

# Coordinated Statewide Flammulated Owl Survey



Final Report

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Cover photograph by Bill Schmoker



## Abstract

The Flammulated Owl (*Psiloscoops flammeolus*) is a small, insectivorous, neo-tropical migrant owl that breeds in the forested habitats of western North America. In Wyoming, the Flammulated Owl has been designated as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department because its distribution and population status are largely unknown in the state. Breeding season records of the Flammulated Owl in Wyoming were limited to a small area of the western slope of the Sierra Madre Mountains prior to 2016, when surveys by the Teton Raptor Center (TRC) documented an estimated 23 nesting territories around Jackson Hole. In 2019, TRC and the Wyoming Natural Diversity Database implemented the coordinated statewide survey described in this report to improve understanding of the species' range and distribution in Wyoming. We developed a deductive model of potential habitat that we used together with expert opinion to select sample areas, which we surveyed using a combination of nocturnal callback routes and automated recording units. From mid-May through June, 2019 we surveyed a total of 718 points across Wyoming and deployed 9 acoustic recorders at locations with positive callback detections. We detected Flammulated Owls at 33 (4.6%) points surveyed, with an average of 1.2 individuals at points with detections. Results from this survey suggest Flammulated Owls are considerably more widespread in Wyoming than previous known. We documented multiple individuals across the western, central, and southern portions of the state, including five mountain ranges where the species had not previously been detected during the breeding season: the Absaroka, Laramie, Medicine Bow, Wind River, and Wyoming ranges. We did not detect Flammulated Owls in the Bighorn Mountains, but effort was limited there and further surveys are justified. Habitat surrounding new detections of Flammulated Owls was broadly similar to historical records, with the majority of locations associated with aspen woodlands or mixed-conifer forests with an aspen component. Our results expand the known range of the Flammulated Owl by >150 km and suggest this species could breed throughout most of Wyoming's mountain ranges. Results from this study will be useful to guide future monitoring efforts, refine habitat models, and inform species status rankings and management of the Flammulated Owl in Wyoming.

## Introduction

The Flammulated Owl (*Psiloscoops flammeolus*) is a small, nocturnal cavity-nesting owl that occurs in forested habitats of western North America. The status of Wyoming's Flammulated Owl population is largely unknown. Accordingly, it is designated as a Species of Greatest Conservation Need (SGCN) with a Native Species Status rank of Unknown (NSSU, Tier III) in the State Wildlife Action Plan (Wyoming Game and Fish Department 2017). The Flammulated Owl is also included on the Sensitive Species lists for both U.S. Forest Service (USFS) Regions in Wyoming (2 and 4) and classified as a Species of Special Concern in Canada (COSEWIC 2010). The Partners In Flight (PIF) Western Working Group has designed Flammulated Owl a priority species and recommended a west-wide inventory and regional monitoring plan (Neel and Sallabanks 2009).

Historically, there were only a small number of occurrence records for Flammulated Owl in Wyoming (Faulkner 2010). Most range maps did not classify the state as breeding habitat and prior to 2016 breeding-season records were limited to a small area on the western slope of the Sierra Madre Mountains near the border with Colorado. The breeding population in the Sierra Madre was discovered in 2005 when a joint effort between the Rocky Mountain Bird Observatory and Audubon Wyoming documented 10 singing males and 1 occupied nest (Faulkner 2010). In 2012, the Wyoming Natural Diversity Database (WYNDD) conducted surveys in areas of the Medicine Bow National Forest adjacent to the known range and detected Flammulated Owls at 2 sites (I. Abernethy, WYNDD, unpublished data). From 2016–2018, the Teton Raptor Center expanded the known range in Wyoming to include the area around Jackson Hole by conducting nighttime callback surveys and deployments of automated recording units (ARUs) that resulted in 35 detections from an estimated 23 nesting territories (Bedrosian 2016, B. Bedrosian unpublished data). These efforts revealed that the Flammulated Owl occurred in areas of Wyoming contiguous with its known distribution in adjacent states. However, prior to this study, no broad-scale surveys had been conducted to clarify the breeding distribution of the Flammulated Owl across Wyoming.

The Flammulated Owl is one of the only neotropical migrant owls and is therefore unlikely to be detected during surveys for other owl species that are typically conducted before its arrival from spring migration. Flammulated Owls generally return to the Northern Rockies in early May (Linkhart and McCallum 2013), while most owl surveys are completed by mid-March. Although their later phenology requires dedicated surveys, detection rates of Flammulated Owls are high when callback surveys are conducted during the courtship and incubation period under suitable field conditions (Barnes and Belthoff 2008).

Flammulated Owl habitat typically consists of Douglas fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) forests with large, older-aged trees, and open stand structures, often adjacent to mature aspen (*Populus tremuloides*) where these insectivorous owls find prey and nesting cavities (Reynolds et al. 1992, Hayward 1994, Carlisle and Stuber 2010). The majority of records for Flammulated Owls in adjacent states are from forests dominated by ponderosa pine and Douglas fir, but recent data from Wyoming documented the species in

lodgepole pine (*Pinus contorta*), aspen, and spruce-fir (*Picea engelmannii*, *Abies lasiocarpa*) forests (B. Bedrosian unpublished data). These forest types are increasingly at risk in Wyoming due to a range of factors, including insect outbreaks, disease, drought, and wildfire.

To address the need for information on the distribution of the Flammulated Owl in Wyoming, we developed a statewide deductive model of potential habitat that we used together with expert opinion on habitat and accessibility to select a sample of survey areas. We then surveyed these areas during the detectable period for the species using nocturnal callback routes and verified a subset of positive detections with ARUs.

### *Objectives*

1. Develop a statewide model of potential nesting habitat for Flammulated Owl based on scientific literature and existing models.
2. Select a sample of survey locations based on the model and expert opinion.
3. Conduct nighttime callback surveys at selected sites from May–June, 2019, verifying detections at a subset of sites using ARUs.
4. Use detections to determine where nesting populations may occur.
5. Assess effectiveness of current survey protocols based on callback and ARU results.
6. Evaluate habitat associations of Flammulated Owl to refine deductive models of potential nesting habitat across Wyoming.
7. Provide results and data to inform conservation planning and ranking of the Flammulated Owl in Wyoming.

## Methods

### *Habitat model*

To inform selection of survey sites, we developed a deductive habitat suitability model for the Flammulated Owl across Wyoming. We began by reviewing the literature for information on habitat use, with an emphasis on similar montane habitats in adjacent areas of Colorado, Idaho, Montana, and Utah. From this information and existing habitat suitability models, we created a preliminary model of potential nesting habitat for Wyoming. First, we compared the vegetation categories included in a habitat suitability model created for Wyoming in 2011 by WYNDD (Aycrigg et al. 2015) and a range-wide model created in 2013 by the U.S. Geological Survey Gap Analysis Program (USGS-GAP 2017). We then combined the vegetation classes included in these models using an updated version of the vegetation classification data (LANDFIRE 2016), added vegetation classes with Flammulated Owl records from Teton Raptor Center (TRC) and WYNDD that were not included in previous models, and excluded some vegetation classes that resulted in questionable predictions of potential habitat in low-elevation areas (Table 1). The resulting model was intentionally broad and included substantial areas of montane habitat in all mountain ranges in the state (Figure 1). Unlike previous habitat suitability models, we did not clip the extent of predictions to the suspected range of the species. While this likely resulted in predictions outside the actual range, it was appropriate for our goal of understanding the species' distribution by exploring areas of potentially suitable habitat outside its known range. After

conducting surveys in 2019, we extracted the majority LANDFIRE vegetation class within a 300-m radius around the estimated locations of Flammulated Owls and compared them to the vegetation classes included in the preliminary habitat suitability model.

### *Site selection*

We used the preliminary habitat suitability model and expert opinion to select potential locations for surveys. Because little was known about Flammulated Owl habitat in Wyoming and habitat preferences may vary across a species' range, we developed a broad-based model and selected survey sites in diverse habitats. We defined our sample frame as all Public Land Survey System (PLSS) townships (approximately 36 mi<sup>2</sup> or 93 km<sup>2</sup>) with >20% area classified as potential habitat, which we judged to be the minimum amount of habitat necessary to justify the effort of traveling to a survey location. We excluded the Black Hills because our survey effort was limited and it was the farthest region from known locations of Flammulated Owls. We initially excluded the Bighorn Mountains for the same reason, but volunteers and added staff time enabled us to conduct a limited survey effort there. Additionally, we excluded the Wind River Indian Reservation because we did not hold permits to survey on tribal lands.

We used our habitat suitability model, sample frame of townships, review of literature on habitat associations, and knowledge of road access to select priority areas for surveys in consultation with USFS wildlife biologists. Given the lack of knowledge on habitat associations and distribution of the Flammulated Owl in Wyoming, we chose survey sites by expert opinion to increase our odds of detecting owls. The goal of our project was to survey as broad an area as possible, so we primarily sampled areas that field personnel could directly access with motor vehicles.

### *Survey methods*

Survey methods followed the PIF Flammulated Owl Survey Protocol (Fylling et al. 2010). This protocol recommends conducting surveys from May 15–June 30, corresponding to the courtship and incubation period of Flammulated Owls in the northwestern U.S. and central Rockies. During this period, detection rates of Flammulated Owls are nearly 100% under ideal survey conditions (Barnes and Belthoff 2008). We scouted survey routes in daylight to assess accessibility and habitat, began surveys 30 minutes after sunset, and surveyed an average of approximately 4 hours per night. Most surveys were conducted with motor vehicles from roads, but in some cases we accessed trails on foot or with all-terrain vehicles. To cover a larger area, we increased the spacing of survey points to 600 m, based on twice the maximum distance Flammulated Owls are known to travel in response to call playback (Linkhart et al. 1998). Each 10-minute point survey was divided into 5 2-minute intervals, beginning with 1 interval of silent listening, followed by 4 intervals that each consisted of a 30-second broadcast of the territorial male hoot and 1.5 minutes of listening. We did not survey in constant precipitation or when wind speeds exceeded 10 mph.

To maximize efficiency and reduce travel costs, we divided the state into two regions. Teton Raptor Center field personnel conducted surveys in the northwestern region (NW), including the

Wyoming, Wind River, Teton, Absaroka, Owl Creek, and northern Bighorn Mountain Ranges, with help from Katy Duffy to survey the northern Yellowstone Plateau. The WYNDD field personnel surveyed the southeastern region (SE), including the Laramie, Medicine Bow, and Sierra Madre Mountain Ranges, with help from Zach Hutchinson (Audubon Rockies) in the northwestern Laramie Range and C.J. Grimes (Canyon Wren Consulting) in the southern Bighorn Mountains. We deployed ARUs at a sub-set of the survey locations where Flammulated Owls were detected to provide confirmation of detections from callback surveys.

We recorded only basic habitat data because the goal of our survey was to rapidly sample a large area. Accordingly, vegetation data collected were limited to the dominant or co-dominant tree species and ocular estimates of average diameter at breast height (DBH).

As part of a concurrent study, we deployed ARUs at 45 locations to survey for Flammulated Owls in the Jackson Hole valley during 2019 (Bedrosian 2019). This study was designed to assess presence or absence of Flammulated Owls in forest treatment areas on the western edge of Jackson Hole in the Bridger-Teton National Forest, where TRC has been conducting surveys with a mixture of ARUs and nighttime callback surveys since 2017. The survey points were not based on suspected habitat, but rather designed to completely survey treatment areas with ARU locations a minimum of 600 m apart.

## Results

From May 15 to June 29, 2019 we surveyed a total of 718 points across Wyoming (509 in the NW and 209 in the SE region), covering portions of 133 townships (NW: 96, SE: 37), and deployed 9 acoustic recorders at locations with positive callback detections (NW: 3, SE: 6; Figure 2). We detected Flammulated Owls at 33 (4.6%) points and 20 (14.9%) townships surveyed (Figure 2). The percentage of points with detections was greater in the SE survey region (11%) compared to the NW region (2%). We counted an average of 1.2 individuals at points where Flammulated Owls were detected, including 25 points with 1 individual and 8 points with 2 individuals. We detected Flammulated Owls in five mountain ranges where the species had not previously been documented during the breeding season: the Absaroka, Laramie, Medicine Bow, Wind River, and Wyoming ranges. We did not detect Flammulated Owls in the Bighorn Mountains, but only conducted opportunistic surveys of a limited area near the end of the survey period.

Estimated detection distances averaged 399 m (range: 50–800 m, SD: 213 m). Detections of Flammulated Owls occurred during all 2-minute intervals of the 10-minute survey period (Figure 4), with the fewest (9%; 3 detections) in the first interval during which surveyors listened without broadcasting calls, and the most in the third interval (34%; 11 detections) following the second call broadcast. Recordings made during surveys with handheld recorders and with ARUs deployed at sites helped confirm species identifications.

Forest habitats used by Flammulated Owls were broadly consistent with the types included in our preliminary model. Vegetation classes within a 300-m radius of estimated locations of

Flammulated Owls were dominated by two types of aspen woodlands and included other forest and shrubland vegetation types (Table 2). We did not revise our deductive habitat suitability model based on results of the survey because the vegetation classes for the majority of new Flammulated Owl detections were already included in the preliminary model. Several observations mapped to shrubland vegetation types that were not included in the model and are not typically associated with Flammulated Owl habitat. This was likely due to errors in available vegetation data layers or estimated distances and azimuths from our survey. Thus, to avoid spurious predictions we did not add these shrubland vegetation types to the model. Based on vegetation data collected in the field, 24 (73%) of points where at least one Flammulated Owl was detected had aspen as a dominant or co-dominant tree species. The most common tree species occurring with aspen were Douglas fir and lodgepole pine, and sites without aspen (27%) were dominated by ponderosa pine or lodgepole pine, the latter co-dominant with Engelmann spruce or sub-alpine fir. Average DBH of trees at sites with Flammulated Owls was relatively small ( $\leq 10$  inches DBH at 72% of sites) or medium (10–20 inches at 28%).

In addition to Flammulated Owls, we detected 5 other owls species and 2 nightjar species during surveys: 3 Boreal Owls (*Aegolius funereus*), 1 Eastern Screech Owl (*Megascops asio*), 13 Great Horned Owls (*Bubo virginianus*), 4 Long-eared Owls (*Asio otus*), 34 Northern Saw-whet Owls (*Aegolius acadicus*), 8 unidentified owls, 17 Common Nighthawks (*Chordeiles minor*), and 22 Common Poorwills (*Phalaenoptilus nuttallii*) (Table 3).

During the 2019 ARU surveys in Jackson Hole, we detected Flammulated Owls at 9 (20%) of survey locations. However, three detections were at locations directly adjacent to other positive detection locations. Therefore, we conservatively estimated that a total of 6 unique territories were detected (Bedrosian 2019).

## Discussion

Results from this survey suggest Flammulated Owls are considerably more widespread in Wyoming than previous known. In 2019, we documented multiple individuals across the western, central, and southern portions of the state, including five mountain ranges where the species had not previously been detected during the breeding season. Our initial results expand the known range of the Flammulated Owl by  $>150$  km and suggest this species could breed throughout most of Wyoming's mountain ranges.

In the southeastern region of the state, we detected numerous Flammulated Owls within and adjacent to their known range in the Sierra Madre Mountains, as well as in the western portion of the Medicine Bow Mountains, where they were not previously known to occur. We detected Flammulated owls on two occasions in the central Laramie Range near Esterbrook in the same township as a historical observation recorded October 29, 1969 and previously assumed to be a migrant. The detection on Casper Mountain further expands the known distribution of the Flammulated Owl to the western extent of the Laramie Range.

In the northwestern region, we focused on surveying townships outside of Jackson Hole since surveys have documented many Flammulated owls there in the past four years. We detected Flammulated Owls on the southeastern end of the Wind River Range, southern end of the Wyoming Range, Hoback, Upper Green, western edge of the Owl Creek Mountains, and in the Absarokas west of Cody. We did not detect any Flammulated Owls during surveys of the northern, southern, and central portions of Yellowstone National Park or in the Bighorn Mountains. However, we conducted only a small number of surveys in the Bighorn Mountains and did not cover the range well enough to infer absence. In 2016 and 2017, TRC surveyed deductively predicted habitat in the Jackson Hole region using the callback method. From 179 locations surveyed in 2016–2017, we detected Flammulated Owls at 53 locations, from at least 29 different territories (Bedrosian 2016, 2017). In 2017, we detected owls at 8 (80%) of territories located in 2016. Within the Bridger-Teton forest treatment areas surveyed with ARUs from 2017–2019, we found a re-occupancy rate of 50% from 2017 to 2018. Of 2019 ARU locations that overlapped any previous territory from 2016–2018, 50% were re-occupied (Bedrosian unpublished data). These results suggest both short- and long-term variability in territory re-occupancy rates in western Wyoming.

Habitat surrounding new detections of Flammulated Owls was similar to historical records, with the majority of locations associated with aspen woodlands or mixed-conifer forests with an aspen component. We detected 3 Flammulated Owls in ponderosa pine forest, a habitat strongly associated with this species elsewhere in its range (Reynolds et al. 1992), but where it had not previously been recorded in Wyoming. We did not collect detailed habitat measurements because the goal of our study was to rapidly inventory a large area for owls. Nonetheless, the basic ocular vegetation data we collected supported the importance of aspen as a dominant or co-dominant tree species at the majority of sites. The most common tree species co-occurring with aspen were Douglas fir and lodgepole pine, while sites without aspen were dominated by ponderosa pine or lodgepole pine. Ponderosa pine occurred in single-species stands, while lodgepole pine was commonly co-dominant with Engelmann spruce or sub-alpine fir. Contrary to our expectations based on available literature, we detected several Flammulated Owls in forest stands consisting almost entirely of lodgepole pine. Further research is necessary to understand if Flammulated Owls were nesting in lodgepole pine stands, or if these stands included components of aspen or other cavity-forming tree species that were not within view of the survey point. We also recorded Flammulated Owls in pure aspen stands surrounded by sagebrush (*Artemisia* spp.) in valley and mountain foothills settings, which was opposed to our expectation that Flammulated Owls would use aspen primarily as a component of mixed-conifer forests in montane settings. Future survey efforts should collect more detailed vegetation data at used and available locations to better document habitat selection of this species in Wyoming.

Detections of Flammulated Owls occurred throughout the 10-minute survey period (Figure 4). The most detections occurred during the middle 2-minute interval of the count period (34%); however, a considerable proportion of detections occurred during the final 2-minute interval (22%). We had considered shortening the 10-minute survey period to increase the efficiency of our effort, but the high number of detections recorded in the final interval suggested the 10-

minute survey duration was warranted. We did not directly compare detection efficiency between callback surveys and ARUs. Due to the lack of knowledge on the distribution of Flammulated Owls in Wyoming, we focused this study on a targeted inventory over a broad area. Given that objective, we did not think it was worth our effort to deploy ARUs in areas where owls had not been detected. Instead, we deployed a limited number of recorders to confirm species identifications at sites where Flammulated Owls were detected. Once the distribution and habitat of this species have been clarified in Wyoming, ARUs could be used to monitor trends in breeding territory occupancy and survey new areas of likely habitat, as demonstrated by TRC for other forest owl species (e.g., Bedrosian 2019).

Survey conditions during the 2019 field season were challenging due to an unusually late spring with high snow pack and heavy rains. These conditions limited our access to mountain roads and resulted in loud background noise from rivers and creeks at many survey points. We had to delay surveys by several weeks and reduce our effort accordingly. Snow limited access to many roads across western Wyoming throughout the entire survey period. Thus, while our detections of Flammulated Owls significantly expand the known range and number of records for the state, survey points without detections should not be interpreted to indicate absence. Moreover, the low intensity of sampling over a broad area and expert opinion-based selection of sample units make it impossible to determine absence of the species from any township or mountain range where it was not recorded. Areas with potentially suitable habitat, but no detections include the Uinta Mountains, most of the Laramie Range, most of the Wyoming Range, eastern slope of the Wind River Range, Bighorn Mountains, much of the area around Dubois, western edge of the Teton Range and Yellowstone Plateau, and northern range of Yellowstone National Park. Detections in the Laramie Range and Absarokas suggest surveys are warranted in the neighboring Bighorn Mountains and Black Hills.

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Table 1. Vegetation classes (LANDFIRE 2016) considered for inclusion in a deductive habitat suitability model for the Flammulated Owl in Wyoming. Shown are the number of historical Flammulated Owl records in each vegetation class prior to this study and from this study; whether each class was included in habitat suitability models by USGS-GAP (2017), WYNDD (Aycrigg et al. 2015), and the model created for this study; and the percent contribution of each vegetation class to the model for this study (pixels per class/total pixels). Grey shading indicates vegetation classes included in habitat suitability models and/or with owl records.

Vegetation class	Flammulated Owl records (N)		Habitat suitability models			Contribution (%)
	Historical	This study	GAP	WYNDD	This study	
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	≥ 1	2	Yes	No	Yes	22.4
Rocky Mountain Lodgepole Pine Forest	2	4	Yes	No	Yes	13.7
Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	0	0	No	Yes	Yes	10.4
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	0	1	Yes	Yes	Yes	8.8
Rocky Mountain Aspen Forest and Woodland	54	12	Yes	Yes	Yes	7.6
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	3	0	No	No	Yes	4.9
Xeric Montane Douglas-fir Forest	9	2	No	No	Yes	4.9
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	6	8	Yes	No	Yes	4.9
Southern Rocky Mountain Ponderosa Pine Woodland	0	3	Yes	Yes	Yes	3.7
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	1	1	Yes	Yes	Yes	1.6
Rocky Mountain Poor-Site Lodgepole Pine Forest	0	0	No	Yes	Yes	1.3
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	0	0	Yes	Yes	Yes	0.3
Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland	0	0	Yes	Yes	Yes	0.1
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	0	0	Yes	No	Yes	0.0
Introduced Upland Vegetation-Annual Grassland	0	0	Yes	No	No	0.0
Western Great Plains Floodplain Forest and Woodland	0	0	Yes	No	No	5.5
Rocky Mountain Montane Riparian Forest and Woodland	1	0	Yes	No	No	4.0
Rocky Mountain Foothill Limber Pine-Juniper Woodland	0	0	Yes	No	No	3.6
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	0	0	Yes	Yes	No	0.9
Southern Rocky Mountain Ponderosa Pine Savanna	0	0	Yes	No	No	0.8

Vegetation class	Flammulated Owl records (N)		Habitat suitability models			Contribution (%)
	Historical	This study	GAP	WYNDD	This study	
Rocky Mountain Subalpine/Upper Montane Riparian Forest and Woodland	0	0	Yes	Yes	No	0.5
Colorado Plateau Pinyon-Juniper Woodland	0	0	Yes	No	No	0.2
Rocky Mountain Bigtooth Maple Ravine Woodland	0	0	Yes	No	No	0.0
Southern Rocky Mountain Pinyon-Juniper Woodland	0	0	Yes	No	No	0.0
Great Basin Pinyon-Juniper Woodland	0	0	Yes	No	No	0.0
Western Great Plains Dry Bur Oak Forest and Woodland	0	0	No	Yes	No	0.0
Inter-Mountain Basins Montane Sagebrush Steppe	≥ 1	0	No	No	No	0.0
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna *	na	0	Yes	Yes	No	0.0
Colorado Plateau Pinyon-Juniper Shrubland *	na	0	Yes	No	No	0.0
Introduced Riparian and Wetland Vegetation *	na	0	Yes	No	No	0.0
Western Great Plains Cliff and Outcrop *	na	0	No	Yes	No	0.0
Western Great Plains Riparian Woodland and Shrubland *	na	0	No	Yes	No	0.0

\* Vegetation class not included in current LANDFIRE version

Table 2. Vegetation classes (LANDFIRE 2016) within 300-m of the estimated locations of Flammulated Owls detected in 2019. Shrubland vegetation classes not included in deductive habitat suitability model are indicated with asterisks.

<b>Vegetation Class</b>	<b>Number of Detections</b>
Rocky Mountain Aspen Forest and Woodland	12
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	9
Artemisia tridentata ssp. vaseyana Shrubland Alliance *	4
Rocky Mountain Lodgepole Pine Forest	4
Southern Rocky Mountain Ponderosa Pine Woodland	3
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	2
Xeric Montane Douglas-fir Forest	2
Inter-Mountain Basins Big Sagebrush Shrubland *	1
Inter-Mountain Basins Big Sagebrush Steppe	1
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	1
Rocky Mountain Lower Montane-Foothill Shrubland *	1
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	1

Table 3. Detections by species from coordinated Flammulated Owl survey, 2019, including the number of individuals, points, and townships.

Species	Number of Detections		
	Individuals	Points	Townships
Flammulated Owl *	41	33	20
Boreal Owl	3	3	2
Eastern Screech Owl †	1	1	1
Great Horned Owl	14	13	12
Long-eared Owl	4	4	3
Northern Saw-whet Owl	35	34	20
Unidentified Owl	9	8	6
Common Nighthawk ‡	19	17	9
Common Poorwill	23	22	14

\* Includes detection by Audubon Rockies

† Opportunistic observation

‡ Includes only SE survey region

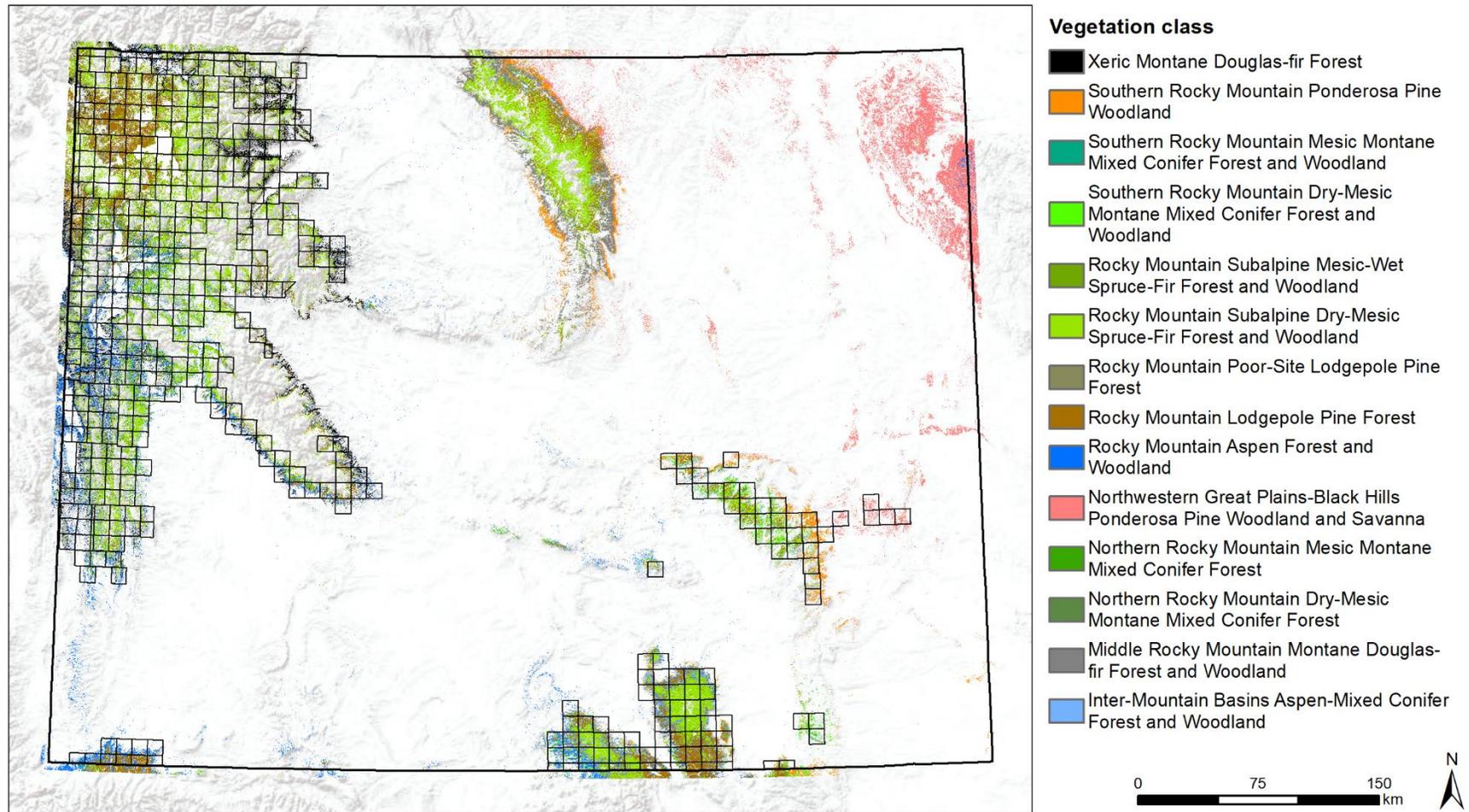


Figure 1. Potential Flammulated Owl habitat in Wyoming. Vegetation classes included in the deductive habitat suitability model are shown in colored shading and townships with >20% predicted habitat considered for sampling as black squares. This model was developed to guide surveys of potential habitat and is not intended to represent the actual distribution of the species.

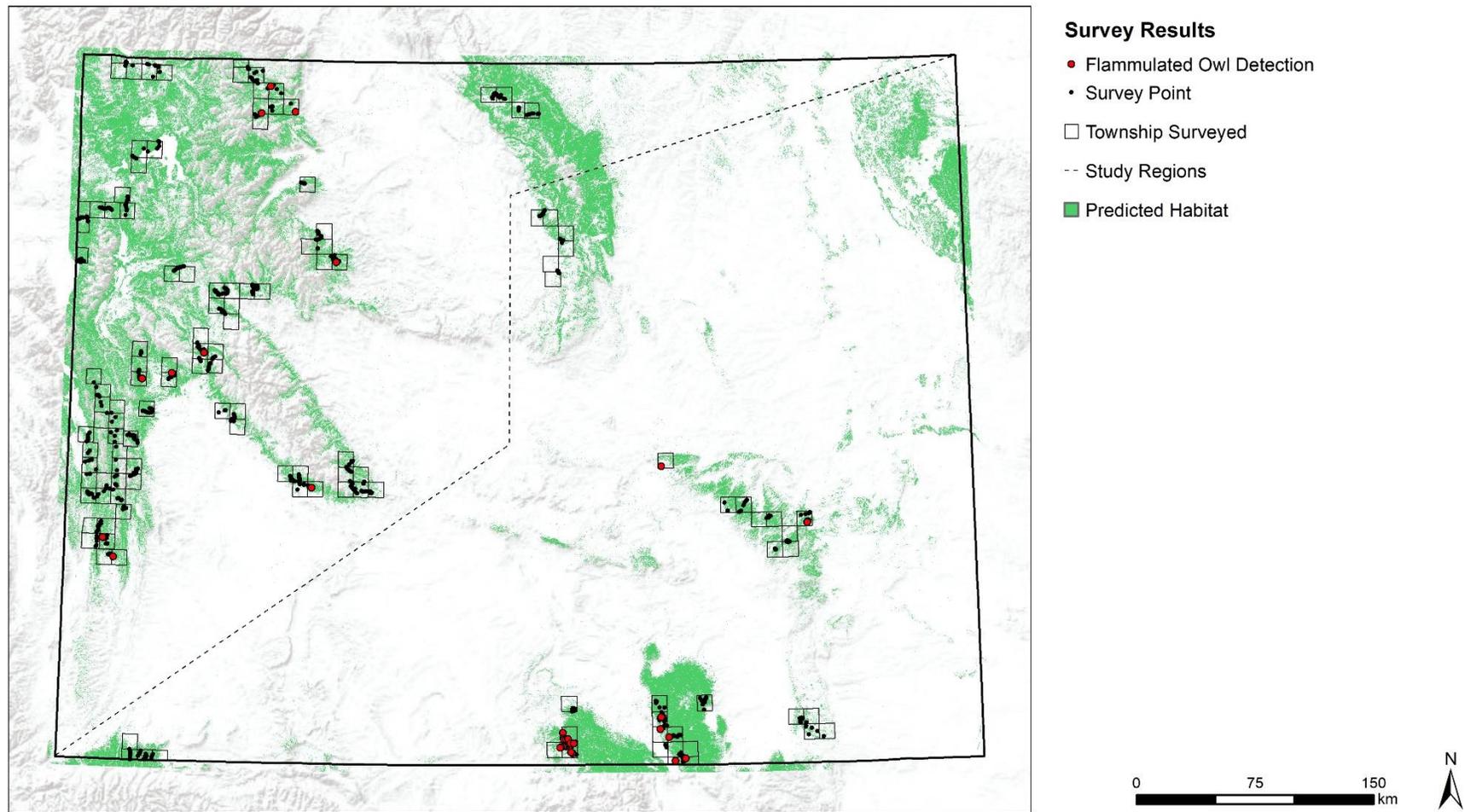


Figure 2. Results of coordinated Flammulated Owl survey, 2019. Shown are locations of Flammulated Owl detections, points and townships surveyed, boundary between northwestern and southeastern study regions, and predicted potential habitat.

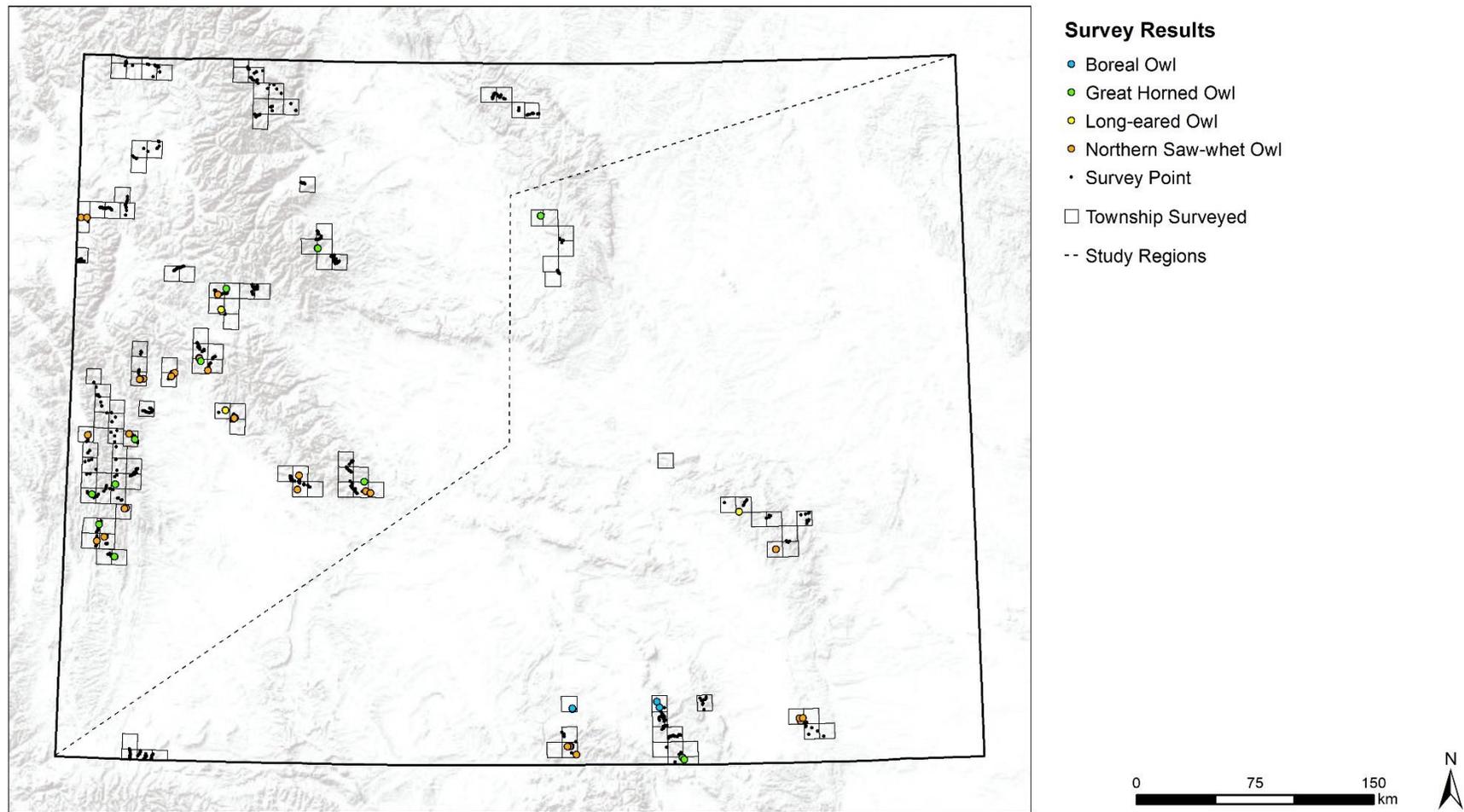


Figure 3. Locations of other owl species detected during coordinated Flammulated Owl survey, 2019. Shown are locations of detections by species, points and townships surveyed, and boundary between northwestern and southeastern study regions.

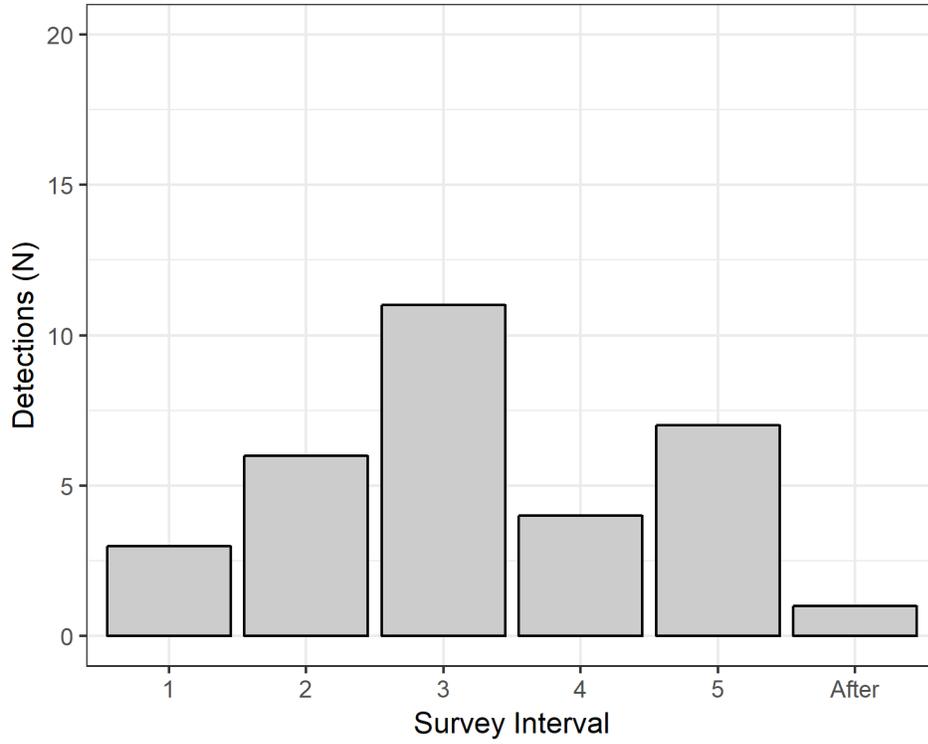


Figure 4. Number of Flammulated Owl detections by survey interval. Surveys consisted of 5 2-minute intervals, beginning with 1 interval of silent listening, followed by 4 intervals that each consisted of a 30-second call broadcast and 90 seconds of listening.