HOME RANGE ANALYSIS OF REHABILITATED AND RELEASED GREAT HORNED OWLS (*Bubo virginianus*) IN DENTON COUNTY, TEXAS, THROUGH RADIO TELEMETRY

Jennifer Lynn Johnston, B.A.

Thesis Prepared for the Degree of

MASTER OF SCIENCE

UNIVERSITY OF NORTH TEXAS

December 2007

APPROVED:

Samuel F. Atkinson, Major Professor
Earl Zimmerman, Committee Member
Kenneth Steigman, Committee Member
Art Goven, Chair of the Department of
    Biological Sciences
Sandra L. Terrell, Dean of the Robert B.
    Toulouse School of Graduate Studies

Johnston, Jennifer Lynn. Home range analysis of rehabilitated and released great horned owls *(Bubo virginianus)* in Denton County, Texas, through radio telemetry. Master of Science (Biology), December 2007, 36 pp., 3 tables, 13 illustrations, references, 25 titles.

Raptor rehabilitation has become commonplace globally, yet studies on the survival and adaptation of great horned owls *(Bubo virginianus)* after release has been neglected to an appreciable extent. The primary objective of this study is to provide quantitative data on the success of rehabilitated and released great horned owls in the North Texas region. Owls (*N*=12) were rehabilitated and released onto the Ray Roberts Greenbelt Corridor in Denton County, Texas, and monitored using radio telemetry to evaluate home range (November 2002 – February 2005). With approximately 75% of the birds released for this study surviving until transmitter battery failure, it is believed that the rehabilitation process was successful for these birds.

ACKNOWLEDGEMENTS

I would like to extend my appreciation to the Brandenburg Foundation for generously granting funds for the purchase of transmitters. I would also like to thank Dr. Douglas Elrod and Dr. Kenneth Steigman for their assistance and guidance during the planning phases of this project. Special thanks go to the staff of the Heard Museum and Wildlife Sanctuary's Raptor Rehabilitation Center as well as Mr. Sonny Solis of the Texas Parks and Wildlife Department for their assistance. For their unlimited encouragement, support and help I would like to thank my family and friends, Jeff Bowers, Gary Hagen, Dane Wilson, Carlos Diaz, Jared McCarty and Matt Kuykendall – your hours spent in the field with me are greatly appreciated.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Project Significance and Background

The primary objective of the conducted research was to provide quantitative data on the success of rehabilitated and released great horned owls (*Bubo virginianus*) in the North Texas region, specifically Denton County. Rehabilitation of raptor species has become commonplace globally, however, studies on the survival and adaptation of the rehabilitated birds after release has neglected to include great horned owls to an appreciable extent.

Many birds are rehabilitated and released back into the wild; however, few quantitative data on survival and movements of released raptors exist (Servheen and English 1976, 1979; Duke and others 1981; Daniels 1984; Kimmel and Zwank 1983; Hamilton and others 1988; Allbritten and Jackson 2002). One of the underlying goals of raptor rehabilitation is for a released bird to survive and resume “normal” activities. Most importantly, it is assumed, these birds become part of the breeding population, thus contributing to the conservation of their species (Fraser and Moss 1985). This information is critical when assessing the value of rehabilitation to the conservation of populations.

Post-release survival studies of rehabilitated birds are critical to determine whether rehabilitation and prerelease training methods are adequate to assume survival of rehabilitated individuals (Allbritten and Jackson 2002). Raptors have been studied by radio-tagging for three decades, starting with work on eagles in North America (Southern 1964; Kenward and Walls 1994). Although radio telemetry is an excellent tool for studying survival, space, and habitat use patterns – especially of highly vagile species – time, expense, and lack of resources have limited its use to a great extent.

Study Site

The Ray Roberts Greenbelt Corridor in Denton County, Texas, was chosen as the release site for the rehabilitated birds. It is located approximately 12 km northeast of the city of Denton (population 93,435), and situated between the upper end of Lewisville Lake at State Highway 380 and the Lake Ray Roberts Dam at Farm Road 455, while being bisected by FM 428. The greenbelt comprises nearly 2,000 ha, approximately 500 ha of which are remnant stands and corridors of bottomland forest. The Elm Fork of the Trinity River flows through the greenbelt, traversing approximately 22 river km over the space of 16 linear km (Fischer and others 1999).

Denton County occupies approximately 2,450 km^2 in north-central Texas. The three primary bioregions found in Denton County are all present within the greenbelt study area. They consist of the Blackland Prairie, the Grand Prairie, and the Cross Timbers. The characteristic tree species of the Cross Timbers include post oak *(Quercus stellata)*, blackjack oak *(Q. marilandica)*, and hickory *(Carya spp.)*. Bottomland hardwood forests occur in the floodplains of the river and creek bottoms of the county. The term "bottomland hardwoods" is most often used to describe mixed hardwood forests that grow on floodplain soils that are saturated or inundated during certain parts of the year (Fischer and others 1999).

The variety of vegetation of the greenbelt is dominated by cedar elm *(Ulmus crassifolia)*, hackberry *(Celtis occidentalis* and *C. laevigata)*, and green ash *(Fraxinus* *pennsylvanica)*, with occasional occurrences of bur oak *(Quercus macrocarpa)*, pecan *(Carya illinoensis)*, and eastern cottonwood *(Populus deltoids)*. Black walnut *(Juglans nigra)*, chittamwood *(Bumelia lanuginosa)*, bois d'arc *(Maclura pomifera)*, box elder *(Acer negundo)*, and hawthorn *(Crataegus spp.)* are also present (Fischer and others 1999).

The Ray Roberts Greenbelt Corridor was officially opened to the public in 1999 and designated as a multi-use facility. There is a "hard surface" trail constructed of gravel and concrete that spans from FM 455 to SH 380 and runs along the Elm Fork of the Trinity River, remaining within 150 m of the banks of the river. There are additional unimproved "soft surface" trails that also span the same distance and run somewhat parallel to the gravel trail. There are also unimproved trails that traverse areas away from the river, primarily used for hiking, biking, and horseback riding. Canoe launches are located at each of the three access points, and canoes, kayaks, and small, non-motorized fishing boats utilize the river. Camping is not permitted within the Greenbelt Corridor (Bruce 2003).

Study Animal

Great horned owls are one of the most widespread and common owls in North America, ranging from the Arctic tundra to the tropical rainforests of South America. It is not atypical to find them in habitats ranging from desert landscapes to suburban backyards. Great horned owls are opportunistic hunters with a prey list that consists of insects, small mammals, rabbits, skunks, birds, reptiles, fish, amphibians and even domestic house cats. They have no known predators other than humans.

In most states, great horned owls and other birds of prey have been given complete protection, and their presence has been recognized as one that contributes to the control of pest populations. As a top predator in the food chain, they have been deemed an indicator species of the overall health of the ecosystem in which they live. Typically, the home range of the great horned owl is constant throughout the year; however, this can be influenced greatly by the availability of prey animals. Migration in the classic sense does not occur, but relocation to areas of higher prey abundance during periods of severe conditions is common.

No studies were found in published literature that recorded survival rates and movements of great horned owls in the North Texas region; whether the study subject be captive-reared and released, or native wild. Radio telemetry was determined to be a feasible tool to utilize in the collection of these data.

The Heard Natural Science Museum and Wildlife Sanctuary's Raptor Rehabilitation Center in McKinney, Texas, accepts over 200 injured and/or orphaned birds of prey annually. Each bird completes conditioning exercises and live prey hunt testing in a flight cage prior to release. Great horned owls have been successfully rehabilitated at this facility and also make up a significant percentage of orphans brought in during the late winter/early spring months, thus making the Raptor Rehabilitation Center an excellent source of owls as subjects for the study.

Radio Telemetry

Radio telemetry has become the most widely used sampling technique for making observations on the location of an animal in its home range (Worton 1995). Due to the predominantly nocturnal nature of great horned owls, it has become a valuable tool in determining the activities of these birds. Transmitters, each with a unique identifying frequency, are attached to the animals, and signals from these transmitters are received by biologists to track the animals (White and Garrott 1990).

Purpose

This research provides new information regarding the behavior of rehabilitated and released great horned owls in the North Texas region. Home ranges for these birds were determined for use as a basis of comparison to native wild great horned owls in the area. Acquiring these quantitative data will document movements and survival rates of these animals and hopefully contribute to advance the development of successful rehabilitation methods.

CHAPTER 2

MATERIALS AND METHODS

Acquisition and Marking

Juvenile great horned owls were acquired for the study from the Heard Natural Science Museum and Wildlife Sanctuary's Raptor Rehabilitation Center in McKinney, Texas. All birds were brought to the facility as fledglings and raised in outdoor flight cages with birds of the same species. When deemed appropriate by the staff, each bird was prey-tested to determine its ability to hunt on its own in order to survive after release.

Once prey-testing had commenced, each bird was affixed with a U.S. Fish and Wildlife Service identification band on the ankle, provided by the United States Geological Survey's (USGS) Patuxent Wildlife Research Center's Bird Banding Laboratory (Laurel, Maryland 20708). Each band was inscribed with a serial number and a contact telephone number should a banded bird or a band be found at a later time. A 150-MHz, RI-2CM(12) tail-mount radio transmitter from Holohil Systems, LTD., (112 John Cavanaugh Road, Carp, Ontario, Canada KOA1L0) was affixed to the central retrices of each bird according to manufacturer's instructions. Three-minute epoxy was also applied to the attachment for additional stability. The transmitters were made specifically for large raptor birds and weighed approximately 6.4 g, no more than 2-3% of the bird's bodyweight as suggested by Kenward (2001).

According to the manufacturer, pulse rate is ~36 pulses/min (p/m) with nominal battery life of approximately 12 months; however, the life span of the transmitter can range from 6-18 months. A mortality signal was incorporated into each transmitter which increased the pulse rate to ~75 p/m if a 12-hr period of non-movement occurred. After a brief acclimation period, the owls were released on the Ray Roberts Greenbelt Corridor along the Elm Fork of the Trinity River.

Telemetry Equipment

A 150-MHz mobile receiving unit was purchased from AVM Instrument Company, LTD. (2356 Research Drive, Livermore, California), model La12-Q, and was used to receive signals transmitted from each bird, with inputs from a three-element, hand-held, collapsible Yagi antenna. All tail-mount transmitters were purchased from Holohil Systems, LTD., as stated above.

Data Collection

Each bird was monitored using radio telemetry triangulation techniques. Bearings were utilized only if the intersection of two compass azimuths were greater than 45° and less than 135° in order to reduce the amount of error in locations. A 1-m DOQQ (1995) image of the study area was obtained from the Texas Natural Resources Information System Website and carried in the field. The angular bearings obtained were transferred directly onto the DOQQ (1995) image. Only lines in which the clarity and audibility of the signal were at their best were recorded. Triangulation was achieved by drawing the line of direction from three separate reception points. From the triangle produced, it was assumed that the bird was within that area, with the center of that triangle used as the location in evaluation of home range.

In order to prevent autocorrelation of observations, it was suggested by Winter (2000) that researchers locate each animal every 6-48 h. This allows sufficient time for the animal to move from one end of its home range to the other and sustain independence of observations. Each bird was tracked 3-4 times per wk at various times throughout the day. Days were divided in four groups: 06:00-08:59 (sunrise hours), 09:00-17:59 (afternoon), 18:00-21:59 (sunset hours), and 22:00-05:59 (overnight). Care was taken to not track a bird during the same time group more than twice in one week. Due to the nocturnal nature of the owls, approximately 75% of locations were obtained between 1 hr before sunset and 2 hrs after sunrise. At least one location per week was obtained during afternoon hours.

All birds were tracked until one of the following could be determined:
a) mortality (mortality signal produced by transmitter or by physical assessment)
b) transmitter battery failure, or c) bird location could not be established after extensive search of the study area for approximately 5 d (possible emigration or premature transmitter failure).

Home Range Analysis

Home range analysis has been described by Burt (1943) as the area traversed by an individual animal in its normal activities of food gathering, mating and caring for young. Estimation of the utilization distribution (UD: the term given to the distribution of an animal's position in a plane) is of great importance to home range studies (Worton 1989). Many methods have been created to measure the UD, but the minimum convex polygon and 50% and 95% kernel estimators were used for this study.

The minimum convex polygon (MCP) estimator is appealing to wildlife biologists as it is well-defined and straightforward to evaluate. An MCP connects the outermost location points assuming that all area within that boundary is the animal's home range. However, it is important to understand the statistical properties of the MCP as an estimator of an appropriate definition of home range size. Since the MCP is based on the peripheral points of the data set, it is extremely sensitive to “outliers,” irrespective of the distribution of the inner points, and thus these outer points have greater influence on the home range size estimate (Worton 1995).

Kernel methods free the utilization estimate from parametric assumptions and provide a means of smoothing locational data to make more efficient use of them. Kernel estimates have well-understood consistent statistical properties and are widely used in both univariate and multivariate probability estimation (Worton 1989). The Home Range Extension for the ArcGIS 9® (ESRI, Redlands, California) software was used to calculate the minimum convex polygons and the 95 and 50 % kernel estimators. These data were calculated for each bird and projected directly onto the DOQQ (1995) image of the study area (Figures 1-13).

CHAPTER 3

RESULTS

Triangulation Bearings and Animal Locations

Rehabilitated great horned owls (*N=12*) were tagged, released, and monitored from November 2, 2002, to February 7, 2005 (Table 1). Eight birds were tracked for at least 4 mo and four birds were tracked for less than 4 mo. Tracking was terminated due to animal mortality (*n=2*), transmitter battery failure (*n=9*), and unknown reasons (*n=1*). A total number of 754 location points were obtained for all birds monitored, as illustrated in Figure 1. Table 2 provides the total number of location points for each bird.

Bird F01 (U.S. Fish and Wildlife Service band #788-47007) was released on January 3, 2003, at 15:45, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.226 MHz, and the bird was located by triangulation 74 times over a period of 5 mo. Location points are illustrated in Figure 2. Termination of tracking was due to battery failure of the transmitter.

Bird F02 (U.S. Fish and Wildlife Service band #788-47019) was released on June 24, 2004, at 20:50, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.309 MHz, and the bird was located by triangulation 98 times over a period of 6.5 mo. Location points are illustrated in Figure 3. Termination of tracking was due to battery failure of the transmitter.

Table 1. Study Animals Released for Monitoring in Denton County, Texas

Animal Number	Sex	Date Released	Time Released	Time Monitored (months)
F01	Female	01-03-03	15:45	5
F02	Female	06-24-04	20:50	6.5
F03	Female	06-24-04	20:50	7.5
F04	Female	07-20-04	20:12	4
F05	Female	07-22-04	20:35	3.5
F06	Female	07-30-04	20:20	4
F07	Female	07-30-04	20:45	2.5
M01	Male	11-02-02	15:30	6
M02	Male	07-25-03	20:15	1.5
M03	Male	07-25-03	20:15	1
M04	Male	07-20-04	20:17	4
M05	Male	07-22-04	20:20	4

Table 2. Number of Location Points for Study Animals Monitored in Denton County Texas.

Animal Number	Sex	Date Released	Total Location Points (Triangulation Bearings)
F01	Female	01-03-03	74
F02	Female	06-24-04	98
F03	Female	06-24-04	120
F04	Female	07-20-04	65
F05	Female	07-22-04	53
F06	Female	07-30-04	56
F07	Female	07-30-04	37
M01	Male	11-02-02	92
M02	Male	07-25-03	18
M03	Male	07-25-03	11
M04	Male	07-20-04	75
M05	Male	07-22-04	55

Bird F03 (U.S. Fish and Wildlife Service band #788-47018) was released on June 24, 2004, at 20:50, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.338 MHz, and the bird was located by triangulation 120 times over a period of 7.5 mo. Location points are illustrated in Figure 4. Termination of tracking was due to battery failure of the transmitter.

Bird F04 (U.S. Fish and Wildlife Service band #788-47023) was released on July 20, 2004, at 20:12, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.380 MHz, and the bird was located by triangulation 65 times over a period of 4 mo. Location points are illustrated in Figure 5. Termination of tracking was due to battery failure of the transmitter.

Bird F05 (U.S. Fish and Wildlife Service band #788-47024) was released on July 22, 2004, at 20:35, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.431 MHz, and the bird was located by triangulation 53 times over a period of 3.5 mo. Location points are illustrated in Figure 6. Termination of tracking was due to battery failure of the transmitter.

Bird F06 (U.S. Fish and Wildlife Service band #788-47026) was released on July 30, 2004, at 20:20, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.460 MHz, and the bird was located by triangulation 56 times over a period of 4 mo. Location points are illustrated in Figure 7. Termination of tracking was due to battery failure of the transmitter.

Bird F07 (U.S. Fish and Wildlife Service band #788-47027) was released on July 30, 2004, at 20:45, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.475 MHz, and the bird was located by triangulation 37 times over a period of 2.5 mo. Location points are illustrated in Figure 8. Termination of tracking was due to mortality. The USGS Bird Banding Lab was contacted by a citizen reporting that the bird had been found, and a postcard was received by the Heard Museum's Raptor Rehabilitation Center notifying them of the find. Several attempts to contact the Bird Banding Lab to obtain further information received no response. Cause of death is unknown.

Bird M01 (U.S. Fish and Wildlife Service band #788-47005) was released on November 2, 2002, at 15:30, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.187 MHz, and the bird was located by triangulation 92 times over a period of 6 mo. Location points are illustrated in Figure 9. Termination of tracking was due to battery failure of the transmitter.

Bird M02 (U.S. Fish and Wildlife Service band #1207-36813) was released on July 25, 2003, at 20:15 pm, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.204 MHz, and the bird was located by triangulation 18 times over a period of 1.5 mo. Location points are illustrated in Figure 10. Termination of tracking was due to possible emigration of the bird out of the study area. After extensive searches for five consecutive days, the bird could not be located.

Bird M03 (U.S. Fish and Wildlife Service band #1177-30207) was released on July 25, 2003, at 20:15, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.270 MHz, and the bird was located by triangulation 11 times over a period of slightly more than one month. Location points are illustrated in Figure 11. Termination of tracking was due to believed mortality. A mortality signal was detected on the night of September 2, 2003, and after extensive search of the area the following day, no further signal was heard. Cause of death is unknown as no carcass was located. It is interesting to note that birds M02 and M03 were raised together at the Raptor Rehab Center and released together. After the apparent mortality of bird M03, bird M02 was only able to be tracked for the next 13 d before the signal was lost. Each bird seemed to remain within close proximity of the other until the death of bird M03.

Bird M04 (U.S. Fish and Wildlife Service band #1207-86832) was released on July 20, 2004, at 20:17 pm, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.348 MHz, and the bird was located by triangulation 75 times over a period of 4 mo. Location points are illustrated in Figure 12. Termination of tracking was due to battery failure of the transmitter.

Bird M05 (U.S. Fish and Wildlife Service band #1207-86833) was released on July 22, 2004, at 20:20, approximately 500 m south of FM 428 within the Ray Roberts Greenbelt Corridor. The transmitter frequency assigned was 150.409 MHz, and the bird was located by triangulation 55 times over a period of 4 mo. Location points are illustrated in Figure 13. Termination of tracking was due to battery failure of the transmitter.

Home Range Estimations

Minimum convex polygon (MCP) and kernel estimators were used to measure the home range size of each bird monitored. The MCP took into account all location points, while the 95% kernel estimation, based on the utilization distribution, was used to eliminate any "outliers" that would artificially inflate the home range estimate. The 50% kernel estimator, often referred to as the "core area" of home range, was also calculated. Figures 2-13 illustrate the MCP, 95% kernel, and 50% kernel estimations for each study animal. All estimated home ranges are outlined in Table 3.

Table 3. Three Home Range Estimates (in Hectares) for Study Animals Released in Denton County, Texas

Animal Number	Minimum Convex Polygon (MCP)	95% Kernel	50% Kernel
F01	549.07	1463.89	130.46
F02	625.87	485.02	66.49
F03	489.06	763.05	71.14
F04	769.64	1360.80	271.02
F05	1843.71	4622.58	1034.88
F06	799.61	1524.75	179.60
F07	75.34	117.90	17.85
M01	1918.81	1273.88	138.03
M02	106.97	433.49	29.84
M03	62.56	302.00	33.18
M04	390.52	570.91	105.80
M05	518.32	1407.83	275.72

MCP estimations for all study animals ranged from 62.56 ha – 1,918.81 ha. It is important to note that the three smallest MCP estimates of 62.56 ha, 75.34 ha, and 106.97 ha were gathered from birds that were tracked for less than 2.5 mo while the other birds in the study were tracked for 3.5 mo and longer. Excluding the three smallest values obtained (two due to mortality and one possible emigration from the study area), the mean MCP home range for the remaining birds was 878.29 ha.

Kernel estimations of 95% for all study animals ranged from 117.90 ha – 4,622.58 ha, with a mean of 1,193.84 ha. Excluding the three smallest ranges, as was done for the MCP calculation, the mean value for the 95% kernel estimate was 1,496.97 ha. Bird F05 exhibited a 95% kernel home range of 4,622.58 ha, more than three times as large as the next highest value, which artificially inflated the average. When this value is removed, along with the previous three, the 95% kernel averages 1,106.27 ha.

Kernel estimations of 50% for all study animals ranged from 17.85 ha – 1,034.88 ha, with a mean of 196.17 ha. The same situation of the three smallest values belonging to the three birds that did not complete the study is evident in the 50% kernel home range estimates. After exclusion of those values, the 50% kernel increased to 252.57 ha. Bird F05 recorded a 50% kernel estimate of almost four times greater than the next largest value, as was exhibited in the 95% kernel estimate. Excluding this value, along with the previous three, would decrease the 50% kernel home range mean to 154.78 ha.

CHAPTER 4

DISCUSSION

Great horned owls (*N=12*) that were rehabilitated at the Heard Natural Science Museum and Wildlife Sanctuary's Raptor Rehabilitation Center in McKinney, Texas, were released onto the Ray Roberts Greenbelt Corridor in Denton County, Texas. All were equipped with tail-mount radio transmitters to track their movements and determine their home ranges for the duration of transmitter battery life.

Location points obtained ranged from 11 (Bird M03) to 120 (Bird F03) with the median being 61 points. It is important to note that points for Animals M02 and M03 were 18 and 11, respectively. Bird M03 was able to be tracked only 1 mo due to possible mortality (mortality signal received), and Bird M02 ceased being tracked after 1.5 mo due to either transmitter failure or possible emigration from the study area. Bird F07 also ceased being tracked after 2.5 mo due to mortality. Data gathered on these three birds, although important in and of itself, artificially influenced the cumulative remaining home range data. Because of this, home range results were tabulated both with and without these data.

Home Range Estimate Evaluation

Minimum convex polygon (MCP) estimations of home range were evaluated for each bird. MCP ranged from 62.56 ha (Bird M03) to 1,918.81 ha (Bird M01), with an average of 679.12 ha. Elimination of data for the three birds that did not complete the study yielded an increase in mean MCP to 878.29 ha.

Kernel estimates of 95% for all birds ranged from 117.90 ha (Bird F07) to 4,622.58 ha (Bird F05), with a mean of 1,193.84 ha. Elimination of data for the three birds that did not complete the study yielded an increase in 95% kernel estimate mean to 1,496.97 ha.

Kernel estimates of 50% for all birds ranged from 17.85 ha (Bird F07) to 1,034.88 ha (Bird F05), with a mean of 196.17 ha. Elimination of data for the three birds that did not complete the study yielded an increase in 50% kernel estimate mean to 252.57 ha.

Female vs Male Estimates

Due to the lack of published data on home range estimates of native great horned owls in the North Texas region, coupled with the limited sample size for this study (*N=12*), most statistical analyses are not feasible. However, comparison data within the study group are presented for future reference.

Females in the study group (*n=7*) had a mean MCP of 736.04 ha, while that for males (*n=5*) averaged 599.44 ha. Elimination of data for Birds M02, M03, and F07, which did not complete the study, resulted in an increase in MCP mean to 942.55 ha for males and 846.16 ha for females. The 95% kernel estimates for females averaged 1,476.86 ha, while mean for males was 797.62 ha. Excluding data for Birds M02, M03, and F07 increased the mean to 1,084.12 ha for males and 1,703.35 for females. The 50% kernel estimates for females averaged 253.06 ha, and males averaged 116.52 ha. Excluding data for Birds M02, M03 and F07 increased the mean to 173.18 ha for males and 292.27 ha for females.

Non-territorial “Floaters”

Hamilton (and others 1988) reported that rehabilitated hawks remained near release sites for the first few days after release. This was also documented for bald eagles (Martel and others 1991) as well as great horned owls in southern Louisiana (Kimmel and Zwank 1983). All of the owls in this study exhibited the same behavior. Lack of muscle tone due to captivity could have limited early activities (Servheen and English 1976, 1979), as activity range eventually increased. Additionally, unfamiliarity with release area and pre-release feeding may have affected post-release hunting behavior. Territorial attacks from resident birds could also be responsible for dispersal of rehabilitated birds from release sites and could potentially affect the fate of introduced rehabilitated raptors (Hamilton and others 1988).

For owl populations, there is evidence for the presence of non-territorial “floaters,” (Austing and Holt 1966; Hirons 1985; Franklin 1992), but detailed information on space use and behavior of non-territorial owls is not available (Rohner 1997). Due to the short amount of time that the birds in this study were tracked, it is impossible to determine with any certainty if any of the birds exhibited this behavior beyond the tracking period.

Visual inspection of tracking data showed some of the owls utilizing what would appear to be separate areas within the calculated home range over the tracking period. Whether this was due to the “floating” behavior or other circumstances such as prey availability or territory disputes could not be ascertained, however, it can be shown that these movements did increase the calculated home range substantially. Examples of this can be seen with Birds F01 (Figure 2), F04 (Figure 5), F05 (Figure 6), F06 (Figure 7), M01 (Figure 8), and M05 (Figure 13).

Conclusion

Despite the lack of large-scale follow-up on the success of released birds, there is good evidence of survivability among birds that have been radio-tagged and/or banded, suggesting that post-release survivorship of a prey-tested, rehabilitated raptor is a reasonable expectation provided strict criteria for performance ability are observed prior to release (Redig and others 1988). With approximately 75 percent of the birds released for this study surviving until transmitter battery failure, it is believed that the rehabilitation process was successful for these birds.

Advances in telemetry methods through the use of GPS (Global Positioning Systems), GIS (Geographic Information Systems), and miniaturization of transmitters should prove to be a tremendous advantage to future studies of the success of rehabilitated and released raptors. Not only will it allow researchers the ability to track target organisms with greater accuracy, but also to obtain near real-time animal behavior and habitat information (Seegar and others 1997).

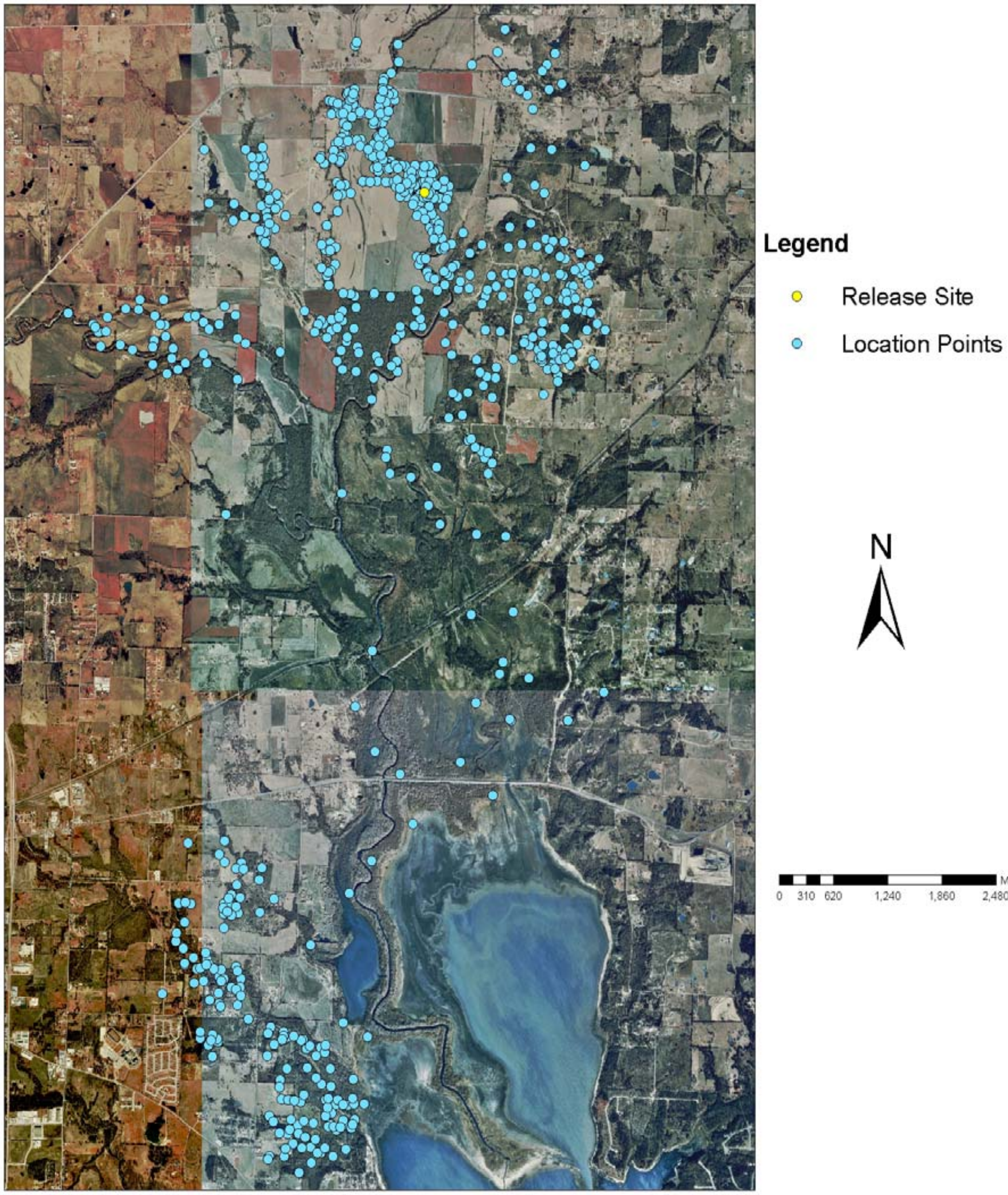

Figure 1. Triangulation bearings (location points) for all research animals monitored on the Ray Roberts Greenbelt Corridor (November 2002-February 2005).

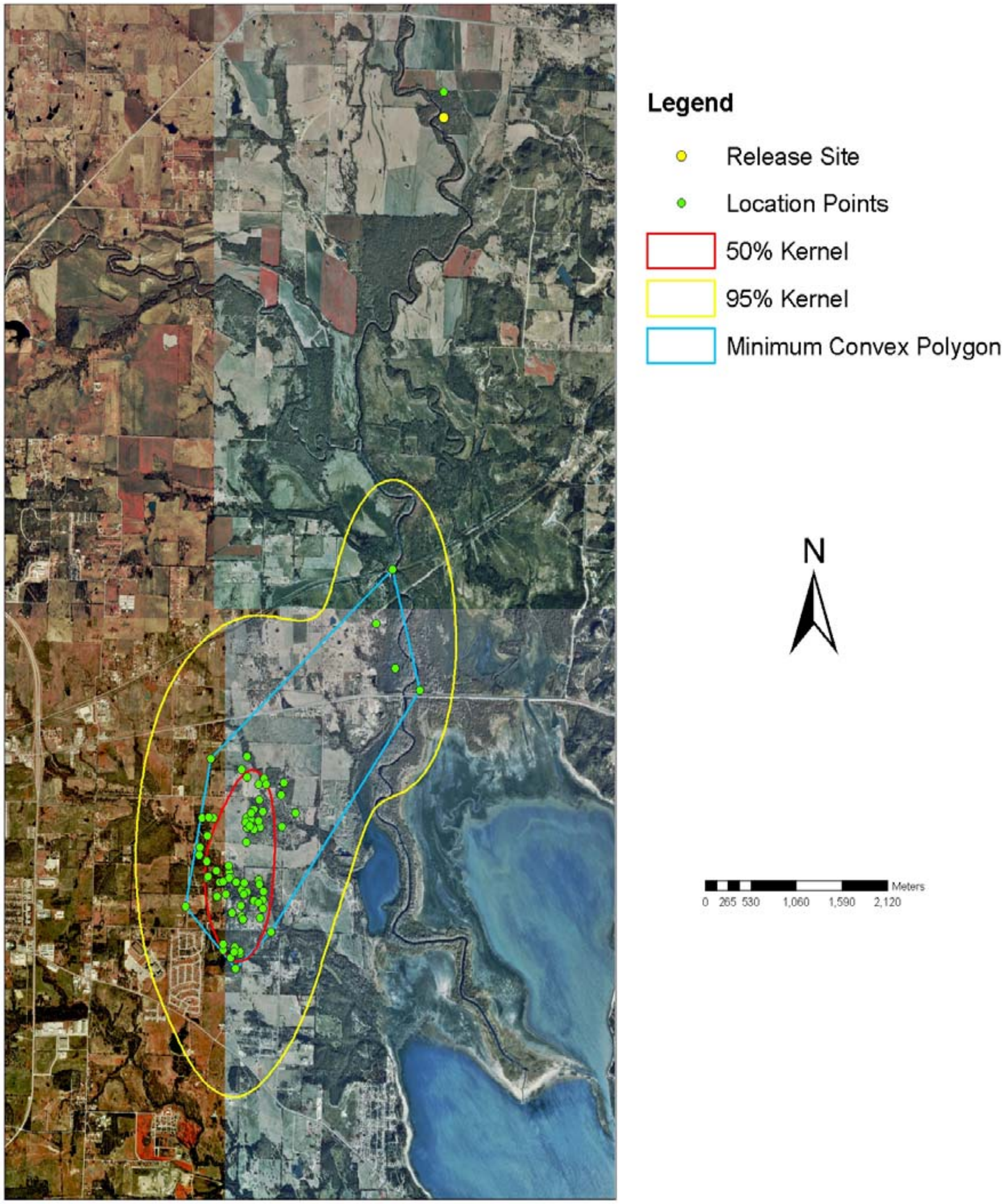

Figure 2. Home range estimations and triangulation bearings (location approximations) for Bird F01 (January 2003-June 2003).

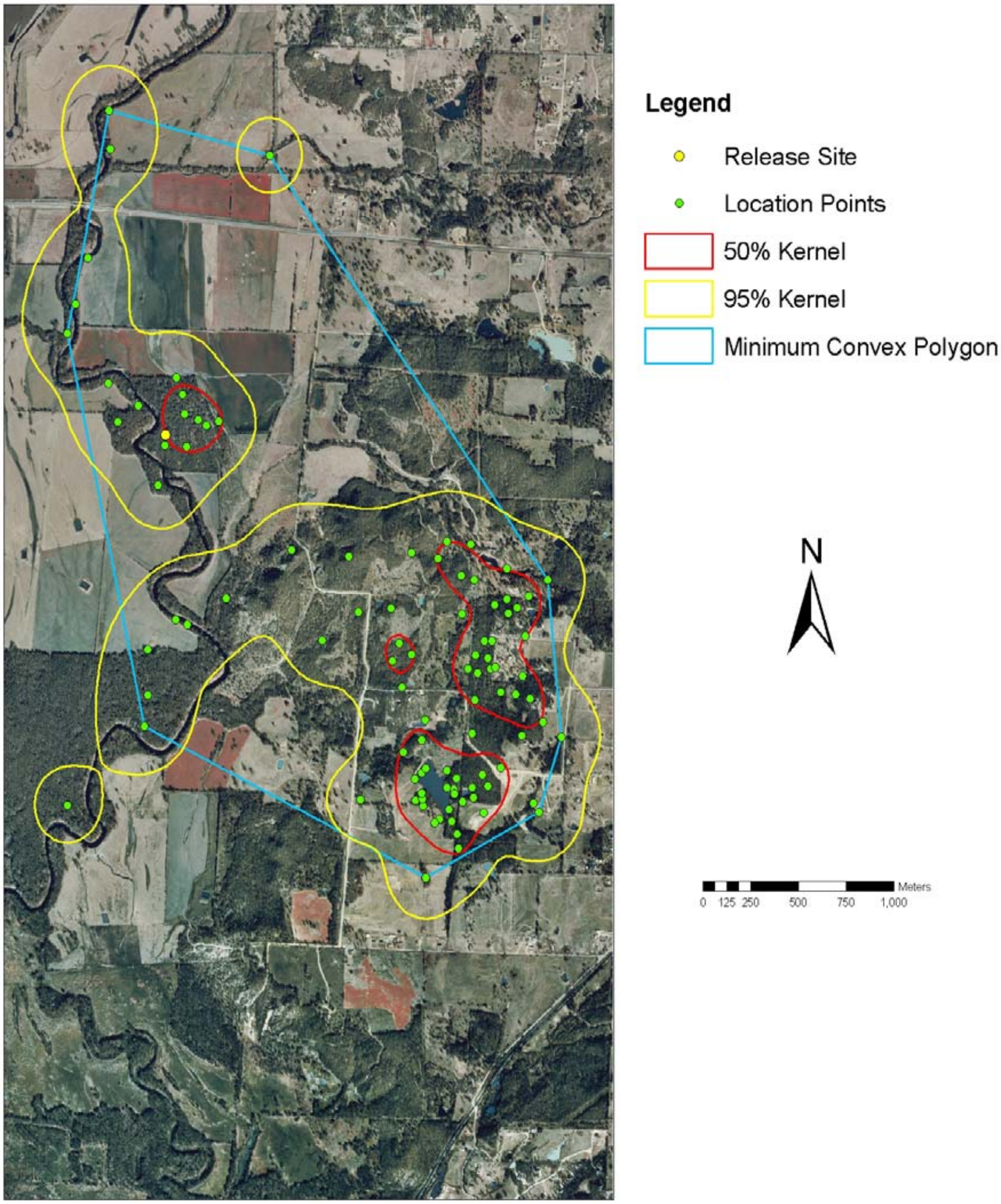

Figure 3. Home range estimations and triangulation bearings (location approximations) for Bird F02 (June 2004-January 2005).

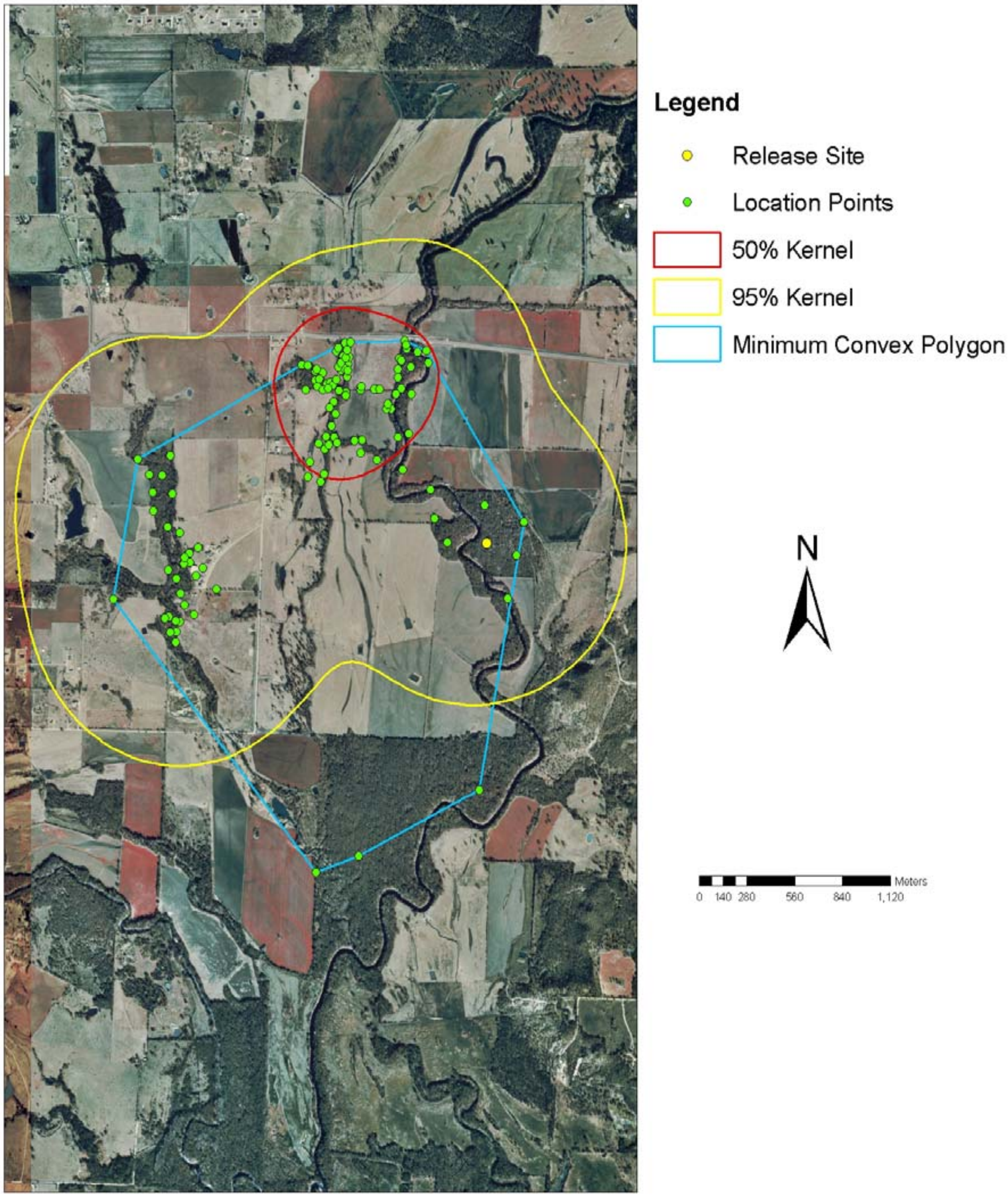

Figure 4. Home range estimations and triangulation bearings (location approximations) for Bird F03 (June 2004-February 2005).

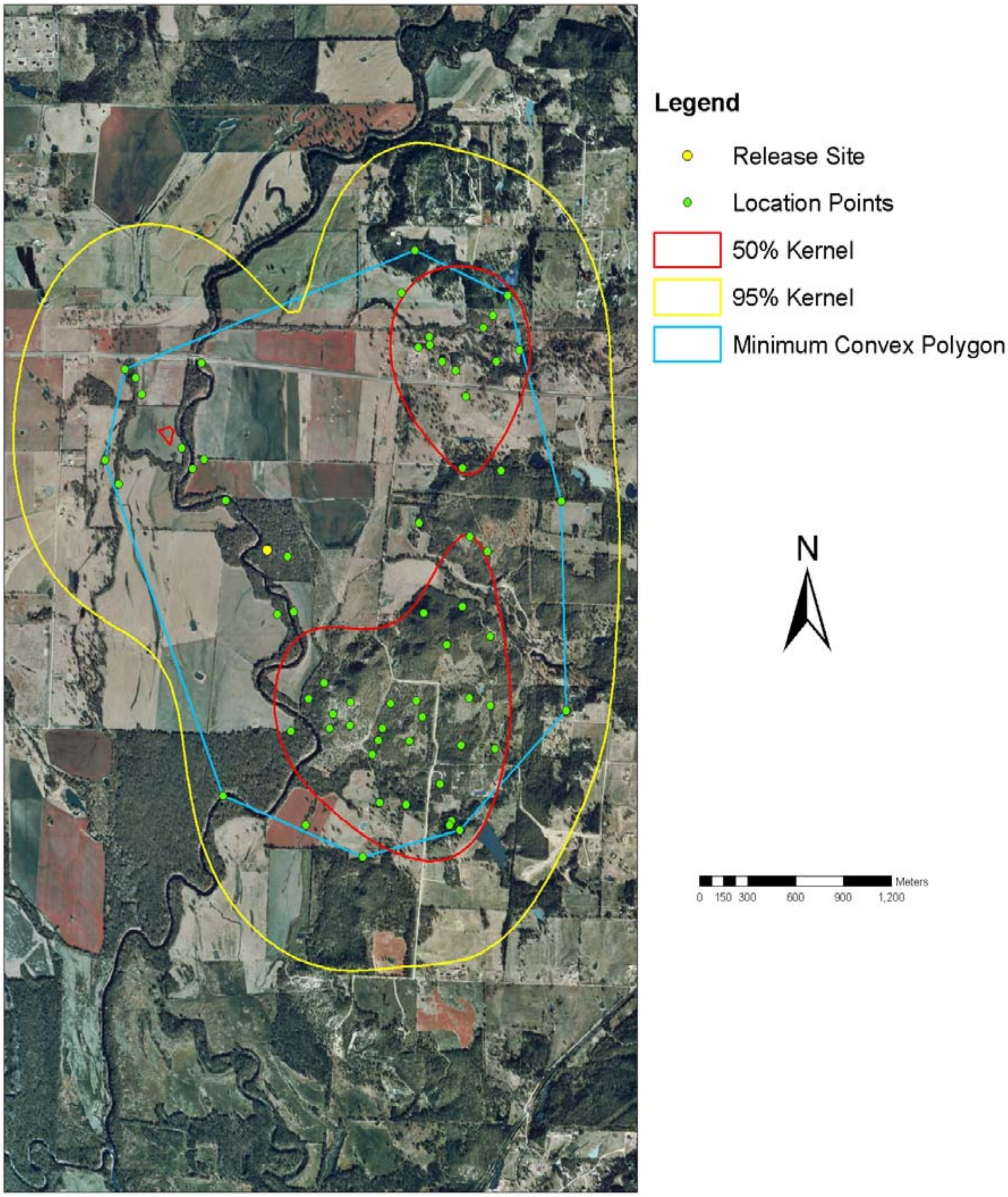

Figure 5. Home range estimations and triangulation bearings (location approximations) for Bird F04 (July 2004-November 2004).

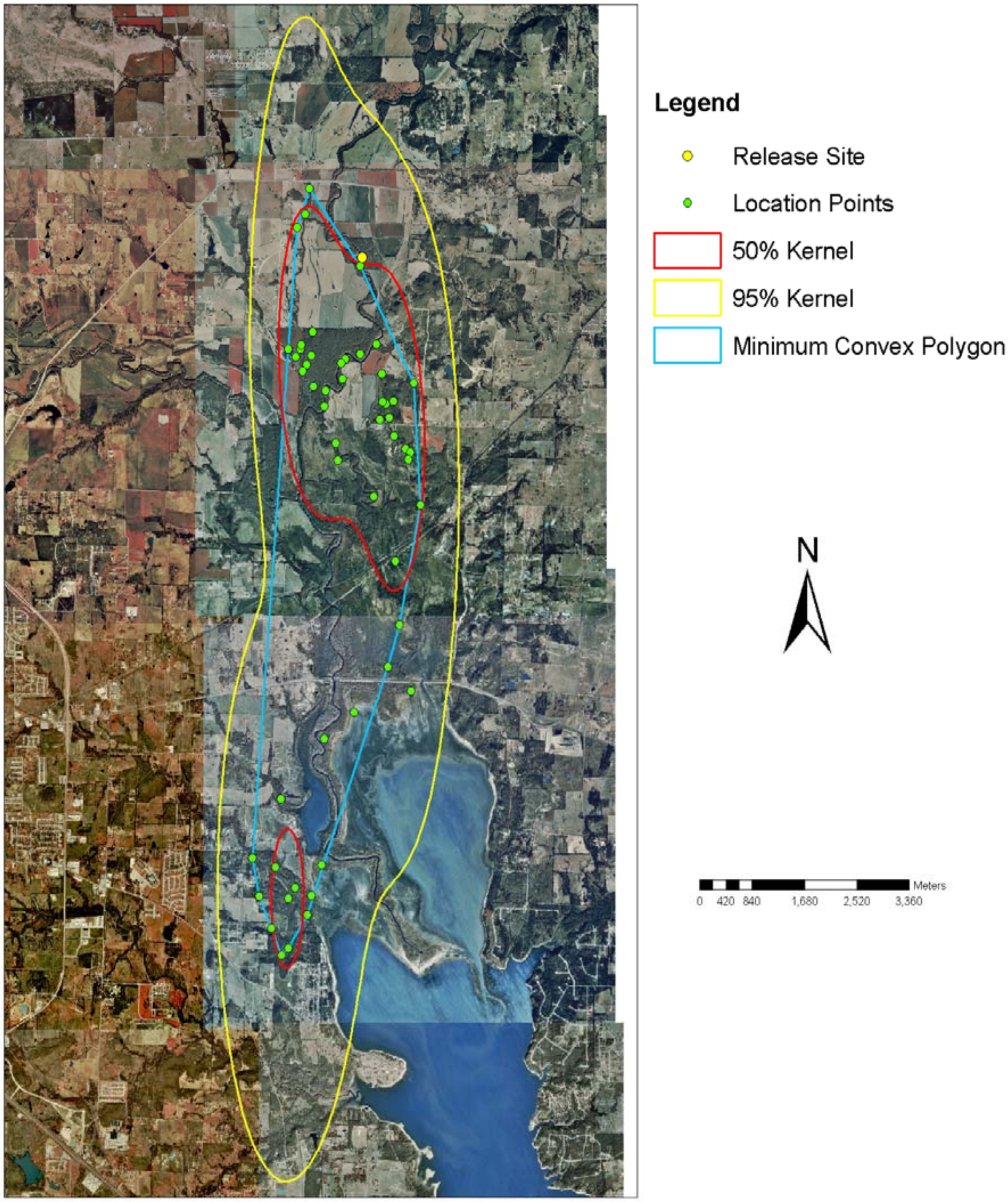

Figure 6. Home range estimations and triangulation bearings (location approximations) for Bird F05 (July 2004-November 2004).

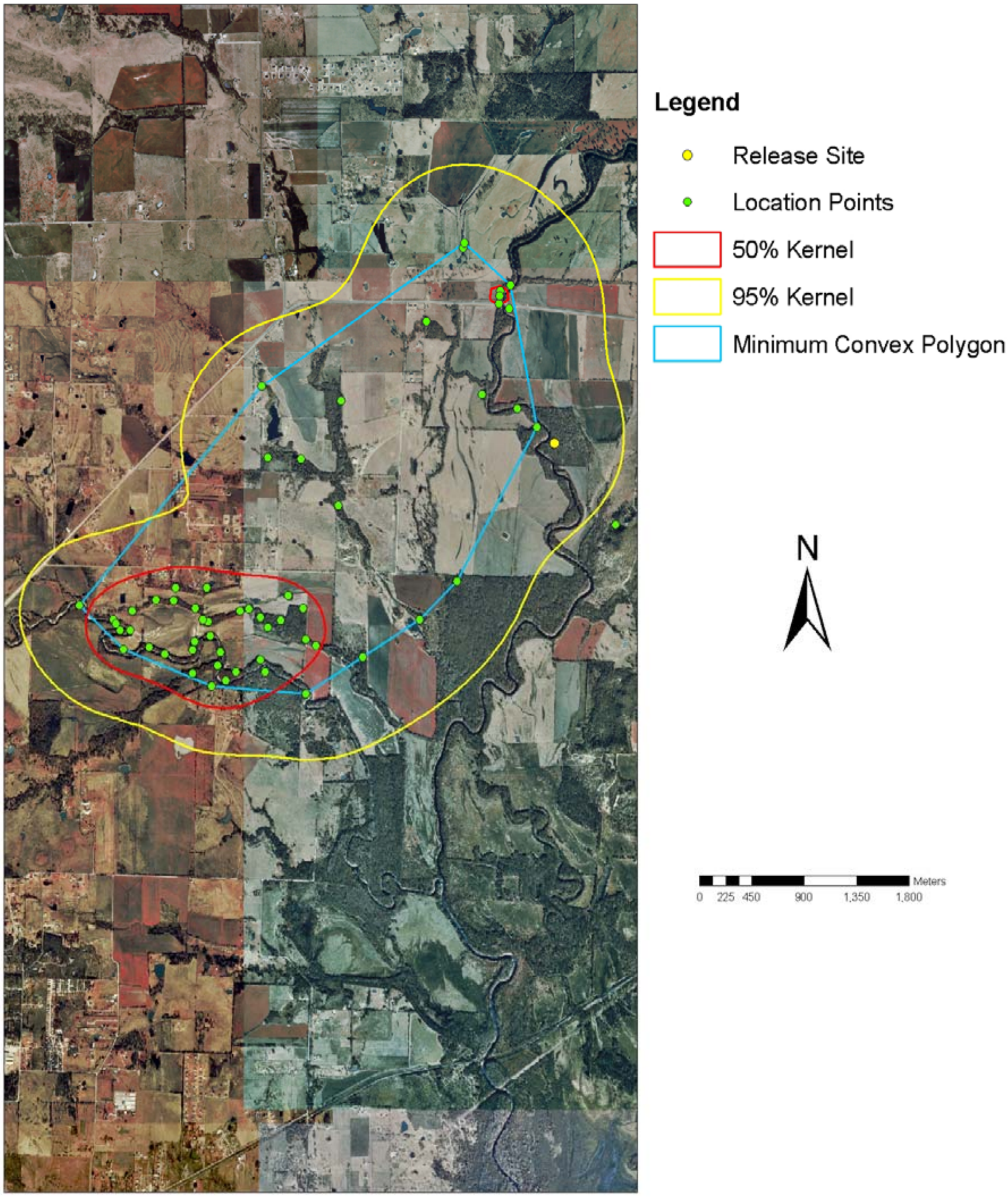

Figure 7. Home range estimations and triangulation bearings (location approximations) for Bird F06 (July 2004-November 2004).

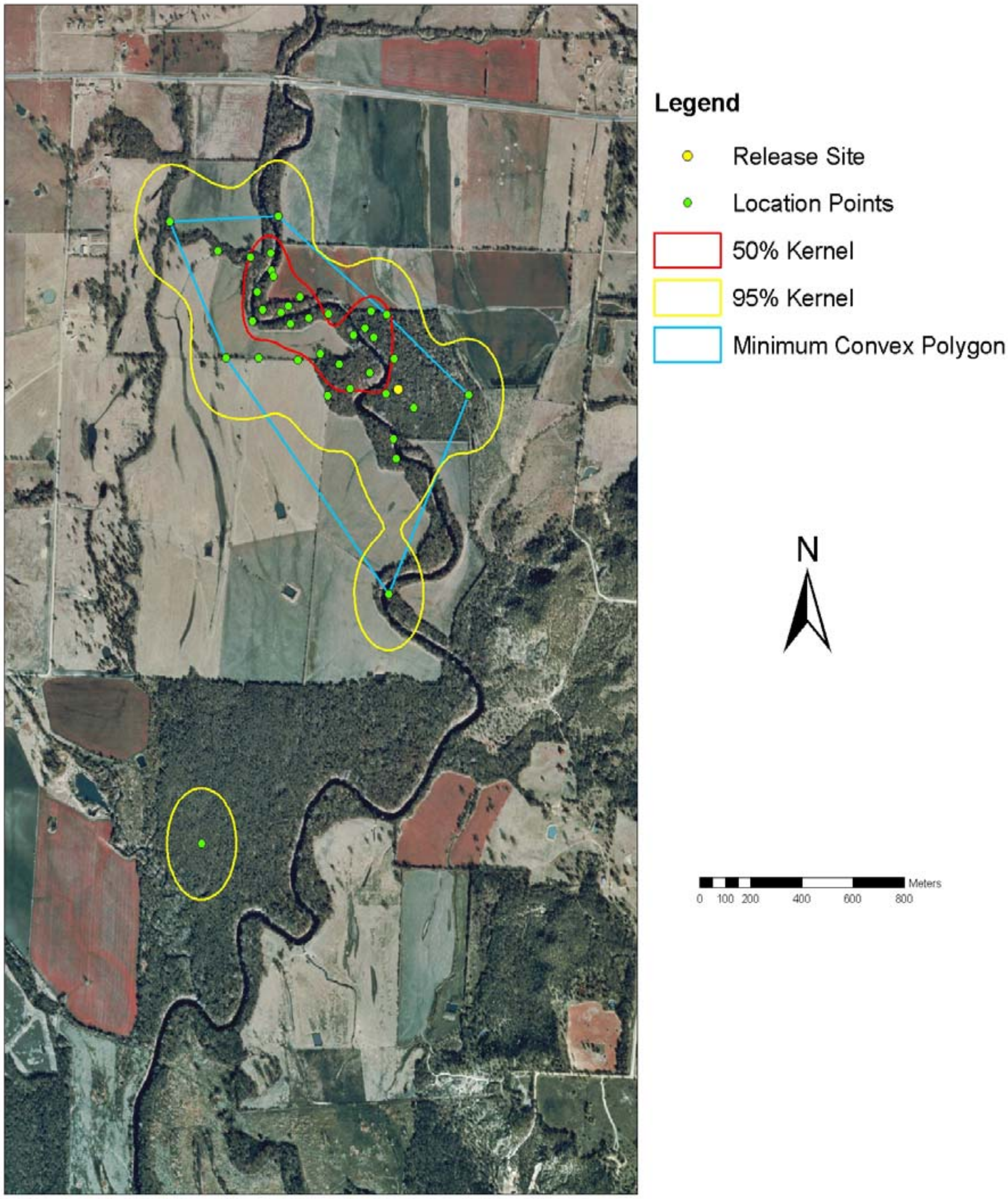

Figure 8. Home range estimations and triangulation bearings (location approximations) for Bird F07 (July 2004-October 2004).

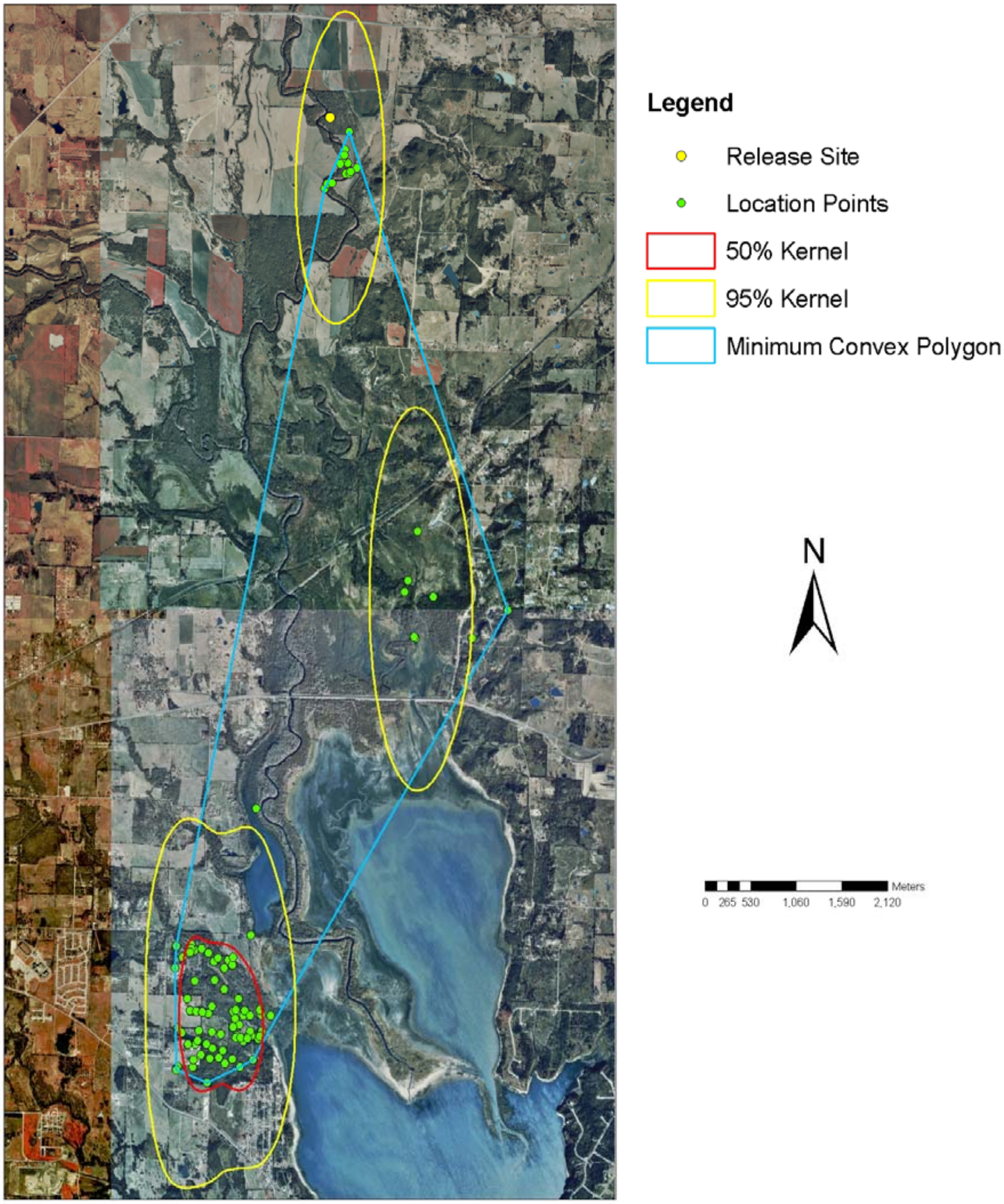

Figure 9. Home range estimations and triangulation bearings (location approximations) for Bird M01 (November 2002-May 2003).

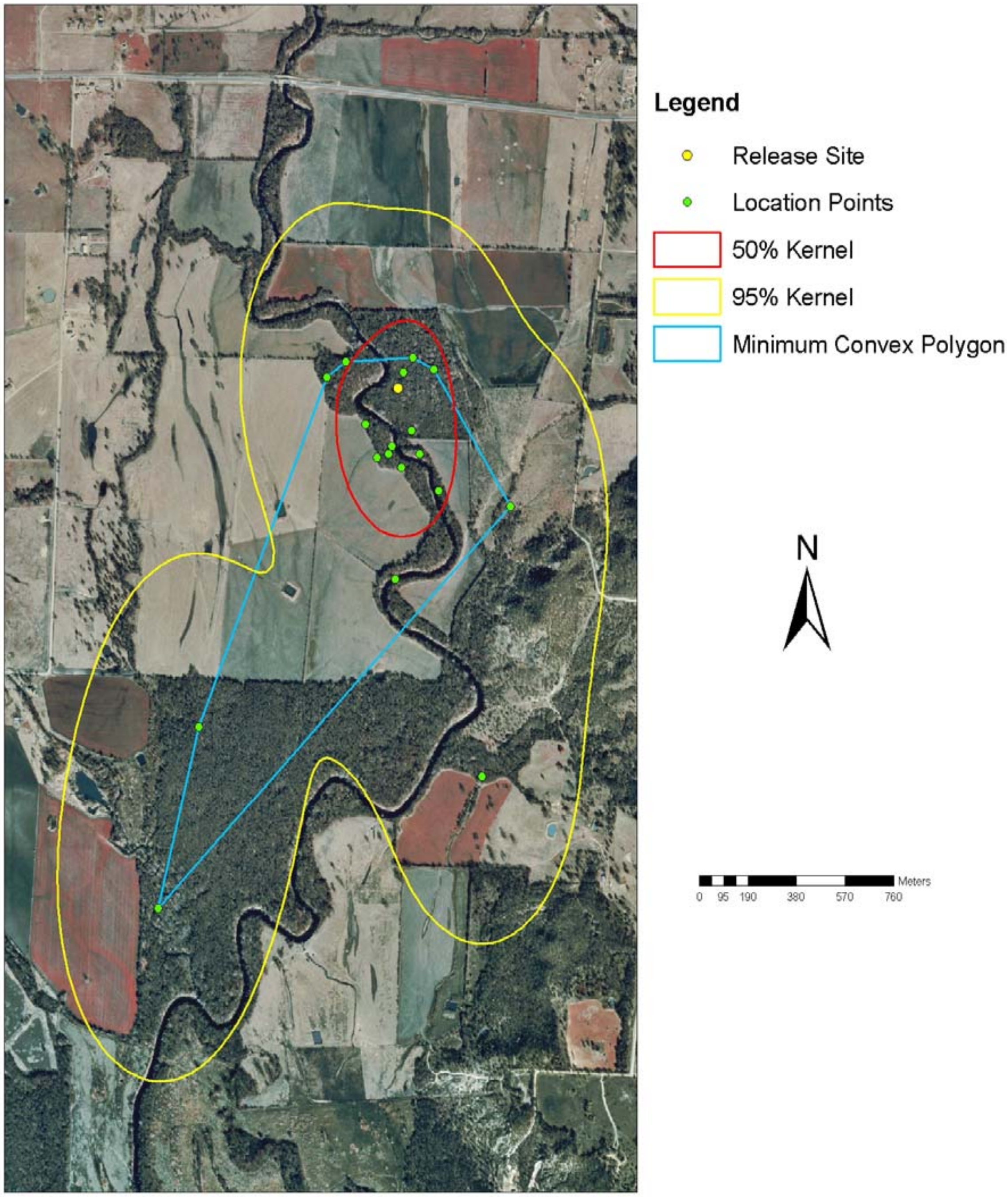

Figure 10. Home range estimations and triangulation bearings (location approximations) for Bird M02 (July 2003-September 2003).

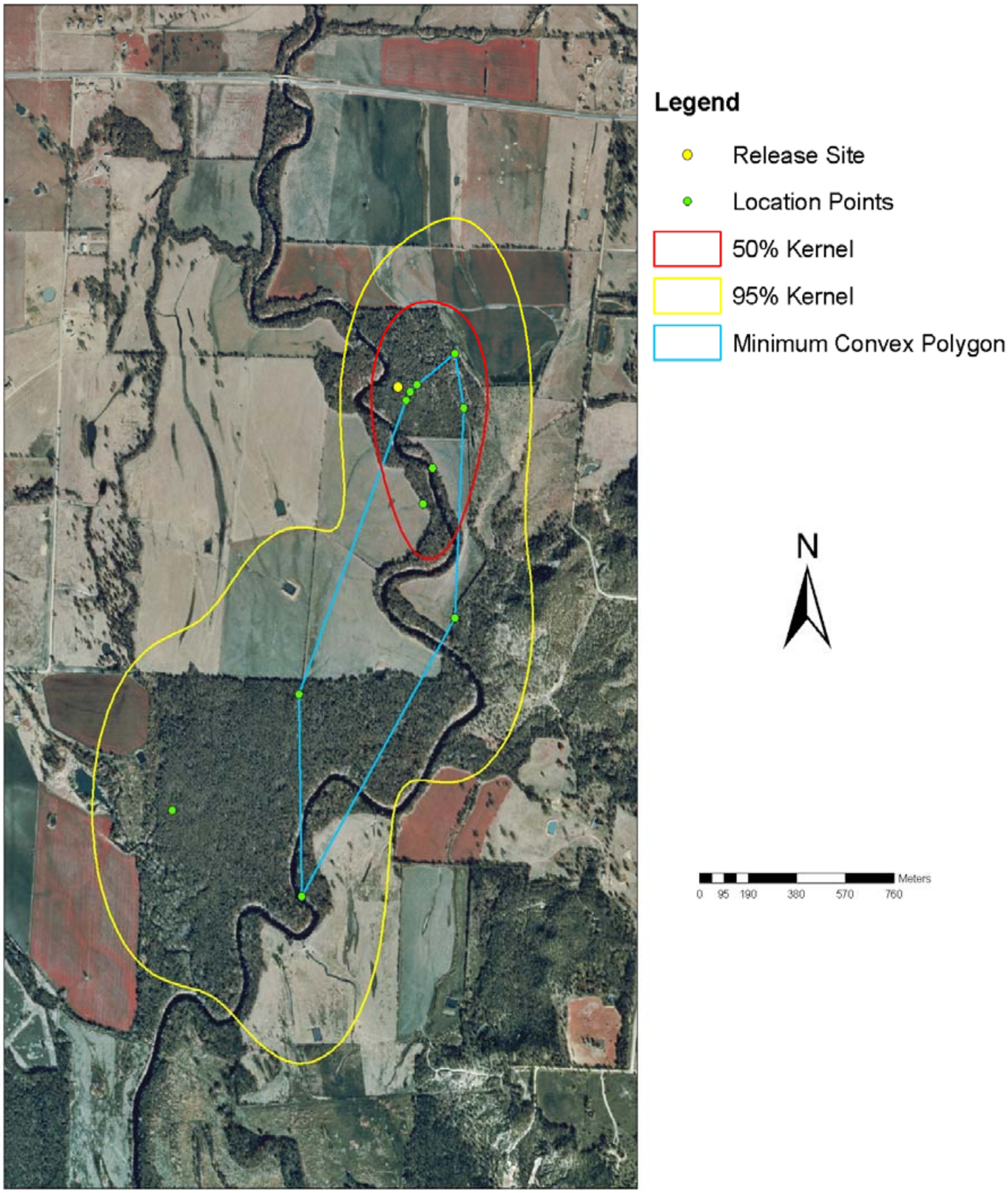

Figure 11. Home range estimations and triangulation bearings (location approximations) for Bird M03 (July 2003-September 2003).

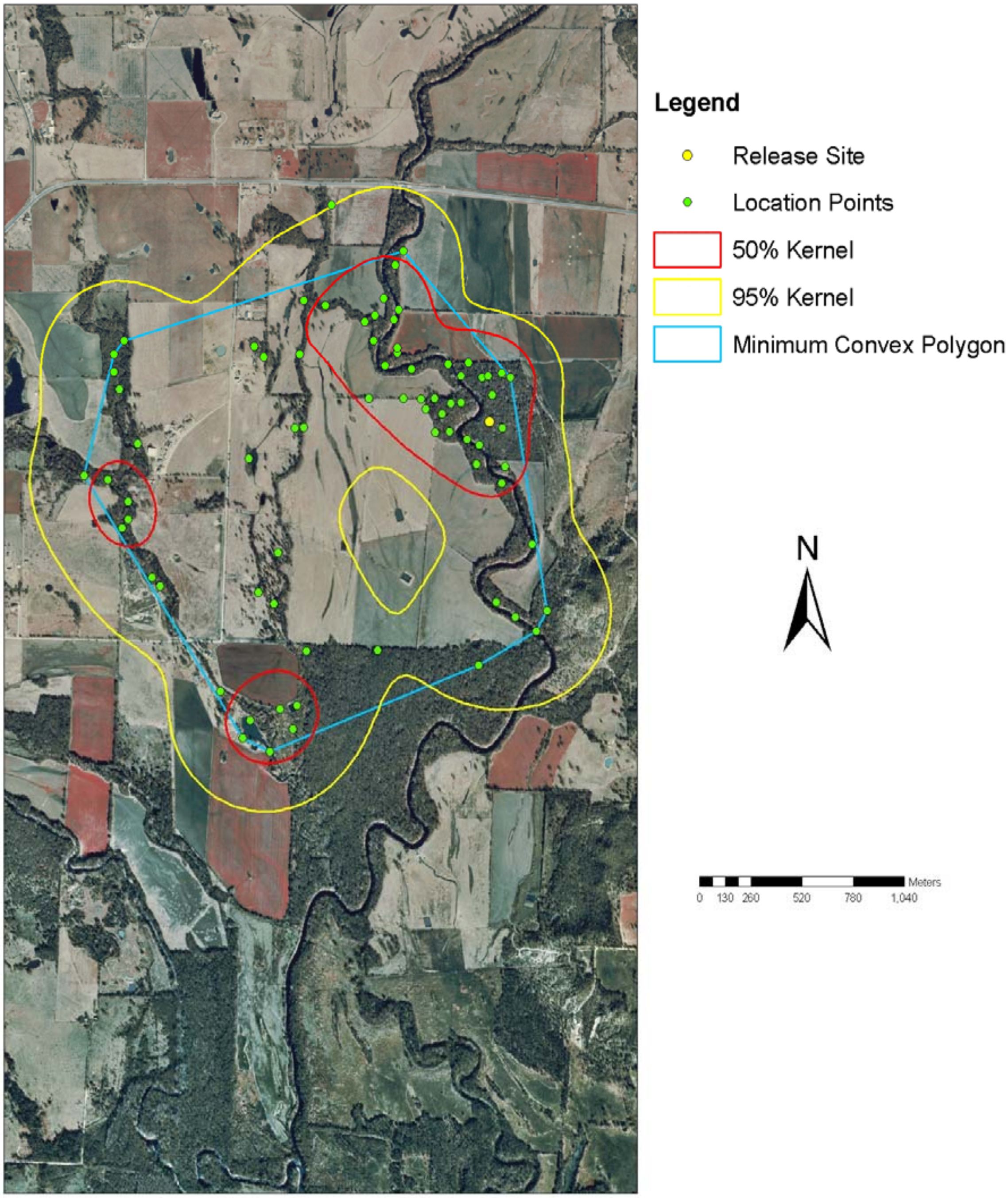

Figure 12. Home range estimations and triangulation bearings (location approximations) for Bird M04 (July 2004-November 2004).

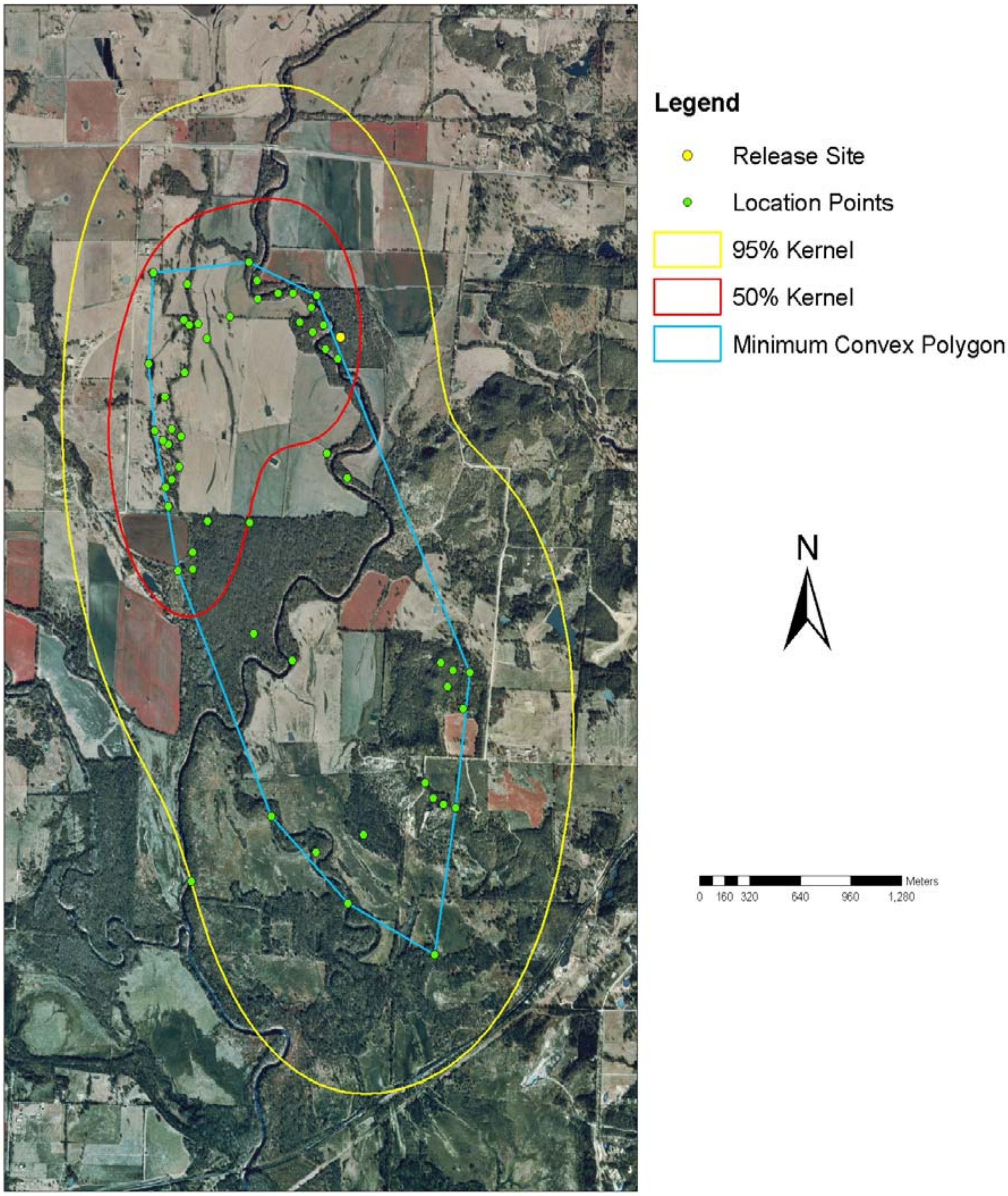

Figure 13. Home range estimations and triangulation bearings (location approximations) for Bird M05 (July 2004-November 2004).

LITERATURE CITED

Allbritten M, Jackson D. 2002. A post-release study of rehabilitated western screech owls (*Otus kennecotti*) in Douglas County, Oregon. Journal of Wildlife Rehabilitation 25(4):5-10.

Austing GR, Holt JB. 1966. The world of the great horned owl. Philadelphia, Lippincott: Living World Books. 158 p.

Bruce TK. 2003. Utilization of corridor habitat by white-tailed deer *(Odocoileus virginianus)* in Denton County, Texas [thesis]. Denton (TX): University of North Texas. 111 p.

Burt WH. 1943. Territoriality and home range concepts as applied to mammals. Journal of Mammalogy 24:346-352.

Daniels JM. 1984. Results of a post-release telemetry study involving barn owls (*Tyto alba pratincola*) in Northern Illinois, 1983. Animal Keepers Forum 11:283-289.

Duke GE, Redig PT, Jones W. 1981. Recoveries and resightings of released rehabilitated raptors. Raptor Research 15:97-107.

Fischer RA, Martin CO, Barry DQ, Hoffman K, Dickson KL, Zimmerman EG, Elrod DA. 1999. Corridors and vegetated buffer zones: A preliminary assessment and study design. Vicksburg (MS): U.S. Army Corps of Engineers Waterways Experiment Station. Technical Report EL-99-3. 52 p.

Franklin AB. 1992. Population regulation in northern spotted owls: Theoretical implications for management. In: McCullough D, Barrett R, editors. Wildlife 2001: Populations. London:Elsevier. P 812-827.

Fraser JD, Moss MB. 1985. Comment: a need for agency policies on wildlife rehabilitation. Wildlife Society Bulletin 13:202-204.

Hamilton L, Zwank P, Olsen G. 1988. Movements and survival of released, rehabilitated hawks. Journal of Raptor Research 22(1):22-26.

Hirons GJM. 1985. The effects of territorial behaviour on the stability and dispersion of tawny owl (*Strix aluco*) populations. Journal of Zoology 1:21-48.

Kenward RE, Walls SS. 1994. The systematic study of radio-tagged raptors: I. Survival, home-range and habitat use. In: Meyburg BU, Chancellor RD, editors. Raptor conservation today; Proceedings of the IV world conference on birds of prey and owls; 1992 May 10-17; Berlin, Germany. Buteo Books. p 303-316.

Kenward RE. 2001. A manual for wildlife radio tagging. San Diego (CA):Academic Press. 311 p.

Kimmel F, Zwank P. 1983. Post-release survivorship, dispersal and food habits of captive reared great horned owls. In: Beaver P, editor. Proceedings of the second annual national wildlife rehabilitation symposium; 1983 Mar 23-27; Naperville (IL):Exposition Press, Inc. p 104-108.

Martell M, Redig P, Nibe J, Buhl G. 1991. Survival and movements of released rehabilitated bald eagles. Journal of Raptor Research 25(3):72-76.

Redig PT, Degernes L, Martell M. 1988. The release of one-eyed, one-footed, and otherwise physically impaired raptors. In: Proceedings of the National Wildlife Rehabilitator's Association annual meeting. Foster City, California.

Rohner C. 1997. Non-territorial 'floaters' in great horned owls: space use during a cyclic peak of snowshoe hares. Animal Behavior 53:901-912.

Seeger WS, Fuller MR, Seegar JKD, Henke MB. 1997. Advanced satellite tracking system will contribute to natural resources conservation and management [abstract]. In: Forum on wildlife telemetry: Innovations, evaluations, and research needs; 1997 Sep 21-23; Snowmass Village (CO). Program and Abstracts. U.S. Geological Survey and the Wildlife Society. 82 p.

Servheen C, English W. 1976. Bald eagle rehabilitation techniques in western Washington. Raptor Research 10:84-87.

Servheen C, English W. 1979. Movements of rehabilitated bald eagles and proposed seasonal movement patterns of bald eagles in the pacific northwest. Raptor Research 13:79-88.

Southern WE. 1964. Additional observations on winter bald eagle populations; including remarks on biotelemetry techniques and immature plumages. Wilson Bulletin 76:121-137.

White GC, Garrott RA. 1990. Analysis of wildlife radio-tracking data. San Diego (CA): Academic Press. 383 p.

Winter JD. 2000. Designing telemetry studies and other technical and analytical considerations. In: Eiler JH, Alcorn DJ, Neuman MR, editors. Biotelemetry 15: Proceedings of the 15th international symposium on biotelemetry. 1999 May 9-14; Juneau (AK). Wageningen, Netherlands: International Society on Biotelemetry. p 229-247.

Worton BJ. 1989. Kernel methods for estimating the utilization distribution in home-range studies. Ecology 70(1):164-168.

Worton BJ. 1995. A convex hull-based estimator of home-range size. Biometrics 51(4):1206-1215.