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OBSERVATIONS OF MIGRATING GOLDEN EAGLES (*AQUILA CHRYSAETOS*) IN EASTERN INTERIOR ALASKA OFFER INSIGHTS ON POPULATION SIZE AND MIGRATION MONITORING

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ABSTRACT.—Migratory Golden Eagles (*Aquila chrysaetos*) from Alaska winter across a vast region of western North America, much of which is undergoing rapid change from a diversity of indirect and direct human activities. To address recent conservation concerns, we are studying the year-round movements of migratory Golden Eagles from interior and northern Alaska to identify and evaluate potential risks to their survival. We are also developing new survey techniques to estimate population size and trends. As part of our ongoing studies, we observed migrating Golden Eagles in spring and autumn 2014 during field investigations to locate Golden Eagle capture sites in eastern interior Alaska, and in spring 2015 during capture activities. We observed large numbers of Golden Eagles in both spring and autumn, suggesting that the Mentasta Mountains are an important migration corridor for this species. Further, our observations, including 1364 migrating Golden Eagles in October 2014, suggested that the Alaska Golden Eagle population is much larger than is reflected in the only currently available statewide population estimate of 2400 eagles. In combination with historical and contemporary tracking studies, our observations in the Mentasta Mountains provide important new information about Golden Eagle migration in Alaska and stimulate interest in answering fundamental questions about using counts of migrating Golden Eagles to estimate, and detect change in, the population size of Alaska's migratory Golden Eagles. Our observations also provide new information about Rough-legged Hawk migration in Alaska.

KEY WORDS: *Golden Eagle*; Aquila chrysaetos; *Rough-legged Hawk*; Buteo lagopus; *Alaska*; *migration*.

LAS OBSERVACIONES DE *AQUILA CHRYSAETOS* EN EL ESTE DE ALASKA PROPORCIONAN PISTAS SOBRE EL TAMAÑO POBLACIONAL Y EL SEGUIMIENTO DE LA MIGRACIÓN

RESUMEN.—Los ejemplares migratorios de *Aquila chrysaetos* provenientes de Alaska invernan a lo largo de una amplia región del oeste de América del Norte, gran parte de la cual está siendo sometida a un cambio rápido ocasionado por una diversidad de actividades humanas directas e indirectas. Para abordar preocupaciones de conservación recientes, estamos estudiando, a lo largo del año, los movimientos de ejemplares migratorios de *A. chrysaetos* provenientes del interior continental y del norte de Alaska para identificar y evaluar riesgos potenciales para su supervivencia. También estamos desarrollando nuevas técnicas de muestreo para estimar el tamaño y las tendencias poblacionales. Como parte de nuestros estudios en curso, observamos ejemplares migratorios de *A. chrysaetos* en primavera y otoño de 2014 durante investigaciones de campo para ubicar lugares de captura en el este continental de Alaska, y en primavera de 2015 durante las actividades de captura. Observamos gran número de ejemplares de *A. chrysaetos* tanto en primavera como en otoño, lo que sugiere que las montañas Mentasta son un importante corredor migratorio para esta especie. Además, nuestras observaciones, que contabilizaron 1364 ejemplares migratorios de *A. chrysaetos*, sugieren que la población de esta especie en Alaska es mucho mayor que la documentada en la única estimación poblacional estatal disponible de 2400 águilas. En combinación con estudios de seguimiento históricos y contemporáneos, nuestras observaciones en las Montañas Mentasta proporcionan información nueva e importante sobre la migración de esta especie de águila en Alaska y despiertan interés en dar respuesta a preguntas fundamentales acerca del uso de conteos de ejemplares

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migratorios de *A. chrysaetos* para estimar y detectar cambios en el tamaño poblacional de esta especie. Nuestras observaciones también proporcionan nueva información acerca de la migración de *Buteo lagopus* en Alaska.

[Traducción del equipo editorial]

Managing and conserving raptors requires a thorough understanding of their ecology, including factors that influence population size and trends, distribution, resource use across space and time, and threats to population size and persistence (Newton 1979, Katzner et al. 2012, Millsap et al. 2013). There is a conspicuous absence of fundamental ecological and demographic information for most species of raptors nesting in interior and northern Alaska, including Osprey (*Pandion haliaetus*), Northern Harrier (*Circus cyaneus*), Sharp-shinned Hawk (*Accipiter striatus*), Northern Goshawk (*A. gentilis*), Red-tailed Hawk (*Buteo jamaicensis*), Rough-legged Hawk (*B. lagopus*), Golden Eagle (*Aquila chrysaetos*), American Kestrel (*Falco sparverius*), Merlin (*F. columbarius*), and Gyrfalcon (*F. rusticolus*). Further, nine of the 12 species of diurnal raptors that commonly nest in interior and northern Alaska are migratory, but little is known about their movements and resource use throughout the year and across their annual range.

Golden Eagles occur throughout much of Alaska. The Alaska population consists of both residents and migrants (Kochert et al. 2002), with migrants wintering across a vast region of western North America, including southwestern Canada, the western United States (west of the Mississippi), and central and northern Mexico (Goodrich and Smith 2008, McIntyre et al. 2008, McIntyre 2012, B. Bedrosian pers. comm., R. Domenech pers. comm., T. Booms pers. comm., S. Lewis and C. McIntyre unpubl. data). Landscapes across this vast region are rapidly changing due to increasing human activities (e.g., Knick et al. 2003, Steenhof et al. 2014, Watson et al. 2014), resulting in increasing direct (e.g., electrocution and wind-turbine strikes) and indirect (e.g., habitat loss and degradation) threats to Golden Eagle survival. Further, a carry-over effect (Harrison et al. 2011), resulting from conditions and events on wintering grounds and along migration corridors, are suspected of influencing reproductive success of migratory Golden Eagles in some parts of Alaska, including Denali National Park and Preserve (McIntyre and Schmidt 2012).

Concern over the conservation status of Golden Eagles in North America has increased as threats to populations become better understood (Katzner et al. 2012, Millsap et al. 2013). Currently, it is unknown if Golden Eagles, including those from Alaska, have the demographic resiliency to absorb additional mortality from increasing threats or if their environment is changing at a rate that exceeds their ability to adapt (Millsap et al. 2013). We launched several new studies in Alaska to address these concerns and the paucity of information regarding population size. As part of these new efforts, we are capturing and tracking Golden Eagles from interior and northern Alaska to identify and evaluate potential risks to their survival. At the start of these studies, we conducted exploratory work in the eastern Alaska Range to identify suitable locations where Golden Eagles from interior or northern Alaska could be captured during spring and autumn migration. During this work, we observed a noteworthy migration of Golden Eagles that provides new insight into the potential population size for Golden Eagles in Alaska. Further, our observations, in combination with historical and contemporary tracking studies, provided opportunities to consider the feasibility of using data collected through migration monitoring to estimate the size and trends of Alaska's Golden Eagle population.

Herein, we (1) describe our observations; (2) discuss our findings in relation to other counts that include Alaskan Golden Eagles in Yukon and Alberta, Canada, and Montana, U.S.A.; (3) discuss how our observations provide new insight about current population estimates for this species in Alaska; (4) summarize fundamental questions that need to be addressed when considering migration monitoring as a tool for estimating the population size or trends of Alaska's migratory Golden Eagles; and (5) make recommendations for developing effective conservation strategies for this migratory population.

Methods

We conducted our work in the Mentasta Mountains in the eastern Alaska Range, Alaska (Fig. 1). The Mentasta Mountains are approximately 70 km long and 40 km wide and run southeast from Mentasta Pass to the Nabesna River. To the north is

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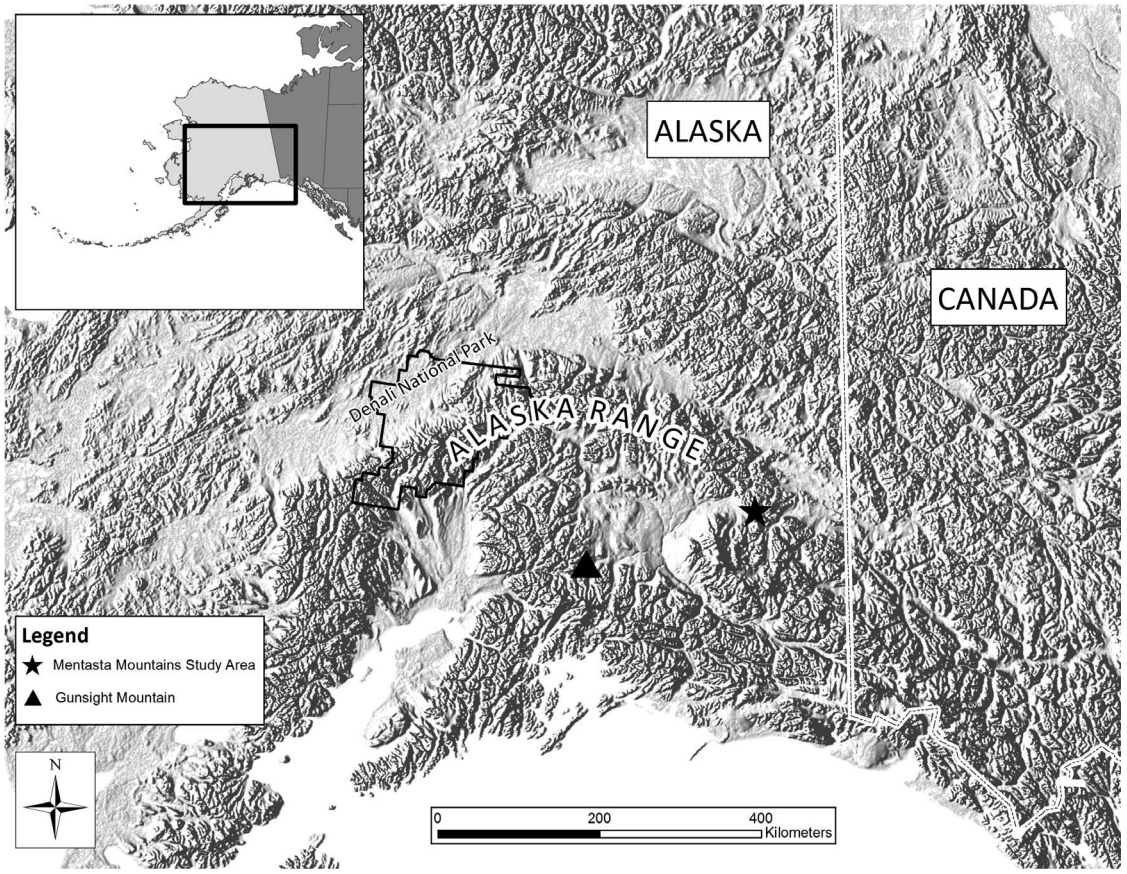


Figure 1. General location of spring and autumn observation sites in the Mentasta Mountains (solid star) in relation to the spring count site at Gunsight Mountain (black triangle), Alaska.

the broad (>80 km wide) upper Tanana River valley and to the south are the broad (>40 km wide) upper Nabesna and Copper River valleys. Noyes Mountain (2483 m) is the highest peak in the Mentasta Mountains. The much higher Wrangell Mountains, with elevations as high as 4996 m, form the southern boundary of the upper Nabesna and Copper River valleys. We selected the Mentasta Mountains as our study area based on information from historical and contemporary satellite-telemetry studies on Golden Eagles from interior Alaska (McIntyre et al. 2008, S. Lewis and C. McIntyre unpubl. data) and historical observations of Golden Eagles migrating in the area in previous springs (up to 45 eagles per hr; D. Rosenkrans pers. comm.).

During our reconnaissance work in 2014, we visited potential capture sites along the southern slopes of the Mentasta Mountains within 4 km of the Nabesna Road to determine if it was feasible to establish a temporary trapping station in areas where Golden Eagles concentrated during migration. This involved traveling to potential capture sites and making observations to locate and count migrating Golden Eagles. In spring 2015, we established two temporary trapping sites near sites we visited in 2014. We traveled by dogsled and snowmobile in spring and by all-terrain vehicle and on foot in autumn.

Our observation sites were just above tree line at approximately 1150 m and offered unlimited views to the east, west, and south (Fig. 2 and 3). The closest mountains (1–5 km away; elevation 1310–2070 m) limited the view to the north. In spring and autumn 2014, we counted migrants from several vantage points that offered relatively unobstructed views across the landscape. In contrast, we counted migrants in spring 2015 while we were establishing trapping stations (6 d; 12–16 and 22 March), during

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Figure 2. View looking east from a spring observation site near Rock Creek on the southern slope of the Mentasta Mountains, March 2014. In spring, migrating Golden Eagles were detected across a broad front, from the Mentasta Mountains to the north (left side of photo) to the Boyden Hills to the south (right side of photo).

capture work (5 d from an east-facing blind, 17–21 March, and 5 d from a west-facing blind, 23–27 March), and while we dismantled our field camp and trapping sites (1 d; 28 March).

We conducted fieldwork from 1000–1800 H, the daily period when we expected Golden Eagles to be migrating (Kerlinger 1989). We recorded weather conditions during each observation hour, including temperature, estimated wind speed, wind direction (e.g., N, NE, E, SE, S, SW, W, and NW), and cloud cover. We scanned the sky and horizon with the naked eye and 10×40 binoculars to locate migrating Golden Eagles and other raptors. We counted Golden Eagles that we detected flying past an observation site in a westerly direction in spring, or in an easterly direction in autumn, in a manner that suggested migration (i.e., soaring high in thermals and then directional flight or direct point-to-point flight along ridgelines or over the observation site; Swem 1985). For each migrant Golden Eagle, we noted the time of detection (within hourly intervals), its general location in relation to the observation site (north, south, or overhead), general flight pattern (thermal soaring, riding ridges, or powered flight), flight posture (tuck and glide, soaring, or flapping; Dunne et al. 2012), and apparent behavior (migrating or hunting). We attempted to classify each migrant as either an adult or a non-adult based on the presence of white in their tail and flight feathers following Liguori (2004). We classified eagles that were completely dark with faint, gray mottling in the tail feathers and remiges as adults. We classified eagles that had white patches at the bases of the remiges or in their tail as non-adults.

During all counts, we made efforts to avoid double-counting and to distinguish resident individuals from migrants based on behavior. This latter was necessary because we found three occupied Golden Eagle breeding territories in the survey area in spring 2014 and one occupied territory in the area in spring 2015. Resident eagles usually exhibited territorial behavior when migrants were present, such as undulating flights and vocalizations, whereas migrants proceeded steadily in the direction of migration and did not change their behavior visibly as they passed by occupied breeding territories.

Results

Spring Migration. We counted for 13 hr between 1100–1700 H from 26–29 March 2014, covering one site per day for 2–4 hr each. Clear skies (no cloud cover) predominated, east winds ranged in speeds from 6–30 km/hr, and temperatures ranged from –25 to +9°C. Snow covered most of the ground at lower elevations, but large areas along the southern slopes of the nearby Mentasta Mountains were snow-free.

We detected 113 migrating Golden Eagles (8.7 eagles per observation hr) during spring 2014. We detected most of these eagles when they were rising or soaring in thermals (the thermal-soar and glide strategy described by Duerr et al. 2012) or using powered flight. Twenty-two of the 113 migrating eagles exhibited hunting behavior (i.e., coursing

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Figure 3. View looking to the northwest (top) and northeast (bottom) from an autumn observation site near Lost Creek on the southern slopes of the Mentasta Mountains, October 2014. In autumn, most Golden Eagles were detected as they migrated along the higher ridges of the Mentasta Mountains to the north of the observation site.

low along slopes or circling low over the landscape) and 91 appeared to be primarily intent on migrating. We did not observe any white feathering on most of the eagles we detected in spring 2014.

We counted for 91 hr between 1000 and 1900 H on 17 d from 12–28 March 2015. Weather conditions ranged from days with clear skies to days with snowstorms that limited visibility to <1 km. Winds were primarily from the northeast and temperatures ranged from –32 to +4°C. We detected 402 migrating Golden Eagles (4.4 migrating eagles per observation hr) during spring 2015, most (303) from 17–21 March when we counted from an east-facing blind. We detected the first migrant on 17 March. Most of the migrating eagles we detected in spring 2015 were soaring on thermals or migrating along the ridges to our north. In contrast to spring 2014, most of the eagles we observed in spring 2015 were too far away for us to observe their plumage and assign them to an age class.

Autumn Migration. We counted at a single site for 39.5 hr between 1000–1800 H on 9 d from 3–14 October 2014 (Table 1). Logistical constraints precluded observations on 4, 9, and 10 October. Weather conditions ranged from days with clear skies and unlimited visibility to days with overcast

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Table 1. Hourly counts of migrating Golden Eagles at the Lost Creek observation site, Mentasta Mountains, AK, during October 2014.

	Count Start Time								Count	Number of
Date	1000	1100	1200	1300	1400	1500	1600	1700	Hours	Eagles Detected
3 Oct	-[a]	-	-	-	-	14	-	-	1	14
4 Oct	-	-	-	-	-	-	-	-	-	-
5 Oct	-	-	-	-	-	-	6	-	1	6
6 Oct	-	-	-	-	-	-	12	21	2	33
7 Oct	4	75	95	98	109	102	66	19	8	568
8 Oct	-	2	42	121	38	109	5	2	7	319
9 Oct	-	-	-	-	-	-	-	-	-	-
10 Oct	-	-	-	-	-	-	-	-	-	-
11 Oct	-	-	22	44	12	8	12	-	5	98
12 Oct	-	21	31	18	43	119	24	13	7	269
13 Oct	-	-	1	1	6	11	4	-	5.5	23
14 Oct	-	-	3	2	0	29	-	-	4	34

[a] Indicates that no count was conducted.

skies and snow squalls that limited visibility to <1 km. On most days, the winds were from the northeast or east. Estimated wind speeds ranged from 0–32 km/hr, with gusts on some days as high as 64 km/hr. Hourly temperatures ranged from –11 to +13°C.

We counted 1364 migrating Golden Eagles in October 2014 (Table 1). We recorded the highest daily counts on 7 October (568 eagles; 81.1 migrating eagles per hr) and 8 October (319 eagles; 49.1 eagles per hr; Table 1), two days after a large cold front brought the first significant snowfall to much of interior and northern Alaska. The weather conditions on these days included northeast winds ranging in speed from 12–50 km/hr, 40–60% cloud cover, and temperatures ranging from –4 to +1°C.

Most of the eagles we detected in autumn (>95%) appeared intent on migrating; typically we detected them as they were flying directly west to east along the ridges to our north or soaring in a thermal and then gliding eastward. Eagles migrating along the ridges often flew swiftly and directly in a tuck-and-glide position. The flight behavior (tuck and glide position) and the distance (>3 km) of most of the eagles (1169 of 1364) that we detected in October 2014 prevented us from observing their plumage and assigning them to an age class.

Other Species. We detected seven other species of diurnal raptors during autumn migration: Northern Harrier ($n = 1$), Sharp-shinned Hawk ($n = 7$), Northern Goshawk ($n = 9$), Red-tailed Hawk ($n = 1$), Rough-legged Hawk ($n = 525$), American Kestrel ($n = 1$), and Merlin ($n = 4$). We also noted both adult and non-adult Bald Eagles in autumn, but could not distinguish migrants from local residents because they did not exhibit a specific flight direction.

The highest daily counts of Rough-legged Hawks occurred on 7 October ($n = 121$) and 8 October ($n = 298$), the same days with the highest counts of Golden Eagles. Nearly 80% of the Rough-legged Hawks that we detected migrated past us on just two days and we suspect that, like the eagles, the hawks were responding to the large cold front that swept through much of interior and northern Alaska in early October. Rough-legged Hawks generally migrated at lower elevations than Golden Eagles, often over the rolling uplands on the southern slopes of the Mentasta Mountains, and often in loose aggregations of up to 15 individuals.

Discussion

Our exploratory fieldwork provided us with the opportunity to document an important migration corridor for Golden Eagles in the eastern Alaska Range. Our counts suggest that a substantial number of Golden Eagles migrate through this area in both spring and autumn, perhaps in similar numbers as those recorded at other raptor migration monitoring sites in western North America. For instance, we counted 1364 migrating Golden Eagles in just 39.5 hr of observation in October 2014. Although this count is among the highest recorded for this species at a migration-monitoring site in North America (Goodrich and Smith 2008), we suspect that it, and our spring counts, greatly

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Table 2. Number of migrating Golden Eagles recorded at four count sites within the potential migration corridor of Alaskan migratory Golden Eagles in autumn 2014.

Count Location	Latitude, Longitude	Count Period	Count Hours	Eagles Counted
Mentasta Mountains, AK, U.S.A.	62.6°N, 143.1°W	3–14 Oct	39.5	1364
Teslin Lake, Yukon Territory, Canada[a]	60.2°N, 132.9°W	23 Jul–31 Oct	na	293
Mt. Lorette, Alberta, Canada[b]	51.1°N, 115.2°W	20 Sep–15 Nov	584.4	2837
Bridger Mountains, MT, U.S.A.[c]	45.8°N, 110.9°W	1 Sep–2 Nov	394.2	1222

[a] Data taken from Schonewille 2015.
[b] Data taken from http://www.eaglewatch.ca/ index.html.
[c] Data taken from http://hawkcount.org.

underrepresent the magnitude of eagle migration in this region for several reasons. First, we undoubtedly missed some high-flying eagles on days when there was no cloud cover (Swem 1985). This may have been particularly true in spring when clear weather predominated during the count periods. Second, telemetry studies show that Golden Eagles migrate through this area in spring from mid-March through late May and in autumn from early September through late October across a very broad front (>100 km wide; McIntyre et al. 2008, T. Booms pers. comm., S. Lewis and C. McIntyre unpubl. data). Our observations only covered a small part of the migration seasons and encompassed a small portion of the migration corridor. Hence, we suspect that many eagles migrated through this area outside of our observation periods and beyond the limit of our vision during our observation periods. Finally, we made our spring 2015 counts incidentally to other field activities or from a small blind with limited visibility; thus, many migrants probably passed by undetected.

Assigning Golden Eagle migrants to an age class was very difficult. Conditions during spring migration in 2014, with high albedo resulting from consistent snow cover and bright sunshine, allowed us to see the finer details of the plumage of many of the eagles that passed overhead. However, most migrants in autumn 2014 and spring 2015 passed by either too far away or in a tuck-and-glide posture that did not allow us to observe plumage patterns. The resulting large proportion of unknown-age eagles precluded confident assessments of age-specific composition and migration timing (Omland and Hoffman 1996).

Although our efforts were focused on Golden Eagles, we also recorded all bird species detected during our observations. Of particular note were the 525 migrating Rough-legged Hawks that we counted in October 2014. This count exceeds the number of Rough-legged Hawks observed during nearly full-season counts conducted in the upper Tanana River valley from 1987–1994 (McIntyre and Ambrose 1999) and suggests that Mentasta Mountains are also an important migration corridor for this species. We were surprised that we did not observe more species of migratory raptors in late March, as we expected to see at least a few individuals of species such as Northern Harrier, Red-tailed Hawk, and Merlin (C. McIntyre unpubl. data). Although we noted seven other species of migratory raptors during autumn, we were also surprised that we did not see more individuals of species such as Northern Harrier and Red-tailed Hawk (C. McIntyre unpubl. data).

Comparisons with Other Golden Eagle Migration Counts. Counts in the Mentasta Mountains and at Gunsight Mountain in south-central Alaska (Fritz and Fritz 2011) suggest that large numbers of Golden Eagles migrate past both sites in spring. However, because no season-long counts were conducted at both sites in spring, comparisons of the numbers of eagles migrating by these sites in spring currently was not possible.

Although we recognize that seasonal counts of migrants vary across years, we compared our autumn 2014 counts to those made at other count sites within the potential migration corridor for Alaskan Golden Eagles (Table 2) to help place our observations in context. Our count of 1364 migrating Golden Eagles was more than four times higher than the 293 eagles counted near Teslin Lake in the southcentral Yukon Territory (Schoenwille 2015). As expected, we detected fewer eagles in the Mentasta Mountains than were detected at Mt. Lorette (2837; Table 2). Mt. Lorette, approximately 2100 km southeast of the Mentasta Mountains, has a much larger potential source area and counts were

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Table 3. Number of Golden Eagles detected on Breeding Bird Surveys (BBS) in eight western U.S. states, 1968–2013 (summarized from Pardieck et al. 2014).

State	Number of BBS Routes[a]	Number of Eagles Detected	Eagles Detected per BBS Route
Alaska	1806	78	0.04
Washington	2187	58	0.03
Oregon	2629	548	0.21
California	5569	681	0.12
Idaho	1518	167	0.11
Montana	1845	392	0.21
Wyoming	2165	1056	0.49
Colorado	2829	611	0.22

[a] Refers to the total number of completed BBS routes. Each BBS route has 50 sampling points located approximately 800 m apart (Pardieck et al. 2014).

conducted there throughout the migration season. The Bridger Mountains in Montana also have a much larger potential source area and counts were conducted there for 2 mo; however, contrary to expectations, we detected more Golden Eagles during our limited counts in the Mentasta Mountains than were detected at Bridger Mountain (Table 2). These simple comparisons suggest that a substantial number of Golden Eagles migrate through the Mentasta Mountains in autumn and provide new opportunities for thinking about the population size of the migratory population of this species in Alaska.

Insights About Population Size. The U.S. Fish and Wildlife Service (U.S.F.W.S.) requires accurate population size and trend estimates for Golden Eagles to address permitting requests and develop effective management actions (Millsap et al. 2013). Using data from the Breeding Bird Survey (BBS), U.S.F.W.S. estimated the population size of Golden Eagles in Alaska, including residents and migrants, at 2400 individuals including 588 nesting pairs (U.S.F.W.S. 2009). BBS data, in combination with other survey data, were used to estimate population size and trends for Golden Eagles in the western United States (Millsap et al. 2013). However, we suspect that it will be difficult to use BBS data to estimate population size and trends of this species in Alaska because those surveys cover only a small portion of the state and very few eagles are detected on those surveys (Table 3). Furthermore, based on the U.S.F.W.S. population estimate, we detected nearly 57% of the Alaska Golden Eagle population during only 39.5 hr of observation in October 2014. This scenario is highly unlikely and provides new support for the U.S.F.W.S. (2009) suggestion that their only available population estimate for Golden Eagles in Alaska is coarse.

Using Migration Monitoring Counts to Estimate Population Size. Estimating the size of the migratory component of the Alaskan Golden Eagle population using migration counts will be challenging until understanding of the eagles' flight behaviors and migration pathways increases and a representative network of standardized migration counts across their migration corridor is established. For instance, the organization and high density of hawk-count sites throughout the Appalachian migration corridor in eastern Pennsylvania provided sufficient data for Dennhardt et al. (2015) to develop capture histories and estimate the population size of migratory Golden Eagles in eastern North America. In contrast, there are few well-established raptor migration monitoring sites in Alaska and northwestern Canada and still fewer sites where sustained season-long monitoring has occurred (Swem 1985, McIntyre and Ambrose 1999). The absence of raptor migration counts in northwestern North America probably reflects the extreme remoteness of the region, the difficulties of conducting fieldwork under extreme weather conditions, the lack of easily accessible areas where raptors migrate, the relatively low density of people to serve as citizen scientists (Dennhardt et al. 2015), and the paucity of information about where migratory raptors concentrate. Gaining access to areas in Alaska where migrating Golden Eagles and other raptors concentrate and persevering to conduct season-long counts can be difficult (Swem 1985), expensive, and unattractive for volunteer participation (Bildstein et al. 2007). A notable exception to some of these challenges in Alaska is Gunsight Mountain, where counts can be conducted from a pullout along a major highway relatively close to Alaska's largest city, Anchorage (Fritz and Fritz 2011).

In addition to the logistical challenges of sustaining migration counts at northern latitudes, several fundamental questions need to be answered before counts made at locations in and outside of Alaska can be used to accurately and effectively estimate the population size and trends of Alaska's migratory Golden Eagles (Fish 2001, Bildstein et al. 2007). (1) What are the geographic sources of migrants observed at count sites (e.g., Hoffman et al. 2002,

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Nelson et al. 2015) and what proportions of the migratory population are available to be sampled at different count sites? For instance, what proportion of the migrating Golden Eagles detected at Mt. Lorette, Alberta, Canada, (Sherrington 1993, 2003) is from Alaska? (2) How does flight behavior (i.e., thermal soaring versus slope soaring) influence the availability and detectability of migrants at different count sites (Dennhardt et al. 2015, Miller et al. 2016)? (3) Do spring and autumn migration periods vary interannually or from region to region, and does spatial or temporal differential migration occur depending on the sex, age, or breeding status of individual eagles (e.g., tracking data currently suggest that younger Golden Eagles return to Alaska later than individuals that hold or are seeking to establish territories; McIntyre et al. 2008, T. Booms pers. comm., S. Lewis and C. McIntyre unpubl. data)? (4) How do seasonal variation in thermal generation and weather conditions influence Golden Eagle migration (e.g., see Duerr et al. 2014, Yates et al. 2001) and counts of migratory eagles? (5) Do changes in counts of migrating Golden Eagles reflect changes in population size, changes in migratory behavior, or wintering distribution (Bildstein et al. 2008, Paprocki et al. 2014)? (6) Does variation in the relationship between counted samples and actual population size change through time and hamper detecting changes in actual abundance (T. Swem pers. comm.)?

Considerations for Conserving Alaska's Migratory Golden Eagles. Assessing both the population-level significance of any authorized take of Golden Eagles and the eagles' long-term population status in light of major, widespread changes in habitat and prey availability requires reliable population size estimates and an understanding of the uncertainty in those estimates (Millsap et al. 2013, Nielson et al. 2014). Our counts indicate that Alaska supports a substantial population of migratory Golden Eagles, certainly more than the current U.S.F.W.S. estimate of 2400 suggests. Documenting and interpreting changes in the population size of Alaska's migratory Golden Eagles requires continuing monitoring and research on the breeding grounds (e.g., McIntyre and Schmidt 2012, Alaska Department of Fish and Game unpubl. data, U.S.F.W.S. unpubl. data) in combination with studies across the annual cycle of these northern migrants.

Alaska's migratory Golden Eagles cross many ecological and political boundaries during their annual cycle. Effective conservation of these wide-ranging northern migrants requires a collaborative approach that integrates the results of applied research and monitoring studies with specific management activities and habitat protection efforts across their annual range (Braham et al. 2015). This approach is being successfully implemented by the Eastern Golden Eagle Working Group (Katzner et al. 2012) and by several other groups who are focused on conserving other species of migratory birds (e.g., North American Waterfowl Management Plan, U.S. Shorebird Conservation Plan, and International Wader Group). Implementing a similar collaborative program is essential for conserving migratory Golden Eagles from Alaska and northwest Canada.

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