

## Decorah Bald Eagle Tracking Project Introduction

by Brett Mandernack

The Decorah Bald Eagle satellite tracking project began in 2011 after RRP founder and friend Bob Anderson and I decided to collaborate with the objective of answering the question he was most often asked: “Where do the eagles go when they leave Decorah?”

To put the Decorah project into perspective, Eagle Valley’s (EV) initial eagle tracking efforts began as a partnership with researchers from The Raptor Center at the University of Minnesota from 1999 through early 2002. Their field research program ended at that time and EV took over the project with the generous financial support of my employer, Kohler Co., and the Kohler Trust for Preservation (KTP) from 2002 through the project’s conclusion in 2014. This initial phase of eagle tracking focused primarily on adult Bald Eagles that wintered in impressive numbers in the EV area of southwest Wisconsin. Results of this study were published in the *Journal of Raptor Research* in 2012 (*J. of Raptor Research*, 46(3):258-273 (2012). <https://doi.org/10.3356/JRR-10-77.1>). A foundational premise of the study was to better understand travel behavior. After all, how can we understand a species and expect to steward it effectively without this fundamental information?

The Decorah eagle study, phase 2, was funded by RRP for the first two birds, D-1 and D-14, and by Kohler Co. and KTP for subsequent eagles. RRP provided tremendous logistical support and education outreach throughout. This phase provided a unique opportunity to examine travels of fledglings from the same parents over multiple years. Is eagle migration/travel behavior genetically influenced? Plus, we had little concrete knowledge of travel behavior of birds fledged from this region. Previous data collection methods of banding, color marking, and short-distance VHF transmitter tracking yield a fraction of the behavior information satellite tracking provides. We now have access to day-to-day details of eagle travels and, if the transmitters function for several years, can document changes in travel behavior, if any, over time.

This question initiated EV’s third phase of tracking, whether immature eagle travel changes over time. It has been documented that immature movements are variable and nomadic. If there is a change, is it abrupt or gradual, consistent or variable, etc.? Additionally, the “revelation” of D-1’s amazing travels inspired us to learn more about immature eagle travels. With Kohler Co./KTP’s continued support, we fitted 10 more immature eagles in the EV area with satellite transmitters, five in early 2015 and five more during winter 2015-16.

Co-author Ryan Schmitz and I have provided a summary of Decorah eagle travels through February 2018, at which time D-24 and D-27 were still transmitting data. (This continues to be the case at this writing in late February 2019, so future updates can be expected.) Included in the paper are sections on hatch, fledge and dispersal dates, migration comparisons, summer and winter range use, home range size and causes of mortality. We have included a LOT of detail in the individual travels section under “Results”, because satellite technology enables this level of movement behavior nuances to now be recognized. I also realize this level of depth is not going to be to be appreciated by everyone, so skim, skip sections, take it in “chunks” at your convenience. Find the areas you are curious about and have fun learning about those eagles! And please let us know areas you would like more information on and we will do our best to deliver. Feedback is appreciated, whatever its form.

# Satellite Tracking Decorah, Iowa Fledgling Bald Eagles, 2011-2018

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## ABSTRACT

A Bald Eagle nest near the Decorah Fish Hatchery in northeast Iowa had a video camera installed over it in 2007 to provide never-before-witnessed details of nesting and fledging behavior of eaglets produced there to millions of viewers world-wide via Raptor Resource Project's website. The most frequently asked question by viewers was "Where do those eagles go after they leave the nest area?"

To begin to answer that question we fitted seven juvenile eagles with satellite transmitters between 2011 and 2017. We documented fledging age, post-fledging and dispersal movements, travel behavior of siblings, migration tendencies, fidelity to migration routes and summer and winter ranges, and mortality causes to that suburban eagle family.

Eagles were tracked for periods ranging from 4 days to 3 years. Two transmitters continue to send data, though one is intermittent. Average eagle fledging age was 77 days. The fledglings stayed within a mile of the nest for a month following fledge, then most began ranging out on exploratory flights, but returned to the nest occasionally. Eagle age at dispersal from the natal area averaged 162 days, nearly 85 days after they fledged. Two siblings from 2016 exhibited several similarities but also marked differences in dispersal behavior. Dispersal for different year siblings was variable in timing and direction.

The nest camera has confirmed the adult eagles do not migrate. However, four of the fledglings completed a fall migration from the natal area. Spring and fall migration was variable, though similarities were observed. One eagle exhibited long-distance, repeated migration of over 850 straight-line miles to a northern Ontario summer range, then returned to northeast Iowa for the winter. The other three migrated shorter distances (75 to 206 miles) in their first fall from the nest area to a winter range in southeast Iowa. One perished there, another returned to northeast Iowa the following spring, and a third began heading north in late February at the end of the period monitored. Movement behavior of juveniles, in general, is often erratic and unpredictable. Some birds embarked on long summer or fall journeys north from their natal area but were not truly migrating. The eagle that traveled long distances showed increased efficiency in time and miles traveled on subsequent migrations. Overall, the Decorah juveniles exhibited variability in summer and winter range sizes across individuals and, less so, between years.

Four of the seven eagles died from electrocution (three) or vehicle collision (one) within their first year. Survival rate of the Decorah eagles was lower than reported in other studies, despite limitless food resources and tolerance to human disturbance. Anthropogenic mortality causes, those caused or influenced by humans, may temper the higher productivity of this suburban site.

We will continue to track the remaining eagles until transmitter failure to further develop our understanding of travel patterns by eagles in this region. Will migration tendencies diminish or cease as they approach breeding age? How far will they nest from their natal area? We must also realize threats posed to suburban-raised eagles and take action to improve their survivability.

## INTRODUCTION

A Bald Eagle (*Haliaeetus leucocephalus*) nest near the Chuck Gipp Decorah Fish Hatchery, or “the hatchery”, in northeast Iowa had a video camera installed over it in 2007 by long-time raptor conservationist Robert (Bob) Anderson and the Raptor Resource Project (RRP), a not-for-profit organization he founded. The intent was to capture a live video stream of never-before-witnessed details of nesting behavior of that non-migratory pair of eagles and make that video stream available to the public via RRP’s website. In 2011, the Decorah Eagles’ nest became the most-watched live video in history. Over 270 million people from 189 countries tuned into northeastern Iowa to watch the eagles build their nest, lay eggs, welcome eaglets, and raise them through an Iowa spring. After watching the eaglets fledge, the most frequently asked question by nest viewers was “Where do they go after they leave the nest area?”

The ability to observe Bald Eagle behavior has become increasingly more efficient and accurate as technology improves. Nest cameras can capture egg laying, incubation, hatching, and the pre-fledgling period. Satellite tracking reveals an abundance of long-term information on post-fledging behavior and beyond. The post-fledging dependence period (PFDP) is an important stage when young eagles leave the nest and develop flight and hunting skills and ultimately begin independence. The next critical part of their life history is natal dispersal, which is the movement between an individual’s natal area and its first breeding site (Reinking et al. 2015, Weston et al. 2018). This process results in how organisms and genetic information are spread across the landscape. The distribution is dynamic, especially for birds, in that individuals can easily immigrate or emigrate, sometimes long distances. With the late-maturing Bald Eagle, however, breeding may not occur until four or five years of age (Gerrard et al. 1978, Buehler 2000) and in areas of high eagle density that may be delayed until eight years of age (Bowman et al. 1995).

Little is known about the PFDP, dispersal, subsequent travel behavior, and mortality of progeny born to the same Bald Eagle parents in the same year and those born to the same parents in different years. Limited research has shown that Bald Eagle siblings disperse and migrate independently (Laing et al. 2005, Hunt et al. 2009). However, Hunt et al. (1992) reported that migratory paths of siblings were more similar than non-siblings. In addition, Penteriani and Delgado (2011) observed Eurasian Eagle Owl (*Bubo bubo*) siblings of the same year and siblings born in the same nest in different years dispersing at similar ages and using the same areas.

Differences in migratory behavior have been observed in eagles of different origins and age classes. It has been established that Bald Eagles from southern states such as Florida, Texas, Arizona, California, and Louisiana, perform long-distance northward migrations (Wood 1992, Mabie et al. 1994, Hunt et al. 2009, Linthicum et al. 2007, and Smith et al. 2017, respectively), and eagles from Canada migrate south following dispersal (Gerrard et al. 1978, Laing et al. 2005). Other studies documented non-migratory behavior consisting of relatively short distance dispersal in Oklahoma (Reinking et al. 2015) and Chesapeake Bay (Buehler et al. 1991).

Mandernack et al. (2012) satellite tracked two immature Bald Eagles, a second-year and a third-year bird, that migrated north from winter ranges on the Upper Mississippi River Valley. Bowman et al. (1995) and Laing et al. (2005) described immature eagle behavior as nomadic and McClelland et al. (1994) stated immature eagle travel was much less direct and more variable than adult eagles. Buehler (2000) suggested that young eagles undergo a prolonged period of great exploration that may last four years.

Eagle mortality can occur by many means and is impacted by eagle age (Buehler et al. 1991, Bowman et al. 1995, Harmata et al. 1999) and origin. The Decorah Fish Hatchery nest is situated just outside the city of Decorah, Iowa, and can be categorized as suburban. Hager (2009) cited vehicle collisions and electrocutions as important mortality sources for several suburban/urban raptor species. Millsap et al. (2004) indicated that suburban eagles were more likely to die from anthropogenic causes, particularly electrocution and vehicle collisions, after they disperse than those from rural populations and further identified electrocution as a leading cause of suburban eagle mortality.

Our objectives were to describe movement behavior of seven juvenile Bald Eagles that fledged from the Decorah Fish Hatchery site. Specifically, we 1) documented fledging age, 2) described post-fledging dependency and dispersal movements, 3) compared behavior of siblings hatched the same year and those hatched in the same nest in different years, 4) assessed whether the juveniles migrated and, if so, determined their routes, distances, duration, and whether the routes changed as the eagles aged, 5) examined winter and summer range size and fidelity to those ranges in subsequent years, and 6) documented causes of mortality. These results will enable a more complete understanding of dispersal behavior and risks to juvenile Bald Eagles, especially those fledged from suburban environments, and, therefore, allow for more effective management.

## **STUDY AREA**

The Decorah Fish Hatchery is located at the junction of Siewers Spring and Trout Run Roads, about 0.75 mi (1.2 km) south of Decorah's southern city limit. The Upper Iowa River runs through Decorah and is 1.3 mi (2.1 km) from the hatchery at its closest point. The first nest to host a camera, known as N-1, was built in 2007 in a large Cottonwood tree (*Populus deltoides*) overlooking Trout Creek just 80 yds (73 m) north of the hatchery. It was abandoned in Fall 2012 and a new nest, known as N-2, was built 154 yds (141 m) east-northeast of N-1 also in a Cottonwood over the same creek. The limb supporting N-2 broke off in July 2015 due to high winds. RRP board members, staff, and many volunteers built a foundation for a new nest, to be known as N-2B, in an adjacent Cottonwood 17 yds (15 m) from the N-2 tree in September 2015. The eagles quickly adopted the starter nest as their new nest site and continued building N-2B later that fall, successfully fledging young in 2016.

With the exception of 2013 when the adults moved from N-1 to N-2 and no camera installation was possible without risking disturbance to the adult pair, all nest activities from 2007-2018 including nest building and refurbishing, egg-laying, incubation, hatching and fledging were observed by RRP and viewed online annually by hundreds of thousands, and eventually by millions. In addition, the fledglings were observed and photographed daily until their dispersal

by eagle enthusiasts from throughout the United States that congregated at the hatchery. The Decorah eagles are perhaps the most documented Bald Eagles in North America.

The adult Decorah eagles displayed an obvious tolerance to human disturbance (passing vehicles on the road, hatchery workers and visitors, lawn mowers, etc.). With that and an unending supply of trout from the hatchery, an abundance of Eastern Fox Squirrel (*Sciurus niger*), Eastern Gray Squirrel (*Sciurus carolinensis*), Eastern Cottontail rabbits (*Sylvilagus floridanus*), and assorted other prey items and carrion, this pair routinely hatched and fledged three young per year, though two hatched in 2016.

## METHODS

We captured seven Decorah eagles to fit them with satellite transmitters, which includes a pair of siblings in both 2014 and 2016. They were caught 9 to 51 days post-fledge to give them time to build flight muscles which would permit a better fitting backpack-style harness. The exception was in 2014 when all three young fledged prematurely before their flight skills had been adequately honed. They had been harassed for weeks prior to fledging by clouds of Black Flies, likely *Simulium meridionale*, which may have prompted the early departure. These fledglings vanished for four days post-fledging until one was spotted by local law enforcement standing in a road near the nest. Consequently, that bird was captured by hand and received its transmitter just four days post-fledging.

The other fledglings were captured using a padam noose trap baited with fish. Upon capture we hooded them, attached a US Geological Survey aluminum band, and took various measurements to determine sex (Bortolotti 1984, Garcelon et al. 1985). We then fitted each with a 55-gram solar-powered Doppler (four from 2011-2014) or GPS (three from 2016-2017) platform transmitter terminal, or PTT, manufactured by Geo-Trak, Inc. (Apex, NC) using a backpack-style harness (Kenward 1987) of Teflon ribbon (Bally Ribbon Mills, Bally, PA). The Doppler PTTs were set with duty cycles of 8 hours ON followed by 18 hours OFF, continuously. The GPS units yielded a data point every three hours. To facilitate local tracking, we affixed VHF transmitters to all PTTs.

We received the location data using the Argos data collection and processing system through CLS America (Lanham, MD). Data were sorted and plotted (see Mandernack et al. 2012 for details) using ArcGIS 10 (ESRI, Redlands, CA). Distances were also calculated in ArcGIS from point to point and did not account for travels between all points, thus are conservative. We defined the start of migration as the initiation of steady northbound (spring) or southbound (autumn) movement preceded by concentrated localized movement that delineated a winter or summer range.

Home range and core use areas were estimated using the kernel density method via the adehabitatHR package (Calenge 2013) in Program R. We used the reference bandwidth ( $h_{ref}$ ) as the smoothing parameter and considered the 90% and 50% density contours to represent the home range (HR) and the core areas (CA), respectively, presented as  $HR = xxx.xx \text{ mi}^2$  ( $xxx.xx \text{ km}^2$ );  $CA = xxx.xx \text{ mi}^2$  ( $xxx.xx \text{ km}^2$ ). For Doppler data, only data points with a location class of 1, 2, and 3 were used. The expected error for location class 1 = 1000 m, class 2 = 350 m, and

class 3 = 150 m. For GPS data, all points were included in home range analyses because they yielded higher accuracy (within 25 m).

Mortality was suspected when transmitter data indicated the eagle was in the same location for multiple days and the activity sensor data within the transmitter showed little or no movement. The bird was subsequently recovered when feasible. In one instance, local electric company personnel noted anomalies in their lines, investigated, and found a dead eagle. RRP representatives then recovered the bird.

## RESULTS

Seven fledgling Bald Eagles (four males, three females) from the Decorah Fish Hatchery nests were satellite tracked between 2011 and February 2018 (Table 1). Tracking duration ranged from four days to three years. Mean hatch date was 01 April and fledging occurred an average of 77.4 (range = 74 - 81 days) days later (17 Jun). Males fledged at an average age of 77 days; females at 78 days. The average date when the eagles spent the first night away from the hatchery was 01 August (44.8 days post-fledge) but during the post-fledging dependency period, all the eagles, except D-1, would return to the natal area. Overall, dispersal (i.e., independence) occurred on 10 Sep (162.2 days old or 84.7 days post-fledge). Four of the seven eagles died from anthropogenic causes within their first year of life, three by electrocution, the other by vehicle collision.

Following is an overview of each bird's travels and status.

**D-1, female (2011).** D-1 remained within 1 mi (1.6 km) of her nest during the month following the attachment of the PTT; no exploratory flights longer than that were documented. She abruptly left her natal area on 14 August 2011 and traveled north-northwest 33 mi (53 km) into southeast Minnesota. By 18 August she had flown north then north-northwest another 147 mi (237 km) to northwest Wisconsin (Figure 1); an impressive debut of her flight ability. She shifted another 25 mi (40 km) north-northwest to Yellow Lake, WI, near the St. Croix River on 22 August and remained in that general area until 5 September. That day she began a four-day loop to just west-northwest of the western tip of Lake Superior then back again to northwest Wisconsin where she spent time along several lake shores. In mid-October, she flew southeast to the Black River area of western Wisconsin, then moved slowly south-southwest along the Black River throughout November to its confluence with the Mississippi River by early December. She then continued south down the Mississippi River to far southeast Minnesota, then into northeast Iowa arriving back in the Decorah area by 28 December 2011. D-1's summer/fall 2011 HR, including the extensive journey to Lake Superior and back, was 17,929 mi<sup>2</sup> (46,436 km<sup>2</sup>); CA = 5,455 mi<sup>2</sup> (14,129 km<sup>2</sup>) (Figure 2).

The next four months were spent ambling about northeast Iowa venturing as far west as the Wapsipinicon River, with one five-day loop into southeast Minnesota, then back to the Decorah area. The estimated winter 2012 HR = 3,476 mi<sup>2</sup> (9,003 km<sup>2</sup>); CA = 996 mi<sup>2</sup> (2,580 km<sup>2</sup>) (Figure 3).

D-1 left northeast Iowa on 4 May 2012 and flew north to the Mississippi River, then north-northeast through Wisconsin reaching the south shore of Lake Superior on 8 May. She headed west, rounded the western point of Lake Superior then veered north-northeast into Ontario. In late May while west of Lake Nipigon, north of Lake Superior in southern Ontario, she backtracked approximately 98 mi (158 km), but by 1 June was again aimed north-northeast. She arrived at her summer range in Polar Bear Provincial Park (PBPP) in northern Ontario on 14 June 2012, logging an estimated 1,296 mi (2,086 km) over 42 days. She remained on her small summer range through 12 September 2012.

The summer 2012 HR=121 mi<sup>2</sup> (314 km<sup>2</sup>); CA=24 mi<sup>2</sup> (63 km<sup>2</sup>) (Figure 2) extended from as far west as 8 mi (13 km) west of James Bay shore to the James and Hudson Bay shores. Night roost locations were varied from near the shores of both Hudson and James Bays, but the greatest concentration was 2.5 mi (4 km) west of the James Bay shore with a more dispersed focal point 3 mi (4.8 km) south of there. Daytime locations were both near the shore of the bays as well as inland near night roost sites.

On 13 September D-1 began her southbound migration. She did not re-trace her northbound route; instead she flew south along the James Bay shore, then inland but paralleling the shore. She flew a roughly 110-mi (177 km) loop on 14 through 16 September, then continued south then south-southwest until she reached the north-central shore of Lake Superior on 21 September. D-1 tarried there until 10 October when she moved slowly but steadily west then southwest along the lake shore. She rounded the western tip of Lake Superior on 20 October then marched steadily south-southeast through western Wisconsin, then through the southeast corner of Minnesota and back to northeast Iowa, 7 mi (11 km) from Waukon and 16.7 mi (27 km) from the hatchery by 1 November, ending her 50-day 1,117 mi (1,798 km) fall migration.

D-1 wintered from as far east as the Mississippi River near Prairie du Chien, WI, in early November, then along the Turkey River in northeast Iowa mid-month but by 19 November she was back in Decorah and did not venture more than 6 mi (10 km) from her natal area through 29 December 2012. In fact, she remained in northeast Iowa, with Decorah as a focal point, through 13 February 2013. However, most of March, April, and early May were spent in southeast Minnesota focusing on the Zumbro River. She returned to northeast Iowa on 10 May and remained there through 7 June 2013. Her winter 2012-13 HR = 4,872 mi<sup>2</sup> (12,619 km<sup>2</sup>); CA = 1,385 mi<sup>2</sup> (3,587 km<sup>2</sup>) (Figure 3).

D-1 began her 2013 northbound migration on 8 June, over one month later than in 2012, heading north through southeast Minnesota then northeast through west-central Wisconsin. On 13 June, she veered northwest across northwest Wisconsin and by 15 June had rounded the western tip of Lake Superior into Minnesota. She headed northeast through Ontario, some days covering 170 mi (274 km) per day (e.g., 19 June), and reached the James Bay shore by 20 June. She followed the shore north and by 24 June had reached her summer range on the south shore of Hudson Bay in PBPP 10 mi (16 km) from the previous year's core area, which she flew to the following day. She arrived 10 days later than the previous year. The approximate distance travelled was 1,097 mi (1,765 km) over 17 days, trimming 199 mi (320 km) and 26 days from the previous year's trip.

Her summer 2013 HR = 89 mi<sup>2</sup> (231 km<sup>2</sup>); CA = 22 mi<sup>2</sup> (56 km<sup>2</sup>) (Figure 2). Only once did she travel over 3.5 linear mi (5.6 km) from one data point to the next. She travelled a loop of 6.2 mi (10 km) on 7 Sept, but flights of that distance were uncommon. Her daily flights from night roost to daytime areas varied in direction from east-bearing flights near the James Bay shore to west of her roost area. She predominantly used three night roost areas, oriented north to south from 2 to 5.2 mi (3.2 to 8.4 km) west of James Bay. The night roosts were more tightly clustered than those used in 2012 suggesting favored spots gained with time and experience there.

The northern half of the summer range was the focal point from her arrival until 5 August, at which time she shifted south. She remained near the center of a 5.5-mile (8.9 km) diameter area, both day and night, from then until she left the summer range with no apparent visits to the James Bay shore. Her last full day on the summer range was 18 September.

D-1 began her southbound migration on 19 September and headed south-southwest, then west until she intercepted a perhaps familiar travel path from spring 2012. She efficiently aimed south-southwest again and flew west of the Lake Nipigon shore by 1 October near her spring 2012 route. By 4 October she had crossed into Minnesota and headed south past the western tip of Lake Superior and into western Wisconsin. She returned to Iowa on 13 October and was back on familiar winter range following her 964-mi (1,551 km), 25-day migration.

She visited Decorah on 16 October roosting near the water treatment facility. D-1 headed south on 17 October to the Turkey River, spent a few days there, then traveled 32 mi (51 km) north-northwest on 25 October and was 5 mi (8 km) southeast of Decorah. On 2 November, she was within 0.5 mi (0.8 km) of her nest tree. She remained in northeast Iowa, with Decorah as her focal point, and visited several rivers including the Turkey, Volga, Upper Iowa, and Yellow through mid-March 2014. On 17 March she flew 62 mi (100 km) northwest to the South Fork Zumbro River, 3 mi (4.8 km) north of Rochester, MN, and visited both the North and South Fork of the Zumbro River through 24 March. She headed back southeast 47 mi (76 km) to the Root River in southeast Minnesota, stayed a few days, then returned to the Upper Iowa River near Decorah on 28 March. D-1 focused the remaining time on her winter range along the Turkey and/or Volga Rivers approximately 35-40 mi (56-64 km) southeast of Decorah, or the Upper Iowa River near Decorah. Her winter 2013-14 HR = 1,784 mi<sup>2</sup> (4,621 km<sup>2</sup>); CA = 388 mi<sup>2</sup> (1,005 km<sup>2</sup>) (Figure 3).

On 27 May D-1's third spring migration commenced from the Turkey River and Robert's Creek near Elkader, IA. She traveled at least 94 mi (151 km) that day bearing north-northeast into western Wisconsin. After another 91 mi (146 km) on 28 May she roosted near Rice Lake, WI, and the following day had flown 103 mi (166 km) to and then around the western tip of Lake Superior. Her pace slowed through southern Ontario in early June, using a couple of the same night roosts for more than one night. After reaching Lake Nipigon on 9 June, her pace quickened and she was approximately 100 mi (161 km) southwest of her previous year's summer range by late on 11 June, a straight-line distance of 324 mi (521 km) over the two-day span. On 14 June she was along the James Bay shore and by later that day had traveled 50 mi (80 km) north to her summer range in PBPP for the third year. Arrival date was the same as in 2012 and 10 days earlier than in 2013. The 19-day spring 2014 migration covered 1,036 mi (1,667 km); 61 mi (98 km) shorter than 2013 and 260 mi (418 km) shorter than the 2012 trip.

The transmitter abruptly stopped sending data on 1 July 2014. Movements from arrival on the summer range until that day appeared very typical, using several of the same daytime and roost sites from previous years. There was no indication of mortality, such as a signal from a stationary location for multiple days. We suspect the transmitter failed.

**D-14, male (2012).** D-14 stayed within a mile (1.6 km) of the nest for the first month following transmitter deployment, then made a 2.1-mi (3.4 km) flight northeast of the nest on 26 July (Figure 4). He extended his range from the nest to 4.7 mi (7.6 km) northeast on the Upper Iowa River on 30 July and roosted away from the nest that night, presumably for the first time. That trend continued in early August as he traveled further and stayed away from the nest area for a week while exploring the Upper Iowa River. Another exploratory flight took him 12 mi (19.3 km) west of the nest to the Turkey River on 22 August, then back to the Upper Iowa River the next day. D-14 also ventured 24 mi (38.6km) south from the Upper Iowa River to a southern section of the Turkey River in early September. He returned to the Upper Iowa River approximately five days later and remained there northwest of Decorah through 21 September. D-14's summer 2012 HR = 191 mi<sup>2</sup> (493 km<sup>2</sup>); CA = 37 mi<sup>2</sup> (95 km<sup>2</sup>) (Figure 2).

Early on 22 September he was just 1.4 mi (2.3 km) north-northeast of the nest/hatchery in or over the city of Decorah. The following day he traveled west-southwest into unfamiliar territory, dispersing from his natal area. He headed southwest nearly 50 mi (80.5 km) over the next several days, then jogged 17.5 mi (28.2 km) south-southeast on 28 September to the Cedar River just northwest of Waterloo, IA, then west-northwest the next day. By 1 October he was 69 straight-line mi (111 km) southwest of the nest, the farthest distance he would travel from it. After spending a couple of days on or near the West Fork of the Cedar River, he flew southeast 20 mi (32.2 km) then changed course again and headed generally north 45.2 mi (72.7 km) on 6 and 7 October. Later on 7 October he veered southwest 10.1 mi (16.3 km) and settled on the Cedar River between Charles City and Nashua through 26 October. On 27 October, he flew 12.5 mi (20.1 km) southwest to the Shell Rock River and resided along it on the stretch between Green and Nora Springs, IA, through 17 November. His PTT activity sensor, which records movement, remained static from that day. Anticipating mortality, we drove to that location and found him one foot from the bottom of an old power pole with burns on his feet, which confirmed electrocution. His physical condition (fat reserves, muscle mass and feather condition) was very good.

**2014 Fledglings.** Spring and summer 2014 were filled with incredible numbers of Black Flies which we believe prompted the premature fledging by the three young eagles. There was no sign of any of the eaglets for four days until Bob Anderson got the call about an eagle in the road. On 22 June, just after we completed the fitting of the transmitter on that female, named "Four" and were about to release her at the hatchery, we were summoned by several people near the hatchery that there was another eagle in Trout Creek near the N-1 nest tree. That male eagle was quickly recovered from the creek but had an obvious broken wing. He was hooded and watched while arrangements were made to transport him immediately to a rehabilitation clinic, SOAR, in Dedham, IA.

The third youngster, a male, would not appear until 25 June, seven days post- "fledging", on top of a large mulch pile at the Decorah Yard Waste Facility 1.2 mi (1.9 km) northeast of the nest.

This site would soon become a focal point of activity for the two remaining fledglings and the adults.

**Four, female (2014).** With Four's almost certain premature fledging, her flight skills were rudimentary for the week following deployment of the transmitter. Lack of adequate flight experience in that period put her in harm's way several times. Had she not had a transmitter and people watching over and tracking her daily she surely would have perished. Examples include being on the ground and vulnerable one or more nights, being drenched by an evening thunderstorm and trapped in a 4-foot-tall cornfield all night unable to extend her wings to escape and being trapped while treading water in the fish hatchery raceway. In all examples, she was recovered and brought back to the hatchery or set atop a mulch pile at the Decorah Yard Waste Facility, as was the case on 29 June when Four was first placed there after being rescued from the cornfield after a rainstorm. The adults came to the compost site multiple times per day and delivered food regularly to both youngsters. This site was a focal point for Four until late July.

By mid-July Four became a more capable flier and flew up to 8 mi (12.9 km) along the Upper Iowa River and would occasionally roost there (Figure 5). She spent her first night away from the nest and/or mulch pile on 18 July along the Upper Iowa River northwest of Decorah. On 20 July, she was reported by a Decorah resident to be laying on the ground for several hours. She had been non-fatally electrocuted. Later that day she was able to fly off. She was closely monitored the next several days. We captured her on 25 July to be certain she had no electrocution burns or other injuries that would debilitate her. She appeared completely healthy and was released minutes later at the nest area where we were confident she would be assisted by the adult eagles. Later that day she was observed perched in the N-1 nest tree with both parents.

Four stayed within 1.2 mi (1.9 km) of the nest/hatchery area until 10 September when she flew 3.2 mi (5.1 km) north and roosted along the Upper Iowa River. Her exploratory flights increased in frequency after that. In fact, she flew 21 mi (33.8 km) northwest on 23 September, by far her longest flight, along the Upper Iowa River on the Iowa/Minnesota border. She returned to the hatchery a few days later and did not venture far from it until the latter half of October. On 4 November, she flew 17 mi (27.4 km) southeast from the Upper Iowa River 14 mi (22.5 km) north of Decorah to near Calmar, IA, and remained there through 5 November, the last day on her summer range. Her summer 2014 travels covered a HR = 118 mi<sup>2</sup> (306 km<sup>2</sup>); CA = 16 mi<sup>2</sup> (41 km<sup>2</sup>) (Figure 2).

She began a slow migration south on 6 November. She drifted slowly south and southeast traveling along several creeks and rivers including the Turkey, Volga, and Maquoketa. On 1 December, she flew 35 mi (56.3 km) south-southwest to just north of Iowa City, IA. Data indicated she occasionally visited agricultural fields and farm woodlots, perhaps searching for and feeding on carrion. She stayed near the Cedar River and its tributaries until late December then shifted west-northwest to the Iowa River/Coralville Lake area. By 29 December she veered southwest then over the next several days had meandered south-southwest, and by 5 January 2015 had concluded her fall migration.

On 8 January she was as far as she would ever be, 150 mi (241.4 km) from her nest, near Batavia, IA. She headed back northeast to north of Fairfield, IA, then three more miles (4.8 km) northwest to near Packwood, IA, where she would reside through 30 January. Daytime hits in

January suggested she was again foraging in agricultural fields, presumably on hog carrion. From 30 January through 3 February she moved north nearly 13 mi (20.9 km) to Clear Creek concentrating her time just west of Keota, IA. She remained in that general area through 3 March.

Transmitter data showed no activity after 3 March. Anderson drove to the area to check on Four's status on 6 March. He observed numerous hog confinement operations and "hundreds and hundreds of eagles" in that area feeding on hog carcasses. He found Four 2 ft from the bottom of an old power pole. We examined the carcass the next day and confirmed electrocution as the cause of death. Four had remarkably ample fat reserves and excellent muscle mass. Feathers and feet were also in near perfect condition. Although she did not complete a full season, Four had a winter 2015 HR = 267 mi<sup>2</sup> (691 km<sup>2</sup>); CA = 70 mi<sup>2</sup> (181 km<sup>2</sup>) (Figure 3).

**Indy, male (2014).** Indy was the third fledgling, a male, which appeared on the mulch pile at the Decorah Yard Waste Facility on 25 June, as described earlier. Indy spent his days at the mulch pile waiting for food deliveries from the adult eagles and flying to the treeline 200 yds (183 m) away where he typically roosted for the night. When Four was placed at the mulch pile following her recovery from the cornfield "trap" on 29 June, the two bonded again and were often seen together lounging atop their respective mulch piles and squabbling over food deliveries from the adults.

Indy was captured at the mulch pile at first light on Independence Day, hence the name "Indy", before Four or either adult had shown up. He was released with transmitter back at the mulch pile a short time later with plenty of food for both him and Four. This would provide our first opportunity to study travel behavior of same-year siblings.

Indy stayed within a mile (1.6 km) of the mulch pile through 8 July and had become an accomplished flier in that short time (Figure 5). He was seen soaring an estimated 800 ft (235 m) over the area surrounding the yard waste facility on that morning. Later that morning the electric company detected an anomaly in a transmission line approximately 0.5 mile (0.8 km) from the mulch pile which warranted an investigation. The technician found Indy dead beneath the high voltage lines. The transmitter and harness were completely intact and performing normally, which indicated they played no part in the electrocution.

**2016 Fledglings.** Two of the three eggs hatched in 2016, a departure from the usual three in previous years. Both were males and they were observed to be close companions, perching, resting, playing, and soaring together often following the fledgling. With multiple GPS-based transmitters in hand, we were hopeful of fitting both of "the boys" with them to examine whether they would disperse and travel together or independently.

**D-24, male (2016).** D-24 stayed within a mile (1.6 km) of the nest for the month following transmitter deployment on 30 June. On 30 July, he flew 1.3 mi (2.1 km) north-northeast of the nest then returned a few hours later (Figure 6). The next day he flew over 6 mi (9.7 km) northeast, then another 5.3 mi (8.5 km) east, where he roosted for the night. A nearly 11-mi (17.7 km) flight on 1 August had him back at the nest area by early afternoon. His next significant venture from the nest occurred on 4 August when he flew 14.7 mi (23.7 km) northeast, then veered northwest another 8.5 mi (13.7 km) to near the Iowa/Minnesota border; he

returned to the nest area the following day. A day trip of 11 mi (17.7 km) northeast to the Upper Iowa River and back again took place on 13 August. The next significant trek began on 21 August bearing northeast then changing course several times ending up again on the Iowa/Minnesota border on 23 August. He then headed southwest to Bluffton, IA, then south to the Upper Iowa River, northwest of Decorah by mid-afternoon on 26 August. On 28 August, he flew 8.6 mi (13.8 km) west, then back east 3.6 mi (5.8 km); on 30 August, he headed 5.6 mi (9 km) southeast, now southwest of Decorah and by late that day returned to the hatchery. That trip had him away from the nest for nine days and covered nearly 80 total mi (128.7 km).

D-24 left the nest/hatchery on 31 August and, according to our data, would never return to it, though he would often be close. On 31 August he went south, then southwest to the Little Turkey River where he resided through 11 September. Later that day he flew 26 mi (41.8 km) north-northwest near Cresco, IA. He briefly crossed into Minnesota the next day then headed west-southwest back into Iowa to the Upper Iowa River by dusk. On 13 September, he had flown 26 mi (41.8 km) south-southeast to 6.4 mi (10.3 km) south of the hatchery, but then flew almost 13 mi (20.9 km) southwest that afternoon, back to the Little Turkey River 4 mi (6.4 km) east of where he had been just a few days prior.

On 17 September, he headed over 50 mi (80.5 km) southeast to Delhi, IA, where he stayed for nearly a week. At this time, the transmitter became less reliable at sending daily data due to the inability to sufficiently recharge the batteries. There was a gap from early on 23 September until early afternoon of 27 September. By then he was 26 mi (41.8 km) south-southeast of Delhi and he continued south until he was just west of Muscatine, IA, approximately 70 mi (112.7 km) from Delhi, by late afternoon of 28 September. Another three-day data gap from 1 to 4 October masked exactly when he flew back north-northwest 62 mi (99.8 km) but he was back near Delhi by 4 October. He stayed in the Delhi/Greeley, IA area until early on 20 October, then headed south-southwest 18 mi (29 km) to the Wapsipinicon River where he stayed through the remainder of October. He then looped back north-northeast to the Maquoketa River by 3 November and remained there through 6 November. Transmitter data gaps of three to four days were occurring more frequently by this time, but by 9 November he had moved nearly 17 mi (27.4 km) north to Elk Creek, northeast of Greeley, IA. On 12 November, he flew 11.3 mi (18.2 km) northeast to the Mississippi River and was just 1 mi (1.6 km) southwest of Eagle Valley. Another data gap occurred from 12 to 20 November and by then he had flown 18 mi (29 km) north-northwest to Clayton County, IA, 4 mi (6.4 km) west of the Mississippi River. He was there through 23 November, but an even longer gap occurred from that day through 7 December, and by then he had returned to the Mississippi River 3 mi (4.8 km) southeast of Eagle Valley, where he remained through 10 December. His summer 2016 HR = 4,056 mi<sup>2</sup> (10,505 km<sup>2</sup>); CA = 884 mi<sup>2</sup> (2,289 km<sup>2</sup>) (Figure 2).

On 13 December, following a three-day data gap, D-24 was headed steadily south, suggesting he was beginning fall migration. He had flown nearly 16 mi (25.7 km) southwest from the Mississippi River to near Greeley, IA, then proceeded south past Delhi the next day. By 17 December he had reached the Wapsipinicon River and by the following day had moved south to the Cedar River in northwest Cedar County, IA. He remained there through at least 29 December. The next data point on 3 January 2017, showed he had traveled 14 mi (22.5 km) northwest to 5 mi (8 km) southeast of Cedar Rapids, IA. Later that day he had shifted 9 mi (14.5

km) south to the Iowa River and continued to move slowly south along it through 7 January, his final day of fall migration.

Winter was spent focusing on the Iowa River just southwest of Conesville, IA, through January. On 1 February, he headed southeast along the river to near Wapello, IA. He tarried there for just two days before heading back upriver to near Conesville once again. While he focused primarily on the Iowa River he visited agricultural fields southwest of the river on 11 February. His winter 2017 HR = 107 mi<sup>2</sup> (277 km<sup>2</sup>); CA = 16 mi<sup>2</sup> (41 km<sup>2</sup>) (Figure 3).

On 12 February D-24 began his spring migration heading northeast to the Cedar River floodplain, then upriver the next day to near Wilton, IA. He flew 24 mi (38.6 km) north on 17 February to the Wapsipinicon River, tarried there until 21 February when he continued his northern trek to some agricultural fields with scattered woodlots near Cascade, IA. He remained there through 26 February. The next data point we received on 3 March had him 26 mi (41.8 km) northwest to just north of Greeley, IA, and by the next day he had flown 43 more mi (69.2 km) northwest to the Little Turkey River near Waucoma, IA. Crane Creek was the area of interest on 7 and 8 March. We attempted to get a visual of D-24 on 9 March and got a strong transmitter signal near the Jackson Junction and Waucoma, IA area but did not see him. Data review the following day revealed he had flown 9 mi (14.5 km) southwest to the Little Wapsipinicon River later that day. By 15 March he was heading northeast, then jogged northwest over 4 mi (6.4 km) to Crane Creek on 16 March, then back northeast to within 6 mi (9.7 km) of his natal area on 17 March, ending spring migration.

D-24's first day on the summer range was spent on and north of the Upper Iowa River. The next day, 19 March, he flew northwest, crossed the Minnesota border, then veered north to the Mississippi River covering approximately 53 mi (85.3 km). By 21 March he was headed back south and was 2 mi (3.2 km) from the nest by early afternoon. He traveled along the Upper Iowa River the next couple of days, then was within a few hundred feet of the hatchery nest on 24 March. The visit "home" was brief, however, as he ventured nearly 6 mi (9.7 km) northwest along the Upper Iowa River later that afternoon. Most of his time was spent north of Decorah on the Upper Iowa River through 30 March. He then headed west approximately 8 mi (12.9 km) west of the hatchery the next two days, then returned to the Upper Iowa River late on 1 April.

Early April was spent meandering along the Upper Iowa River and west to Ten Mile Creek 8 mi (12.9 km) west-northwest of the hatchery. Data transmission was consistent all month with just one three-day gap from 3 to 6 April. On 17 April, a roughly 25-mi (40.2 km) loop heading south from the Upper Iowa River area, then west, then north-northwest to near Bluffton, IA, occupied most of that day. Another such peregrination occurred on 21 April leaving the Upper Iowa River northeast of the hatchery heading 9 mi (14.5 km) south-southwest, then 18 mi (29 km) west-northwest to near Ridgeway, IA, then east over 6 mi (9.7 km) to Ten Mile Creek, 7 mi (11.3 km) northwest of the hatchery. On the afternoon of 22 April, he flew nearly 17 mi (27.4 km) from the Upper Iowa River south-southeast to northwest of Calmar, IA, 5 mi (8 km) south of the hatchery. He flew nomadically the next couple of days before returning to the Upper Iowa on 24 April. The remainder of April through 1 May was spent in the Upper Iowa River and Ten Mile Creek area, northwest of the hatchery.

There were three data gaps in May: the afternoon of 1 May through early afternoon 4 May, mid-afternoon of 8 May through late morning 11 May, and 20 through 26 May. Following the first gap D-24 was 5.4 mi (8.7 km) southwest of the hatchery, then flew over 4 mi (6.4 km) south-southeast to farm country, east of Ossian, IA, then 10 mi (16.1 km) north-northwest by day's end to within a mile (1.6 km) of the hatchery. He was on the Upper Iowa River northeast of the hatchery between 5 and 8 May. Another lengthy loop flight was undertaken beginning 11 May from north of the Upper Iowa River bearing south for 15 mi (24.1 km) to farm country northeast of Ossian, IA, then northeast 6 mi (9.7 km) more by day's end. On 13 May he continued his trek heading southwest, then switched to the east, then northeast, completing a minimum of 25 mi (40.2 km) that day, ending nearly 25 mi (40.2 km) east of the hatchery. On 14 May he headed west-northwest to the Upper Iowa River northeast of the hatchery. It appeared he spent most of his time on the Upper Iowa River and Canoe Creek through the morning of 27 May, though the last May data gap clouded that. On 27 May he headed south over 10 mi (16.1 km) to the Calmar/Ossian area he had visited a few times during the previous several weeks. He tarried there until 2 June when he flew north to the Upper Iowa River once again. His focal point through 6 June was the Upper Iowa River and Canoe Creek, but a second focal point appeared to be in the making, as he flew back 5-6 mi (8-9.7 km) south of the hatchery, the Calmar/Ossian area, then returned to the Upper Iowa River later that day.

A major trek began on 7 June when D-24 flew 117 mi (188.3 km) north to northwest Wisconsin. He covered 11 more mi (17.7 km) the next day, then nearly 53 mi (85.3 km) more on 9 June, reaching Webb Lake, near Webb, WI. He remained there through at least 14 June, when another data gap occurred that extended through midday 20 June. By then he had traveled over 143 straight-line mi (230.1 km), minimum, east-northeast into the Upper Peninsula of Michigan. On 21 June, he traveled 85 mi (136.8 km) southwest, then west back into northern Wisconsin. On 23 June, he headed generally south and covered 36 mi (57.9 km). By the morning of 24 June, the PTT had once again shut down. The next data point received was the morning of 1 July. He had traveled over 171 straight-line mi (275.2 km) during that gap and was in far northeast IA, 11.8 mi (19.0 km) north of the hatchery. By early afternoon that same day he was 4.9 mi (7.9 km) southeast of the hatchery and northeast of Calmar/Ossian. On 3 July, he was located by Eagle Valley staff using the VHF signal at a hog farm in that vicinity, and later that day was spotted 3 to 4 mi (5 to 6.4 km) further west and photographed by visiting eagle enthusiasts who spotted him sitting atop a power pole along a rural road.

Data became extremely infrequent after 4 July, the next hits coming on 27 September, when he was 4-6 mi (6.4-9.7 km) south of the hatchery, again in the Calmar/Ossian area, then on 11 November from the same area. His summer 2017 HR = 11,321 mi<sup>2</sup> (29,320 km<sup>2</sup>); CA = 1,667 mi<sup>2</sup> (4,317 km<sup>2</sup>) (Figure 2).

Winter data from late December 2017 and early January 2018 continued to be from that area from 2.3-10.3 mi (3.7-16.6 km) south of the hatchery. Though data was infrequent, the consistency of use of that new focal point, Calmar/Ossian, was obvious. Eagle Valley staff traveled there on 4 January 2018 to attempt to get a visual of D-24. We quickly had a strong VHF signal once in the Calmar/Ossian area. We saw him perched in a wooded swale 25 yds (23 m) south of a rural road with several other eagles of various ages.

**D-25, male (2016).** No locations for D-25 were recorded further than 0.5 mi (0.8 km) from the nest until 30 July. He flew 2.1 mi (3.4 km) north-northwest and returned to the nest area later that day (Figure 7). The next day he flew 5.7 mi (9.2 km) north-northwest, then 1.5 mi (2.4 km) southwest, then over 5 mi (8 km) late that afternoon returning to the N-1 nest tree before dusk. D-25's flights became increasingly ambitious. On 1 August, he traveled 16.5 mi (26.6 km) northwest and spent his first night away from the hatchery. He continued generally north and covered over 25 mi (40.2 km) on 2 August and 48.5 mi (78.1 km) more on 3 August ending the day near Wabasha, MN, on the Mississippi River, a total trek of 94 mi (151.3 km) from the hatchery. He tarried there nearly two days then headed back south on 5 August and was back at the hatchery by midday on 6 August, covering 76 mi (122.3 km) on the return trip. He remained near the hatchery area through 10 August before taking a roughly 3 mi (4.8 km) south, then back north, day-trip. The hatchery area was his focal point for the remainder of August, though he took several one-to-three-day trips in various directions but stayed within 12 mi (19.3 km) of the hatchery.

The last time D-25 was located at the hatchery was 1 September. His next journey began by heading south-southwest to the Turkey River, then northwest on 3 September to the Upper Iowa River on the Iowa/Minnesota border, then northeast into Minnesota the next day. He veered east, then southeast, crossing back into Iowa on 6 September. On 8 September, he flew nearly 32 mi (51.5 km) southeast crossing the Mississippi River into Wisconsin and stayed on the Wisconsin River for two days. On 10 September, he crossed the Mississippi River back into Iowa and flew nearly 27 mi (43.5 km) west-southwest to the Volga River. He headed 17 mi (27.4 km) west-northwest on 12 September, still on or next to the Volga River, then the next day flew 17 mi (27.4 km) south-southwest to the Wapsipinicon River. He stayed along the Wapsipinicon until 17 September when he flew 13 mi (20.9 km) northeast to Fayette County, Iowa, between Maynard and Westgate. He spent time northeast of there on the Volga River, then south of there on the shore of Lake Oelwein on 19 September, then returned to the Volga on 20 September. His summer 2016 HR = 2,353 mi<sup>2</sup> (6,095 km<sup>2</sup>); CA = 243 mi<sup>2</sup> (629 km<sup>2</sup>) (Figure 2).

Data from 22 September showed he was once again between the towns of Maynard and Westgate, but his signal was stationary after 7:42 AM. Data continued to come from the same location the next couple of days. We drove there on 26 September and using the VHF receiver located D-25, dead alongside a rural road, victim of vehicle collision while scavenging a raccoon carcass in the middle of the road.

**2017 Fledglings.** The three 2017 fledglings, two males and a female, fledged in typical fashion and by late June were observed perching near the hatchery, as virtually all fledglings from previous years had done. Attempts to capture one of the fledglings for fitting with the final PTT of the tracking project were diligent for two weeks in late June and early July, as David and Ann Lynch faithfully set out trout "bait" every morning at day break in the same place and in the same fashion as our immensely successful capture efforts in previous years. These young eagles, however, were less interested in our bait. Curiosity fly-bys over bait became fairly regular occurrences, but instead of coming to land near the bait to further inspect and sample, these youngsters began loud and frequent food begging calls in an attempt to gain an even easier meal delivered from a parent bird back at the nest tree; and it worked for several weeks.

By 6 August, a month later than most previous capture dates, the female had come to bait set out by Brian Malaise, manager of the hatchery, for two consecutive days. We set our padam before light the next morning and had captured the female, D-27, shortly after day break.

**D-27, female (2017).** D-27's later than usual PTT deployment on 7 August and subsequent advanced physical development compared to previous fledglings was evident in her extended trips from the nest/hatchery area just two days following capture. It is possible she made such trips before PTT deployment. On 9 August, she flew northeast 4.8 mi (7.7 km) to the Upper Iowa River, spent the night away from the nest/hatchery, then returned the next day (Figure 8). She had two more trips of similar length, one to the northwest, the other northeast, where she also stayed overnight away from the nest through 17 August.

D-27 took her first significant trip from the hatchery on 19 August and that was the last time she was known to be there in 2017. She headed northwest, then north-northwest over 35 mi (56.3 km) to the Root River in southern Minnesota. She resided there until early on 22 August when she headed back into Iowa 11 mi (17.7 km) east of the hatchery, then veered northeast to just south of the Upper Iowa River by day's end, covering 48 mi (77.2 km) that day. By 25 August she had ventured east to the Mississippi River 2 mi (3.2 km) north of Lansing, IA. Later that day she meandered upriver to De Soto, WI, then on 27 August went north 26 mi (41.8 km) to just north of LaCrosse, WI. On 28 August, she was pointed south-southwest and by late on 30 August was back in far northeast Iowa near the Upper Iowa River. By midday on 31 August she was 6 mi (9.7 km) southeast of the hatchery concentrating on a roughly 10-mi (16.1 km) stretch, east to west, and appeared to be visiting several farms, possibly scavenging carrion.

On 13 September, D-27 flew south-southeast 15 mi (24.1 km) to near Postville, IA, stayed a few days then headed south-southwest on 18 September to the Turkey River. On 19 September, she began heading south and southeast reaching the Volga River near the town of Volga, IA, then changed course that afternoon and headed 20 mi (32.2 km) northwest back to the Turkey River. After three days in that vicinity she was off to the northeast, then dipped down to the area southwest of Postville once again and stayed through 29 September. That day she flew nearly 17 mi (27.4 km) south, then bounced back north nearly 3 mi (4.8 km) the next day to the Volga River. October began with a looping two-day, 35-mi (56.3 km) peregrination headed east, then southeast, then north-northeast to near Elkader, IA, then northwest to near Elgin, IA and the Turkey River. The next day she was 4 mi (6.4 km) north in her spot southwest of Postville. She meandered in that general area until early on 24 October when she headed 4.8 mi (7.7 km) south-southwest to Otter Creek, then the next day flew east-northeast, then south-southwest to Brush Creek, northwest of Arlington, IA. This area suited her until 3 November when she moved west-southwest over 9 mi (14.5 km), then jogged northwest for 2.4 mi (3.9 km) to the Volga River, west of Fayette, IA. She resided in that area until 18 November, except for 10 and 11 November when she took a nearly 19-mi (30.6 km) one-way jaunt south, then back. On 18-20 November, she headed east along the Volga River, then early on 21 November flew south-southeast, then south-southwest nearly 18 mi (29 km) to the Maquoketa River near Dundee, IA, just south of Backbone State Park. She stayed in this area through 6 December. We attempted to locate her on 29 November and were close enough to get a weak VHF signal from the park early, but then we lost it as she flew out of range. D-27 had a summer 2017 HR = 1,923 mi<sup>2</sup> (4,980 km<sup>2</sup>); CA = 528 mi<sup>2</sup> (1,367 km<sup>2</sup>) (Figure 2).

Fall migration began on 7 December with a 30-mi (48.3 km) jaunt southward to the Wapsipinicon River. On 9 December, she continued south another 46.5 mi (74.8 km) to the Cedar River. Fall migration concluded with a 17-mi (27.4 km) shift southeast on 13 December, arriving at the Mississippi River near Port Louisa, IA.

Life on the winter range began the next day with D-27 traveling a roughly 110-mi (177 km), two-week long loop in southeast Iowa that started and ended at the Mississippi River. That trek took her northwest to the Iowa River, where she stayed until 19 December. She then headed south, then west to the East Fork of Crooked Creek, near Winfield, IA. She resided there until 27 December then that afternoon proceeded generally west-southwest to an area near Wayland, IA, in northwest Henry County, near the Skunk River. She headed south over 20 mi (32.2 km) on 30 December then 2 more mi (3.2 km) the next day reaching the farthest southwest point of her loop. On the afternoon of New Year's Day 2018 she pointed east and flew 30 mi (48.3 km) reaching the Mississippi River near Burlington, IA, by late afternoon.

D-27 spent the rest of the winter along or adjacent to the Mississippi River, to a large extent, concentrating her time in the area south of Oquawka, IL. She moved inland on 9 January and the next day was on the Iowa River southeast of Wapello, IA. She spent time along agricultural field edges and farm woodlots south of the Iowa River on 11 through 13 January, then went back north to the Iowa River. She headed east along the Iowa River and arrived back at the Mississippi River near Keithsburg, IL, on 16 January. Three days later she shifted 8 mi (12.9 km) upriver to near New Boston, IL. On 4 February, she shifted back downstream to re-visit the area south of Oquawka, IL, then continued slowly downstream the next couple of days to near Shokokon, IL. By 12 February she was drifting back upstream and spent time near Keithsburg, then New Boston, IL, where she stayed until 24 February, her final day on the winter range. Her winter 2017-18 HR = 1,076 mi<sup>2</sup> (2,788 km<sup>2</sup>); CA = 292 mi<sup>2</sup> (755 km<sup>2</sup>) (Figure 3).

Spring migration commenced on 25 February with D-27 aimed northeast through Illinois intercepting the Mississippi River later that day 16 mi (25.7 km) north of her departure point.

## DISCUSSION

**Hatching and Fledging.** The mean hatch date of 1 April for the Decorah Fish Hatchery eaglets was determined by a live nest camera. Other nest cameras in the Upper Midwest (Decorah North, MN DNR, MN Bound, Arconic) revealed hatching dates from early March through early April. Fledging occurred at roughly 11 weeks of age for all seven Decorah eagles, which is consistent with reports of fledging at 10-12 weeks (Stalmaster 1987), 12 weeks (Hunt et al. 2009), and 11-13 weeks (Buehler 2000).

**Post-fledging Dependency Period.** The PFDP for the Decorah eagles lasted an average of 12 weeks. The premature fledge and non-fatal electrocution of Four may have contributed to her extended PFDP of nearly 20 weeks. During the first month, all fledglings stayed within 1 mi (1.6 km) of the nest. After that time, the length of exploratory excursions from the nest increased progressively in distance and duration, and natal visits became shorter for most Decorah birds. The exception was D-1, which took no pre-dispersal exploratory flights prior to emigration. Hunt et al. (1992) observed that during the first week post-fledge, the eagles remained near the

nest and then moved to nearby lakes and rivers, often returning near the nest to roost. Like the Decorah eagles, Wood et al. (1998) reported that the distance of fledglings observed from the nest increased with age during the PFDP. In contrast to Decorah, those fledglings returned to their natal nest each day until dispersal. In Arizona, three eagles exhibited “false starts” where eagles left the nest area but returned 1-3 days later (Hunt et al. 2009). Several of the Decorah eagles exhibited this behavior, which we refer to as exploratory flights, but occasionally spent considerably longer time away from the natal area before returning. For example, D-24 spent 9 days on an exploratory flight in late August and D-25 returned to his natal area 5 days after a 160 mi (257 km) voyage in early August, also displaying a remarkable homing instinct. Exploratory flights are advantageous in that individuals could explore their ability to survive during independence while still having the benefit of returning to parental care (Weston et al. 2018).

**Dispersal.** Dispersal of the Decorah eagles occurred at 19-31 weeks (mean = 23) of age. Hunt et al. (1992) attached radio transmitters to five nestlings in California that dispersed at 14-17 weeks old. Hunt et al. (2009) identified a 16-20-week dispersal age for 11 nestlings radio-tracked from Arizona. In Florida, Wood et al. (1998), also using radio telemetry, documented dispersal at 15-22 weeks for 40 nestlings. Six radio-tracked and two color-marked fledglings in Minnesota dispersed at 19-29 weeks (Kussman 1977), assuming a 12-week-old fledgling period, similar to our results. Gerrard et al. (1974), Harper (1974), and McCollough (1986) reported dispersal between 17 and 22 weeks of age. Dispersal may be triggered by a decline of foraging opportunities for some populations (Hunt et al. 1992). The eagles of the Decorah Fish Hatchery are not limited by food in the nest area because of the ample supply of trout at the hatchery, as well as other sources, therefore, leave for other reasons. This could be a key factor resulting in the later than average dispersal compared to other studies. D-1 was observed being fed a fish by the adult female prior to her dispersal two months following fledge. While no provisioning of fledglings by adults was documented after two months following fledge, they are certainly being tolerated in the natal area with all its familiar resources, and learning from the adults, which has obvious survival advantages. No aggressive behavior from adults to their fledglings was ever observed. Weston et al. (2018) observed such tolerance by adult Golden Eagles (*Aquila chrysaetos*) in Scotland toward their fledglings and believed there was fledgling benefit derived from the extended stay.

**Sibling Dispersal.** All seven of the Decorah eagles were produced from the same parents from 2011 through 2017. Two sets of same year siblings (eagles Four and Indy and eagles D-24 and D-25) were tracked; however, Indy was electrocuted just 4 days after transmitter deployment, so few comparisons between Four and Indy could be drawn.

D-24 and D-25 exhibited some remarkable similarities and some marked differences. Although D-25 fledged six days later than D-24, both embarked on their first flight of over a mile from the nest on the same day, but flew in different directions. Both returned to the nest/hatchery area within a few hours of departure. Both made significantly longer exploratory flights the next day, but again in different directions. Their first night spent away from the hatchery was a day apart and dispersal from the natal area occurred a day apart (Table 1). Though both began emigrating south-southwest for a few days, their paths became variable and soon diverged. Both Laing et al. (2005) and Hunt et al. (2009) each tracked two pairs of siblings that differed in emigration timing and direction, though Hunt et al. (1992) proposed that post-fledging migratory direction was genetically influenced in that siblings tracked had paths more similar than non-siblings.

Dispersal for different year Decorah siblings was variable in timing (14 Aug – 06 Nov) and direction. This variability suggests that the genetic influence indicated by McClelland et al. (1996) and Hunt et al. (1992) may not play as large a role in migration with eagles, especially when abundant food is still available at the time of dispersal. Similarly, Harmata et al. (1999) suggested that dispersal of juveniles from the Greater Yellowstone Ecosystem was not driven by a lack of resources. Other factors such as dominant wind direction during dispersal initiation (Delgado et al. 2010) or previous success during the exploratory phase of the post-fledging dependency period, might have led to the variability. The area surrounding the Decorah nest site is replete with rivers and creeks offering countless fishing opportunities, as well as numerous hog farms and exceptional White-tailed Deer (*Odocoileus virginianus*) populations that provide an abundance of carrion. Other eagles can lead young birds via visual cues to these resources, so the drive to undertake migrations of pre-determined timing, direction or distance may not be so impactful. In fact, it is unlikely that the area the Decorah birds emigrate to has more food resources than the one they just left. Perhaps encounters with other eagles at foraging areas influences fledgling dispersal timing and direction. More in-depth observations of interactions of fledglings at time of dispersal will help reveal this potential impact.

**Migration.** The adult Decorah eagles do not migrate, which was clearly evident by year-round on-site observations and the live nest camera. The high-resolution RRP nest cameras permit clear identification of individuals by examination of physical features such as beak and brow shape, and unique retina spots. Other eagle nests monitored by cameras in similar latitudes, such as Decorah North, Eagle Valley, MN DNR, MN Bound, and Arconic, have shown this is not unusual for adults and may be the norm.

Four Decorah fledglings completed a migration from their natal area. While the sample size is small, spring and fall migration was variable, though similarities were observed. Migration behavior varied from D-1's long-distance, repeated spring/summer migrations of over 850 straight-line mi (1368 km) to northern Ontario and overwintering in northeast Iowa and southeast Minnesota, to D-24's relatively short (75 straight-line mi [121 km]) fall migration south in fall 2016 and his return to northeast Iowa in spring 2017, with no apparent migration out of that area through January 2018, though data gaps render the fall 2017 movement (or lack thereof) inconclusive. Eagles Four and D-27 also made short distance southward migrations (128 and 93 straight-line mi [206 and 150 km], respectively) in their first autumns to their winter ranges. Continued tracking of D-24 and D-27 will help further reveal similarities and differences in sibling's travel behavior.

Migration timing by eagles in the Upper Midwest can prove to be more ambiguous than that exhibited by more northern, or southern, nesting/summering eagles that typically travel long distances. Summer and winter mobility within a range, especially a large one, can muddle migration start and end times. We found this to be true with adults (Mandernack et al. 2012) as well, but perhaps even more so with juveniles, as their movements have been described as "erratic" and "unpredictable" (McClelland et al. 1994), "nomadic" (Bowman et al. 1995) or "wandering" (Harmata et al. 1999). We described such behavior by the Decorah birds during dispersal and migration, with abrupt and sometimes frequent changes of course in a single day. Double-backs or loops during travels are also examples of erratic or unpredictable flight behavior.

Adding to travel behavior terminology ambiguity are the examples of D-1's first trip to the western tip of Lake Superior in her first summer/fall and the trek by D-24 in his second summer. Perhaps these could more accurately be called "journeys" or "treks", rather than what we typically attribute to "migration". Neither of those had a specific range at its terminus that was occupied for more than a few days. Instead, they wandered for a few months (D-1) or weeks (D-24) and returned to their natal area. D-1's travel behavior changed in subsequent years to what became a more typical migration from summer to winter range. Unfortunately, D-24's intermittent PTT did not permit further elucidation of his complete travel behavior.

Only D-1 provided long-term data to compare migration routes between years. Both spring and fall migration routes showed variability. The spring 2012 route differed from the fall route suggesting a possible loop migration as described by Linthicum et al. (2007), but the following spring route (2013) was closer to the 2012 fall route traveling along or near the north shore of Lake Superior and staying east of Lake Nipigon, whereas the 2013 fall route was closer to the spring 2012 and 2014 routes, away from the Lake Superior shore and west of Lake Nipigon.

D-1's spring migration start dates varied from as early as 4 May in 2012 to 8 June the next year; the 2014 start date was 27 May. Spring migration end dates were less variable, ranging from 14 June in both 2012 and 2014 to 24 June in 2013. Number of days on spring migration dropped from 42 days in 2012 to 17 and 19 days in 2013 and 2014, respectively. Perhaps most interesting was the decreased mileage (conservative estimates) tallied in successive years, trimming 199 mi (320.3 km) in 2013 compared to 2012, then another 61 fewer mi (98.2 km) in 2014 compared to 2013. The 2013 route was more direct and included no double-backs compared to 2012 and 2014's was slightly improved over 2013.

D-1's fall migration efficiency from PBPP also appeared to improve from the first to the second year. Fall migrations started within six days of each other but the fall 2013 migration was half the duration (25 days) of the 2012 fall migration (50 days), and the estimated mileage decreased by 153 mi (246.2 km). Experience at identifying landmarks or remembering successful foraging areas along the way or taking better advantage of weather conditions for more efficient migration may have contributed to the increased efficiency. The fact that D-1 returned to PBPP in successive years suggests purposeful rather than random trips the second and third times and resources there must have been at least adequate the first time to compel her to make the subsequent trips.

**Home Range.** For most of the Decorah juveniles, the 90% summer home ranges (HR), including the fledging year which includes several exploratory flights, were in northeast Iowa around their natal area, but some extended into southeast Minnesota and/or far western Wisconsin (Figure 2). The exceptions were D-1 each summer and D-24 in his second summer, with his northern summer trek. The 90% summer HR size of those eagles (not including the exceptions) ranged from 118 mi<sup>2</sup> (306 km<sup>2</sup>); CA = 16 mi<sup>2</sup> (41 km<sup>2</sup>) by the relatively sedentary Four to 4,056 mi<sup>2</sup> (10,505 km<sup>2</sup>); CA = 884 mi<sup>2</sup> (2,289 km<sup>2</sup>) by D-24 in his first summer. D-1's first summer/fall HR, including her trek to Lake Superior, escalated to 17,929 mi<sup>2</sup> (46,436 km<sup>2</sup>); CA = 5,455 mi<sup>2</sup> (14,129 km<sup>2</sup>) and D-24's second summer HR with the summer trek was 11,321 mi<sup>2</sup> (29,320 km<sup>2</sup>); CA = 1,667 mi<sup>2</sup> (4,317 km<sup>2</sup>).

D-1 was the only long distant migrant, therefore, her summer range was unlike her siblings in that she used a small range (HR = 89-121 mi<sup>2</sup>; 231-314 km<sup>2</sup>; CA = 22-24 mi<sup>2</sup>; 56-63 km<sup>2</sup>) within

PBPP in northern Ontario for three consecutive years (the summer 2014 HR size was not included in HR calculations since the transmitter signal stopped early that summer; Figure 2 inset for D-1). Only Four's summer range was of comparable size to D-1's, but under very different circumstances. The mean summer 90% HR size for all six Decorah juveniles across all years was 4,233 mi<sup>2</sup> (10,965 km<sup>2</sup>), range (both set by D-1) = 89-17,929 mi<sup>2</sup> (231-46,436 km<sup>2</sup>). Smith et al. (2017) satellite tracked four subadults from Louisiana to Canada and, using the conservative Brownian movement model method, documented an average summer range of 241.3 km<sup>2</sup>, similar to D-1's PBPP summer ranges. Mojica (2006) used a 95% kernel density method to estimate summer range size of 44 subadult Florida Bald Eagles and reported a mean range of 6,166 km<sup>2</sup>, less than our average but similar to the summer range sizes of D-25 and D-27. Different methods of tracking (VHF vs. satellite, number of hits, and quality of location determination), different home range calculation methods between studies, plus our small sample size lead to wide variation in home range comparisons.

The collective 90% winter HR of the four eagles that established those ranges extended from southeast Minnesota to southeast Iowa and the adjacent Wisconsin and Illinois shores of the Mississippi River (Figure 3). Winter range sizes were also highly variable ranging from HR = 107 mi<sup>2</sup> (277 km<sup>2</sup>); CA = 16 mi<sup>2</sup> (42 km<sup>2</sup>) for D-24 during his first winter to 4,872 mi<sup>2</sup> (12,619 km<sup>2</sup>); CA = 1,385 mi<sup>2</sup> (3,587 km<sup>2</sup>) for D-1 during her second winter. The mean winter HR of all Decorah eagles was 1,714 mi<sup>2</sup> (4,439 km<sup>2</sup>). By using a minimum convex polygon method, Grubb et al. (1989) estimated the mean winter home range size of four immatures at 401.2 km<sup>2</sup> and Stahlecker and Smith (1993) radio-tracked an immature eagle with a winter range of just 16 km<sup>2</sup>. McClelland et al. (1994) reported winter range sizes of 102 and 386 km<sup>2</sup> for two juveniles tracked from Glacier National Park, Montana. Mojica (2006) reported migratory Florida subadult eagles had an average winter range size of 25,218 km<sup>2</sup>, much larger than the Decorah eagles.

Of the two eagles that were tracked for multiple years, D-1 showed strong fidelity to her summer and winter range, though she was more mobile on the winter range. D-24 had a strong fidelity to his natal area, only leaving it the first winter and choosing to stay on it the second winter. Winter and summer range fidelity has been documented by Smith et al. (2017). However, McClelland et al. (1994) indicated that immature Bald Eagles appeared less likely to exhibit winter range fidelity by documenting major shifts in winter ranges of one juvenile and three subadult eagles.

Overall, the Decorah juveniles exhibited variability in summer and winter range sizes across individuals, and less so between years, though our sample size is limited. Griffin and Basket (1985) reported differences in range size across individuals and between years as foraging opportunities changed. It is likely that the exploratory flights during the PFDP help locate future summer ranges with higher quality foraging opportunities. As experience is gained throughout the dispersal period, young eagles can refine their home ranges. For example, D-1 had her smallest winter range during the third year. However, Mandernack et al. (2012) and this study observed seasonal "treks" of sometimes great distances out of and back into a core use area by both subadult and non-breeding adult eagles even after a home range had been established.

**Mortality.** Survival rates for first-year Bald Eagles have been reported at 63% (Wood et al. 1992), 69% (Hunt et al. 2009), 71% (Bowman et al. 1995), and 91% (McClelland et al. 1996). The first-year survival rate of the seven tracked Decorah eagles was 43%, having lost three to

electrocution and one to vehicle collision (Table 1). An un-tracked 2012 sibling of D-14 was also electrocuted shortly after fledge. Harmata et al. (1999) stated the highest proportion of known mortalities of eagles from the Greater Yellowstone area was electrocution or collision with power lines. During the PFPD, the Decorah juveniles were routinely observed perched on rooftops and atop power poles around the hatchery. Transmission lines account for fewer fatalities than distribution lines because of the larger spacing between phases (Harness and Wilson 2001); however, Indy was killed by a 96kV transmission line while D-14 and Four were killed by distribution lines. Mojica et al. (2018) identified distribution lines of <69kV as the largest risk factor associated with Golden Eagle electrocutions and age as the second greatest factor with juveniles being two times more likely to be electrocuted than subadults and adults. Electrocution will be an increasing concern for suburban-fledged eagles and utility companies, as birds that are raised in this setting and utilize power poles as perches will be more susceptible to electrocution beyond the natal area after dispersal. Working with utility companies to retrofit existing power poles and installing new raptor-friendly poles in areas not interfering with high-use travel corridors (Mojica et al. 2009) is critical in the success of suburban nesting eagles and the survival of their offspring.

As Grier (1980) concluded with his modeling, Bald Eagle survival rates have a greater effect than reproductive rates on the population's existence, and management should focus on survival of the living. While the suburban environment of the Decorah Fish Hatchery nest has an advantage of an abundant food supply and the eagles have learned to tolerate various human disturbances, leading to high productivity, added mortality risks may temper overall survival rates.

We will continue to monitor the travels of D-24 and D-27 until transmitter failure to continue to develop our understanding of the travel patterns of eagles in this region, in particular, those of the same parental lineage, as well as which habitats are most utilized for migration, foraging, and roosting. Will migration tendencies diminish as the birds reach breeding age, as suggested by Stalmaster (1987) and stated by Wood (2009) for Florida eagles? We also hope to shed light on whether these eagles become breeders and, if so, how far they nest from their natal site. We must also realize threats posed to suburban-raised eagles and take action to improve their survivability.

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Table 1. Significant dates through dispersal and status of seven Bald Eagles fledged from Decorah, Iowa Fish Hatchery nests.

Eagle Name	Sex	Hatch Date	Fledge Date	PTT Deployment Date	First Night Away From Hatchery (days since hatch)	Dispersal Date (days since hatch)	Status
D-1	F	3-Apr-11	23-Jun-11	12-Jul-11	14-Aug-11 (133)	14-Aug-11 (133)	Unknown-Off Air (01-Jul-14)
D-14	M	31-Mar-12	18-Jun-12	27-Jun-12	30-Jul-12 (121)	23-Sep-12 (176)	Deceased-Electrocution (17-Nov-12)
Four	F	3-Apr-14	18-Jun-14	22-Jun-14	18-Jul-14 (106)	06-Nov-14 (217)	Deceased-Electrocution (03-Mar-15)
Indy	M	2-Apr-14	18-Jun-14	04-Jul-14	<sup>a</sup>		Deceased-Electrocution (08-Jul-14)
D-24	M	29-Mar-16	11-Jun-16	30-Jun-16	31-Jul-16 (124)	31-Aug-16 (155)	Active/Intermittent
D-25	M	31-Mar-16	17-Jun-16	05-Jul-16	01-Aug-16 (123)	01-Sep-16 (154)	Deceased-Vehicle Collision (26-Sep-16)
D-27	F	1-Apr-17	17-Jun-17	07-Aug-17	09-Aug-17 (130) <sup>b</sup>	19-Aug-17 (140)	Active

<sup>a</sup> The mulch pile at the Decorah Yard Waste Facility acted as the nest/hatchery since Indy was separated from the actual nest following premature fledge.

<sup>b</sup> With the late PTT deployment, it is possible she roosted away from the nest/hatchery pre-deployment.

# Decorah Eagle D-1

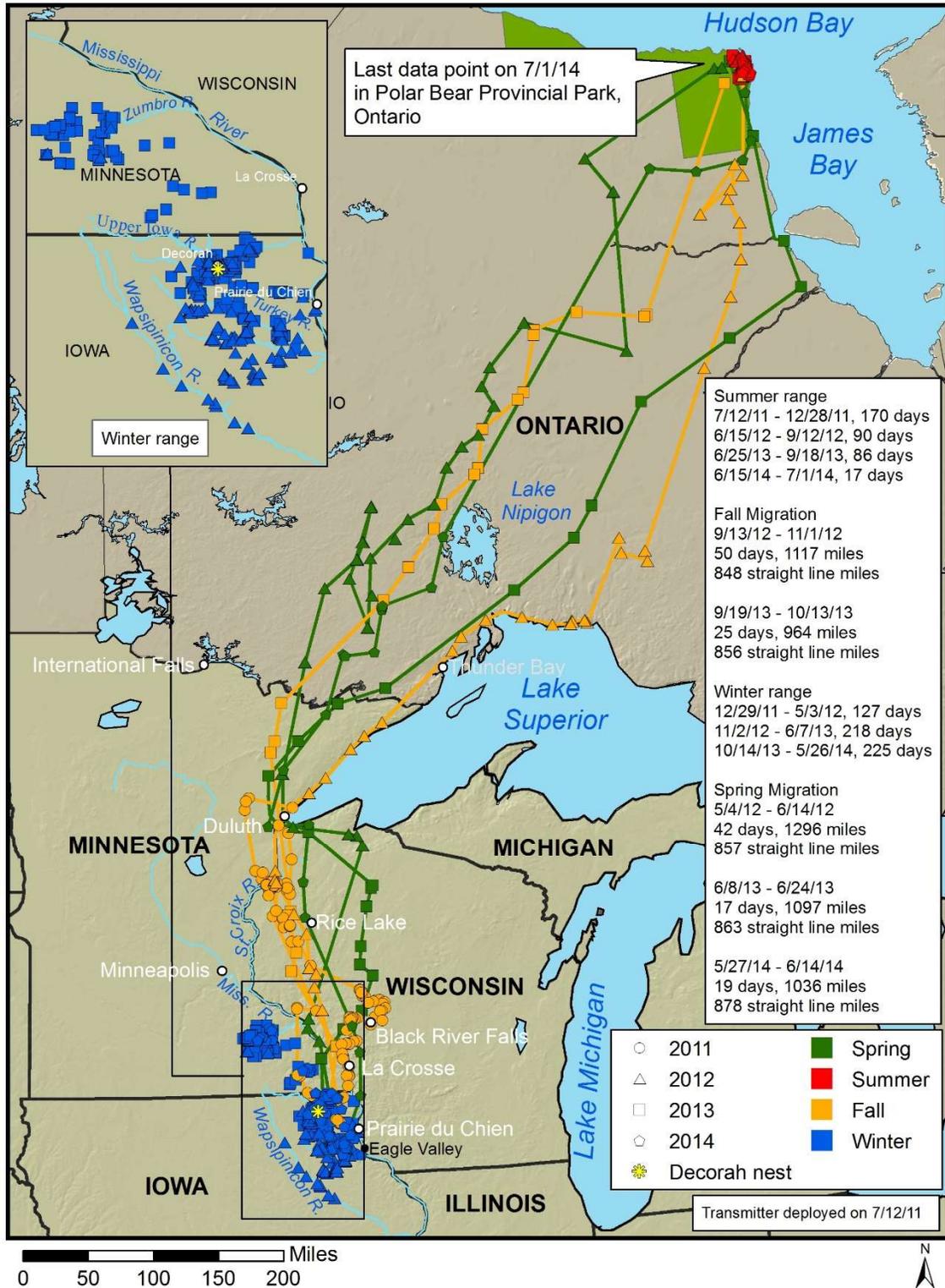


Figure 1. Decorah, IA, Bald Eagle D-1 seasonal locations and migration routes tracked from 12 Jul 2011 through 01 Jul 2014.

## Summer Home Ranges

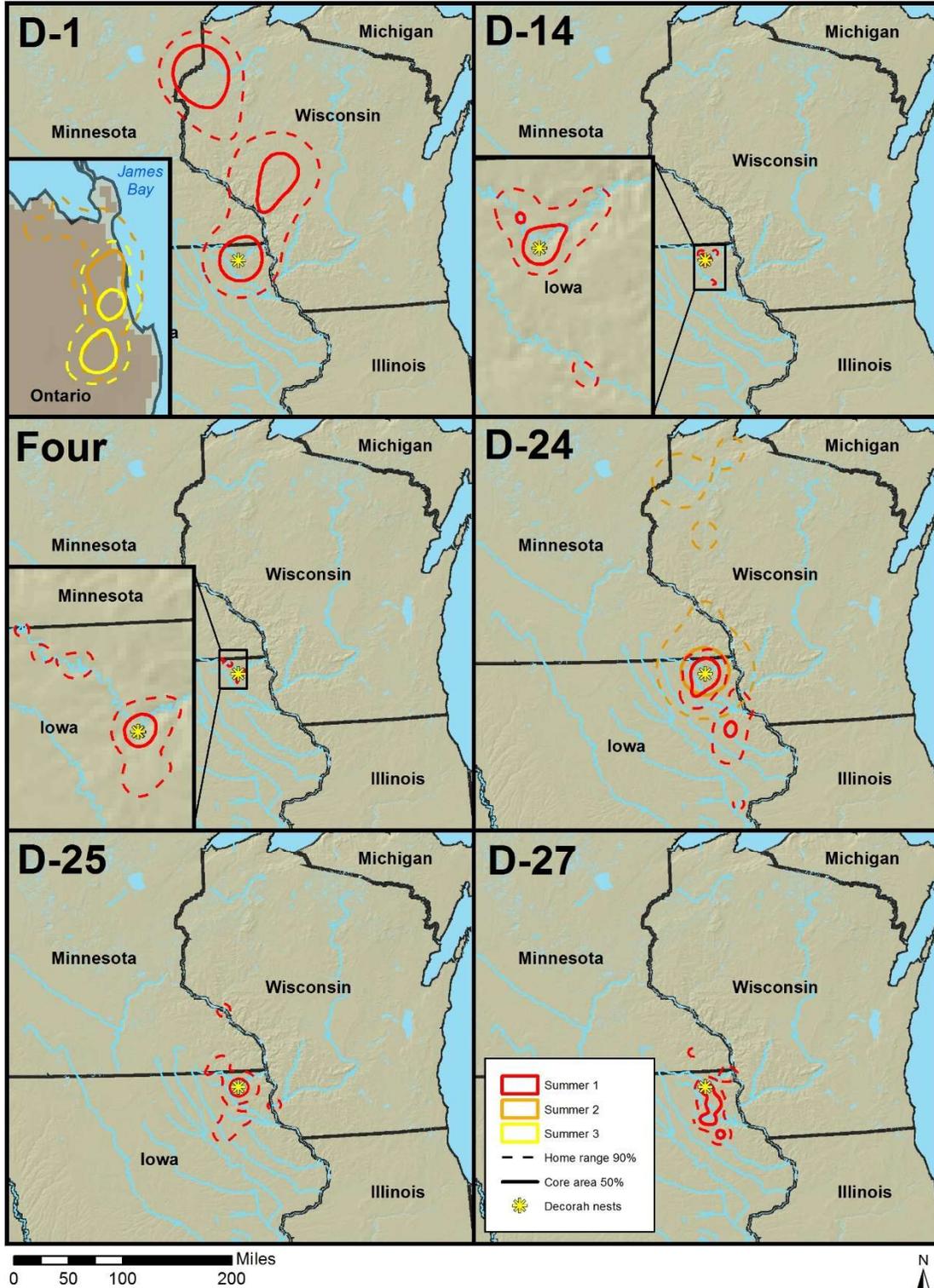


Figure 2. Kernel density utilization distribution estimates for summer home range (90%) and core areas (50%) for six Decorah, IA, Bald Eagle fledglings.

### Winter Home Ranges

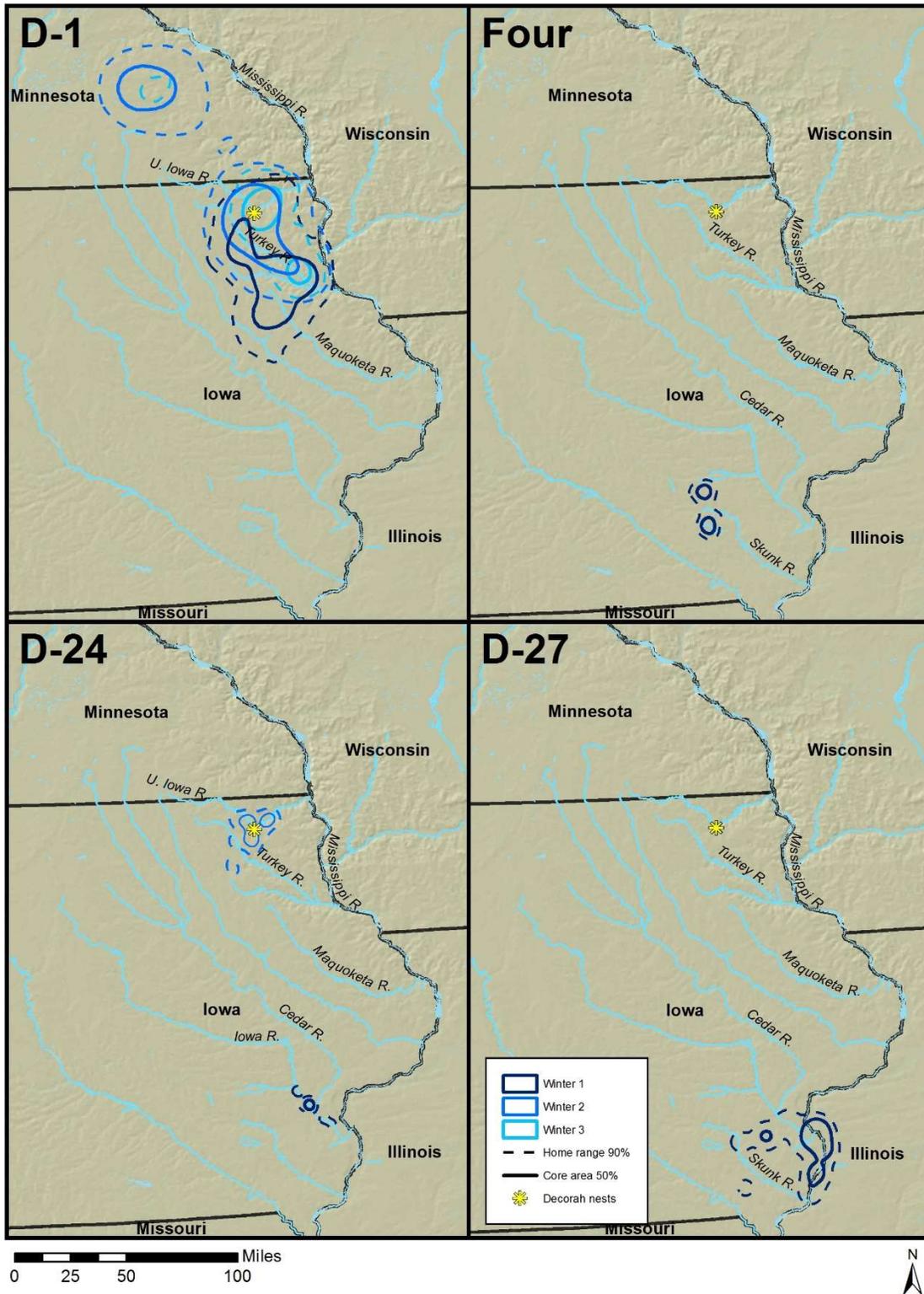


Figure 3. Kernel density utilization distribution estimates for winter home range (90%) and core areas (50%) for four Decorah, IA, Bald Eagle fledglings.

# Decorah Eagle D-14

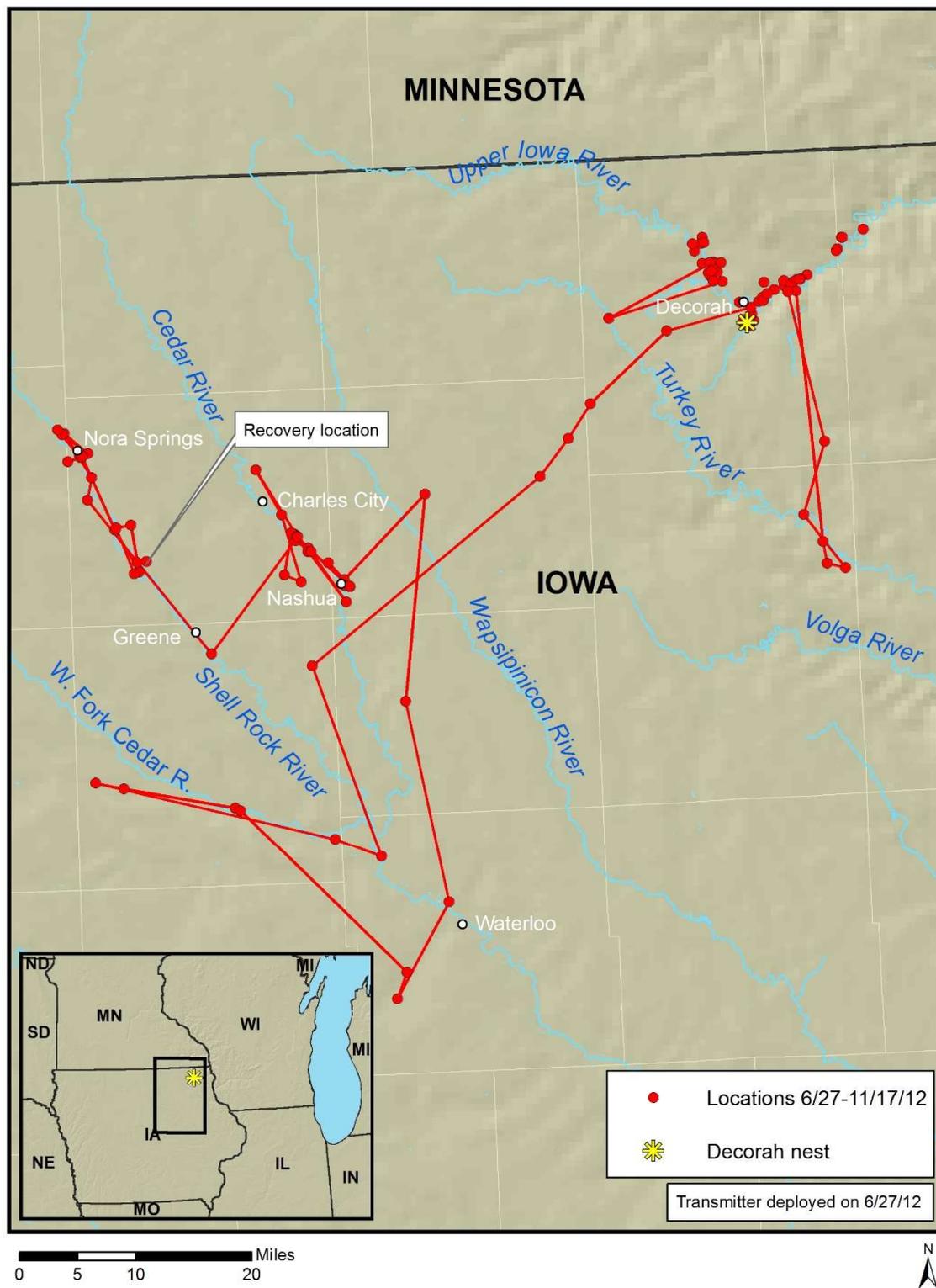


Figure 4. Decorah, IA, Bald Eagle D-14 seasonal locations and migration routes tracked from 27 Jun 2012 through 17 Nov 2012.

# Decorah Eagles Four and Indy

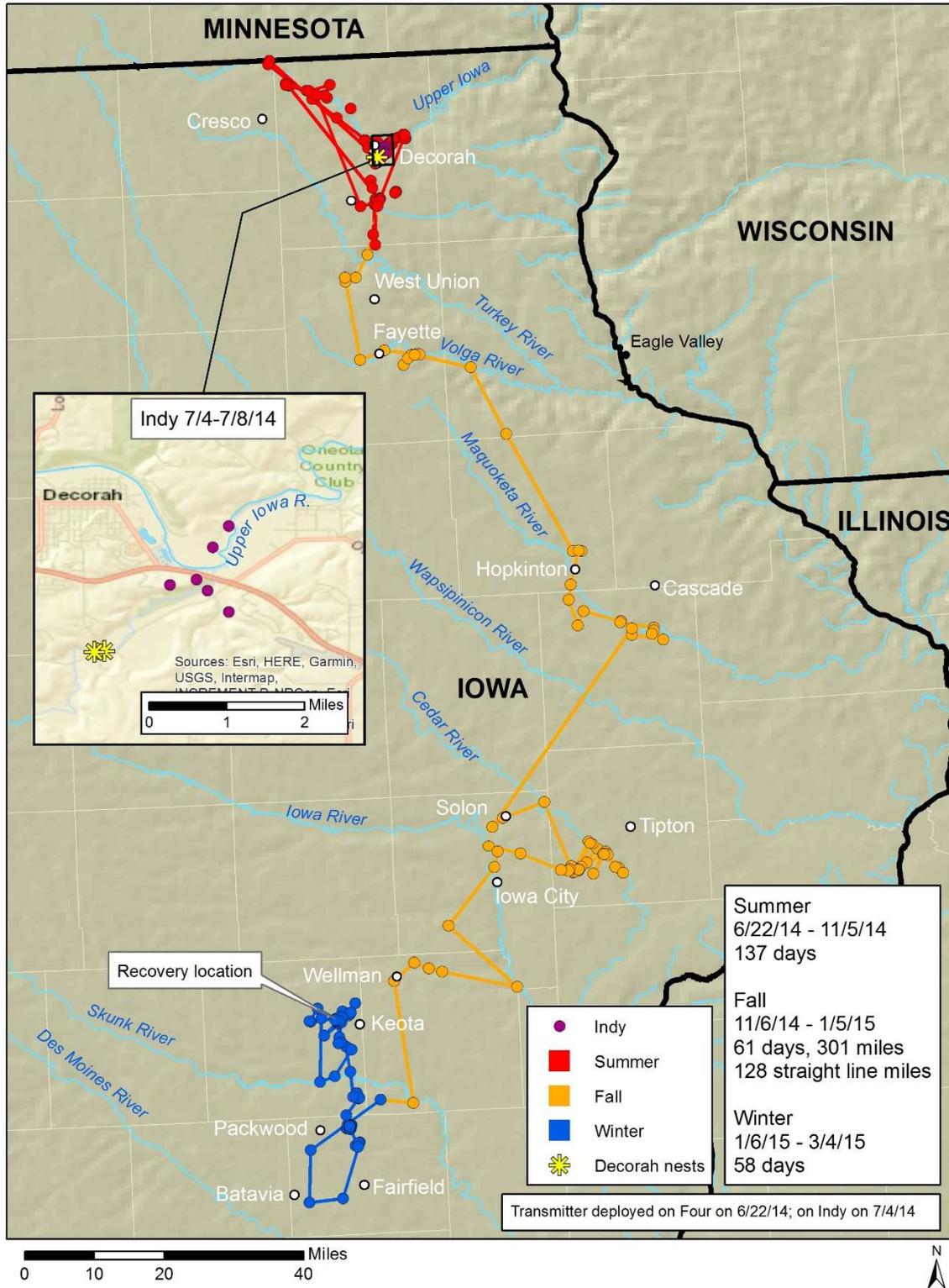


Figure 5. Decorah, IA, Bald Eagle Four seasonal locations and migration routes tracked from 22 Jun 2014 through 04 Mar 2015 and Indy locations from 04 Jul 2014 through 08 Jul 2014.

# Decorah Eagle D-24

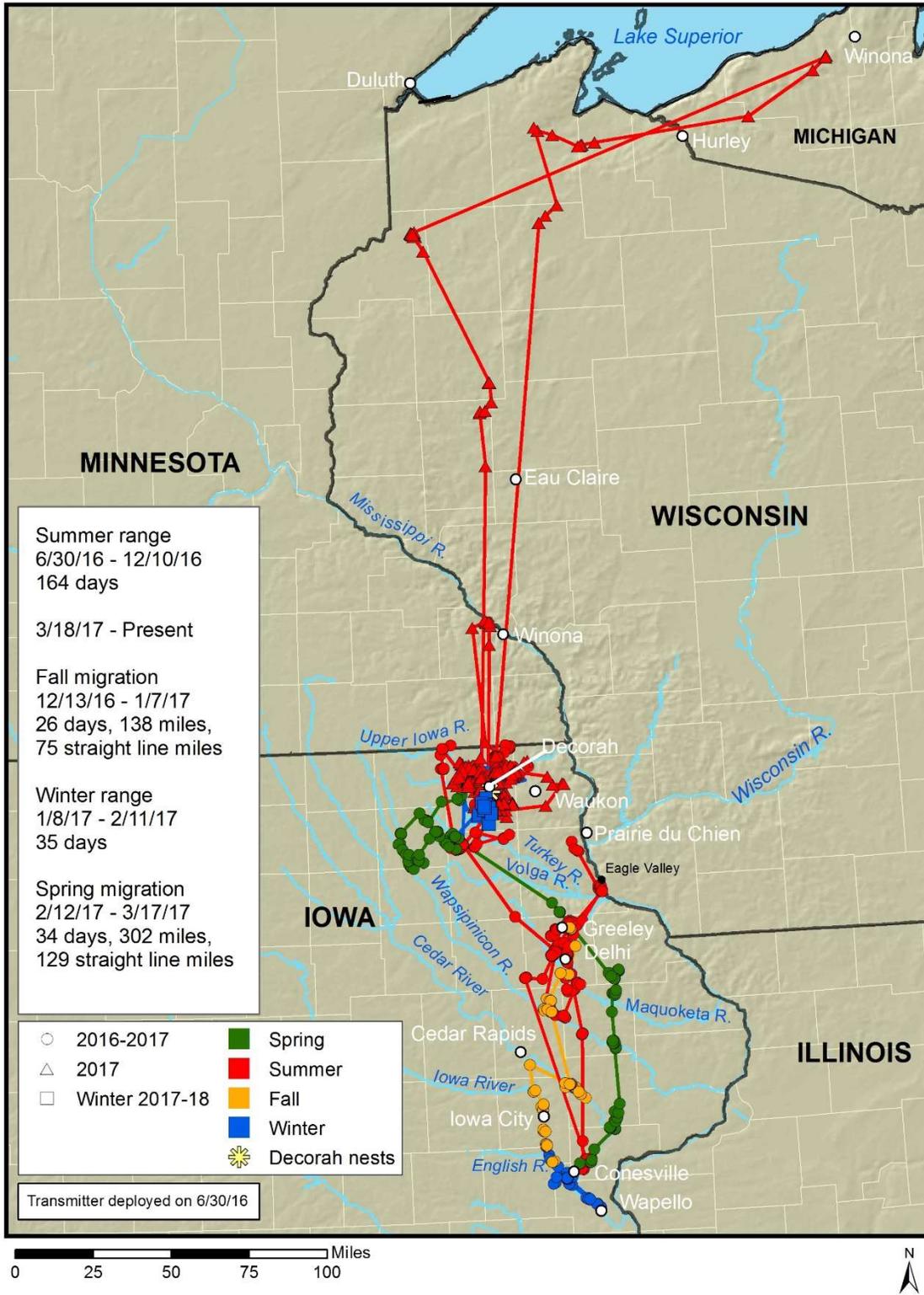


Figure 6. Decorah, IA, Bald Eagle D-24 seasonal locations and migration routes tracked from 30 Jun 2016 through present.

# Decorah Eagle D-25

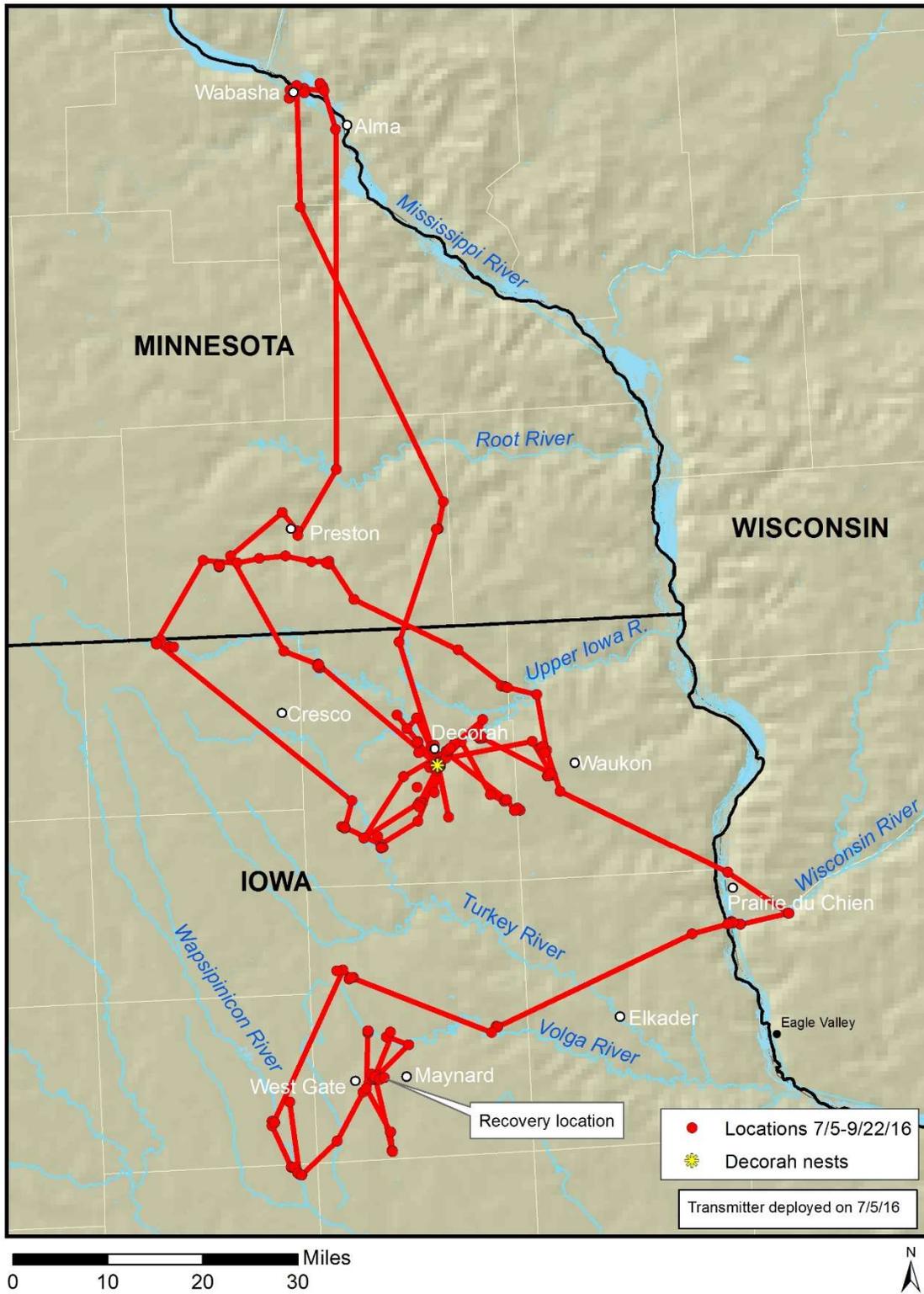


Figure 7. Decorah, IA, Bald Eagle D-25 locations tracked from 05 Jul 2016 through 22 Sep 2016.

### Decorah Eagle D-27

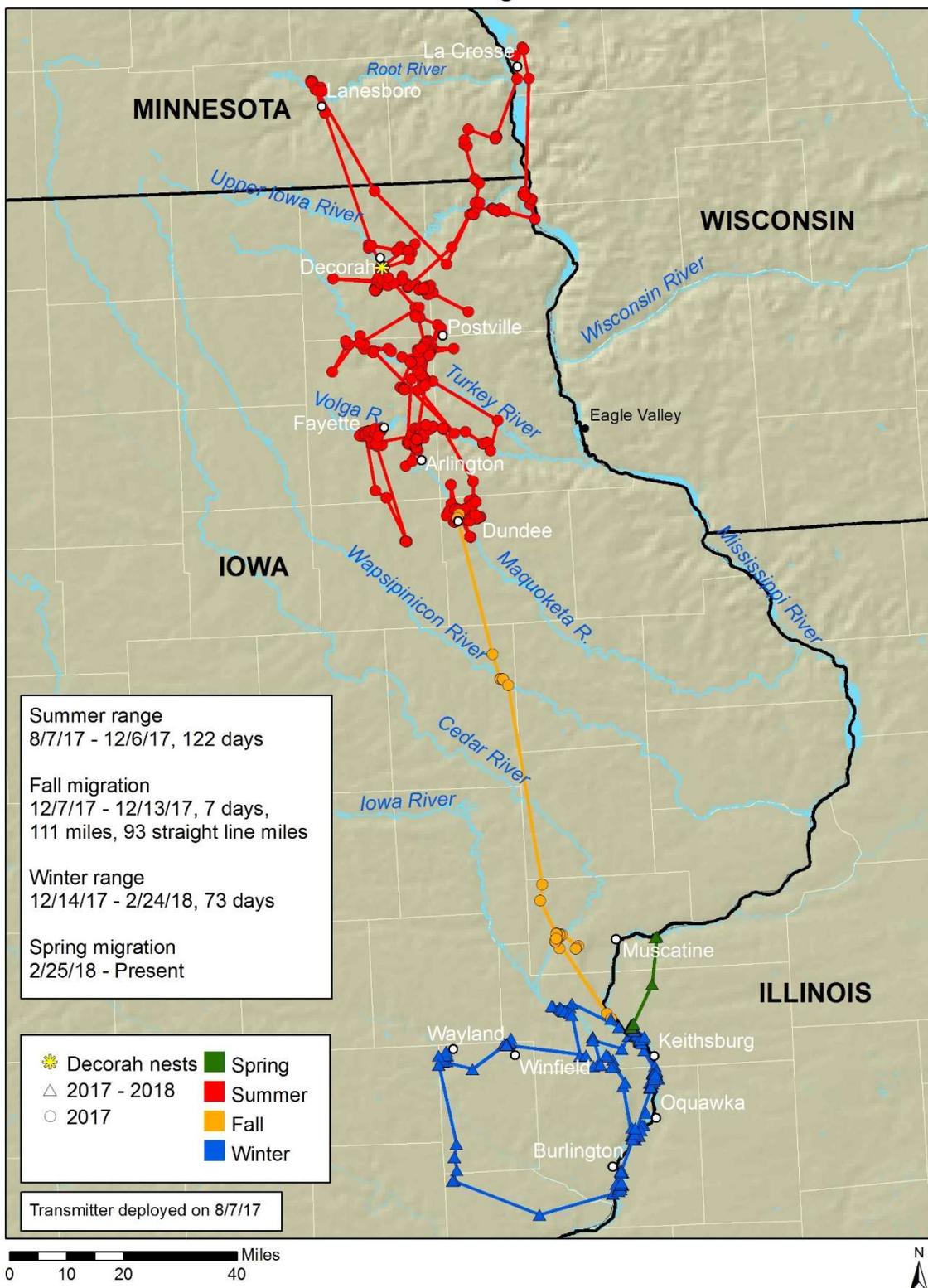


Figure 8. Decorah Bald Eagle D-27 seasonal locations and migration routes tracked from 07 Aug 2017 through present.