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INCREASING CAPTURE FREQUENCY FOR FLAMMULATED OWLS AND NORTHERN SAW-WHET OWLS DURING FALL MIGRATION

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Flammulated Owls (*Psiloscops flammeolus*) were once thought to be nonmigratory, but now are considered obligate medium- to long-distance migrants (Smith et al. 2012). Of all the North American Strigiforms, the Flammulated Owl has the longest migratory route (Johnsgard 2002), breeding as far north as British Columbia and wintering as far south as El Salvador (Linkhart and McCallum 2013). They are listed as a species of concern by most state and federal agencies within their breeding range, including as a Species of Greatest Conservation Need in Idaho (I.D.F.G. 2005, U.S.F.S. 2013). Little is known about their migratory patterns in the northern part of their range (Linkhart and McCallum 2013, Smith et al. 2012). Moreover, there is a lack of knowledge regarding their habitat use during migration (Reynolds and Linkhart 1984, Smith et al. 2012).

Mist nets with audio lures are the primary method used to capture Flammulated Owls during fall migration at most banding stations (Erdman and Brinker 1997, DeLong 2003). However, the influence of various factors, such as the distance of the nets from the audio lure and the net array design, has not been documented for Flammulated Owls (Whalen and Watts 1999). Here, we consider a method to potentially increase capture rates for the Flammulated Owl during fall migration, which could contribute to increasing our understanding of the species migratory ecology.

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METHODS

Our study area, Lucky Peak, is about 12 km east of Boise, Idaho, on the Boise Ridge. Lucky Peak (1845 m elevation, 43°36′N, 116°03′W) is the southern-most forested point of the Boise Ridge and is the last refuge to provide food and shelter to many woodland migrants before they cross the Snake River Plain. This topography combined with the habitat diversity at the site concentrates southbound migrant birds and provides a stopover site (e.g., Carlisle et al. 2004, Stock et al. 2006). Lucky Peak is located at the convergence of two major ecotones, montane forest of the Rocky Mountains and shrub-steppe of the Great Basin, and three major habitat types occur in a mosaic (Carlisle et al. 2012). On north- and east-facing slopes, Douglas-fir (*Pseudotsuga menziesii*) overstory with a mountain ninebark (*Physocarpus monogynus*) understory dominates. Shrub-steppe vegetation, primarily composed of big sagebrush (*Artemisia tridentata*), bitterbrush (*Purshia tridentata*), and rabbitbrush (*Chrysothamnus nauseosus*) dominates on south- and west-facing slopes. A third important habitat type, montane deciduous shrubland, composed of many deciduous species, but primarily bitter cherry (*Prunus emarginata*) and chokecherry (*Prunus virginiana*), occurs mostly at the interface between the coniferous forest and shrub-steppe.

Exploratory field efforts, net locations, and methods varied during 1998–2000, but we established a standardized annual protocol, modified from Erdman and Brinker (1997), during fall 2001. Our standard protocol for attracting owls into mist nets included using an audio lure, which consisted of an mp3 player with remote speakers broadcasting species-specific vocalizations at a volume of approxi-

Table 1. Number of Flammulated Owls (FLOW) and Northern Saw-whet Owls (NSWO) banded during fall migration at Lucky Peak, Idaho, 2001–2013.

Species	Year												
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
No. of FLOW captured	17	12	17	15	10	2	6	62	27	3	43	41	98
No. of NSWO captured	159	67	163	60	65	105	121	178	151	93	551	550	271

mately 80–85 dB at 2 m from the speaker. We broadcast ''hooting'' calls to attract Flammulated Owls and male ''solicitation'' calls to attract Northern Saw-whet Owls (*Aegolius acadicus*) into stations. Each year, we operated two standard net/audio lure stations, located about 300 m apart in separate stands of conifers, from 28 August–28 October. Both stations were located in open, mature Douglas-fir forests with a lot of woody debris and little vegetative understory that consisted mostly of mountain ninebark. Each station had an audio lure with five or six mist nets configured in a rough square or triangle pattern within 10 m of the audio lure. For both stations together, our standard owl nets consisted of four 18 m × 3.2 m 60-mm mesh nets and seven 12 m × 3.2 m 60-mm mesh nets. We opened nets 30 min after sunset and closed them 30 min before sunrise.

In the fall of 2011, we detected (visually or aurally) several Flammulated Owls in dense montane shrubs up to 100 m away from our traditional (audio lure) netting stations. To determine whether we could increase the capture frequency for Flammulated Owls, we experimented with placing mist nets within these dense deciduous shrub patches (mainly bitter cherry and chokecherry) ranging from 1–5 m tall. Because 2011 efforts were exploratory, we initially did not open these nets in the dense shrubland for the same duration as our traditional array of nets, and they were not always opened on a regular schedule. In 2012 and 2013, we began the netting in the dense shrubland nightly on 31 August and 28 August, respectively, to encompass the entire Flammulated Owl migration season; nets were opened and closed at the same time as standard nets for the entire season. In 2011 we opened four mist nets from our songbird monitoring array that were approximately 50–100 m from the closest audio lure. In 2012 and 2013, we used two of the same songbird nets used in 2011 (about 75 m from nearest audio lure), and added two new net locations approximately 60 m and 100 m from the nearest audio lure for a total of four new net locations. We used 12 m × 2.5 m 30-mm or 32-mm mist nets at all new net locations as these were the only nets available to us. Because 2011 coverage was limited and inconsistent, we did not include those data here. We include standardized results from 2012 and 2013. Our data did not allow us to statistically compare habitat preferences because we did not sample both habitat types at the same time with the same audio lure, number of nets, or size of nets. However, we examined differences in capture rates between the habitat types using confidence intervals.

Results

Both Flammulated Owl and Northern Saw-whet Owl captures in 2012 and 2013 were the first and fourth highest to date in 13 seasons (Table 1). Our data suggested that without large changes in the number of open nets (four new nets), capture rates greatly increased (Table 2). During

Table 2. Capture rates (number of owls/10 m^2/100 hr) for standard open understory and nonstandard dense-shrubland nets at Lucky Peak, Idaho, 2012–2013 for Flammulated Owl (FLOW) and Northern Saw-whet Owl (NSWO).

Capture Variable	2012		2013	
	Open Understory Nets[a]	Dense-shrubland Nets[b]	Open Understory Nets[a]	Dense-shrubland Nets[b]
No. FLOW captures	10	31	42	56
No. NSWO captures	281[c]	260[c]	205	66
Net hours	1165.7	577.8	1198.8	615.9
Net area (m^2)	28 473.6	8485.8	28 627.2	10 050.3
FLOW capture rate	0.003	0.063	0.012	0.090
NSWO capture rate	0.085	0.530	0.060	0.107

[a] Standard open understory nets consisted of four 18 m × 3.2 m 60-mm mesh nets and seven 12 m × 3.2 m 60-mm mesh nets within 10 m of the audio lure.

[b] Dense-shrubland nets were 12 m × 2.5 m 30-mm or 32-mm mesh nets.

[c] Net hours and area were reported incorrectly on 8 September and 12 October (weather forced some temporary net closures); therefore, owls captured on those nights are not included in this analysis.

Table 3. Mean capture rates and confidence intervals (number of owls/10 m^2/100 hr) for standard open understory nets (2012–2013) and nonstandard dense-shrubland nets (2012–2013) at Lucky Peak, Idaho, for Flammulated Owl and Northern Saw-whet Owl.

	Capture Rate	
Species	Open Understory 2012–2013	Dense-shrubland 2012–2013
Northern Saw-whet Owl	0.072 ± 0.017	0.318 ± 0.294
Flammulated Owl	0.0076 ± 0.0064	0.077 ± 0.019

2012 and 2013, mist nets placed in dense shrublands had Flammulated Owl capture rates 7.5 to 21 times higher than the capture rate for standard mist nets within conifer forest with very little or no understory (Table 2). The mean capture rate for Flammulated Owl in standard open understory nets (2012–2013) did not fall within the confidence interval of nonstandard dense-shrubland nets (2012–2013), demonstrating there was a difference in capture rates between these two net arrays (Table 3). Although the capture rate means for Northern Saw-whet Owl standard open understory nets (2012–2013) did fall within the confidence interval of nonstandard dense-shrubland nets (2012–2013), the overlap was slight (Table 3).

Discussion

We experimentally added nonstandard nets in dense shrublands to our owl monitoring array and found much higher capture rates for two small owl species when compared to the standard nets surrounding audio lures in mature conifer forests with little to no understory. Specifically, our use of the nets in the dense shrubland significantly increased captures of Flammulated Owls by 7.5 to 21 times, whereas the relative increase for Northern Saw-whet Owls was less (1.8 to 6.2 times). The fact that such a high proportion of Flammulated Owls were captured in the dense-shrubland nets suggests that this approach can considerably increase capture frequency for this species. We suggest several hypotheses, including (1) habitat structure, (2) net placement relative to audio lure, (3) mesh size, and (4) annual differences in relative abundance, that may explain the marked observed increase in capture rates and we consider each in more detail below.

Small owls may prefer dense cover during migration, either because of prey availability and/or because of the presence of other owls (conspecific or heterospecific). Dunn (2001) recommended that owl nets should be placed in dense understory cover, as small owls feel more secure in thick cover. In addition, placing mist nets in thick shrubs might increase capture effectiveness by breaking up their outline and thus hiding nets somewhat. Also, owls moving through shrubs of shorter stature will tend to fly at or near net level, reducing the opportunity for avoiding capture by simply flying over the nets. Flammulated Owls, in particular, are open-forest birds that often hunt at edges or openings in the breeding season (Linkhart and McCallum 2013), but specific habitat-use patterns during fall migration are not well studied. Perhaps dense shrubby habitat at forest edges is representative of habitats they target during migration, but it is also possible that migrating owls may be distracted from active migration by the use of audio lures in otherwise inappropriate habitats (Dunn 2001).

Second, Whalen and Watts (1999) proposed that the distance of the nets from the audio lure as well as the array design may influence capture rates. There is some evidence that smaller owls are more likely to be caught farther from an audio lure than larger owls (e.g., male versus female Northern Saw-whet Owls; Whalen and Watts 1999), so perhaps the small size of the Flammulated Owl could account for the higher capture rate with increasing distance from the audio lure. However, intraspecific size differences might not produce the same dynamic as interspecific size differences and we found no patterns between size and capture location for Flammulated Owls.

Closed arrays (like triangles or squares) can miss some owls, as some owls will simply circumnavigate the array and avoid capture (Dunn 2001). Our nets in dense shrubland were located individually within patches of shrubs, in contrast to our geometrical arrays around the audio lure at both standard owl stations.

Third, it is also possible that the smaller mesh size of the dense-shrubland nets (30 or 32 mm) relative to 60 mm that is typical of nets used for small owls and that we use in our standard station may have an influence on capture rate. In general, mesh sizes of 30–32 mm are best suited for capturing small- to medium-sized passerines, whereas 60-mm mesh is often used for species ranging from larger songbirds like American Robin (*Turdus migratorius*) to small owls, including Northern Saw-whet Owls. Thus, we would expect that 60-mm nets would be more effective at capturing both owl species than smaller mesh sizes. The relative difference in the proportional increase in capture rates for each species could suggest a role of mesh size and/or differences in habitat-use patterns. For example, Flammulated Owls may use deciduous shrub habitat more than saw-whet owls do, and therefore be captured there proportionately more frequently. Alternatively, because saw-whet owls are larger and weigh more, they might be less likely to get tangled and captured in nets of smaller mesh size. We only had 30- and 32-mm mesh available, but we intend to replace the four new nets with 60-mm mesh in future seasons.

Finally, there may have simply been more owls migrating in 2012 and 2013 relative to prior years. This appeared to be the case for Northern Saw-whet Owls: in most autumns prior to 2012 we captured <200 of this species, but in 2012 and 2013, in our standard net array alone, we captured 281 and 205, respectively. However, the case is less clear for Flammulated Owls, in that 2012 and 2013 capture totals from our standard net array were 10 and 42, respectively (Table 2). Though these baseline numbers differed between years, they are both within the long-term range of annual Flammulated Owl captures (Table 1), which might suggest that the abundance of this species during these two fall migrations was similar to that during prior years.

Another question was whether the new nets in the dense shrubland were simply catching owls that would have eventually been captured in the standard array near the audio lures. The fact that our dense shrubland nets were located roughly between the two audio-lure stations might suggest that this would be possible for at least some of the captures. However, particularly in the case of Flammulated Owls, the increase in capture rates of 7–21 times in the deciduous shrubs suggests that although this could have been a small component, we were not merely catching birds that would have eventually been captured near the audio lures. Instead, it suggests that by placing nets in a different habitat type, a short distance from the audio lures, we were able to greatly increase capture rates for Flammulated Owls and moderately increase capture rates for Northern Saw-whet Owls.

We believe that having nets in the dense shrub habitat and the placement of nets between the two audio-lure stations were the two major contributors to the increased capture rates. This technique could be used to increase capture rates in other places where researchers capture Flammulated Owls, and may be applicable in a wide variety of densely vegetated habitats. Additional research will help clarify the effects that habitat type, use of audio lures, distance from audio lures, and net mesh size has on Flammulated Owl capture rates.

INCREMENTO DE LA FRECUENCIA DE CAPTURA DE *PSILOSCOPS FLAMMEOLUS* Y *AEGOLIUS ACADICUS* DURANTE LA MIGRACIÓN OTOÑAL

Resumen.—Hemos estado anillando individuos de *Psiloscops flammeolus* y *Aegolius acadicus* durante la migración otoñal en Idaho desde 1998. Nuestras redes de niebla con señuelos auditivos se ubican dentro de bosques de *Pseudotsuga menziesii* con muy escaso sotobosque. Durante el otoño de 2011 observamos algunos individuos de *P. flammeolus* dentro de parches densos de matorrales deciduos de montaña ubicados hasta 100 m de distancia del señuelo auditivo. Por ello, a mitad de la temporada de 2011, colocamos experimentalmente redes de niebla dentro de estos hábitats densos de arbustos deciduos para evaluar si podíamos incrementar la frecuencia de captura de *P. flammeolus*, la cual está catalogada como una especie de preocupación por la mayoría de las agencias estatales y federales dentro de su área de cría. Estandarizamos este protocolo para las temporadas de 2012 y 2013. Las redes de niebla colocadas en matorrales densos tuvieron tasas de captura de *P. flammeolus* de 7 a 21 veces más altas que nuestras redes de niebla tradicionales colocadas en el sotobosque, lo que sugiere que el emplazamiento de las redes en este tipo de hábitat puede ser valioso para estudios de anillamiento. Aunque nuestro objetivo principal fue aumentar la tasa de captura de individuos de *P. flammeolus*, también documentamos un incremento menor en la tasa de captura de *A. acadicus* en las mismas redes.

[Traducción del equipo editorial]

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