Annual vs. Multiple-Year Home Range Sizes of Individual Blanding's Turtles, *Emydoidea blandingii*, in Central Wisconsin

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Most studies of home ranges occur over short time periods and may not represent the spacial requirements of long-lived organisms such as turtles. Home ranges of 18 individual Blanding's Turtles *(Emydoidea blandingii*) were measured using minimum convex polygons. Annual space use was compared to multi-year space use by individual turtles. We found a significant difference between annual home range size (25.5 hectares) and multi-year (two to six years) home range size (65.7 hectares; $n = 18$, $P = 0.016$). Caution should be employed when making management decisions based on short-term studies of long lived species.

Key Words: Blanding's Turtle, *Emydoidea blandingii*, life range, home range, Wisconsin.

Annual home range is the total area used by an organism in a given year for daily life activities such as foraging, mating, hibernating, and resting (Burt 1943). The short duration of typical wildlife studies (one to three years) adequately captures the spacing mechanisms used by most organisms because of their relatively short life-spans. The concept of a life-long home range for long-lived species is something that has not been seriously studied because, until recently, most wildlife research has not focused on animals with prolonged life-spans such as turtles (Brecke and Moriarty 1989; Grgurovic and Sievert 2005).

Blanding's Turtles are a long-lived species. A record exists of one in Minnesota reaching 77 years of age (Brecke and Moriarty 1989; Pappas et al. 2000). Reported home range sizes of Blanding's Turtles vary from 0.6 hectares (Ross and Anderson 1990) to 63.0 hectares (Piepgras and Lang 2000). These home range studies were of one or two years in duration. Grgurovic and Sievert (2005) noted that short-term home range data for Blanding's Turtles may be inadequate: "In our 2-year study of Blanding's turtle home ranges we found a low amount of home range overlap for the same individuals followed…, indicating that our calculations greatly underestimate lifetime home ranges for single animals."

In 1994 we began radio-tagging Blanding's Turtles in Sandhill Wildlife Area, managed by the Wisconsin Department of Natural Resources. Our intent was to teach secondary-level students the importance of wetlands and how biological data on wildlife, such as spacial needs, are acquired through field studies. For convenience, we attempted to re-radio the same Blanding's Turtles each spring because familiarity with individual turtle home ranges facilitated location and recovery when escorting school groups in area marshes. This provided a unique opportunity to compare single-year and multi-year home ranges of radio-tagged Blanding's Turtles monitored from one to six consecutive foraging seasons to test whether differences really existed, as suggested by Grgurovic and Sievert (2005). We report the results in this paper.

Study Area

Sandhill Wildlife Area is a 3884 hectare research facility located in Wood County, Wisconsin (44°17'N, 90°10'W). The property is surrounded by a 29 km long, 3 m high, deer-tight fence. During the Wisconsinan glacial event, Sandhill was covered by sandy lake bottom sediments. Post-glacial soils produced a mixture of habitats, such as sphagnum bogs, sedge meadows, willow (*Salix* spp.) swamps and upland oak (*Quercus* spp.), Jack Pine (*Pinus banksiana*) and aspen (*Populus* spp.) forests (Kubisiak et al. 2001).

In the late 1800s and early 1900s, ditches and dikes were constructed to drain this region's extensive wetland complexes for agricultural purposes. Between the 1930s and 1950s large acreages were converted to public land ownership, and many of the low-lying areas were re-flooded to create waterfowl habitat. Blanding's Turtles managed to persist despite these disturbances to their preferred habitats (Piepgras and Lang 2000; Bury and Germano 2003; Grgurovic and Sievert 2005).

Monthly temperatures for the region in the past 30 years ranged from a mean low of -9.8 degrees Celsius in January to a mean high of 20.7 degrees Celsius in July. Average annual precipitation was approximately 81 cm, and annual snowfall averaged 105 cm (Midwest Regional Climate Center 2000–2005*).

Methods

Blanding's Turtles were captured opportunistically by hand April through November annually since 1991, and with hoop traps in June through August 1997, 1998,

and 2002. Turtles were weighed, measured, sexed and aged by counting plastral scute growth rings (Sexton 1959; Congdon et al. 1993). Each turtle was given a unique number by notching a series of marginal scutes for future identification (Cagle 1939). Radio transmitters (Advanced Telemetry Systems, Model R1930, average weight 28 g) were glued on the anterior portion of the carapace of two to four turtles annually beginning in 1994. These turtles were held overnight and released the next morning.

Radio-tagged turtles were located by following transmitter signals to the turtle, and occasionally through triangulation. Locations were plotted on habitat maps drawn from aerial photographs. Single active season locations (April through September) were plotted and used to estimate annual home range sizes using the minimum convex polygon method (Mohr 1947). We used the same method to determine multiple-year home range size (Figure 1). We defined multiple-year home range as the aggregate of greater than or equal to two foraging seasons (April through September) for a single turtle.

To compare male and female single-year home ranges, we used a paired *t*-test. We used a paired *z*-test for comparing independent means to analyze the difference between the mean yearly home range size of turtles radioed for a single year and the mean yearly home range size of turtles radioed for multiple years. A paired *t*-test was used to examine the difference between the mean yearly home range size and the mean multi-year range size of nine turtles. We performed a regression analysis comparing the amount of habitat aggregated over a number of years. This was used to show an increase in habitat used per year in an individual turtle. For all analyses, significance was accepted at $P < 0.05$. Data were analyzed using SPSS (SPSS Inc., Chicago, Illinois).

Results

Nine radio-tagged Blanding's Turtles (3 males: 6 females) were monitored for a single year, and nine different turtles (6 males: 3 females) were radio-tagged for at least two years.

Mean annual home range size for 9 males (26.1 hectares) and 9 females (20.7 hectares) radioed for at least one active season did not differ significantly ($n = 18$, $P = 0.5$, df = 17). Additionally, mean yearly home ranges of turtles radioed for a single year did not differ significantly from mean yearly home range sizes of individuals that were radioed for multiple years ($n = 18$, $P = 0.55$, df = 17, $z = 1.96$). This indicates that individual turtles are utilizing essentially the same sized habitat each summer foraging season, and confirms that no differences existed between turtles in our two sub-samples (annual vs. multi-year range).

Turtles monitored over multiple years showed a significant difference between annual home range size (25.5 hectares) and multi-year range size (65.7 hectares) ($n = 18$, $P = 0.016$, df = 17). Figure 2 shows the significant increase in space used by turtles monitored over multiple years ($n = 9$, $r^2 = 0.49$, $P < 0.001$).

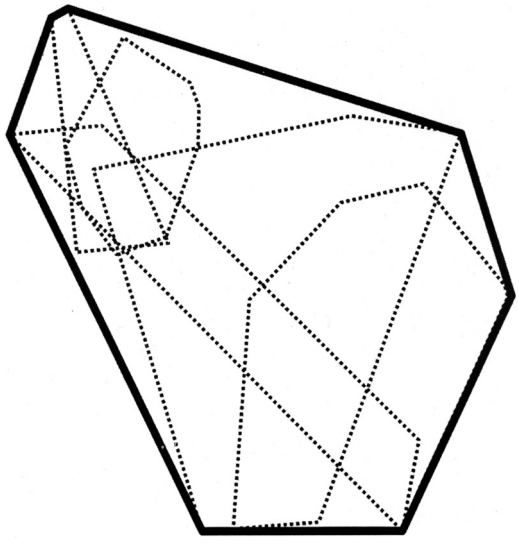

FIGURE 1. Single-year (dashed lines) vs. multiple-year (solid line) home range of Blanding's Turtle 058 male.

Discussion

Blanding's Turtles are experiencing population declines and are presenting management concerns for resource agencies (Grgurovic and Sievert 2005; Kingsbury 2007*). As of 2006, the species was listed as extirpated in three state/provincial jurisdictions; endangered in four; threatened in 10; a species of concern in four; and unprotected in one (Table 1). Destruction of their wetland habitats is a primary cause of such declines, exacerbated by such aspects of their life history as delayed sexual maturity, low recruitment rates, intolerance to accelerated adult mortality rates concomitant to disproportionate rates of gravid female vehicle-caused mortality, and relatively large home range sizes (Congdon and van Loben Sels 1993; Joyal et al. 2001; Steen and Gibbs 2004; Gibbs and Steen 2005; Grgurovic and Sievert 2005). Information on the species' basic needs are vital to restoring or protecting vital habitat for Blanding's Turtles, and it is therefore crucial that data on home range size accurately reflects the species' needs.

Similar to the findings of Grgurovic and Sievert (2005), our Blanding's Turtles displayed significant differences between annual and multiple-year home range sizes. This difference indicates that over their entire life-spans, Blanding's Turtles are undoubtedly using much larger areas than would be revealed in a study of only one or two years' duration. With the exception of Grgurovic and Sievert (2005), we are unaware of any other studies that analyzed long-term differences in home range sizes of individual Blanding's Turtles. Given the long life-spans of Blanding's Turtles, man-

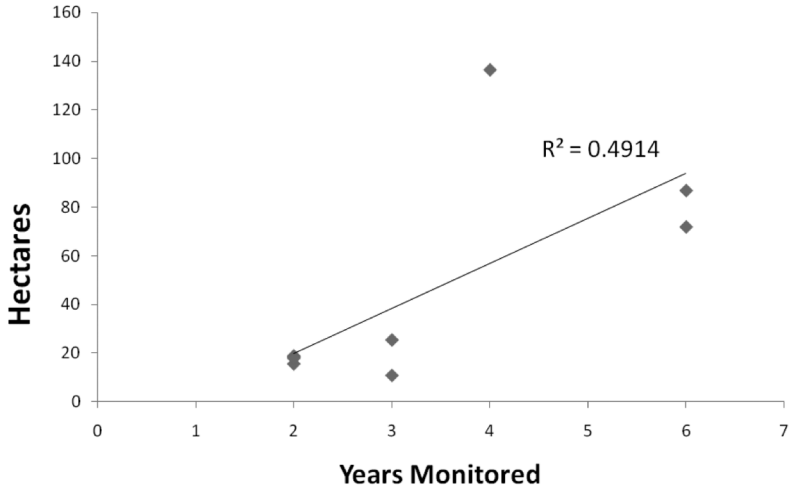

FIGURE 2. Linear relationship of expanding Blanding's Turtle home range size as a function of years monitored.

TABLE 1. Status of Blanding's Turtles throughout the entirety of its range, 2006.[1]

	Current Status of Blanding's Turtles				
State/Province	Endangered	Threatened	Species of Concern	Unprotected	Extirpated
Connecticut					X
Illinois		X			
Indiana	X				
Iowa		X			
Maine	X				
Massachusetts		X			
Michigan			X		
Minnesota		X			
Missouri	X				
Nebraska				X	
New Hampshire			X		
New York		X			
North Dakota	X				
Nova Scotia		X			
Ohio			X		
Ontario		X			
Pennsylvania			X		
Quebec		X			
Rhode Island					X
South Dakota		X			
Vermont					X
Wisconsin		X			
Total	4	10	4	1	3

[1]Kingsbury 2007*

agers should be alert to the duration of spatial studies when using information from such studies in making landscape management decisions that may affect this and other species of long-lived turtles.

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