ILLINOIS NATURAL HISTORY SURVEY

TECHNICAL REPORT

Spatial Ecology of the Blanding's Turtle (*Emydoidea blandingii*) at Lockport Prairie Nature Preserve, Will County, Illinois.

Michael J. Dreslik, Whitney J. Banning, Carl E. Schmidt, Lauren Noffke, and Christopher A. Phillips

Division of Biodiversity and Ecological Entomology
Section of Biotic Surveys and Monitoring

Prepared for:
Illinois Wildlife Preservation Fund
Illinois Department of Natural Resources
One Natural Resources Way
Springfield, Illinois 62702-1271

Grant Number: 597302 (D8350)
Agreement: RC06L17W

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INTRODUCTION

Urbanization and industrial expansion in northeastern Illinois has resulted in a dramatic loss of natural wetland communities. Remaining wetlands have become more isolated within this mosaic of urbanization. This fragmentation often reduces the health and viability of wetland communities by limiting such natural functions as gene flow and nutrient cycling. To preserve natural wetland communities many county nature preserves in Northeastern Illinois have made wetland restoration, creation, and protection paramount among their long-term goals. Once wetlands are protected, they require consistent monitoring to determine their health and assess their long-term viability and functioning as a self sustaining ecosystem. One such type of monitoring are adaptive management techniques based from ecological studies of species within the ecosystem.

Habitat loss, degradation, and fragmentation caused by the pressures of urbanization are responsible for the decline of many aquatic turtle species in the United States. As a result of habitat degradation and fragmentation, populations of turtles may become restricted to small isolated patches of habitat (Mitchell and Klemens, 2000). Generalist turtle species are more tolerant to degraded habitats than specialist species. For example, agriculture, sewage pollution, and construction of locks and dams along the Illinois River have reduced or abolished specialists species such as the Blanding's turtle (*Emydoidea blandingii*), Illinois mud turtle (*Kinosternon flavescens spooneri*), and smooth softshell (*Apalone mutica*) but generalist species such as the red-eared slider (*Trachemys scripta)*, spiny softshell (*Apalone spinifera*), and snapping turtle (*Chelydra serpentina*) have increased (Moll and Moll, 2000).

In the 1890's *E. blandingii* were reported as abundant in prairie wetlands (Garmin, 1890; Kennicott, 1855) but had become rare by 1937 (Cahn, 1937). However as of 1922, *E. blandingii* were still reported as common in the Chicago area (Weed, 1922). In central Illinois, habitat loss due to conversion of prairies to agriculture may have initiated the decline; whereas in the Chicago region, wetland degredation and habitat fragmentation due to urbanization chiefly imperil the species (Redmer and Kruse, 1998). In 1998, *E. blandingii* was listed as threatened in Illinois due to a drastic loss of wetland habitat and isolation of extant populations (Redmer and Kruse, 1998). Because of the threat of extinction in the Chicago area, the McHenry and DuPage County Forest Preserve Districts have initiated head-starting programs and the Lake County Forest Preserve District is exploring the feasibility of head-starting.

Information on recruiting classes such as abundance, survival, and habitat use is critical to addressing the declines in populations. Few studies emphasize the ecology of juvenile turtles because of their cryptic nature and general occurrence at low densities. Some studies have indicated that juvenile *Chrysemys picta* and *Chelydra serpentina* occupy shallower wetland habitats (Congdon et al., 1992). Similar results indicate that juvenile *E. blandingii* also occupy shallower, more heavily vegetated habitats (Pappas and Breck, 1992). Juvenile turtles in populations from the Chicago region appear rare as three studies have found juveniles to comprise ~10% of the individuals captured (Rowe and Moll, 1992; Rubin et al., 2004; Kuhns et al., 2004). Initial surveying at Lockport Prairie Nature Preserve, Will County in 2004 yielded 5 juveniles from 21 individuals and suggests this population is suitable to conduct studies of juvenile habitat use and preference (Dreslik et al., 2004). Without knowledge of the habitat requirements of juveniles and the amount of suitable juvenile habitat at sites where head-starting efforts occur, these efforts are doomed to failure.

STUDY SITE AND PREVIOUS RESEARCH

Lockport Prairie Nature Preserve (LPNP) is managed by the Forest Preserve District of Will County (FPDWC) and was dedicated as a nature preserve in 1983 (Figure 1). The site is bisected by a road dividing it into a northern and southern component. The nature preserve provides suitable habitat to two turtle species currently listed as endangered or threatened by the Illinois Endangered Species Protection Board. The southern component consists of eight wetlands surrounded by marsh and sedge-meadow habitat and have be the focus for an intensive long-term study of the state endangered Spotted Turtle (*Clemmys guttata*) since 1987 (Mauger, 1987). Two relatively large open ponds in the northern component provide deeper water habitat for such species as the Painted Turtle (*Chrysemys picta*), Common Snapping Turtle (*Chelydra serpentina*), Red-eared Slider (*Trachemys scripta*), Common Musk Turtle (*Sternotherus odoratus*), and Spiny Softshell (*Apalone spinifera*), and the state threatened Blanding's Turtle (*Emydoidea blandingii*). LPNP is extremely important in terms of the heritage of turtle fauna in Illinois because it is one of two localities where both *Clemmys guttata* and *Emydoidea blandingii* both coexist.

Past turtle research at LPNP has focused on the spotted turtle (*Clemmys guttata*) in the south region of the preserve (Mauger, 1987, 1990, 1991, 2001, 2002, 2005; Capler and Moll 1988; Mauger & Stillwaugh 1991; Wilson 1994, 2002; Mauger *et al.* 2002). The baseline spotted turtle survey conducted by Capler and Moll (1988) was the first to attempt to quantify overall turtle community structure, while a spotting scope survey by Redmer (1989) provided additional observations of turtle species associated with the large ponds and Des Plaines River. Efforts placing more emphasis on spatial dispersion of spotted and Blanding's turtle in the north region of the preserve was started in 2000 (Mauger 2001). In 2001 effort was undertaken to assess relative abundance of all turtle species in north and south regions of the preserve using hand-capture and visual sightings (Mauger 2002). The first effort to assess the composite turtle community structure of the larger ponds in LPNP north using hoop and fyke-net trapping techniques was began in 2001(Wilson, 2005). A comprehensive picture of the structural dynamics and resources that comprise the entire turtle community at a particular site is crucial to identify the limits of spatial dispersion and abundance of populations of rare turtle species. Thus, this study is the first to build a comprehensive composite picture of the structure and dynamics of the turtle community at LPNP.

MATERIALS AND METHODS

GENERAL METHODOLOGY

Trapping.– The predominant trapping method was baited hoop traps (Legler, 1960) with double throats. These traps were approximately 3ft long and 1.5ft in diameter. We used three sizes of fyke nets. Large fyke nets measured 12ft long with 50ft wings and leads, and a 3ft diameter front hoop. Small fyke nets measured 6ft long with 12ft wings and leads, and a 1.5ft diameter front hoop. Mini fyke nets measured 3ft long, had 8ft wings, and a 6 inch diameter front hoop.

We focused our effort in the East Pond, Lost Pond, West Marsh, and Middle Pond habitat units. Because we were limited in number of traps and because most of the wetland habitat was too shallow, our trap deployment in the remainder of the wetlands in the preserve was minimal. We apportioned traps approximately based on the relative size of core wetland pools, with priority of fyke arrays afforded to the East and Middle ponds. Traps were moved to new locations whenever pulled for repair or when yielded no captures after approximately one week of sampling. In addition, we placed several traps in wetland habitats in the south Unit. Finally, we expanded trapping to include a pool in the Des Plaines River adjacent to the preserve and a backwater pond.

All hoop traps were placed such that no more than two thirds of the trap was submerged by water. Fyke nets were totally submerged in most cases but we placed two plastic milk jugs in the rear chamber to prevent accidentally drowning turtles. All traps were placed parallel to the shoreline or in the case of fyke nets, wings were run up to the shoreline where possible, in an attempt to funnel turtles moving in the water into the traps. We used sardines in water, sardines in oil, clams in juice, tuna in water, and 9-lives tuna and shrimp as baits, which were changed at periods ranging from 2 – 4 days. Fyke nets were not baited and baited hoop traps were checked daily. We supplemented trapping with hand captures during routine trap checks, during radio-telemetry, and in the spring. Upon initial placement of traps, we recorded GPS coordinates (UTM; NAD83).

Individual Turtles.– Every turtle captured within a given species was given a unique shell notch (Cagle, 1939). For each turtle we measured the following morphological variables to the nearest mm using metric tree calipers: carapace length (CL), carapace width (CW), plastron length (PL), and shell height (SH). We measured the left pectoral scute (LPECT) and each scute ring on LPECT (from the pectoral-abdominal seam to the end of the ring on pectoral scute) to the nearest 0.01 mm using metric vernier calipers. We also measured maximum anterior plastral lobe width (APW) and maximum posterior lobe width (PPW) with digital calipers to the nearest 0.01 mm, front and rear angle of the carapace at the midline (FA and RA respectively) and side angle of the carapace between the 2nd and 3rd vertebral scutes (SA) with a goniometer to the nearest degree, and curved carapace length (CCL) and curved carapace width (CCW) between the 2nd and 3rd vertebral scute with a flexible tape to the nearest mm. We weighed all turtles using OHAUS electronic scales.

We palpated the inguinal pockets of all females to determine their reproductive condition. We partitioned individuals of each species into three sex categories; males, females, and unknown. Males were identified by having the combination of elongated fore-claws and cloacal vent extension beyond the posterior carapace margin. Females were identified by having relatively short fore-claws and a cloacal vent that did not extend beyond the posterior carapace margin. All small and questionable individuals were classified as unknown. We took blood samples from the cervical sinus from the majority of turtles for future DNA analysis. We took no more than 0.1 cc per 100 grams of turtle mass. All samples are stored at the INHS in a -80°C freezer.

Radio-telemetry.– Thirty-five turtles were outfitted with two-stage radio transmitters (Holohil Systems Ltd., Carp, Ontario; Wildlife Materials International Inc., Murphysboro, Illinois; and L.L. Electronics, Mahomet, Illinois). Five male, 13 female, and eight juvenile Blanding's turtles (*Emydoidea blandingii*) were monitored via radio telemetry beginning May 2005. Turtles were tracked approximately three to seven times a week from May – October. Gravid females were tracked during evening hours throughout the nesting season. We reduced the frequency of locations in November to one to two times a month when it became apparent that turtles had entered wintering sites and had ceased nearly all surface activity. At each location, we recorded GPS coordinates (UTM-NAD 83 CONUS). Times of tracking were rotated so that each turtle was located at different intervals of the day (i.e. morning, midday, evening). At each visual location, we recorded behavior as well as a suite of habitat and environmental variables; air temperature, soil/water temperature, relative humidity, water depth, ground cover, and canopy cover, vegetation height, presence of absence of aquatic vegetation, and habitat type.

DATA ANALYSIS

Population Structure – We partitioned all turtles of a given species into 10 mm size classes by sex/stage for graphical representation. Because of the severe drought and draw-down of the wetlands, for species with enough captures, we examined if there was and effect on turtle size between the largest wetland units (East Pond and Lost Pond). We first tested if mean plastral lengths of males and females differed between the ponds using t-tests. To determine if there was a temporal pattern and if this pattern varied by sex, we used linear regression on the mean plastral length of turtles captured at each wetland and date of capture.

We calculated the overall sex ratio using the number of sexable males and females and the adult sex ratios for all species with sufficient representation. We also calculated the juvenile to adult ratio for each species with sufficient representation. We determined if sex ratios deviated from equality using χ^2 tests.

We estimated population size for all species with a sufficient enough recapture rate using the Schumacher-Eschmeyer regression method. We tested the assumptions of equal catchability and population closure using linear regression on the proportion of recaptures in a sample versus the cumulative number of turtles marked. We also forced the regression through the origin to fix the y-intercept at zero. The assumptions are then met if the regression is significantly positive (Krebs, 1989).

We calculated density by dividing the estimated population size by the amount of open water habitat and open water and marsh habitat combined in hectares. Biomass was calculated by taking the mean body weight multiplied by the population size and divided by the wetland area studied.

Population Viability and Sensitivity.– We conducted population viability analyses using VORTEX for species that had complete demographic information from the literatures. Specific data for each species used in the models is presented for each species in Table 1. In general, we used the initial population size from our population estimates, assumed a stable age-distribution, because we had no data on age structure, and ran 1000 simulations for 50 years. For the sensitivity analyses we modeled different levels of hatchling, juvenile, and adult mortality rates as well as varying reproductive parameters. For all sensitivity analyses we used our initial population estimates and proportion of adult males in the population.

Nesting.– Gravid females were tracked during evening hours throughout the nesting season. If females were observed nesting, location was noted with minimum disturbance and environmental variables were recorded some distance away from the nesting location. The following morning, we would return to the nest site to record the site's habitat variables as well as locate the female and palpate for presence or absence of eggs to verify if the nesting attempt was completed. Suspected nests were left undisturbed.

Mortality.– Mortality was calculated for radio located individuals using the Mayfield method (Winterstein *et al.*, 2001). The daily survival rate for each species was calculated by dividing the number of deaths by the total number of exposure days – the number or radioed animals.

Head-starting.– *E. blandingii* eggs from an uncompleted nesting attempt in June were collected and incubated at room temperature through the summer. Hatchlings are being held over winter in order to increase growth and survival once they are released in the spring. Hatchlings are being held in a 20 gal aquarium complete with a heat lamp and a UV light. Rocks, sticks, and live plants were placed in the aquarium to mimic natural aquatic habitat. Diet includes Wardley Reptile Sticks and Fluker's Aquatic Turtle Diet pellets coated with Fluker's Repta-Calcium dietary supplement to increase vitamin D intake, and Tetrafauna ReptoTreat dried freshwater shrimp. Live prey including fish, shrimp, and crayfish are also regularly released in the aquarium in order to provide a more natural diet and promote instinctive foraging behavior. To differentiate among individuals, a small dot of epoxy was applied to a different vertebral scute of each turtle except for one that could be distinguished by its kinked tail. Measurements including mass, carapace length (CL), carapace width (CW), shell height (SH), and plastron length (PL) are regularly recorded to monitor growth progress. We released head-started hatchlings in the early summer; however, the details of that information will be included in a subsequent report.

Movement.– All coordinates were plotted on an aerial photograph overlaid with the habitat composition map of the preserve using Arcview 3.2 GIS software and its extensions (Environmental Research Institute). The Spatial Analyst and Animal Movement (Hooge and Eichelaub, 1997) extensions were used to calculate and create movement paths and home ranges for individuals. Monthly movement patterns were compared across females, males, and juveniles. Mean daily distance moved (MDD), total distance moved (TDIS), total number of moves (#Moves), and mean distance per move (MDPM) was calculated for each individual using either the Animal Movement extension or in Microsoft Excel spreadsheets. Differences in movement variables among male, gravid female, non-gravid female, and juvenile *E. blandingii* were tested using ANOVA. Differences in monthly movement patterns among male, female, and juvenile *E. blandingii* were tested using the Kruskal-WallaceH-test. All females were grouped together for analysis regardless of reproductive status because 3 of the 4 gravid females were captured during presumed nesting forays.

Home Range.– Home ranges were estimated using minimum convex polygons (MCP) and 95%, 75%, and 50% kernel density isopleths. The average MDD for each species was used as the smoothing parameter for kernel estimation. Incremental area curves were constructed using both sequential and bootstrapped analysis. For the sequential analysis MCP area was plotted versus time; whereas, for the bootstrap analysis, 100 random points were pulled from the total number of locations for a particular turtle, an MCP area was calculated and the process was repeated until no more points were available. To determine if a sufficient number of locations had been collected for each turtle to adequately represent that individual's home range, both curves must asymptote. Sequential MCPs areas were generated in Biotas (Ecological Software Solutions) and random MCPs areas were generated by bootstrapping (100 samples) using the Animal Movement extension. Any turtles that were found to have been inadequately sampled were removed from subsequent analyses. Differences in home range estimations among male, gravid female, non-gravid female, and juvenile *E. blandingii* were tested using ANOVA. Average MCP area used each month was compared among females, males, and juveniles.

Habitat Use and Preference.– The proportion of habitat use by each individual was calculated by dividing the number of locations in each habitat by the total number of locations for that individual. Mean proportions of habitats used by male, female, and juvenile *E. blandingii* were calculated. Only locations within the preserve were included in this analysis because we have not yet determined the amount and types of available habitat beyond the preserve boundaries. Differences in habitat preference, in relation to habitat availability, among *E. blandingii* were tested using Friedman's Rank test, (White and Garrott, 1990). For each individual, the proportion of available habitat within the preserve was subtracted from the proportion of locations that individual had within that habitat. Differences in availability and selection for each individual were ranked and ranks were summed for each habitat type. The test statistic was then calculated to determine if differential preference in habitat types occurred among all *E. blandingii* and within males, females, and juveniles.

RESULTS

Population Structure.– We made 22 trap captures (16 individuals, 6 recaptures; Appendix I) and 20 hand captures of *E. blandingii*. The majority of *E. blandingii* captured fell in two modes, one between 80 to 130 mm PL and one between 170 to 210 mm PL (Figure 2). Hatchlings fell at the 20 mm PL mark (Figure 2). Typically the largest individuals in the population were adult females (Figure 2). We captured 5 males and 16 females for a sex ratio of 1M:3.2F, which was significantly different from equality ($\chi^2 = 5.79$, $p = 0.016$). Of those turtles, we captured 5 adult males and 12 adult females for an operational sex ratio 1M:2.4F, also not significantly skewed ($\chi^2 = 2.88$, $p = 0.090$). We captured 17 adult, 4 immature, and 12 juvenile individuals for a juvenile to adult ratio of 1J:1.1A, which was not significantly skewed ($\chi^2 = 0.03$, $p = 0.862$).

Population Size, Density, and Biomass.– When we combined the 2004 census data with our census data for 2005, we met the assumptions of equal catchability and closure without collapsing our sampling periods ($r^2 = 0.80$, $p < 0.001$). Thus, the population estimate for LPNP wetlands is 42 *E. blandingii* (95% C.I. - 34, 54). The density and biomass of *E. blandingii* differs considerably when considering the total marsh habitat and that of permanent water. When considering only open bodies of water, we obtained a density estimate of 16.3 turtle/ha and a corresponding biomass of 5.2 kg/ha. When we considered all marsh habitat and open bodies of water, our density and biomass estimates dropped to 1.1 turtles/ha and 0.4 kg/ha. Because we have captured *E. blandingii* throughout the preserve, the density estimate lies closer the estimate using total wetland area.

Population Viability and Sensitivity.– All parameters in the model are listed in Table 1. The majority data is cited from Congdon *et al.* (1993); however, we used our population size and proportion of adult males in the breeding pool. The results of the preliminary PVA suggest that within 50 years the LPNP *E. blandingii* population faces a 27.5% chance of extinction and the current population growth rate is -0.017 +/- 0.376. Although the population sizes of all simulations appears not to deviate too far from our original estimate, over 50 years only 72.5% of the simulations remain extant (Figure 3). Thus the *E. blandingii* population is projected to be on a slow decline toward extinction (Figure 3). Simulations suggest that it will take great effort to achieve a positive population growth rate over fifty years. Clutch size, reproductive frequency of females, and age of maturity for females cannot be manipulated to achieve a positive population growth rate (Figure 4). All mortality traits can be manipulated, but it would take reducing hatchling mortality to at most 51.7%, juvenile mortality to at most 18.5%, adult mortality to at most 2%, or a combination thereof (Figure 4). A management regime aimed at these three mortality traits will be required to secure the population.

Nesting.– Throughout the nesting season, four gravid females were monitored during evening hours to obtain nesting data. Three of the females were captured on land during the nesting season and were presumed to be on nesting forays (Figure 5). Two of these females (EMBL 11, EMBL 21) were captured on separate dates by hand during early evening hours near the West Trail in LPNP South. At time of capture, these females were observed moving rapidly on land through dry prairie habitat. One female (EMBL 16) was captured by hand on land southwest of the East Pond oriented toward Division Street. The fourth female (EMBL 7) was captured before nesting season in mid-May in a trap located in the East Trail Central Subunit. Gravid females attempted to nest close to the West Trail, either adjacent to the path itself or along the raised embankment of the trail in mesic dolomite prairie or dry dolomite prairie. One female attempted to nest in the south prairie about 100 m west of the trail in sedge meadow. The substrate composition of the trail area where nesting attempts occurred can be primarily characterized as rocky with a few centimeters of soil. Vegetation consists mainly of sparse grasses and other prairie vegetation. Piles of old roofing material are scattered in areas along the trail. One female attempted to nest in one of these piles.

The first nesting attempt was observed on 9 June at 2240hrs and the last nesting attempt was observed on 29 June. At least two of the females had multiple incomplete nesting attempts where turtles were observed excavating chambers but laying never occurred. A total of 8 nesting events were witnessed (Figure 5). These occurred from 2105-2210hrs and in all cases females almost always were observed digging chambers. Only two nests were located during this period. One of these nests was depredated 2 days after completion by an unknown mammalian predator. The female that created the second nest failed to dig a chamber large enough to accommodate her eggs and was unsuccessful in completely burying them. Of 13 eggs, 3 were completely concealed but one was broken. Two others were partially covered but were left exposed at the surface, and the remaining 8 were deposited on the ground near the chamber. All intact eggs from this nest were collected and placed in a plastic container with vermiculite and incubated throughout the summer.

Mortality.– No mortality was observed for the radio-located *E. blandingii* ($\hat{S}_d$=1). However, one hatchling was found DOR on Division Street and the remains of 2 adults were found in LPNP North. One individual was found in the Railroad Marsh west of the railroad tracks and the second individual was found in prairie west of the North ORV Trails.

Head-starting.– Five of the *E. blandingii* eggs hatched in late August. Hatchlings are investigative and moderately active, swimming, climbing, and foraging throughout their surroundings, but they also spend large periods of time basking. All turtles have voracious appetites and are quite capable of catching live prey. Growth rate varies among each individual but all are growing steadily (Figures 6 & 7) and appear healthy. One individual (Curly) hatched with a congenital shell defect and a kinked tail. Several carapacial scutes appeared whitish in color as if worn or degenerated. However, new shell growth seems normal and the turtle has not exhibited behavioral abnormalities.

Movement.– Movement statistics were compared across 13 female, 5 male, and 8 juvenile *E. blandingii* (Table 2). Individual turtles were located anywhere from 13-146 times ($\bar{x}$ = 69.6) from 19-218 days ($\bar{x}$ = 138). Turtles moved an average mean daily distance (MDD) of 14.6 m (s = 13.2) and the average maximum distance moved (MAXDIS) was 369.7 m (Table 2). Over the course of the project, turtles moved (#Moves) an average of 33 times over an average total distance (TDIS) of 1704.3 m (Table 2). Approximately, half the locations were unique sites and the average distance per move (MDBW) was 49.0 m (s = 33.4). Juveniles tended to move shorter distances than adults and males on average moved farther maximum distances but females averaged farther total distances (Table 2). MDD, MAXDIS, MINDIS, TDIS, #Moves, %Moves, and MDBW did not statistically vary among females, males, or juveniles (F = 0.196, p = 0.823; F = 0.646, p = 0.533; F = 1.137 p = 0.338; F = 1.601, p = 0.223; F = 0.124, p = 0.884; F = 1.128, p = 0.341; F = 1.890, p = 0.174, respectively). Several adult turtles were frequently located outside of the preserve boundary (EMBL 01, EMBL 03, EMBL 05, EMBL 07, EMBL 08, EMBL 24, and EMBL 27) and 2 juveniles also made moves beyond the boundary (EMBL 13 and EMBL 15).

Monthly movement patterns were compared for female, male, and juvenile *E. blandingii* (Figures 8, 9, &10). Movement activity for females and males peaked during early summer and then generally declined throughout the following months with a small increase in activity in the fall (Figures 8, 9, &10). Males averaged farther distances than females in early summer but tended to move less frequently (Figures 8, 9, &10). Juveniles consistently moved more frequently throughout the active season than adults until late summer but averaged shorter distances (Figures 8, 9, &10). Females made few late season movements but these movements were usually large (Figures 8, 9, &10). Males made about the same number of late season movements as females but moved shorter distances (Figures 8, 9, &10). Juveniles did not move in November but for October averaged as nearly many movements as females but moved shorter distances (Figures 8, 9, &10). From May-October, August was the only month average distance moved varied among groups (KW = 37.04, $p < 0.001$); no difference was found for any other month (May-KW = 1.99, p = 0.370; June-KW = 2.99, p = 0.225; July-KW = 4.98, p = 0.083; September-KW = 5.55, p = 0.062; October-KW = 0.911, p = 0.634).

Home Range. – The sizes of the MCP's and 95%, 75%, and 50% kernels for total and unique locations were compared across all *E. blandingii* (Table 3). For total locations, juveniles had smaller mean MCP areas (4.98 ha) than females (12.74 ha) and males (10.59 ha) but there was no significant variability among the three groups (F = 0.953, p = 0.400). Similarly, although juveniles typically had smaller kernels and fewer centers than adults, there were no differences in 95%, 75%, or 50% core areas (F = 1.358, p = 0.277; F = 0.417, p = 0.664; F = 0.639, p = 0.537, respectively) or centers of activity (F = 0.321, p = 0.729). For unique sites, juveniles also tended to exhibit smaller mean kernel areas and fewer centers, but again, there were no significant differences among the core areas (F = 2.231, $p = 0.132$; F = 1.732, $p = 0.201$; F = 0.736, $p = 0.491$) or activity centers (F = 2.389, $p = 0.116$). Turtles used the greatest amount of area during June (Figure 11). The average area used declined throughout the rest of the active season except in September when males moderately increased area used. The area curves generally began to asymptote around 70 locations for females, males, and juveniles (Appendix III). Exceptions mainly included individuals whose radio transmitters had fallen off before the end of the active season (EMBL 06, EMBL 22, EMBL 24, EMBL 27, EMBL 09, EMBL 10, EMBL 12, and EMBL 15).

Habitat Use and Preference. – All *E. blandingii* were located most often in marsh habitats, characterized by abundant cattail (*Typha*), duckweed (*Lemna*) and organic substrates, but were also found in many other habitat types, including river and forested floodplain areas outside of the preserve boundary (Figure 12; Appendix IV). Juveniles used fewer habitat types and, unlike adults, were never found within floodplain grassland, floodplain forest, dry upland dolomite prairie, or river habitats (Figure 12). However, one juvenile (EMBL 15) was located once in upland forest habitat south of the preserve boundary. River and floodplain forest habitats were the 2nd and 3rd most frequently used habitat types by females whereas pond and floodplain forest habitats were the 2nd and 3rd most frequently used habitat by males (Figure 12).

Overall, *E. blandingii* disproportionately preferred habitats within the preserve in relation to their availability ($\chi^2 = 246.7$, $p < 0.001$; Figure 13). In relation to the availability of the most frequently used habitats, females and juveniles preferred marsh habitat ($\chi^2 = 113.3$, $p < 0.001$; $\chi^2 = 2062.1$, $p < 0.001$; Figure 13) but males selected ponds more frequently than marshes ($\chi^2 = 39.2$, $p < 0.001$; Figure 13).

All individuals aestivated at some point from mid to late summer. Periods of inactivity were frequent and lasted from days up to weeks (Appendix II). During this time, some individuals moved, but movements were usually small and within the same wetland area (Appendix IV). Turtles typically aestivated in forms primarily within marshes but also semi-frequently in floodplain forest, floodplain grassland, and prairie habitats. In dry marsh habitat, turtles would partly to completely burrow into the substrate and under dead cattails (*Typha*) and duckweed (*Lemna*) or in depressions within cattail roots. If in the prairie or floodplain grassland, turtles would also burrow beneath dead grasses and other vegetation or if in the floodplain forest, burrow under leaf litter and sticks or even within piles of logs and debris washed up by the river. Turtles located in pools within the Railroad Marsh often aestivated in mud forms below the surface of the water.

Individuals generally over-wintered in the same habitats they used during the active season. In many cases, aestivating turtles remained at their locations during the winter. Turtles that used the river during the active season, either moved back to dry marsh habitat or permanent ponds within the floodplain to over-winter. Individuals that over-wintered on land, deeply burrowed into the substrate or into depressions within cattail roots. Individuals in aquatic habitats burrowed into mud or below logs. As of December 2005, no turtles had made any significant (>1 m) from their previous location although at this time, water had begun to accumulate and rise in the North Unit West Marsh and the Railroad Marsh. Additionally, ice covered all aquatic habitats and the entire preserve was covered in approximately 30 cm of snow. Most turtles in these areas were probably submerged under standing water within their burrows.

DISCUSSION

Population Structure. – The majority of Blanding's turtles were from larger size classes. This trend is similar for populations in Michigan (Gibbons, 1968a), Nebraska (Germano *et al.*, 2000), Minnesota (Pappas *et al.*, 2000), and Wisconsin (Ross, 1989). Of these larger individuals, most are adult females. When categorized by sex, the Weaver Dunes, Minnesota, population also showed a similar trend (Pappas *et al.*, 2000). Thus, most populations that have been study comprise larger and potentially older individuals. Although growth rates and body size do not correlate with the attainment of sexual maturity in females (Congdon and van Loben Sels, 1991), traits such as clutch size and egg size do relate (Congdon and van Loben Sels, 1991).

The body size of the hatchling we found was 28 mm PL and 6.2 grams in mass. This confers that at least some individuals are successfully recruiting. This measurement also falls close to those from the E. S. George Reserve, Michigan, which measure 35.3 mm PL and weigh 9.2 g (Congdon and van Loben Sels, 1991) and from Massachusetts, which measure 33.5 mm PL and weight 9.9 g (Graham and Doyle, 1979). Although we only captured one hatchling, more focused effort on trapping these smaller size classes in shallower water habitat will be conducted in the upcoming field season. Also, the large number of females already with transmitters will allow us to track them to nests and obtain hatchling sizes during emergence.

Our sex ratios were not biased, as was the case for 2004 (Dreslik *et al.*, 2004). When we combine the data for both years we get an overall ratio of 1M:1.5F, which is also not different from equality. Although the operational sex ratio was not biased in 2004 or 2005, when combined, the operational sex ratio of 1M:2.2F is biased. Populations in Maine (Joyal *et al.*, 2000), Massachusetts (Graham and Doyle, 1977), Nebraska (Germano *et al.*, 2000), and four populations in northeastern Illinois (Rubin, 2000; Rowe, 1987) have been found to have equal operational sex ratios. There are populations that are skewed, for example populations in Nebraska (Rowe, 1992), Minnesota (Pappas *et al.*, 2000), and Wisconsin (Ross, 1989) were skewed toward adult females. A population recently studied in Lake County, Illinois was skewed toward adult males, with the adult sampling comprising of 44 males and 19 females (Kuhns, *et al.*, 2005).

Although sampling methods may explain these differences, for populations with biases, there are two factors that can contribute to such a natural phenomenon. They are an increased mortality rate of adults and an increased production rate. Road mortality of nesting females can account explain population skewed toward males because of complex road-networks and heavy traffic volumes in urbanized areas, such as northeastern Illinois. Such factors have accounted for biases in the sex ratios of turtle populations in other regions of the United States (Aresco, 2005). Males could potentially make long distance forays at any time whereas females may be restricted to longer nesting forays only during the breeding periods (which may be biennially). However, movements in the LPNP population do not support this argument (see below).

Favorable nesting habitat for *E. blandingii* is generally sandy soils (Ernst *et al.*, 1994) and these soils are typically warmer, especially if over-story structure is minimal. Because *E. blandingii* have TSD where eggs incubated at higher temperatures produce successively more females (Gutzke and Packard, 1987; Ewert and Nelson, 1991), it is possible that nests at LPNP and Minnesota are generally warmer. This is entirely plausible at the LPNP population because the soils are generally shallow above the bedrock layer and nesting has been observed in habitats with minimal canopy cover (see below). A skew in the sex ratio of nests has been observed for *C. picta*. Nests in cooler, more vegetated habitats produced more male hatchling whereas nests in warmer, more exposed habitats produced more females (Janzen, 1994).

The LPNP *E. blandingii* population was significantly biased toward adults in both years when considered separately; however, when the data are combined, there is no difference (1J:1.6A). Throughout much of their range *E. blandingii* populations tend to be skewed toward adults. This is the case for populations in Maine (Joyal *et al.*, 2000), Massachusetts (Graham and Doyle, 1977), Michigan (Gibbons, 1968a; Congdon *et al.*, 1983), and Nebraska (Rowe, 1992). Most important there appears to be a similar pattern of heavily adult biased populations in the Chicago region (Rowe 1987; Rubin, 2000; Kuhns *et al.* 2004, 2005). Conversely, the Weaver Dunes population is heavily biased toward juveniles suggesting extremely successful recruitment (Pappas *et al.*, 2000). Similar to our population, another from Nebraska (Germano *et al.*, 2000) showed no significant bias toward adults. Thus although recruitment is occurring at our site at a better detectable rate than others, it is unknown if the current level can subsist the population over a long term.

Population Size, Density, and Biomass. – In our 2004 survey we had estimate the population size of *E. blandingii* at 69 individuals (Dreslik *et al.*, 2004). This was an overestimate because we based the population size on relative abundance in relation to *C. picta* (Dreslik *et al.*, 2004). With the results from this survey we were able to gain an accurate estimate of the population size at 42 individuals. Although both estimates are far below 100 individuals, it reassures that some pressing management needs to occur in order to maintain the persistence of *E. Blandingii* at LPNP over the long-term.

Although the density and biomass of *E. blandingii* at LPNP produced from last years results was 22 turtles/ha and 20.6 kg/ha, it only accounts for permanent surface water. Because *E. blandingii* will foray overland and use multiple wetland types, this year we provide two estimates, one based on all open water and one based on all marsh and open water habitats. When focusing on only open-water habitats, the density of 16.3 turtles/ha for LPNP remains the third highest reported in the literature. Populations in Missouri and Wisconsin were much higher at densities of 55 turtles/ha and 27.5 turtles per hectare respectively (Kofron and Schreiber, 1985; Ross and Anderson, 1990). The open-water density estimate is higher than those reported for Maine (5.9 turtle/ha), Massachusetts (6.3 turtles/ha), Michigan (8.8 – 15.8 turtles/hectare), and Minnesota (3 – 6 turtles/ha) (Gibbons, 1968a; Graham and Doyle, 1977; Congdon *et al.*, 1986; Joyal *et al.*, 2000; Pappas *et al.*, 2000). However, if we consider all wetlands (open-water and marshes) our density estimate is 1.1 turtles/ha and falls far below all others reported in the literature. More likely, the density and biomass of *E. blandingii* at LPNP is between the two estimates and probably closer to the lower end due to a high preference for marsh habitats (see below).

Population Viability and Sensitivity.– The results of the preliminary PVA suggest that within 50 years the LPNP *E. blandingii* population faces 27.5% of extinction. In general small populations of less than fifty individuals are often prone to extinction simply from stochastic events. Such factors range from environmental stochasticity, (such as droughts) to demographic stochasticity (higher mortality rates). As observed in the Figure 10, population size remains nearly constant over time; this is most likely because of the extreme longevity of adults and their corresponding lower mortality rates (Congdon *et al.*, 1993). Although we lack the data to obtain precise estimates of demographic vital rates (such as mortality) for LPNP, the high probability of decline warrants rigorous management efforts.

Our sensitivity analysis on clutch size, reproductive frequency, age of female sexual maturity, and mortality rates suggests that serious measures require implementation to achieve viability. At the current population size, none of the reproductive parameters can be manipulated to achieve a growing population. All mortality rates can be manipulated but either hatchling survival must be below 51.7%, juvenile mortality below 18.5%, or adult mortality below 2%. Because we lack site-specific vital rates for the species, it is unknown how much change is required from what is naturally occurring at LPNP, however below we present a list of management actions that need consideration.

Nesting.– In Michigan, approximately 48% of female *E. blandingii* lay eggs in a year (Congdon *et al.*, 1983) and 81% of females nested annually in a 2-year study conducted in Nova Scotia (McNeil, 2002), but only 4 of our 13 females radio-located at LPNP were found to be gravid. Females generally nest from late May to early July during evening hours (Ernst *et al.*, 1994) and at LPNP nesting was observed between 9 June and 29 June. One female was located at 2240hrs shortly after she had completed her nest and other known nesting attempts occurred from 2105-2210hrs. Nests are typically completely by 2300hrs (Ernst *et al.*, 1994). One nest along the West Trail was depredated by an unknown mammalian predator within 48 hours of completion. Unfortunately, high nest predation is common for *E. blandingii*. Congdon *et al.* (1983) observed in a 6-year study, an average predation rate of 67% (42-93%) and found that 84% of nests were destroyed within 5 days. Ross and Anderson (1990) observed 100% nest predation in Wisconsin. However, only 3 of approximately 18 nests were depredated in Nova Scotia (McNeil, 2002). In Michigan, the most common nest predators are raccoons, *Procyon lotor*, and foxes, *Urocyon cinereoargenteus* and *Vulpes vulpes* (Congden *et al.*, 1983) and in Wisconsin nests are frequently depredated by skunks, *Mephitis mephitis* (Ross and Anderson, 1990).

Wisconsin turtles primarily nested in grasslands with sedge cover in sandy loam soil or sand (Ross and Anderson, 1990). In Minnesota, nests were constructed in sunny exposed sites (Piepgras and Lang, 2000). Turtles in Nova Scotia were observed nesting in a gravel parking lot, a gravel pit, gravel roads, a slate cobble trail, and slate cobble lake islands (McNeil, 2002). At LPNP most nesting attempts occurred in sparsely vegetated areas in dolomite prairie along the path or embankment of the West Trail. Several of the nesting attempts were abandoned and one was left almost completely exposed possibly due to the substrate composition of the area. In Nova Scotia, females often abandoned attempts when they encountered large rocks or solid bedrock while digging (McNeil, 2002). Likewise, the rocky, shallow substrate at LPNP may have inhibited females from digging adequately sized chambers.

The West Trail seems to be a popular area for nesting but it also appears to provide low quality nesting habitat. The path may also be frequently used by predators which will increase the likelihood predation of nests in proximity of the trail. Additionally, we observed one female attempting to nest in one of the mounds of deteriorating roofing material strewn about the West Trail area. The material in these mounds has a fine texture similar to that of sand which may appeal to gravid females and deter them from nesting in actual prairie substrates. However, harmful compounds may occur in the roofing material and pose a threat to developing embryos if they diffuse through the eggshell.

We suggest that some small steps should be considered in order to enhance the known nesting habitat for *E. blandingii*. The mounds of roofing material should be removed from the West Trail area so they do not serve as a "sink" to nesting females. Additionally, in an attempt to decrease nest abandonment, small loads of soil to increase substrate depth should be placed in a few areas near the trail.

Mortality.– No mortality was observed for *E. blandingii* that were radio-located during this study. However, one hatchling was found dead on Division Street and the remains of two adults were found in the North Unit of the preserve. The cause of death for the adults is unknown; one individual was found in the marsh west of railroad tracks and the other in prairie habitat. Annual survival rates were determined for the *E. blandingii* population from the E. S. George Reserve in Michigan (Congdon *et al.*, 1993). Hatchling survival is ~ 26%, juvenile survival ~ 78%, and adult survival ~ 96%. Causes of mortality for turtles include predation (Congdon *et al.*, 1983), kills on roadways (Mitchell and Klemens, 2000) and even indirectly from drawdowns due to exposure to extreme environmental conditions (Hall and Cuthbert, 2000). Exploitation for the pet trade can also contribute to turtle population declines (Thorbjarnarson *et al.*, 2000). Congdon *et al.* (1994) found that in demographic models of *C. serpentina* populations, which share a similar life history with *E. blandingii*, removal of 10% of adults will decrease the population by 50% in as little as 15 years. Although adult mortality is assumed to be low at LPNP, any mortality in older individuals has drastic consequences on the future *E. blandingii* population.

Head-starting.– The hatchlings that we have been rearing are growing steadily and appear to be healthy. Their ability to catch live prey is impressive and provides assurance that they will survive once released back into LPNP. We plan to monitor the hatchlings with radio-telemetry throughout the summer. Information we collect on movements, habitat use, behavior, and survival will grant insight into the feasibility of head-starting programs for this species.

Movement.– Typically, monthly movement patterns were similar for females and males at LPNP. Movement activity peaked during early summer and then generally declined throughout the following months with a small increase in activity in the fall. Similarly, Kofron and Schreiber (1985) found bulk feeding activity occurring in Missouri from April through July with a second shorter burst of activity occurring in the fall. Fall activity may be associated with movements to over-wintering sites and mate searching by males (Piepgras and Lang, 2000). In Nova Scotia, mating activity peaked during October and November at over-wintering sites (McNeil, 2002). Peaks in female activity are usually associated with nesting activity (Piepgras and Lang, 2000). Lack of pre-nesting movement data for our gravid females may explain the lower activity in our females during early summer. Additionally, movement patterns may be atypical for the LPNP because of the drought conditions experienced by this region during the past year.

No significant difference for mean daily distance moved among females, males, and juveniles throughout the duration of the project differed from findings of other studies. Rowe and Moll (1991) found that males moved significantly greater distances per day than females from May through August. Conversely, Piepgras and Lang (2000) found that males moved less than females and juveniles on a daily basis. Overall, our turtles averaged shorter daily movements than found in other populations. In Minnesota, straight-line daily distance of females and juveniles averaged 45 m/day and males averaged 26 m/day (Peipgras and Lang, 2000). The smaller averages of the LPNP turtles are likely due limited movement associated with the drought conditions. However, average maximum distances traveled by adult LPNP *E. blandingii* (females = 400.2 m; males = 452.2 m) were similar to mean long distances traveled by individuals (396.2 m) in central Wisconsin (Ross, 1989).

Most wetlands within the preserve dried by mid-summer, leaving few aquatic resources and may have limited movement. Many turtles became inactive during this period and frequently aestivated for varying amounts of time usually in forms. Shorter periods of inactivity during the active season have been observed in other studies (Ross and Anderson, 1990) including those where wetland habitat was scarce (Rowe, 1987; Joyal *et al.*, 2001; Rubin *et al.*, 2001). In other studies, all turtles moved between locations during the active season (Piepgras and Lang, 2000).

Several turtles moved beyond the preserve boundary and spent extensive time in river or floodplain habitats once the preserve wetlands receded and dried. Movements in the river included short concentrated moves within shallow slow flowing coves to large treks up and down the river adjacent to LPNP, as well as, sporadic river crossings. Some individuals also spent a significant amount of time aestivating within the floodplain forest bordering the east side of the river. Additionally, five *E. blandingii* moved west across the railroad tracks into Railroad Marsh, the only wetland within the preserve that retained water throughout the entire season. These turtles were never located during passage from one side of the tracks to the other so it is unclear whether the turtles climbed over the tracks, traveled through culverts, or used the two wooden turtle crossing troughs below the rails. Rubin *et al.* (2001) found Blanding's to use culverts to pass below railroad tracks in northeastern Illinois. Thus a determination needs to be when sufficient flow data have been collected that would allow conclusion of the hydrology study and the culverts to be re-opened. Regardless of whether the hydrology study requires continuation, installation of additional under rail troughs should strongly be considered.

Most turtles ceased movement mid-September to early October. This is the earliest reported over-wintering for a population. Yet, it is likely that this was influenced by the drought conditions. Individuals that inhabited permanent bodies of water were generally active up to mid-November. These findings are similar for other studies. In another northeastern Illinois study, turtles discontinued activity in late October (Rowe and Moll, 1991). In other studies over-wintering began between 20 September and 22 October in Wisconsin (Ross and Anderson, 1990), late October and mid-November in Missouri (Kofron and Schreiber, 1985), and in mid-November in Minnesota (Piepgras and Lang, 2000). Most turtles over-wintered at the same sites where they aestivated during the summer so it is difficult to approximate when over-wintering began and classify late season movements either as those that occurred prior to or during over-wintering.

Lack of movements during the normal activity season may have reduced the number of male-female interactions and consequently the number of mateings that occurred. This may be reflected in the number of nests produced during the 2006 nesting season and may affect the number of offspring recruited this year.

Home Range. – We found no difference in home range or activity center estimates among females, males, or juveniles at LPNP. In other studies using similar home range and activity center estimations, no differences were found among females, males, (Rowe and Moll, 1991; Rubin *et al.*, 2001; Hamernick, 2000) or juveniles (Ross and Anderson, 1990; McNeil, 2002) but Piepgras and Lang (2000) found juveniles to have smaller home range estimates than adults using the grid summation method. Average female, male, and juvenile MCP areas for LPNP were smaller than estimates for females, males, and juveniles in Minnesota (Piepgras and Lang, 2000; Hamernick, 2000) and Nova Scotia (McNeil, 2002) but larger than estimates for other adults in Illinois (Rowe, 1987). Once again, these smaller estimates were likely influenced by the drought. Small home range estimates have been associated with lack of wetland habitat (Rubin *et al.*, 2001; McNeil, 2002).

The number and types of wetland use varied across *E. blandingii*. Some individuals made movements across multiple wetlands whereas others demonstrated wetland fidelity and never left a particular wetland during the study. This disparity in among wetland movement has been observed in a Wisconsin population (Ross, 1989), a Nova Scotia population (McNeil, 2002) and in females and juveniles in a Minnesota population (Piepgras and Lang, 2000). However, males from the Minnesota population used multiple wetlands (Piepgras and Lang, 2000) and most adult individuals from a population in Maine used multiple wetlands and frequently traveled between them (Joyal *et al.*, 2001).

Habitat Use and Preference.– LPNP is an ecotonal community composed of a variety of wetland and prairie habitat types. These habitat types include marshes, ponds, dry upland dolomite prairie, wet lowland dolomite prairie, sedge meadow, floodplain grassland, floodplain forest, spring, successional field, dry mesic savanna, and shrub swamp. Study areas for *E. blandingii* are typically composed several wetland habitat types (Ross and Anderson, 1990; Pappas *et al.*, 2000; Piepgras and Lang, 2000; Rubin *et al.*, 2001; Joyal *et al.*, 2001, McNeil, 2002). *E. blandingii* generally occur in aquatic habitats with clean shallow water, organic bottoms, and abundant vegetation and may be found in lakes, ponds, marshes, creeks, wet prairies, and sloughs (Ernst *et al.*, 1994). *E. blandingii* at LPNP were located most often in marsh habitats, but they also frequently used ponds, wet lowland dolomite prairie, floodplain grasslands, and floodplain forest. It is important to note that turtles also frequently used habitats outside of the preserve boundary, particularly riverine habitats and floodplain forest along the east side of the river. In relation to availability, LPNP males preferred ponds over marshes but females and juveniles still preferred marsh habitat more frequently. Turtles in Wisconsin also spent most time in marshes but also highly used ponds and ditches but found that ponds were used more than other habitats based on availability (Ross and Anderson, 1990) and Rubin *et al.* (2001) located *E. blandingii* more frequently in natural wetlands than artificial wetlands when natural wetlands were available. Rowe (1987) found that *E. blandingii* selected ponds that were highly productive and more densely vegetated more often than those that were sparsely vegetated. Ross and Anderson (1990) also found that turtles rarely used ponds with sand substrate and no aquatic vegetation. Piepgras and Lang (2000) found that turtles spent most time in shrub swamps. Hamernick (2000) found that turtles selected areas having emergent or submergent-rooted floating aquatic vegetation and woody terrestrial habitats. Small juveniles in

Minnesota were found to chiefly use shallow sedge habitats and alder hummocks while the larger and largest juveniles used sedge/water interfaces and open water, respectively (Pappas and Brecke, 1992). Although we were unable to radio-locate small juveniles, this pattern in habitat use appears similarly consistent with juveniles at LPNP based on captures from previous surveys (D. Mauger, *pers. com.*). Small individuals are commonly captured in shallow sedge meadows, while older juveniles are frequently captured at sedge/cattail marsh interfaces or within cattail marsh pools.

Several turtles migrated to the river when the wetlands within the preserve began to recede. These turtles spent a large amount of time and used a considerable amount of area within the river and floodplains surrounding it. There are few reports of *E. blandingii* using riverine habitats (Rowe, 1987). This suggests that this behavior is atypical for this species and that these areas at LPNP provided refugia and resources once they became limited within the preserve. Within the river, turtles were frequently located in shallow (< 100 cm) slow flowing areas with rocky substrates, just a few meters from the bank. These sites usually comprised patches of submergent aquatic vegetation and numerous fish and invertebrates. Flowing water and shade created by the forest likely provided a buffer in these areas against the warm summer temperatures. In Nova Scotia, turtles took refuge within a bog in channels under banks when surrounding wetlands dried during a drought (McNeil, 2002).

The amount of time turtles spent outside of the preserve where their habitat is unprotected is alarming. In the river and backwater habitats, there is a large amount of trash. Turtles may incidentally ingest small items while capturing prey or become entangled in large pieces of refuse such as plastic bags and drown. Pollutants and contaminants in the water may also threaten the health of the turtles. Further, fishermen were frequently observed in the river and the large backwater pond, Lost Pond, and the turtles may attempt to consume their lures and baited hooks.

Turtles that did not migrate to the river during the drought halted most activity and began aestivating with infrequent bouts of short activity. During periods of inactivity, turtles frequently aestivated in forms for periods of days and weeks primarily in dry marsh habitat but also in prairie, floodplain grassland, and floodplain forest habitats. Turtles also demonstrated aquatic aestivation in mud within marsh pools. These periods of inactivity are the longest reported for any *E. blandingii* population. Ross and Anderson (1990) reported one individual aestivated on land beneath herbaceous growth and two individuals aestivated within the silt substrate of a creek and beneath cattail matting in a marsh during mid-summer. Rowe and Moll (1991) observed individuals resting on land in leaf litter or vegetation for periods of up to 6 hours in May. *E. blandingii* in Maine used upland forest for large periods of dormancy during late summer (Joyal *et al.*, 2001). The limited resources and periods inactivity during the typical active season may have affected the ability of the turtles to successfully over-winter. Reserves for individuals aestivating on dry land were likely used before winter months began. It may also ultimately decrease the number of nesting females if reserves typically used for egg production were utilized during the long periods of dormancy.

Active season habitats were used similarly as over-wintering habitats. Most aestivating turtles remained at their locations during the winter but those in the river migrated back to marsh habitat or permanent ponds within the floodplain to over-winter. Likewise, Rowe (1987) found that individuals utilized the same habitats or adjacent habitats for over-wintering as during the active season. In Wisconsin, most individuals over-wintered within at least one of their summer activity centers but moved from marshes, shallow ponds, and ditches to ponds (R oss and Anderson, 1990). In Maine (Joyal *et al.*, 2001) and Minnesota (Peipgras and Lang, 2000), *E blandingii* typically used different wetlands types during the active season than during the winter. Joyal *et al.* (2001) found turtles typically over-wintered in forested swamps and wet meadows but used seasonal and permanent pools during the summer as well as terrestrial upland habitat. Turtles in Nova Scotia over-wintered in the pools of a wooded swamp beneath leaf litter and soft mud and in channels along a bog (McNeil, 2002). LPNP individuals that over-wintered in dry marshes burrowed into the substrate or into a depression within cattail roots and by December, some of these areas, particularly the West Marsh North Unit were once again beginning to fill. Turtles that began over-wintering in aquatic habitats usually burrowed into mud below the surface of the water. Ross and Anderson (1990) also observed over-wintering turtles partially buried in organic substrate. We observed no over-wintering movements as of December 2005. Other populations in Wisconsin (Ross and Anderson, 1990) and Illinois (Rowe, 1987) similarly reported no activity during this period but individuals in Missouri (Kofron and Schreiber, 1985) made short movements of 1-2 m.

It seems that LPNP may not provide enough suitable habitat to support the population of *E. blandingii* that inhabit the preserve. To remedy concerns associated with extreme movements beyond the preserve boundary and drought conditions, we recommend creating new wetland habitats, possibly in successional field areas and during dry periods, actively managing wetlands to keep them hydrated. Such newly constructed wetlands could have a direct link to the river, such that, at high river levels, the marsh pools and ponds will flood. Similar to what currently occurs at the East Pond and Lost Pond.

CONCLUSIONS

Nature preserves are critical components in the conservation of fauna and flora. However, even the best nature preserves can suffer the effects of fragmentation and insularization (Shafer, 1990). The effects are the elimination of potential sources of immigrants, reduction in immigration between habitat patches because the landscape between habitat patches is converted, and restriction of vital resources outside of the protected boundary (Wilcox, 1980; Wilcox and Murphy, 1985). Thus, nature preserves are intended to serve as self sustaining ecosystems that are sources for population and protection for rare biota (Shafer, 1990). In reality, most nature preserves are not large enough to be self-sustaining and thus must require a great amount of management. Therefore it is imperative that sound ecological knowledge of rare species in nature preserves guide management.

LPNP has one of the richest and diverse turtle communities described for Illinois, as both lentic and lotic and common and rare species use the preserve. In relation to management, we need to shift from an autecological perspective and broaden the scope of research to include how the different species utilize the site and interact to form such a diverse community. To accomplish this we need to gather life history and ecological data for each species to assess what role each species occupies within the overall turtle community. Once we have a better understanding of how each species utilizes and partitions the resources available at LPNP, we can then design management strategies that conserve the function(s) of the entire community. Also, a comprehensive understanding of the turtle community as a whole should help determine why the rare species appear to have lower population sizes and restricted patterns of population dispersion within the preserve.

In marked contrast to previously thought, the *E. blandingii* population at LPNP is at high risk of extinction because of a low numbers of adults and the dependence upon wetland habitat outside the boundaries of the preserve. Further information is required to address specific management questions relating to the amount and suitability of habitat, what actions need to be taken to stabilize population decline, and how long and how costly these efforts would be. Finally, steps should be taken toward collating all the previous research on *C. guttata* so that a life table can be constructed. Once constructed, a PVA can be run on the LPNP population to determine its viability. A composite database needs to be created that contains the results of all *C. guttata* research and can be manipulated using GIS software.

RECCOMENDATIONS AND FUTURE DIRECTIONS

CONSERVATION AND MANAGEMENT OF THE BLANDING'S TURTLE

Monitoring the Ecology of E. blandingii.– Previous surveys at LPNP have always produced a dozen or more *E. blandingii* captures per year representing all stages. With the addition of our survey, we have documented that the population is in serious jeopardy of extinction over the long-term. This is in contrast to last years results and exemplifies why short-term studies should be regarded with caution before enacting conservation measures. Nonetheless, the most interesting aspect is that there is evidence of successful recruitment of *E. blandingii* at LPNP. Studies from other natural areas in DuPage County have found that juvenile recruitment in *E. blandingii* populations is low (Rubin, 2000). Our results have demonstrated that juveniles comprised a large proportion of the population. Comparatively from the natural areas in DuPage County, only three juveniles and two hatchlings were captured over a five year period despite intensive trapping (Rubin, 2000). Thus, focusing on the ecology and life history of *E. blandingii* in a population that is demonstrating recruitment can provide a strong basis for developing management recommendations that can be widely applied for this declining species in other areas of the Chicago region.

We will continue tracking individuals from last year to determine if they use the same habitat and areas between years. Also, this will allow creating a more robust habitat use model that can be used to assess the suitability of other natural areas in the region. Also, efforts should continue on the spatial ecology and habitat requirements of juveniles. If successful, a habitat use model can be developed and shared with other management agencies in the region so they can assess the quality of their natural areas with respect to juvenile *E. blandingii.* This can be accomplished by monitoring several adult and immature individuals for a few activity seasons. Additional telemetry will also afford insight into female reproductive effort, nesting ecology, and juvenile recruitment rates. Once nesting habitat is located, appropriate management recommendations can be made to maintain the habitat and allow the protection of natural nests to reduce first-year mortality rates.

Because the chance of extinction can occur within 50 years, there is time to enact conservation measure to stabilize or increase the population size. Results from the sensitivity analysis demonstrate that it is more important to focus on mortality issues, specifically in the hatchling and juvenile age-classes. More specifically, hatchling and juvenile mortality offer the greatest likelihood for management.

Increasing Hatchling Survivorship. – Our sensitivity analysis revealed that reducing hatchling mortality below 52% could suffice for stabilizing the population. Of the four gravid females we radio-located, we were only able to locate the nests of two without risking altering female nesting behavior. One nest was too shallow and abandoned, whereas the second was depredated. Before extremely manipulative measures are attempted (such as head-starting programs), nest protection appears to be a simpler and less expensive alternative. Seigel and Dodd (2000) recommend a stepwise approach to conservation of turtle populations. In their scheme, the least manipulative tactics for hatchlings are habitat protection and public education. In the case of LPNP, harm is not done to nests by the public and the habitat is protected, therefore, we should proceed to the next level which is nest protection. Although most efforts at nest protection are directed toward sea turtles (e.g. Mroziak *et al.*, 2000), one study exists on *Emydoidea blandingii*. Over a ten year study of *E. blandingii* in Nova Scotia 101 nests were protected and only one (<1%) was depredated (Standing *et al.*, 2000). Comparatively, of the 23 nests that were not protected, 15 (65%) were depredated (Standing *et al*., 2000). However, nest protection devices did not significantly decrease depredation rates in a sea turtle study at a communal nesting beach (Mroziak *et al.*, 2000). This is presumably because of the large number of females nesting in a relatively small area.

What will need to be explored over the next few years is determining the actual nest predation rate. Although our models suggest that a reduction of hatchling mortality to below 52% would result in an increasing population, it is unknown whether the actual rate is at or below this. If the rate is already low, then additional measures would need to be addressed. Additional modeling can determine how long nest protection would need to be maintained so costs of the conservation measure can be assessed. Also, what needs to be determined is specifically what nest protection would required at LPNP, how much it might cost and who would do the work. It would probably require a collaborative partnership between the FPDWC, IDNR, INHS and possibly others to ensure adequate funding was available to pursue such endeavors.

Maintaining High Levels of Adult Survivorship.– As with most turtle species, maintaining high adult survivorship is crucial to viability. Any conservation measure enacted that does not include an adult component will, at best, be only maintaining stability. Research indicates that slight increases in adult mortality will overcome the benefits of strategies for long-lived turtle species (Heppell *et al.*, 1996a,b; Congdon *et al.*, 1994). Additionally, conservation efforts aimed at reducing adult mortality are most likely to stabilize populations (Heppell, 1998). Although we have not detected any adult mortality, additional data is required to determine what the actual rate is at LPNP. This can be achieved through continued radio-telemetry. However, with two-years of mark-recapture and one year of radio-tracking study some precautionary measures can be enacted to reduce the potential.

1) **Railroad Tracks**
   Historically individual adults have been found dead between the railroad tracks on the west side of the preserve (D. Mauger *pers. com.*). Currently ten turtles that have been salvaged from the railroad tracks are housed in the INHS collection. Three of these were *E. blandingii* and one was an adult female and a second was an adult male. To help

reduce this, managers from the FPDWC created artificial chutes to allow turtles to crawl through and escape from if caught between the railroad tracks. During our study several turtles (adults and juveniles) made the crossing successfully. We have some inference that turtles used these chutes so as a precautionary measure recommend tripling the number of them and making them as wide and deep as possible to afford the free movement of adults. These chutes should be clustered along side where the north unit of the West Marsh and the Railroad Marsh run parallel. Increasing the number, size and depth of the chutes requires coordination with the railroad operators. A more comprehensive regimen for monitoring turtle mortality on the tracks or use of underpass chutes by turtles is desirable.

2) Enforcement of Posted Speed Limits

We have observed turtles of a few species crossing the road and observed road-killed turtles on Division Street. Snakes and frogs are routinely found dead on the road. Up to 2005, six turtles have been turned in to the INHS herpetological collection, of these one was an *E. blandingii* and one an adult male *C. guttata*. We have also observed numerous violations of the posted speed limit while conducting research over the last two years. Thus, there is the potential for motorists to kill turtles passing between the North and South Units. We recommend that two strategies be enacted to reduce road-mortality. If road-mortality is directly related to motorists not following the posted speed limit, then speed bumps could be strategically placed along the road. Placing speed bumps where the pond or marsh habitats abut the road have the greatest potential of slowing motorists down at these sensitive crossing. If speed bumps still do not reduce road mortality, then we would recommend closing the gate and only allow foot traffic in the preserve. This still affords public access while reducing the potential of adult turtles being killed on the road. Employees needing to get to the Lockport Power Plant could be given gate keys. Closing the road would be a substantial measure to reduce road mortality of all herpetofauna and would go a long way towards minimizing the potential risk of any turtle species that crosses the road. However, if the road where closed off at the existing gate, then planning would be required to address parking issues.

Potentially Increasing the Amount of Marsh and Pond Habitat.– During our study we found that *E. blandingii* moved outside LPNP's boundaries during a drought. This suggests that there is a lack of permanent water habitat within the preserve, or that hydrology has changed. Although the drought in 2005 was severe, radio-telemetry needs to be conducted during average patterns of precipitation to examine if movement and habitat use patterns are the same. Nevertheless, it is possible that LPNP does not have enough wetland habitat to maintain a viable population of *E. blandingii*. What is needed along with additional radio-telemetry is the use of spatially explicit PVA models (such as RAMAS GIS). Spatially explicit PVAs can directly answer whether there is enough habitat. If not, spatially explicit PVA models can determine how much is needed and how it should be juxtaposed. Such work would be required before restoration or re-creation of more wetland in selected areas of the preserve could be considered.

CONTINUATION OF THE MARK/RECAPTURE STUDY

Although we are providing a firmer understanding of the structure of the LPNP turtle community, there are still several areas that require a third year of survey work. First, additional captures of some of the rarer species will increase the precision of some of our estimates of population sizes, densities, and biomass. Further, with the large number of individuals marked, we will be able to gain inference into mortality, survivability, and recruitment rates specific to LPNP. Finally, we can use more reliable methods of growth based on mark/recapture data which may also be expanded to include estimates of growth and maturity for the other species. Thus, obtaining more detailed demographic data will eventually play a role in determining population viability for all the species in the community and improve the existing preliminary viability models.

In the third year, trapping should continue to include more wetlands in the south to effectively determine if it is possible to capture sufficient number of *C. guttata* to augment existing survey efforts. This year we were able to demonstrate that trapping can be adapted to target *C. guttata* and present a sufficient enough sample of captures and recaptures to estimate population size. Continued sampling in the north will aid in supporting the fact that we have seen all of the *E. blandingii* that reside in the preserve over the last two years, as well as *C. guttata* inhabiting the North Unit. Additionally, because of the large number of turtles marked in the first two seasons, trapping in different wetlands may provide a rough understanding of movements within the preserve and help clarify the spatial dispersion of the populations of all turtle species across the entire preserve. It may also help to further explain why the *C. guttata* population appears to be so concentrated in limited sections of LPNP South. Finally, because *E. blandingii* and *S. odoratus* readily left the preserve boundaries and were active in the Des Plaines River, additional trapping along the river corridor will allow us to determine how many other species and at what proportions of the individuals exhibit activity outside the preserve boundaries. At a landscape level, this plays a crucial role in conservation planning because it is possible LPNP does not provide enough area or habitat to support a viable population alone. Finally, because this was a drought year we need to determine if high level of river activity we observed with *E. blandingii* was an aberrant result or is a regular phenomenon.

TARGETED LIST OF FUTURE OBJECTIVES

Emydoidea blandingii

- Continue mark/recapture study to obtain demographic vital rates
- Assess sources of mortality and provide solutions
- Continue radio-telemetry to determine if extra-preserve movements are normal
- Assess nesting and determine what the natural nest predation rates are

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Table 1: Variables used for population viability analyses of *Emydoidea blandingii* at Lockport Prairie Nature Preserve, Will County, Illinois using Vortex. Data is a composite from Congdon *et al.* (1993) and from our data.

Variable	***E. Blandingii***
Iterations	1000
Duration	50 years
Extinction	1 sex remaining
EV with Reproduction and Survival	Yes
Catastrophes	0
Inbreeding Depression	No
Reproductive System	Polygynous
First Reproduction for Females	18
First Reproduction for Males	14
Maximum Age of Reproduction	77
Maximum number of Offspring per year	22
Sex Ratio at birth	50
Density Dependent Reproduction	No
% Females in Breeding Pool	80% +/- 10%
Mean number of Eggs	11 (Std. Dev. 2)
Distribution of Offspring per female	Normal
Mortality Rates	
Age 0 - 1	73.9% +/-26.1%
Age 1 - 2	21.74% +/- 15%
Age 2 - 3	21.74% +/- 15%
Age 3 - 4	21.74% +/- 15%
Age 4 - 5	21.74% +/- 15%
Age 5 - 6	21.74% +/- 15%
Age 6 - 7	21.74% +/- 15%
Age 7 - 8	21.74% +/- 15%
Age 8 - 9	21.74% +/- 15%
Age 9 - 10	21.74% +/- 15%
Age 10 - 11	21.74% +/- 15%
Age 11 - 12	21.74% +/- 15%
Age 12 - 13	21.74% +/- 15%
Age 13 - 14	21.74% +/- 15%
Age 14 <	4% +/- 5%
Initial Population Size	42
Age Distribution	Stable
Carrying Capacity	5000 +/- 1000
Harvest	No
Supplementation	No
Genetic Management	No
Citation	Congdon *et al.*, 1993

Table 2: Movement statistics of duration of tracking, mean daily distance moved (MDD) and standard deviation, maximum distance moved (MAX), minimum distance moved (MIN), total distance moved (TDIS), number of moves, percent of moves, mean distance per move (MDBW) and standard deviation, number of radiolocations (*n*), mass, carapace length (CL), and plastron length (PL) by sex for 26 *Emydoidea blandingii* radio-located from May 2005 to December 2005 at Lockport Prairie Nature Preserve, Will County, Illinois. All movement measures are in m, duration of tracking is in days, mass is in g, and CL and PL are in mm. Turtles marked with an * denotes a gravid female.

Females	**Duration**	**MDD**	***s***	**MAX**	**MIN**	**TDIS**	**#Moves**	**%Moves**	**MDBW**	***s***	***n***	**Mass**	**CL**	**PL**
7*	214	29.3	85.5	516	0	6263	89	61	70.4	100.1	146	1114	199	195
16*	190	7.6	38.8	295	0	1436	31	25	46.4	66.4	123	1153	200	195
11*	170	3.7	23.7	203	0	622	17	15	36.6	52.6	115	1111	196	189
21*	152	10.2	52.0	325	0	1549	32	30	56.4	81.9	105	1227	203	201
1	210	23.9	145.4	1133	0	5027	44	35	114.3	226.8	124	------	194	192
5	196	30.2	80.1	421	0	5911	84	64	70.4	90.8	132	1196	207	201
6	66	18.6	57.9	253	0	1228	27	93	45.5	58.3	29	851	192	183
8	195	15.2	100.0	800	0	2965	44	35	67.4	159.3	124	693	172	170
18	185	1.9	8.1	46	0	343	25	21	13.7	12.9	120	1072	205	199
22	33	9.7	42.0	168	0	319	10	59	31.9	50.2	17	744	180	174
24	32	49.4	218.7	801	0	1581	11	85	143.8	225.2	13	1000	199	191
25	160	5.5	26.8	165	0	880	19	17	46.3	50.0	112	1353	226	210
35	138	3.4	12.7	76	0	467	20	20	23.4	19.4	100	1397	214	207
Totals/ $\bar{x}$	**149.3**	**16.0**	**13.9**	**400.2**	**0.0**	**2199.3**	**34.8**	**43.1**	**59.0**	**36.1**	**96.9**			
Males														
2	218	4.6	34.5	355	0	1012	32	26	31.7	61.6	121	1109	210	194
3	218	20.4	113.0	990	0	4438	67	51	66.2	151.5	132	1397	212	201
17	75	35.1	143.4	710	0	2633	23	56	114.5	174.9	41	974	194	182
26	180	1.9	9.3	69	0	336	23	20	14.6	16.2	115	1270	212	198
27	56	12.8	35.8	137	0	714	22	81	32.5	36.8	27	688	127	186
Totals/ $\bar{x}$	**149.4**	**14.9**	**13.4**	**452.2**	**0.0**	**1826.6**	**33.4**	**47.0**	**51.9**	**39.7**	**87.2**			

Table 2 (Cont.):

Juveniles	**Duration**	**MDD**	***s***	**MAX**	**MIN**	**TDIS**	**#Moves**	**%Moves**	**MDBW**	***s***	***n***	**Mass**	**CL**	**PL**
4	217	5.5	20.6	121	0	1196	44	33	27.2	28.4	135	211	113	114
9	81	8.5	25.6	797	0	685	31	86	22.1	26.2	36	389	139	136
10	40	14.3	40.5	166	0	573	15	83	38.2	41.1	18	309	131	128
12	29	7.4	17.2	58	0	216	13	81	16.6	17.5	16	147	100	99
13	171	5.3	27.9	201	0	910	43	39	21.3	41.6	111	431	143	139
14	180	8.1	37.1	350	0	1451	52	44	27.9	51.7	117	269	126	126
15	19	44.5	51.2	174	9.8	845	12	92	70.4	51.2	13	163	104	104
23	181	3.9	28.3	282	0	712	30	27	23.7	50.9	111	335	131	131
Totals/ $\bar{x}$	**114.8**	**12.2**	**13.4**	**268.6**	**1.2**	**823.5**	**30.0**	**60.7**	**30.9**	**17.2**	**69.6**			
Grand Total/ $\bar{x}$	**138.7**	**14.6**	**13.2**	**369.7**	**0.0**	**1704.3**	**33.1**	**49.3**	**49.0**	**33.4**	**86.7**			

Table 3: Duration of tracking, number of total and unique locations, home range areas (ha), smoothing parameters (h), and number of 50% KDI activity centers partitioned by sex for 26 *Emydoidea blandingii* radio-located from May 2005-December 2005 at Lockport Prairie Nature Preserve, Will County, Illinois. Turtles marked with an * denotes a gravid female.

Females		**Locations**			**Total Locations**					**Unique Locations**				
Turtle	**Duration**	**Total**	**Unique**	**MCP**	***h***	**95%**	**75%**	**50%**	**Centers**	***h***	**95%**	**75%**	**50%**	**Centers**
7*	214	146	89	24.63	55.45	1.65	0.17	0.07	1	60.78	26.18	8.26	3.55	3
16*	190	123	31	5.24	16.23	0.58	0.29	0.15	2	31.04	9.33	4.43	1.47	1
11*	170	115	17	2.70	19.05	0.24	0.14	0.08	1	51.57	6.74	2.30	0.89	1
21*	152	105	32	10.15	37.14	0.85	0.30	0.10	2	42.75	5.08	1.88	0.96	1
1	210	124	44	43.82	68.18	1.49	0.47	0.15	3	102.75	13.15	2.70	0.90	1
5	196	132	84	30.43	57.39	3.15	0.86	0.22	4	70.21	12.77	3.89	1.61	2
6	66	29	27	3.59	37.68	1.59	0.37	0.13	2	38.18	8.98	3.44	1.09	2
8	195	124	44	30.20	73.76	1.29	0.50	0.18	2	84.06	9.40	3.06	1.23	2
18	185	120	25	0.28	5.09	0.52	0.18	0.09	1	7.50	---	---	---	---
22	33	17	10	0.25	23.78	0.55	0.16	0.08	1	26.28	4.29	1.57	0.90	1
24	32	13	11	11.10	149.78	1.46	0.21	0.08	1	156.73	13.11	5.96	2.09	1
25	160	112	19	2.39	25.55	0.56	0.24	0.10	2	32.56	7.71	3.86	1.67	2
35	138	100	20	0.80	11.29	0.70	0.23	0.08	1	18.06	4.77	2.68	1.48	1
$\bar{x}$	**149.31**	**96.92**	**34.85**	**12.74**		**1.13**	**0.32**	**0.12**	**1.77**		**10.13**	**3.67**	**1.49**	**1.50**
s	**64.53**	**45.64**	**25.29**	**14.54**		**0.78**	**0.20**	**0.05**	**0.93**		**5.96**	**1.88**	**0.75**	**0.67**
Males														
2	218	121	32	1.64	25.04	0.76	0.34	0.20	1	49.41	5.17	2.48	0.90	1
3	218	132	67	20.36	49.35	1.35	0.38	0.17	2	65.78	16.01	7.14	2.62	4
17	75	41	23	0.37	103.22	1.88	0.51	0.12	2	112.47	13.72	4.82	1.94	3
26	180	115	23	0.18	23.19	0.90	0.33	0.12	2	11.33	3.68	2.02	1.03	1
27	56	27	22	30.43	23.28	0.84	0.24	0.09	1	23.73	4.28	1.71	0.96	1
$\bar{x}$	**149.40**	**87.20**	**33.40**	**10.59**		**1.15**	**0.36**	**0.14**	**1.60**		**8.57**	**3.63**	**1.49**	**2.00**
s	**78.43**	**49.20**	**19.22**	**13.98**		**0.47**	**0.10**	**0.04**	**0.55**		**5.82**	**2.31**	**0.76**	**1.41**

Table 3 (Cont.):

Juveniles	Locations				Total Locations					Unique Locations				
Turtle	**Duration**	**Total**	**Unique**	**MCP**	***h***	**95%**	**75%**	**50%**	**Centers**	***h***	**95%**	**75%**	**50%**	**Centers**
4	217	135	44	5.37	14.29	0.39	0.16	0.09	1	25.05	6.16	2.44	0.93	1
9	81	36	31	2.92	10.77	0.77	0.26	0.09	1	10.83	3.56	1.88	1.04	1
10	40	18	15	2.59	15.44	0.76	0.28	0.09	2	16.72	4.16	1.97	1.02	1
12	29	16	13	2.24	13.48	0.74	0.38	0.19	2	13.93	3.91	1.57	0.90	1
13	171	111	43	21.11	24.94	0.57	0.28	0.16	2	23.89	---	---	---	---
14	180	117	52	1.61	29.21	0.59	0.28	0.12	1	44.62	4.85	1.66	0.93	1
15	19	13	12	2.18	35.84	1.43	0.42	0.14	2	35.84	8.16	4.09	2.05	1
23	181	111	30	1.84	13.73	0.33	0.15	0.08	1	29.04	4.42	1.73	0.97	1
$\bar{x}$	**114.75**	**69.63**	**30.00**	**4.98**		**0.70**	**0.28**	**0.12**	**1.50**		**5.03**	**2.19**	**1.12**	**1.00**
s	**80.63**	**53.21**	**15.53**	**6.62**		**0.34**	**0.09**	**0.04**	**0.53**		**1.61**	**0.88**	**0.41**	**0.00**
Grand Totals/ $\bar{x}$	**138.69**	**86.65**	**33.08**	**9.94**		**1.00**	**0.31**	**0.12**	**1.65**		**8.32**	**3.23**	**1.38**	**1.46**
Overall s	**71.19**	**48.24**	**20.93**	**12.53**		**0.63**	**0.15**	**0.04**	**0.75**		**5.35**	**1.81**	**0.67**	**0.83**

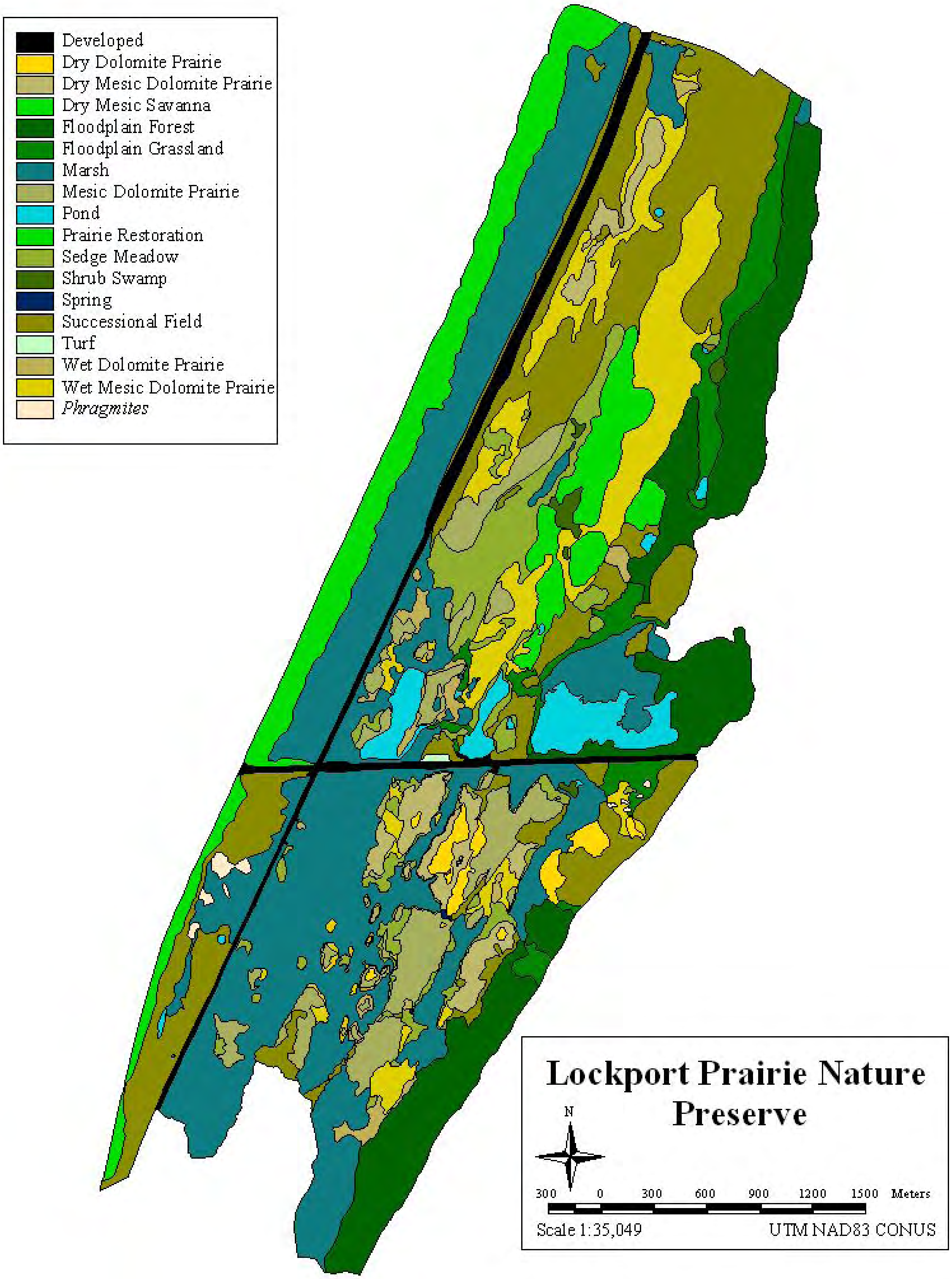


Figure 1: Habitat map of Lockport Prairie Nature Preserve, Will County, Illinois. Map was constructed from a GIS data layer provided by the Forest Preserve District of Will County.

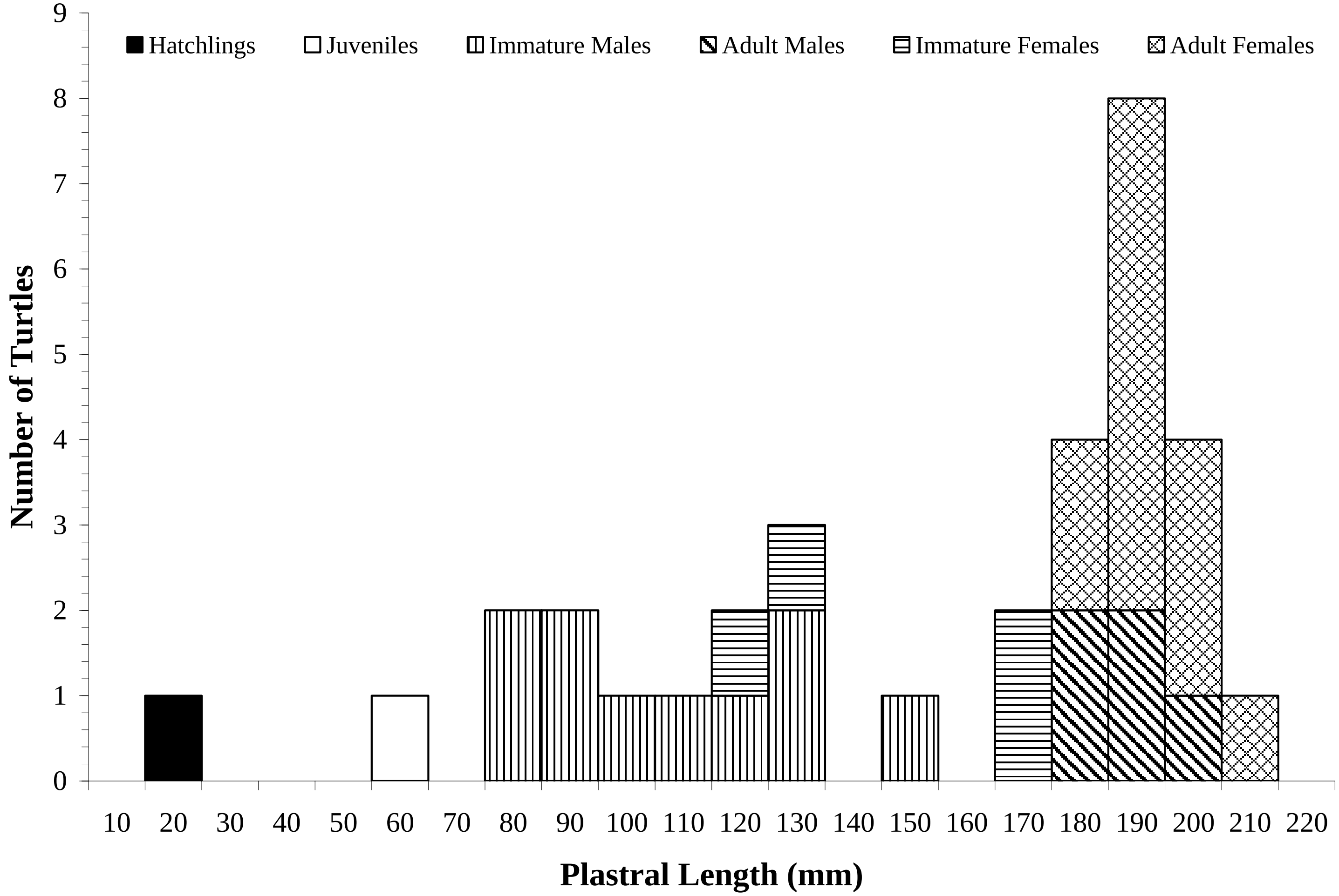


Figure 2: Size structure of plastral length (PL) for *Emydoidea blandingii* captured at Lockport Prairie Nature Preserve, Will County, Illinois for the 2005 field season. Bars are broken down into hatchling, juvenile, immature male, immature female, adult male, and adult female classes.

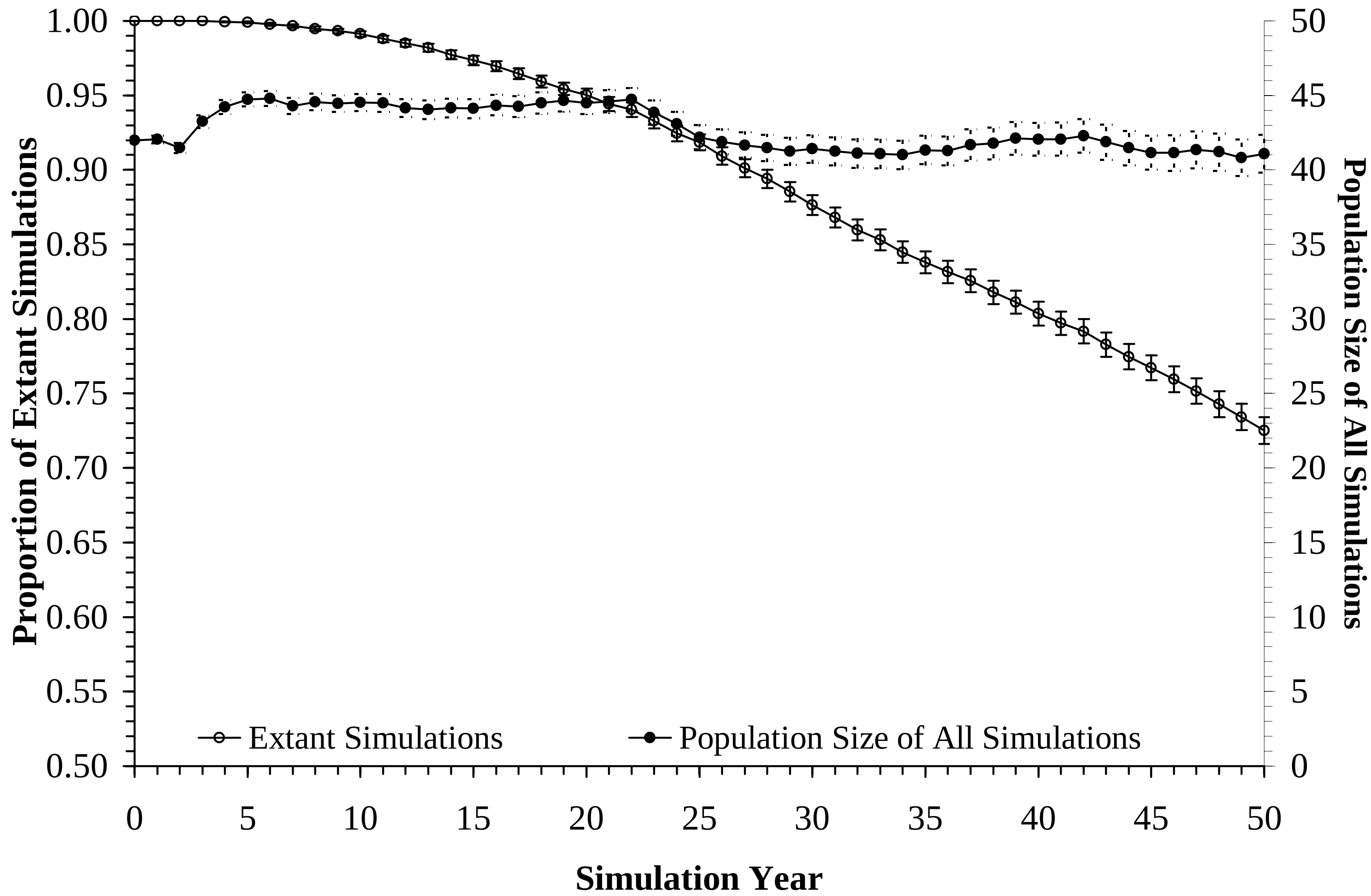


Figure 3: Proportion of extant simulations by year and population size of all simulations by year of a preliminary population viability analysis for *Emydoidea blandingii* at Lockport Prairie Nature Preserve, Will County, Illinois. Simulations were run in VORTEX using the population estimate and proportion of reproductive males reported herein. Survival and reproductive data were used from Congdon *et al.* (1993) and Ernst *et al.* (1994). Bars represent two standard errors.

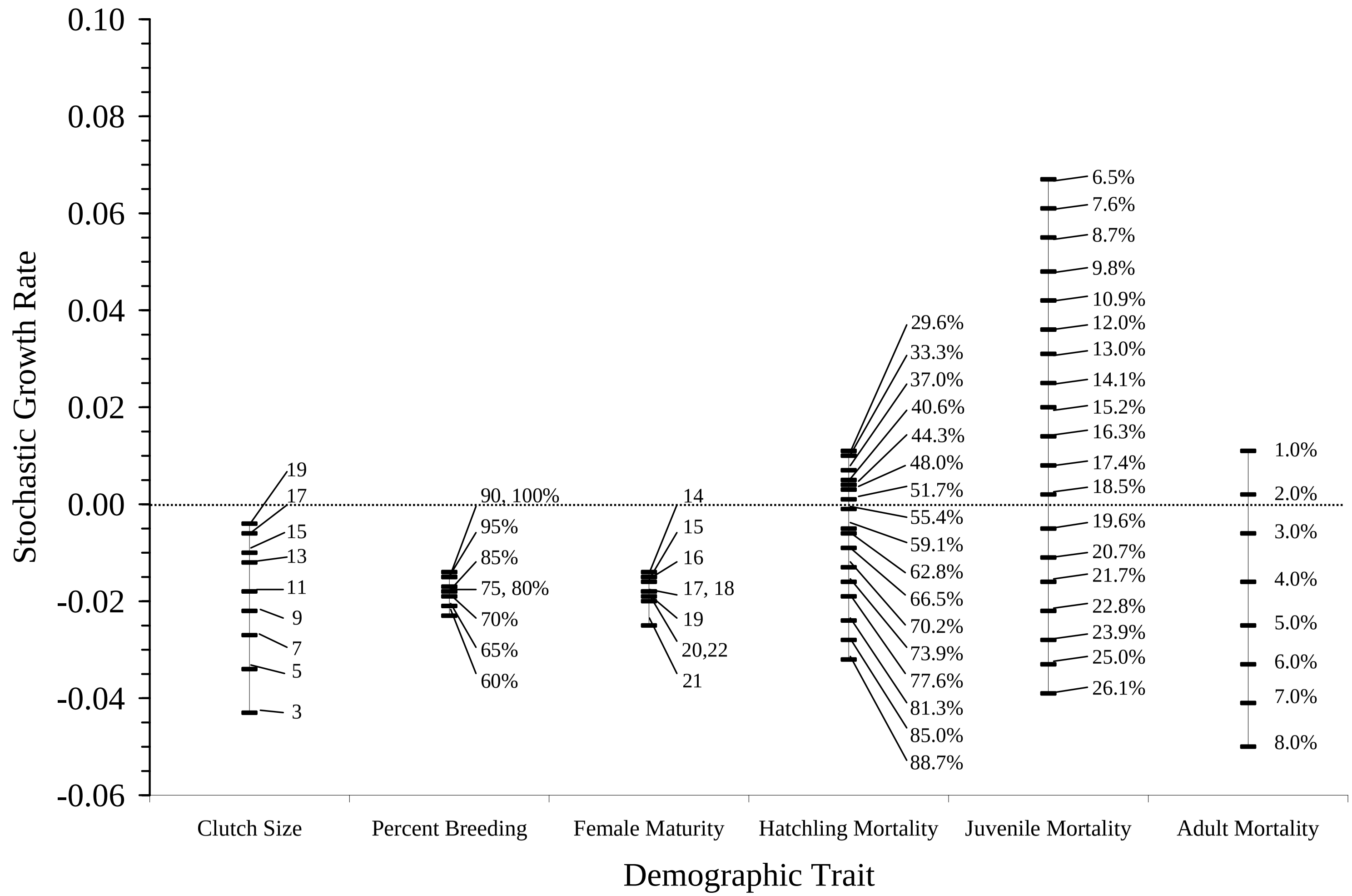


Figure 4: Sensitivity analysis of six demographic traits in relationship to the stochastic population growth rate for *E. blandingii* at Lockport Prairie Nature Preserve, Will County, Illinois. Data are from VORTEX simulations using mortality and reproductive data from Condon *et al.* (1993).

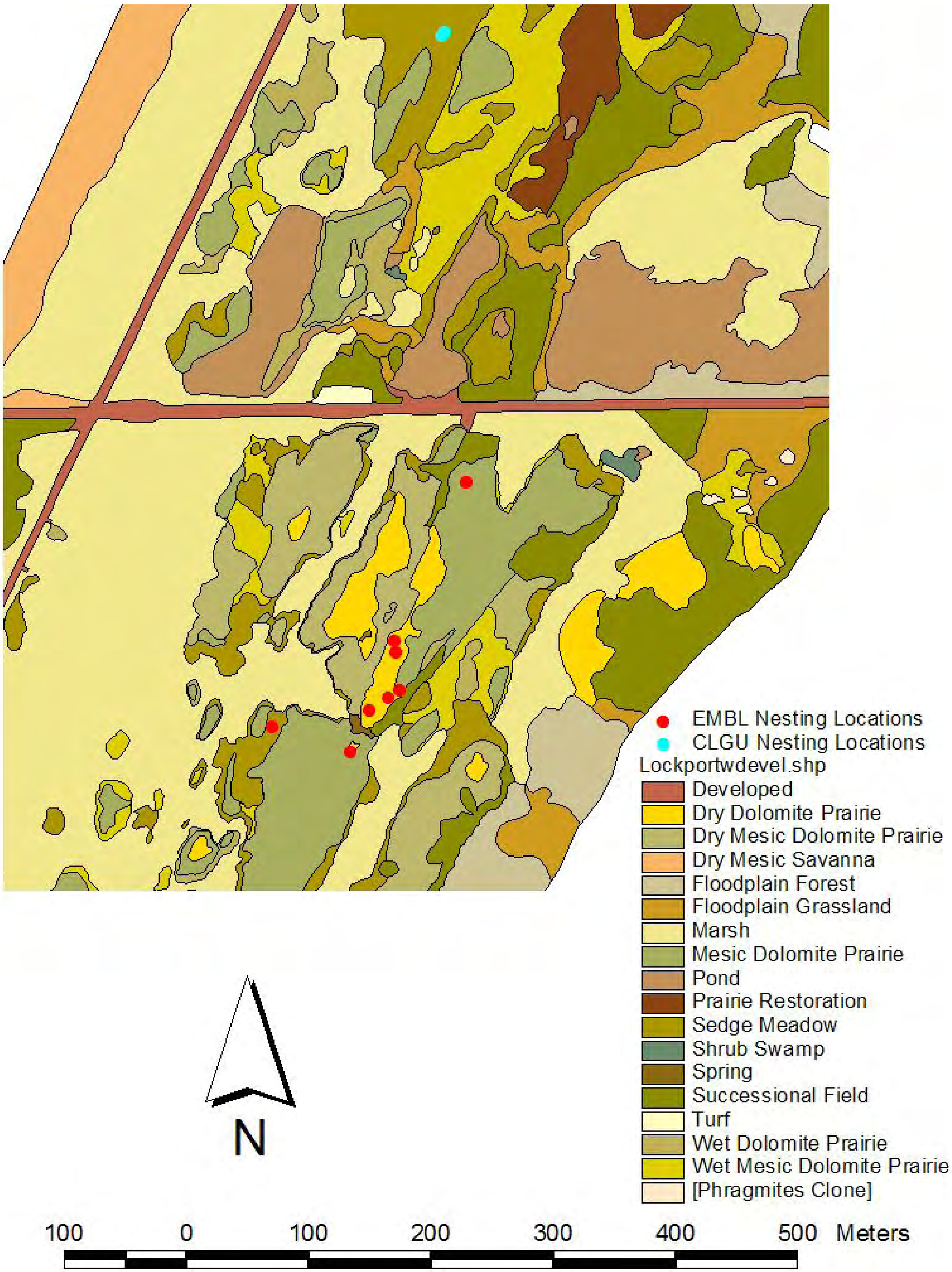


Figure 5: Nesting locations for 4 *E. blandingii* (EMBL) and one *C. guttata* (CLGU) during June 2005 at Lockport Prairie Nature Preserve, Will County, Illinois.

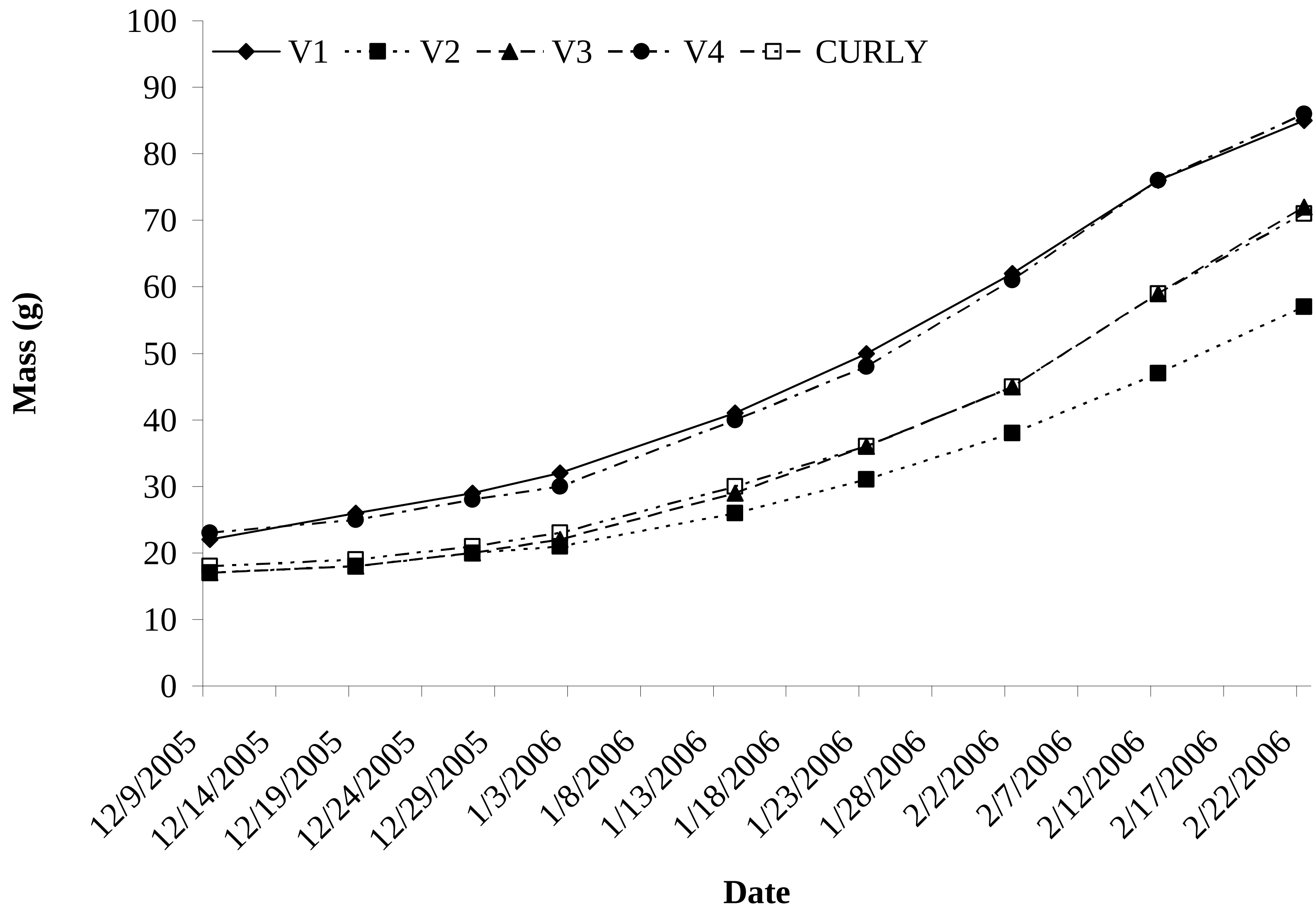


Figure 6: Growth in mass (g) of 5 head-started *E. blandingii* from 2005-2006 from Lockport Prairie Nature Preserve, Will County, Illinois.

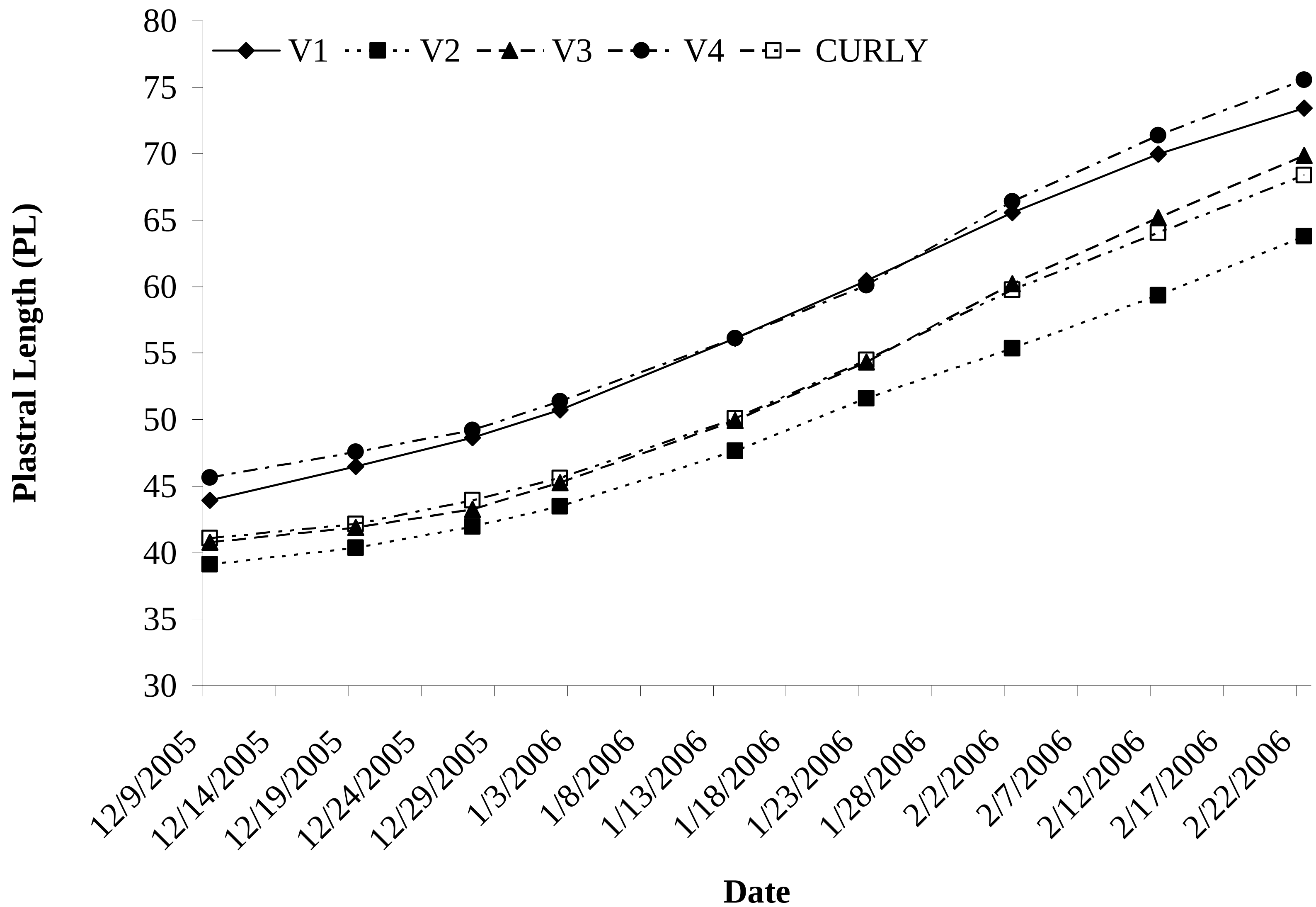


Figure 7: Growth in plastron length (mm) of 5 head-started *E. blandingii* from 2005-2006 from Lockport Prairie Nature Preserve, Will County, Illinois.

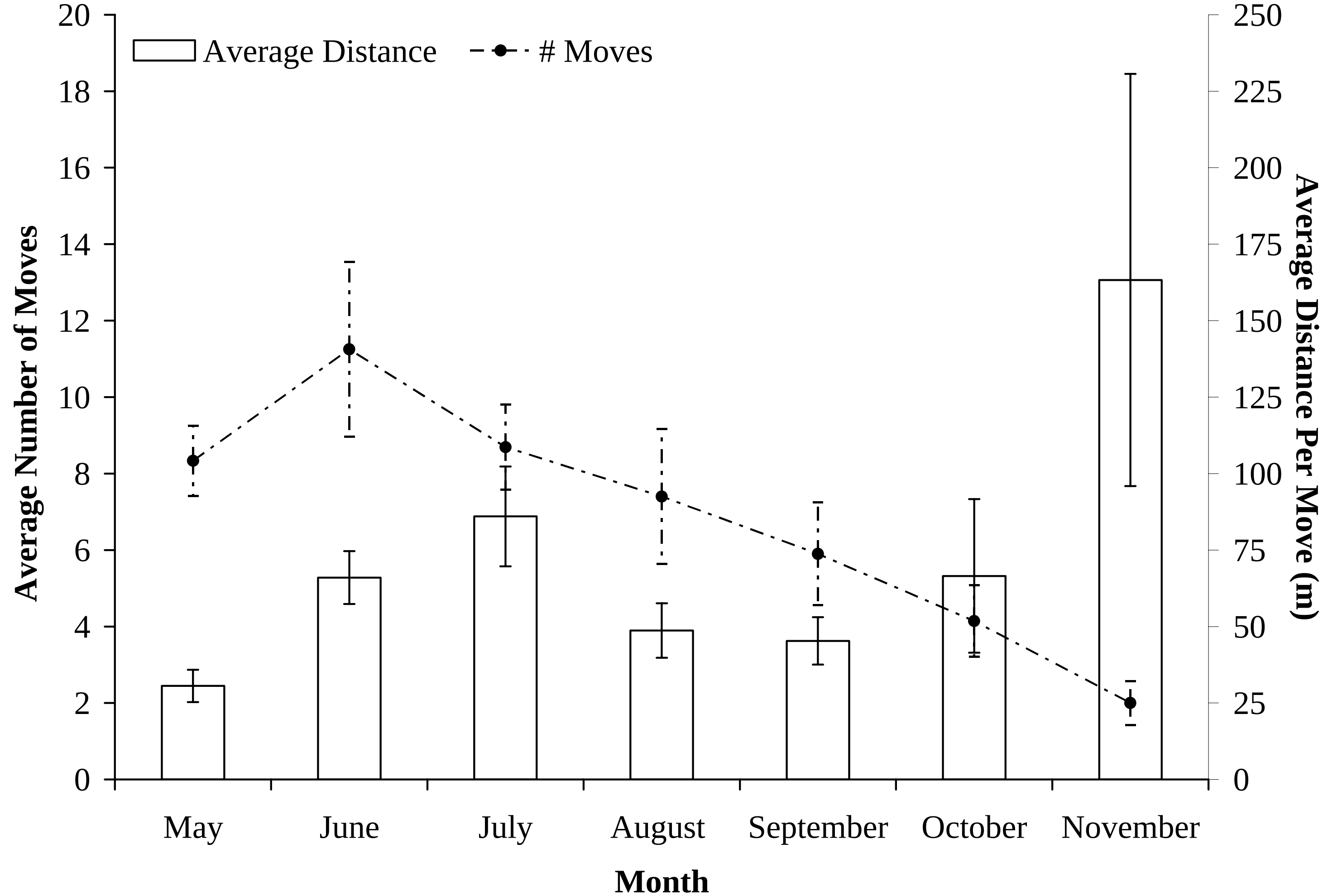


Figure 8: Average number of moves per month and average distance traveled per move from May 2005-November 2005 for female *E. blandingii* at Lockport Prairie Nature Preserve, Will County, Illinois.

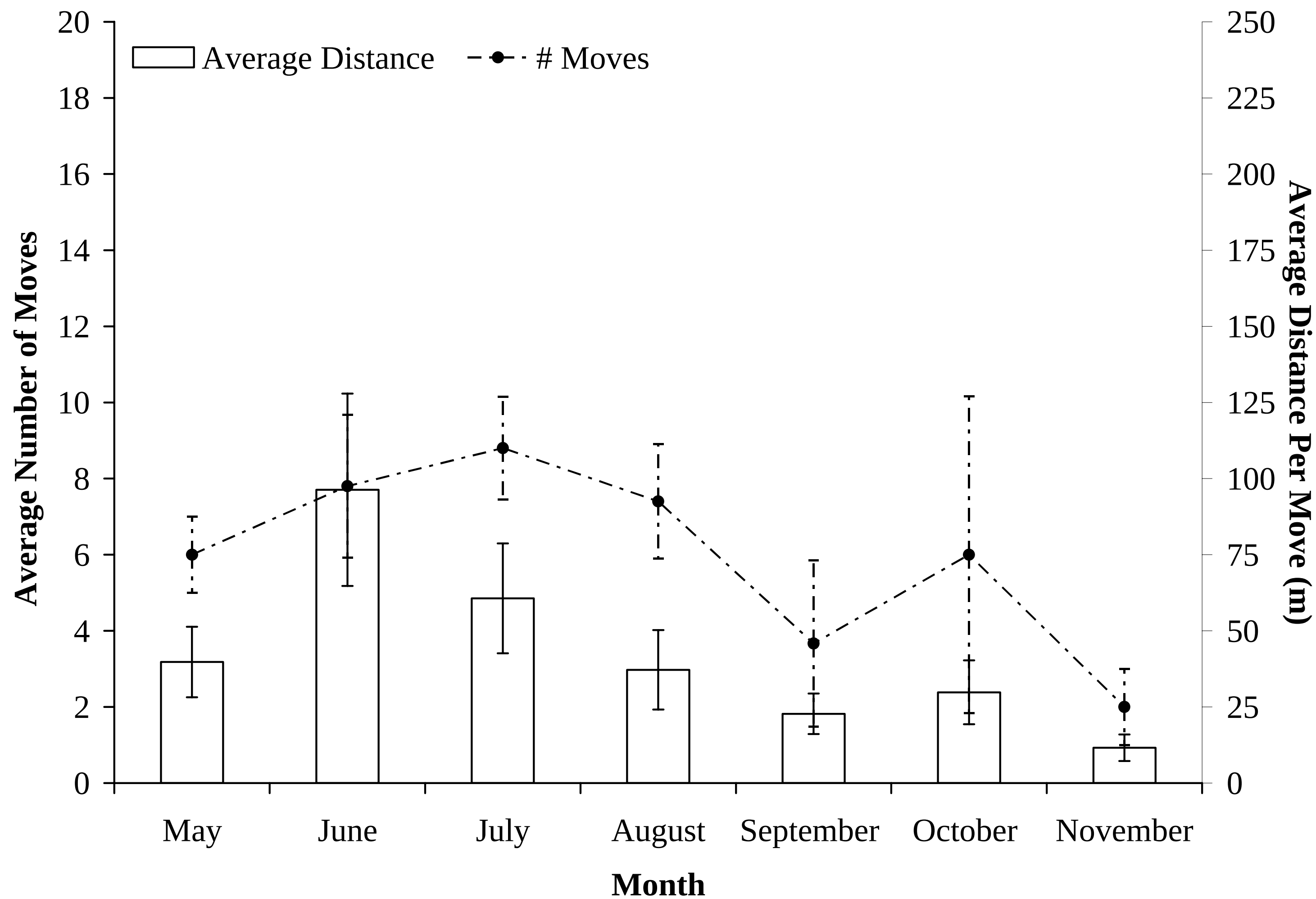


Figure 9: Average number of moves per month and average distance traveled per move from May 2005-November 2005 for male *E. blandingii* at Lockport Prairie Nature Preserve, Will County, Illinois.

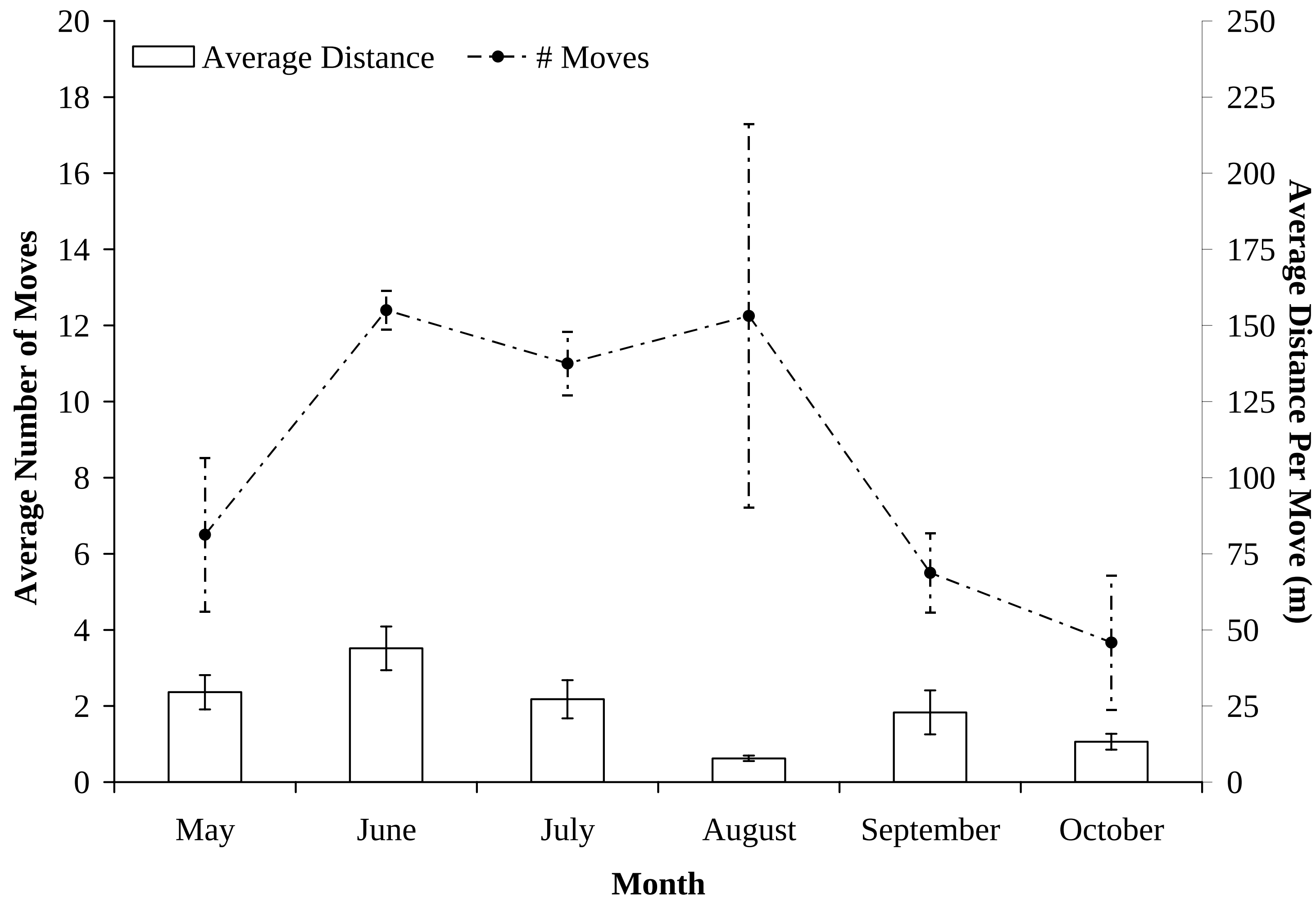


Figure 10: Average number of moves per month and average distance traveled per move from May 2005-November 2005 for juvenile *E. blandingii* at Lockport Prairie Nature Preserve, Will County, Illinois.

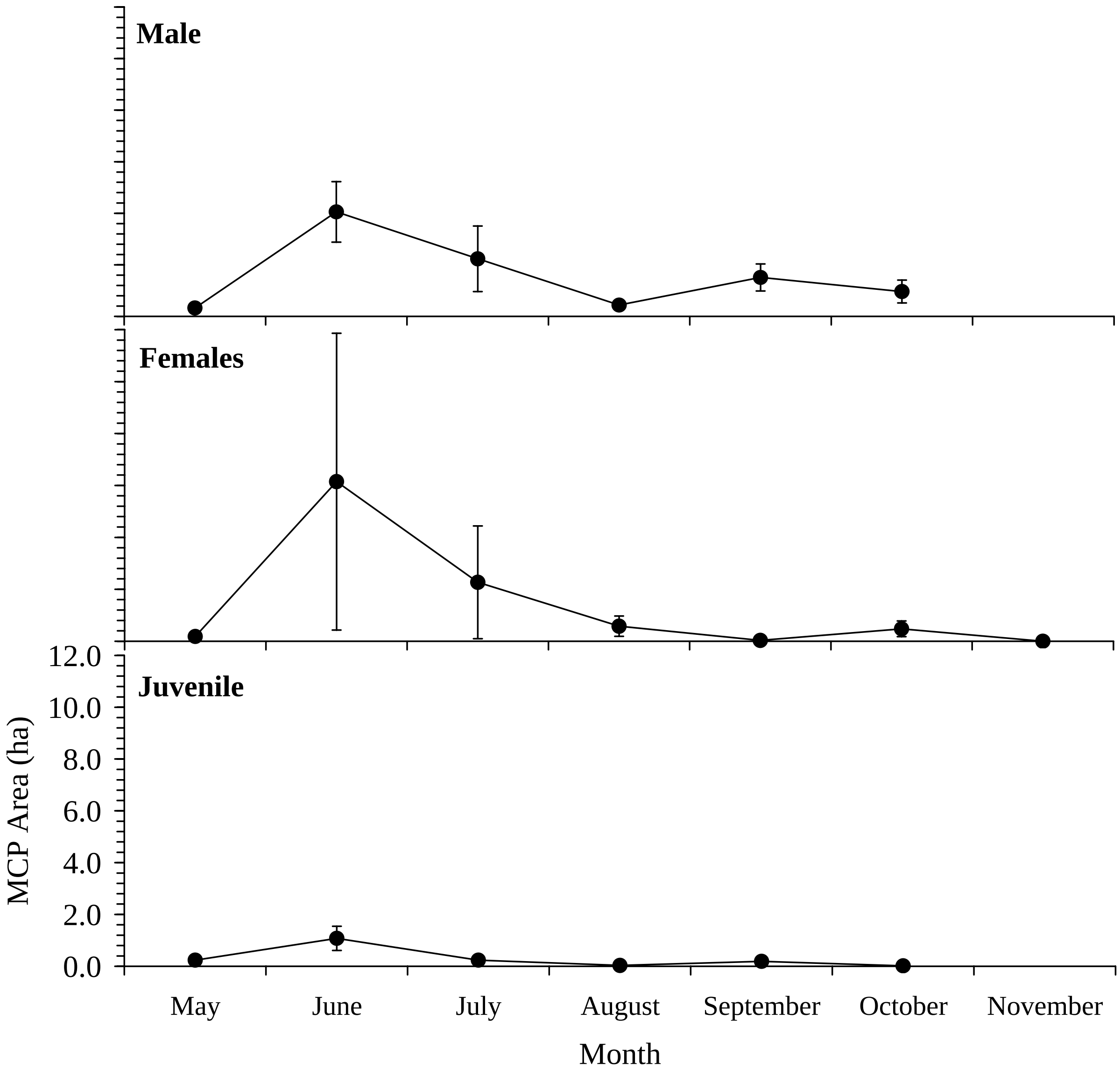


Figure 11: Average amount of MCP area used by month for female, male, and juvenile *E. blandingii* from May 2005-November 2005 at Lockport Prairie Nature Preserve, Will County, Illinois.

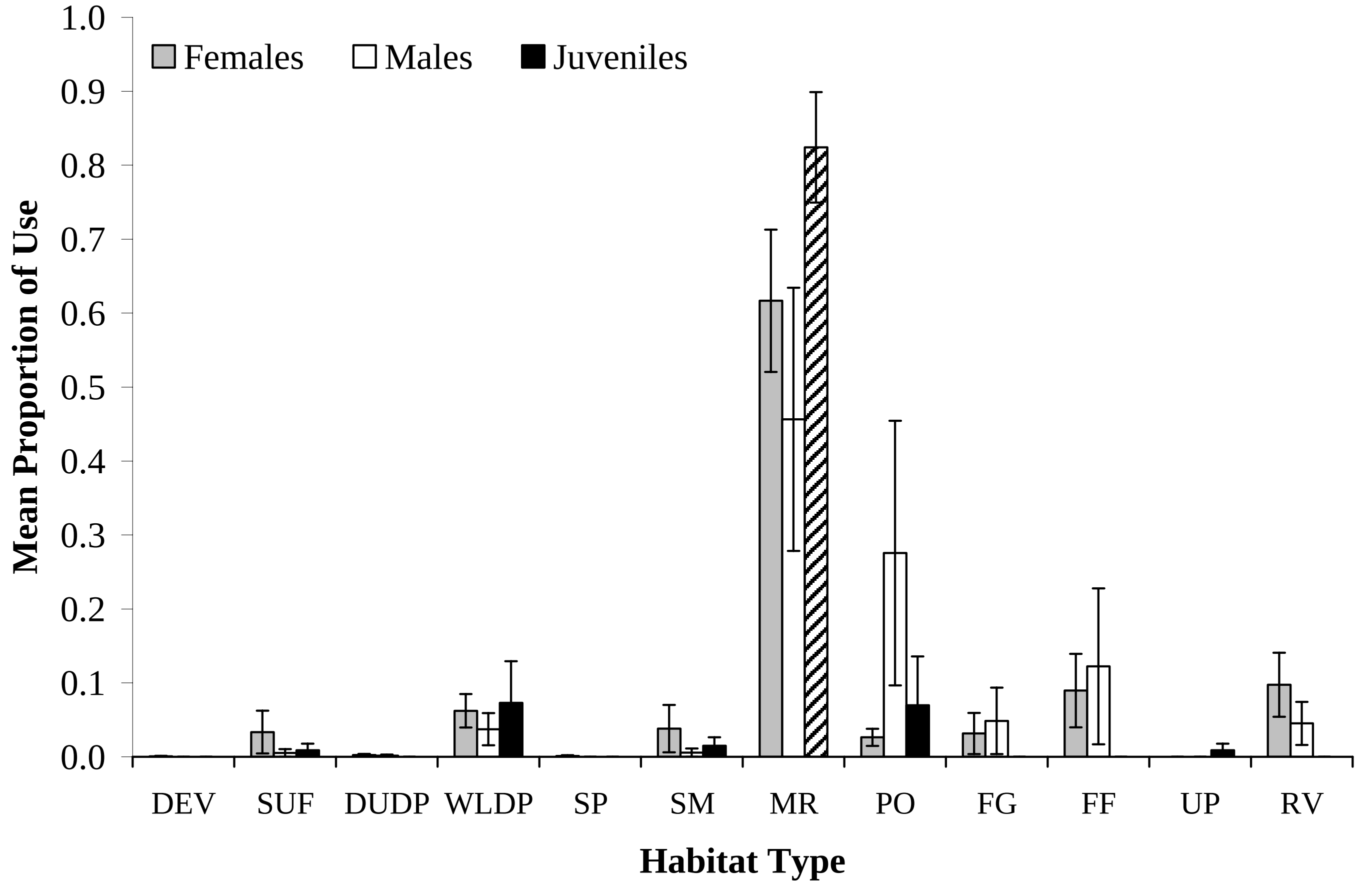


Figure 12: Mean proportion of use for habitat types for female, male, and juvenile *E. blandingii* radio-located from May 2005-December 2005 at Lockport Prairie Nature Preserve, Will County, Illinois. Habitat types are: Developed (DEV), Successional Field (SUF), Dry Upland Dolomite Prairie (DUDP), Wet Lowland Dolomite Prairie (WLDP), Spring (SP), Sedge Meadow (SM), Marsh (MR), Pond (PO), Floodplain Grassland (FG), Floodplain Forest (FF), Upland Forest (UF), and River (RV).

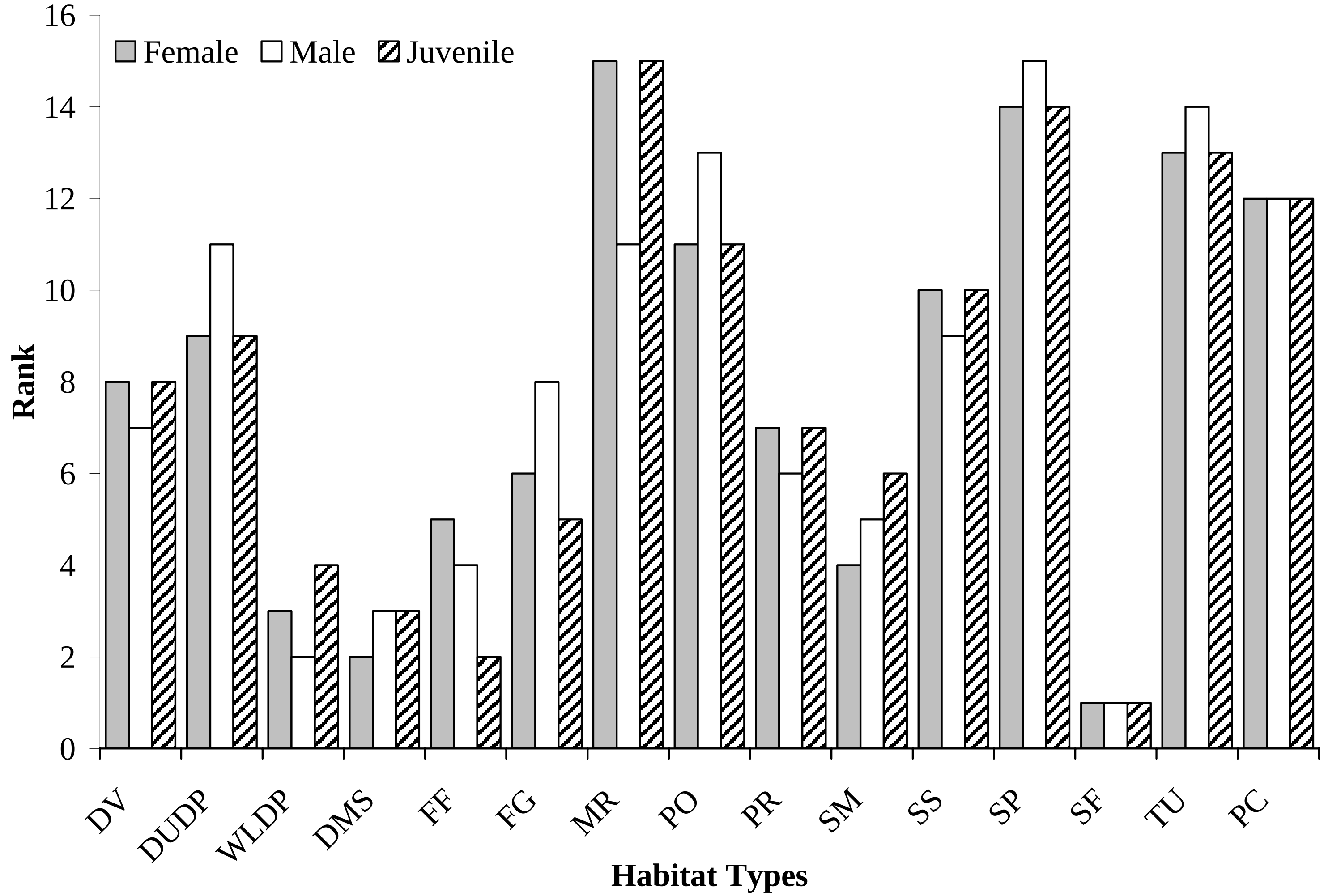


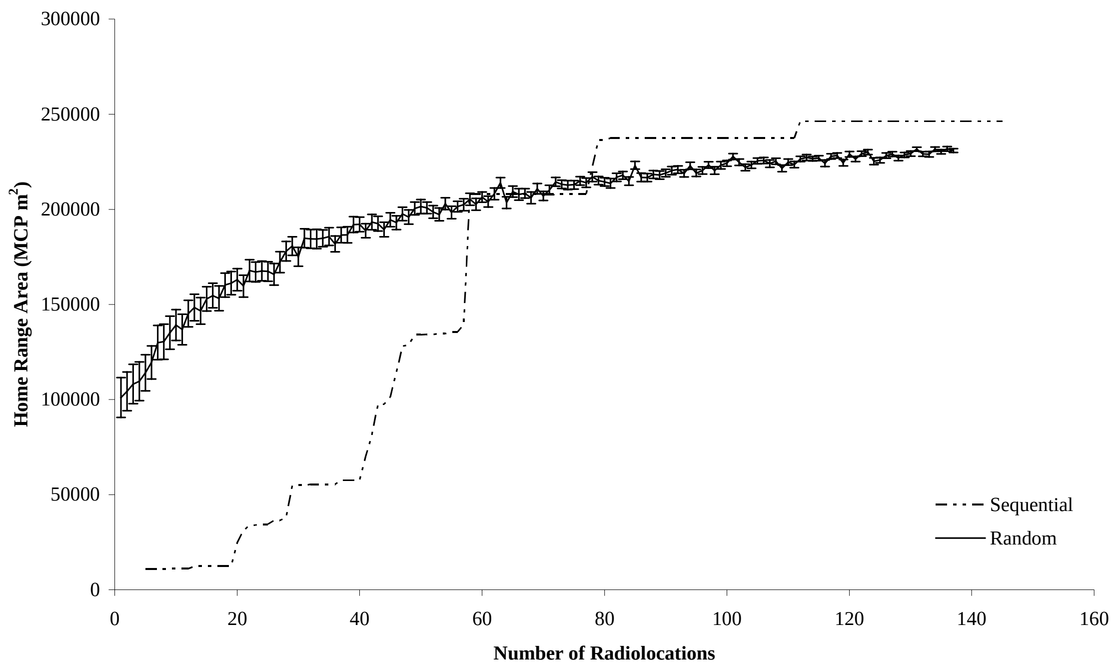
Figure 13: Rankings of habitat selection within the preserve boundary in relation to availability of habitat types for female, male, and juvenile *E. blandingii* radio-located from May 2005-December 2005 at Lockport Prairie Nature Preserve, Will County, Illinois. Habitat types are: Developed (DV), Dry Upland Dolomite Prairie (DUDP), Wet Lowland Dolomite Prairie (WLDP), Dry Mesic Savanna (DMS), Floodplain Forest (FF), Floodplain Grassland (FG), Marsh (MR), Pond (PO), Prairie Restoration (PR), Sedge Meadow (SM), Shrub Swamp (SS), Spring (SP), Successional Field (SF), Turf (TU), and *Phragmites* Clone (PC).

APPENDIX III

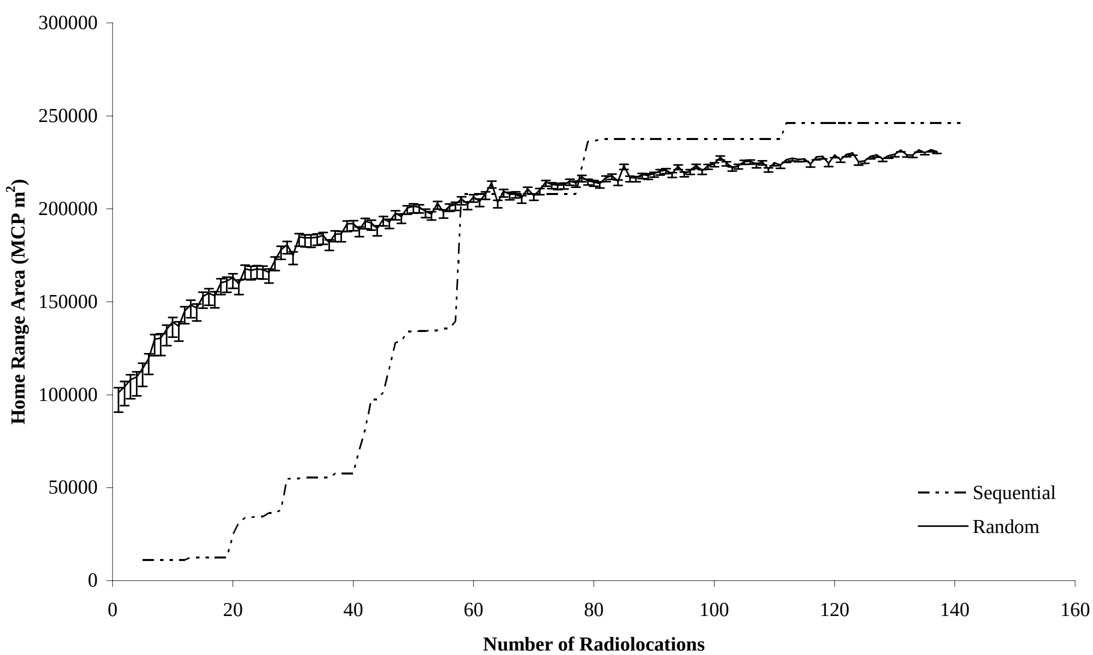
Incremental area curves for *Emdoidea blandingii*
tracked at Lockport Prairie Nature Preserve, Will County, Illinois for the 2005 tracking season.

Females (* denotes gravid female)

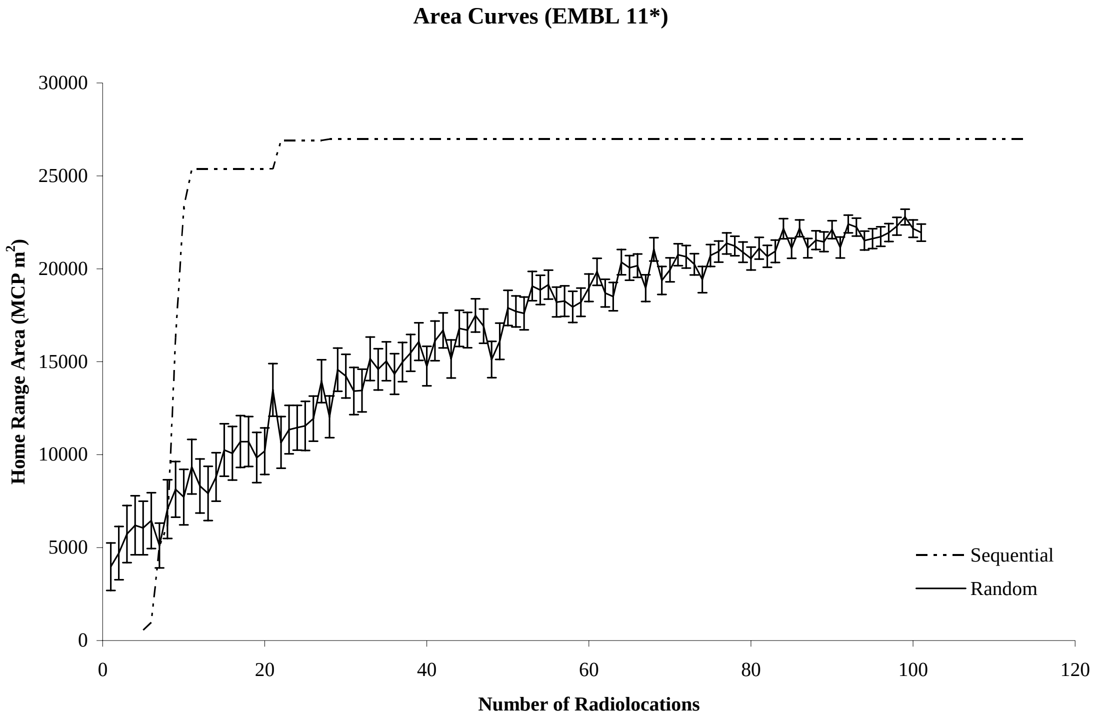
Area Curves (EMBL 07*)

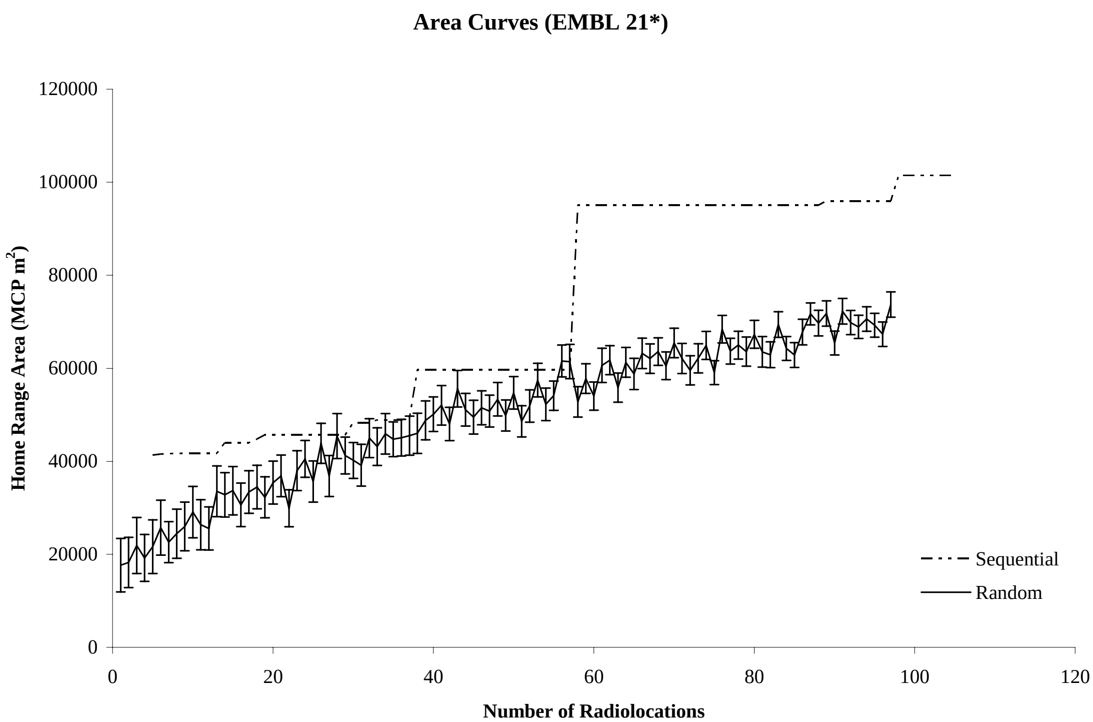


Area Curves (EMBL 16*)



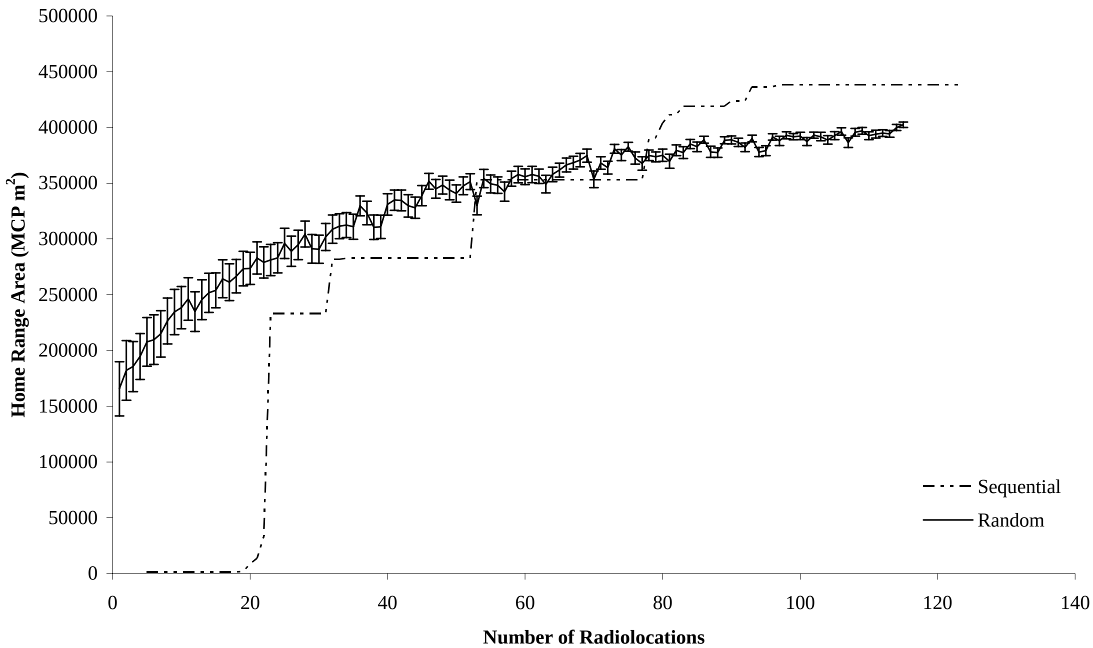
APPENDIX III (Cont.)



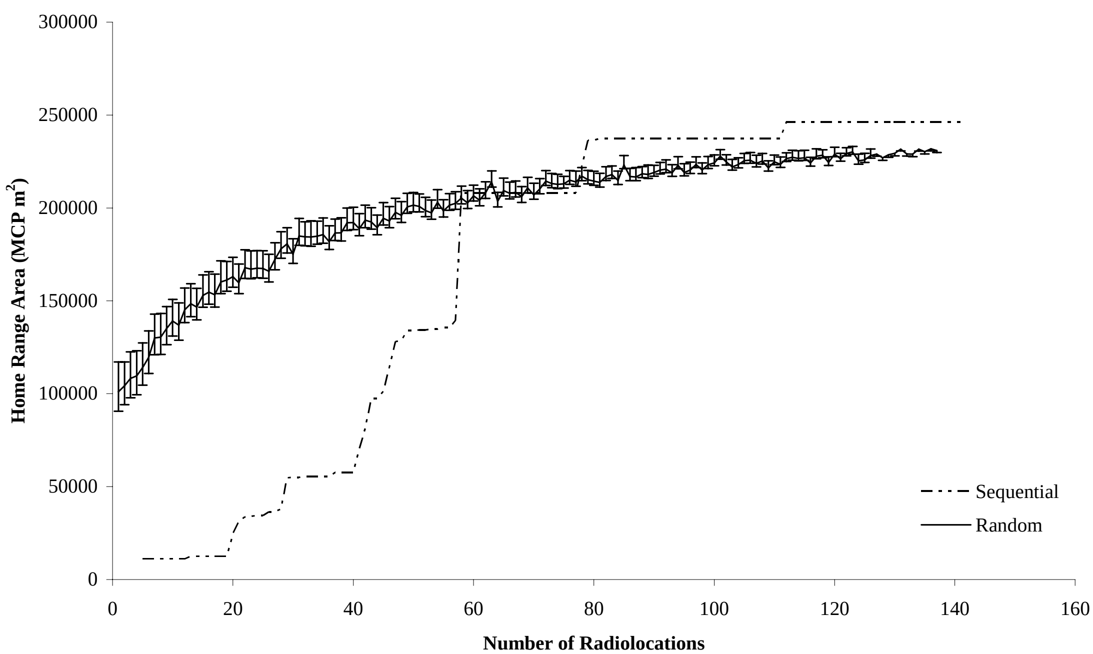


APPENDIX III (Cont.)

Area Curves (EMBL 01)

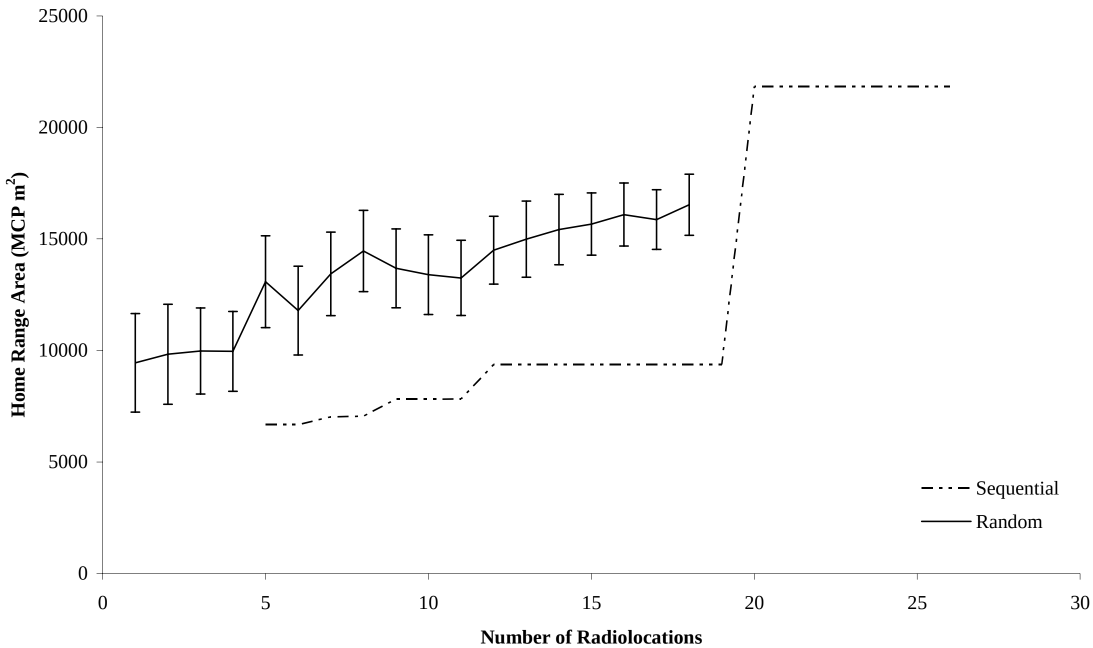


Area Curves (EMBL 05)

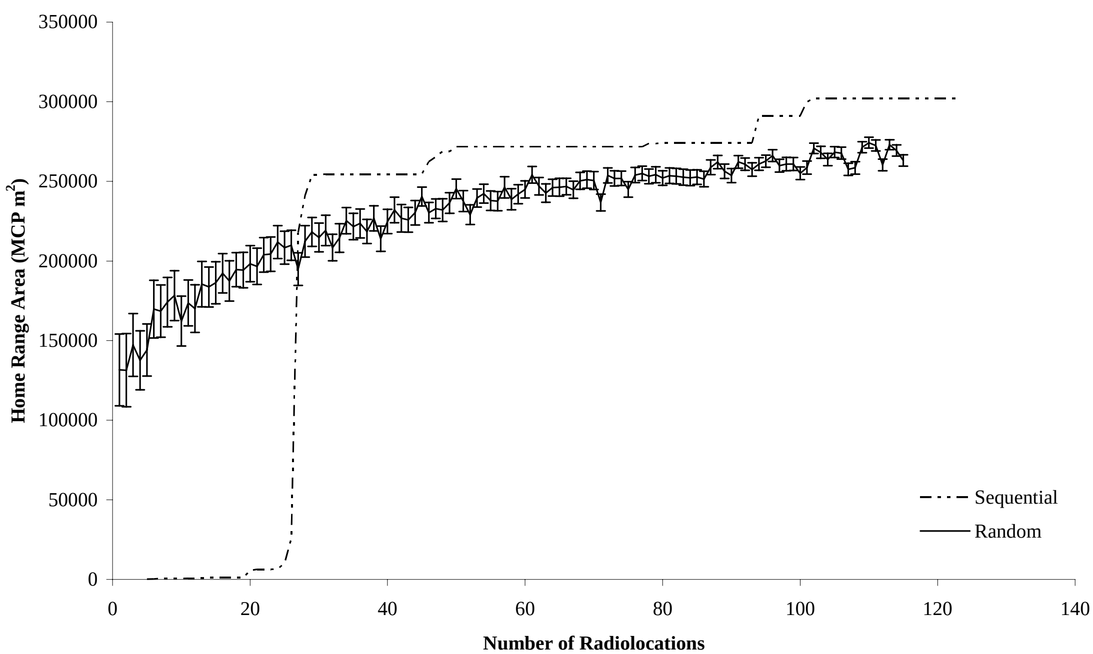


APPENDIX III (Cont.)

Area Curves (EMBL 06)

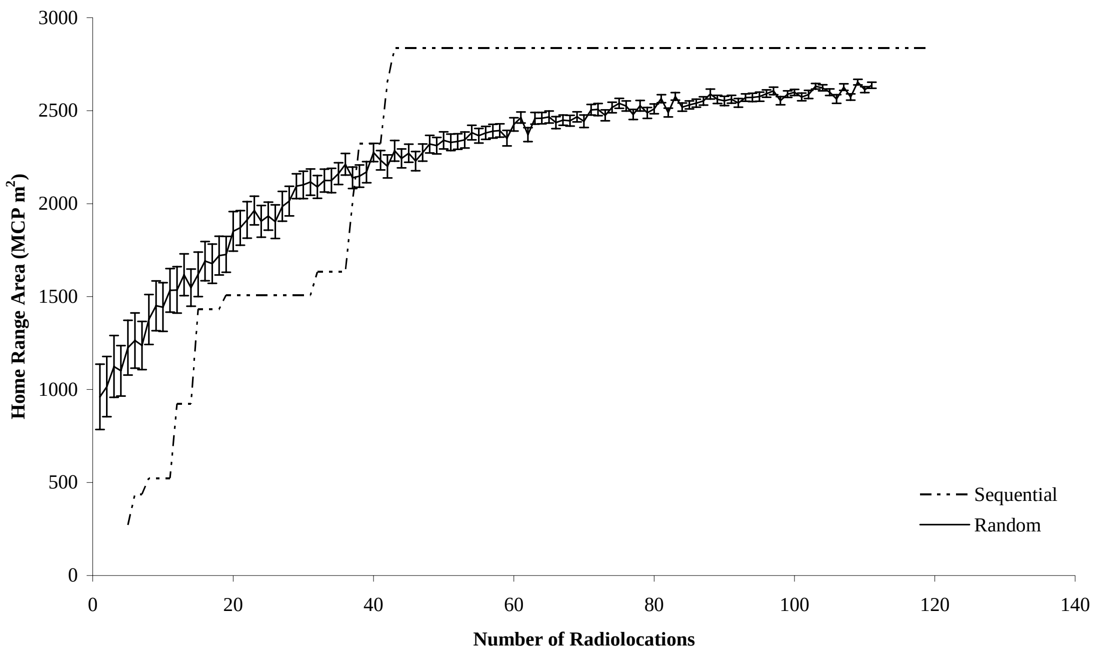


Area Curves (EMBL 08)

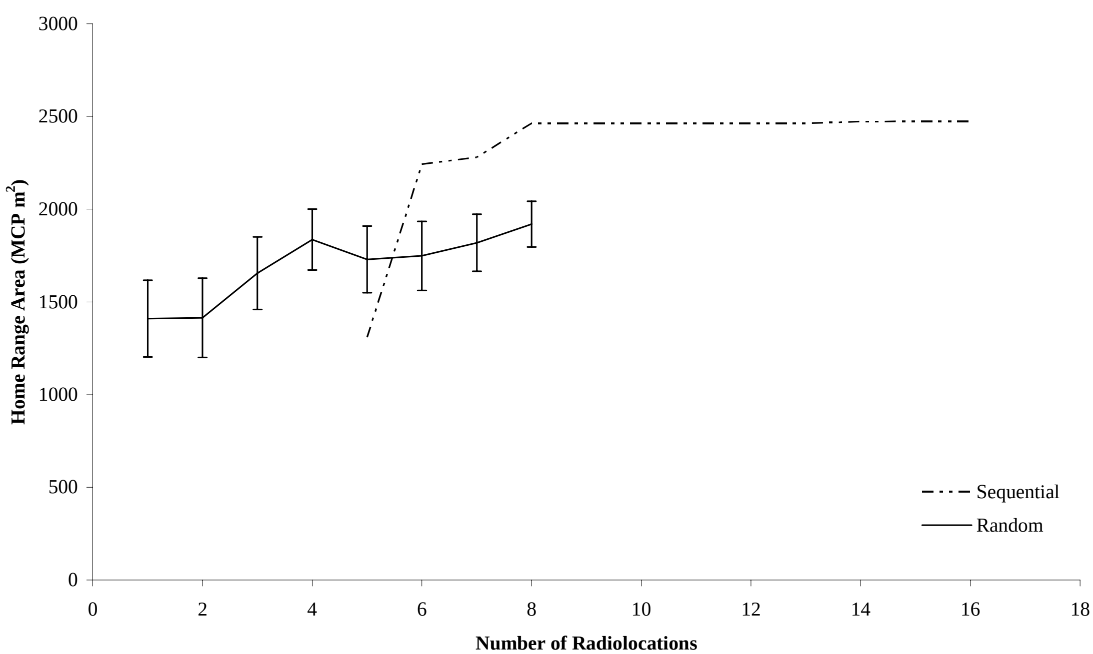


APPENDIX III (Cont.)

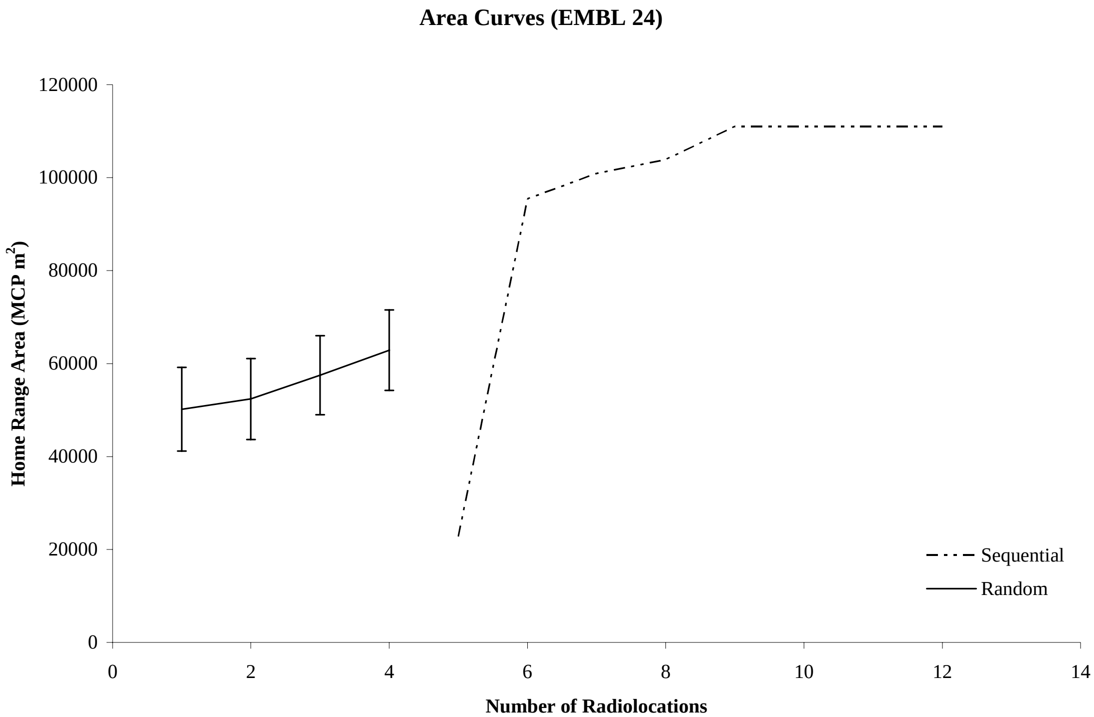
Area Curves (EMBL 18)

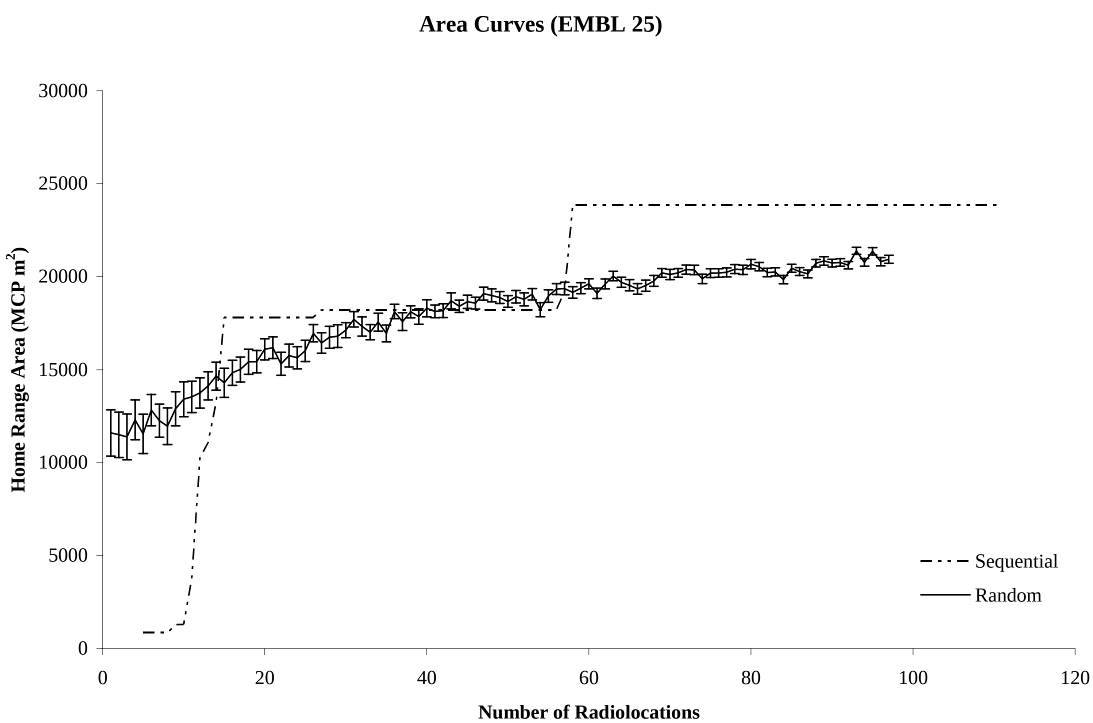


Area Curves (EMBL 22)

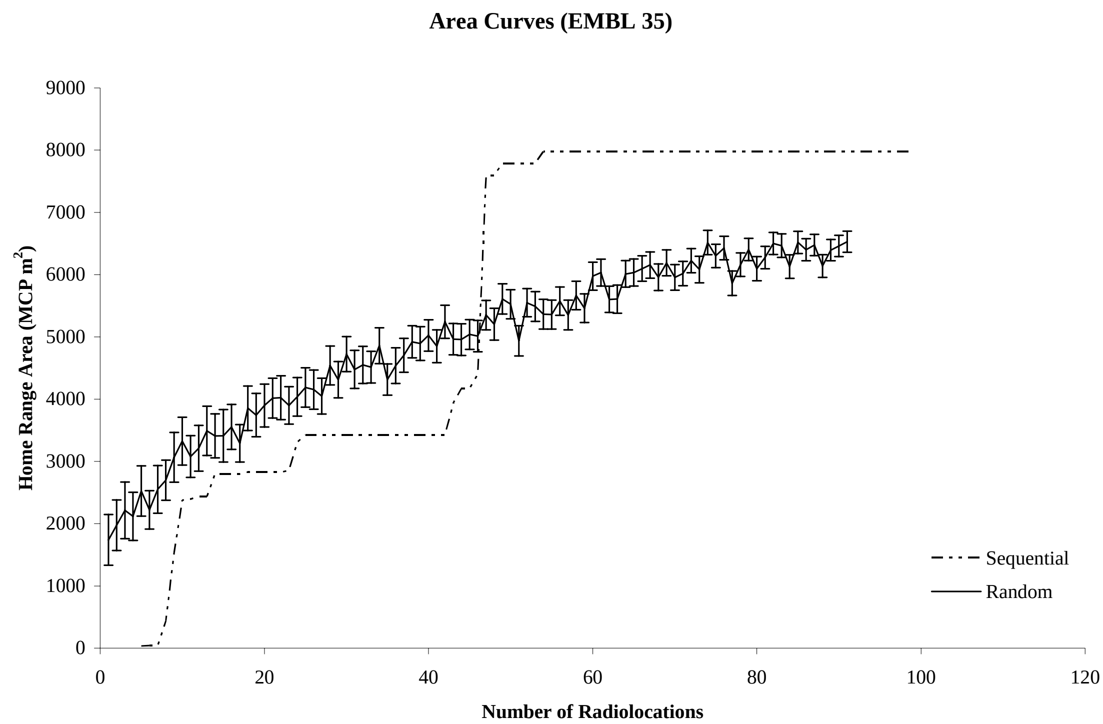


APPENDIX III (Cont.)

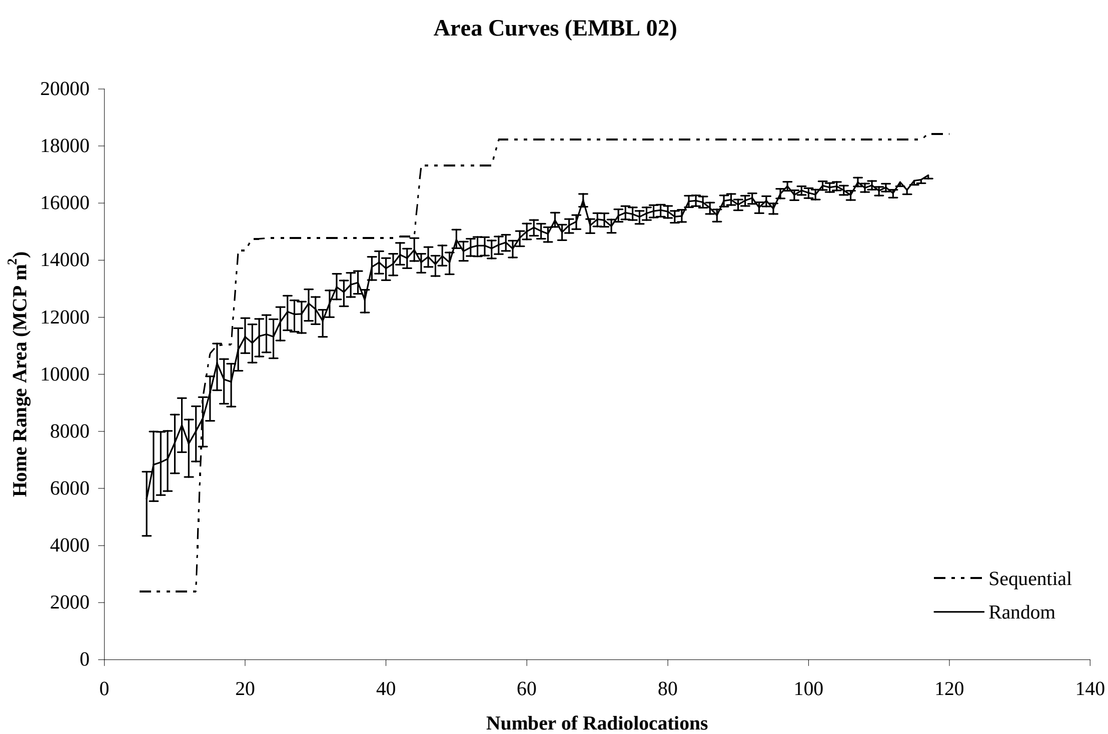




APPENDIX III (Cont.)

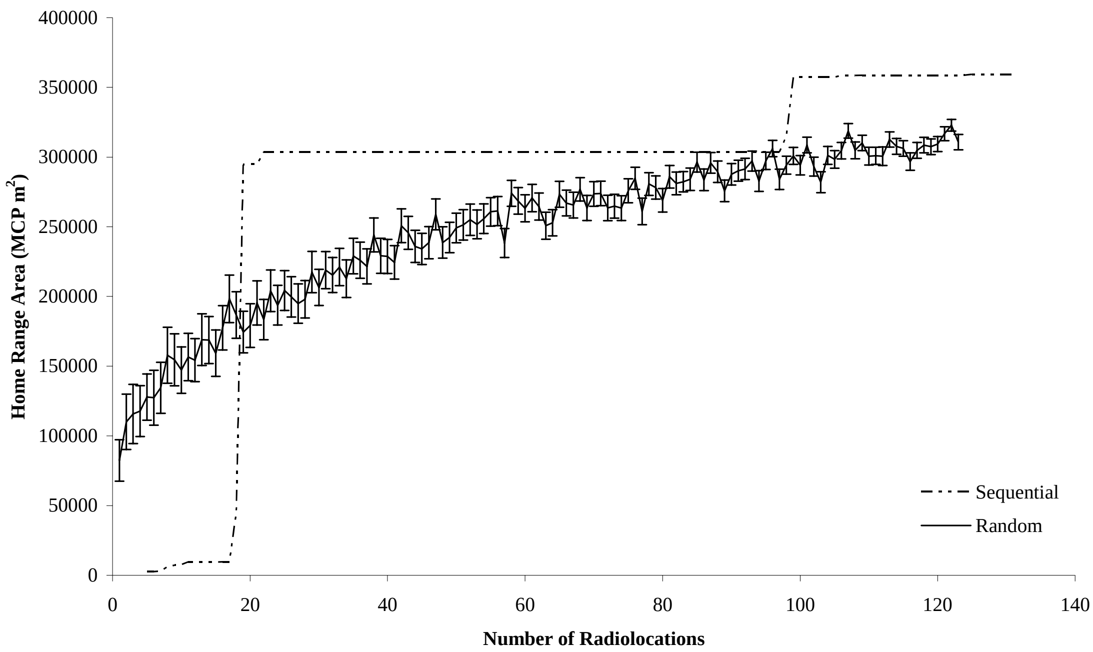


Males

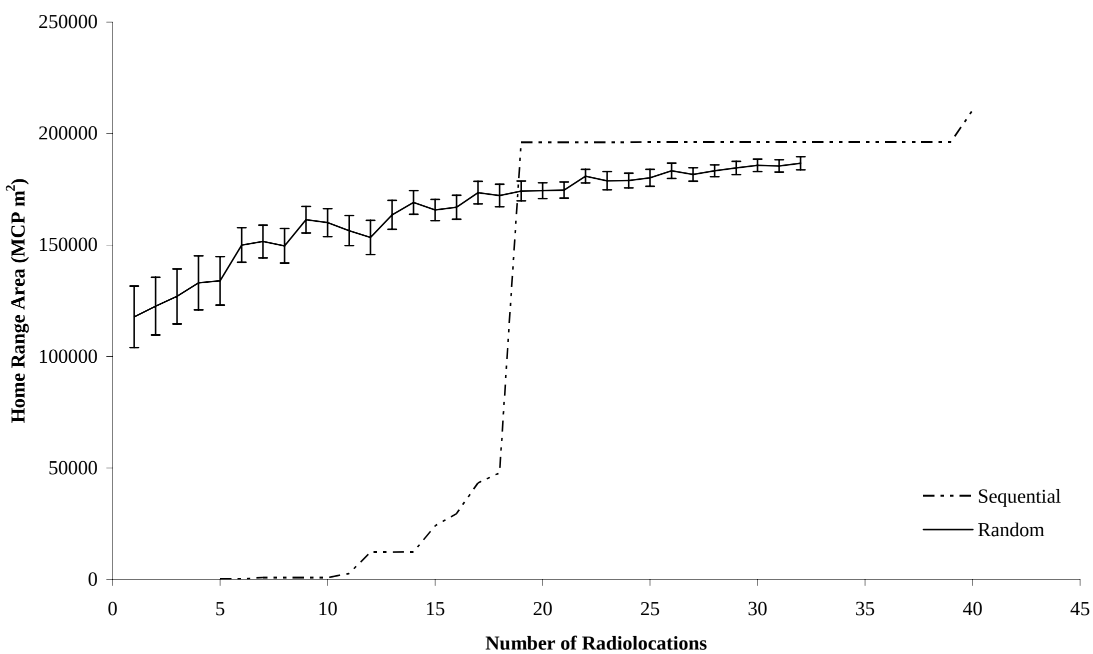


APPENDIX III (Cont.)

Area Curves (EMBL 03)

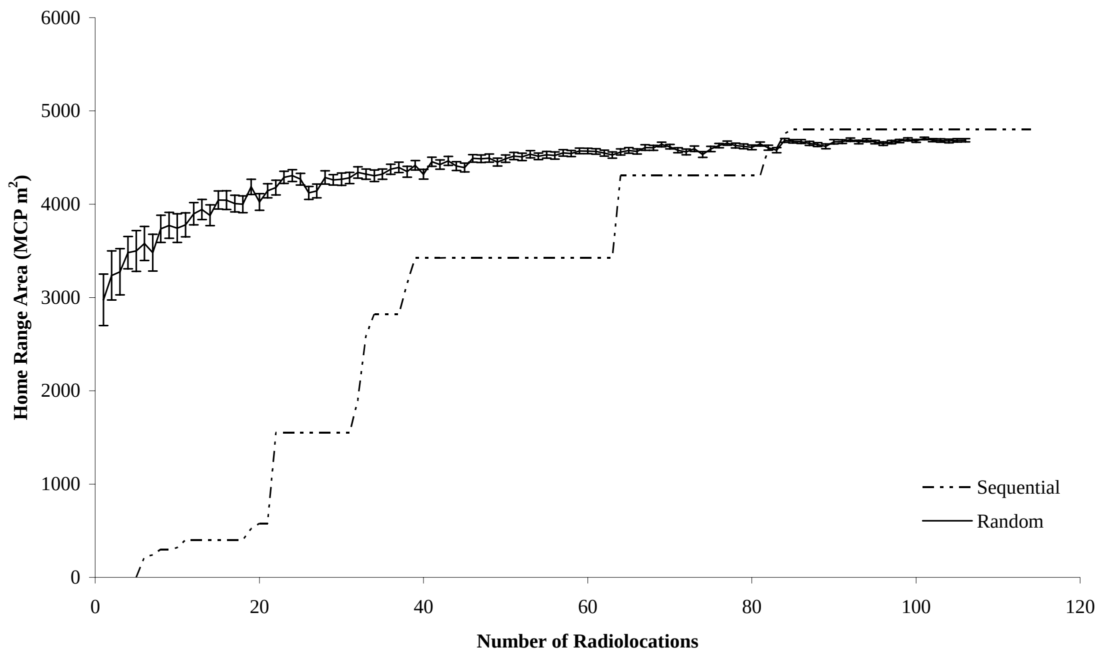


Area Curves (EMBL 17)

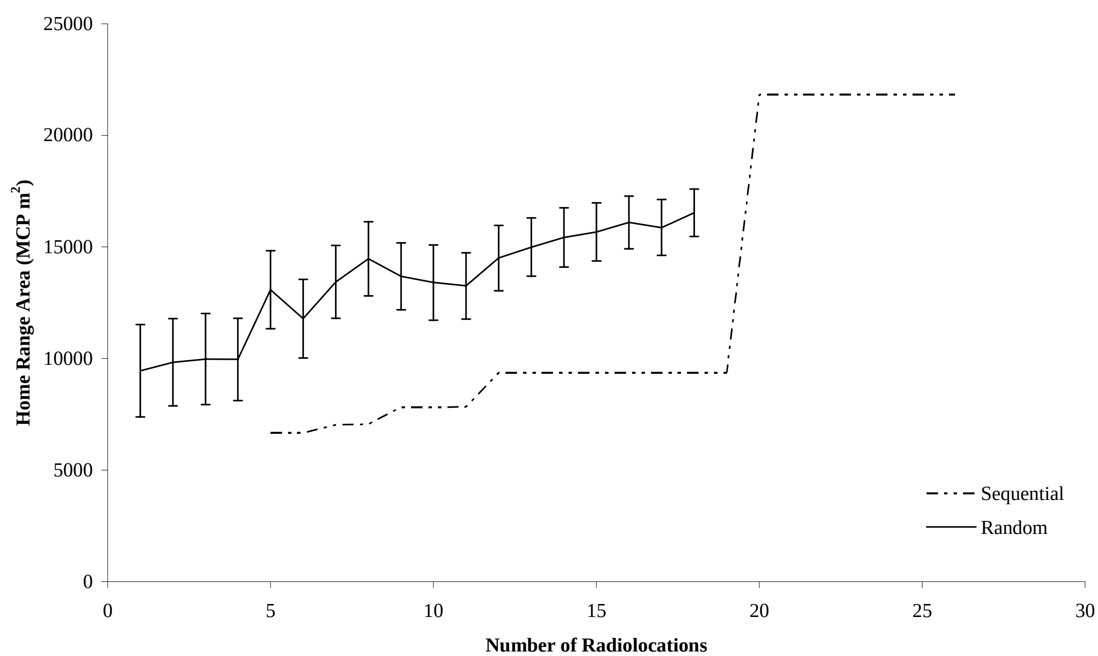


APPENDIX III (Cont.)

Area Curves (EMBL 26)

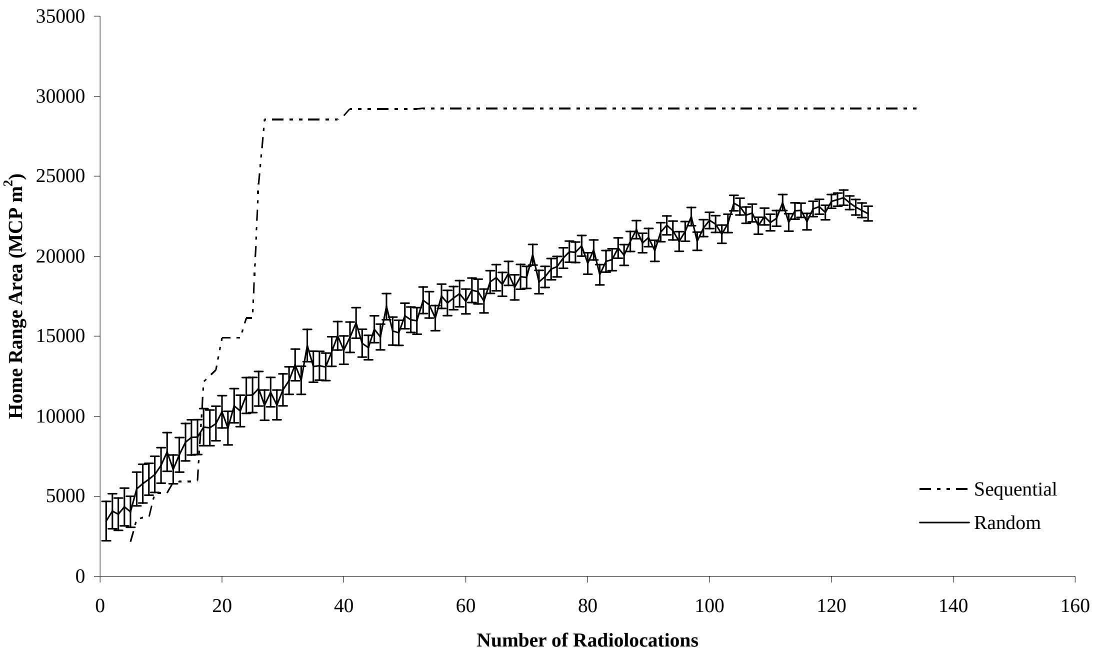


Area Curves (EMBL 27)

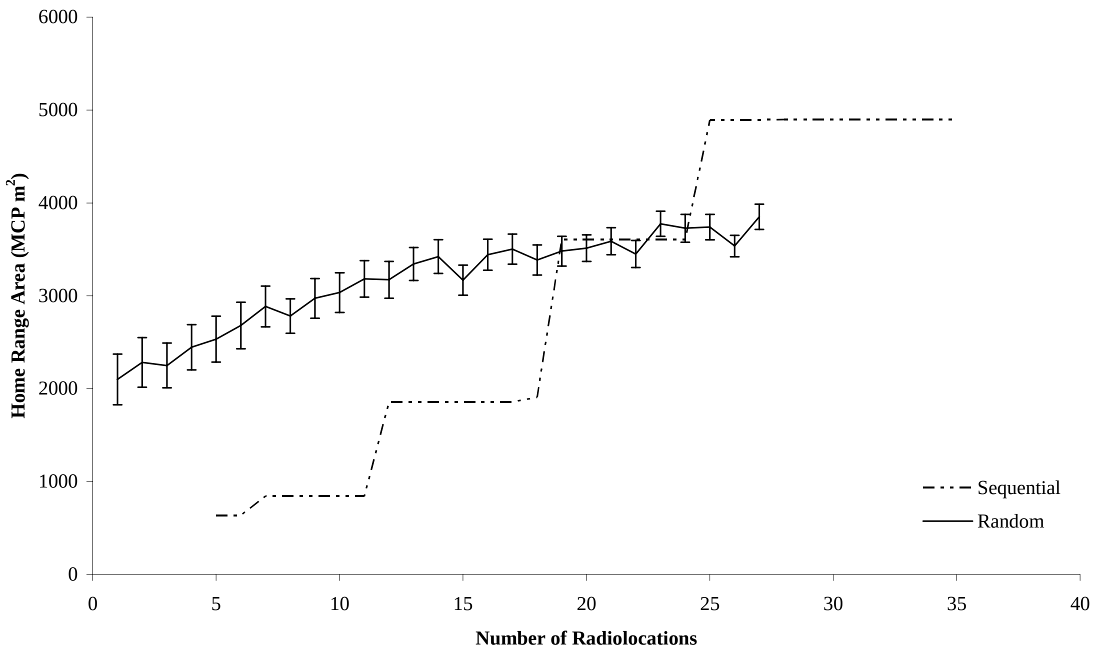


APPENDIX III (Cont.)
Juveniles

Area Curves (EMBL 04)

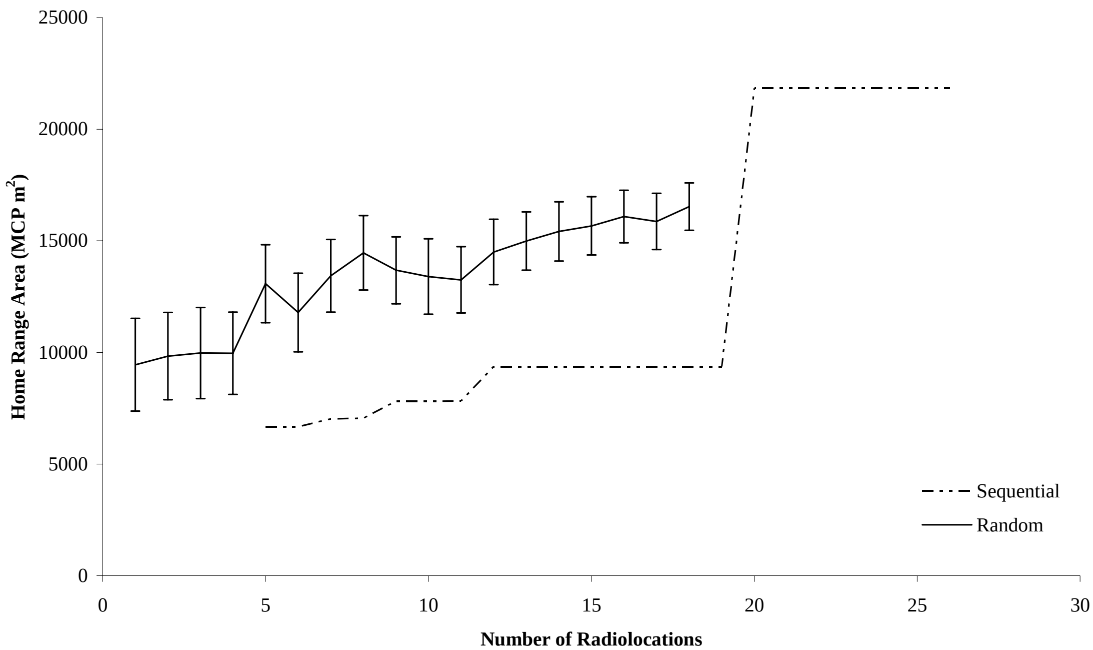


Area Curves (EMBL 09)

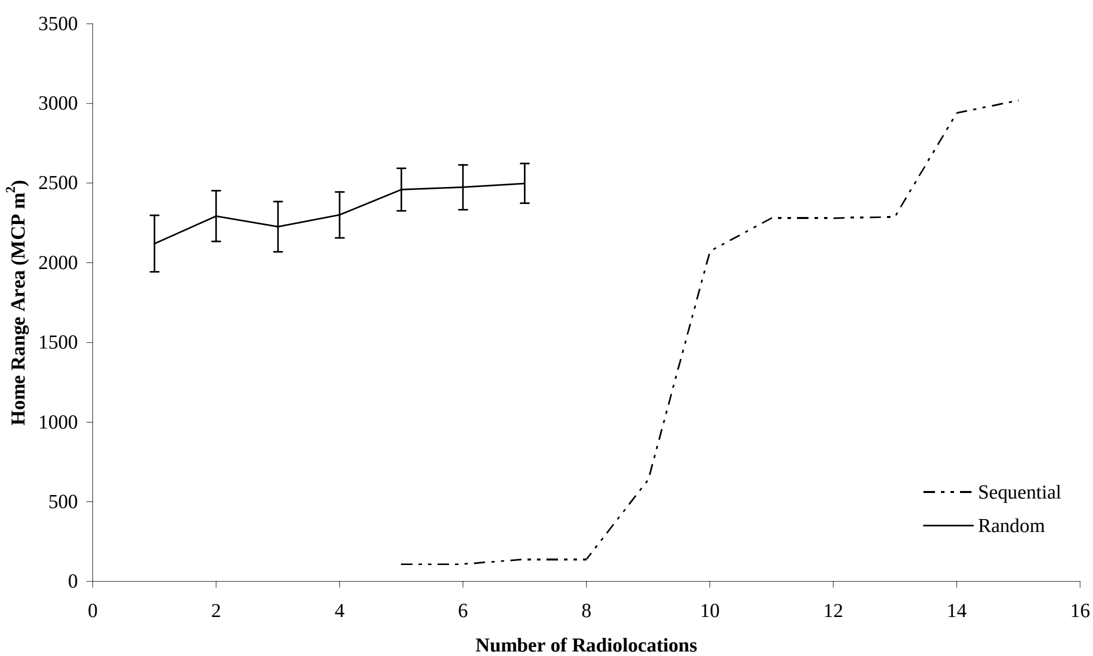


APPENDIX III (Cont.)

Area Curves (EMBL 10)

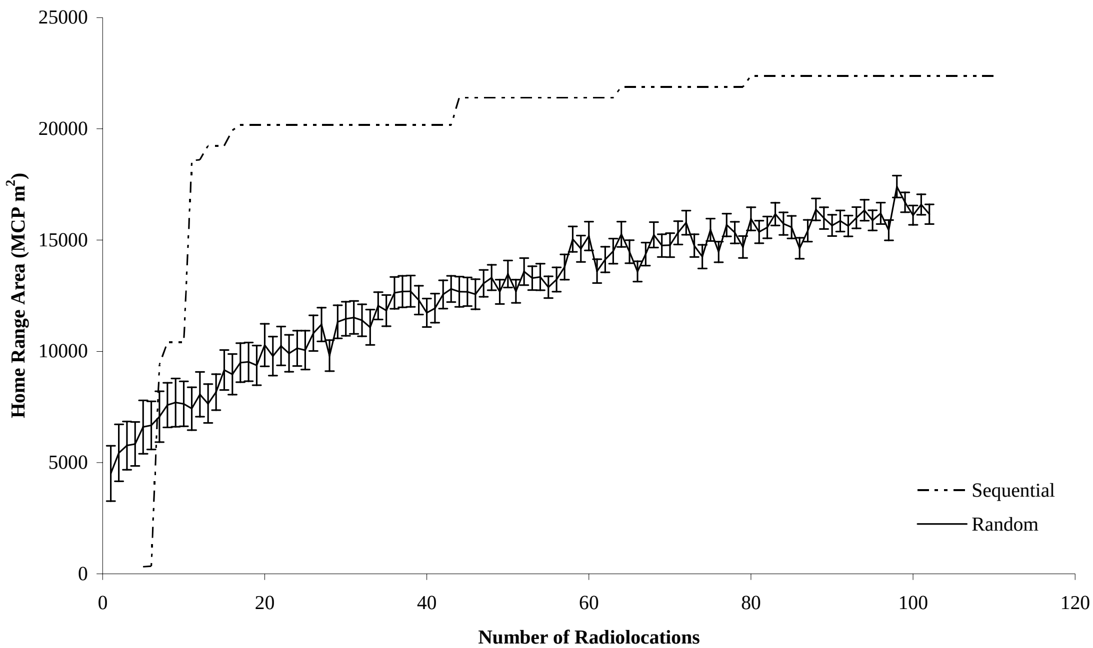


Area Curves (EMBL 12)

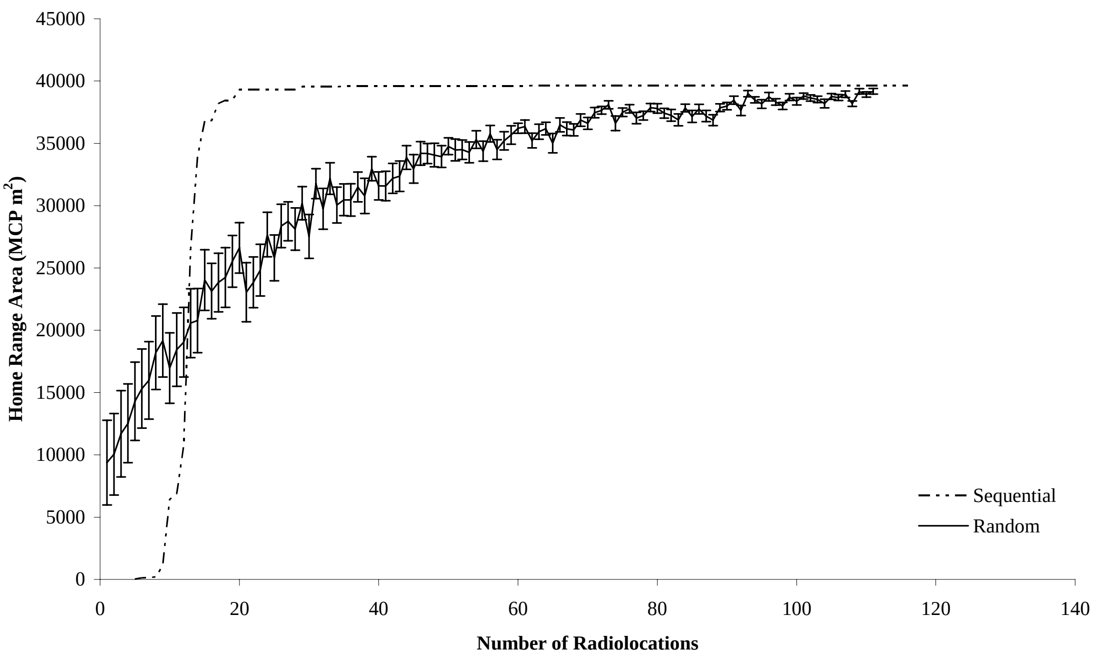


APPENDIX III (Cont.)

Area Curves (EMBL 13)

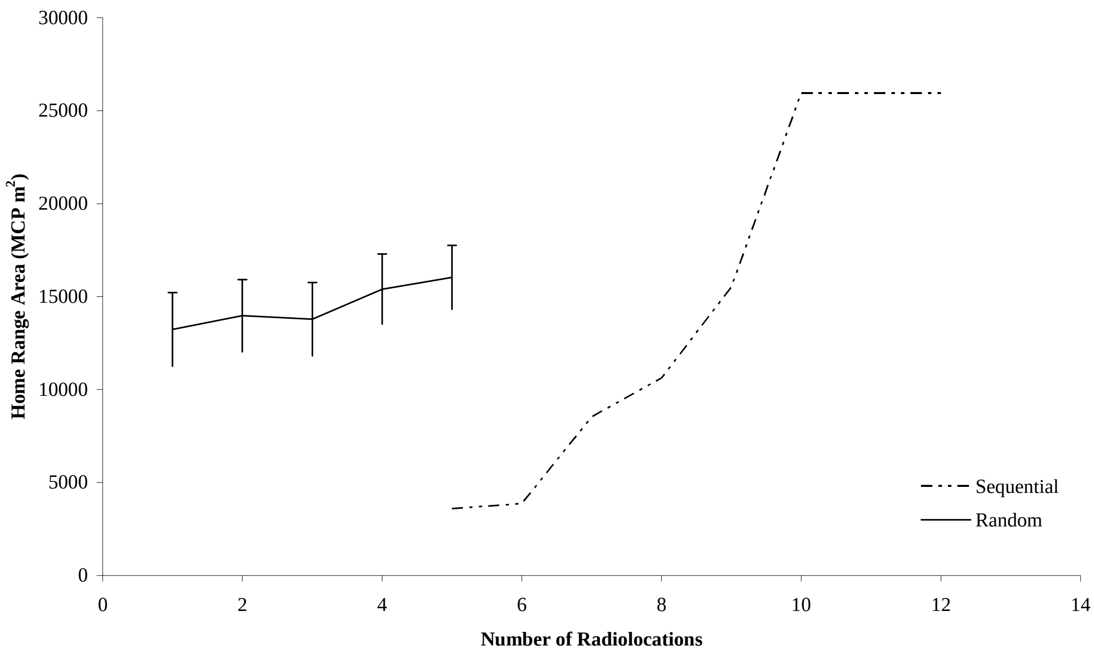


Area Curves (EMBL 14)



APPENDIX III (Cont.)

Area Curves (EMBL 15)



Area Curves (EMBL 23)