Population Viability in New York (Angelena Ross, Tom A Langen, and Glenn Johnson)

Susceptibility of Ruffed Grouse to West Nile Virus (Justin D. Brown, Lisa M. Williams, Richard A. Bowen, Angela M. Bosco-Lauth, and Nicole M. Nemeth)

Behavior and Nesting Ecology of Appalachian Ruffed Grouse (Brian W. Smith, Andrew N. Tri, Chris A. Dobony, John Edwards, and Petra Bohall Wood)

Landscape Capability as a Predictor of Upland Game Bird Space Use in the Northeastern United States (Zachary Lohman)

Are Sooty Grouse Associated with Big Trees Throughout California? (James Bland)

Surveillance for Lymphoproliferative Disease Virus in Wild Upland Gamebirds in Pennsylvania (Justin Brown, Christopher Cleveland, Lisa Williams, Mary Jo Casalena, and Michael Yabsley)

Display behavior of male ruffed grouse in two key cover types in Minnesota (Lorelle Berkeley and Rocky J. Gutiérrez)

Nest-Site Selection and Nesting Success of Ruffed Grouse in Maine (Joelle Mangelinckx, Erik J. Blomberg, Samantha B. Davis, Brad Allen, and Kelsey Sullivan)

Habitat Selection and the Effects on Male Ruffed Grouse Display Behavior and Performance in Central Maine, USA (Samantha Davis, Erik Blomberg, Joelle Mangelinckx, Brad Allen, and Kelsey Sullivan)

Is Autumnal Display Associated with Territorial Defense Or Mate Prospecting? A Case Study with Spruce Grouse (Joel M. Tebbenkamp, Erik J. Blomberg, Daniel J. Harrison, and Rebecca L. Holberton)

Resource Denial as a Means to Reduce Avian Predation of Greater Sage-Grouse (Robert J. Lewis and Michael Conover)

A Ground-Based Lidar Test of GAP-Intercept Applications to Estimate Mean Shrub Height within Greater Sage-Grouse Nesting Habitat (Khodabakhsh Zabihi and Kenneth L. Driese)

The Effects of a Wind Energy Development on a Greater Sage Grouse Population (Chad Lebeau, Gregory Johnson, Matthew Holloran, Jeffrey Beck, Ryan Nielson, Mandy Kauffman, Eli Rodemaker, and Trent McDonlad)

Assessing Potential Synergies between Drought and Grazing on Lesser Prairie-Chicken Demographics (Sarah Fritts, Blake A. Grisham, Robert D. Cox, Clint W. Boal, David A. Haukos, and Patricia McDaniel)

Reproductive Costs for Female Greater Sage-Grouse in Northern Nevada and Southern Oregon (Tessa L. Behnke, Phillip A. Street, Levi A. Jaster, and James S. Sedinger)


Lesser Prairie-Chicken Foraging in Native and CRP Grasslands of Kansas and Colorado (Daniel S. Sullins and David A. Haukos)

Determining the Temporal Nesting Ecology and Changes in Predator Communities of Wisconsin Greater Prairie-Chickens (Rachel Konkle, Matthew Broadway, Jason Riddle, Scott Hull, Michael Hardy, and Benjamin Zuckerberg)

Forest grouse in North America: a rich heritage (Michael Schroeder)

Phylogeography, classification, and management units of North American forest grouse (George Barrowclough, Michael Schroeder, and Rocky J. Gutiérrez)

Forest management trends and implications for ruffed grouse conservation in the Eastern United States (Meadow Kouffeld-Hansen)

Landscape dynamics, spatial heterogeneity, and grouse conservation in upper Michigan: A new business model? (R. Gregory Corrace, III)

The Appalachian Cooperative Grouse Research Project (Dean Stauffer and Gary Norman)

Forest grouse harvest management in North America (Dave Dahlgren)

Escaping the winter: ruffed grouse display strong behavioral plasticity in use of snow roosting (Amy Shipley and Benjamin Zuckerberg)

Emerging issues for forest grouse conservation in western North America, a fresh look at some familiar problems (Eric Thacker)

Intergrating new technologies in forest grouse research and management (Erik Blomberg)

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RECENT GROUSE LITERATURE

For a complete bibliography on grouse, go to: http://www.suttoncenter.org/about/publications/ (please note that the link in previous editions may not be current).


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molecular discrimination within the Mesocestoides species complex. Parasitology Research XXX:XXX-XXX (online early) (Rock Ptarmigan).


Widén, E. 2016. Hur påverkas tjäder (Tetrao urogallus), orre (Tetrao tetrix) och järpe (Bonasa bonasia) av dagens moderna skogsbruk? [How is the Capercaillie (Tetrao urogallus), Black Grouse (Tetrao tetrix) and Hazel Grouse (Bonasa bonasia) of today’s modern forestry?] Unpublished paper, Independent Project in Biology, Uppsala University. (in Swedish).


