2018 Annual Reports

2018 TRC Staff and Students

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Bald Eagle Genetics in the GYE

2018 Annual Report – Teton Raptor Center

2018 Permits:

Wyoming Game and Fish Department 33-1066
Grand Teton National Park 2018-SCI-0003
Yellowstone National Park 2018-SCI-7078

Project Collaborators:

Bryan Bedrosian– Teton Raptor Center bryan@tetonraptorcenter.org
Michael Whitfield – Heart of the Rockies Initiative
Ron Van Den Bussche – Oklahoma State University
Megan Judkins – Oklahoma State University
Susan Patla – Wyoming Game and Fish Department, retired

Statement of Study Purpose & Objectives:

The Bald Eagle population in the Greater Yellowstone Ecosystem (GYE) was an isolated population during the 1980's when the Bald Eagle was listed as an endangered species in the United States and was considered a source population that significantly helped the recovery of this species in the West. Banding efforts during the 1980's and 1990's within the GYE resulted in hundreds of nestlings being tagged, several of which have become known breeders within and around the GYE. We are proposing to utilize historic genetic samples and new samples from nestlings and known-aged eagles with known banding locations to investigate the following objectives:

- Relative genetic success and dispersal distances of individuals within and surrounding the GYE
- Genetic connectivity, inbreeding coefficients, and current eagle management sub-units
- Understand the degree to which the GYE population acted as a genetic source to the Bald Eagle recovery
- Understanding the genetic health of the GYE Bald Eagle population following recovery
- Determine how the GYE population fits into the eagle management units across North America

Results:

In 2016, we began collecting genetic samples from Bald Eagles within the GYE and continued through the 2017 and 2018 nesting seasons. Teton Raptor Center (TRC) collected data from Montana and Wyoming, while Michael Whitfield (Heart of the Rockies) concurrently collected data in Idaho. With funding from 1% for the Tetons, the Meg and Bert Raynes Wildlife Fund, and Teton Raptor Center, we were able to complete the field-portion of this study. This report pertains to data collected by TRC crews under the above permits in 2018 (not data collected by M. Whitfield in Idaho under different permits).

We visited 85 nest sites across northwestern Wyoming in 2018 to assess occupancy, activity and accessibility for climbing. Primary observers this year were Nathan Hough and Bryan Bedrosian (TRC) with significant help from arborist Max Milburn. S. Patla provided nest site and activity data from flights conducted in WY. Brenna Cassidy and Lauren Walker provided nest site information for Yellowstone National Park. Sarah Hegg provided nest information for Grand Teton National Park, and Case Martin provided safe river transport. Additional help and banding was provided by Allison Swan (TRC).

In 2016 and 2017 we banded a total of 41 nestlings from 25 nests across southern Montana and northwest Wyoming. In 2018, we banded an additional 26 nestlings at 18 nest locations in Wyoming and Idaho (Figure 1), for a total of 87 eaglets tagged over the past three years for this study. This year, we targeted nests in areas not previously sampled: Yellowstone National Park, Grand Teton Nation Park, and the Upper Green River area by Pinedale. We also banded additional nests not previously sampled, as available, around the Jackson Hole region.

In 2018, we collected a blood sample from all nestlings but one due to small size, though we did get a blood sample from its sibling. All nestlings but three received green metal bands with unique alpha numeric codes. Those three nestlings were not color-banded due to lack of available unique numeric codes at the time. We also collected molted feathers from below 20 nests, including 14 nests we collected blood samples from and six nests that failed or were unsafe to climb. Two eaglets exhibited pied plumage during this study, one in 2016 and one in 2017. One nest in 2016 had an addled egg and three nests in 2018 had addled eggs. Of the three nests with addled eggs in 2018, two were found in nests that also successfully raised one chick.

We obtained flight survey data from S. Patla (WGFD) and Lauren Walker (YNP) showing 75 active nests across the study area (incubating early season) and we determined known nest fate on 70 of those. Of the 70 nests we visited, 40% (n = 28) had failed by typical banding age and 60% (n = 42) were successful (Table 2, Figure2). We found an average brood size of 1.50 chicks per nest across Wyoming, although both nest success and average brood size was lower for Yellowstone than the rest of the study area (Table 2). Because of the large disparity in nest timing and vast geographic area, we were unable to check for successful fledging at every nest, therefore we defined nests as successful if the young survived to week 7.

Most nests visited across the region were inaccessible for sampling due to unsafe trees for climbing. Landowner access was granted in most cases, with the biggest difficulty being finding contact information for landowners. Only in a few instances were crews denied access.

Future Work

Teton Raptor Center will opportunistically continue to collect genetic samples from areas that did not have as high sample size as desired throughout the study, although all major sampling efforts are complete. A few more samples from Yellowstone National Park as well as samples from the Dubois area are desired.

Samples from all three years have been sent to collaborators at Oklahoma State University for analysis. We anticipate final DNA sequencing to be complete by 2020.

Data Access

Data on nests visited, location, nest status, and productivity (when known) will be provided individually to each state or Park biologist at their request.

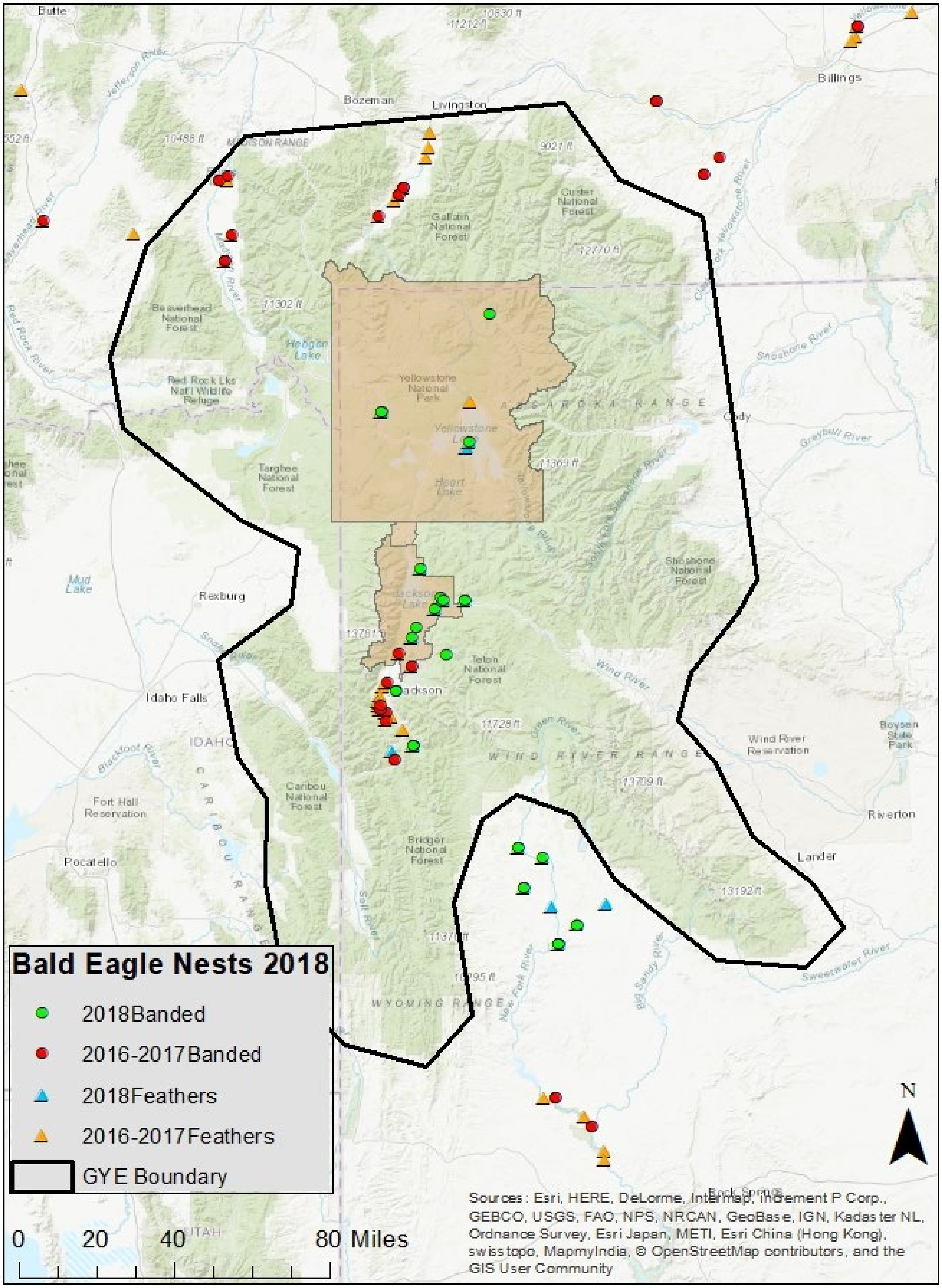

Figure 1: All Bald Eagle nests banded or had feather samples collected by Teton Raptor Center (2016-2018).

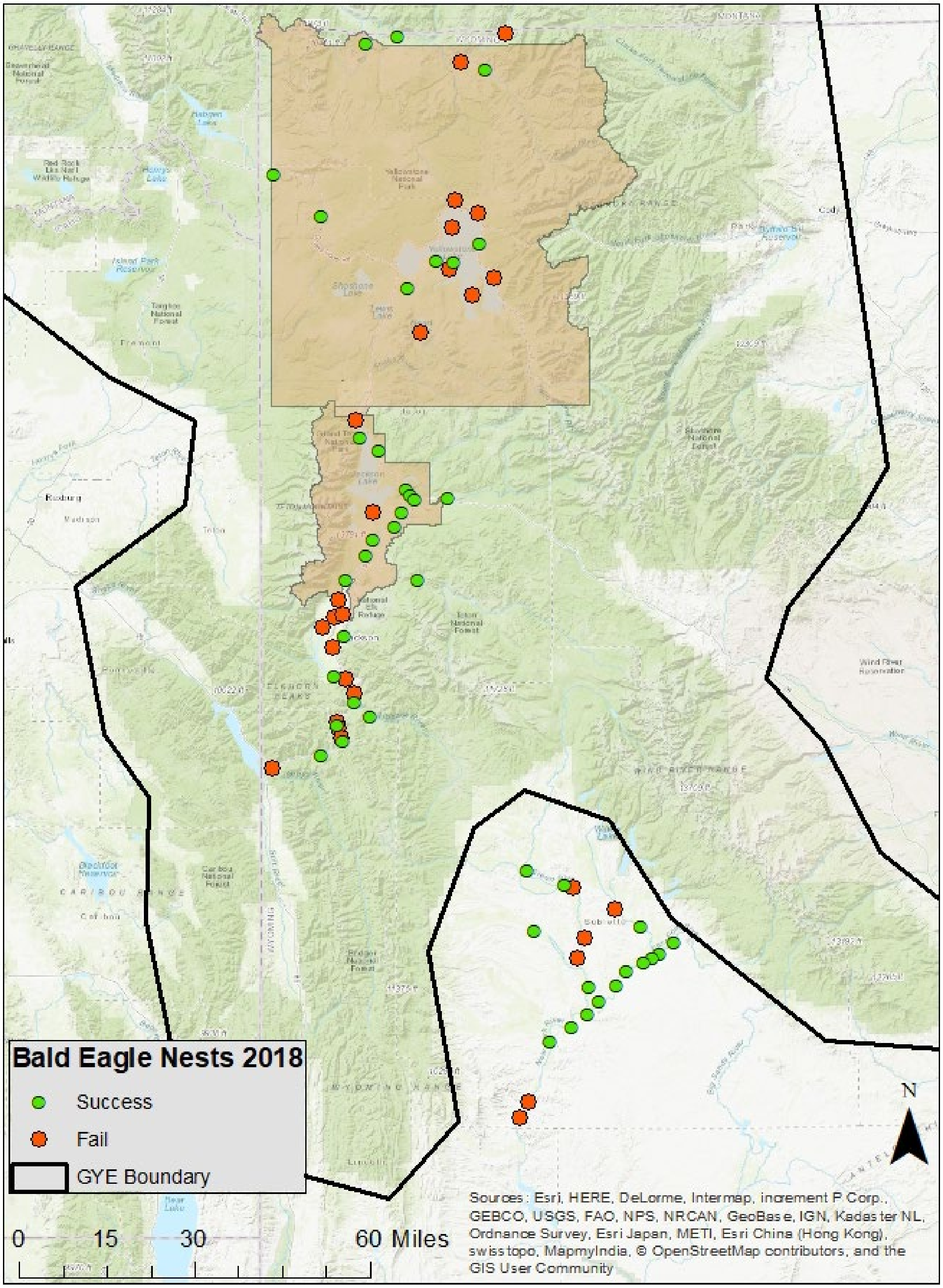

Figure 2: Nest fate of all nests checked on the ground by Teton Raptor Center in 2018.

Table 1: All Bald Eagles banded in Wyoming during the 2018 nesting season.

Date Captured	Location	UTMx	UTMy	Total Captured	USGS Band #	Color Band
5/16/2018	Buffalo Valley	547729	4854313	2	1098-03271	6L
5/16/2018	Buffalo Valley	547729	4854313	2	0709-08856	9L
5/24/2018	7 Mile Ranch	579974	4747574	1	0709-08859	3P
5/24/2018	New fork-east of Confluence with Green	586512	4711883	3	0709-08860	5P
5/24/2018	New fork-east of Confluence with Green	586512	4711883	3	0709-08861	6P
5/24/2018	New fork-east of Confluence with Green	586512	4711883	3	0709-08862	7P
5/24/2018	Old Fort Bonneville	569418	4751617	2	0709-08857	1P
5/24/2018	Old Fort Bonneville	569418	4751617	2	0709-08858	2P
5/25/2018	Cottonwood Creek	571710	4734618	2	0709-08863	8P
5/25/2018	Cottonwood Creek	571710	4734618	2	0709-08864	9P
5/29/2018	Visitor Center (East Gros venture Butte)	519180	4816258	2	0709-08867	3M
5/29/2018	Visitor Center (East Gros venture Butte)	519180	4816258	2	0709-08868	4M
5/29/2018	Spotted Horse - Hoback	526263	4793850	2	0709-08865	0M
5/29/2018	Spotted Horse - Hoback	526263	4793850	2	0709-08866	1M
6/11/2018	New Fork - new nest 2016	594073	4719591	2	0709-08869	5M
6/11/2018	New Fork - new nest 2016	594073	4719591	2	0709-08870	6M
6/12/2018	Pacific Creek	537451	4855060	1	0709-08871	7M
6/12/2018	RKO	534873	4850365	1	0709-08873	8M
6/20/2018	Lamar YNP	557930	4972317	1	0709-08872	9M
6/20/2018	Goose Lake complex YNP	512827	4932046	1	0709-08874	None
6/21/2018	Sergents Bay	528906	4867139	1	0709-08876	None
6/21/2018	Slide Lake	539629	4831407	1	0709-08875	None
6/28/2018	Bar BC	525350	4838666	1	0709-08878	1T
6/28/2018	Schwabecker	527392	4842771	1	0709-08877	0T
7/2/2018	Frank Island YNP	549558	4919609	1	0709-08879	2T
7/3/2018	Moran Junction	538657	4853793	1	0709-08880	3T

Table 2: Nest success of Bald Eagles nesting in Wyoming during the 2018 season, by hydrologic regions

Area	Success%	Failure%	Avg. Nestlings
Snake River	61	39	1.37
Upper Green	65	35	1.86
Yellowstone	50	50	1.22
Total	60	40	1.50

Identifying Key Golden Eagle Migration Corridors and Winter Ranges to Help Conserve Key Sagebrush-Steppe and Grassland Habitats

2018 Report

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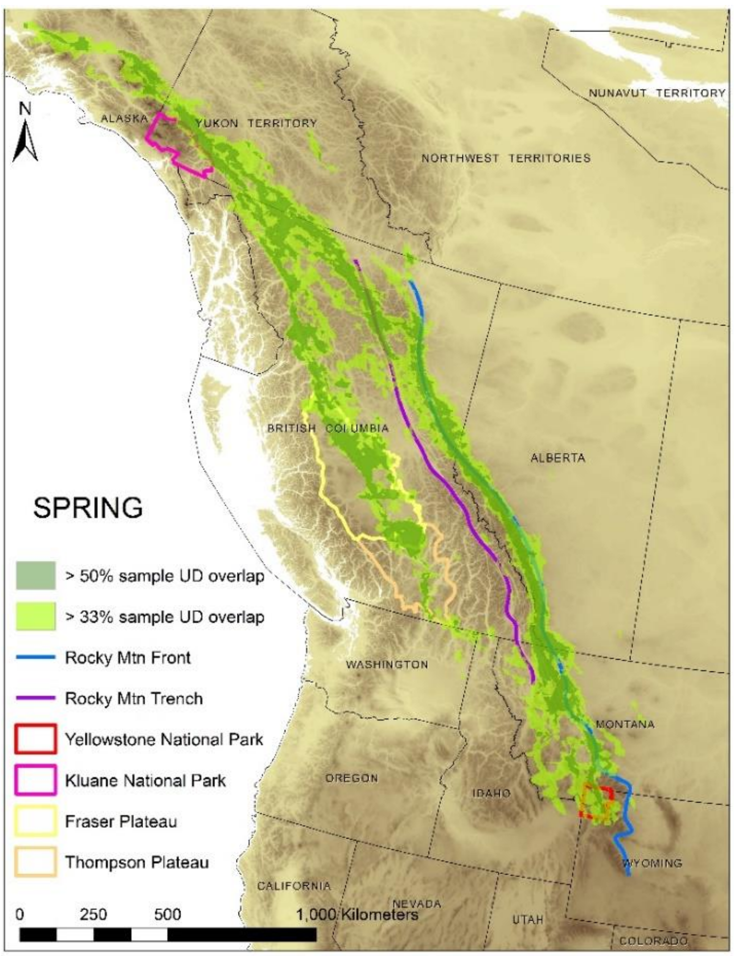
Study Background & Objectives:

Sagebrush steppe and grassland habitats that dominate much of the landscape across the West are increasingly at risk due to a variety of compounding factors including direct habitat loss, fragmentation, fire, invasive species, and grazing regimes. The cumulative effects from loss and disturbance in these habitats led to the decline and concern for many species in the West, including sage-grouse, golden eagle, ferruginous hawk, mule deer, pygmy rabbit, brewer's sparrow, and mountain plover, among others. As the sagebrush steppe and grasslands of the Wyoming Basin and Great Plains become increasingly fragmented, understanding and conserving key areas for wildlife is vital for the long-term persistence of many species.

Wind energy development is forecasted to significantly increase in future years and Wyoming is host to some of the best wind resources in the country. This is exemplified by the Chokecherry-Sierra Madre wind project that is currently under production in south-central Wyoming and will be the largest wind facility in the world with 1,000 turbines. While alternative energy production is needed, placement of these facilities is typically outside of both the sage-grouse core areas and the areas being developed by oil and gas, leading to additional cumulative habitat loss. This novel development can significantly impact wildlife populations by further eliminating or fragmenting habitat in addition to causing direct mortality to bird and bat species.

There is a growing concern for Golden Eagle populations in western North America due to declines in some local breeding populations, a 40% decline in migratory eagles, and new mortality risks due to direct collisions with turbines. Golden Eagles are long-lived with slow reproduction and even a small increase in adult mortality can significantly impact populations. The main cause of mortality for golden eagles is starvation/disease (which is a direct result of habitat quality and prey availability), followed by poisoning, shooting, vehicle collisions, and electrocutions[4]. While the majority of starvation deaths are in young eagles, roughly two-thirds of all adult mortalities are a result of anthropogenic causes[4]. Any new causes of mortality such as collisions with wind turbines, lead poisoning and/or increases in shooting, trapping, power line electrocutions, car collisions, or starvation due to habitat degradation have the potential to significantly affect the population.



Conservation of important habitats for eagles will not only help this iconic species, but also help maintain the many other species within their range. Golden Eagles are an apex predator that rely on large tracts of habitat that host adequate numbers of prey (such as jackrabbits, cottontails, prairie dogs, and grouse) and serve as an indicator species of relative habitat quality and ecosystem health. Understanding and mapping key habitats for eagles will help identify the most productive habitats to target conservation efforts.

Because Golden Eagles are protected by both the Migratory Bird Act and Eagle Act, the regulatory mechanisms and potential for litigation for any eagle mortalities has been a driving force behind many companies' decisions to not build new wind facilities. These mechanisms therefore provide a unique opportunity for habitat conservation by deterring new developments in areas that have demonstrated importance and high-use by Golden Eagles. Identifying and modeling high-use eagle areas can significantly affect development siting and help direct easement decisions to maximize conservation success.

While we and other colleagues have been working diligently to address some of the recent concerns for Golden Eagle population trends across the West, there are several key aspects of Golden Eagle ecology that are still unknown but needed to help inform agencies, managers, and conservation efforts. For example, we recently created the first population-level models of both spring and fall Golden Eagle migration corridors in the West by combining 65 eagles outfitted with solar-charging GPS transmitters from four different studies; three in Montana and one in Alaska (above). While we know that many migratory Golden Eagles move through or winter in areas south of Montana, the studies used in this initial analysis were all in Montana and Alaska, precluding us from defining key migration routes across further south.

The goal of this project is to identify key migration corridors and wintering habitat of adult Golden Eagles across the contiguous US. Mapping migration corridors south of Montana requires capturing eagles while on migration before they reach Wyoming. In 2018, we initiated the next phase of our work at new migration pinch point recently located in southern Montana to accomplish this objective. The goal of this project is to outfit at least 30 adult eagles with solar-powered GPS satellite backpack transmitters at this location over the next three years and track the adult eagles as they migrate through or winter in Wyoming. The transmitters gather ca. 10 GPS locations/day for up to 5 years. These data will allow us to extend and map key migration corridors through the conterminous western US and model movements and habitat use of adult Golden Eagles during the winter season. Coupling these products with recent efforts to model breeding habitat for the sage-steppe and grasslands will offer a year-round picture of critical eagle habitats.

A secondary objective of this study was to assess the study site at the southern end of the Big Belts as a long-term Golden Eagle migration monitoring station. Preliminarily assessed in 2007 by RVRI biologists, Grassy Mountain appeared to be near a key pinch point for the eagle migration through Montana. In 2015, MT Audubon, MT Fish, Wildlife, and Parks, the Helena National Forest and other collaborators began annual monitoring of the migration near Duck Creek Pass, about 11 miles north of our study site at Grassy Mountain and ca. 1,400 ft higher in elevation. Over the past three years, they confirmed that the Duck Creek count site hosted the most migrating Golden Eagles in the contiguous US[5]. However, the count site near Duck Creek is difficult to access and often precludes counting due to the high elevation and associated weather. In coordination with the team at Duck Creek Pass, we were interested in investigating potential correlations in migration counts between the two sites.

Results:

We began this study in 2018 at the southern extent of the Big Belt mountain range on Grassy Mountain in south-central Montana. We began actively counting all migrating raptors and trapping Golden Eagles on September 27th, and continued through October 25th. During that time, we counted a total of 1,814 migrating raptors, 1,473 of which were Golden Eagles (Figure 1, Table 1). Of the 26 days of study, we were unable to count on three days due to inclement weather. We were actively targeting Golden Eagles for capture to outfit with GPS transmitters, but we also opportunistically captured other large raptors for banding and blood sample collection. During the 2018 season, we captured a total of 75 Golden Eagles (76% male, 24% female) and 20 other raptors (Table 1).

With funding provided by the Knobloch Family Foundation, we were able to deploy 14 satellite GPS transmitters on adult eagles (Figure 7) to track their migration routes over the coming years. We deployed 10 transmitters at the Grassy mountain site, and four at the Rodgers Pass study site operated near Lincoln, MT, including eight male and six female adult eagles. All transmitter harnesses were fitted with a break-away system developed over the years for previous studies that typically last 3-4 years. Using the break-away system allows us to gather necessary data while eliminating the potential for an eagle to carry a non-functioning transmitter for its lifetime. This also allows us to recover, refurbish and re-deploy the transmitter to increase sample size for this study. As of mid-November, 13 eagle transmitters were functioning well. One unit appears to have failed or is not adequately charging. Five eagles appear to have settled on their wintering areas in New Mexico, two in Colorado, five in Wyoming, and two in Montana (Figure 6).

We conducted daily total raptor migration counts from within our trapping blind. This count data was intended to be directly compared to the count data from the Duck Creek Pass site located ca. 11 miles north of Grassy Mountain. Key differences in methodology included observers at Grassy Mountain counting 1) from within a blind, 2) without the aid of an owl decoy, and 3) while often preoccupied with captured raptors. This likely resulted in reduced counts relative to traditional counting methods. We did find a trend between sites, but there was little correlation ($r = 0.64$, Figure 5).

At Grassy Mountain, we counted 1,814 total migrating raptors in 140 hours of counting. Golden Eagles accounted for 81% of the total (1,473 counted). The season means were 64 Golden Eagles/day and 10.5 eagles/hr. We observed peak Golden Eagle migration on Oct 17 and 18, with a mean passage rate of 43 eagles/hr on the 17^{th} (maximum = 105 eagles/hr). Across the season, we found the highest mean daily passage rates between 13:00-16:00. It appeared that a larger percentage of eagles moving early in the season were young, with a greater proportion of adults moving during peak (Figures 2, 3, 4). The majority of eagles counted (47.3%) were adults followed by unknown age, sub-adults, and juveniles (22.9%, 17.4%, and 12.5%, respectively). Because it is often difficult to distinguish between juvenile and immature eagles, we combined the two non-breeding age classes (29.9% of eagles counted) to visualize age classifications by day (Figure 2). We observed an immature:adult ratio of 0.63 at Grassy Mountain.

Discussion:

Grassy Mountain proved to be an extremely effective location for capture and tagging Golden Eagles on migration in Montana. This year, we were able to capture more than twice the number of Golden Eagles tagged annually at any other banding station in the world. Prior to our knowledge of the success rate at Grassy Mountain, we deployed a transmitter on any adult captured. This resulted in front loading the number of transmitters deployed early in the season, prior to the peak movements of adults. The objective of this project is to document migration corridors south of Montana, so eagles overwintering in Montana will not add to that objective (though they will be useful in modeling critical winter habitats). While samples size of individual eagles overwintering in each state are extremely limited based on our sample, the two eagles wintering in Montana were both captured during the first week of trapping. While birds tagged that week also wintered in Wyoming (n = 1) and New Mexico (n = 2), there may be utility in delaying deployments in future years to increase the likelihood that we will tag migrants wintering further south. However, three eagles tagged between Oct 15–19 are currently overwintering in Wyoming, so it is possible this is not something we can predict or account for.

The observed flight at Grassy Mountain is widespread and varies significantly with weather. Eagles were extremely widespread on calm, warm days with thermal lift and generally further west than the study site. Captures were near impossible on east wind days, and anecdotal evidence suggested the eagles were moving on the eastern side of the range those days. Because counts were conducted from within the trapping blind, we were unable to observe most eagles on east wind days, and likely significantly fewer on days when eagles were flying farther to our west.

Our goal is to add a minimum of 10 transmitter deployments in 2019 at Grassy Mountain to increase sample size. We will continue to monitor all tagged eagles daily for movements and any sign of mortality/dropped transmitter. We will investigate any such cases as quickly as possible to add to the national Golden Eagle mortality database. After gathering data on each eagle through 2011, we will create updated models of critical migration corridors and winter habitat in the contiguous US.

Acknowledgments

Data collection in 2018 was conducted by Nathan Hough, Allison Swan, Sam Diaz, Sarah Ramirez, and Mary Scofield. We could not have conducted this work without significant support of Helena National Forest (Denise Pengeroth, Pat Shanley) and Montana Fish, Wildlife and Parks (Allison Bagley, Lauri Hanuska-Brown). Funding was provided by Knobloch Family Foundation, Teton Raptor Center, and Raptor View Research Institute. We are grateful to Grassy Mountain Cabins for helping our crew keep warm and dry.

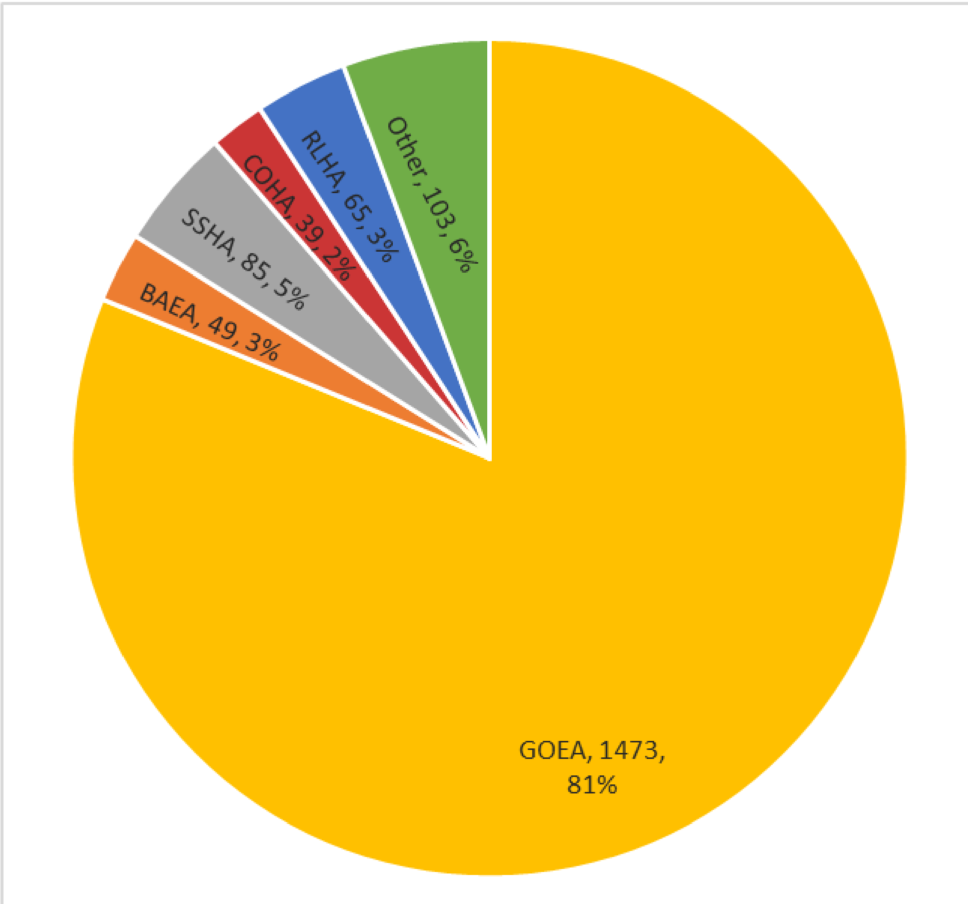


Figure 1: Species, number, and percentage of total raptors seen at the Grassy mountain migration site.

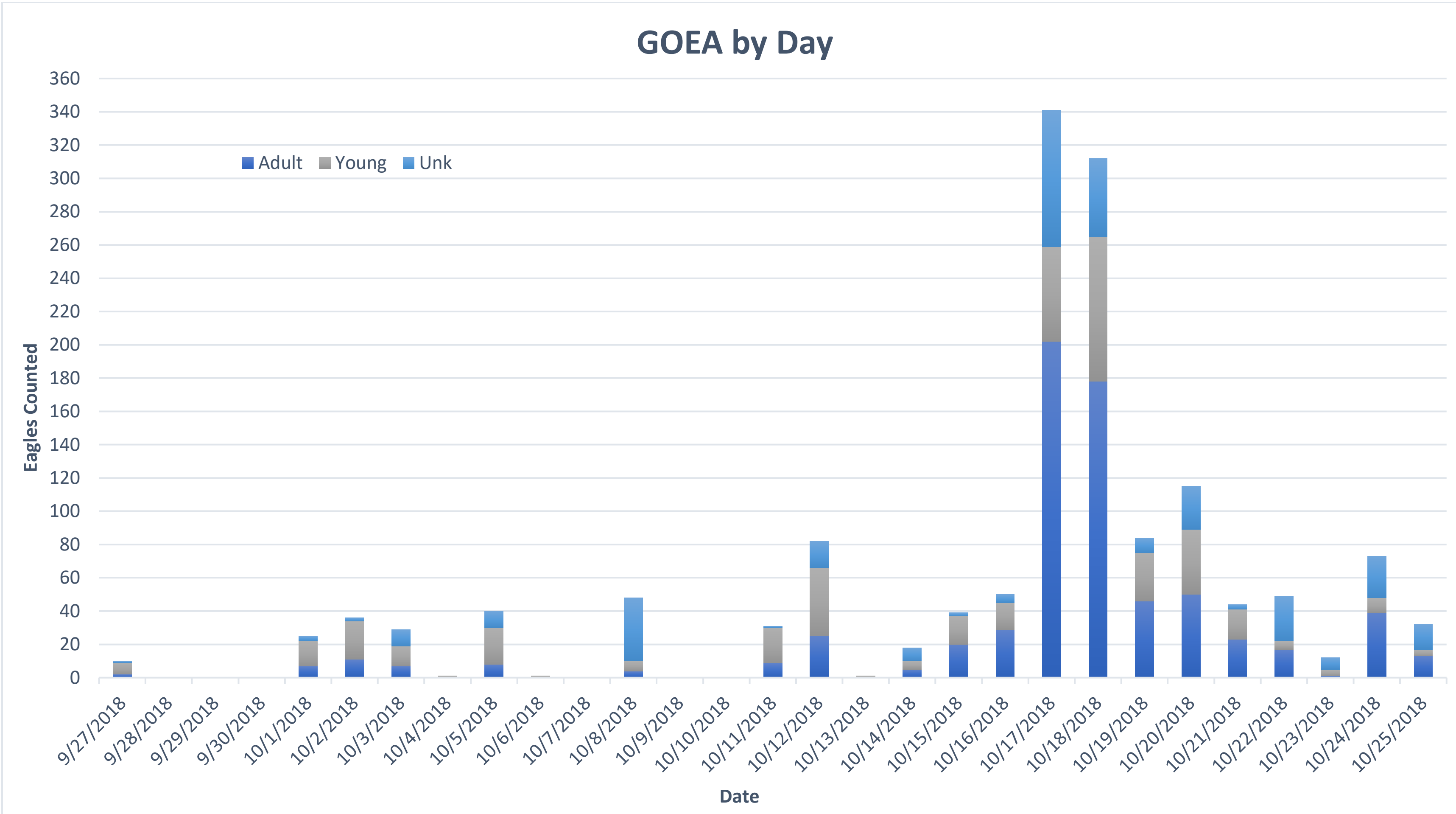


Figure 2: Breakdown of eagle age classes counted each day throughout the season. The young category includes juveniles and sub-adults, adults are generally 5 years or older. Dates with no bars shown or numbers listed had counts too low to appear on this chart, though Oct 7th, 9th, and 10th were the only weather days we were unable to count any birds.

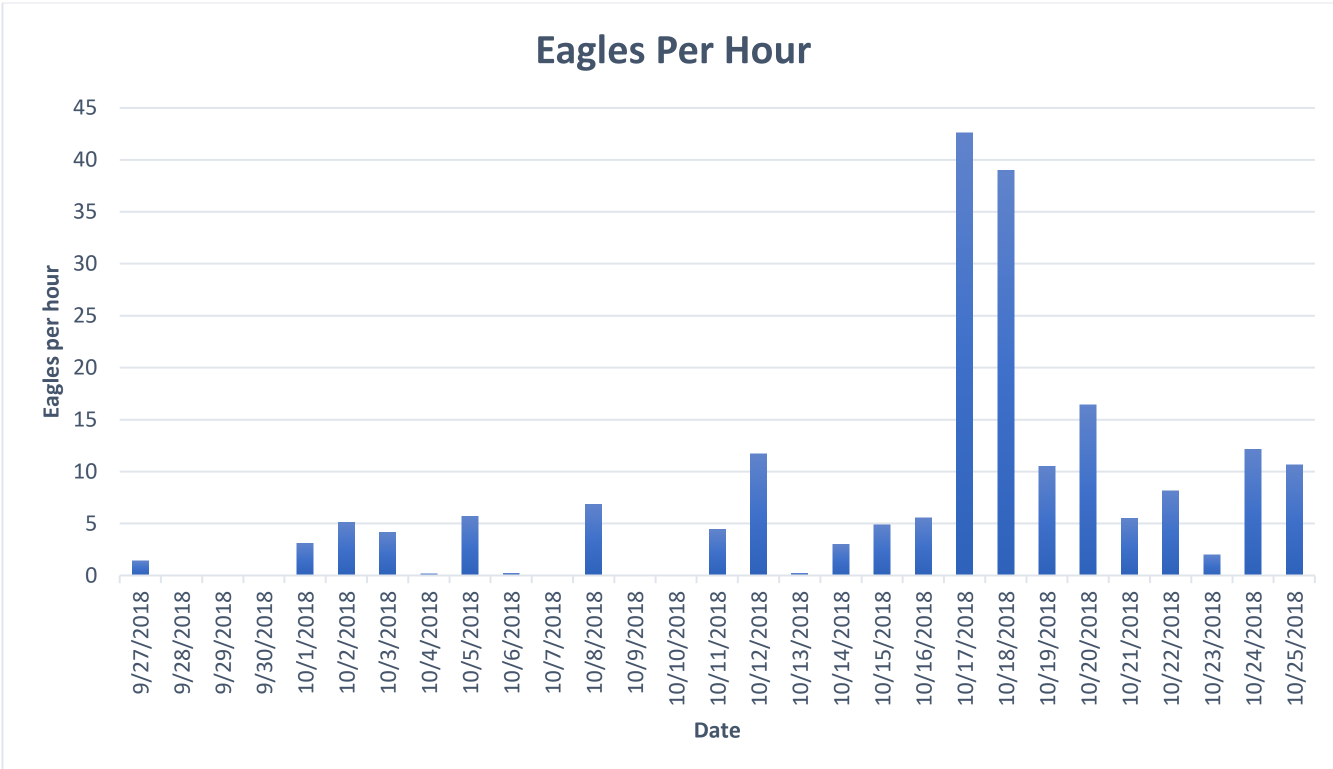


Figure 3: Golden eagles seen per hour

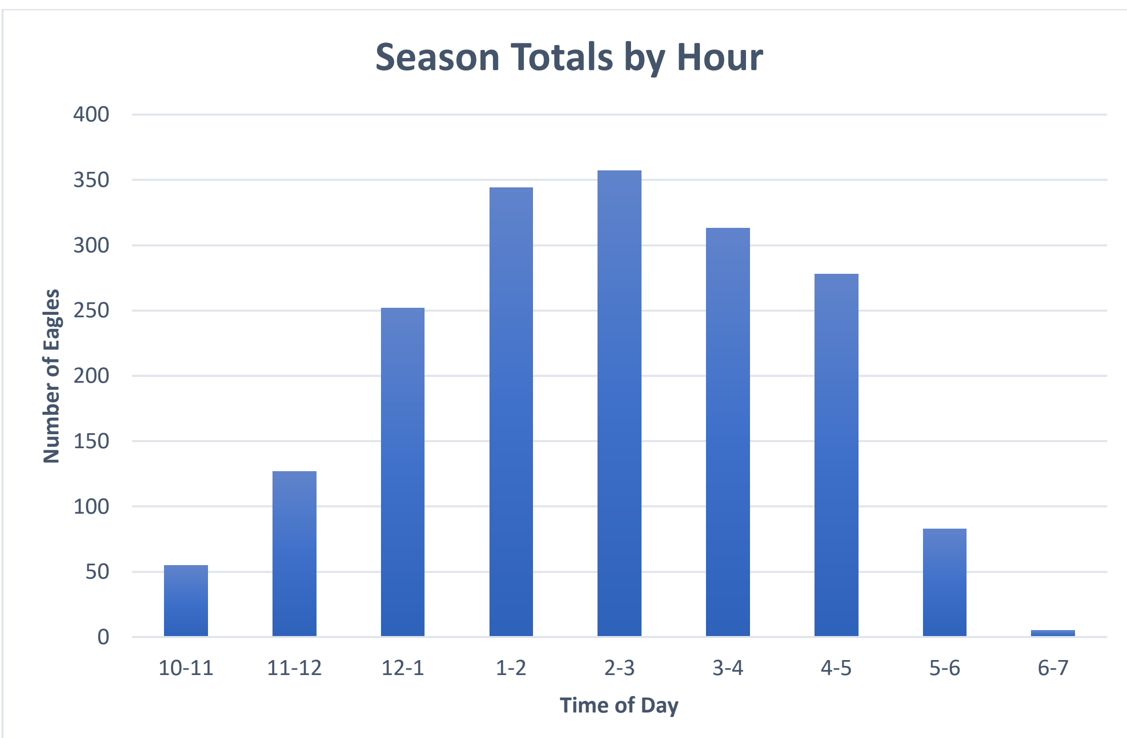


Figure 4: Eagle totals seen during hour time intervals throughout the season

	GOEA				BAEA		UE	SSHA			COHA			NOGO			UA	RTHA			RLHA			UB	AMKE			MERL			PRFA			PEFA			UF	NOHA			TUVU	OTHER	TOTAL
Date	J	I	A	U	A	I	U	A	I	U	A	I	U	A	I	U	U	A	I	U	A	I	U	U	M	F	U	M	F	U	M	F	U	M	F	U	U	M	F	U			
9/27/2018	1	6	2	1						4	1	1						2	1		1		4		1		2			1													**28**
10/1/2018	6	9	7	3	1			1		1	1	1	1		1		3	1		1			1		2	1													1				**42**
10/2/2018	7	16	11	2						1			1	1							2																						**41**
10/3/2018	2	10	7	10	1			6	1	3	1	1	1					5					3		1					1									2		1		**56**
10/4/2018	1							2	1																																		**4**
10/5/2018	9	13	8	10	1			1	1		1		1					1			1				1																		**48**
10/6/2018	1																																										**1**
10/7/2018																																											**0**
10/8/2018	3	3	4	38	1				1	3	1					1	2				2		6										1								1		**67**
10/9/2018																																											**0**
10/10/2018																																											**0**
10/11/2018	9	12	9	1	1	1		3					1			1	1				1		1																				**41**
10/12/2018	15	26	25	16	1		1	4	1	1	3	2	1	1			2	1					2		1					1													**104**
10/13/2018		1			1																																						**2**
10/14/2018	1	4	5	8	1								1	1				1			2		2															1				1	**28**
10/15/2018	10	7	20	2	1	4		4	2		2	1	1					3			3							1															**61**
10/16/2018	5	11	29	5	3	3		4		1	3				2			4	1		1		2														1						**75**
10/17/2018	30	27	202	82	4	3		5		1	3						5	1					1													1							**365**
10/18/2018	35	52	178	47		1		1		3						1		2																									**320**
10/19/2018	19	10	46	9	1	1		3						2	2		1				4	4	2																			1	**105**
10/20/2018	18	21	50	26	1	1		4		3	2						1				1		1										1							1			**131**
10/21/2018	5	13	23	3				6		2	1	1		1				1			2	1	4	1							1							1				1	**67**
10/22/2018	2	3	17	27	7					2						1	2				1		5	1																		2	**70**
10/23/2018	3	1	1	7	1	1				1		1		2								1	2															1					**22**
10/24/2018	1	8	39	25	4	1		1		6	2		2	1	1								1										1						1			1	**95**
10/25/2018	1	3	13	15	2	1		1							1						1			2									1										**41**
																																											1814

Table 1: Count data from Grassy Mountain showing specific species/age/sex breakdown when possible.

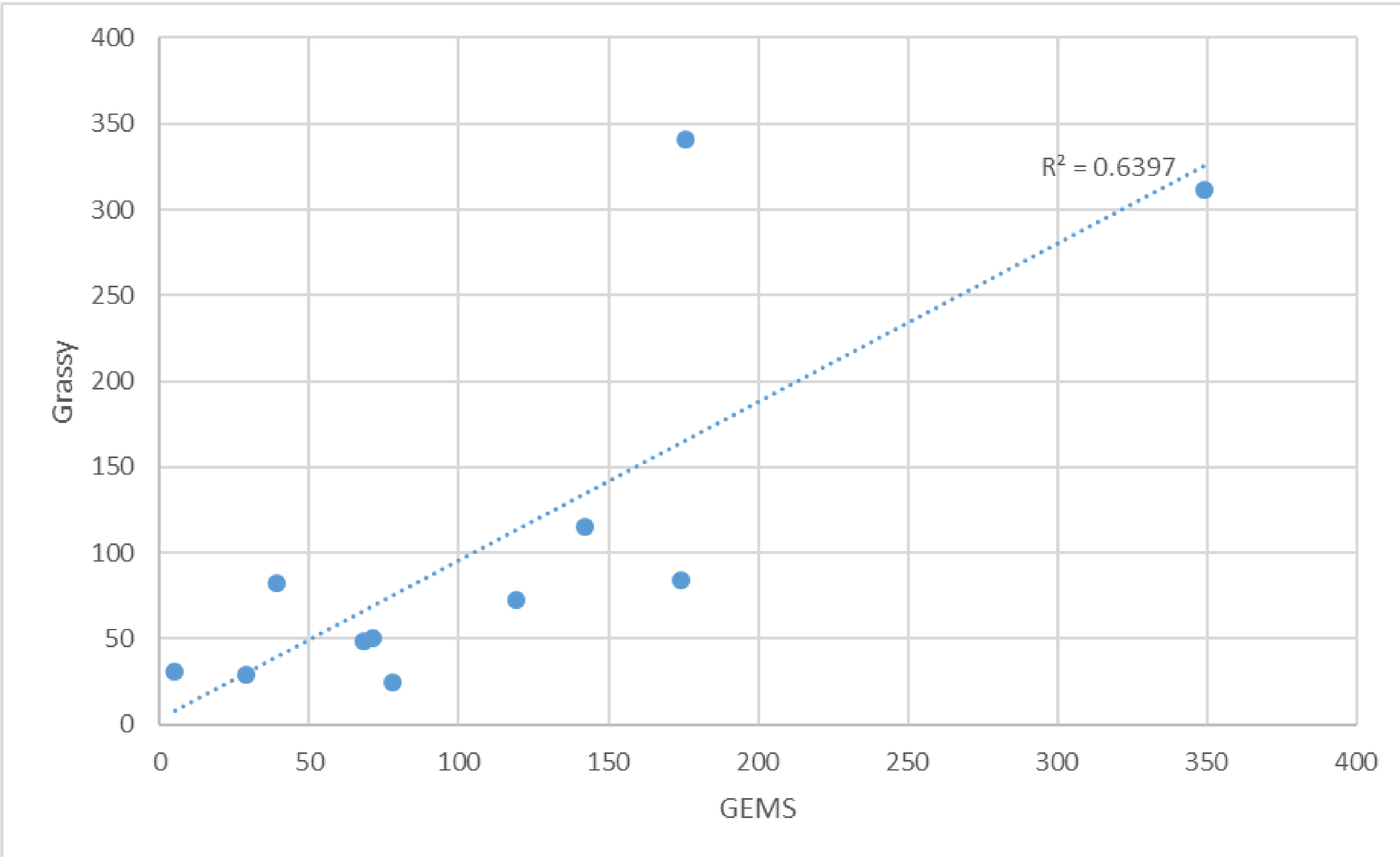


Figure 5. Comparison of daily count totals of Golden Eagles at the Duck Creek Pass site (GEMS) and Grassy Mountain (Grassy) for 11 days between Oct 1–24, 2018.

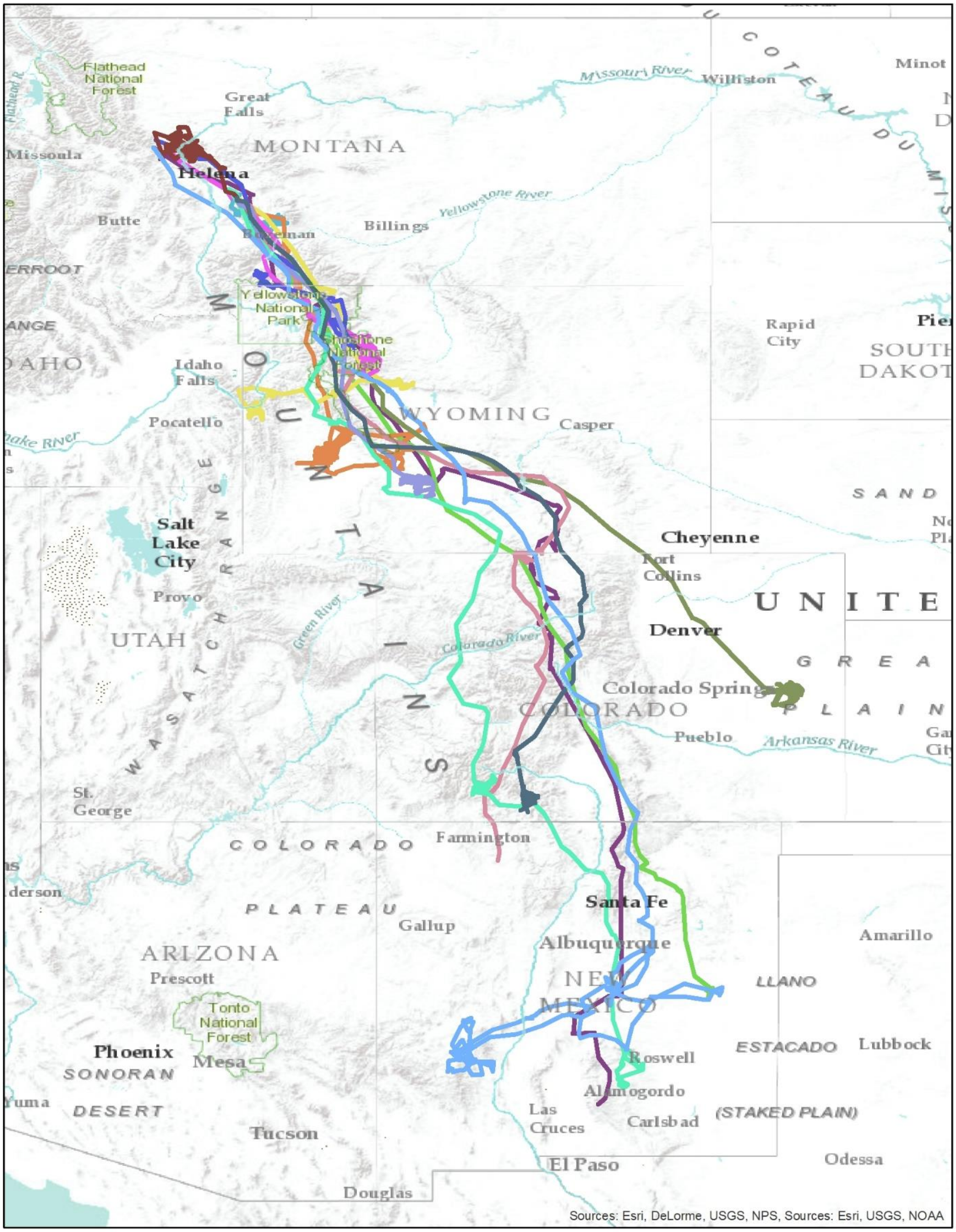


Figure 6. Fall migration tracks of adult Golden Eagles tagged in 2018 at Grassy Mountain (n = 10) and Rogers Pass (n = 4) migration sites in southern and central Montana.

Figure 7. Adult golden eagle with new GPS transmitter backpack

Great Gray Owl Project, 2018 Annual Report for Grand Teton National Park

Principle Investigators:
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Katherine Gura, Research Assistant, University of Wyoming, kgura@uwyo.edu; 919.619.8353

Project Personnel: Allison Swan, Sam Diaz, Nathan Hough

Wyoming Game and Fish Department Permit #: 33-1011
Study Species: Great Gray Owl

INTRODUCTION:

In 2018 we continued a multi-year study on Great Gray Owls in northwestern Wyoming that began in 2013. This year, we took our study in a new direction by beginning to collect data on Great Gray Owl habitat selection by utilizing remote-download GPS transmitters. We initiated a study on Great Gray Owl winter habitat selection that we will continue in 2019. Additionally, in 2018 Katherine Gura, a research assistant at the University of Wyoming, began pursuing a master's degree in the Department of Zoology and Physiology and is conducting research on Great Gray Owls in Teton County in conjunction with Teton Raptor Center. Her master's research is focused on determining home-range size and habitat selection of adult Great Gray Owls during the breeding season, and her study area includes Grand Teton National Park. She will collect winter habitat use data as well to bolster Teton Raptor Center's research project on winter habitat selection.

Along with these two new foci for our Great Gray Owl research, we continued to collect data on territory occupancy, nest initiation rates, productivity, and survival of previously marked owls. We also continued to monitor snow characteristics within Great Gray Owl territories to assess how snow conditions relate to Great Gray Owl habitat use, movements, and nest success across years. Snow loads in the spring and crust hardness may affect timing of Great Gray Owl nesting, hunting success, and prey abundance. We also continued to utilize automated recorders to monitor territory occupancy of Great Gray Owls.

METHODS:

The primary study area in 2018 is the base and foothills of the Teton Range as well as the Snake River riparian corridor, stretching from Red Top Meadows north to the Blackrock area on Bridger-Teton National Forest. Within Grand Teton National Park (GTNP) the study area ranged from Granite Canyon trailhead near Teton Village north to Moose, WY in the southern end of the park, and it also included northern areas within GTNP (e.g., Emma-Matilda/Two Oceans area). The typical forest habitats consisted of Douglas fir, lodgepole pine, sub-alpine fir (*Abies lasiocarpa*), and aspen (*Populus tremuloides*) surrounding the valley and mixed cottonwood (*Populus* spp.) spruce (*Picea* spp.) forests within riparian areas.

We continued to track previously radio-tagged owls and monitor known Great Gray Owl territories through night surveys, nest-checks, and fledgling surveys. We surveyed for pocket gophers and snow conditions in a number of Great Gray Owl territories and monitored existing nesting platforms (not within GTNP) to determine if nest sites may be limiting nesting.

Territory Occupancy

During the courtship period of Great Gray Owls (mid-February – April), we deployed audio recorders adjacent to known nest sites across the study area to determine whether Great Gray Owls were present. Our main intent was simply to determine whether these known territories were active or not. We analyzed the recordings by running them through Kaleidoscope®, an automated bioacoustics software. We trained the software to locate Great Gray Owl territorial calls, and if Great Gray Owl calls were detected, we determined the territory was occupied.

Nest Monitoring

We monitored all known Great Gray Owl territories. We considered a territory "active" only if we found direct evidence of breeding, such as an incubating female or fledglings. We considered a territory "occupied" if we documented a territorial Great Gray Owl on our recordings. A nest was considered active if a female began incubation, and a nest was considered successful it fledged young. We also continued to check the 42 nesting platforms we installed in a portion of our study area in previous years to see if they were used by Great Gray Owls (note: none of these platforms are placed within GTNP). We checked all platforms at least once during the incubation period.

Gopher Surveys

We surveyed for pocket gopher abundance following van Riper et al. (2013). We digitized all meadows within 500 m of known nests and randomly selected three (when available) for surveys. We started at the head of each meadow and walked 45-degree diagonal transects back and forth until reaching the end of the meadow, tallying fresh and old gopher mounds visible within 10 m of the transect. We are interested in relative abundance between years and among territories, so we tallied total survey area (total transect length x 20 m) for each territory and divided by the total number of mounds to create an index of gopher abundance. Because we regularly observe owls hunting within forested areas, we also added a survey transect bisecting the territory through representative forest habitat. We tested for correlations between new, old, and total gopher mound abundance and between forest and meadow. We tested for relationships between years and between gopher abundance and productivity.

Tracking

We continued to monitor Great Gray Owls that are outfitted with VHF transmitters. We attempted to listen for each marked owl once per month throughout the study to confirm that each owl is alive.

Additionally, in order to better assess Great Gray Owl winter habitat selection, we outfitted Great Gray Owls with GPS remote-download tail-mount transmitters (manufactured by Lotek Wireless Inc.) that collect high volumes of locations on tagged owls. Tail-mount transmitters collected locations between 15 December 2017 – 28 February 2018) as well as between 15 April 2018 – summer of 2018. These tail-mount transmitters weigh 8 grams and are affixed to the two central rectrices – when the owls molt their tail feathers, the transmitters can be retrieved, recharged, and redeployed on new study birds. We plan on re-deploying these transmitters in November and December or 2018 as well as in 2019. As part of her master's research, Katherine Gura deployed GPS remote-download back-back transmitters (again, Lotek Wireless Inc., unit weight = 30g) on breeding-aged male Great Gray Owls beginning in March of 2018 to investigate breeding-season habitat selection and home-range size. These transmitters are expected to last through at least one more breeding season, and she will deploy 12 more transmitters in the fall/early winter of 2018 as well as in the spring of 2019.

Snow Measurements

In the winter of 2018, we continued conducting snow measurements near known Great Gray Owl territories across the study area. We measured each territory on the same day. We collected snow data one day/month from January-April. We measured snow depth by placing a measuring stick vertically down through the snow until it reached the ground. We measured snow crust strength by dropping a filled 1-liter Nalgene water bottle (ca. the same weight as an adult Great Gray Owl) one meter above the top of the snow (not the ground) and measuring how far the bottle penetrated the snow. We dropped the bottle both horizontally and vertically and averaged the depths. In each territory, we measured snow characteristics in a meadow and in a forest representative of the territory. The same meadow and forest sites were consistently measured across years. We made sure to conduct the measurements in areas representative of the area's average snow conditions (ie. not directly in a tree well, nor in an area disturbed by human activities).

RESULTS:

Call-Back Surveys

Our previous data has indicated that call-back surveys are not an effective means for determining occupancy of Great Gray Owl nests. Instead, in 2018 we only deployed automated recorders in all known territories to document occupancy rates and create a long-term bank of calls. We are still analyzing recordings from 2018 to determine whether territories were occupied or not.

Nest Monitoring

In 2018, we monitored 24 known Great Gray Owl territories in the study area. While several territories had pairs of owls occupying them, only one territory within GTNP was documented as active (initiated incubation) and it successfully fledged one young. This observation of owls occupying territories but not necessarily nesting reflects a broader pattern of low productivity that we observed throughout the study area beyond GTNP: only two of 24 territories with known nest sites successfully fledged young in 2018. Therefore, of our 24 known territories, two fledged young in 2018, amounting to a 8.3% apparent nest success rate.

Gopher Surveys

We conducted pocket gopher surveys at 17 owl territories between 10 of July and 17 of July, 2018. We are still analyzing this prey data to see how gopher abundance in 2018 compares to previous years.

Snow Measurements

We conducted snow measurements at 17 known Great Gray Owl territories across the study area. Measurements were taken as early as 16 of January through 17 of April. We took measurements at each site once/month, at all territories on the same day. We are still analyzing snow measurement data to see how snow conditions within Great Gray Owl territories in 2018 compared to previous years.

Banding and Tracking

In previous years of the study, we band fledglings from Great Gray Owls nests. We only observed two territories successfully fledge young (including one nest in GTNP). We banded the one chick that fledged from the Emma Matilda nest in 2018. We did not know the other territory that was active in 2018 was successful until after the young fledged (the pair relocated its nest from past years), so we did not band those two fledglings.

In November and December of 2017 as well as in 2018, we deployed eight tail-mount GPS transmitters on Great Gray Owls (6 on adult females, one on a sub-adult female, and one on an adult male). Thus far, no tail-mount transmitters were deployed in 2018 within GTNP, but several of these tagged owls localized in GTNP (primarily in the southern area of the park along Moose-Wilson Road).

Katherine Gura outfitted 8 adult owls and one sub-adult male owl with transmitters during the spring and early summer of 2018. Five of her study birds were captured within GTNP (specifically near Granite Canyon, Moose-Wilson Road near the Murie Center, Spalding Bay, Emma Matilda Lake, and Pacific Creek Road). One of her tagged birds nested in the northern part of GTNP at the Emma Matilda Lake territory.

CONCLUSION:

Long-term monitoring of Great Gray Owls is essential in order to assess overall population health. In 2018, only two of our known Great Gray Owl nests were active (and they also successfully fledged young). Similarly, 2017 had even lower productivity, with only one active nest (that ended up failing) and no young successfully fledged from known territories. In contrast, 2016 was the most productive year within our study, with 21 active nests and 17 successful attempts (fledged young). Like 2017, 2018 was a surprisingly low year for Great Gray Owl nesting and highlights the importance of monitoring nesting and productivity across years.

Our hope is that by further investigating Great Gray Owl habitat selection, we can better understand how resource availability influence territory selection and reproductive success. We are assessing both winter as well as breeding-season habitat selection, both of which are critical periods that may determine whether owls are able to nest successfully. By assessing resource selection and habitat conditions within territories, we hope to identify factors that are driving these stark fluctuations in nest success from year-to-year.

In addition to our two new habitat selection studies on Great Gray Owls, we intend to continue nest-monitoring and prey-sampling in order to evaluate the health of Great Gray Owls in the Greater Yellowstone Ecosystem in the face of anthropogenic and natural changes over time. Snow conditions likely have an influence on Great Gray Owl winter habitat selection, seasonal movements, timing of breeding, and nest success, but these data need to be collected across years in order to adequately assess how climate affects this species. Furthermore, as Great Gray Owls are a denizen of boreal forests that will likely be effected by climate change, it is important to study how this species responds in light of rising temperatures and a changing environment.

Biochemical Investigation of Lead Detoxification in Common Ravens

2018 Annual Report – Teton Raptor Center

Principle Investigators:
Bryan Bedrosian, Teton Raptor Center
Michal Shoshan, Dept. of Chemistry and Applied Biosciences, University of Zurich

Affecting enormous populations worldwide, metal poisoning currently poses a major challenge for medicinal chemistry. Although chelation therapy is the most efficient way to handle metal toxicity, the five approved chelating agents suffer from many drawbacks. As relatively small molecules, these chelators cannot distinguish between essential and toxic metal ions, causing the deactivation of essential ions in the body. As a result, most of these compounds are highly toxic and many segments of the population, are prohibited from treatment with them.

Several families of natural chelators were discovered along the years in many organisms, where all of these chelators are short proteins or peptides. In the majority of the cases, these molecules were evolved by the organisms as solutions for heavy metal detoxification, for example, the mercury transporter (Mer) superfamily; the plant peptides phytochelatins; and metallothioneins that can be found in many organisms, from yeasts to humans. Inspired by nature that chose the peptidic scaffold for handling metal poisoning, our new research group aims to develop various peptides as selective and effective heavy metal chelators, with the intention to optimize them toward medicinal and environmental applications.

Among the destructive effects of lead (Pb), poisoning wildlife animals, mainly raptors, was recently reported worldwide. Lead-containing rifle bullets in the legal hunting of various mammals undergo fragmentation after penetration and spread to the internal organs far from the shot wound as odor-less, taste-less micrometric particles. Scavengers consume these offal piles that are left in the field and as a result, accumulate elevated levels of lead in their blood. The main raptors that suffer from lead poisoning are California condors, bald and golden eagles. In fact, Bedrosian and coworkers identified a correlation between the hunting seasons in the Great Yellowstone area and the blood lead levels (BLL) of captured eagles, where during the hunting season the typical BLL that were detected are above 100 µg/dL, 20 times higher than the toxic concentration for humans as determined by the World Health Organization (WHO). These eagles suffer from various poisoning symptoms that eventually cause their death. In his observations, Bedrosian also noticed that common ravens (*Corvus corax*) consume the same piles but show no symptoms for lead poisoning. By analyzing blood samples from more than 300 ravens, he identified that ravens also consume lead fragments, as the BLL during hunting seasons were dramatically higher compared to the non-hunting time. However, the highest BLL that was detected in ravens was ~40 µg/dL and the median BLL was 10.7 µg/dL, which is twice higher than the toxic BLL for humans by the WHO, but is 10-times lower than the typical values detected in eagles.

Based on these observations, we hypothesize that ravens as opportunists possess an unknown biochemical advantage that enables their resistance towards the toxic effect of lead by chelating Pb(II) ions and extracting them through the urinary system. The goal of this proposal is therefore to identify the lead chelator(s) in common raven blood. Towards this goal, a collaboration with Mr. Bryan Bedrosian and the Teton Raptor Center has been established. The research will be held by Dr. Michal Shoshan and a PhD student at the department of chemistry of the University of Zurich, within a timeframe of up to a year. Herein, we shortly describe the planned steps toward achieving the goal:

2018 Results:

During the 2018 hunting session (November – January 2018) we collected blood and feces samples from 15 individual ravens that were captured on private lands in Jackson Hole. The BLL of these samples were immediately determined by the Leadcare® portable blood lead analyzer (ESA Biosciences Inc., Chelmsford, MA) and ranged from no detect – 21.1 ug/dL. Samples were frozen and will be shipped to Dr. Shoshan in early 2019 for lab analysis.

Rough-Legged Hawk Project Report, 2018

Principle Investigators:
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Jeff Kidd, Kidd Biological
John Stephenson, Grand Teton National Park

Project Personnel:
Nathan Hough and Allison Swan

2016

In the winter of 2016, capture efforts first began, targeting Rough-Legged Hawks in northwestern Wyoming to document migration routes and important stop-over areas of hawks that winter in Wyoming. Banding began 1 January 2016 and continued through 15 February 2016, and then began again 15 November 2016 through 19 December 2016. Capturing involved the use of standard bal-chatri and pan traps baited with mice.

In 2016, we captured three Rough-Legged Hawks, all of which received backpack transmitters. Blood samples and standard ornithological measurements were taken from these three birds as well. We captured one subadult female, one adult female, and one juvenile male Rough-Legged Hawk. Both the adult female and juvenile male were outfitted with PTT satellite transmitters, and the subadult female was outfitted with an Ecotone GPS/GSM logger.

Transmitters on two of the Rough-Legged Hawks were deployed in the Jackson Hole Valley in December 2016, and the third transmitter was deployed near Big Piney in January 2016. The individual tagged in Big Piney (Figure 1, Red) migrated south and settled on the Wyoming/Colorado border for winter. In the spring, this bird migrated north through Alberta and the Northwest Territories, finally summering in Nunavut, Canada. In the fall, this bird migrated south through Nunavut, passed across Saskatchewan and south through Alberta and Montana before settling on the Wyoming/Colorado border again just west of Laramie. After wintering in Laramie it headed north into Saskatchewan and Alberta before losing a satellite signal and never returning from the breeding grounds.

The juvenile male migrated north through Montana, Alberta, and the Northwest Territories before settling in the northern region of Nunavut (Figure 1, Blue). Due do a transmitter issue, we are unsure of the migration route because of missing data. We do know that this individual wintered South of Pocatello ID, and was back in summer range in Nunavut be early June. This bird's GPS has not checked in after this past summer of 2018. The adult female flew north through Montana, up into Alberta, crossing over into Saskatchewan before continuing up to the Northwest Territories, and settling in the northern region of Nunavut (Figure 1, Black). It traveled south along a similar route and wintered in Western Wyoming 2017 → 2018. Spring of 2018 it used the rocky mountain front to travel north again, but this time it ventured out into Saskatchewan then proceeded north to its breeding range in Nunavut. Late summer into fall 2018 it moved around in Nunavut before migrating south along Western Manitoba, through North and South Dakota, to northern Colorado where it appears to be wintering.

2017

We captured two Rough-Legged Hawks between 13 November 2017 and 29 December 2017, one of which received a backpack transmitter. We captured one juvenile male and one adult female. The female was outfitted with an Ecotone GPS/GSM logger (Figure 1, Dark green). This transmitter stopped working late February 2018 for unknown reasons. We did not outfit the juvenile with a transmitter since we are targeting adults for this study. Blood samples and standard ornithological measurements were taken from both birds.

We captured an additional three Rough-Legged Hawks at a migration site on Grassy Mountain, Montana on 10 October 2017 using a bow-net. Two birds were adult, one male and one female, and were equipped with Ecotone GPS/GSM loggers. The third was a young bird of unknown sex, so no transmitter deployed. The male (Figure 1, Purple) flew from western central Montana, southeast across the state of Wyoming, and stopped just northeast of Denver. Spring of 2018 it moved north across Wyoming and central MT, through Alberta, across the bottom of the Northwest Territories, and ended in Nunavut on the Melville peninsula. Fall 2018 it moved back south along the Hudson Bay, across Saskatchewan, and back through Montana and Wyoming to the same field it wintered in during 2017-2018 winter. The female (Figure 1, Pink) spent some time around Montana before flying southwest through a portion of Wyoming and Idaho, until reaching Utah, stopping just north of Salt Lake City. From here, the bird continued west into Nevada and wintered in the central part of the state. In 2018 spring it traveled through Idaho and western Montana, through Alberta and the Northwest Territories, and crossed over the Brooks Range to summer on the North slope. Fall 2018 it crossed the Brooks Range, traveled south through the Yukon and followed the Rocky Mountain front into western Montana where it cut south through Idaho and back into Nevada. It did not settle in Nevada this year, but instead journeyed back Northeast across Utah and most of Wyoming to end just west of the Bighorn Mountains in Wyoming.

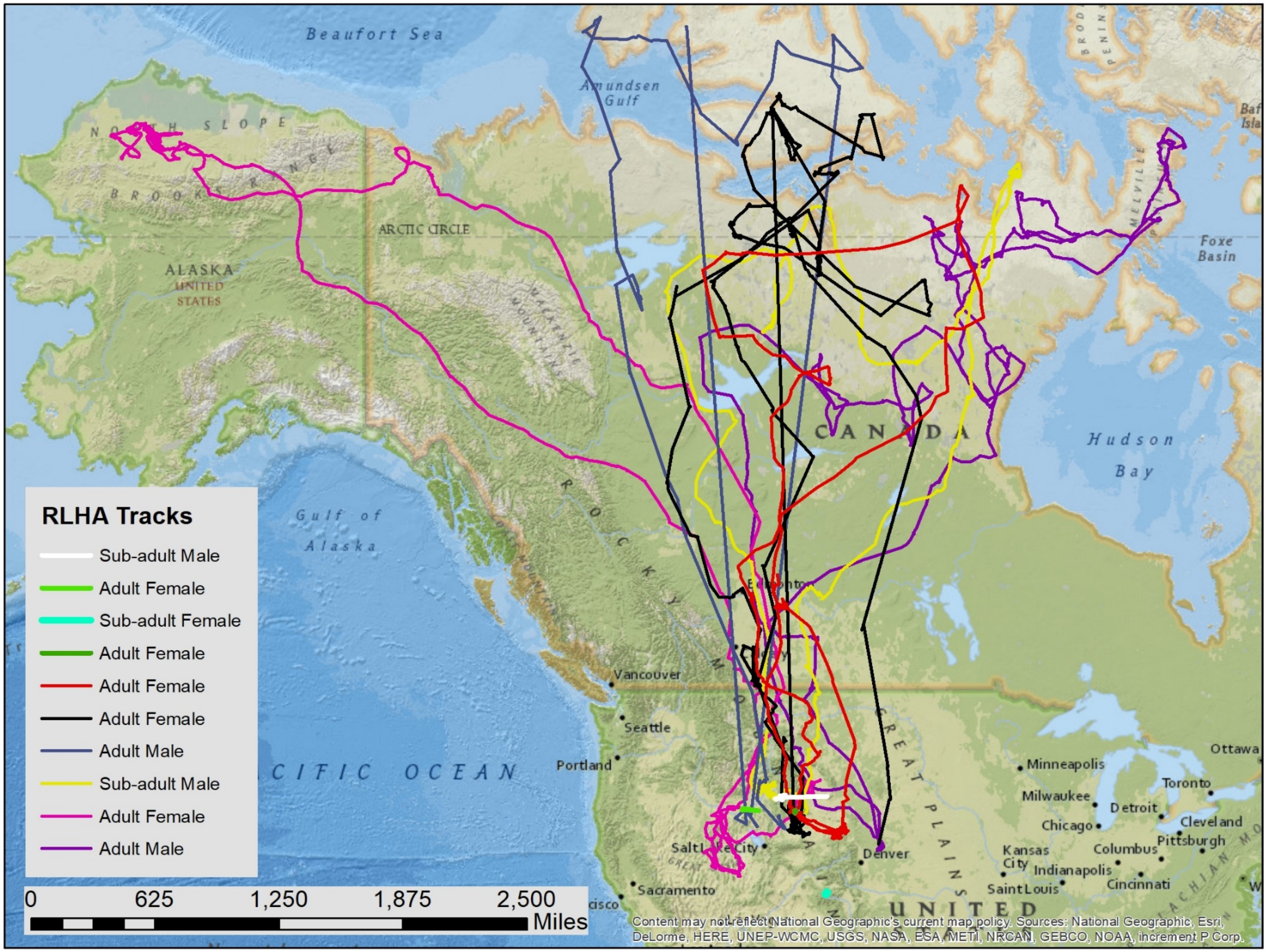
2018

In 2018 we continued our trapping effort and captured 13 Rough-legged hawks starting trapping efforts January 1st and ending January 30th. We captured an additional 4 hawks at the Grassy mountain migration site bringing our total to 17 for the calendar year. We deployed 4 transmitters, 3 Ecotone, and 1 Biotrack ARGOS. All of our transmitter birds were in their second year or older, and were mixed gender with 2 males and 2 females.

Out of the 4 hawks with transmitters from 2018, 3 of the transmitters are still working. The Biotrack transmitter placed on one of the males unfortunately malfunctioned and only sent locations for 2 months after deployment (Figure 1, white). In that time the individual stayed in the Jackson area. The other male (Figure 1, Yellow) moved west to an area north of Idaho falls for the remainder of last winter before migrating back north through Alberta, past Great Bear lake in Northwest Territories, and finally moving east to breeding grounds in Nunavut. Fall 2018 it migrated back through Saskatchewan, Montana and into Wyoming. It moved along the highway from Lander to Jackson, and continued over the Tetons west of Rexburg where it spent last winter. One female is wintering West of Pocatello (Figure 1, light green). The other female is wintering just East of Telluride Colorado (Figure 1, light blue).

It is interesting to note all birds used the eastern edge of the Rocky Mountains through Montana for fall migration, but took different paths after reaching the Calgary area. Migrating back south showed more variability in route. Out of the six hawks that have made one complete migration cycle with a transmitter, none of these birds show route fidelity between spring and fall migration, and the two hawks we have multiple years data (Figure 1: blue, black) do not show route fidelity between any migration event. We will continue to monitor the movements of all tagged individuals remotely via transmitters.

Figure 1. Tracks from Rough-legged Hawks tagged by Teton Raptor Center. Red, dark blue, and black were all captured in 2016. Dark green, purple, and pink were all captured in 2017. White, yellow, light green, and light blue were all captured in 2018. Legend shows age of the bird as it would be December 2018, not the capture age.



TETON RAPTOR CENTER

2018 Teton to Snake Project Report

Goals

1. Conduct surveys for sensitive raptors for two years pre- and two years post-treatment, when possible.

   A. March 15 – April 5th SoundScout surveys for BOOW, GGOW, and NOGO, simultaneously

   B. April 6 – April 28th Follow-up SoundScout surveys at locations of positive detections that also have ambiguity in nesting forest stand

   C. May 15 – June 15: SoundScout surveys for FLOW

   D. June 5 – July 14: SoundScout surveys for nestling GGOW and NOGO chicks in areas nests are not located

2. Nest search for target species, when possible

   A. May 1 – June 15: GGOW and NOGO in areas with positive detections

   B. June 15 – July 15: FLOW in areas with positive detections

Survey areas for 2018

- All mechanical treatment areas (T1-11, 14-16, 19, 21, 23, 25, 31, 33, 35, 36, 43)
- 2018 prescribed fire (PF 20, 29)
- 2019 prescribed fire, if time allows (PF 01, 02)

Methods

Survey locations were predetermined in a GIS using a 300m detection radius of the SoundScout automated recording units (ARUs). Topography, access, and safety were all considered when placing survey locations. Areas of unsuitable habitats were not included and all potential habitat was covered with survey locations. Survey locations were divided into three groups, depending on safety and seasons, 1) a low-slope (safely accessible in spring), 2) high slope (inaccessible for spring surveys) and 3) late-season surveys for Flammulated Owls.

Recorders were deployed for a total of six consecutive nights, once during the early call period (Objective A). Recordings will be reviewed for species occurrence the week following deployment. Flammulated Owls were surveyed for with recorders beginning mid-May after arriving on breeding grounds (Objective C). We conducted targeted nest searching, when possible, in nest stands with positive detections of Great Gray Owls, Northern Goshawks and Flammulated Owls. Recordings from the late season were reviewed for fledgling Great Gray Owls and Northern Goshawks in areas with positive detections (Objective D). In several instances, we combined recorders for objectives C and D for efficiency.

We targeted six deployment areas over the main three week calling period for owls and goshawks. We deployed 21 ARUs in the Phillips Ridge and Trail Creek areas in week one. We then utilized backcountry ski expertise to deploy 27 recorders in the Mosquito Creek burn area and along the Mosquito Creek road corridor, and simultaneously deployed 16 units in the Red Top, Butler Creek and Taylor Creek areas. We also re-deployed in locations where the battery died or microphones were not engaged during the initial deployment. Later in the season, we deployed 24 ARUs in the Red Top and Butler Creek areas to survey for Flammulated Owls. We then deployed 37 units in the Phillips Canyon, Trail Creek, and Taylor Creek areas, followed by 24 ARUs deployed at locations in the Mosquito Creek and Red Top areas.

Table 1. Sensitive raptor monitoring schedule for Teton-2-Snake fuels reduction project. Schedule is designed for two years pre- and post-treatment (when possible).

					Raptor Surveys					
Unit	Map_Label	Treatment Year	2017	2018	2019	2020	2021	2022	2023	2024
Rec Trail Unit 1	T-14	2017								
Rec Trail Unit 2	T-11	2017								
Rec Trail Unit 3	T-16	2017								
Rec Trail Unit 4	T-15	2017								
Phillips Bench Unit 1	T-05	2019								
Phillips Bench Unit 2	T-03	2018-2019								
Phillips Bench Unit 3	T-07	2020								
Phillips Bench Unit 4	T-08	2020								
Phillips Bench Unit 7	T-04	2019								
Red Top Unit 1	T-33	2019-2020								
Red Top Unit 2	T-35	2019-2020								
MosqCrk RX	PF-20	2019-2021								
Taylor Mtn RX Unit 2*	PF-30	2019								
Taylor Mtn RX Unit 4	PF-29	?								
Highland Hills Unit 1	T-31	2019								
Phillips Bench Unit 5	T-06	2020								
Phillips Bench Unit 6	T-09	2021								
Powerline Unit 1	T-10	2020								
Red Top Unit 4	T-43	2019								
Singing Trees Unit 2*	T-23	2019								
Phillips Canyon RX Unit 1	PF-01	?								
North Fork Phillips RX	PF-02	?								
Red Top Unit 5	T-36	2021								
Singing Trees Unit 4	T-25	2021								
MungerMtn RX Unit 1	PF-47	?								
Singing Trees RX	PF-26	2022								
Trails End RX*	PF-34	2019								
Rec Trail Unit 5	T-19	unk								
Rec Trail Unit 6	T-18	unk								
Rec Trail Unit 7	T-17	unk								
Singing Trees Unit 1	T-21	unk								
* Anticipated Treatment Date Moved Up to 2019										
? Unknown if Feasible										

Results

In 2018, we deployed SoundScout ARUs at 150 locations to detect Great Gray Owls, Northern Goshawks, and Boreal Owls (Figure 1). We surveyed all treatment areas outlined in Table 1 for 2018. We deployed ARUs in 65 locations from 16 March – 10 April and an additional 85 locations from 23 May – 21 June to detect Flammulated Owls (and other species opportunisitically). We reviewed recordings for territorial calls of focal species in the early season deployments. Late season deployments were reviewed for territorial calls of Flammulated Owls.

This year, we detected no Great Gray Owls calling at survey locations during the early season. These data were consistent with audio recorders we deployed at known Great Gray Owl territories in early March 2018 for a concurrent project. The area experienced a dense snowpack in spring 2018 with a hard crust layer, which can impact an owl's ability to hunt effectively and is one potential reason Great Gray Owls may not have been calling on territory in March. However, we did opportunistically detect Great Gray Owls at 5 locations in mid-May during the late round of deployments. Detections were in the Red Top mechanical treatment areas and Taylor Mountain burn near detection sites identified in 2017 (Figure 2). We have two known nest sites within the Red Top treatment areas and the Taylor burn is between two known nest sites. There was very low Great Gray Owl production in 2018, with only two of 25 known nest sites around the valley successfully fledging young and no others known to initiate. This is the second year of low Great Gray Owl productivity in the Jackson Hole Valley.

We detected one Northern Goshawk territory in 2018 within the Mosquito Mtn Rx (Figure 3). We found goshawk calls on three adjacent recorders and suspect they are of one territorial pair, likely associated with the known nest site south of the road. The historical nest was not active this year, however the territory may have had a new, unknown nest site. This Northern Goshawk territory was also detected from our ARU deployments in 2017, along with two potential territories in the Red Top mechanical treatment areas.

We detected Boreal Owls at five of 65 locations surveyed in 2018 (Figure 4). This is a marked contrast from 2017, when we detected Boreal Owls at 60% of survey locations. Boreal Owls are known to experience boom and bust cycles directly related to vole abundance, their primary food source. In years of low vole abundance, Boreal Owls will rear smaller broods or not breed at all, instead becoming more nomadic in search of prey. Comparing data from the past two years, it appears 2017 was a good year for Boreal Owl productivity, while in 2018 very few Boreal Owls attempted to nest, perhaps relating to prey availability.

In 2018, we detected as many as five Flammulated Owl territories within the Taylor Mtn Rx Unit 4, and two territories within and directly adjacent to the Red Top mechanical treatment areas (Figure 5). This year we used only automated recorders to survey for Flammulated Owls, eliminating the possibility of attracting owls outside of their nesting territory with call-back surveys. We detected Flammulated Owls at Red Top and Taylor Mountain both years of surveys. However, Flammulated Owl detections were lower this year, compared to 2017. This could be that call-back surveys were soliciting more responses than the number of owls actually holding a territory, or it may be that 2018 was a year of low overall raptor productivity, as observed in the other species we surveyed for.

Conclusions and Continued Work

We found that recorders and automated detectors worked well to effectively survey for calling raptors within the extensively large areas within the Teton-to-Snake project areas. In 2017, we surveyed for Flammulated Owls using both call-back surveys and automated recorders. In 2018, we only used recorders to eliminate the possibility of drawing Flammulated Owls outside of their nesting territories to respond to callbacks, as has been shown in other studies and may erroneously affect results. Additional years of data collection will help us better understand the territory centers for these owls.

The Red Top mechanical treatment areas have high use by all BTNF sensitive raptors and should be avoided for treatments based on our results. Similarly, Great Gray Owls, Boreal Owls, and Flammulated Owls were all detected within the Taylor Mtn Unit 4 Rx suggesting this is an area of high use and important habitat of forest raptors, and should be avoided.

We anticipate following the schedule outlined in Table 1 and have secured funding for the 2019 field season. We will seek additional funding from BTNF for subsequent years and strongly urge managers to continue the original goals of surveying areas for two years post-treatment to gather critical and novel information on potential treatment effects on the sensitive forest raptors. This information can greatly benefit future treatments across the forest.

Acknowledgements

We could not have completed this work without the significant investment and support of BTNF biologists Kerry Murphy, Randy Griebel, and Jason Wilmot and Andy Hall. ARU deployments were completed by Bryan Bedrosian, Bev Boynton, Litt Clark, Katherine Gura, Nathan Hough, Maxwell McDaniel, Bo McDowell, Tommy McLaren, Steve Poole, Sarah Ramirez, Allison Swan, and Ron Whitey. Bev Boynton, Kate Gersh, and Nathan Hough helped review recordings and Allison Swan ran and validated automated analysis software for this project.

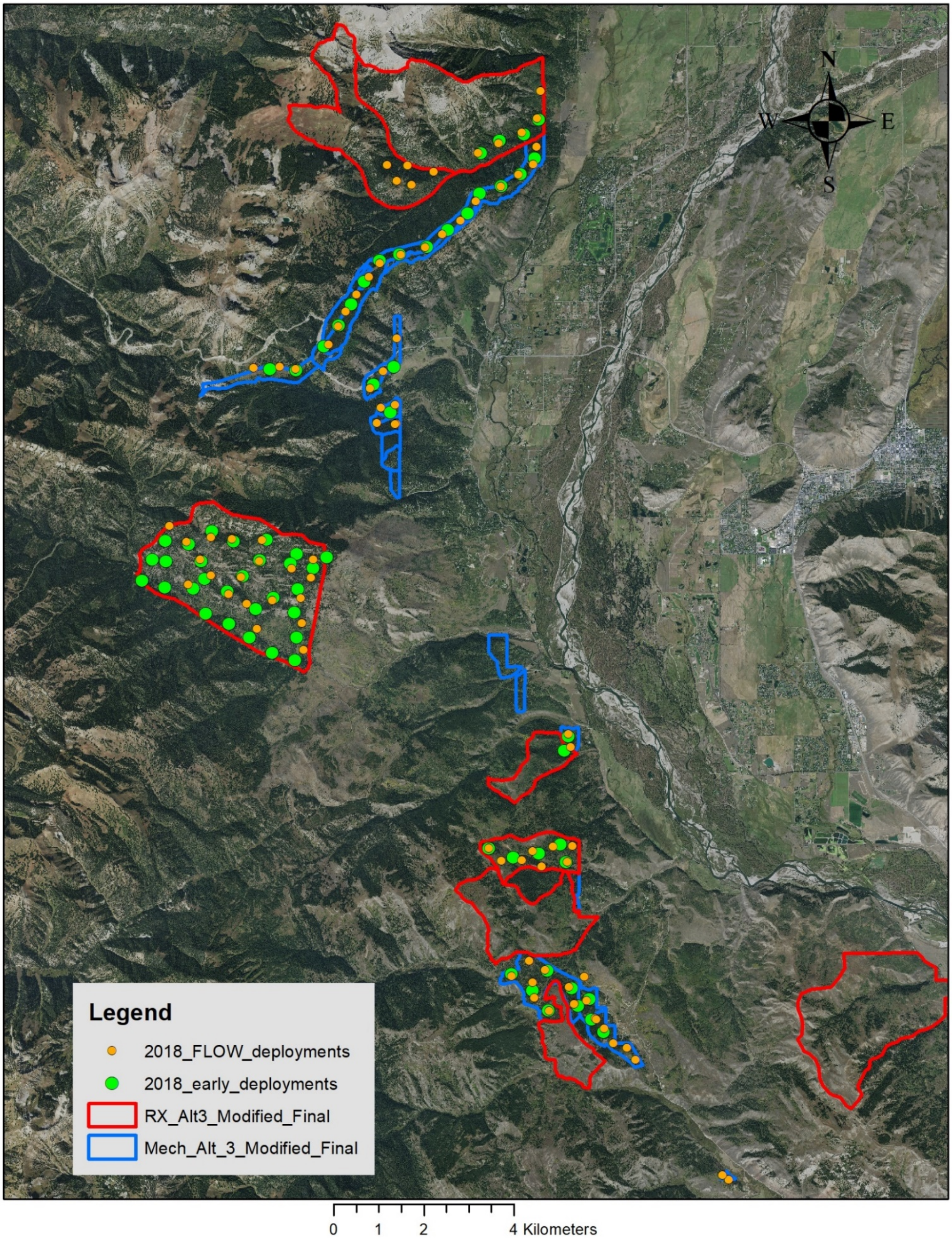


Figure 1. Locations of deployed automated recording units and treatment areas in 2018.

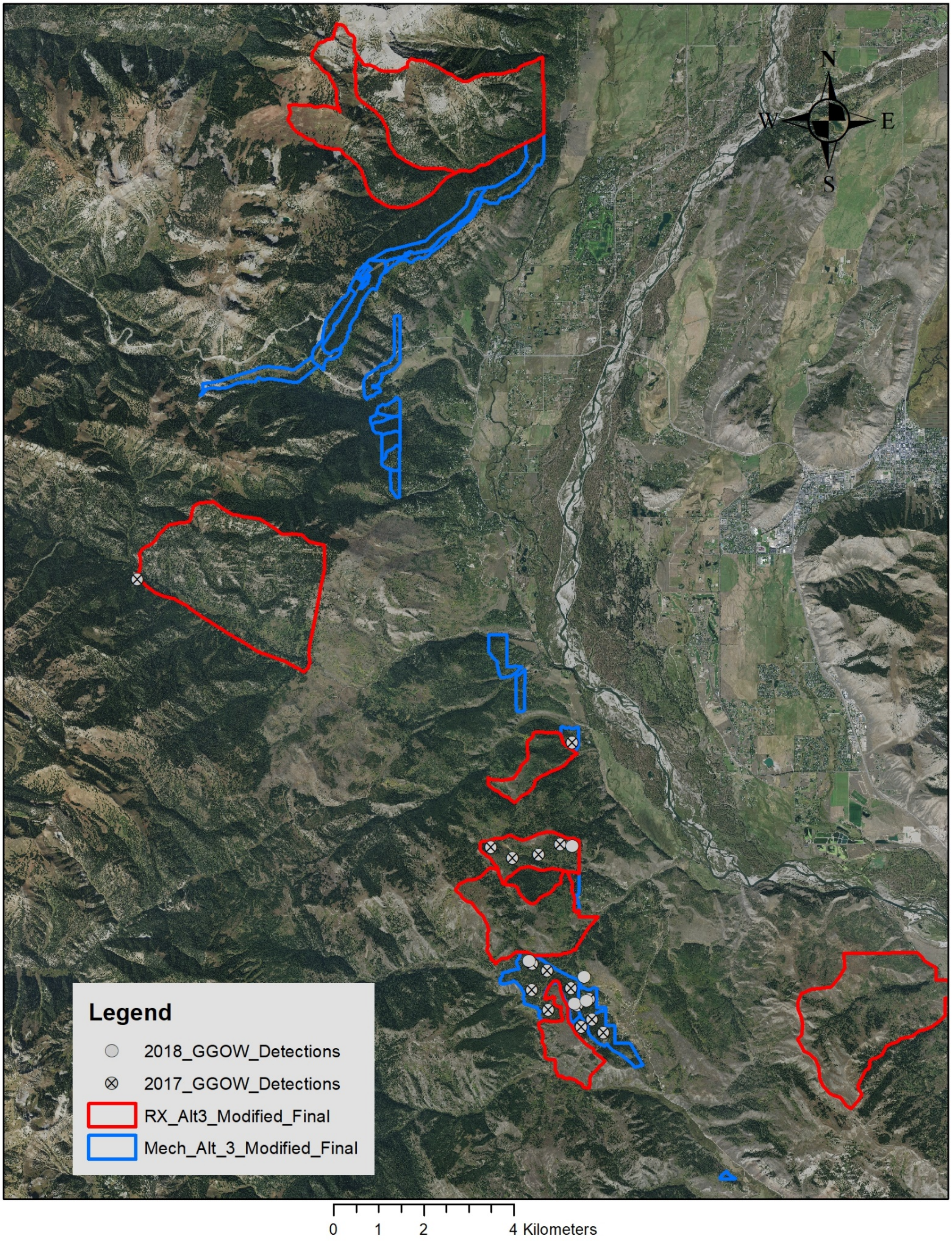


Figure 2. Locations of 2017 and 2018 Great Gray Owl detections.

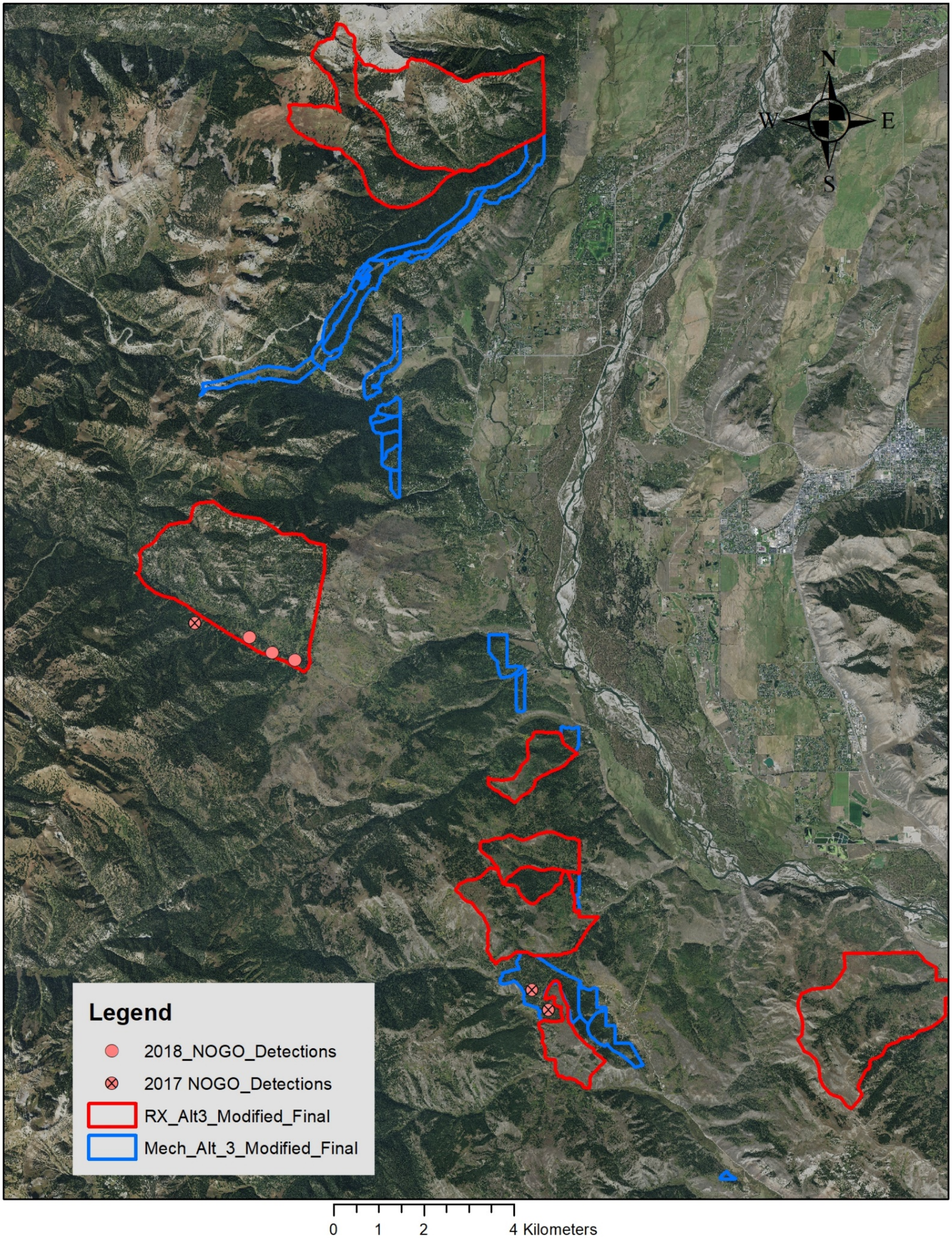


Figure 3. Locations of 2017 and 2018 Northern Goshawk detections.

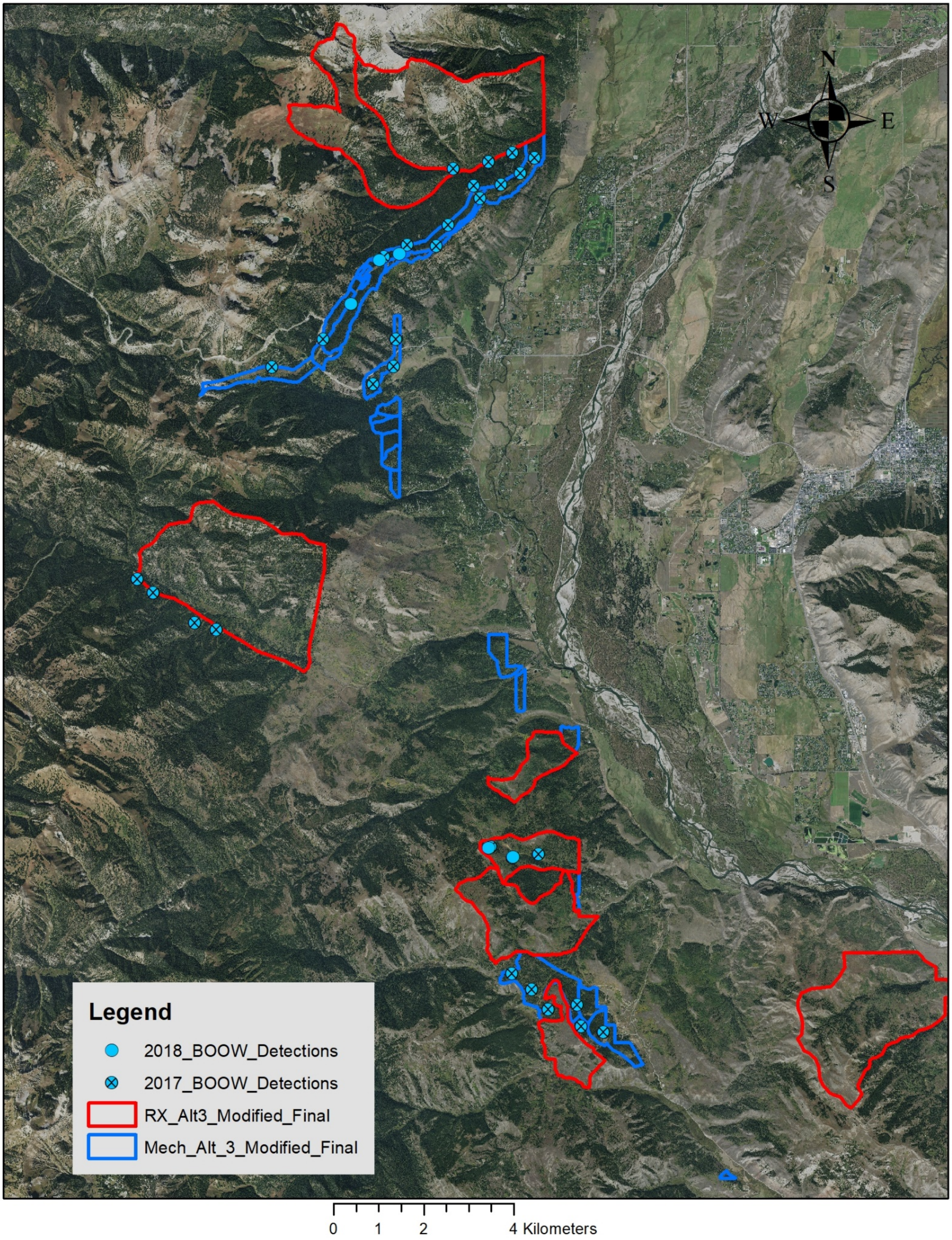


Figure 4. Locations of 2017 and 2018 Boreal Owl detections.

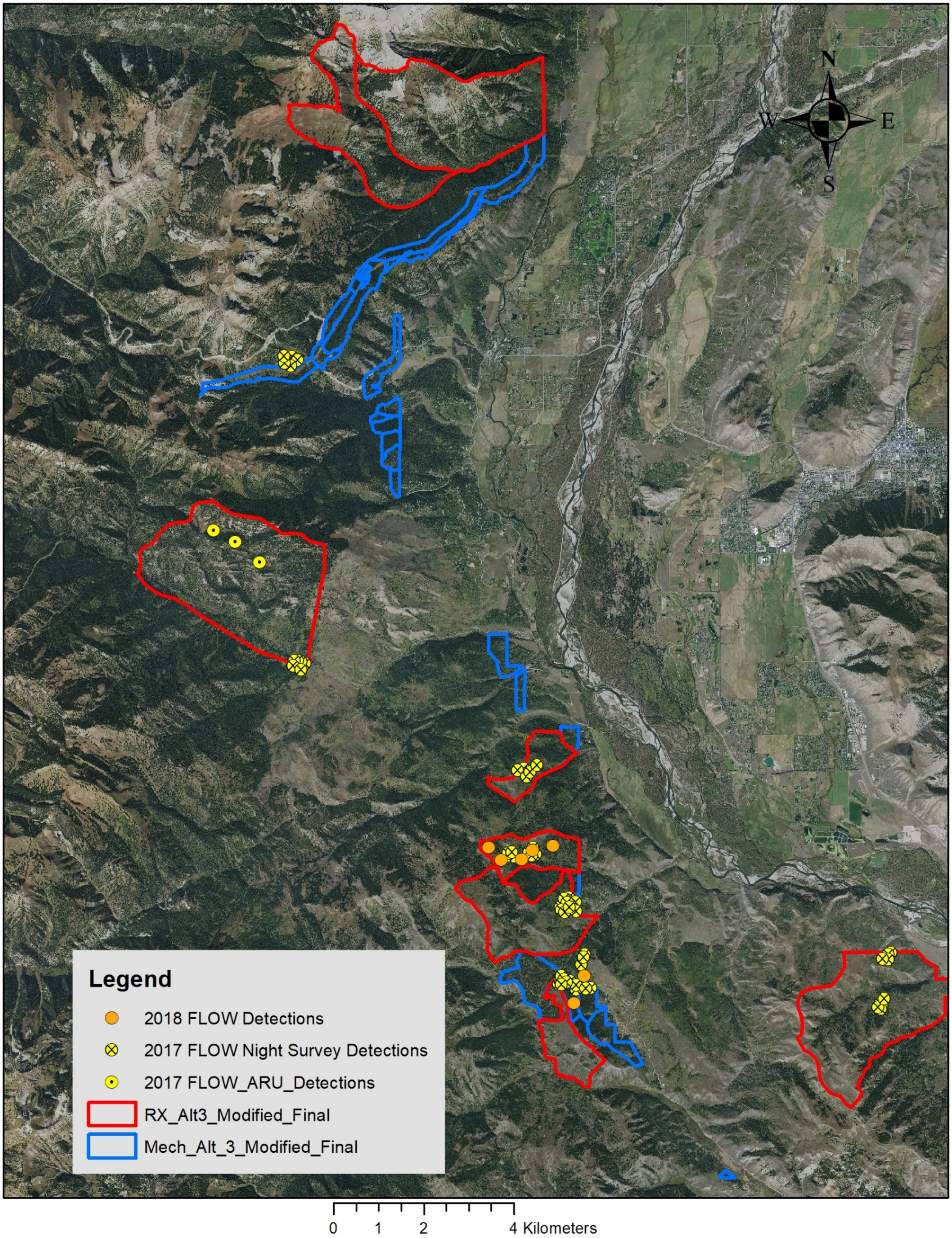


Figure 5. Locations of 2018 and 2017 Flammulated Owl detections by type.

Appendix 1. Locations of Automated Recording Units deployed in the early season in 2018 and associated raptors detected at each location (0 = no detection, 1 = detection, a = not possible during survey period).

Deployment	General Location	Pt Num	UTM Lat	UTM Long	Start Date	Early_Late	GGOW	NOGO	BOOW	FLOW
384	Phillips	T2S49	511073	4821389	3/16/2018	Early	0	0	0	a
385	Phillips	T2S38	510749	4821063	3/16/2018	Early	0	0	0	a
386	Phillips	T2S19	510205	4820924	3/16/2018	Early	0	0	0	a
387	Phillips	T2S18	509791	4820639	3/16/2018	Early	0	0	0	a
388	Phillips	T2S30	507981	4818392	3/16/2018	Early	0	0	1	a
389	Phillips	T2S31	508580	4818549	3/16/2018	Early	0	0	0	a
390	Phillips	T2S32	509049	4818930	3/16/2018	Early	0	0	0	a
391	Phillips	T2S33	509490	4819301	3/16/2018	Early	0	0	0	a
392	Phillips	T2S34	509762	4819745	3/16/2018	Early	0	0	0	a
393	Phillips	T2S35	510236	4819911	3/16/2018	Early	0	0	0	a
394	Phillips	T2S36	510670	4820175	3/16/2018	Early	0	0	0	a
395	Phillips	T2S37	510982	4820526	3/16/2018	Early	0	0	0	a
396	Phillips	T2S29	507538	4818246	3/16/2018	Early	0	0	1	a
397	Phillips	T2S28	507198	4817778	3/16/2018	Early	0	0	0	a
398	Phillips	T2S27	506906	4817277	3/16/2018	Early	0	0	1	a
399	Phillips	T2S26	506622	4816809	3/16/2018	Early	0	0	0	a
400	Phillips	T2S25	506303	4816337	3/16/2018	Early	0	0	0	a
401	Trail Creek	T2S24	505680	4815808	3/16/2018	Early	0	0	0	a
402	Trail Creek	T2S23	505091	4815838	3/16/2018	Early	0	0	0	a
403	Trail Creek	T2S20	507854	4815888	3/16/2018	Early	0	0	0	a
404	Trail Creek	T2S22	507394	4815492	3/16/2018	Early	0	0	0	a
405	Red Top	T2S1	512513	4801095	3/23/2018	Early	0	0	0	a
406	Red Top	T2S2	512248	4801373	3/23/2018	Early	0	0	0	a
407	Red Top	T2S3	511942	4801675	3/23/2018	Early	0	0	0	a
408	Red Top	T2S4	512195	4801830	3/23/2018	Early	0	0	0	a
409	Red Top	T2S5	511806	4802067	3/23/2018	Early	0	0	0	a
410	Red Top	T2S6	511265	4802464	3/23/2018	Early	0	0	0	a
411	Red Top	T2S7	510934	4802607	3/23/2018	Early	0	0	0	a
412	Red Top	T2S10	511286	4801583	3/23/2018	Early	0	0	0	a
413	Red Top	T2S8	510474	4802380	3/23/2018	Early	0	0	0	a
417	Mosquito	T2S67	506360	4811647	3/23/2018	Early	0	0	0	a
418	Mosquito	T2S69	506053	4811414	3/23/2018	Early	0	0	0	a
419	Mosquito	T2S66	505690	4811726	3/23/2018	Early	0	0	0	a
420	Mosquito	T2S68	505546	4811518	3/23/2018	Early	0	0	0	a
421	Mosquito	T2S70	505721	4810942	3/23/2018	Early	0	0	0	a
422	Mosquito	T2S71	505644	4810422	3/23/2018	Early	0	0	0	a
424	Mosquito	T2S57	503812	4812238	3/28/2018	Early	0	0	0	a
425	Mosquito	T2S58	503564	4811565	3/28/2018	Early	0	0	0	a
426	Mosquito	T2S59	503645	4811176	3/28/2018	Early	0	0	0	a
427	Mosquito	T2S51	503393	4810961	3/28/2018	Early	0	0	0	a
428	Mosquito	T2S72	505696	4809868	3/28/2018	Early	0	0	0	a
429	Mosquito	T2S61	504783	4810499	3/29/2018	Early	0	0	0	a
430	Mosquito	T2S52	505173	4810756	3/29/2018	Early	0	0	0	a
431	Mosquito	T2S60	504146	4810896	3/29/2018	Early	0	0	0	a
432	Mosquito	T2S62	504483	4811235	3/29/2018	Early	0	0	0	a
433	Mosquito	T2S65	504873	4811584	3/29/2018	Early	0	0	0	a
434	Mosquito	T2S64	505025	4812049	3/29/2018	Early	0	0	0	a
435	Butler N	T2S13	511069	4805065	3/30/2018	Early	0	0	0	a
436	Butler N	T2S14	511556	4805264	3/30/2018	Early	0	0	0	a
437	Butler N	T2S15	511686	4804880	3/30/2018	Early	0	0	0	a
439	Resor North	T2S16	511730	4807666	4/1/2018	Early	0	0	0	a
443	Mosquito	T2S56	503286	4811939	4/3/2018	Early	0	0	0	a
445	Mosquito	T2S54	502787	4811567	4/3/2018	Early	0	0	0	a
446	Mosquito	T2S53	502481	4811603	4/3/2018	Early	0	0	0	a
447	Mosquito	T2S40	505142	4809529	4/4/2018	Early	0	1	0	a
448	Mosquito	T2S39	505655	4809358	4/4/2018	Early	0	1	0	a

449	Mosquito	T2S44	502755	4810984	4/3/2018	Early	0	0	0	a
450	Mosquito	T2S45	502249	4811128	4/3/2018	Early	0	0	0	a
451	Mosquito	T2S43	503667	4810404	4/4/2018	Early	0	0	0	a
452	Mosquito	T2S42	504180	4810178	4/4/2018	Early	0	0	0	a
453	Mosquito	T2S41	504643	4809873	4/4/2018	Early	0	1	0	a
457	Trail Creek	T2S21	507772	4814877	4/5/2018	Early	0	0	0	a
459	Butler N	T2S11	509966	4805183	4/6/2018	Early	0	0	1	a
460	Butler N	T2S12	510504	4804975	4/6/2018	Early	0	0	1	a
462	Red Top	T2S9	510930	4802021	4/10/2018	Early	0	0	0	a

Appendix 2. Locations of Automated Recording Units deployed in the late season in 2018 and associated raptors detected at each location (0 = no detection, 1 = detection, a = not possible during survey period, d = detection found opportunistically while listening for other species).

Deployment	General Location	Pt Num	UTM Lat	UTM Long	Start Date	Early_Late	GGOW	NOGO	BOOW	FLOW
485	Butler North	64 Flam 18	511822	4805231	5/15/2018	Late	d	a	a	0
486	Butler North	65 Flam 18	511708	4804882	5/15/2018	Late	a	a	a	0
487	Red Top	76 Flam 18	512088	4802324	5/14/2018	Late	d	a	a	1
488	Red Top	81 Flam 18	513220	4800474	5/14/2018	Late	a	a	a	0
489	Red Top	80 Flam 18	513030	4800738	5/14/2018	Late	a	a	a	0
490	Red Top	79 Flam 18	512733	4800845	5/14/2018	Late	a	a	a	0
491	Red Top	78 Flam 18	512528	4801175	5/14/2018	Late	a	a	a	0
492	Red Top	77 Flam 18	512327	4801395	5/14/2018	Late	a	a	a	0
493	Red Top	72 Flam 18	511871	4801728	5/14/2018	Late	d	a	a	0
494	Red Top	75 Flam 18	512132	4801790	5/14/2018	Late	d	a	a	0
495	Red Top	73 Flam 18	511745	4802091	5/14/2018	Late	a	a	a	0
496	Red Top	67 Flam 18	511299	4801569	5/14/2018	Late	a	a	a	0
497	Red Top	74 Flam 18	510978	4801851	5/14/2018	Late	a	a	a	0
498	Red Top	71 Flam 18	511213	4802469	5/14/2018	Late	a	a	a	0
499	Red Top	66 Flam 18	511549	4802662	5/14/2018	Late	a	a	a	0
500	Red Top	68 Flam 18	510940	4802198	5/14/2018	Late	a	a	a	0
501	Red Top	69 Flam 18	510466	4802332	5/14/2018	Late	a	a	a	0
502	Red Top	70 Flam 18	510856	4802672	5/14/2018	Late	d	a	a	0
503	Butler North	61 Flam 18	510691	4804911	5/21/2018	Late	a	a	a	1
504	Butler North	59 Flam 18	510243	4804906	5/21/2018	Late	a	a	a	1
505	Butler North	60 Flam 18	509964	4805182	5/21/2018	Late	a	a	a	1
506	Butler North	62 Flam 18	510941	4805112	5/21/2018	Late	a	a	a	1
507	Butler North	63 Flam 18	511393	4805222	5/21/2018	Late	a	a	a	1
508	Butler North	58 Flam 18	511141	4804778	5/21/2018	Late	a	a	a	0
511	Phillips	8 Flam 18	510701	4821092	5/23/2018	Late	a	a	a	0
512	Phillips	11 Flam 18	511022	4820777	5/23/2018	Late	a	a	a	0
513	Trail Creek	32 Flam 18	507555	4814976	5/23/2018	Late	a	a	a	0
514	Phillips	26 Flam 18	505660	4815834	5/23/2018	Late	a	a	a	0
515	Phillips	25 Flam 18	505311	4815885	5/23/2018	Late	a	a	a	0
516	Phillips	27 Flam 18	504729	4815868	5/23/2018	Late	a	a	a	0
518	Trail Creek	34 Flam 18	507469	4814636	5/22/2018	Late	a	a	a	0
519	Trail Creek	33 Flam 18	507878	4815043	5/22/2018	Late	a	a	a	0
520	Trail Creek	31 Flam 18	507322	4815407	5/22/2018	Late	a	a	a	0
521	Trail Creek	29 Flam 18	507613	4815783	5/23/2018	Late	a	a	a	0
522	Phillips	10 Flam 18	511043	4821412	5/29/2018	Late	a	a	a	0
523	Phillips	9 Flam 18	511119	4822014	5/29/2018	Late	a	a	a	0
524	Phillips	18 Flam 18	509335	4819134	5/30/2018	Late	a	a	a	0
525	Phillips	15 Flam 18	508925	4818827	5/30/2018	Late	a	a	a	0
526	Phillips	16 Flam 18	508548	4818537	5/30/2018	Late	a	a	a	0
527	Phillips	17 Flam 18	508009	4818379	5/30/2018	Late	a	a	a	0

528	Phillips	4 Flam 18	508158	4820357	5/30/2018	Late	a	a	a	0
529	Phillips	1 Flam 18	507699	4820381	5/30/2018	Late	a	a	a	0
530	Phillips	2 Flam 18	507912	4820019	5/30/2018	Late	a	a	a	0
531	Phillips	3 Flam 18	508249	4819927	5/30/2018	Late	a	a	a	0
532	Phillips	5 Flam 18	508742	4820229	5/30/2018	Late	a	a	a	0
533	Phillips	12 Flam 18	510945	4820389	5/30/2018	Late	a	a	a	0
534	Phillips	13 Flam 18	510618	4820161	5/30/2018	Late	a	a	a	0
535	Phillips	14 Flam 18	510228	4819891	5/30/2018	Late	a	a	a	0
536	Phillips	21 Flam 18	509671	4819562	5/30/2018	Late	a	a	a	0
537	Resor North	57 Flam 18	511729	4807716	5/24/2018	Late	a	a	a	0
538	Resor North	56 Flam 18	511779	4807434	5/24/2018	Late	a	a	a	0
539	Phillips	6 Flam 18	509727	4820639	5/30/2018	Late	a	a	a	0
540	Phillips	7 Flam 18	510178	4820859	5/30/2018	Late	a	a	a	0
541	Phillips	30 Flam 18	506393	4816375	6/5/2018	Late	a	a	a	0
542	Phillips	24 Flam 18	506615	4816787	6/5/2018	Late	a	a	a	0
543	Phillips	23 Flam 18	506773	4817114	6/5/2018	Late	a	a	a	0
544	Phillips	22 Flam 18	507014	4817496	6/5/2018	Late	a	a	a	0
545	Phillips	20 Flam 18	507293	4817886	6/5/2018	Late	a	a	a	0
546	Phillips	19 Flam 18	507532	4818194	6/5/2018	Late	a	a	a	0
547	Phillips	28 Flam 18	507909	4816514	5/31/2018	Late	a	a	a	0
548	Trail Creek	35 Flam 18	507900	4814618	5/31/2018	Late	a	a	a	0
549	Mosquito	46 Flam 18	504177	4810831	6/8/2018	Late	a	a	a	0
550	Mosquito	45 Flam 18	504447	4811214	6/8/2018	Late	a	a	a	0
551	Mosquito	40 Flam 18	504255	4812060	6/8/2018	Late	a	a	a	0
552	Mosquito	41 Flam 18	503782	4812092	6/8/2018	Late	a	a	a	0
553	Mosquito	48 Flam 18	504582	4810614	6/8/2018	Late	a	a	a	0
554	Mosquito	39 Flam 18	504915	4812032	6/8/2018	Late	a	a	a	0
555	Mosquito	38 Flam 18	504855	4811564	6/8/2018	Late	a	a	a	0
556	Mosquito	49 Flam 18	505151	4810693	6/8/2018	Late	a	a	a	0
557	Mosquito	47 Flam 18	504810	4810062	6/8/2018	Late	a	a	a	0
558	South Fall Creek	82 Flam 18	515296	4797811	6/12/2018	Late	a	a	a	0
559	South Fall Creek	83 Flam 18	515159	4797908	6/12/2018	Late	a	a	a	0
560	Mosquito	55 Flam 18	505846	4809590	6/8/2018	Late	a	a	a	0
561	Mosquito	54 Flam 18	505805	4810187	6/8/2018	Late	a	a	a	0
562	Mosquito	53 Flam 18	505784	4810741	6/8/2018	Late	a	a	a	0
563	Mosquito	52 Flam 18	506012	4811201	6/8/2018	Late	a	a	a	0
564	Mosquito	51 Flam 18	505571	4811402	6/8/2018	Late	a	a	a	0
565	Mosquito	50 Flam 18	506060	4811607	6/8/2018	Late	a	a	a	0
566	Mosquito	36 Flam 18	502858	4812343	6/12/2018	Late	a	a	a	0
567	Mosquito	43 Flam 18	503238	4811991	6/12/2018	Late	a	a	a	0
568	Mosquito	42 Flam 18	503536	4811608	6/12/2018	Late	a	a	a	0
569	Mosquito	44 Flam 18	503779	4811249	6/12/2018	Late	a	a	a	0
570	Mosquito	37 Flam 18	503278	4811050	6/12/2018	Late	a	a	a	0
571	Red Top	72 Flam 18	511858	4801722	6/14/2018	Late	a	a	a	1
576	Red Top	77 Flam 18	512356	4801370	6/21/2018	Late	a	a	a	0

GOLDEN EAGLE LEAD INGESTION IN THUNDER BASIN NATIONAL GRASSLAND

2018 Annual Report

Project Collaborators:

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Statement of Study Purpose & Objectives:

It has been well established from many studies that raptors are poisoned from ingesting lead fragments that remain in gutpiles of big-game that are harvested with lead-based bullets. Several studies have directly linked lead exposure from this source to California Condors, Bald Eagles, Golden Eagles, and Common Ravens. While the connection between lead-based ammunition for big-game hunting and blood lead levels in raptors is well established, there are several other sources of hunting for which data are lacking, including upland game and varmint hunting.

The Thunder Basin National Grasslands (TBNG) in eastern Wyoming hosts large populations of black-tailed prairie dogs, Golden Eagles, and Ferruginous Hawks. Because of several management objectives, the TBNG has been closed to prairie dog shooting for over ten years. In 2017, TBNG temporarily lifted hunting restrictions in order to reduce prairie dog populations for the year. Shooting was anticipated to continue in 2018, however there was a boubonic plague outbreak which lead to shooting being restricted for the year as well as a large decline in the prairie dog populations. Shooting prairie dogs in TBNG provides a unique opportunity to investigate the lead exposure risk from prairie dogs to nestling eagles and hawks in Wyoming, with a few key objectives, most of which are dependent on the shooting ban being lifted:

- Determine the extent to which nestling raptors are exposed to lead from recreation prairie dog shooting in TBNG
- Understand the lead fragmentation rates in shot prairie dogs
- Determine bi-monthy rates of lead ingestion through feather deposition and blood lead levels
- Examine the liklihood that lead ammunition collected from from prairie dogs is the source of eleveated blood lead levels in nestlings using stable lead isotopic analysis
- Relative nesting density in Thunder Basin in relation to prairie dog colonies
- Asses the effect of plague on the prairie dog colonies and look at population rebound

Results

In 2018 we conducted early season surveys in February looking for territory occupancy and searching for nests prior to spring leaf-out. Many eagles were observed on territory at that time, with copulation seen on two seperate occations. In 2017, we checked a total of 33 territories, both historical and new, to determine activity and climbability. We were able to add onto our existing work and check a total of 53 territories in 2018 with primary observers being Nathan Hough, Bryan Bedrosian, and Allison Swan (TRC) with significant logistical help from Tim Byer (FS) (Figure 1).

There were no new nest or nestling samples of any species added to the study in 2018. While most of the territories were occupied, there were only two confirmed nesting attempts which resulted in incubation. Since there were only two active nests in the study area and no prairie dog shooting, we did not collect any samples or continue to monitor the two active nests.

Late summer through winter of 2017 there was a plague outbreak in the Thunder Basin Black-tailed prairie dog colonies. Compared to the the thousands of prairie dogs seen in 2017 scattered over vast colonies, we observed single digit numbers on a small portion of their previous extent in 2018. Likely due this crash in prairie dog numbers, there was a matching decline in eagle reproduction. The only two nests that initiated incubation were at their closest 2.5 km from any prairie dog colonies, but nearly 20 km from the main colonies where plague we most impactful (Figure 1). It is probable that the two active nests in 2018 rely on food sources besides prairie dogs even in high prairie dog years due to their distance from any colony.

Future Work

The shooting ban is forcasted to continue during the 2019 nesting season due to the plague outbreak in order to continue increasing prairie dog population sizes. We are planning a more extensive search of the study site for nests in the 2019 season. We will conduct ground-based searches and work with local mining companies to increase the number of nests sampled.

If the shooting ban is lifted in 2019, we plan to continue collecting prairie dogs for x-ray, retrival of possible lead fragments, and, if lead-based, lead isotope analysis. One question that arose from the 2017 data is how blood lead levels correlate to lead deposition in feathers. In 2018 we had almost no reproduction and no prairie dog shooting, therefore we were unable to look at this question. It is highly unlikely that pairie dog pupulaitons will rebound enough to lift the shooting ban in 2019 to continue the lead portion of this study. However, over the past two years, we have begun gathering enough data on nesting territory locaitons and productivity, we feel it is warrented to continue monitoring nesting density and fecudity in this population as it relates to prey resources. There are few areas in the West such as TBNG with the historical data associated with Golden Eagle abundance and prey resources. Observing the significant decline in nesting rates in 2018 in response to low prey numbers, an opportunity exists to further our knowledge on eagle/prey relationships as prairie dog numbers slowly rebound. One additional objective we will add in 2019 is prairie dog and jackrabbit surveys to asses the health of the populations in the recovery period after a plague outbreak, and hopefully relate the rebound of prairie dog populations with a rebound in Golden Eagle reproductive success.

Data Access

Data on nests visited, location, nest status, and productivity (when known) will be provided to the Forest Service managers at Thunder Basin National Grasslands.

Figure 1: All territories observed active in 2017 and 2018, nests banded in 2017, active nests in 2018, and prairie dog colonies as of 2017 before the plague outbreak