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TRAPPING SUCCESS USING CARRION WITH BOW NETS TO CAPTURE ADULT GOLDEN EAGLES IN SWEDEN

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Although a wide variety of traps are available for capturing raptors, and the literature is replete with publications describing how to build and use them, there are few published accounts on success rates and level of effort with various trap types (Fuller and Christenson 1976, Bloom 1987, Bloom et al. 2007). Capturing adult Golden Eagles (*Aquila chrysaetos*) in their breeding territories is important for their management, but is challenging and can be time-consuming and thus expensive. The most frequently used traps for capturing Golden Eagles include bow net, cannon or rocket net, launch net, and pit trap (Bloom 1987, Bub 1995, Bloom et al. 2007, Harmata and Restani 2013). Bow nets are relatively small, easy to transport and set up, and provide relatively high trapping success.

Here we describe our success rates trapping adult Golden Eagles using bow nets with carrion (Clark 1970, Jackman et al. 1994) during late summer and autumn of 2010 and 2011 in the boreal forests of northern Sweden. The use of live lures or any agricultural animals for trapping is generally prohibited in Sweden. Thus, only wildlife carcasses were used for this study. Carcasses from vehicle and train collisions and offal from harvested wild ungulates, which are routinely eaten by Golden Eagles in Sweden, were used as bait. Indeed, eagle nesting density has been correlated with the presence of carrion in Europe (Watson and Langslow 1989, Watson et al. 1992).

STUDY AREA

All trapping was conducted approximately 150–300 km south of the Arctic Circle, in the northern Swedish counties of Västerbotten and Västernorrland, between 63–65°N latitude at elevations ranging from 250–500 masl (Fig. 1). Trap site selection was facilitated by previous monitoring of Golden Eagle territories in these counties for approximately 30 yr by the Swedish Golden Eagle Society (Moss et al. 2012). The dominant habitat is managed boreal forest, primarily Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*), and silver birch (*Betula pendula*), with open spaces consisting of mires (bogs), pastures, and clear-cut areas (Engelmark and Hytteborn 1999). Small settlements, some low-intensity farming, paved roads, major highways, and numerous unimproved roads exist within the study area, although most trap sites were accessed by unimproved logging roads (Moss et al. 2014). Moose (*Alces alces*) hunting is extensive in Sweden and about 100 000 moose,

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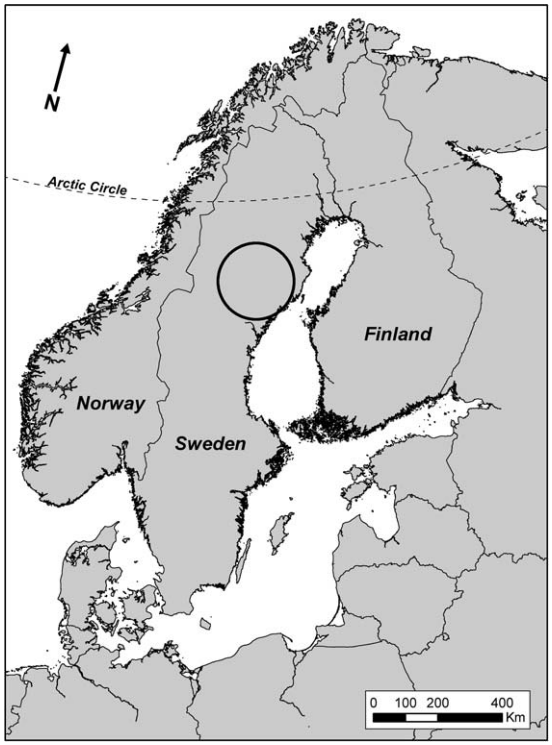

Figure 1. Study area, roughly within circle, in northern Swedish counties of Västerbotten and Västernorrland, between 63–65 degrees north latitude.

of a population of about 300 000–400 000, are taken by legal hunting between September 1 and January 31 throughout all of Sweden (Svenska Jägareförbundet 2014).

METHODS

We used a bow net design and release mechanism (Superior Bownet and Design 2014) fitted with an electronic release solenoid. The blind and bow net were camouflaged to mimic adjacent habitat. Trap camouflage included snow, leaves, moss, lichen, bark, and grass. In 2010 and 2011, traps were typically set 20–50 m outside the forest edge, with the blind positioned in the trees when possible. Carcasses were centered in the bow net. Bow net springs were tightened prior to use to prevent added weight from camouflage from affecting the speed or effectiveness of the trap. In subfreezing temperatures, canola oil (cooking spray) was applied to the net prior to use to minimize freezing of moisture on the nylon mesh.

Trapping locations included previously identified active nesting territories within and adjacent to sites proposed for wind energy development and control sites away from planned development. We trapped at 10 territories in 2010 and 13 in 2011, with three territories used in both years. Trapping methods differed in several ways between 2010 and 2011. In 2010, trapping commenced on 5 October and ended 8 November. In 2011, trapping was initiated and ended earlier, extending from 23 September to 20 October. On most days in 2010, two or (rarely) three trap sites were operated simultaneously in different territories. In 2011 we typically operated two to three independent traps, and on rare occasions as many as four traps per day in different territories.

During 2010, most trap sites were pre-baited at least several days before trapping began and maintained with fresh carcasses or offal piles from hunter-killed or vehicle-killed moose and red fox (*Vulpes vulpes*). Traps were monitored nightly in 2010 with automatic Ltl Acorn 12MP 5210A trail cameras provided by the SLU Wildlife Department. Trapping typically commenced only after an eagle was first detected on camera. Typically, on the morning following the initial camera detection of an eagle feeding at the carcass, we added fresh bait, test-fired and re-camouflaged the trap before entering the blind during early morning darkness. In 2011, trap sites were usually set the night prior to trapping, without pre-baiting, using almost exclusively moose remains and relied much less on cameras; instead, we targeted sites near known nest trees where local young had been recently detected.

We defined a ''trap-day'' as one when the trapper spent at least part of the day in the blind attempting to trap, regardless of whether the day was ended prematurely for one of several possible reasons (e.g., eagle capture, inclement weather, or disturbance from hunting dogs). Once an eagle was captured, we typically processed the bird as a team and abandoned the trap site for the remainder of the day or longer. ''Trap hours'' were calculated as the period between entry and exit of the blind each day. Trapping rate was calculated based on the number of ''trap-days'' required to capture a single adult eagle, as well as on the number of trapping hours required, on average, to capture an eagle. Trapping success was calculated as the percentage of capture attempts that resulted in a captured eagle. We identified adult eagles as those that exhibited plumage and molt characteristic of individuals in their late fourth calendar year of life or older (Jollie 1947, Tjernberg 1988, Bloom and Clark 2001, Watson 2010).

We defined a failed capture attempt as one in which an eagle was in a safe position within the bow net, but the eagle was not captured due to trapper error or trap failure resulting from mechanical or electrical issues. We did not consider unanticipated disturbances from humans, hunting dogs, or other sources to be a failed capture attempt, although these events did occur and potentially affected trapping rate and trapping success.

RESULTS

We captured 30 adult eagles during 120 trap-days over the 2-yr period. We captured eight eagles in 2010 during 54 trap-days, for an average trapping rate of 6.75 trap-days per captured eagle. In 2011, we captured 22 eagles in 66 d,

resulting in an average trapping rate of 3.00 trap-days per eagle. Thus, on average, each successful capture in 2011 required only 44.4% of the time required in 2010 (3.00 versus 6.75 trap-days, respectively).

The number of trap-hours per day ranged from 2 to 11 hr/d in 2010 (for 400 hr total), and from 2 to 14 hr/d in 2011 (for 593 hr total). Overall, more trap-hours were required, on average, per capture in 2010 (50.0 hr/eagle) compared to 2011 (27.0 hr/eagle).

Trapping was not conducted at the same times of year during 2010 and 2011 (Fig. 2) and capture rates varied seasonally. The highest observed hourly capture rate (24.4 hr/eagle) occurred during the early trapping period of 23 September to 5 October 2011 (Fig. 2). Trapping was not conducted during this period in 2010. Trapping occurred in both years from 5 to 20 October (shaded area in Fig. 2), and the trapping rates were similar in 2010 and 2011 during this period (31.8 versus 29.1 hr/eagle, respectively), despite the higher level of effort during 2011. The lowest observed capture rate, at 80.3 hr/eagle, was experienced during late 2010 from 21 October to 8 November (Fig. 2). Trapping was not conducted during this period in 2011.

Trap success was 100% in 2010, yielding eight eagles in eight attempts, compared to 92% in 2011 (22 of 24 attempts successful). The two trap failures in 2011 included one due to a frozen net and another due to an electronic failure of a solenoid. One additional potential capture was spoiled by high winds lifting the blind off the ground and flushing an incoming eagle prior to any attempt to trigger the mechanism.

DISCUSSION

Biologists are often faced with difficult decisions due to time and budget constraints when planning for trapping operations that play an important role in wildlife management. Successful trapping and tagging of individuals is required to examine the home-range use patterns of wild animals, such as adult territory-holding eagles, and this type of work is becoming increasingly important with increasing levels of development in and near eagle breeding habitat. In this study, we examined our success at trapping adult territory-holding Golden Eagles in northern Sweden using bow nets baited with carrion as a lure. We found that 3.00–6.75 d of trapping were required per capture, with trapping success of 92–100%.

The average number of days required to trap one eagle in 2011 was less than half that required in 2010. Although there were differences in trapping methodology between the two years, the available evidence suggests that the better trapping rate in 2011 may have been due to an earlier starting date resulting in higher trapping rates when adult eagles were more often present. Our earliest trapping period in 2011 yielded our best trapping rate (Fig. 2). During the period of overlap for both years, the number of eagles trapped per hour was similar, while the average trapping rate for our latest period (late October) in 2010 was the slowest.

This study was not designed to test for differences in trapping success at different points in the season, and other factors that were not considered could also explain the observed difference in success between years. Nonetheless, low trapping rates later in the season could be attributed to the coincidental timing of dispersal of young eagles and the post-nesting movement of adults away from their nesting territories (Moss et al. 2014). Most fledgling Golden Eagles from the study area disperse from natal sites by mid-October (Sandgren et al. 2014). Once young dispersed and moose carcasses became more available due to the onset of the moose hunting season, adults appeared to display less fidelity to the nest vicinity. Some adults may have left their territories; hence, capture of adults became more time-consuming than if we had started earlier.

Frozen nets, electronics, and camouflage, etc., can become problematic when trapping in inclement weather. During both years, we addressed net equipment issues by opening frozen nets, spraying nets with Canola oil, thawing release mechanisms, and making mechanical adjustments to release mechanisms. Occasionally, we encountered interruptions that did not necessarily result in failures, but did result in at least four shortened trap days due to disturbance by hunters, hunting dogs, commercial berry pickers, or inclement weather. Other factors influenced the time required to capture eagles, but were not quantified. For example, in addition to the 54 d spent trapping in 2010, perhaps another 50 d were expended preparing for trapping, including selecting trap sites, setting field cameras, searching for and hiding other carcasses within the trapping vicinity, and pre-baiting at potential trap sites. This preparation time was reduced substantially in 2011 due to familiarity with the site and methodological changes.

Common sense strategies that may increase trapping success in future studies include: (1) avoiding areas with human activities; (2) initiating trapping prior to seasonal severe weather; (3) understanding the movement patterns of fledglings and their targeted parents; (4) inspecting and testing of bow nets and release equipment daily; and (5) considering the use of other trap types capable of capturing eagles, based on the situation. In the future, evaluating the effectiveness of utilizing play back calls to attract eagles to the trap area should also be considered.

To facilitate quantitative comparisons among various trapping methods, we encourage researchers to include measures of trapping effort and trapping success, including the number of hours or days of trapping required per successful capture, and the percentage of trapping attempts that were successful (when using active trapping mechanisms; Bloom et al. 1992). In other cases where avian capture rates are much higher (e.g., passerine mist-netting), it may be more meaningful, or more easily interpreted, to express trap success as the number of birds captured per unit time. For example, although the success rates of ''200 birds/d'' and ''0.005 d/bird'' are identical, the former may be more easily interpreted.

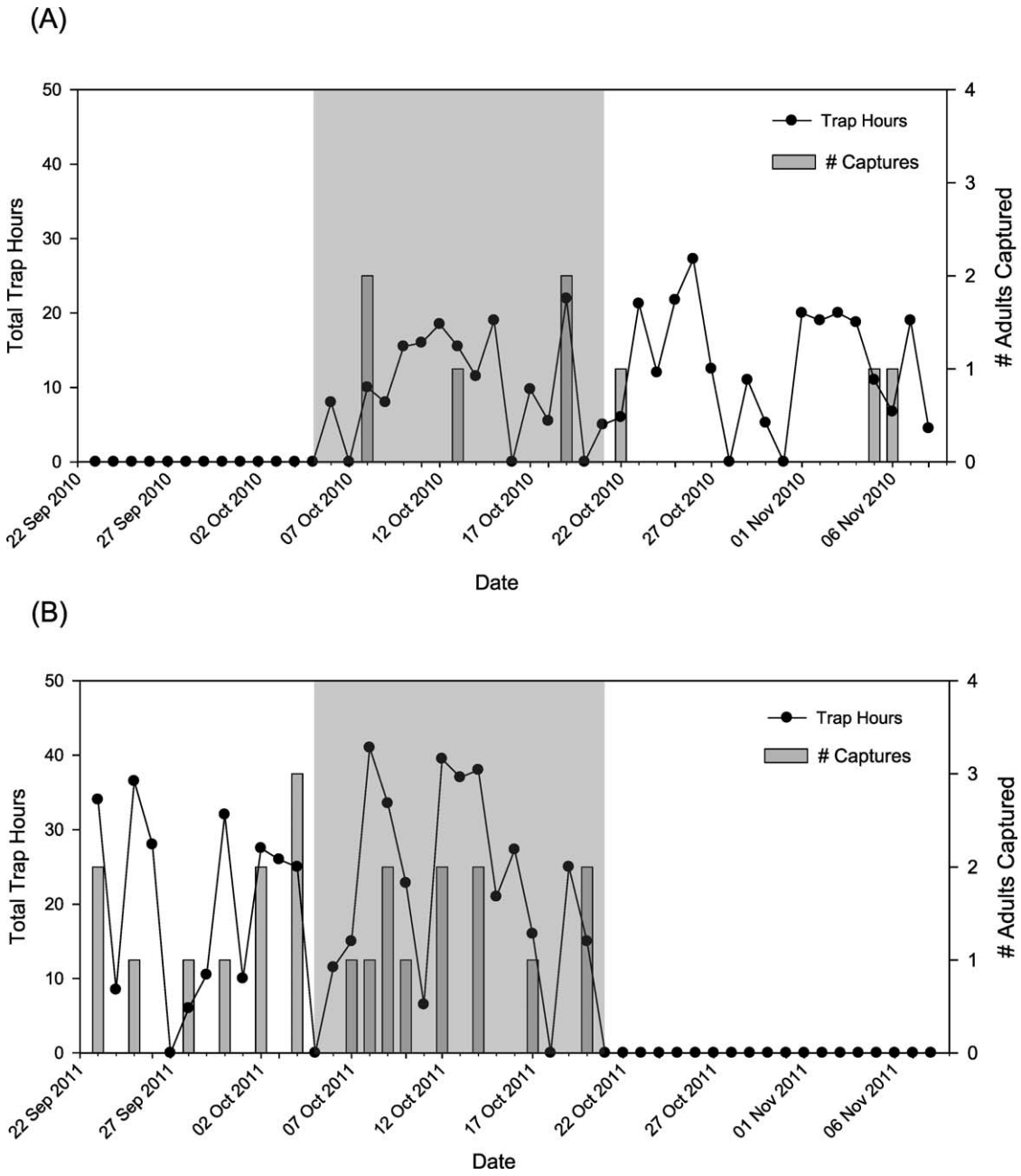

Figure 2. Total daily trap hours (black circles with black line; left vertical axis) and total daily adult Golden Eagle captures (gray bars; right vertical axis) as a function of date during the (A) 2010 and (B) 2011 trapping seasons in northern Sweden. The shaded area extending from 5–21 October represents the period in which trapping occurred during both years.

ÉXITO DE CAPTURA DE INDIVIDUOS ADULTOS DE *AQUILA CHRYSAETOS* UTILIZANDO CARROÑA Y REDES DE ARCO EN SUECIA

RESUMEN.—Existen numerosos métodos y dispositivos disponibles para la captura de especies de rapaces de gran tamaño, pero la efectividad relativa de estas metodologías está pobremente documentada en la literatura. Como parte de varias propuestas de desarrollo de proyectos de energía eólica en el norte de Suecia, intentamos capturar individuos adultos de *Aquila chrysaetos* dentro de sus territorios de cría para colocarles transmisores. Nuestros intentos de captura se realizaron a finales de otoño y comienzos de invierno en el norte de Suecia, cuando los individuos de *A. chrysaetos* se alimentan a menudo de despojos dejados por cazadores y de cadáveres producto de colisiones con vehículos. Debido a las restricciones en Escandinavia respecto del uso de animales vivos como cebo, la selección de trampas se limitó a aquellos tipos de trampa que funcionan exitosamente con carroña. Por este motivo, utilizamos redes de arco basados en la existencia de experiencias previas exitosas con carroña, la facilidad de su transporte y la rapidez de su armado. Normalmente operamos de dos a tres trampas en 2010 y de tres a cuatro trampas en 2011, totalizando 120 días-trampa (54 en 2010 y 66 en 2011) en escondites durante un total de 993 horas (400 en 2010 y 593 en 2011). Capturamos 30 (8 en 2010 y 22 en 2011) individuos adultos de *A. chrysaetos* en 16 territorios. La mayor tasa de captura ocurrió en septiembre, previo a la dispersión de los jóvenes y antes de que algunos adultos se dispersaran de sus territorios de cría.

[Traducción del equipo editorial]

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