Does landscape composition determine home range size of Blanding's Turtles, Emyoidea blandingii, in disturbed habitats in Ontario, Canada?

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ABSTRACT

Habitat loss is a major factor in species decline around the world (Venter *et al.,* 2006). Almost all of Blanding's turtle (*Emydoidea blandingii*) habitat in Ontario has some degree of anthropogenic disturbance. To maintain relevant protection criteria for this species at risk, we must investigate what factors influence their home range size. I hypothesized that landscape composition predicts home range size. Using radio telemetry and GPS tags we recorded location data for 39 turtles (33 females, 6 males) from April 2012 to October 2013. I used a multiple linear regression model to show that the proportion of four landscape classes were marginally significant in predicting home range size. There was no significant difference in home range size of males and females. My results suggest that we should be concerned with the conservation of high quality upland areas and wetlands within Blanding's turtles habitat. Landscapes across the province have varying proportions of disturbed areas. Further research could determine at what proportion disturbed environments begin to significantly affect home range size.

Key Words: animal movement, habitat quality, radio telemetry

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1. INTRODUCTION

Increased anthropogenic activity around the globe has resulted in declines in biodiversity (Venter *et al.,* 2006). There are many activities leading to this loss, including introduced species, pollution and overexploitation (Venter *et al.,* 2006). The leading cause of species loss globally and in Canada is habitat loss and fragmentation (Kerr & Cihlar, 2003, Venter *et al.,* 2006). The loss of biodiversity on any and all scales has severe impacts on ecological systems and human lives (Chapin et al. 2000). Areas with less diversity are more vulnerable to takeover by invasive species and are less resilient to damage (Naeem, 2002, Davis, 2003). Habitat protection is extended to those species which are at risk of being lost and this protection must be the best possible. Much of today's landscape has been altered in some way by human development and it is important to know how species will react to these changes. Increased road building may lead to increased mortality and even at a very low rate of mortality, the population size of Blanding's turtles can be impacted severely (Gibbs *et al.*,2002)

Blanding's turtles are found in southern Ontario, western Quebec, Nova Scotia and in the United States (COSEWIC, 2005). We studied an Ontario population of turtles but our results could be applied in other regions. Blanding's turtles are a species at risk in Ontario, Canada who are protected but still live in human altered habitats (COSEWIC 2005). Both degradation and development in wetlands and habitat fragmentation by roads has a large impact on freshwater turtle populations (Burger and Garber, 1995). Gibbs *et al.* (2002) suggests that females are more susceptible to vehicle mortality because of their nesting behaviours. This sensitive species can be used to evaluate how animals use disturbed landscapes so that we may determine how to minimize loss. The province of Ontario recognizes protection 30m from nests and overwintering sites, as well as 30m and 250m around suitable wetlands where there has been an occurrence (MNR, 2013). They have defined these designations based on knowledge of Blanding's turtle habitat and its ability to tolerate alteration (MNR, 2013). It is very important that we have evidence that the species can tolerate disturbance so that we can adjust these regulations accordingly.

Intraspecific variation in animal movements and habitat selection has been studied in many different species (Hu *et al.*, 2013, Bruton *et al.,* 2013). Previous work includes analyses of Blanding's turtles movement within their habitat in different regions as well as the composition of their habitat (Fortin *et al.*, 2012, Millar and Blouin-Demers, 2011). This work includes the analysis of habitat selection of turtles in pristine landscapes (Edge *et al.,* 2010, Millar and Blouin-Demers, 2011). Fortin *et al.*(2012) found that landscape composition significantly influences home range size in Blanding's turtle, however the model explained low proportion of observed variation meaning that landscape composition had a weak effect on movement. There is a lot of variation in the home range size of Blanding's turtles in the literature (Grgurovic and Sievert, 2005, Millar and Blouin-Demers, 2011). Other studies have shown that areas with more wetland are more suitable whereas areas with more roads and cropland are less suitable (Miller *et al.,* 2012).

Previously conducted studies have also looked at how sex, reproductive class, age and body size are related to habitat (Millar and Blouin-Demers, 2011, Millar *et al.,* 2012, Fortin *et al.*, 2012). Fortin *et al.* (2012) found that sex and body size had little influence on home range size. Miller *et al.* (2012) found that reproductive class did influence home range size. Warmer habitats are generally more suitable (Miller *et al,* 2012). Seasonal variation has also been shown to impact turtle movement (Miller and Blouin-Demers, 2011).

Blanding's turtles are a semi-aquatic turtle which means they use land and water in their habitat. Some of these areas include bogs, marshes, forests and soft substrates for nesting. It has been found that they prefer all types of wetlands over all upland areas (Edge *et al.,* 2010). They do require upland regions for certain parts of their lifecycle, including nesting (MNR, 2013). If the immediate surroundings of an animal are very poor quality then they are likely going to travel farther distances to find a landscape in which they can fulfill their ecological needs (Fortin *et al.*¸2012). When animals are required to do this, they have a larger home range size. The presence of anthropogenic disturbances should increase the amount of area used because it reduces the amount of usable habitat. For example, paved roads or buildings do not offer any opportunities for the animal to be protected or feed. In the region I am studying, there are some disturbances but it is relatively pristine.

I am interested by inter-individual variations in home range size in Blanding's Turtles. I have tested the hypothesis that variation in home range size is a function of landscape composition. More specifically, I tested the predictions that 1) turtles in areas that are rich in wetlands (high habitat quality) should have smaller home ranges and 2) turtles that are in areas impacted by humans (low habitat quality) should have larger home ranges. Since sex has been shown (Fortin et al. 2012) to affect home range size, I controlled for the effect of this variable.

2. METHODS AND MATERIALS

2.1 Study Sites

We conducted this study from April 2012 to October 2013. There were three study sites: Site A was 40 km SE of Bancroft, Site B was 40km SW of Bancroft, and Site C was 20km SW of

Bancroft, Ontario, Canada. We chose study sites which were inhabited by at least one male and one female Blanding's turtles because these populations had the potential to reproduce. We also considered the sites to reflect pristine wetlands and land interspersed with areas that had been disturbed in some form, including roads, sand pits and cottages. All three sites have a high density of wetlands. The habitats are spread out well across the study sites so there is not a high risk for a problem with spatial autocorrelation.

2.2 Radio Telemetry and GPS Tracking

We caught turtles before the study period and fit them with a radio transmitter on the back of their carapace using WaterWeld (J-B Weld, 2014). We also fit some turtles with a GPS datalogger (Lotek, 2014). We used Yagi antenna (Lotek, 2014) and a Biotracker receiver (Lotek, 2014) for telemetry. During the initial capture the animals were weighed. We also gave each turtle a notch on the back of their carapace using a file in order to identify them. Sex was determined by plastron concavity in adults. There were no juveniles in the study.

Over the study period, we continuously tracked 39 turtles (33 males, 6 females) using radio telemetry and the GPS dataloggers (bugs). We recorded telemetry locations for each turtle on a 3 or 4 day interval. GPS bugs were used to collect data every hour during the active season (May-October) for up to 18 of the turtles without disturbing the animal. We increased this interval during times of high movement (nesting season) and decreased the interval in mid-summer when there was less movement so that it was more manageable to change the GPS bugs before their battery died. We changed GPS bugs every 4-12 days depending on the frequency of hits. Changing the GPS bugs took less than one minute and we always replaced the animal in the same location. This should minimize the amount of disturbance to the animal. We did not observe any abnormal behaviour after handling the animals. Using a receiver and a Yagi antenna, we tracked turtles in the water or on land to their exact location or triangulation was used if we were unable to come within 1m of the animal. We collected coordinates using Garmin Montana 650, UTM Zone 17 and Zone 18 (Nad83) (Garmin). We conducted telemetry during the winter, about 3 times per turtle during hibernation. At each relocation, we recorded location, type of habitat, any new damage to the turtle that might impact its movement ability, and quality of the equipment.

2.3 Landscape

We determined five categories of landscape representing a range of potential habitat. These categories were Disturbed area, Open water, Stream, Land and Wetland. I created these in ArcMap (ESRI 2012). I drew these polygons based on interpretation of satellite imagery and my experience in the area. Disturbed land included residential and seasonal buildings, roads, hydro cuts, sand and gravel pits.

There are several ways to calculate home range size, including minimum convex polygons (MCPs) (ESRI, 2012) and kernel density polygons (Beyer, 2012). We used a combination of both MCPs and kernels to measure home range size. MCPs can include area that the animal may not use at all and they do not provide information on intensity of use. It has been suggested to use kernels when studying habitat selection even though they can have high amounts of variation (Row & Blouin-Demers, 2006). We used 95% kernels since they had about the same area as the MCP (Row & Blouin-Demers, 2006). We measured the proportion of each land use within each home range in ArcMap (ESRI 2012).

2.4 Modelling

We ran a multiple linear regression with the predictor variables proportion of each stream, land, wetland, disturbed areas and the response variable home range size. The data met assumptions of normality, linearity and homoscedasticity. All analyses and tests were run with R Stats (R Core Team, 2013), we considered tests with $\alpha=0.05$ to be significant. To avoid non-independence within the variables we chose to exclude one variable. There was very little variation in the proportion of open water across home ranges therefore we chose it to exclude. This resulted in a sum of less than 100% for all of the variables. We conducted an ANOVA (R Core Team, 2013) which determined that there was not a significant difference between the home range size of males and females. Therefore we chose to pool the sexes and exclude the factor of sex from the regression.

3. RESULTS

Home range size, proportion of wetland, proportion of land, proportion of stream and proportion of disturbed areas were used in the model. I chose to keep the full multiple linear regression model with a p-value of 0.0876 and a R^2 of 0.207. Proportion of disturbed landscape was the only marginally significant variable in the model ($p=0.0893$). The other three variables were not significant (Table I).

4.DISCUSSION

Most previous research agrees that home range size is influenced by many factors, often including composition (Fortin *et al.,* 2012, Miller *et al.,* 2012). We set out to determine if home range size was influenced by landscape quality. Our results suggest that home range size may be predicted by landscape quality, our results were marginally significant. Our results also suggest that poor quality habitat is the most significant predictor in home range size. Only 20% of the variation in home range size was explained by the model. There are other factors that may have a greater influence on home range size.

Our results suggest that more disturbed areas may lead to larger home range sizes, but more research is needed to confirm this since we only had marginally significant results. One of the reasons for this could be because of the low levels of disturbed area. Our study sites were actually quite pristine. Fortin *et al.* (2012) found that with only 0-11% of the area being disturbed, landscape weakly predicted home range size. In our study sites only 0-6% of the home ranges were disturbed areas. Perhaps, studies with higher proportion of the land disturbed, would find more of an impact on home range size. If there is not an abundance of areas with Blanding's turtles and high proportion of disturbed areas, it would be interesting to know at what proportion of disturbed areas the Blanding's no longer found.

This research was designed to acquire an applicable result for creating protected areas for this species in logging and other resource extraction areas or disturbed areas. The results of the project add to current information that policy makers can use to better predict what areas should be protected.

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APPENDIX

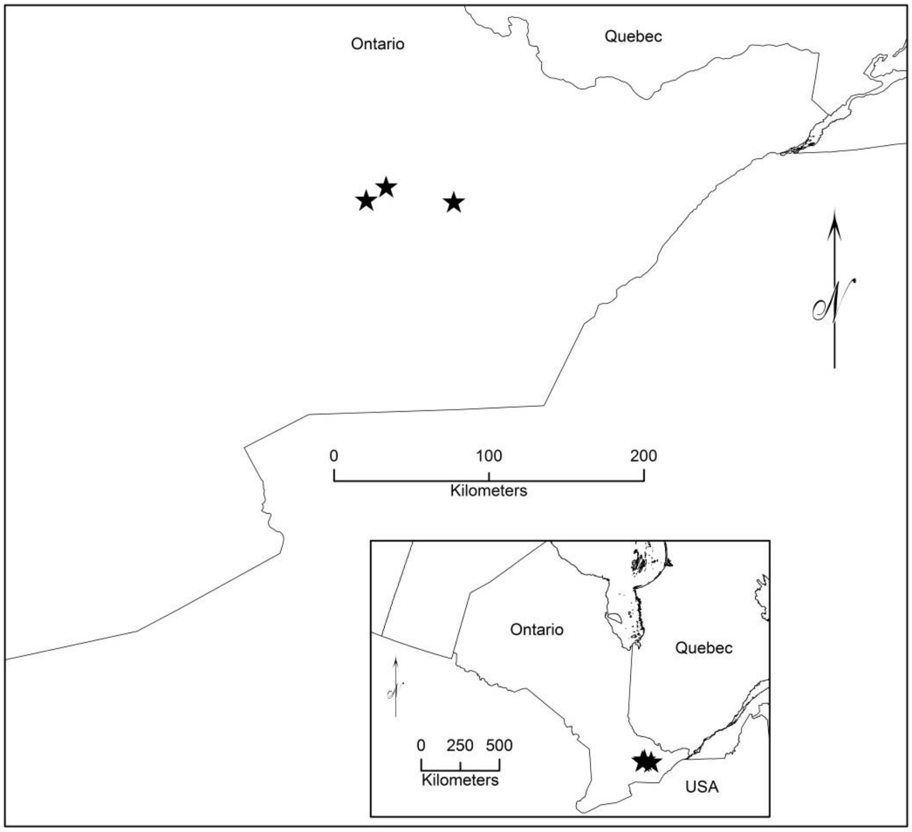

Figure I: Study sites A, B, C near Bancroft, Ontario, Canada.

Variable	p
Wetland Proportion	0.4381
Land Proportion	0.6437
Disturbed Proportion	0.0893
Stream Proportion	0.4381
Full Model	0.0876

Table I: Correlation coefficients of landscape categories, plotted against home range size of Blanding's Turtles (n=39). Full model multiple linear regression with R=0.207.