2015 Campbell County, Wyoming Raptor Symposium Proceedings

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Ecosystem Research Group, Editors[1]

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List of Acronyms

ADC	Rocky Mountain Avian Data Center
AMKE	American kestrel
ANS	Artificial nest structures
BACI	Before-After-Control-Impact
BAEA	Bald eagle
BFO	Buffalo Field Office
BLM	Bureau of Land Management
BUOW	Burrowing owl
CBM	Coal-bed methane
COHA	Cooper's hawk
DEQ	Department of Environmental Quality
FEHA	Ferruginous hawk
GHOW	Great horned owl
GOEA	Golden eagle
km	Kilometer
LEOW	Long-eared owl
m	Meter
MERL	Merlin
mi	Mile
NGO	Non-governmental organization
NOHA	Northern harrier
PRB	Powder River Basin
PRFA	Prairie falcon
RLHA	Rough legged hawk
RTHA	Red-tailed hawk
SA	Study area
SGIT	Sage-grouse Implementation Team
SEOW	Short-eared owl
SWHA	Swainson's hawk
TUVU	Turkey vulture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WGFD	Wyoming Game and Fish Department

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Acknowledgements

The Campbell County Commissioners thank the people of Campbell County for their support of our efforts to remain engaged in Federal land management policy and decision-making. This symposium represents one part of that effort to project a strong, clear voice for the interests of Campbell County. We thank Governor Matt Mead, who's vision of a balanced economy set the tone for this Symposium and who supported this symposium with funds from the Federal Natural Resource Policy Account. We also thank Converse County, Johnson County, the Bureau of Land Management, the U.S. Forest Service, the Wyoming Game and Fish Department, the Wyoming Natural Diversity Database, a part of the Natural Heritage Network, Devon Energy, and Sweetwater River Conservancy for all of their support. We thank Ryan Lance, for contributing his time and vision to the symposium. We thank Gillette College, for allowing us to use their space for the symposium, which contributed greatly to an atmosphere of learning and forward thinking. We thank Pete Obermueller and the Wyoming County Commissioners Association, who contributed their time to moderating and facilitating discussions around the science and policy of raptor conservation. Last but not least, we thank the presenters and attendees, who took time out of their busy schedules to come to Gillette and contribute to lively, informed, and productive discussions. We are confident that the momentum carried forward from this symposium will advance the science of raptor management. It is the attendees and presenters that will be making those advances. Thank you.

Executive Summary

Campbell County is a leading producer in Wyoming in the energy, agriculture, and tourism sectors. One of the questions facing Campbell County is, "How do we move forward with development in a way that provides an appropriate balance between the uses of our landscape?" This is a tough question, and one that needs to be answered by science, data, and cooperation. The challenges facing Campbell County are emblematic of the challenges facing the state and the country.

This symposium focused on the science that is needed to strike a better balance between energy development and raptor habitat protections in the Wyoming. Campbell County, Wyoming and this country as a whole may look to the outcomes of this symposium to help society strike a more appropriate balance between our need for energy and our need for wildlife habitat.

The Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940 require that federal land management agencies prevent the taking of birds protected by these acts. Stipulations to prevent these takings are based on limited data for many species and often vary by agency and locality. This symposium was designed to identify how the existing data can be used to improve the effectiveness and efficiency of stipulations that prevent the taking of protected birds and to identify the kinds of new data that are needed to make those same improvements. Lastly, this symposium was designed to foster greater cooperation between the entities engaged in surveying, monitoring, and decision-making regarding raptor habitat use and energy development.

Some of the issues that arose during this symposium included:

- How do individual species respond to disturbance?
- What is the status and trend of individual species?
- Are nest inventories sufficient to identify population level trends?
- Is nest monitoring sufficient to identify recruitment levels?
- Are there other limiting factors such as prey availability that need to be considered when modeling the effects of energy development on raptors?
- Are the established protective measures sufficient and consistent with the science?
- Should we be collecting data in a manner that allows us to model the sustainability of a species?
- How can we better coordinate data collection and analysis to answer more landscape-scale questions?

Summary of Technical Session 1: Latest research conclusions

Slater presentation

Slater's research found a negative relationship between raptors habitat use and oil and gas development in the Price and Rawlins areas, therefore current stipulations including buffer widths may not be sufficient for some species of raptors.

Slater could not evaluate population-level impacts of development using the historic data. He found that vegetation and climate variable influenced the relationship between development and raptors and influenced the breeding status of all raptor species. Raptor territories with artificial nest structures (ANS) exhibited a positive relationship with oil and gas development in this study.

Slater found that impacts of human uses on raptors were confounding due to habituation of raptors, lag effects, and landscape-scale effects. He recommended that future research include a Before-After-Control-Impact (BACI) study, which could allow for stronger inferences between raptors and energy development.

Carlisle presentation

Carlisle determined that with 3,412 nests and 14,764 nest observations over a 9 year period, there was a non-linear pattern of nest use over time. The observations showed that nests more than one-half mile (mi) away had greater nest use than nests less than one-half mi away, though the difference was not statistically significant.

This study found that a buffer of 1 mi would have an average observed difference in nest use of 15% inside versus outside the buffer and an 18% difference with a buffer of 1.5 mi. Both of these differences were statistically significant.

Carlisle saw the need for a controlled experiment that could provide greater clarity to the questions, "What drives non-linear patterns in nest use over time?" and, "What is an acceptable level of disturbance?"

Oakleaf presentation

The studies that Oakleaf presented suggested that ferruginous hawks (FEHAs) and golden eagles (GOEAs) are most threatened by losses of grassland habitat, disturbance at nest sites, and illegal shooting. FEHA occupancy is higher with the presence of ANS and GOEA can become habituated to development.

These studies suggest that other variables drove nest success more than density of post-construction oil and gas wells. The results of this research failed to support the a-priori prediction that energy development at current levels (300 to 400 wells per township) caused avoidance by FEHAs, however it is assumed that there are upper limits, such as the Jonah field. This study did not find a positive correlation between FEHAs and oil and gas development, as others have. Data from this study suggests that prey availability, not oil and gas development, is responsible for reduced GOEA nest occupancy.

Oakleaf suggested that BACI studies could make stronger inferences between raptors and energy development. He recommended a probabilistic, state-wide sampling effort.

Dwyer presentation

Dwyer presented raptor electrocution risk models that can be used to prioritize utility line upgrades to prevent electrocution and outages. There is the possibility that upgrades to transmission infrastructure could be involved in a program that seeks to offset take, such as for wind energy developments.

Technical Session 2: Current status of prairie associated raptors

Birek presentation

For population, status, and trend information on a large scale, Birek pointed to the availability of resources such as the Breeding Bird Survey, eBird, Raptor Population index, and Rocky Mountain Avian Data Center (ADC).

Birek suggested that most raptors are not disturbed by regular, established human activity, although new activity during the nesting season (March through August) can be deleterious. Raptors respond well to habitat improvements such as stock tank ladders and nesting and perching structures.

Birek has found that many species (i.e. short-eared owl [SEOW] and Swainson's hawks [SWHAs]) are hard to detect and population data is very limited.

Technical Session 3: Inventory and monitoring of raptors

McKee presentation

McKee has found that monitoring territories instead of nests enhances mitigation planning and effectiveness, but requires operator investment and understanding of the value of territory monitoring. The currently available data is mostly limited to energy development sites and ignores undeveloped portions of the landscape.

McKee said that disparities in regulations and different operator rules increases the difficulty of mitigation planning. Disparities in timing and spatial restrictions among agencies results in significant challenges when planning operations. McKee has also found that disparities in survey requirements make wide-ranging comparisons across data sets more difficult.

Vetter presentation

Vetter has found that survey protocols do not necessarily require the collection of information that may serve important raptor management needs. Those needs include population monitoring, assessing impacts from oil and gas development, and the implementation of successful mitigation measures.

Raptor information collected for oil and gas development is generally limited to surveys rather than monitoring. Often, the data from overlapping or adjacent developments varies in spatial extent and uses and contributes to differing agency or jurisdictional datasets.

Vetter identified numerous data gaps that limit the information regarding the impact of development on raptors. Those gaps are listed in the text for this presentation.

Vetter said that current objectives for raptor surveys and inventories related to oil and gas projects do not include the following, but perhaps should for the benefit of raptors and industry as a whole:

1. Contribute to raptor population information and trends,
2. Provide a better means of understanding oil and gas impacts,
3. Contribute to more effective mitigation or to more effective mitigation planning.

Data collection to satisfy the first objective (above) should broaden the spatial and temporal coverage of surveys and inventories, include more targeted species efforts, and should standardize data collection between entities for addressing population trend analysis.

Data collection to satisfy the second objective (above) should measure the proximity to and nature of disturbance and should collect data on factors that influence or compound raptor nesting outcomes.

Data collection to satisfy the third objective (above) should take a landscape-level approach to monitoring, gather territory and spatial use information, and gather information about tolerance to disturbance.

Ostheimer presentation

Ostheimer said that the majority of the data in the Buffalo Field Office (BFO) Raptor Database was collected by oil and gas consultants to plan and permit gas wells. The data is not very useful for answering population level questions and negative data is not recorded. Ostheimer said that the database is not useful for interpreting how well conservation measures are working.

Ostheimer has found that problems with the existing data system include duplicate nest data and redundant nest visits. The database is also not coordinated with other datasets. He suggests that there should be a real-time, web-based system that is populated routinely throughout the field season. This could be modeled after the greater sage-grouse lek database housed by the Wyoming Geographic Information System Center.

Byer presentation

Byer said that an estimated 85% to 90% of raptor nest locations within Thunder Basin are known and that the U.S. Forest Service (USFS) database is not public because it contains data about several sensitive species. The problems with the database include its unwieldiness, its maintenance cost, and the nest data is not consistent with other agencies.

Byer said that concerns with adding a centralized database included the additional cost of adding another database to the system, Thunder Basin data needs to be consistent with USFS reporting requirements, and some data is sensitive and caution may be warranted before releasing this data to the public.

Beauvais presentation

Beauvais said that the three questions that can help target the science regarding raptor disturbance and oil and gas development are:

1. What is the target organism (species, subspecies, and distinct population segment)?
2. Where is the target organism (range, distribution, seasonal habitats)?
3. How is the target organism doing (trends, viability, threats)?

Beauvais said that we need good data to have good information in order to make good management decisions regarding raptors. For data to produce the best possible higher-level models and estimates it needs to be collected with those eventual models and

estimates in mind, this is the basis of targeted data collection. But, he said, even simple count data and opportunistic data can be used to build useful information products if done with care and attention.

In the case of regional raptor ecology and management, Beauvais said that we have some targeted data collection that feeds specific models and we have a lot of count and opportunistic data that informs site specific decisions with only minimal analysis or modeling, therefore the questions are, "Is this body of science adequate for management?" and, "Can it be better?"

'Summary Points' and 'Next Steps'

These points were brought up during a discussion amongst Symposium attendees and presenters with regard to the questions, "What have we learned during this symposium so far?" and, "Where do we go from here?"

- There is a lack of prey density data over the broader region.
- There is a real opportunity to monitor trends in FEHA and GOEA data.
- This would be a good starting point to answer the question, "Is energy development affecting occupancy by raptors?" The data is available.
- Are there ways to start standardizing data?
- The Bureau of Land Management's (BLM) Rawlins Field Office has a good model for 'monitoring without borders'; perhaps there could be a pre-survey meeting to monitor the Powder River Basin (PRB) as a whole.
- Perhaps we could create a protocol site for data that is already available.
- We should look at the Southern Wings program to see if we can affect issues on wintering grounds.
- We should be moving towards full life-cycle analysis for these raptor species.
- How are we going to bring together data to think about strategy in management?
- We should differentiate between project and landscape level data.
- We should take steps towards a centralized, state-wide database.
- We should investigate the effects of novel predators whose existence is subsidized by water developments.
- Could there be more non-governmental organization (NGO) cooperation for data collection?
- What other types of data should be collected (i.e. – disturbance levels, etc.)?
- There should be more research partnerships with industry and more outreach.

Technical Session 4: Panel Discussion

The following are key points from the panel discussion moderated by Pete Obermueller. The panelists included Becky Byram, Alison Lyon-Holloran, Andrea Orabona, Dennis Saville, Gary Beauvais, Patricia Sweanor, and Tim Byer.

- There should be a database clearinghouse for raptor data.
- The process of developing that clearinghouse should start with standardizing survey methodologies.
- It makes sense that the Wyoming Natural Diversity Database stores the data in the clearinghouse.
- Currently, we are missing a process for decision-making based on science and adaptive management regarding raptors.
- We need to convene a stakeholder group to address: 1) data standardization and storage, 2) monitoring standardization, 3) research questions, and 4) policy. The first three can be used to inform the fourth.
- It's good to remember what we've more or less always known - wildlife populations are dependent on precipitation and climate cycles.
- Seventy percent of the land out there is private; we need more partnerships with private land management in order to be successful.
- It does not seem we are getting enough research done that gives us a picture of the whole system. We need more of that kind of research.
- We need to: 1) identify a stakeholder group to address raptor disturbance issues, 2) identify objectives for addressing those issues, 3) establish a timeline for meeting those objectives.

Introduction

The Campbell County Commissioners are acutely interested in public land management. Campbell County is home to a great variety of natural resources and a thriving energy community. We look for smart, sustainable approaches to both resource conservation and appropriate energy development and evolution.

While working with the BLM, our state Game and Fish Department (WGFD) and our natural resources consultants (Ecosystem Research Group), we decided to investigate the effectiveness of broad brush conservation measures suggested for the local BLM Resource Management Plan. We determined that any review of energy issues and natural resources (in this case raptors) must include four broad categories of stakeholders; government agencies (federal, state and local), academia, the energy industry, and NGOs. We recognized from our earliest conversations that all four groups are key to making progress and changes to current approaches.

The presentations in these proceedings are organized into technical sessions one, two, three, and four as they were at the symposium. Each presentation includes an abstract submitted by the author(s). The key findings and conclusions and recommendations written by the presenters and the editors. The editor's notes are an attempt to synthesize the material from the presentations.

The 'next steps' section, which follows the presentations, is a result of a brainstorming session with attendees after the presentations and before the panel discussion. During this brainstorming session, the editors recorded items from the session on a whiteboard. Items included in the next steps section include answers to, "Where do we go from here?", "What were the themes of this symposium?", and "What issues shall we discuss in the panel discussion?" The panel discussion section in Technical Section 4 was written by the editors from a review of the symposium video. An executive summary, written by the editors proceeds this introduction and several appendices appear at the end, including presenter bios, a list of attendees, and a recommended reading list.

Remarks from Governor Matt Mead

From the mid-eighties to today, we've seen a lot of growth, development, and changes in Campbell County. Campbell County is one of the largest bread baskets for the entire state in terms of the wealth it provides from energy, agriculture, and tourism. As we see the challenges facing Campbell County, we can also see the challenges facing Wyoming, the western states, and the country.

How do we, as a county, state, and country move forward with development in a way that provides the appropriate balance? We are still not meeting the global energy needs and many millions of people still live in energy poverty. Additionally, we need to meet the energy needs of a growing, global middle class. Last year, for the first time in a long time, the United States produced enough energy to meet its own needs.

The question, "Do we want energy development or a clean environment?" is a false question, the fact is, we want a clean environment, we want healthy habitat, and we want to take pride in the way we take care of species in our state. The correct question to be asking is, "How do we make sure we can have the development that we need and at the same time, have the habitat for the health of ourselves and our wildlife?" This is a tough question, but one that needs to be answered by science and data.

What I propose to you today is that with science, data, and reality, we can find the appropriate balance. What we are doing with sage-grouse should be a model for how we address the situation with raptors, in terms of the science, the data, and cooperation.

As we see the future of the state and country, we know we will never reach a point when we say that we do not need energy, and we will never reach a point when we say we don't need these species. We need answers from science to help us find the appropriate balance, and with those answers, you will be helping to insure a great future for our citizens and our wildlife species,

importantly, raptors. So thank you for the important work that you are doing in this regard.

Remarks from Mike Hillis

When we look at the ownership, energy development, and wildlife patterns, we see that we have a complex management situation. An important part of this symposium will be to ask: 1) What questions can the data answer? 2) What questions does the data not answer? 3) What kind of data do we need to answer those questions? 4) How do we get that done? Other challenges for managers include crucial winter ranges, archeological sites, historic trails, sage-grouse habitat, and black-footed ferrets. There is a lot going on in this part of the world.

Some of the issues that might come up during this Symposium include: 1) How do individual species respond to disturbance? 2) What is the status and trend of individual species? 3) Are nest inventories sufficient to identify population levels and trends? 4) Is nest monitoring sufficient to identify recruitment levels? 5) Are there other limiting factors such as prey availability that need to be considered into the equation about the effects of energy development? 5) Are established protective measures sufficient and consistent with the science? 6) Should we be collecting data in a manner that allows us to model the sustainability of a species?

Keynote Remarks from Ryan Lance

A lot of the discussions that will be had during this Symposium are also being had at a national and international level, so don't take them lightly. This is a dialog we can freely have in Wyoming; others are envious of that freedom. The theme here is that some of the small actions and local conversations change the complexion of how our country looks at some of these very important issues. That will happen in the context of raptors and the Migratory Bird Treaty Act, it is happening.

I think it is really fitting that Governor Mead was here today, because it marks what Wyoming is really about. It's about showing up and being present, we don't take our politics and sit on the sidelines in this state, we get into the arena and we engage it. We also understand that the person that joins the fray and picks up the pen to write a rule usually writes about 85% of it. That is why it is so important that we come together, sort out the science, and maybe write the policy in time.

What does that mean? In the case of energy development in Sublette County, in our efforts towards real world solutions to development and species protection we wrote about three policies that are still being used today by the BLM national office.

One of the realities that we learned with the sage-grouse issue is that, at some point, you are just going to have to sit down and talk because most of the dialog is pitched, especially when it gets into the media, and if you don't take control of the conversation early it will take control of you. If we can't sort out the policies tied to raptors, migratory birds, and endangered and threatened species, we're in a heap of trouble. There is a federal nexus at every turn. So we can sit back and leave the discussion to others or we can have that discussion ourselves.

We are at the same cornice of implications with raptors that we were at with sage-grouse, and I can assure you that the implications are just as severe. I look forward to the discussions and I look forward to engaging in the policy implications.

Technical Session 1: Latest Research

Effects of Oil and Gas Field Activities on Nesting Raptors

Steve Slater, Conservation Science Director, HawkWatch International

Abstract

We assessed the potential impacts of past oil and gas development activities on nesting GOEA (*Aquila chrysaetos*), FEHA (*Buteo regalis*), red-tailed hawk (RTHA) (*B. jamaicensis*), and prairie falcon (PRFA) (*Falco mexicanus*) on lands managed primarily by the BLM. We used state oil and gas records, nest records from near Price, Utah (1998–2006) and Rawlins, Wyoming (1978–2006), and vegetation and climatic data to model relationships between development and nesting activity, while controlling for the potential influence of environmental covariates. The number of oil and gas wells increased by ≥2.6 times in the two study areas (SAs) with apparent effects on raptor breeding activity. We found more consistent evidence of negative impacts in the Rawlins SA, with all four focal species exhibiting negative impacts from development occurring within either a 0.8 or 2.0 kilometer (km) radius of the territory nest cluster. Our results also suggested that oil and gas development produced negative effects in both SAs for species with the largest sample sizes (i.e., Price and Rawlins GOEAs and Rawlins FEHAs). We suggest that current BLM 0.8 km radius nesting season protective buffers should not be reduced, as Price GOEAs and Rawlins FEHAs, RTHAs, and PRFAs exhibited negative relationships with development at this scale. Further, existing buffers may have been insufficient to avoid negative impacts to some species, as we also detected negative relationships for Price and Rawlins GOEAs and Rawlins PRFAs at the 2.0 km spatial scale. We also briefly highlight our assessment of the ability of ANS to mitigate oil and gas disturbance for nesting FEHAs in the Rawlins SAs. Our development of detailed recommendations for future monitoring programs aimed at evaluating the impacts of land use change on nesting raptors, and highlight additional research needs.

Key Findings

Few studies have specifically investigated potential disturbance effects of oil and gas development amongst nesting raptors. The potential effects can be surmised from studies of nesting raptors and other human activity, (Brambilla et al. 2004; Steidl and Anthony 2000; Swarthout and Steidl 2003; White and Thurow 1985). Other recent relevant literature includes Keeley and Bechard 2011; Keough and Conover 2012; Millsap et al. 2014; Steenhof and Kochert 1985; and Steenhof et al. 2014.

The Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940 require that federal land management agencies prevent the taking of birds protected by these acts. Stipulations to prevent these takings are based on limited data for many species and often vary by agency and locality. The Raptor "Radii" Research Project compiled historic data to evaluate the relationship between nesting raptors and oil and gas development. The historic data was used to evaluate the effectiveness of buffers and to assess the ability of ANS to mitigate oil and gas impacts on FEHAs. This project also assessed the strength and weakness of historic data, provided recommendations on how it can be improved, and resulted in the publication of three BLM Technical Reports (Neal et al. 2015; Smith et al. 2015a; Smith et al. 2015b).

The two study sites for this project were the Price SA and the Rawlins SA. The Price SA saw an increase in the number of wells from 451 in 1,777 between 1998 and 2006 (**Figure 1**). Raptor territories experienced a corresponding decrease in the distance from the territory to a well and a corresponding increase in the well density within a territory. The breeding status of GOEAs, RTHAs, and PRFAs was: 1) negatively related to oil and gas development, 2) related in some way to vegetation factors, and 3) positively related to wetter current year conditions, but drier pre-nesting winters.

At the Rawlins SA, wells increased from 1,438 to 4,258 between 1978 and 2006 and the breeding status of GOEAs, RTHAs, FEHAs, and PRFAs was: 1) negatively related to oil and gas development, 2) positively related to non-oil and gas development, 3) associated in some way to vegetation factors, especially landscapes with more forest, grassland, and/or

agriculture, but less sagebrush, and 4) positively related to wetter years with more winter precipitation on the heels of drier years (**Figure 1**).

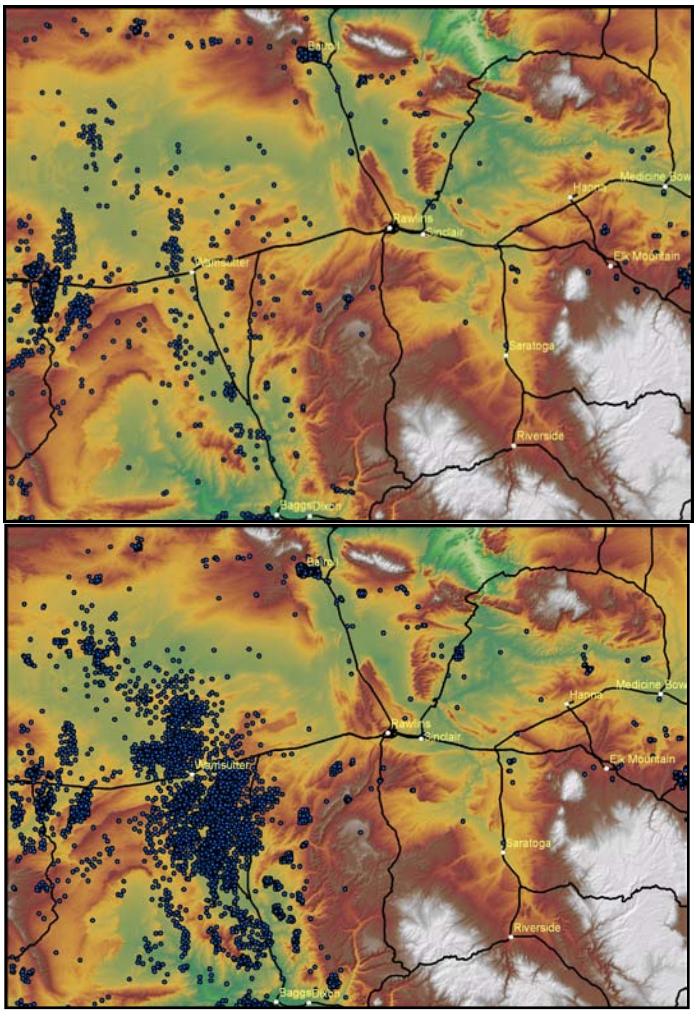

Figure 1. Oil and gas wells (in blue) in the Rawlins SA, 1978 (top), 2006 (bottom).

This research project concluded that there was a negative relationship with oil and gas development in both the Price and Rawlins SA, especially for species with a larger sample size. Current stipulations (0.8 km buffers) should not be reduced given this negative relationship and buffer widths may not be sufficient for some species given the negative relationships. Population-level impacts of development could not be evaluated with the historic data. Vegetation and climate variables influenced relationships with development and generally influenced breeding status of all species in both SAs. Analyses would have likely benefited from greater climatic detail and prey data. A number of other limitations likely limited inference but no better suited datasets existed.

Rapid shifts to ANS were likely due to their location in attractive foraging habitat lacking natural nest sites (**Figure 2**). In contrast to other territories, territories with ANS exhibited a positive relationship with oil and gas development. There was greater raptor nest use and production at inaccessible nest sites, including ANS. Many FEHA territories now consist of a single nest site, mostly commonly an ANS. There is a dearth of research on the post-fledgling period to assess survival in a potentially dangerous matrix of heavily trafficked oil and gas roads.

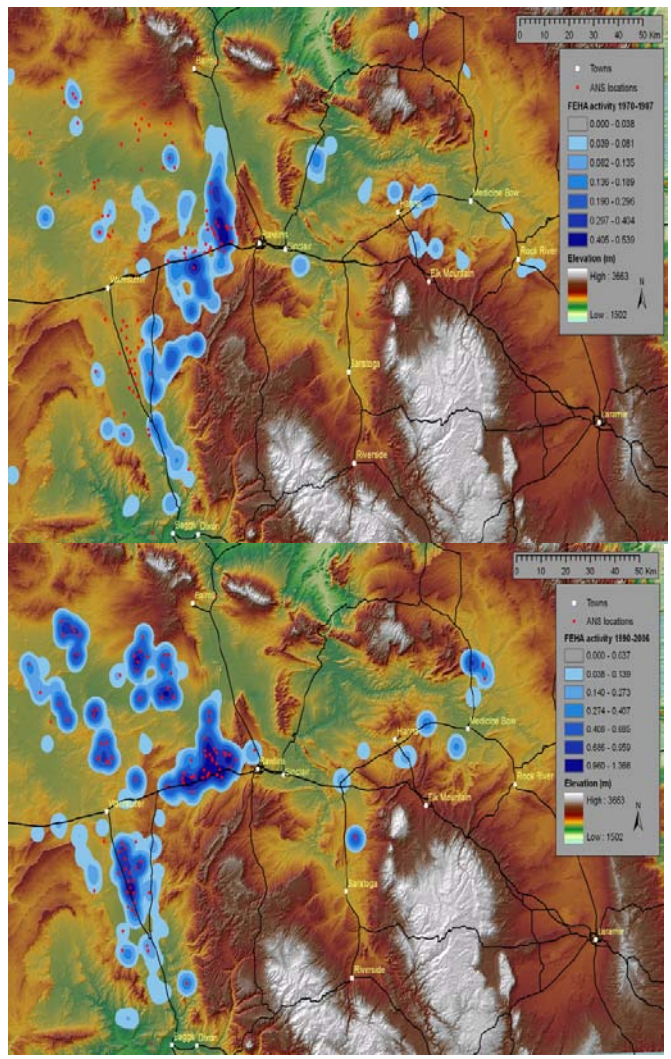

Figure 2. FEHA activity (in blue) before (top) and after (bottom) the installation of ANS (in red).

Future research needs and issues resulting from this project included the need for a Raptor Radii, Phase II

project; a pre-development / post-development study of raptor nest responses to oil and gas development. This research raised the questions, "What is the impact of topographic and vegetative screening of oil and gas development on raptor nesting?" and "What is the role of secondary impacts such as increased human access within the development footprint?" This study found that the impacts of human uses on raptors are confounding, due to habituation of raptors, lag effects, and landscape-scale effects.

Conclusions and Recommendations

Retrospective analyses must be viewed with caution, but conducting properly controlled experiments is difficult due to lack of control over drilling operations, market forces, and risk to operators. We attempted to conduct such a study ("Radii Phase II"), but were unable to find suitable study sites with naive populations of raptors where drilling was about to occur and at levels that would produce adequate sample sizes in each of various treatments (i.e., no drilling, drilling at 200, 400, and 800 m) that would allow detection of significant differences in behavioral responses, if they existed. We concluded that simulated drilling activity would likely be the only way to achieve a study of this design. Therefore, it is currently necessary to rely on retrospective analyses, such as ours, and data from other forms of human disturbance (e.g., recreation) research to draw inferences regarding appropriate spatial protections of raptor nests from potential oil and gas development disturbance. The 0.8 km (0.5 mi) buffer is the most commonly applied protection for a variety of raptor species across the West and we recommend continuing to apply this standard unless special site-specific circumstances (e.g., obvious habituation, vegetation screening, etc.) or additional data suggests otherwise.

Editor's Notes

This study found a negative relationship between the breeding status of GOEAs, RTHAs, and PRFAs and oil and gas activity. Therefore, the presenter recommended keeping or extending buffers of 0.8 km around nesting raptors. The reader will find other presenters in these proceedings suggesting that buffers for nesting raptors may be needlessly large. The reader will find additional presenters in these proceedings suggesting that our understanding of the effect of oil and gas development on nesting raptors would benefit from further study, including a BACI design experiment. This presenter suggested the use of simulated drilling activity in a BACI design experiment.

This presenter made note of the confounding effects of climate and prey availability on the status of nesting raptors. The reader will find other notes about these effects as they read on. The reader will also find similar results to those of this study regarding the effectiveness of ANS, especially for FEHAs.

Effects of CBM development on raptor nest site occupancy in the Powder River Basin [Pre-publication]

Jason Carlisle, Dr. Anna Chalfoun, Lindsey Sanders, and Dr. Ken Gerow, Departments of Zoology and Physiology and Statistics, University of Wyoming

Abstract

The PRB of northeast Wyoming has undergone widespread CBM development in recent decades, and the BFO of the BLM has been compiling data on raptor nest use in order to determine whether the extensive development has affected raptors nesting in the area. We analyzed data spanning nine years from 2003-2011, consisting of 3,412 nests of 18 raptor species. Our objectives were to first determine the trend in raptor nest use over time by species, and second, to determine if treatment nests (those with a CBM well within 80 m or one-half mi) had different use than control nests (those at least 805 m or one-half mi from a CBM well). We found that for most species, annual nest use did not trend consistently over time, but rather varied greatly from year to year in a potentially cyclical manner. Nest use was highest between 2005 and 2007 and lowest between 2009 and 2011 for those species with many nests monitored (i.e., RTHA, FEHA, GOEA, and great-horned owl [GHOW]). We found no meaningful differences in nest use between treatment and control nests, but caution that the control nests in our study were located within the same broadly developed landscapes and typically not far removed from adjacent CBM development. Further analysis into the most abundant species (RTHA), showed that when control nests were redefined using a larger buffer (i.e., nests had to be farther from CBM wells to be in the control group), the differences between treatment and control nests became more sizeable, with control nests having as much as 18% higher use. We recommend the monitoring of nests truly removed from CBM development in the future in order to better understand the potential effects of CBM development on nesting raptors. Additional data beyond nest use, such as nest-site selection, nest success, juvenile survival, prey availability, etc., may yield additional insights into the population viability and nesting ecology of the area's raptors in the face of ongoing energy development.

Key Findings

The BFO of the BLM started requiring operators to locate and monitor raptor nests within one-half mi (805 m) of planned CBM developments about ten years ago. Data from this monitoring effort might be useful in answering the following questions:

1. How has nest site use changed over time?
2. Does CBM development influence nest site use?
3. What questions remain to be answered regarding CBM development and raptor nesting?

The SAs for this research included Sheridan, Johnson, and Campbell counties in northeast Wyoming. The nest monitoring data was from 2003 through 2011 and included 3,412 nests and 18 species. There were a total of 14,764 nest observations for an average of 4.3 observations per nest. The population for this study was the 3,412 nests. The proportion of nests monitored that were in use peaked at 51% in 2006 and bottomed out at 12% in 2010 (**Figure 3**). These data helped answer the first question (above); nest site use between 2003 and 2011 displayed a non-linear pattern.

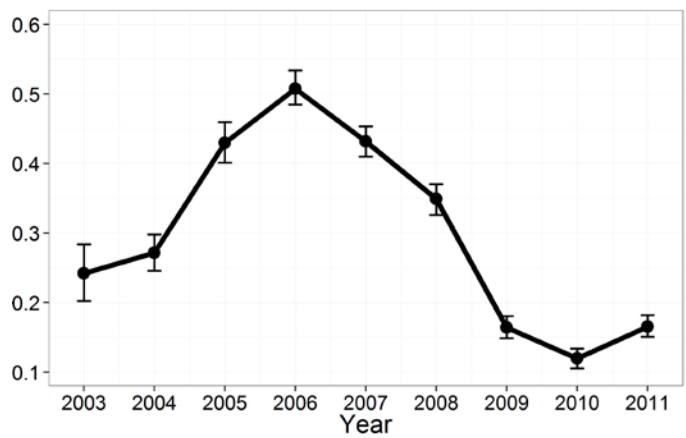

Figure 3. Proportions of nests in use, 2003 through 2011 (all species pooled).

To answer the second question (above), the same population of nests were used, as were data from the approximately 29,000 CBM wells constructed between 1993 and 2011. Out of the 3,412 nests, 2,839 nests were within one-half mi (805 m) of a well and made up the treatment group and 573 of the nests were at a distance greater than one-half mi (805 m) from a well and made up the control group.

The nest occupancy data for RTHA, split by treatment and control groups appears in **Figure 4**. Notice that the general trend is that nest use in the control group is somewhat greater than nest use in the treatment group. As per **Figure 4**, the nine year average difference between proportions of nest in use for control and treatment groups for RTHA was .08, meaning use at control nests was 8% higher than at treatment nests.

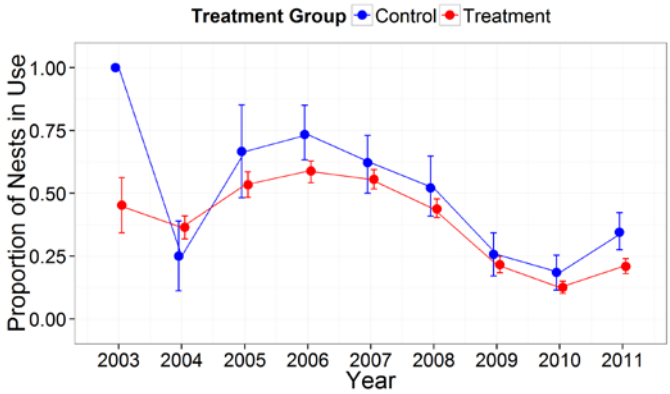

Figure 4. Proportion of nests in use by treatment group for RTHA.

Figure 5 shows the same information as **Figure 4**, but for the 12 most abundant species. Using this information, a nine year average difference in proportion of nest use was calculated for these 12 species. AMKE, BAEA, burrowing owl (BUOW), Cooper's Hawk (COHA), FEHA, GOEA, LEOW, PRFA, and RTHA had a higher nine year average proportion of nests in use amongst the control group. GHOW, NOHA, and SWHA had a higher nine year average proportion of nests in use amongst the treatment group.

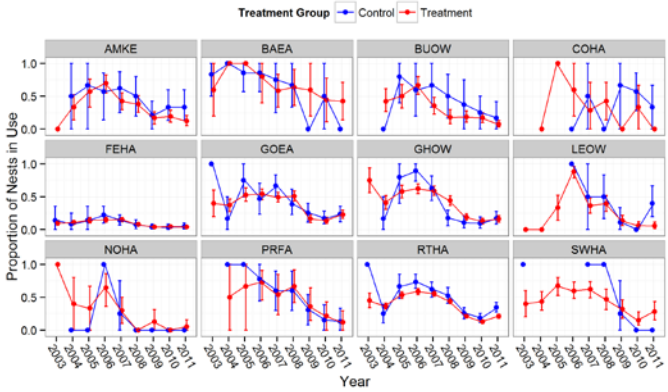

Figure 5. Comparing control and treatment nests, by species (2003 through 2011).

Are the differences in proportions of nests in use over the nine year period statistically significant, or are they more likely due to chance? To find out, the study of nest occupancy was replayed over 1,000 trials with random assignments of nests to control or treatment groups (i.e., a randomization test). The nine year average difference between treatment and control groups was calculated for each of the 1,000 randomization trials. The observed nine year average difference was then compared to the 1,000 randomization trials. The results of this comparison for RTHA appear in **Figure 6**. The unshaded area in the middle shows the range of the statistic of interest (i.e., a species' nine-year average difference in the proportion of nests used between control and treatment nests) that would be expected simply due to chance. The red-shaded area shows the range of the statistic where it could be concluded that treatment nests had higher use than expected due to chance (with $p < 0.05$), and the blue-shaded area shows the range of the statistic where it could be concluded that control nests had higher use than expected due to chance (with $p < 0.05$) Since the observed difference in proportion of nest use (green bar) falls between the shaded regions in **Figure 6**, it is likely that the differences between control and treatment nest use we observed are due to chance ($p > 0.05$), and not indicative of an actual CBM effect on RTHA nest use (at the 805 m or one-half mi scale of comparison).

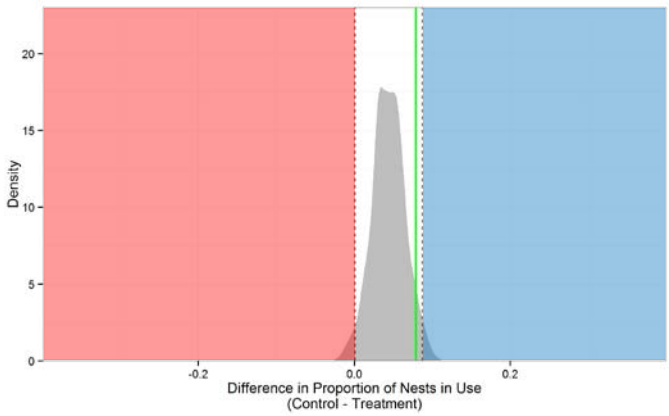

Figure 6. Difference in nest use for RTHA in 1,000 randomized trials.

Repeating the randomization test for each species yielded **Figure 7**, which shows that the differences between control and treatment nest use observed are likely due to chance ($p > 0.05$), and not indicative of an actual CBM effect on nest use for any of these 12 species at the 805 m or one-half mi scale of comparison.

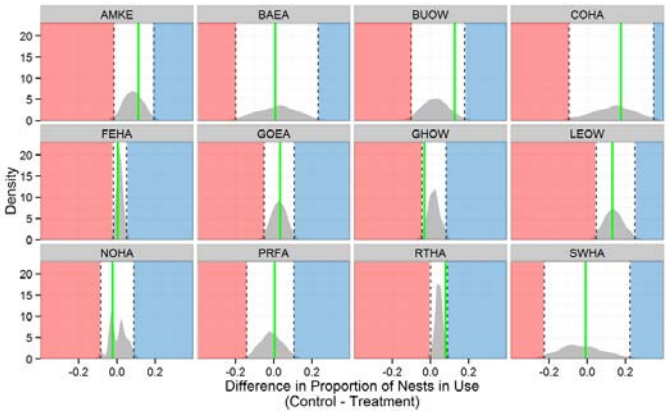

Figure 7. Difference in nest use by species based on species-specific randomization tests.

Conclusions and Recommendations

Nest use was higher at control nests for nine of 12 species, and higher at treatment nests for three of 12 species, but the size of those differences are not beyond what would be expected by chance alone (i.e., not statistically significant, $p > 0.05$ for all species). This conclusion addresses question two (above).

The following are cautionary notes on the comparison of the 1,000 randomized trials to the observed data:

- The statistics were complicated by the observed non-linear trends in the nest use (**Figure 4**).
- There was no accounting or controlling for other variables (e.g., habitat characteristics, etc.).
- There was no accounting for imperfect detection of nest use.
- Nests were assigned to only one species throughout the study; whereas nests are commonly used by different species in different years.
- The focus was on nests, not territories of the nesting birds which may contain multiple nests.
- Most importantly, even the control nests were still very near CBM development.

Questions that remain (third question, above) include:

- What is nest use like in truly non-impacted areas?
- Would requiring control nests to be farther from CBM affect the results?
- What drives non-linear patterns in use over time?
- Did nest use increase since 2010?
- Why does nest use vary so much among species?
- Does CBM development affect raptor prey?
- Does CBM development affect the production and recruitment of raptor young?

There is evidence from further analysis of the RTHA nests (the most abundant species) that the difference in nest use would increase with larger buffers (i.e., if nests within 1 mi or 1.5 mi were considered treatment and not control nests). As stated earlier, the average observed difference in nest use between control and treatment groups for RTHA was 8% ($p = 0.10$). Data from this study suggests that a buffer of 1 mi would have an average observed difference of 15% ($p = 0.01$) and the average observed difference with a 1.5 mi buffer would be 18% ($p = 0.01$). This suggests that raptor nests near CBM development may have meaningfully lower use; however, the design of the original monitoring protocols (i.e., only requiring nests near development to be monitored) limits our ability to make comparisons with nests in areas truly not impacted by CBM development.

Next steps: 1) monitoring of nest site use and productivity near CBM development could serve as an

early warning system for greater effects of CBM development on raptors, and 2) controlled experiments, namely those that include monitoring control nests removed from CBM development, could provide greater clarity on the remaining questions.

Editor's Notes

This study determined that, for nine out of twelve raptor species, nest use within one-half mi of CBM development was observed to be lower than nest use beyond one-half mi. The differences in nest use were determined to not be statistically significant and possibly due to chance. Further, the data suggested that the observed difference in nest use between control and treatment nests increases when the distance separating treatment from control groups was increased to one mi (15% higher use for RTHA) and 1.5 mi (18% higher use for RTHA). Both of these differences were statistically significant ($p < 0.05$) Other presenters also found differences in how raptors use nests close to energy development, yet this study is unique in showing that difference is not statistical significant with a half mi buffer, but is with a one mi and 1.5 mi buffer. The fact that the effect of CBM development on raptors becomes more evident at greater distances suggesting that a distance decay function may exist for disturbance of raptors at their nests. This leads to the question, "What is an acceptable level of disturbance?" and, "What is that average distance from CBM and oil and gas development?"

Similar to other presenters, Carlisle sees the need for a controlled experiment, which could provide greater clarity on these remaining questions.

Lastly, one of the questions Carlisle is left with is, "what drives non-linear patterns in nest use over time?" Other presenters at this symposium suggested that climate and prey-base is a major driver of nest use.

Effects of development on the productivity and distribution of ferruginous hawks and golden eagles

Robert Oakleaf, WGFD (retired)

Abstract

In 2010, we implemented a series of interrelated studies of FEHAs (*Buteo regalis*) and GOEAs (*Aquila chrysaetos*) in Wyoming to evaluate the effects of energy development on occupancy, productivity, nest-site selection, and prey availability. We selected our SA by first estimating distribution across Wyoming using an updated nest database, and modeled suitable habitat. We stratified our SA by ecoregions and oil and gas well density. We estimated density and abundance of nesting pairs of FEHAs and GOEAs in sagebrush steppe and grassland regions of Wyoming based on aerial line transect surveys of randomly selected townships. In 2010 and 2011, we surveyed 99 townships and located 62 occupied FEHA nests and 36 occupied GOEA nests. We used distance sampling to estimate a nesting pair density of 94.70 km^2 per pair (95% confidence interval: 69.90 – 139.80 km^2) for FEHA, and 165.90 km^2 per pair (95% confidence interval: 126.82 – 230.82 km^2) for GOEAs. From these densities, we calculated a total of 1,163 nesting pairs of FEHA (95% confidence interval: 788 – 1,575 pairs) and 664 nesting pairs of GOEAs (95% confidence interval: 477 – 868 pairs) in our SA during the 2010-2011 nesting seasons. We reviewed results of previous studies and found our estimates of FEHA densities are similar to or lower than those from other studies in previous years. We found consistent evidence that leporids and eagles nesting in lowlands of Wyoming experienced severe statewide declines in abundance around 1993. Our review also indicates that the abundance of nesting eagles has remained stable but at low levels since 1993. However, other studies have recently documented that nesting eagle numbers have remained unchanged in mountainous habitats of northwest Wyoming.

Key Findings

The conservation status of FEHAs and GOEAs:

- Both species are sensitive to disturbance.
- There have been some contractions in portions of their range, while other parts of their range are stable or increasing.
- FEHAs and GOEAs are most threatened by losses of grassland habitat, disturbance at nest sites, and illegal shooting (Bechard and Schmutz 1995).

The Wyoming Ferruginous Hawk Project has found that current energy developments in Wyoming strongly overlap with FEHA distribution and FEHA is a Species of Greatest Conservation Need (**Figure 8**). GOEAs are habitat generalists that are holarctic in distribution and sympatric with FEHAs. GOEA breeding and wintering habitat overlaps with energy development in Wyoming and has the potential to affect populations.

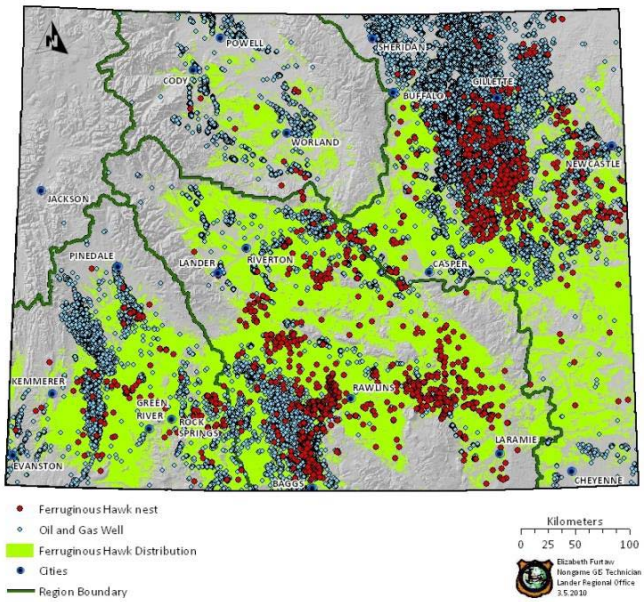

Figure 8. FEHA distribution (in green), nests (in red), and oil and gas wells (in blue).

The following were the objectives for this study:

- Estimate FEHA distribution, population, occupancy, and productivity relative to energy development and estimate GOEA population.
- Estimate spatial and habitat use relationships of FEHAs when selecting nest sites and foraging adjacent to energy disturbance.

- Estimate density of key prey around FEHA nest sites; estimate impacts of energy development on prey abundance.

All townships in the SA had less than 300 wells. Aerial surveys of the SA in 2010 and 2011 found 90 nests occupied by FEHA and 36 nests occupied by GOEA. Calculations based on occupancy modeling of estimated that there were 1,163 FEHA nesting pairs occupying nests and 664 GOEAs.

Comparing the density and estimated number of breeding pairs with other states suggests:

- FEHA abundance appears to be similar over time, but GOEA had 50% less nesting in 2010-2011 than in the mid-1980s.
- GOEA decline is correlated with rather drastic declines in jackrabbit and cottontail populations. The jackrabbit population crashed in 1993, so GOEA numbers may reflect this.
- Black-tailed prairie dog numbers were high in the early 2000s before declining, control and use of Rozol increased, then plague in northeast Wyoming increased.
- Oil and gas development took off in the late 1990s and early 2000s, so it is not the cause of GOEA declines.

Results of helicopter surveys in cliffs for GOEA in northeast Wyoming:

- This highland population isn't as tied in with jackrabbits so hadn't declined.
- Lowland GOEAs have lower occupancy rates versus highland GOEA occupancy rates that approach 100%, so occupancy rates can't be blamed on oil and gas development.

Population levels of FEHA and GOEA vary with prey abundance (Steenhof et al. 1997). Surveys were done of major prey species in FEHA and GOEA nesting territories once in 2010, twice in 2011, and twice in 2012. There were 631 transects sampled an average of 3.5 times. Lagomorphs, chipmunks, ground squirrels, and white-tailed prairie dogs were all detected. The sample selection was stratified based on the following areas:

- Bighorn Basin
- Northwestern Great Plains
- High Plains
- Wyoming Basin

FEHA and GOEA occupancy study findings:

- FEHA occupancy is higher with the presence of ANS.
- Broad-scale measures of environmental heterogeneity were sufficient to distinguish landscape features selected by nesting FEHAs.
- The results of this research failed to support a-priori prediction that energy development at current levels (300 to 400 wells per township) caused avoidance by FEHAs, however it is assumed that there are upper limits (such as Jonah field). Additionally, this study did not see a positive correlation between FEHAs and oil and gas development as others have (Keough and Conover 2012; Van Horn 1993).
- FEHAs select nest habitat with low topographic roughness and higher values of bare ground.
- FEHA occupancy is positively correlated to roads (Benitez-Lopez et al. 2010; Chace and Walsh 2006; Gilmer and Stewart 1983). This may be due to a positive association between roads and prey, which is probably due to more moisture and vegetation along roads (Zelenak and Rotella 1997). Also, both FEHA and GOEA occupancy is correlated with tall structures, including fence posts and power poles along roads (Gilmer and Stewart 1983). GOEA can become habituated to development.
- FEHAs selected ANSs over other substrates and FEHA occupancy is higher with the presence of ANSs (Neal et al. 2015; Schmutz 1984). Most ANSs in SA were located in territories with few other elevated structures. The availability of elevated structures limited density of raptors in non-forested habitats (Janes 1994; Restani 1991).
- Taller nest sites are associated with higher occupancy rates for many raptors, including GOEA

(Mcintyre and Schmidt 2012; Roth Jr and Marzluff 1989; Wightman and Fuller 2006). In fact, nest height is the greatest predictor of GOEA nest site selection. Taller nest sites provide security from ground-based mammalian predators and may offer improved vantage to defend nests from avian predators.

Nest productivity study findings:

- There was a strong positive correlation between nest productivity and ANSs and a strong negative correlation between nest productivity and percent cover of sagebrush.
- There was a strong negative correlation between nest productivity and the number of severe storm events in June.
- Nest productivity was not strongly correlated to prey abundance or anthropogenic features other than ANSs.
- Authors of other studies suggest that GOEA limit reproduction during years of low prey abundance, but still occupied and defended territories as an investment in future reproduction.

Prey study findings:

- There were lower prey densities in Bighorn Basin and the northwestern Great Plains than in the Wyoming Basin and the High Plains.
- Prey density decreased as distance from a road increased. This was likely due to increased soil moisture and its effects on vegetation.
- An increased density of ground squirrels was correlated with an increased minimum winter temperature and with increased precipitation.
- There was a decreased density of ground squirrels associated with greater density of sagebrush and greater spring temperatures.
- This study had a low detection of prey in general; maybe different survey methods are necessary.
- Ground squirrels are important in FEHA's diet (MacLaren et al. 1988; Restani 1991; Steenhof and Kochert 1985).
- Ground squirrels are the most consistent predictor in study, suggesting that abundance of ground squirrels can influence FEHA occupancy.
- GOEA occupancy is unrelated to prey (Mcintyre and Schmidt 2012; Steenhof et al. 1997; Watson 2010).
- Abundance of leporids was not associated with occupancy for either species, yet leporids are the primary food of GOEA throughout their range.
- There is a negative relationship between prey accessibility and sagebrush cover (Wakeley 1978).

Conclusions and Recommendations

Management implications:

- Post-construction density of oil and gas wells does not appear to have a strong influence on occupancy, prey-base, or nest productivity, although the study has some limitations in that regard.
- Protection of FEHA and GOEA habitat in Wyoming should be focused on:
  - FEHA territories with ground squirrels and low sagebrush cover.
  - Management that favors conservation of habitats and populations of ground squirrels and likely prairie dogs could benefit FEHAs.
- While the study results suggested only a weak positive relationship to ANSs for FEHAs, it did not find any negative effects, so it is recommended that they continue to be used for habitat enhancement and mitigation.
- BACI studies could make stronger inferences between raptors and energy development.
- This study suggested that a probabilistic, state-wide sampling effort could be valuable for ongoing monitoring and may be useful for BACI comparisons as the density of development continues to increase.

Limitations:

- The study was post-construction of energy development and only monitored recently occupied nests, so it is possible that the sample was made up of individuals that were already habituated to development, or individuals with territories configurations that minimized potential negative effects of development.

- Relatively few nests were located within 500 m of active well pads, there may be limited power to see the effects of wells at less than or equal to those distances.
- This study did not address the issue of why occupied nests were not located near wells. It could reflect success of recommended 500 m buffers for surface disturbance around active nests. It is equally possible, however, that territories were abandoned following development, and nesting raptors avoided infrastructure.
- The study was a short duration study of long-lived organisms. Because raptors exhibit high territorial fidelity and natal philopatry, it could potentially take years or generations for disturbance to affect occupancy. Therefore, this study is inconclusive with regards to the potential negative effects of oil and natural gas development on FEHA and GOEA.

Editor's Notes

This series of interrelated studies point to a number of factors from climate, weather, and prey-base to structures, topography, and vegetative cover, which affect nest occupancy, productivity, and site selection for FEHA and GOEA. Disturbance from energy development may contribute to or compound these effects, but these studies were unable to identify or isolate those effects at the rates and densities of development occurring at the time. The presenter cautioned that the population studied may have already become habituated to development, therefore any effects of oil and gas on these individuals may have been dampened. And few active nests were studied within 500 m of oil and gas development within which it is presumed effects from disturbance would be much easier to see.

These studies did note the positive correlation between ANSs and FEHAs, as other presenters have, though that relationship seemed somewhat weaker here. And like other presenters, these studies suggest that prey availability has an outsized impact on raptor site selection, occupancy, and productivity when compared to other effects.

Also, like other presenters at the symposium, this presenter recommended that BACI studies be performed and recommended that a probabilistic, statewide sampling effort be undertaken.

Modeling Wyoming-wide and local avian electrocution risk

James Dwyer and Richard E. Harness, EDM International, Inc.

Abstract

EDM International, Inc. (EDM) has been working throughout Wyoming and the U.S. to mitigate negative interactions between birds and overhead electric infrastructure. Recently, EDM developed two models to facilitate efficient conservation and project planning. The first model operates at a local scale using only four variables to consistently identify risk on individual poles within areas of concern. This simple approach allows personnel with little training in electric systems or biology to enter data into a pre-programmed handheld device and instantly generate consistent risk values. The second model operates on a statewide scale to identify general areas of concern based on pole density. When the model of distribution power pole density is viewed in GIS with species-specific habitat maps, areas where high pole densities overlap high quality habitat will indicate areas where evaluation of species-specific risk may be needed. Managers using this model can approach electric utility operators in areas of interest to identify whether current Avian Protection Plans exist. If so, Avian Protection Plans can be used to direct retrofitting, ideally using the local model of pole-specific risk.

Key Findings

Avian electrocution is a state-wide concern leading to ongoing reliability and conservation concerns. The local model of electrocution risk was based on work by EDM quantifying hazard and exposure to develop a risk index (**Figure 9**). By applying this model to particular poles, transparent and consistent risk indices can be determined to rank poles by relative risk. This information can be used to ensure that poles with the highest risk index values are retrofitted first, maximizing the impact of limited financial resources.

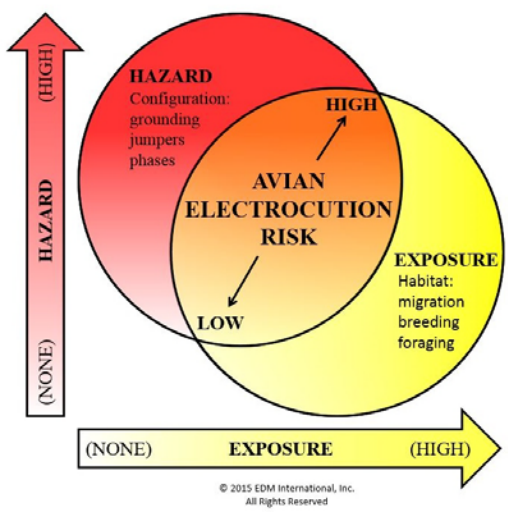

Figure 9. Components of avian electrocution risk on power lines.

The statewide model of electrocution risk was developed based on 1 km² (0.4 mi²) grid incorporating roads, oil and gas wells, slope, development, irrigation, and land cover to identify average pole densities (**Figure 10**). The model indicates areas where electrocution risk may be disproportionately high. Combining this model with habitat models for species of concern, such as GOEAs, provides a framework for systematic spatial prioritization in support of regional conservation planning. The approach will be particularly effective when considering offset mitigation for wind resource areas.

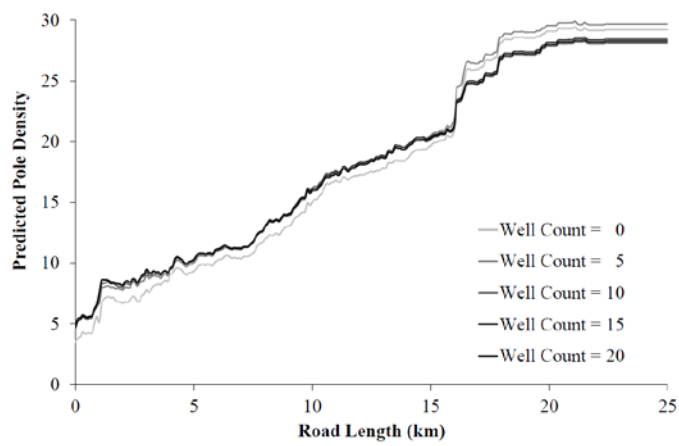

Figure 10. Relationship between road length, number of oil and gas wells, and number of power poles per km^2 in WY and CO.

Conclusions and Recommendations

Because mitigation of avian electrocution has not been addressed at a statewide scale, localized, uncoordinated approaches have allowed persistence of areas containing high-risk poles, and may not focus mitigation where conservation efforts are most

needed. Consequently, avian electrocution risk continues throughout areas of Wyoming.

Oil and gas well density is a primary predictor of power pole density. Because the Rocky Mountain West contains 26% of the natural gas reserves in the U.S., with many of these reserves currently under development, oil and gas well density is likely to increase, possibly exacerbating avian electrocution risk.

Conclusions and Recommendations

These models provide guidance regarding where high risk poles are likely to occur and how to quantify relative risk on poles, allowing the most dangerous poles to be prioritized. This will enable planners to apply explicit species-specific criteria for retrofitting power poles, facilitating systematic spatial prioritization critical to effective communication between resource users and resource managers when not all candidate areas can be addressed immediately.

For more information on the regional model currently in preparation for peer-reviewed publication please contact James Dwyer (jdwyer@edmlink.com) or Rick Harness (rharness@edmlink.com).

Editor's Notes

This presenter indicated that by applying the two models for raptor electrocution risk, they can systematically prioritize investments in raptor electrocution prevention measures. Oil and gas well density is a primary predictor of power pole density in the region. Therefore, growth in oil and gas developments means increased risk of electrocution to raptors, unless preventative measures are taken.

The presenter also suggests that, by applying their models of electrocution risk, installations of preventative measures can be used in offset programs, especially for wind energy developments.

Technical Session 2: Current Status of Prairie-Associated Raptors

Current status of prairie raptors, sensitivity to disturbance, and reliability of current information

Jeff Birek, Rocky Mountain Bird Observatory

Abstract

Population status and trend information is lacking for prairie raptor species. Tools such as the BBS, eBird, and the RPI produce information that can help with management such as distribution, frequency, encounter rates, and indices of bird activity. There are many examples of small-scale population estimates for certain prairie raptor species, but it is not always possible to apply what is learned on the small scale to larger regions due to small sample size and opportunistic biased sampling designs. The BBS began in 1966 and is used to create the only published large-scale population size estimates in North America. Their analysis does not take detection probability into account which can greatly affect population estimates. BBS also has a strong road and observer bias as the sampling sites were chosen along roadways by observers in the field. Partners in Flight used the BBS surveys to develop population estimates in 2004 but the estimates were only as precise as to be within an order of magnitude or greater. BBS trend estimates were developed from these population estimates but since there is so much uncertainty with the population estimates the trend results tend to exacerbate the uncertainty. The largest bird-focused citizen science project in the world is eBird. Anyone can enter observation data from any location around the globe and people can access the data quickly from the website. End users can only generate frequency encounter rates which are not surrogates for population size. eBird also does not take detection probability into account and is not based on a random sampling design. However, with millions of bird observations being recorded annually, there is a lot of potential to use eBird with other tools to detect changes in avian communities on a large scale. The website is ebird.org. The RPI uses data collected from a large network of raptor migration hotspots across North America. It is only an index of the raptor activity and does not produce population estimates. It is only possible to detect precipitous population declines with this. To use this for trend analyses it needs to be coupled with known population sizes (which are currently unavailable on large scales). The Rocky Mountain Bird Observatory can produce population and occupancy estimates for raptors on large scales if enough data is recorded. We have over 1 million bird records in the database. Most raptors do not have enough data for these estimates yet, but hopefully will in the next few years. The ADC is the clearinghouse for our population, distribution and occupancy estimates. You can visit the website at adc.rmbo.org The best way to protect raptors with this uncertainty is to protect nesting, migration and wintering habitats. Raptors become accustomed to regular, established human activity but new activity (especially during nesting season) can be deleterious. Habitat improvements such as nesting and perching structures can help raptors in areas where populations are low.

Key Findings

Population, status, and trend information on a large scale is available from the BBS, eBird, RPI, and ADC. The Breeding Bird Survey was established in 1966. It is the most widely used survey for determining bird population estimates (**Table 1** and **Figure 11**). It uses road-based surveys and has no associated detection probability.

Table 1. Breeding Bird Survey population estimates for 14 raptors (2004).

Species	Population Estimate	Reliability
AMKE	4,350,000	Same order of magnitude
RTHA	1,958,000	Same order of magnitude
TUVU	1,305,000	Likely same order of magnitude
SEOW	696,000	Poor
MERL	650,000	Likely same order of magnitude
BUOW	620,000	Poor
SWHA	460,600	Same order of magnitude
NOHA	455,000	Likely same order of magnitude
BAEA	330,000	Likely same order of magnitude
RLHA	265,000	Poor

GOEA	79,900	Likely same order of magnitude
PRFA	34,560	Likely same order of magnitude
FEHA	23,000	Likely same order of magnitude

Swainsons Hawk *Buteo swainsoni*

BBS Trend Map, 1966 - 2012

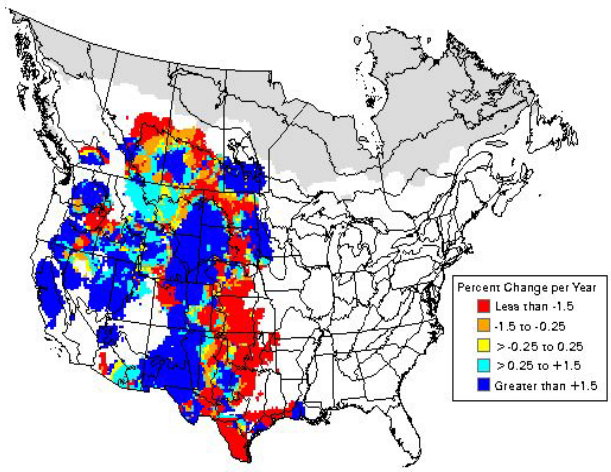

Figure 11. Trends in SWHA population and distribution (1966 to 2012) from the Breeding Bird Survey.

The largest bird citizen science project is eBird. With eBird, users submit a checklist, which is reviewed by a local reviewer. This results in tons of data, but it is difficult to convert frequency of sightings to populations.

The Raptor Population Index is a network of Hawk Watch site, the first of which was Hawk Mountain in Pennsylvania. With the RPI, precipitous declines in populations can be seen, but it is only an index of raptor activity. This index needs to be coupled with known population sizes.

The ADC is a clearinghouse for avian data and information for managers, researchers, and the public. The Center provides project summaries, protocols, datasheets, searchable data tables and results, and reports. Data from the ADC includes nearly one million bird records since 2008, bird survey data from thirteen states, and density and occupancy estimates for over 125 species.

Most raptors are not disturbed by regular, established human activity, although new activity during the nesting season (March through August) can be deleterious. Raptors also respond well to habitat improvements such as stock tank ladders and nesting and perching structures.

Editor's Notes

BBS, eBird, RPI, and ADC are the best available tools for large-scale raptor population and trend analysis, yet each one has its limitations. For instance, BBS and eBird do not take detection probability into account. To use RPI for trend analysis it needs to be coupled with known population sizes, which are not currently available. ADC seems like it will be a powerful tool, but does not yet have enough data for many raptors for population and trend estimates.

This presenter suggested that most raptors are not disturbed by energy development activities, although new activity during the nesting season can be deleterious.

Technical Session 3: Inventory and Monitoring of Raptors

Inventorying and monitoring raptor nests at coal mines in the Powder River Basin

Gwyn McKee, Thunderbird Wildlife Consulting

Abstract

Current regulations, survey requirements and methods, and data collection protocols related to monitoring of nesting raptors in the PRB of northeast Wyoming and southeast Montana vary widely among agencies and energy industries. These differences make it challenging to compare, consolidate, and manage datasets. Such differences also can hinder effective operational and mitigation planning efforts, depending on the type of project and associated monitoring requirements. Due to the enhanced survey requirements for surface coal mines in the PRB, industry has built a comprehensive dataset over the last 40 years that provides invaluable information related to raptor species, territories, and annual nesting efforts and productivity in the region, as well as supporting data relative to the effects of local prey abundance and disturbance activities on nesting raptors. This long-term monitoring has enabled biologists to determine important parameters such as home range territories, tolerance for other species, and ability to acclimate to regular human disturbance for multiple raptor pairs and species, which then allows for effective project planning and successful mitigation of potential impacts. This presentation will describe the type of information collected for surface coal projects in the PRB, some challenges associated with varying survey requirements and efforts to consolidate datasets, and how a standardized approach similar to that used by the coal industry could potentially benefit agency regulators and energy operators in the region.

Key Findings

The PRB, which lies in northeastern Wyoming and southeastern Montana, has over 15 surface coal mines. Due to their long-term presence in the PRB, the coal mines have up to 40 years of annual monitoring data on over 1,700 nest sites of 17 raptor species, including six types of hawks, four types of owls, three types of falcons, two types of eagles, ospreys, and turkey vultures.

The Wyoming and Montana Departments of Environmental Quality (DEQ) serve as agents of the Federal Office of Surface Mining, Reclamation, and Enforcement. Consequently, these State DEQ offices have regulatory authority over all surface coal mine permits in the PRB. As part of that authority, the DEQs provide guidance for baseline wildlife inventories, as well as annual monitoring and mitigation requirements for the mines. The primary objective of these combined efforts is to manage species protected by Federal laws and regulations, including the Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940, as well as state statutes.

Coal mines in the PRB have three basic steps for mine operations with regard to raptor monitoring and mitigation. The first step is pre-mine inventories for species composition, density, and distribution (Wyoming DEQ Guideline 5; Montana DEQ Industrial and Energy Bureau's Fish and Wildlife Guidelines). The pre-mine inventory is typically completed immediately prior to submittal of the mine permit application and requires a minimum of one full year of data collection through all four seasons. In most cases, the area inventoried includes the proposed permit area or amendment, plus at least an additional two mi perimeter for raptors. In addition, each mine must prepare general monitoring, mitigation, and reclamation plans to be submitted for approval by the appropriate agencies. In Wyoming, each coal mine must also have a separate Avian Monitoring and Mitigation Plan that has been reviewed and approved by the U.S. Fish and Wildlife Service (USFWS). This document must be updated as part of the standard five year term-of-permit renewal process for coal mines or with every major change in the mine plan.

The second step is to establish an annual wildlife monitoring program, as required under Appendix B of the Wyoming DEQ Land Quality Division Coal Rules and Regulations and the Montana DEQ Fish and Wildlife Guidelines. This annual monitoring will be conducted throughout the life of the mine, and

includes the permit area and either a one mi or two mi perimeter for raptors, depending on the property.

The third step is post-mine inventories and documentation for species composition, density, and distribution to measure the success of bond release goals (Wyoming DEQ Guideline 20 and Coal Rules and Regulations Chapter 4, Sections 2(a)(ii) and 2(r), and Montana DEQ Fish and Wildlife Guidelines). The area identified for this inventory and documentation may vary by property. The timeline and duration of these efforts also may vary based on habitat types and property. Although reclamation plans include expectations of existing or future wildlife use, confirmation that wildlife habitat goals have been met is often tied to meeting vegetation standards.

Annual monitoring for raptors includes surveys of early nesting species, such as eagles and GHOW. The Wyoming DEQ requires these surveys to be completed on or before mid-February to check for early courtship and nesting behavior. The surveys must occur within one mi of existing and planned mine activities for the current year. Montana DEQ requires that surveys for early nesters be conducted from mid-February to mid-March, though they are not limited to the vicinity of active mining.

Wyoming DEQ requires a minimum of three additional surveys for early-breeders; these efforts also include all other nesting raptor species. Surveys are to be conducted during March, April, and from mid-May through at least mid-June. Montana DEQ does not require a minimum number of additional surveys, but does recommend that the majority of survey effort occur between April and early June. Regardless of their location, these surveys are intended to determine the status of all known nest sites and search for new nests. Although it is not required, most mines in the PRB try to monitor active nests every two weeks, weather permitting, throughout the breeding season to enhance data accuracy. Survey guidelines in both states allow continued monitoring efforts beyond the stated timelines to accommodate differences in raptor biology and breeding chronology.

Annual monitoring requirements for surface coal mines in the PRB have a few notable differences from those of other energy operators in the region. For example, in both Wyoming and Montana, all known raptor nest sites within the survey area, both intact and former, must be checked at least once during each breeding season for the life of the mine. In addition, nest monitoring efforts at the coal mines are almost exclusively conducted from the ground to ensure accurate data collection. Nests are typically checked from a distance using binoculars and a spotting scope to minimize disturbance. The purpose of these surveys is to document occupied territories including annual nesting activity and production. Furthermore, surface coal mines in Wyoming are required to record the distance from each intact nest, active or not, to the nearest known regular human activity annually. Records must include the type of disturbance and whether or not the activity is within line-of-sight of the nest. Lagomorph abundance also must be surveyed annually at Wyoming coal mines; Montana no longer has this requirement, but some operators voluntarily continue these important surveys. As noted, Wyoming coal mines also are required to have and regularly update a USFWS-approved Avian Monitoring and Mitigation Plan. Annual surveys for winter BAEA roosts must be conducted when potential habitat exists within one mi of current year disturbance. Although not part of the annual wildlife monitoring program, surface coal mines in the PRB are also required to collect various weather data every hour throughout each year.

Raptor monitoring requirements for PRB coal mines have multiple important benefits. For example, long-term annual monitoring from nest initiation through production allows for the identification of pair territories, as well as for more accurate and complete nesting data each season. These data are essential for successful mitigation planning and implementation. They also help identify alternate nests early in the season, which decreases potential risks of impact and increases the operational flexibility, or adaptive management, of the mine. Other advantages include less potential for disturbance to nesting raptors through the use of ground-based monitoring and

greater accuracy of data regarding nest activities, species identification, nest location, and final production. Disturbance data can help identify potential risks and document tolerances to disturbance, both across and within species. This information, in combination with prey and weather data, can facilitate the understanding of how natural factors affect raptor production within the survey area (**Figure 12**).

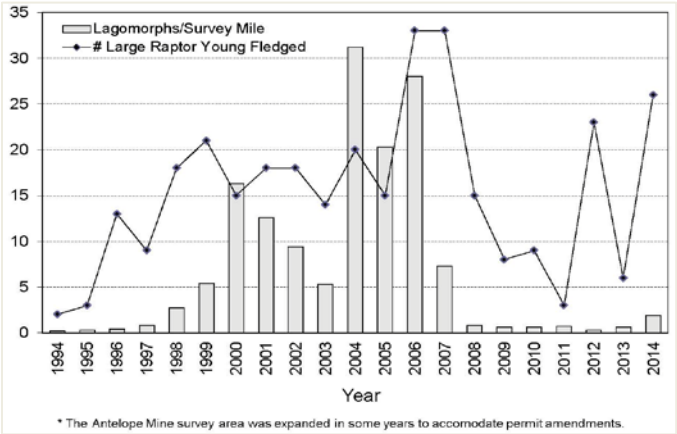

Figure 12. Annual indices for prey abundance and large raptor production at a surface coal mine from 1994 to 2014.

Some of the challenges and questions facing surveys and efforts to establish a consolidated database include:

- Disparities in regulations among industries increase the difficulty of mitigation planning when different operators have different rules, even on the same property.
- Disparities in timing and spatial restrictions among agencies results in significantly greater challenges when planning operations.
- Disparities in survey requirements make wide-ranging comparisons across data sets more difficult.
- Who would manage a statewide raptor database for quality control and to ensure access and usefulness for different industry needs?
- How would quality control be maintained for active, web-based data entry by the public?

Conclusions and Recommendations

- Long-term monitoring through the entire breeding season provides an important foundation of knowledge that enhances proactive planning and successful mitigation efforts.
- Monitoring territories versus nests enhances mitigation planning and effectiveness, but requires operator investment and understanding of the value of territory monitoring.
- Effective project planning that minimizes impacts to raptors could benefit from more consistency among agency requirements and restrictions, standardization of data collection, etc.
- The collection of additional data regarding disturbance and prey-base will further enhance our knowledge base and will benefit both the operators and nesting raptors.
- Results from these efforts could translate into fewer conflicts between nesting raptors and resource extraction and a better understanding of viable solutions when conflicts are unavoidable.

Editor's Notes

This presenter has valuable experience working with coal mines in the PRB. Those mines have over 40 yrs of raptor data.

There are three distinct steps in raptor data collection during the life of a mine: 1) the pre-mine inventory, 2) the establishment of the annual wildlife monitoring program, and 3) the post mine inventory.

The presenter identified several benefits of the raptor monitoring requirements for coal mines in the PRB: 1) they can identify pair territories, 2) they can provide accurate and complete nesting data each season, 3) they can increase operational flexibility, 4) there is less potential for disturbance to nesting raptors, 5) there can provided greater accuracy on nest productivity, species identification, and nest location, and 6) disturbance data can identify risk and tolerance to disturbance, both inter- and intra- species.

The presenter also identified several challenges of raptor monitoring requirements for coal mines in the PRB: 1) disparities in regulations increase the difficulties in mitigation planning, 2) disparities in

timing and spatial restrictions result in increased challenges when planning operations, and 3) disparities in survey requirements make broad-scale analysis of multiple data sets difficult.

The presenter suggests: 1) monitoring territories instead of nests, 2) more coordination between regulators to make project planning more effective at protecting raptors, and 3) collect more data on disturbance and prey-base, which would benefit both raptors and industry.

The information provided in this presentation, based in years of monitoring work and data collection, reinforces the call from other presenters to: 1) collect data in a manner which allows for broad-scale analysis of raptor trends and populations, 2) create consistencies in regulations from all the regulatory entities involved, which, she suggests, would benefit both industry and raptors, and 3) collect more data on the effects of disturbance and prey populations on raptors.

Inventorying and monitoring raptor nests at oil and gas exploration and development sites

Bill Vetter, ICF

Abstract

The ICF International, Gillette, Wyoming office has been involved with raptor surveys and monitoring throughout Wyoming and many neighboring states for over thirty years. Over that time, their biologists have worked extensively with a variety of energy-related industries, including more than 10 years of data collection for oil and gas projects. That work has provided them with considerable experience in data management strategies, raptor nesting data, and the use of numerous established datasets. The requirements for collecting raptor nesting data during the planning and construction phases of oil and gas projects are largely based on resource protection, an important objective. However, survey protocols don't necessarily require the collection of information that may serve other important raptor management needs, such as population monitoring, assessing impacts from oil and gas development, and the implementation of successful mitigation strategies for those projects. Furthermore, the objectives for data collection during the production stage of oil and gas development are not entirely clear, and the data collected during that phase are typically limited in their use by many constraining factors. This discussion attempts to 1) outline some of the data gaps that currently exist with raptor nesting information collected for oil and gas projects and 2) explore whether other resource management objectives are desired, if so, what are some potential avenues to address those data gaps?

Key Findings

ICF has over thirty years of raptor survey data associated with a variety of activities, including more than ten years of data for oil and gas development. This includes data for nearly six thousand raptor nests from about eighteen raptor species, most of which are plains nesting species. Every year, 42 to 59% of those nest sites are surveyed and between 33 and 37% of the sites are more intensively monitored every year. This data overlaps six BLM field offices and is collected on behalf of several state and federal agencies, following their protocols for data collection. In general, these surveys extend throughout the project area and a one-half to one mi buffer surrounding them.

During the planning stage of development, there is a clearance inventory done to identify raptor nest sites and associated habitats, including winter roosts and some prey-base. In undeveloped areas, there is usually no available existing data, while overlapping or existing adjacent development can have previous data available. Often, the data from overlapping or adjacent existing development varies in spatial extent, differing agency or jurisdictional datasets, and varying information contained within the dataset. The planning stage clearance inventory is usually done just prior to the submission of the application for the permit to drill, which means the biological surveys can occur outside the breeding season. Data collected outside the breeding season contains location and condition data only, while data collected within the breeding season includes activity data. The purpose of the planning stage clearance inventory is to identify conflicts between raptor habitat and planned activities.

During the development and construction stage, surveys and inventories follow the conditions of approval, which typically dictate nest surveys annually with continued surface disturbing activities. These surveys are conducted between April 15th and June 30th and the frequency and revisit schedule is largely undetermined. The annual reporting obligations have a flexible schedule, but the data is incorporated into BLM datasets annually. The purpose of the development and construction stage surveys is to determine where raptors are nesting in order to avoid impacts based on timing and distance stipulations.

During the production stage, again surveys and inventories follow the conditions of approval. Post construction surveys can span up to five years after construction is complete. These surveys and inventories are conducted in June to emphasis information on nest productivity. Annual reporting is required and typically due in July. The purpose of the

production stage survey and inventories is unclear, but is possibly required to better understand long-term impacts of development by identifying nest sites that are used after development is complete. Additional circumstances for data collection include programmatic baselines and surveys for certain exception activities.

There are numerous data gaps that limit the information regarding the impact of development on raptors. The planning stage data can be non-breeding data, with limited analytical utility. Also, during the planning stage, non-raptor nesting data (e.g., black-billed magpie nests) are frequently pulled into the dataset, which further complicates the data. During the construction and development stage, survey and inventories miss early nesting attempts with the April 15th start date. If the frequency of inventory and surveys during the construction and development stage is mistimed the data will not clearly show nesting outcomes. These survey and inventory methods can also leave the causes of nest failures uncertain. Surveys and inventories during the production stage do not account for all raptor species nest productivity, especially in the case of SWHA and BUOW. Nest productivity data is dependent on forecasted nest occupancy and productivity information on other nests or new nests is greatly limited.

Current objectives for raptor surveys and inventories related to oil and gas projects do not include the following, but perhaps they should, for the benefit of raptors and industry as a whole:

- Contributing to raptor population information and trends
- Providing a better means for understanding oil and gas impacts
- Providing for effective mitigation or for more effective development of mitigation plans.

Strategizing data collection alternatives to address the first proposed objective above would likely include broader general coverage of surveys and inventories, both in space and time. This could include expanding efforts to account for additional habitats, regions, and disturbance regimes. The timing of data collection could be adjusted to account for all or more species. Data collection alternatives for population monitoring could include more targeted species efforts, including population protocols for species of concern and could target crucial habitats or areas important to population stability. Collecting data useful for population trend analysis would probably need to be more of a unified effort that relies on a more standardized approach. It would also likely benefit from unified data management.

Strategizing data collection alternatives for better understanding oil and gas impacts should include consideration of key information needed for impact analysis. To fulfill this objective, data collection strategies should consider measuring the proximity to and nature of disturbance, collecting line-of-sight information, and collect data on the timing of anthropogenic events. Strategizing should also consider collecting complementary datasets for factors that also influence or compound raptor nesting outcomes, including prey-base and weather and climate data.

How would these strategies look if implemented? Doing case studies is an option. These would be heavily structured studies that could withstand some scientific prodding. This approach has been used for other species. There is the potential for operators to buy into this approach if the data could be applied to a proportion of their approvals in lieu of continued, less-fruitful, blanket surveys across all of their projects.

To achieve the third objective (above) would require monitoring, rather than surveys, and should gather territorial and spatial use information, as well as information about tolerance to disturbance. This monitoring data would need to be compiled over multiple years. Multi-year monitoring data would provide a feedback loop that provides information on what type of mitigation actions work, and which do not. That feedback loop would maintain the flexibility of mitigation measures, keep active parties invested in mitigation efforts, and would ultimately help maximize the effectiveness of mitigation efforts. Taking a landscape level approach to monitoring would capture

overlapping and adjacent disturbances and would include landscape scale biological considerations such as existing territories.

Conclusions and Recommendations

- Raptor information collected for oil and gas development is generally limited to surveys rather than monitoring.
- Surveys are conducted for resource protection on an individual nest basis during the planning and development/construction stages.
- The objective for data collection in the post-construction stage is unclear.
- More comprehensive survey protocols and instances where identified data from monitoring is needed would help shore up numerous data gaps and provide greater analytical utility of the dataset.
- More clearly identifying the objectives for collecting raptor data related to oil and gas development (e.g., population trends, impact analysis, effective mitigation) would help guide the development of more comprehensive protocols and target specific data needs to achieve these objectives.
- A shift of focus from individual nest sites to considerations for raptor territories would greatly enhance raptor management policies.

Editor's Notes

ICF has 30 yrs of raptor survey data, including 10 yrs of data related to oil and gas activity. This includes data on nearly 6,000 raptor nests and about 18 raptor species. Every year about one-half of the nests are surveyed and about one-third are more intensively monitored. While this data set is extensive, there are gaps that deter from one's ability to draw conclusions about raptor disturbance from oil and gas activities. The presenter discussed these gaps and suggested that by adopting the following objectives of data collection, we could move toward a better understanding of raptor disturbance. The presenter's proposed objectives were:

- Data should contribute to raptor population and trend information.
- Data should provide a better means of understanding oil and gas impacts on raptors.
- Data should be able to show the effectiveness of mitigation measures and mitigation plans.

To address the first objective, the presenter suggested 1) broader surveys, both in terms of space and time, 2) adjusting the timing of surveys to account for all or more species, 3) more targeted species surveys, and 4) a unified data collection and data management effort using a standardized data collection approach.

To address the second objective, the presenter suggested: 1) measuring the proximity to and the nature of disturbance to raptors, 2) collecting line-of-sight information on raptor disturbance, 3) collecting data on the timing of anthropogenic events, and 4) collecting prey-base, weather, and climate data.

To address the third objective, the presenter suggested 1) requiring monitoring rather than surveys, 2) incorporating territorial and spatial use information, and 3) incorporating multi-year monitoring that feeds back into reviews of which mitigations are working and which are not. Finally, the presenter suggested a shift away from nest-centric monitoring to territory monitoring.

The presenter forwarded three objectives for consideration and action items for meeting those objectives. These objectives, and many of the action items, came up in other presentations during the symposium.

Buffalo Field Office Raptor Database: What it is, what it is not, what it can be

Bill Ostheimer, BLM BFO

Abstract

The BFO Raptor Database served a good purpose for permitting many thousands of gas wells in the PRB. The majority of data was gathered by oil and gas consultants to plan and permit gas wells. The data is managed by BLM and there is a months-long delay in getting the data turned around to users. The data is not very useful for answering population level questions. There is no negative data recordation. The data is not coordinated with other agency or private data. I propose a real-time web-based system that is populated routinely during the field season. We developed a lek database with Wyoming Geographic Information System Center which would provide a good starting point.

Key Findings

The BFO Raptor Database is massive, with data on over four thousand nests (**Figure 13**). It contains data on over twenty-thousand gas wells drilled between 1999 and 2008, it contains data on twenty-three species, it follows the PRB Interagency Working Group protocols, and it is used for permitting and compliance.

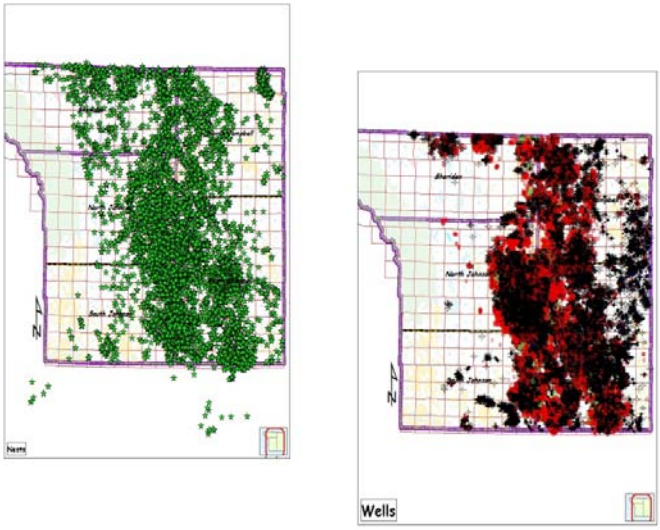

Figure 13. Nest locations (left) and well locations (right) from the BFO Raptor Database

Productivity studies and data have been hit or miss and because of the amount of private mineral development, private lands, and the permitting workload at the BLM, it has not been possible to explicitly interpret how well the conservation measures are working.

If you pull up data for a particular nest you can see how a nest can go unused for several years, and then, seemingly all the sudden, see regular use again.

The BFO Raptor Database is not:

- Developed to answer research questions,
- A good source for negative data (empty areas with no recorded nests are due to lack of mineral exploration and development, not necessarily a lack of raptors),
- Timely or elegant (requires a six month turn-around for data, lots of BLM time put into managing this database).

Problems with the existing system:

- Some of the nest's data are duplicate.
- Some of the nest visits are redundant.
- This is one of a number of datasets in use that are not coordinated with the other datasets.

Where can we go from here?

- I would propose a real-time web-based system that is populated routinely during the field season.
- The web-based, field season data set would be rolled into the main dataset each year.
- There is a need for a data steward and a need for partners to support the construction and maintenance of a shared database.

At the peak of CBM, we had leks with double digit visits. The platform was intended to reduce redundant visits, which it did. The collateral benefit of having data on hand early in the summer is increased communications between field biologists.

Conclusions and Recommendations

The BFO has a huge raptor nest database, but it has limitations: 1) BLM staff time is limited, 2) there is a

large delay in getting the data turned around for use, and 3) the data is not coordinated with other data. This limitations result in redundant site visits, which is a concern for its potential impacts on raptors. There are also some private property concerns with redundant visits. Lastly, by not having our dataset connected to others, we have limited power of analysis. We should be reaching towards a real-time, map-based system that houses multiple datasets.

Editor's Notes

The BFO raptor database houses data on about four thousand nests, yet has several limitations when being used for analyzing the effectiveness of mitigating measures. Those limitations include:

1. The database is not integrated with other data sets, which results in redundant site visits, greater disturbance to raptor nests, private property concerns, and reduced power in analyzing mitigating measures.
2. The database lacks negative data, there is no data about where there are no raptors and there is no data about where there is no oil and gas development. This reduces the power of the dataset to analyze the effectiveness of mitigating measures and the impacts of oil and gas development.

The presenter suggests a coordinated data collection and storage effort, which will reduce redundant site visits, reduce impacts on private land owners, increase the power of scientists to analyze the effects of oil and gas development on nesting raptors and the effectiveness of mitigating measures to reduce those impacts. The presenter suggests that the work that has been done to coordinate sage grouse lek data collection is a good example of the potential benefits of that kind of coordination. They have found that by coordinating data collection and storage efforts for sage grouse, they have been able to reduce the number of visits, reduce the impacts to leks, increase communications between field biologists, and increase their power of analysis. Other presenters and attendees echo this call for coordinated data collection and storage and echoed sage-grouse lek data collection as an exemplar.

Raptor nest summary: Thunder Basin National Grassland

Tim Byer, USFS Douglas Ranger District

Abstract

Thunder Basin National Grassland collects and houses data on over one thousand raptors. The database is unwieldy and requires constant maintenance. Several lessons from managing this database would be of value for launching a centralized raptor database for Wyoming.

Key Findings

Thunder Basin Database tracks over 1200 known nest sites covering 12 species (**Figure 14**). FEHA and GOEA tend to dominate the database. The database includes nest location by Township, Range, and Section as well as by UTM coordinates. It also has data about the nest substrate, the most common species to use the nest, and the nest status (by year) using the WGFD's raptor nest codes.

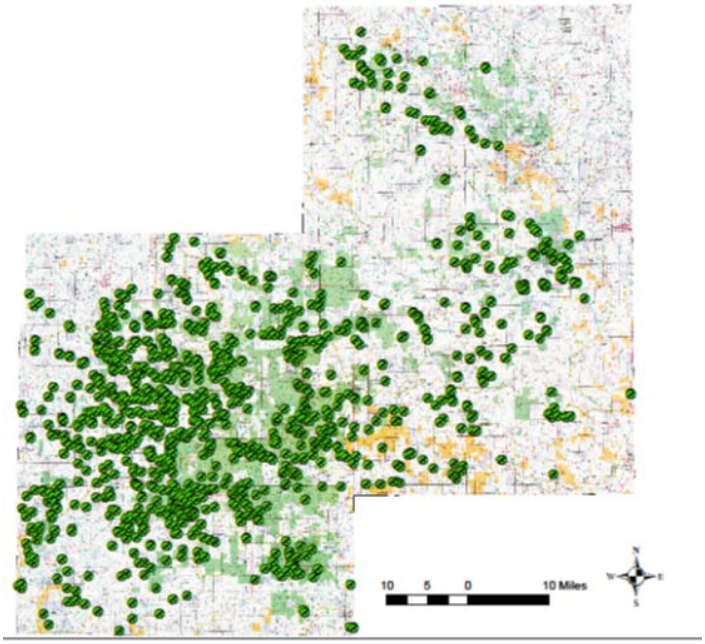

Figure 14. Known raptor nest sites on Thunder Basin National Grassland.

Most Thunder Basin surveys are ground-based and associated with projects, but several aerial surveys have been done in cooperation with the WGFD and different BLM districts. An estimated 85 to 90% of nest locations are known. The Grassland is currently in the process of establishing a set of annual monitoring reports.

The USFS database is not public because it contains data about several sensitive species. The database is used primarily for internal project analysis and USFS habitat management. There is a process in place for allowing parties outside the agency to access the data and several agencies have used our data for research, but that is not a primary use of our database.

The database does have some problems. It is unwieldy in size and requires care and maintenance. It is difficult to keep each nest status current and there is a problem with keeping nest identification consistent between agencies.

Conclusions and Recommendations

Concerns about a shared raptor database for northeast Wyoming include:

- Adding another database to the system adds additional work and cost,
- National Grassland data needs to be compatible with USFS reporting requirements,
- Some data is sensitive, and caution is warranted based on how or if that data is released.

Editor's Notes

The presenter suggested that large databases, such as that for the Thunder Basin National Grassland, require care and maintenance, which requires a constant flow of money. He cautioned that a centralized raptor database would also require similar inputs. He also cautioned that some of the data may be sensitive and not something that the public should have access to.

Inventorying, monitoring, and analyzing raptor data or, the big picture

Gary Beauvais, Wyoming Natural Diversity Database

Abstract

Natural resource developers, managers, and conservationists are broadly committed to the notion that science can profitably inform the management and conservation of raptors in the west. In this context, all parties should recognize that robust scientific conclusions ultimately grow from good base data - i.e., observations and measurements made directly in the field. Resolving the three main questions facing raptor managers – 1) What are the biological units in question (e.g., species, subspecies, populations)? 2) Where are those units (i.e., what is their distribution)? and 3) what are their relevant temporal trends (e.g., status and condition)? – requires attention to organization and centralization of base data that can then be generalized, or modeled, in various ways to produce useful information. Current extrapolations of base data in this region suggest that there are no subspecies or distinct population issues that substantially complicate raptor management. Breeding and wintering distributions of raptor species are understood at useful levels of precision, but migratory routes and preferences should be investigated further and population statuses are understood both broadly and at certain project scales. Improving and updating our understanding of raptors requires thoughtful approaches to efficient and coordinated data collection and, perhaps most importantly, centralization of that data in an organized and accessible database available to all interested parties.

Key Findings

The main driving questions behind the effort to improve raptor data include:

- Do we know enough to maintain the viability of raptor populations in context of continued industrial development?
- What are the practical opportunities to fill priority information gaps given realistic constraints and budgets?
- How can we coordinate the raptor data collection effort to maximize effectiveness and efficiency?

Data is the basis of information, information is the basis of knowledge, and knowledge is the basis of wisdom. Data is not knowledge, and so on (**Figure 15**). Therefore we need good data to have good information, and so on. For data to produce the best possible higher-level models and estimates it needs to be collected with those eventual models and estimates in mind, this is the basis for targeted data collection. But even simple count data and opportunistic data can be used to build useful information products if done with care and attention.

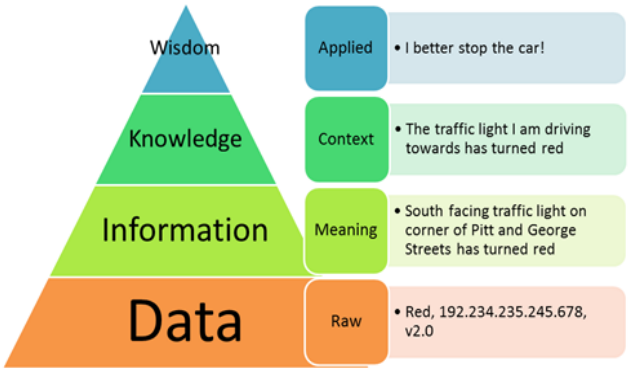

Figure 15. The relationship between data, information, knowledge, and wisdom.

In the context of raptor ecology and management in this region, we have some targeted data collection that feeds specific modeling and analysis needs and we have a lot of count data and opportunistic data that inform site-specific decisions with only minimal analysis or modeling, therefore the questions are, "is this body of science adequate for management?" and "can it be better?"

Three basic questions can help target the science regarding any species or species group:

- What is the target organism (species, subspecies, and distinct population segment)?
- Where is the target organism (range, distribution, seasonal habitats)?

- How is the target organism doing (trends, viability, threats)?

Addressing the first question (above) regarding raptors, as currently understood there are no significant subspecies or distinct population segments issues that substantially complicate raptor management in the region, but we could use some targeted data collection to solidify our knowledge here.

Addressing the second question (above) regarding raptors, the location of raptors is answered with both targeted data and count data. For example, raptor maps are created with breeding locations and a model for different probabilities of occurrence based on location (**Figure 16**). The accuracy of these models relies on the quality and quantity of field data, such as sample size. It is important to note here that negative data are data too. Negative data can be used for habitat preference models and habitat selection analysis. Lastly, this question brings up another question, "Do we understand migration on a fine enough scale?"

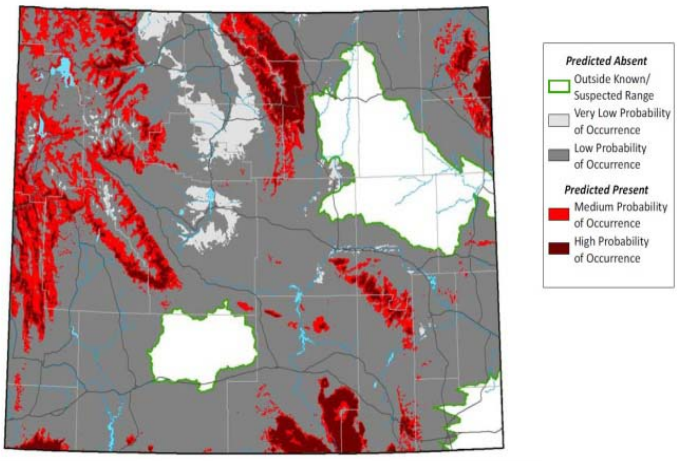

Figure 16. Probability of occurrence of northern goshawks in Wyoming during the breeding season.

Addressing the third question (above) regarding raptors, many range-wide studies have set the context and can help steer more localized work (Farmer and Smith 2009; Millsap et al. 2013). Project and area specific monitoring of nest counts provides finer scale information for population segments and results can provide context within regional information. Project and area specific monitoring is ongoing and provides quality data, but the data is scattered, unorganized, and inaccessible. A raptor data clearinghouse would make data centralized, organized, and available. It would reduce redundancy and be more efficient, but it would require a fulltime data steward and ongoing data collection requires ongoing funding.

Conclusions and Recommendations

Can the clearinghouse concept be applied to scientific information on raptors and not just data? For some managers and project operators, the information regarding habitat use, threats, and mitigation actions is as scattered, unorganized, and inaccessible as basic count data. How can we address that?

Editor's Notes

This presenter lays out a rationale for targeted data collection to achieve objectives beyond project level objectives. Other presenters similarly linked population, trend, and disturbance analysis objectives to actions and changes regarding data collection methods. Also, like other presenters, this presenter points to the significance of negative data, suggesting that it can be used for habitat preference models and habitat selection analysis. Lastly, like so many other presenters, this presenter calls for a centralized data clearinghouse for raptor information.

Next Steps

These points were brought up during a discussion amongst Symposium attendees and presenters with regard to the questions, "What have we learned during this symposium so far?" and, "Where do we go from here?"

Summary Points

- Should there be a financial incentive for upgrading power lines?
- There is a lack of prey density over the broader region.
- There is a real opportunity to monitor trends in FEHA and GOEA data
- The data is available and this would be a good starting point to answer the question, "Is energy development affecting occupancy by raptors?"
- Are there ways to start standardizing data?
- The Rawlins BLM has a good model for "monitoring without borders"; perhaps there could be a pre-survey meeting to monitor the PRB as a whole.
- Perhaps we could create a protocol site for data that is already available.
- We should think about shifting from a nest to territory focus for data collection.
- We should look at the Southern Wings program to see if we can affect issues on wintering grounds.
- We should be moving towards full life-cycle analysis for these raptor species.
- How are we going to bring together data to think about strategy in management?
- We should differentiate between project and landscape level data.
- We should take steps towards a centralized, state-wide database.
- We should collect data to help us investigate the role of alternative nesting structures in impact mitigation, especially regarding FEHAs.
- Are current mitigation measures affecting impacts to raptor populations (especially in regard to FEHAs)?
- We should investigate the effects of novel predators whose existence is subsidized by water developments.
- Could there be more NGO cooperation for data collection?
- What other types of data should be collected (i.e. – disturbance levels, etc.)?
- There should be more research partnerships with industry and more outreach.

Technical Session 4: Panel

Opportunities for improved raptor management as identified from the previous sessions

Becky Byram, Devon Energy; Alison Lyon-Holloran, Audubon Society; Andrea Orabona, WGFD; Dennis Saville, BLM; Gary Beauvais, Wyoming Natural Diversity Database; Patricia Sweanor, USFWS; Tim Byer, USFS. Moderator: Pete Obermueller, Wyoming County Commissioners Association.

Pete: For me, this panel discussion will be valuable because I know that County Commissioners are cognizant that they need to come to the table on issues such as these with data, not anecdotes.

Question 1: Is there anything that has really jumped out at you in the last couple days?

Question 2: Would you like to respond to any questions or statements from the Next Steps: Summary Points?

Becky: What jumped out at me is the clear correlation between raptor numbers and prey-base. As far as next steps, I like the idea of a database clearinghouse for raptors that has accurate data to use as a planning tool for operations. The process of developing that clearinghouse should start with standardizing survey methodologies.

Alison: What has jumped out for me is that we face some hurdles and gaps in getting the information we need. We need to manage the data more holistically and we need to better coordinate our efforts. We are also still missing a process of decision-making based on science and adaptive management. Step 1: bring the stakeholders together (this symposium is a great start). Step 2: develop common and clear goals. Step 3: look at the data. Step 4: put it into models and create scenarios. Step 5: create conservation recommendations. Step 6: implement those recommendations. Step 7: evaluate the effectiveness of the conservation recommendations. Step 8: modify the models and scenarios, which brings you back to Step 4 again, and so on. Sage-grouse is an example of a few pieces of this cycle. This can be done for whatever species or ecosystem and can help us all thrive.

Andrea: The effect of prey availability on raptor populations does not surprise me, but it clearly needs to be addressed in our management. What I found surprising was that Devon said they will fund a product we can all use. I hope other organizations, including the State, can contribute [a Devon representative clarifies that they did not commit to funding anything]. Secondly, I think we need a stakeholder group to address: 1) data standardization and storage, 2) monitoring standardization, 3) research questions, and 4) policy. The first three come together to create policy.

Dennis: My surprise was how many people showed up, I am very pleasantly surprised. Just a thought on where we need to go, I think Leopold or Muir said something like, "if you tug on a thread, you find out everything is connected." This is a good theme for raptor issues. We've got to look at the bigger context. Whatever you do, don't make things worse. Keep the big picture in mind. And remember, we're never going to have enough data to solve every problem.

Patricia: It's encouraging to see that all of us are looking for a new approach. We have approaches for other industries (coal, wind, utilities) we don't have something comparable for oil and gas. Of course, to do that, we need the information that we are all talking about.

Gary: I was surprised by the apparent strength of the relationship between raptors and prey-base. It reminded me of what we're seeing with big game and climate and sage-grouse and climate. It's good to remember what we've more or less always known; wildlife populations are dependent on precipitation and climate cycles. In a good year, we'll have lots of raptors, after a bad year or series of bad years, we're not going to have many. Our area is at high elevation in the interior of the continent with poor soils. There's not much that's going to change that. These are our overall constraints. Regarding the second question,

policy is going to be made whether the science is there or not. We need to make it easier for the science to flow to the managers. We need to target research to make it easy for managers to get to.

Tim: I was surprised to see people moving away from a nest-centric towards a territory-centric data collection. For the second question, 70% of the land out there is private; we need more partnerships with private land management in order to be successful.

Pete: *Do you feel the data is useable and used? What is our opportunity to make better use of the data?*

Alison: There are always data gaps and room for improvement. A big hurdle is coordinating and consolidating the data. I don't think the data is being used as well as it could be. We need to build a system that is transparent, open, and with standardized methodologies.

Becky: The data is there. We use it as a starting point and then ground truth. Is it enough? No. If the goal is to be able to work like the coal mines, we need more and better data.

Dennis: We need a centralized clearinghouse for data. This symposium is a great starting point in that direction. It is going to take some more communication to work these things out.

Trish: It depends on scale. At the project level, it is often piecemeal or snapshot data. I often need better information in my job to help industry comply. Getting landscape scale data that is useable at the project scale would be a good approach.

Converse County Commissioner Willox: *Who leads and who pays for this stuff? Who will hold the data in a clearinghouse?*

Andrea: It makes sense that [WGFD] manage and monitor and that the Wyoming Natural Diversity Database stores the data in the clearinghouse. Probably all the stakeholders should be paying.

Dennis: Consolidating the data into a clearinghouse makes a lot of sense. Maybe the most logical place is at the University of Wyoming, where we can get bright minds for intern salaries. And we've all got to pay.

Gary: Part of the history of Wyoming Natural Diversity Database (WYNDD) is that a committee decided that the University of Wyoming should house WYNDD because it benefits the state. Then the legislature added the core function to WYNDD with the expectation that stakeholders or users pay to use WYNDD. Maybe this history of WYNDD could serve as a model for the proposed raptor database.

Trish: Is this something that could be developed at the County level?

Pete: *Let's get industry's response first.*

Devon Representative: I don't know what the answer is, but this Symposium is a very good start.

Pete: Federal law gives commissioners a seat at the table. It is one thing to have a seat; it's another thing to belong. We want to make decisions based on data, not anecdote.

Commissioner Shober: Sublette County is the sweet spot for oil and gas, but this issue is bigger than our county. We've got a lot a lot invested right here in this symposium. But all that said, this database should be housed at the state level.

Penny Bellah, Samson Resources: I'm a member of the Sage-grouse Implementation Team (SGIT), which may be a good model for centralizing this database. There was quite a bit of funding for research with SGIT. Adaptability and applied science is key to success here.

Alison: The SGIT process has brought a lot of clarity. The SGIT is a good model. We could build off of that. I agree that University of Wyoming is a good place to hold this data. How do the NGO organizations see pulling that stuff together?

Gary: Some could be dealt with technically. This is kind of a database science question. It would require lots of concentration on the model that is the basis for this database. We can align a lot of the data, but some of the data may have to stay with the record generator.

There's a good point to be made regarding the University as neutral place to hold the data. There can be a lot of territoriality and suspicion regarding datasets; that might be another thing worth putting more thought into.

Jeff Birek, Rocky Mountain Bird Observatory: We have a grid-based statewide monitoring program. We have a random spatially balanced survey. We have stratifications done (i.e. Thunder Basin and Yellowstone). This sampling frame is built already and would be ready to go for raptors with less effort. We have two IT staff that solely work on the database. We can't necessarily put all the data together, but you can see all the data, based on location.

Pete: *What should be our next priority for funding?*

Trish: Actually I want to address something else. There is some good data for projects that I get from industry. Part of the problem is the data sharing. Maybe there should be more outreach regarding data between companies. So an important question right now is, "How are we sharing that data and how valuable is the data that is being collected?"

Dennis: I really don't think we can get away from doing both: we've got to compile the data we've been holding onto for years, but we also need to be collecting new data. I think we can make some gains in efficiencies and better use of our money to consolidate the data. That also helps us plan for the future. Let's use a standardized form. Let's not duplicate our efforts. Let's have one agency or one firm collect data from a certain locale. I like the idea of housing it at the University and getting students involved. That's how they learn, that's how we get the next generation involved. It could add benefit to the University educational system.

Gary: I think we want to fund both new data collection and new research and compile the existing data. When we think about new research, we want to think hard about relevant management questions and how they can be answered. This new targeted data collection is valuable because it addresses these meaningful questions that change the way folks do their work every day. I think it's imperative that we put a lot of thought into these questions and how we answer them.

Steve Slater, Hawkwatch International: In Utah, Hawkwatch is facilitating a statewide database for eagles. I think it really helps to think first with what you want to be able to query from the database. The first data stitch can be done, yet is time consuming. We have specific columns that get at territory data. We are on a parallel effort, so I'd be happy to share if you need help.

Andrea: We need to have standardized, peer reviewed survey methods. We need to have standardized terminology. We need to have standardized data sheets. We need to be answering questions that are relevant to managers and have yet to be answered, for example, cumulative impacts, effects of noise and screening, visibility and line of sight, types of disturbance activities, location of disturbance, and prey availability.

Alison: We need to both consolidate existing data and collect new, but more following the cycle of research: we need to take the extant data first and put it into the model and then create the 'what if' scenarios, then see if we get it right or need to fix it, then go back to new research, and then the cycle begins again.

Tim: The first thing we need to do is standardize our data collection protocols. Then we need to figure out where we want to store the data. After that, compile existing data. Research is going to drive us in the future, but we've got things starting up really quickly, so protocol first.

Trish: One of the outputs from the database should be easily generated maps for management.

Bob Oakleaf: There has been a lot accomplished to standardize these methodologies, but it's not being used. I'm very confident that the Governor's Office would fund this stuff.

Andrea: Real quickly, just like Bob said, the first and easiest step is standardizing data collection.

Gary: We are working right now to create a new database to serve the original needs of the Wildlife Observation System (WOS) and the WYNND database. We are getting the funding to do this now.

Commissioner Shober: *Governor Mead spoke of the need for balance and that energy development, wildlife habitat, and a healthy environment are points of pride for Wyoming. What scientific studies of raptors could we start working on today to start to achieve the balance Governor Mead spoke of?*

Gary: One that comes to mind is the idea of reclamation and restoration of disturbed landscapes. How can we do that in a way that is productive for wildlife habitat? I've heard from industry representative that there is not enough research there for sage-grouse. I wonder if that couldn't be an area of focus for raptors.

Tim: The first thing that comes to mind is what does nest relocation do to the rest of the system? What's it doing to sage-grouse, rabbits, and prairie dogs? When I go to a manager and say, here's what I want to do, move this nest, I can't point to the potential effects on the whole system. It doesn't seem like we're getting a whole lot of that kind of research back, research that answers the question, "What's the overall picture of what's happening?"

Pete: *I want to turn this question over to Becky because, from an industry standpoint, you need to move and move relatively quickly. What are we missing, from an industry standpoint, for you to be able to move forward?*

Becky: We are working with the BLM BFO right now on an adaptive management plan to allow us to drill year round, including during the breeding season. We hope to have it approved by the BLM next week. It is modeled after the mine plans. So it is similar to what the mines are doing. It is based on intensive monitoring and allows the rigs to move based on the movements of the birds. Tied into that, we are monitoring prey-base populations, sage-grouse, and we're trying to keep track of the other raptors in the area. The BLM has been very supportive of this applied research. It is a great option for us as an energy company, because as Penny said earlier, we need to be adaptive, as an energy company, we move based on the production of our wells and the economics of the commodity at the time. When oil prices drop, you've got to drill what is most productive and economical, how do you do that? By moving around. We've committed to weekly monitoring in a defined area, and our rigs will only be moving around in that defined area for this breeding season.

Representative Roy Edwards: On your "next steps" list, you have "lack of prey density over a broad region." The way I look at that is that raptors are also a prey. Everything out there is connected and needs to be looked at as a whole. Isn't this true?

Dennis: The idea of balance is really important. The idea is to look at this at a broader context. What will work for Campbell County might not work in Carbon County. But if we institute it in Campbell County, Carbon County will ask, "Why can't we do that?" We get the same thing from individual companies, they come to us with a proposal that they think is balanced. That's important and we want to hear that, but we don't want to be the only ones involved. We would like to know that a company went out and talked to adjacent land owners, the county and adjacent companies. Did they bring in WGFD, did they bring in USFWS? I think so many times we look at an issue as our problem that we need to solve today, which is important, but we have to look at the broader context. Try to make sure you communicate with everyone involved ahead of time. Doing so usually results in a better product in the end.

Unidentified attendee: *At the beginning, we were talking about standardized management policy. Once we standardize data collection and standardize storage the emphasis is going to shift to our inconsistencies from one county to another in terms of management. Therefore, I think we should really consider some concurrent standardization of management policies.*

Tim: As the session opened up yesterday they talked about how the data is going to have to affect policy. Once we have the information at hand, it can influence policy. Unfortunately, most of us are not that

influential on policy. Once this group gets the information into place, then there will be another panel of different people convening that represent policy decision-makers and they will be making that jump from the information to the policy, but I can guarantee you that I am not that guy for my agency.

Pete: *I want to shift gears towards next steps. What can we do next, what can we do soon in our applied research that can give us measureable results sooner rather than later? How do we move forward?*

Alison: The first step is to bring the stakeholder group together, and every single stakeholder has to be at that table, to discuss what is next, what data exists, and how we are going manage that data. Again, what we've done with sage-grouse is a good model.

Becky: I think the first step has already been taken. For example, our adaptive management plan has many stakeholders at the table. BLM, USFWS, private surface owners, adjacent lease holders, I think that first step is there. I think people want this to work; everyone wants a system where energy development and raptors can co-exist. The coal mines have proven that it can work. Oil and gas is different, but let's see if we can make it work at the larger level.

Andrea: I agree that assembling the stakeholder group is first, but I would back it up a half-step and suggest that we have to identify who those stakeholders are in order to get them together.

Dennis: I think convening a stakeholder group is useful. I'd only caution that stakeholder groups can take more time and effort. But collective minds usually come up with a better decision, especially when it comes to policy.

Trish: I agree with Dennis that sometimes these stakeholder groups take longer than anyone would anticipate. So, taking another half-step back from what Dennis said, thinking about the timeline for meeting our objectives should come first. Then, in identifying those stakeholders, we've already got good buy in from coal and oil and gas, but there are a lot of other industry stakeholders out there and they need to be invited to the table. Then we've got to get into the field and start gathering that data.

Gary: I can't argue with anything that's been said. I think there's a chance to do something in the short term, kind of in the 'proof of concept' method. It would be nice to come out of field season 2015 showing that there could be a lot of coordinated data collection on raptor nests using the same kind of protocols. It would be nice to turn around in October and say, "Look, here is the data that was collected this year and it was collected in the same way between all entities and it stitches together into one nice data set." I think having that and being able to take it to one of those stakeholder meetings would be an important thing to do. Maybe we can put something like that in place in the short time we have to prepare.

Gary: Throwing a question back to Alison, it seems like there are a lot of parallels with the SGIT, and it really has worked; when that crisis came up, when listing was found to be warranted, it seemed to really stimulate a lot of effort to deal with the crisis. Do we want a raptor implementation team; do we want to mimic that model before the crisis hits?

Tim: I believe that the question was, "What research is needed immediately?" In my mind, we need that bigger picture and one thing that came to mind is to remember to follow the process. Don't do 'ready, shoot, aim'. I think we need to be careful, we'd like to know that year long drilling can happen, but we don't want to decide what we want the answer to be and then go out and do the research. We want to have the research give us the answer. Seeing a scaled up effort makes me a little nervous. I've seen a lot of things in my career where somebody says, "This is a silver bullet, let's get 2-4D out there and treat these invasives," and then all the sudden you start looking back and seeing all the impacts you didn't expect and didn't want. My caution is to be careful at how we look at our research. I don't want solutions to raptor issues to drive impacts to other species, such as plovers.

Trish: In establishing a timeline, we need to understand that things can be done immediately and things can be done simultaneously. We can begin working on standardizing the data collection and at the same time, begin assembling a group of stakeholders.

Alison: I think you are absolutely right, Gary. I cannot overemphasize this enough; the entire thing is a process that goes around and around and around. The goal is to never hit where we are with sage-grouse now. It is a sad, sad day when we get to that point with raptors. That should be one of our collective goals, to avoid listing.

Pete: Alright, I think that is the perfect place to leave this discussion for now. Thank you all.

Presenter Bios

Commissioner Matt Avery

Matt was born in Sheridan, Wyoming. In 1964 he and his family relocated to Campbell County where he attended elementary school and graduated from high school. He then worked as a ranch hand and later became the ranch manager for Faddis-Kennedy Cattle Company. In 1991 Matt and his wife, Dianne, took over her parents ranching operation after they retired. They own and operate the ranch with the help of their daughter, son-in-law, and two grandchildren. Matt is a former member of the Campbell County Fire Board where he served for six years. He has also served as a volunteer Fire Fighter for the Campbell County Fire Department for 35 years. In December 2010, Matt was elected as Campbell County Commissioner and is serving his second term. He was elected Chairman in 2015. Matt is skilled at saddle-making and leather work. He also enjoys playing the guitar and singing in his free time.

Gary Beauvais

Dr. Beauvais has been responsible for providing scientific and administrative leadership to the Wyoming Natural Diversity Database since January 2000. He obtained his Bachelor's of Arts degree in Biology from Colorado College in May 1990. His thesis was on the home range, habitat use, and behavior of PRFAs (*Falco mexicanus*) wintering in east-central Colorado. He obtained his Ph.D. in Zoology and Physiology from the University of Wyoming in May 1997. His dissertation concerned mammals in fragmented forests in the Rocky Mountains and their community structure, habitat, selection, and individual fitness. His research interests include conservation biology, habitat ecology of vertebrates, landscape ecology, and biogeography.

Commissioner Garry Becker

Dr. Garry Becker was born in 1945 in Jamestown, ND. He was the oldest of 7 children and grew up on a farm in South Central North Dakota. Dr. Becker attended the University of North Dakota for six years and completed his MD degree in 1970 at the University of Texas Health Science Center in San Antonio. After training at Fitzsimons General Hospital in Denver he served for three years with the First Armored Division in Germany. He also served on active duty for five years and then served 20 years with the Army Reserve and the Wyoming Army National Guard retiring in 2003 with the rank of Colonel. In 1974 Dr. Becker started his medical practice in Gillette and retired from the full-time practice in September 2011 after 37 years as an active member of the medical staff. Earlier in his career he played a role in the planning and development of the current hospital which was completed in 1981. During these years he has played an active part on the medical staff serving on all of the committees including three years as chief of the medical staff and eight years as chairman of the credentials committee, and more than 20 years on the executive committee. For 15 years Dr. Becker served with the Campbell County Sheriff's Posse starting with Spike Hladky and later with Byron Oedekoven. His memberships have included; American Legion, NRA, Wyoming Medical Society, Rotary, AMA, Reserve Officer's Association, and Campbell County Republican Committee. Rita, Dr. Becker's wife is a Chiropractor in Gillette. Together they have three children, five grandchildren, and two great-grandsons, all living in Gillette.

Commissioner Rusty Bell

Rusty was born and raised in Gillette, Wyoming. After graduating high school in 1992 from Campbell County High he attended Jamestown College in Jamestown, North Dakota, where he received his Bachelor of Arts in Biology in 1997. After graduation, he worked as a wildland firefighter in Chadron, Nebraska then on the Zig Zag Hotshots at Mt. Hood, Oregon. In 1998, while in Oregon he received an Associate's Degree in Veterinary Technology before moving back to Gillette in 2001. In 2001, Rusty substitute taught and coached 9th grade boys basketball at Sage Valley Jr. High before starting RB Services LLC in 2005, which manages the manufacturing of stock panels for the CBM industry in 2005. Rusty continued to not only coach 9th grade boy's basketball but also coached girls basketball in the summer for the Gillette Force Basketball. In the summer of 2008, Rusty attended Second Nature School of Taxidermy and turned a hobby of taxidermy into a

business. He is currently the owner of Rusty's Taxidermy. Rusty's Taxidermy provides full service commercial and custom taxidermy for both foreign and domestic customers. When elected he was the treasurer of the Wyoming Association of Taxidermy Artists, President of the Wyoming Sportsman's Group, and chair-elect of the Business Advocacy Committee for Campbell County Chamber of Commerce. Rusty and his wife Toni have been married 16 years and have two sons; Bowen is a 6th grade student and Blake is a 3rd grade student at Prairie Wind Elementary. Their family hobbies include hunting, fishing, bow fishing, traveling, and boy scouts.

Jeff Birek

Jeff has worked with raptors, songbirds and game birds in seven states and Mexico. At RMBO Jeff is working on science projects, including HawkWatch and Monitoring the Birds of the Badlands and Prairies Bird Conservation Region (BCR 17). He is also involved in outreach and education efforts. He has a bachelor's degree in environmental biology and management from University of California, Davis (2003).

Tim Byer

Tim is a Wyoming native, born and raised in Casper. He holds a Bachelor's Degree in Wildlife Management from the University of Wyoming, and currently works on the Douglas Ranger District and Thunder Basin National Grassland of Medicine Bow-Routt National Forest and Thunder Basin National Grassland as one of two District Wildlife Biologists. He is responsible for a variety of wildlife resource areas including Raptor management and also is charged with providing wildlife specific management recommendations to a wide variety of proposed activities on National Forest and National Grassland surfaces including mining, grazing, and oil and gas development. Tim has been a USFS representative on several International Committees, including the team that developed the North American Conservation Action Plans for the FEHA, BUOW, and black-tailed prairie dog. Tim also represented the USFS as a part of the Wings Across the Americas – Prairie Wings team in Mexico. He has been a member of the Wyoming Important Bird Area Technical Review Group, the Wyoming Partners in Flight Bird Conservation Planning Team, and several greater sage-grouse working groups. He has worked for the USFS for over 28 years, and has been a Wildlife Technician, District Biologist, Wildlife Program Manager, Acting Deputy District Ranger, and Acting Forest Biologist at different times during his career.

Rebecca Byram

A Wyoming native raised in Wheatland, Wyoming, Rebecca Byram received her BS degree in Microbiology in 2000 and her Ph.D. in Molecular Biology in 2004 from the University of Wyoming. Prior to her career in the oil and gas industry, Rebecca was a graduate student research fellow at Rocky Mountain Laboratories, a division of the National Institutes of Health, in Hamilton, Montana, and a post-doctoral research fellow at the Centers for Disease Control, Vector Borne Disease Laboratory in Fort Collins, Colorado studying the genetic structure of the bacterium that causes Lyme's disease. Rebecca and her husband decided that they wanted to raise their family in Wyoming and moved to Buffalo, Wyoming, in 2006. After working for environmental consulting firms, Rebecca was hired by Devon Energy in 2007 as a Regulatory Analyst. Rebecca's responsibilities with Devon include permitting and compliance related to CBM and conventional oil and gas development, primarily in the PRB, but also throughout the Rocky Mountain Region. Rebecca's areas of special interest include reclamation, wildlife, and water issues as they relate to oil and gas development.

Jason Carlisle

Jason Carlisle is a Ph.D. candidate in the Program in Ecology at the University of Wyoming, based in the Cooperative Fish & Wildlife Research Unit within the Department of Zoology and Physiology. His research interests lie within the broad field of wildlife ecology, specifically in the use of quantitative and spatial tools to understand basic ecological processes and encourage enlightened wildlife conservation and management. His dissertation research is focused on evaluating how effective greater sage-grouse is as an umbrella species for conserving other at-risk wildlife that inhabit the sagebrush steppe. Jason has been assisting Dr. Anna Chalfoun and Lindsey Sanders of the

Cooperative Unit and Dr. Ken Gerow of the Statistics Department with the ongoing statistical analysis of these raptor nest data since beginning his graduate studies in Wyoming in 2011.

Commissioner Mark Christensen

Mark A. Christensen is a fourth-generation Campbell County native who was raised on his family ranch south of Gillette near the Pumpkin Buttes. He and his wife, Erika, also of Gillette, have been married since 2011 and live in Gillette. Mr. Christensen graduated from Campbell County High School in 2001 and attended the University of Wyoming, receiving a B.S. in Finance and a B.S. in Management Information Systems. He then received a M.S. in Real Estate and Construction Management from the Burns School of Real Estate and Construction Management at the Daniels College of Business, University of Denver. After finishing his graduate degree, Mark returned to Gillette in 2006. He owns and operates The MC Family of Companies, LLC, a holding company for his real estate development and construction companies. Since 2010, Mr. Christensen has worked with his wife Erika. He is also involved in the family's ranching activities and handles payroll, accounting, and human resources activities for the family ranch which has grown to include eight locations in three states. Mr. Christensen was elected to the Campbell County Board of Commissioners in 2012 and began his first term in 2013. Prior to being elected to the Board of Commissioners, Mark served two terms on the Campbell County Public Land Board (which oversees the operations of CAM-PLEX) as a member, treasurer, vice-chairman, and chairman. Mr. Christensen also served as treasurer of the Campbell County Healthcare Foundation from 2009 through 2013, during the construction of the Close to Home Hospice Hospitality House and through the completion of fundraising efforts to fully pay-off the project. Mr. Christensen enjoys volunteering for various community organizations and remains very involved with the Campbell County Fair. He and Erika have a German Shepherd dog named Vrodo.

James Dwyer

James (JD) Dwyer is a certified wildlife biologist at EDM International, Inc. JD uses decision-relevant science and wildlife research to facilitate environmentally responsible planning and operations. He received a Ph.D. in Fisheries and Wildlife Sciences from Virginia Tech, an M.S. in Wildlife and Fisheries Science from the University of Arizona, and a B.S. in Biology from the University of Montana.

Gregory Kennett

Gregory Kennett founded Ecosystem Research Group in 1997. He has 33 years of experience in project management, public process, National Environmental Policy Act, and range management. Gregory earned his B.S. in Watershed Management from the University of Montana. As a Soil Conservationist for the U.S. Department of Agriculture, his range management experience included identifying plant communities, natural resource inventories, and agricultural planning (i.e., pasture rotations, irrigation systems, wetland and riparian resource management, weed management). Gregory has worked overseas on projects ranging from researching the illegal trade of endangered plants in China and Hong Kong to rangeland consulting in Mongolia and Mozambique. Gregory taught an advanced course in inventorying and monitoring vegetation to university seniors and graduate students. He is certified by the Society of Range Management as a Certified Professional in Range Management.

Mike Hillis

Mike Hillis worked for the USFS in Montana for 27 years. Now a private wildlife consultant, Mike brings his years of experience to Ecosystem Research Group. He is the lead author of the widely used "Hillis Paradigm," a protocol for determining areas for elk security. He also authored many other USFS Region 1 publications related to lynx, flammulated owls, northern goshawks, and timber restoration strategies. His areas of analytical expertise include habitat sustainability, disturbance ecology, species/habitat relationships, and spatial relationships. Recently Mike worked on projects in the Bighorn and Black Hills National Forests, studying the impacts of proposed

forest management alternatives on wildlife and creating strategies for better forestry techniques to minimize impacts and restore habitat. Mike has participated in five of Ecosystem Research Group's forest planning projects, the Wyoming Oil Shale project, and many other natural resource management projects.

Benjamin Irey

Ben graduated with a bachelor's of science in Resource Conservation and a minor in Wilderness Studies from the College of Forestry and Conservation at the University of Montana in 2000 and with a master's of science in Resource Management in 2013. Ben's master's thesis assessed stakeholder perspectives of the relative importance of ecosystem services produced by the Frank Church – River of No Return Wilderness. After completing his bachelor's, Ben spent a decade working as a wilderness ranger throughout Montana and Idaho for the USFS. After completing his Master's, Ben worked with the USFS Region One Office to prepare a template for ecosystem service assessments as part of the forest planning process and taught field courses for the Wild Rockies Field Institute. He began working for Ecosystem Research Group in Missoula, MT in 2014 as their staff social scientist. Ben enjoys his life in town gardening and socializing, and his life outside of town climbing and skiing the mountains.

Alison Lyon-Holloran

Alison graduated with a Bachelor's of Science in Wildlife Management from the University of West Virginia and obtained her Master's of Science in Zoology and Physiology from the University of Wyoming. Alison's master's research investigated the potential effects of gas and oil development on greater sage-grouse on the Pinedale Mesa. After graduating from West Virginia University, she served two years with the U.S. Peace Corps as a Wildlands Promoter in Honduras. Upon completion of her Master's degree Alison went to work for the Wyoming Cooperative Fish and Wildlife Research Unit developing and executing a research plan examining the potential effects of natural gas development on sage-grouse populations. Alison has been with Audubon for 14 years and currently serves as the Executive Director of Audubon Rockies.

Ryan Lance

Ryan is an attorney with the firm of Crowell & Moring LLP and provides legal counsel to the Sweetwater River Conservancy. Ryan served as the director of the Wyoming Office of State Lands and Investments for Wyoming Governor Matthew H. Mead and as state planning coordinator, deputy chief of staff, policy advisor and Endangered Species Act policy coordinator in the administration of former Governor Dave Freudenthal. Ryan was a central figure in the development of the Core Area Strategy to manage greater sage-grouse populations in Wyoming and has worked on numerous land and species conservation projects, while at the same time guiding carefully planned oil and gas, coal, uranium and renewable development projects through federal and state permitting requirements.

Governor Matt Mead

Matt Mead was sworn in as Wyoming's 32nd Governor on January 3, 2011. Born in Jackson, Wyoming, Governor Mead was raised on the family ranch in Teton County. He has a law degree from the University of Wyoming and a Bachelor of Arts degree from Trinity University in San Antonio. The Governor has served as a county and federal prosecutor, practiced in a private firm, and served as U.S. Attorney for Wyoming from October 2001 to June 2007. After he stepped down as U.S. Attorney, Matt and his wife Carol, the First Lady, returned full time to operating their farming and ranching business in southeast Wyoming. Since taking office, the Governor has put a focus on economic growth, a state energy strategy, consolidation of government services, supporting local government and enhancing infrastructure, and creating additional access to high-speed broadband. Governor Mead continues to travel to communities around the state to hear from residents in the places where they live and work. He maintains an open door policy in his office at the Capitol Building. Representing the interests of the state, the Governor also serves in regional and national leadership roles. He serves on the Council of Governors and the Natural Resources Committee of

the National Governors Association. He is also co-chair of the State and Federal Sage-Grouse Task Force, which brings together federal officials and representatives of 11 western states for a regional conservation effort. Matt and Carol have been married 23 years. They have two teenage children, Mary and Pete.

Gwyn McKee

Gwyn McKee is the president of and principal wildlife biologist for Thunderbird Wildlife Consulting, Inc., currently based in Sheridan, WY. She has worked in the PRB and surrounding region since 1994. Gwyn earned M.S. and B.S. degrees in Wildlife Management/Ecology from the University of Missouri-Columbia. She has over 28 years of experience as a professional biologist, and has worked in several states spanning the Midwest, Great Plains, and Alaska. Gwyn serves as a primary contact for both the energy industry and regulators in the region regarding project requirements and design, impact assessment, and mitigation strategies. Projects range from small, single-day site assessments to large, multi-year efforts. Her work has encompassed a wide range of activities including, but not limited to: project management, wildlife mitigation planning and implementation; impact analyses and technical writing, National Environmental Policy Act document management and preparation, and conducting systematic field surveys or specialized tasks (e.g., avian collaring and radio-tracking) for a wide variety of terrestrial and aquatic fauna, including Federal and State species of concern. She also occasionally serves as a peer review referee or co-author for professional journals, and as an invited speaker at professional meetings.

Bob Oakleaf

Raised in Fort Collins, Colorado

1968 – Present: Married Barbara and help raise four sons, Jim, John, Josh, Jared.

1969 – 1971: Master's degree in Wildlife at University of Nevada, Reno. Thesis was published as a technical bulletin by the Nevada Fish and Game, *The Relationship of Sage Grouse to Upland Meadows in Nevada*.

1971 -1973: Drafted by US Army and stationed Edgewood Arsenal, MD working in an entomology and pesticide research lab.

1973 – 1977: Worked for Nevada Fish and Game as a Nongame Biologist starting and developing their nongame program.

1977- 1985: Nongame Biologist for WGFD

1986 – 2014: Nongame Coordinator for the WGFD, a new full-time employee, supervising from three to five permanent biologists and a highly variable number of technicians.

Retired

Pete Obermueller

Pete Obermueller is the Executive Director of the Wyoming County Commissioners Association, a post he has held since November of 2013. As Executive Director, his duties include representing the state's county commissioners before the Wyoming State Legislature, working collaboratively with the Wyoming Governor's office and other state agencies on local government issues, and providing outreach and guidance to county leaders across the state. Before his position at the WCCA, Pete was the Legislative Director to U.S. Representative Cynthia Lummis (R-WY). He also served as the Executive Director of the Congressional Western Caucus, a legislative group composed of members of the U.S. House of Representatives who promote Western and rural interests in Washington. A Casper native, Pete is a graduate of the University of Minnesota with a Master's Degree in Public Policy.

Andrea Orabona

Andrea graduated with a Bachelor's of Science degree in Wildlife Biology from Colorado State University and obtained her Master's of Science degree in Wildlife Biology from the University of Wyoming. She has worked for the WGFD since 1989, and has been the state's Nongame Bird Biologist for 22 ½ years. She is currently responsible for managing over 300 species of birds across Wyoming, including over 40 Species of Greatest Conservation Need. Andrea enjoys music, traveling, reading, and outdoor activities such as

horseback riding, hiking, camping, wildlife watching, skiing, fishing, biking, and canoeing.

Bill Ostheimer

Bill Ostheimer serves as a natural resource specialist and wildlife biologist, supervising wildlife and recreation programs for the BLM's BFO, in Buffalo, Wyoming. His ten years with the BLM was preceded by four years as a wildlife biologist for the USFWS and as a consultant for the U.S. Navy. His work experience ranges from invertebrates to grizzly bears. Bill completed his undergraduate work at the University of Colorado and received a Masters degree in biology from Montana State University. Bill bats right, throws right and is not a threat to steal bases.

Dennis Saville

Dennis Saville is the current Wildlife and Riparian program leader for the Wyoming BLM located at the Wyoming State office in Cheyenne. He has been a state lead since 2008 and prior to that served as a Field Office Biologist in the Cody BLM office from 1992 to 2008. Dennis started his BLM career in the Craig Colorado District office in 1987 after spending seven years as a seasonal technician with the USFS working in Wildlife, Recreation, and Timber management in Kremmling and Steamboat Springs Colorado. He graduated with a Bachelor's of Science degree in Wildlife Management from the University of Wyoming in 1977 and completed 2 years of graduate school studies in Recreation Management and Wildlife. Dennis has served on Wildlife Work groups with the BLM including Grizzly Bear and Wolf Conservation teams, Wyoming Partners-in-Flight, Prairie Dog Ecosystems subcommittee, and Wyoming Bat working group. He has been involved in preparing a BLM national Migratory Bird Conservation Strategy, BLM Raptor management guidelines, and Renewable Energy Wildlife Guidelines, and in spite of trying to avoid it has been involved in Wyoming greater sage-grouse management over the past 5 years. Dennis is an avid outdoor sports person and soon hopes to be able to fish and hunt full-time in retirement.

Commissioner Micky Shober

Born and raised on a family ranch in Northern Campbell County as a third-generation resident, Micky has experience in agriculture, education, business, and energy. He gives generously of his time and expertise by serving on numerous boards and holding leadership positions to help guide Campbell County. Micky spent 10 years serving on the school board to ensure not only his grandchildren but every child had a quality education. Micky Shober demonstrates his integrity by consistently using quality building practices and exceeding expected standards. This establishes Shober Builders, 25 years and strong, as the premier builder in Northeastern Wyoming. As the first homebuilder to offer tested ENERGY STAR rated homes in the area, he and his wife Linda strive to offer homes that are built for Campbell County's children's children. Family values drive Micky to excel in all aspects and take a pro-active role in the past, present, and future of the area. His father's experience as a World War II B-24 pilot and POW anchors Micky's interest in honoring all veterans and in teaching his 11 grandchildren that history. Micky and Linda have taught their four grown children to take pride in doing any task well and be life-long learners. Micky's love of learning is evident as he researches about any new issue, such as the LXBar Ranch historical project, and talks to the people involved to ensure he sees an accurate view. Desiring the best for Campbell County and its residents, Micky whole-heartedly dedicates himself to his current role as County Commissioner. He was elected in 2010, Chairman in 2012 and re-elected in 2014.

Steve Slater

Steve joined HawkWatch International in June 2006 as the organization's Conservation Scientist and has since become the Conservation Science Director. Much of Steve's recent work has focused on GOEA, including monitoring, transmitter deployment and tracking, and risk assessments. Steve has also served as a principal investigator in research on the impacts of invasive cheatgrass, fire, and prey declines on West Desert (Utah) GOEA, FEHA, and BUOW. He has overseen research on the potential risks of proposed wind developments to local, migratory, and wintering GOEA, the potential impacts of oil and gas development on nesting raptors in Utah and Wyoming, and the ability of perch-deterrent devices to exclude raptor power

line perch use in Southwestern Wyoming. Steve has also been involved in HawkWatch's long-term nesting and migration surveys. His work also focuses on identifying current and emerging threats to raptors, information needs, potential future research projects, and translating raptor science into conservation action. Currently, Steve serves on Utah's BLM Resource Advisory Council and as the facilitator for the Utah Eagle Working Group. Before joining HawkWatch, he spent six years in Wyoming, where he obtained his master's and doctoral degrees in Zoology and Physiology from the University of Wyoming. His master's thesis was on greater sage-grouse use of prescribed and wild burns and was completed in 2003. Steve obtained his Ph.D. in 2006 and wrote his dissertation on issues of scale and bird community responses to riparian cottonwood declines, Russian-olive invasion, and landscape alteration. Steve has had a life-long interest in birds and wildlife of all kinds and enjoys being outdoors with his wife and two boys while hiking, mountain biking, camping, and wildlife watching.

Patricia Sweanor

Trish Sweanor is a wildlife biologist with the USFWS – Wyoming Field Office in Cheyenne. The mission of the USFWS is to work with others to conserve, protect and enhance wildlife and their habitats. As a USFWS biologist, Trish works with other agencies to promote the conservation of raptors in Wyoming and assist project planners, developers, operators and others to understand and comply with federal wildlife resource laws and policies, including those pertaining to raptors.

Bill Vetter

Bill Vetter is a project director and wildlife biologist for ICF International in Gillette, Wyoming. He has worked throughout Wyoming and adjacent states for over 10 years, designing and conducting monitoring programs, assessing environmental impacts, and developing conservation and mitigation plans for raptors. That work has been predominantly associated with energy-related industries, addressing impacts and implementing conservation strategies for oil and gas, mining, wind farms, power line utilities, as well as logging, rail, and highway projects. He earned an Master's degree in Biology from Indiana State University in 2004 and a Bachelor of Arts degree in Biology and Secondary Education from Cornell College in 1994. His authored publications include the determinants of survival and spatial ecology of wintering hawks, predator-prey behavioral relationships between accipiters and passerine prey species, the influence of foraging hotspots on avian home range use, and the ability of avian species to predict weather patterns. Other research and interests include the establishment of banding stations in the Midwest to investigate raptor behavior along minor migratory lead lines, and active participation in the operations of multiple raptor rehabilitation centers.

List of Attendees

Last Name	First Name	Company
Ackerman	Dave	Western Land Services
Aksamit	Allen	Western Land Services
Anderson	Gretchen	Belle Ayr Mine
Anderson	Oaklee	Senator Barrasso's Office
Anderson	Kendra	Campbell County Commissioners
Anderson	Kevin	Denbury Resources
Avery	Matt	Campbell County Commissioners
Beauvais	Gary	Wyoming Natural Diversity Database
Becker	Dr. Garry	Campbell County Commissioners
Bell	Rusty	Campbell County Commissioners
Bellah	Penny	Samson Resources
Bills	Tom	BLM
Birek	Jeff	Rocky Mountain Bird Observatory
Brantz	Tami	Anadarko Petroleum
Brewer	Don	BLM
Burch	Callie	Devon Energy
Burrows	Tony	
Byer	Tim	U.S. Forest Service
Byram	Becky	Devon Energy
Canterbury	Jackie	Big Horn Audubon
Carlisle	Jason	Wyoming Cooperative Fish & Wildlife Research Unit
Christensen	Mark	Campbell County Commissioners
Cowan	Gregory	Wyoming County Commissioners Association
Crowder	Jessica	Wyoming Governor's Office
Davidson	Rob	Council for the Bighorn Range
Decker	Luke	U.S. Forest Service
Douglas	Susan	U.S. Forest Service
Duncan	Hillary	Grouse Mountain Environmental Consultants
Durham	Chris	BLM
Dwyer	James	EDM Link
Eathorne	Frank	Thunder Basin Grasslands Prairie Ecosystem Association
Edwards	Roy	State of Wyoming Legislature
Elkins	Brandon	NRCS
Enzi	Mike	United States Senator
Farnsworth	Preston	Devon Energy Corporation
Fenster	Roy	ICF International
Fisk	CJ	Alpha Wyoming Land Company
Heath	Brian	Environmental & Statistical Consultants
Helms	Brent	Dry Fork Mine
Hillis	Mike	Ecosystem Research Group
Hinkhouse	Jennifer	Campbell County Conservation District
Hodge	Darice	Powder River Energy Corporation
Hohnhorst	Amanda	ICF International
Holloran	Alison	Audubon Rockies

Last Name	First Name	Company
Hope	Pauline	U.S. Fish & Wildlife Service
Huber	David	ARCADIS
Irey	Ben	Ecosystem Research Group
Jallo	Carlos	EOG Resources, Inc.
Jarmusz	Tony	Gillette News Record
Jawors	Scott	BLM
Jones	Tracy	Powder River Energy Corporation
Jones	Matt	Office of Representative Cynthia Lummis
Kamienski	Tomas	USDA-NRCS WY State Office
Kane	Stephanie	ICF International
Kasperik	Norine	State of Wyoming Legislature
Kennett	Greg	Ecosystem Research Group
Keown	Josh	Devon Energy Corporation
Kirol	Chris	Big Horn Environmental Consultants
Knezovich	Rena	Peabody Energy
Knudsen	Jon	Hayden-Wing Associates, LLC
Kritz	Kevin	U.S. Fish & Wildlife Service
Lack	Elizabeth	Western Ecosystems Technology, Inc.
Lance	Ryan	Sweetwater River Conservancy Crowell & Moring, LLP
Lickfett	Todd	U.S. Fish & Wildlife Service
Lindsley	Michael	EOG Resources, Inc.
Maechtle	Tom	Big Horn Environmental Consultants
Magee	Dave	Cameco Resources
Maycock	Jessica	ICF International
McConnell	Logan	Hayden-Wing Associates, LLC
McCormack	Melanie	ICF International
McKee	Gwyn	Thunderbird Wildlife Consulting
Mead	Governor Matt	State of Wyoming
Meaney	Carron	Walsh Environmental
Morse	Diane	National Wildlife Rehabilitators Association
Mueller	Steve	Black Hills Corporation
Nelms	Megan	Campbell County Planning and Zoning Division
Nicodemus	Amanda	ICF International
Norman	Gretchen	Environmental & Statistical Consultants
Novotny	Bill	Johnson County Commissioners
Oakleaf	Bob	Wyoming Game & Fish Department
Obermueller	Pete	Wyoming County Commissioners Association
Orabona	Andrea	Wyoming Game & Fish Department
Ostheimer	Bill	BLM
Palmer	Robert	Campbell County Commissioners
Peckham	Erika	Wyoming Game & Fish Department
Pellatz	Dave	Thunder Basin Grasslands Prairie Ecosystem Assoc
Pinter	Tracy	BLM
Powell	Jake	SWCA Environmental Consultants
Rippeto	Dave	U.S. Fish & Wildlife Service
Rubeck-Schurtz	Nichole	ICF International

Last Name	First Name	Company
Sande	Brent	Devon Energy
Saville	Dennis	BLM
Severs	Scott	Walsh Environmental
Sheets	Christopher	BLM
Slater	Steve	HawkWatch International
Smith	Brandon	ICF International
Stephens	Adam	Devon Energy
Stowe	Robert	Images by Bob
Sutphin	Andrew	Big Horn Environmental Consultants
Sutphin	Linette	Big Horn Environmental Consultants
Sweanor	Patricia	U.S. Fish & Wildlife Service
Sweet	Lynn	Black Thunder Mine
Tait	Rusty	Intermountain Resources
Taylor	Kenton	Environmental & Statistical Consultants
Taylor	Katie	Grouse Mountain Environmental Consultants
Taylor	Renee	Taylor Environmental Consulting, LLC
Thomas	Tim	Wyoming Game & Fish Department
Verplancke	James	BLM
Vetter	Bill	ICF International
Vicklund	Laurel	Peabody Energy
Willox	Jim	Converse County Commissioner
Wittkop	Wyatt	BLM
Total	112	

Recommended Reading

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