

MIGRATION AND SPACE USE OF A ROUGH-LEGGED HAWK (*BUTEO LAGOPUS*) IN WESTERN NORTH AMERICA

Project Report
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Rough-legged Hawks (*Buteo lagopus*) breed in the arctic and migrate to southern Canada and the contiguous United States during the non-breeding season (Bechard and Swem 2002). Migration viewing sites and various field studies have outlined temporal patterns in Rough-legged Hawk migration but little is known on the spatial patterns of Rough-legged Hawk migration. Based on numbers of Rough-legged Hawks recorded at migration sites, there is some evidence to suggest Rough-legged Hawks prefer river valleys that run parallel to ridges with tighter migration patterns and along shorelines of large water bodies (Bechard and Swem 2002, Escott 1985, McIntyre and Ambrose 1999). Specific areas with documented migration activity include the Tanana River valley in Alaska (McIntyre and Ambrose 1999), the Shakwak Trench and Tahini River in Yukon Territory (Mindell and Mindell 1984) and large concentrations of migrating Rough-legged Hawks have been documented along the Great Lakes (Sheldon 1965, Escott 1985, Palmer 1988). Overall, little information exists on spatial migratory trends of Rough-legged Hawks but even less is known on space use of Rough-legged Hawks, with no available published estimates. Our goal was to describe the movement-related habits of an individual throughout the year.

In March of 2014, we captured one adult male Rough-legged Hawk near Jackson, Wyoming (43.48° N, 110.76° W) and attached an 18-gram PTT satellite transmitter (Microwave Telemetry, Columbia, MD, U.S.A.) to track its migratory movements, probable location of

breeding and estimate its breeding-season home range size. The bird was aged and sexed based on plumage characteristics. From March 10, 2014 through July 12, 2016, we have collected 5761 locations of location class 1 or better (*see* Argos 2014 for description of location classes and accuracy). After the bird was captured in March of 2014, he stayed within 15-km of the capture location until departing north on March 26, 2014. He progressed northward through Yellowstone National Park, through Great Falls, Montana up into southeastern Alberta, straddling the Alberta-Saskatchewan border until eventually heading northwest into the northern Northwest Territories and turning back south at the tip of the Parry Peninsula in Amundsen Gulf. The Rough-legged Hawk arrived on the Parry Peninsula on June 7, 2014. The estimated total distance traveled during the 73-day trek from Jackson to Cape Parry based on the sum of all step lengths during that time interval was 6799.2 km, for an average of 93.1 km traveled per day. The hawk proceeded from the Parry Peninsula south and east to north-central Nunavut, approximately 100 km west of Laughland Lake. The hawk arrived at this location and stayed within 50 km from July 11, 2014 through September 9, 2014, a total of 60 days. Using the `adehabitatHR` package in R (R Core Development Team), we estimated the core area and home range using kernel utilization distribution (UD). We defined the core area as the 50% UD and the home range as the 95% UD. The core area where this bird localized in 2014 was 38.0 km² and the home range was 163.4 km². The total distance traveled between Jackson, Wyoming and the assumed breeding location based on step lengths was 9956.3 km.

After the hawk left its summer area in 2014, it traveled south through Nunavut through central Manitoba, crossing Lake Winnipeg and continuing south ultimately ending in southwest South Dakota on the November 11, 2014. The total distance the hawk traveled was approximately 4867.6 km from where it localized during the summer of 2014. The hawk stayed

in southwest South Dakota until February 1, 2015 when it slowly traveled to north-central Colorado near the towns of Rand followed by Toponas. While in South Dakota, the home range of the hawk was 5220.1 km². The hawk left the Toponas-area on April 14, 2015 and headed north through central Wyoming, eastern Montana and western Saskatchewan. The hawk proceeded through the Northwest Territories and western Nunavut and then back into the Northwest Territories ending its northward journey near McClure Strait on the northeast side of Banks Island on June 2, 2015. The total distance from its last wintering area in Colorado to Banks Island was approximately 5307.1 km, which took place over 49 days for an average daily movement of 108.3 km/day. The hawk left Banks Island on July 4, 2015 and localized in an area just south on Victoria Island, east of Minto Inlet in the Northwest Territories. The hawk remained in this general area from July 5, 2015 through September 26, 2015, a total of 83 days. During the summer of 2015, the hawk returned to a central area but continually made fairly large movement throughout the duration of the summer (Fig. 1). Because of these movements, the 2015 core area estimate was 752.3 km² and the home range was estimated at 4709.0 km², substantially larger than the 2014 estimates. The total distance traveled from its wintering area in Colorado to its assumed breeding area in 2015 was 6090.8 km.

After the hawk left its summer location in 2015, it headed south and west towards Great Bear Lake and then south near the western edge of the Great Slave Lake, through Central Alberta continuing through western Montana ultimately ending near Victor, Idaho on November 8, 2015. The total distance traveled from the assumed breeding area to Victor, Idaho was 2984.4 km. The hawk stayed near Victor, Idaho with a trip over the Teton Mountain Range to Jackson, Wyoming near its capture location until April 22, 2016 when he proceeded northward. His non-breeding season home range during the winter of 2015-2016 was 229.9 km². He traveled directly north

through Montana into central Alberta, continuing northward to the Northwest Territories. He traveled again along the western edge of Great Slave Lake to the east side of Great Bear Lake, into Nunavut localizing near Ataniriik Lake on May 12, 2016. From the location near Ataniriik Lake, the bird made one foray north towards the village of Kugluktuk on Coronation Sound but returned to the area near Ataniriik Lake within one day. Based on steplengths, the hawk moved approximately 2703.9 km from Victor, Idaho to the Ataniriik Lake area. The hawk traveled again for 20 days between these 2 areas for an average daily speed of 135.2 km/day. Annual movements from all years are shown in Figure 1.

The movements and variation in breeding locations of this hawk are like none we are aware of in North America. The location where the hawk localized in the summer of 2014 was approximately 2918.9 km from its summer location in 2015. The summer location of the hawk in 2016 was approximately 2308.2 km from the hawk's summer location in 2014 and 1444.4 km from the hawk's summer location in 2015. The migration and wintering patterns appeared more random than pattern-like. In addition, the autumn migration in 2014 well east of autumn migration in 2015. Spring migrations were most similar with routes moving through Montana into central and eastern Alberta and western Saskatchewan into central Northwest Territories, just west of Great Slave Lake towards the eastern edge of Great Bear Lake. The lack of a migration pattern of the tracked Rough-legged Hawk was similar to Red-tailed Hawks (*Buteo jamaicensis*) breeding in Wyoming (Craighead et al. 2016). But, the lack of a prominent migratory route is rare among many migratory raptors in Western North America (Bildstein 2006).

One pattern that did stand out with the tracked hawk was the pre-breeding activity movement seen in 2014 and 2015. The hawk traveled to an area away from where it localized,

spent time in that area and then moved to an area where it subsequently localized. We suggest potential explanations for this behavior were pair formation, attempting to secure a nest site or the hawk was simply a floater. A downside of tracking a bird such as the Rough-legged Hawk that travels great distances is the difficulty of determining what the bird is doing throughout the year. We did not have the ability to confirm this birds nesting behavior in any of the breeding season so exactly what the bird was doing and determining whether the bird was nesting was not possible. And, unfortunately, many aspects of breeding ecology for Rough-legged Hawks is unknown (Bechard and Swem 2002). The hawk was localized for 60 days in 2014 and did not appear to localize at all in 2015. Rough-legged Hawks lay between 1 and 7 eggs, at 2-3 d intervals, incubate for at least 31 d and the young fledge between 31 and 36 d (Bechard and Swem 2002). Therefore, the minimum number of days needed by the adults for a successful nest is approximately 62 days and likely a bit longer for the young to be adequate in flight. It is possible the bird was able to fledge young in 2014 but that is clearly unknown in this situation.

The total distance the tracked Rough-legged Hawk traveled away from its territories was more than Red-tailed Hawks nesting in Wyoming (Craighead et al. 2016) but less than Swainson's Hawks that migrate from North to South America (Kochert et al. 2011). The rate of migration was similar to both Red-tailed Hawks and Swainson's Hawks. The summer home range estimates for the tracked Rough-legged Hawks were quite large compared with other raptors. For example, Red-tailed Hawks nesting in Connecticut had a mean breeding season home range of 0.94 km² (SE = 0.17; Morrison et al. 2016) and male Red-shouldered Hawks (*Buteo lineatus*) in Georgia had an average home ranges size of 1.28 km² (SD=0.02; Howell and Chapman 1997). Other larger raptors, such as Golden Eagles (*Aquila chrysaetos*) in Idaho, have substantially larger breeding season home ranges, averaging 22.8 km² (SD=26.3). But, even

these larger home range estimates do not compare with the estimates we provide for our tracked Rough-legged Hawk even in the summer of 2014. Without documenting the associated behavior with the movements of the bird, it is difficult to fully interpret the estimated home ranges sizes of the tracked individual. But, at a minimum, we have provided space use estimates that can be used for comparison in future studies.

Rough-legged Hawks are a relatively little-studied, northern breeding hawk.

Understanding their movement patterns using satellite telemetry aids in our understanding of the birds' habits substantially due to the large movements the birds undertake throughout the year. As tracking technology becomes more readily available, we may learn whether the unusual patterns exhibited by the individual tracked for this study are an anomaly or the norm for this species.

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Figure 1. Location of capture, annual movements, assumed breeding areas and wintering areas of a Rough-legged Hawk captured in Jackson Hole, Wyoming, U.S.A. in March of 2014.

