Protected Areas and the Conservation of Ontario's Reptile Species at Risk: Safe Havens or False Hopes?

J.F. Crowley*[1] and R.J. Brooks[2]

[1]Department of Integrative Biology, University of Guelph
Guelph, ON. N1G 2W1 (519) 780-2466
crowleyj@uoguelph.ca

[2]Department of Integrative Biology, University of Guelph
Guelph Ontario, N1G 2W1
(519) 824-4120. ext. 53944 fax: (519) 767-1656
rjbrooks@uoguelph.ca

* Corresponding author.

Abstract

The potential for protected areas to play a role in the conservation of Ontario's declining reptile species was examined. Road density and protected area size were used as indicators of the ecological integrity of protected areas. Regional land use resulted in a positive correlation between protected area size and latitude, restricting the size of protected areas in southern Ontario where reptile diversity is highest. Road densities within provincial parks were not independent of those in surrounding areas. Conservation reserves were better at minimizing road density but are not found in southern Ontario where most reptiles occur. While some protected areas had no roads, high levels of regional development surrounding these protected areas may still impede their ability to protect reptile populations.

Keywords: *protected area, provincial parks, conservation reserve, reptile, roads, conservation, development*

Introduction

Ontario's provincial parks contribute to the preservation of Ontario's natural heritage and the conservation of ecosystems and wildlife populations. They also provide some of the last remaining ecologically intact refugia for many species in southern Ontario, where intense development has resulted in the loss of most of the natural land cover (Larson *et al.*, 1999). Many of

Ontario's reptile species are found only in the southernmost regions of the province due to climate restrictions and, as such, are especially dependant on what little habitat remains in southern Ontario. High rates of habitat loss and fragmentation in southern Ontario have resulted in the significant decline of reptiles over the past century: 19 of the 26 species of reptiles that occur in Ontario have been listed as "Endangered," "Threatened," or "Special Concern" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Protected areas have the potential to aid in the conservation of reptiles within Ontario by protecting their remaining habitat and eliminating the threats that are causing their decline.

Although Ontario has a vast network of protected areas, simply designating an area as protected does not guarantee the persistence of its species compositions (Stolton and Dudley, 1999; Liu *et al.*, 2001; Chape *et al.*, 2005). If protected areas are not isolated from regional land use, they will be as susceptible to habitat loss and fragmentation as the surrounding area. Road density has been shown to be a good indicator of land use (Rivard and Seaby, 2003; Wilkie *et al.*, 2000); parks with high road densities will be dominated by anthropogenic land uses and retain low levels of residual natural habitat. Roads can also act as a direct indicator of disturbance, and hence habitat quality, because they are associated with a diverse assortment of negative effects on the biological integrity of a region (Trombulak and Frissell, 2000; Forman and Alexander, 1998). Roads also result in habitat fragmentation which reduces effective habitat size and increases the probability of extinction (Fahrig, 2001). As road density is representative of habitat availability, quality, and fragmentation, it provides a good indicator of the ecological integrity of protected areas and their potential to prevent species extirpations.

The purpose of this study was to examine the size and location of and road density within protected areas throughout Ontario to determine their potential to act as a tool for the conservation of reptiles within the province. It was hypothesized that the size and road densities of protected areas within Ontario will be influenced by regional land use. If this is the case, the potential for protected areas to protect species in southern Ontario, where regional development is high, will be severely limited.

Methods

The current provincial distributions of several of Ontario's Species At Risk (SAR) reptiles were determined from historic records, personal communications, government documents, and observation data from the Ontario *Herpetofaunal Summary Atlas*. These species included the Massasauga rattlesnake

(*Sistrurus catenatus*), Eastern hog-nosed snake (*Heterodon platirhinos*), Eastern ratsnake (*Elaphe obsoleta*), Eastern foxsnake (*Elaphe gloydi*), spotted turtle (*Clemmys guttata*), wood turtle (*Glyptemys insculpta*), and the stinkpot (*Sternotherus odoratus*). A 2005 coverage of provincial parks and the most recent coverage of conservation reserves were obtained from the Ministry of Natural Resources Natural Resources Values Information System (NRVIS) database. The provincial road coverage was obtained from GeoBase, a joint federal, provincial, and territorial government data distribution website. These data were prepared by Natural Resources Canada, along with several partners, and include all roads that are at least five meters in width, drivable, and accessible. It should serve as a good indicator of human use and activity as it includes all drivable roads but does not contain old inaccessible roads and trails. ArcView GIS 3.2 was used for all spatial analyses.

Regional road density was calculated as the road density within a 5 km area around each protected area. Regional road density, protected area size, and latitude were log transformed and correlated with each other to determine if smaller protected areas were located in southern Ontario as a result of regional land-use constraints. Road density, as well as the difference between protected area road density and regional road density, was calculated for all protected areas. These data were then grouped based on the protected areas located within each species' distribution in order to determine how effective protected areas are at providing road-free or low road-density areas that would eliminate or reduce the road-associated threats faced by these species.

To test for an influence of regional land use on protected area, (log) road density in protected areas was correlated with (log) regional road density. Another analysis was performed using only protected areas that had lower road densities than the surrounding region so that the correlation would be a reflection of the ability of protected areas to minimize road density independently of regional road density.

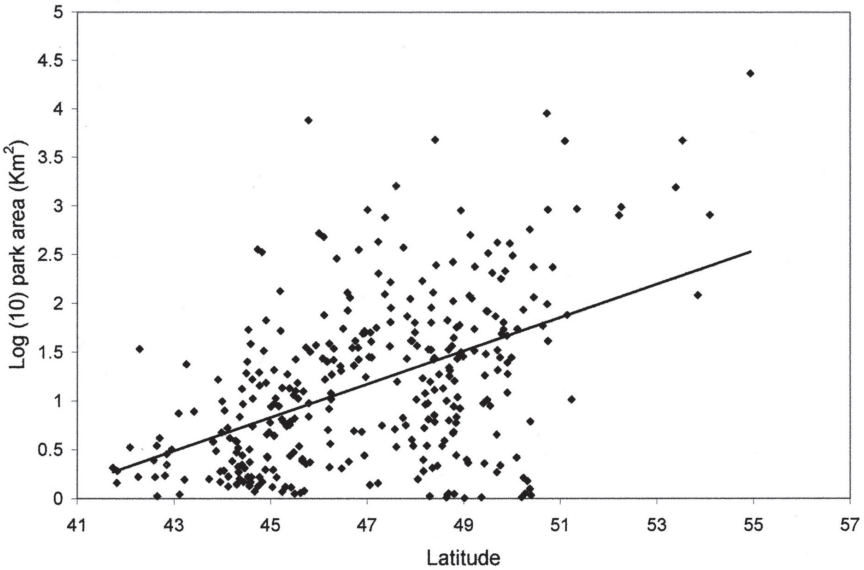
Results

Protected area size increased with latitude (Figure 1 and 2) and this relationship is given by the equations:

$$\text{Log (park area)} = 0.171 \text{ (latitude)} - 6.862 \ (r2 = 0.237, F = 103.447, p < 0.001).$$

$$\text{Log (conservation reserve area)} = 0.141 \text{ (latitude)} - 5.575 \ (r2 = 0.164, F = 54.362, p < 0.001).$$

Figure 1. The relationship between latitude and the size of provincial parks within Ontario.



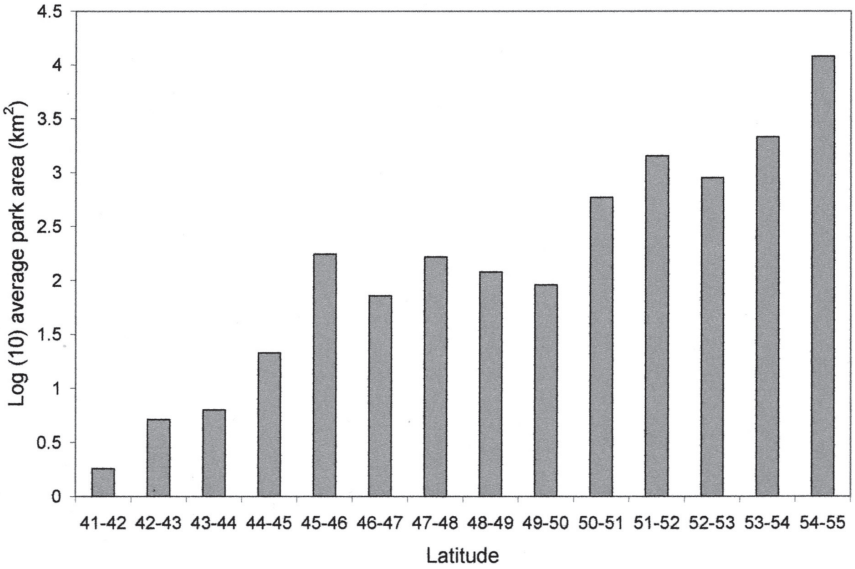
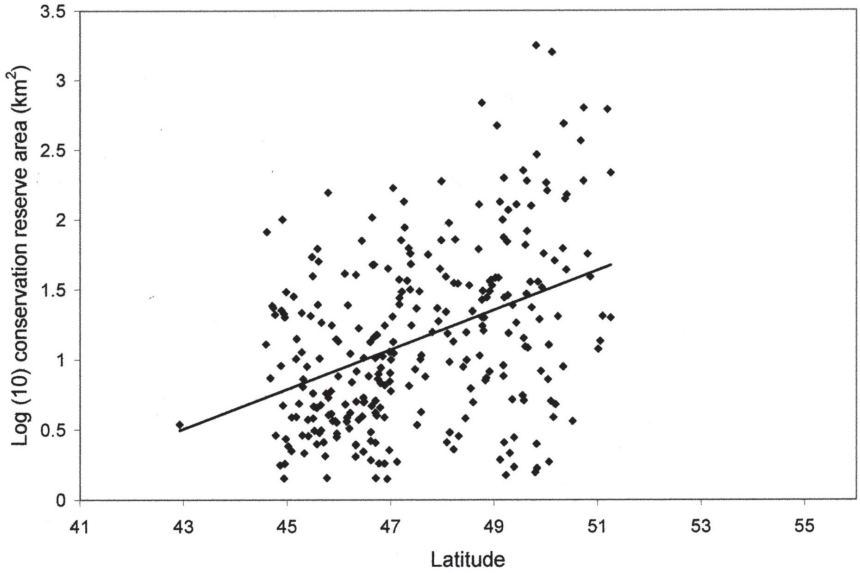
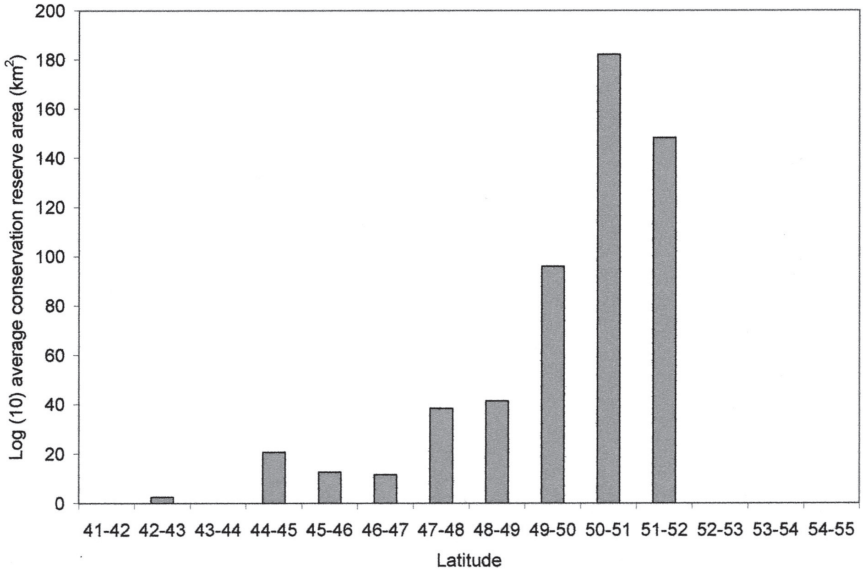


Figure 2. The relationship between latitude and the size of conservation reserves within Ontario.





As Ontario's SAR reptiles are located in the lower latitudes, the average size of provincial parks and conservation reserves found within the distribution of each species is considerably lower than the provincial averages of 233.02 km2 and 51.1 km^2 respectively (Table 1). Provincial parks cover approximately 7.7% of Ontario's land area. While the Massasauga and spotted turtle receive a much higher coverage than the provincial average (18 and 32% respectively), parks only comprise between 2 - 4% of the other five species' distributions. Conservation reserves protect approximately the same proportion of area within the distributions of reptiles as they do provincially (1.4%). However, for most species, the average size of conservation reserves is much smaller than provincial parks and they occupy smaller proportions of each species distribution.

Regional road density surrounding both provincial parks and conservation reserves was negatively correlated with protected area size ($r = -0.451$, $p <$

Table 1. Size and distribution of protected areas within each SAR reptile species distribution.

Species / Size and distribution characteristics	Massasauga	Eastern Ratsnake	Eastern Foxsnake	Eastern Hog-nosed Snake	Stinkpot	Spotted Turtle	Wood Turtle
Number of provincial parks within each species' distribution	21	8	18	60	49	13	19
% of distribution located within provincial parks	18	2	4	3	2	32	3
Average size of provincial parks within each species distribution (km^2)	61.4	13	14.7	24.2	16.6	46.3	87
Number of conservation reserves within each species' distribution	24	0	9	60	23	10	20
% of distribution located within conservation reserves	5	0	2.6	1.7	1	13	1.3
Average size of conservation reserves within each species distribution (km^2)	16.5	0	17.9	14.5	17.7	24.5	13

0.001 and r = - 0.351, p < 0.001, respectively) and latitude (r = - 0.716, p < 0.001 and r = - 0.548, p < 0.001, respectively), indicating that smaller parks are found in the south where regional road density is highest.

Regional road density was positively correlated with road density within provincial parks (r = 0.405, p < 0.001) especially when only parks that have a lower road density than the surrounding area were used (r = 0.495, p < 0.001). Road density within conservation reserves was only weakly correlated to regional road density (r = 0.164, p = 0.003); however, there was a stronger relationship when only conservation reserves with lower road densities than the surrounding area were included (r = 0.351, p < 0.001). Conservation reserves were more effective at providing road-free areas (Table 2).

Table 2. Differences between protected area road density and regional road density in Ontario.

Road density \ Protected areas	Provincial Parks	Conservation Reserves
% of protected areas with 0% of the regional road density	33	61
% of protected areas with less than 50% of the regional road density	35	15
% of protected areas with more than 50% of the regional road density	8	2
% of protected areas with higher road density than the surrounding area	12	3
% of protected areas with no internal or regional road density	12	19

Average road density of provincial parks located within the distributions of Ontario's SAR reptiles was 0.467 km/km^2, which was almost twice as high as the provincial average of 0.246 km/km^2. The proportion of road-free parks within each species' distribution ranged from 0% to 33.5% (Table 3), all of which are below the provincial average of 45%, while 0 to 26% of the parks within each species distribution had higher road densities than the surrounding area. On the other hand, most conservation reserves within each species distribution have few to no roads (Table 4).

Table 3. Difference between provincial park road density and regional road density associated with distribution of several Ontario SAR reptiles.

Road density \ Species	Massasauga	Eastern Ratsnake	Eastern Foxsnake	Eastern Hog-nosed Snake	Stinkpot	Spotted Turtle	Wood Turtle
Number of provincial parks within each species' distribution	21	8	18	60	49	13	19
% of provincial parks with 0% of the regional road density	27.5	12.5	21	30.5	22.5	0	26
% of provincial parks with less than 50% of the regional road density	45.5	75	37	42	47	69	43
% of provincial parks with more than 50% of the regional road density	13.5	12.5	21	13	12	23	5
% of provincial parks with higher road density than the surrounding area	9	0	16	11.5	18.5	8	26
% of provincial parks with no internal or regional road density	4.5	0	5	3	0	0	0

Discussion

Protected areas are often ecologically isolated and the ability of these protected areas to retain their species diversity and composition depends largely on their size (Diamond, 1975; Newmark, 1987). Several studies have supported this claim by showing that rates of extinctions of large mammals are inversely related to park area (Newmark, 1987; Gurd and Nudds, 1999; Grumbine, 1990; Newmark, 1995; Rivard *et al.*, 2000; Wiersma *et al.*, 2003). Park size, therefore, can be considered a direct measure of ecological integrity where larger parks are more likely to preserve the original habitat and species composition. High levels of development in southern Ontario place restrictions on the size of both national (Rivard and Seaby, 2003) and provincial parks and threaten the persistence of reptiles by impeding the creation of large, ecologically-intact protected areas.

Aside from being an indicator of overall ecological integrity, road density has been shown to be a very good predictor of habitat suitability for a

Table 4. Difference between conservation area road density and regional road density associated with distribution of several Ontario SAR reptiles.

Road density \ Species	**Massasauga**	**Eastern Ratsnake**	**Eastern Foxsnake**	**Eastern Hog-nosed Snake**	**Stinkpot**	**Spotted Turtle**	**Wood Turtle**
Number of conservation reserves within each species' distribution	24	0	9	60	23	10	20
% of conservation reserves with 0% of the regional road density	41.5	NA	45	68	48	30	75
% of conservation reserves with less than 50% of the regional road density	46	NA	33	25	43	60	5
% of conservation reserves with more than 50% of the regional road density	0	NA	0	0	0	0	10
% of conservation reserves with higher road density than surrounding area	0	NA	0	0	0	0	0
% of conservation reserves with no internal or regional road density	12.5	NA	22	7	9	10	10

number of species that are adversely affected by human activities including wolves (*Canis lupus*; Thiel, 1985; Jensen *et al.*, 1986), brown bears (*Ursus arctos)* (Clevenger *et al.*, 1997), the moore frog (*Rana arvalis)* (Voss and Chardon, 1998), birds (Gutzwiller and Barrow, 2003) and trout (Baxter *et al.*, 1999). Road density was also related to the extirpation of vertebrates within Canadian national parks (Rivard *et al.* 2000). Specifically, reptiles have been shown to be negatively affected by road mortality (Bernardino and Dalrymple, 1992; Rosen and Lowe, 1994; Ashley and Robinson, 1996), human activity (Cameron and Brooks, 2002; Webb *et al.*, 2002) and habitat loss and fragmentation (Brown, 2001; Rouse and Wilson, 2002). Roads not only result in the direct mortality of reptiles, but open up areas to human activity and are the precursors to anthropogenic habitat loss (Wilkie *et al.*, 2000; Young 1994). Furthermore, regions of high road density have been associated with the extirpations of reptile populations throughout Ontario (Crowley, 2006).

The influence of regional land use on land use within provincial parks, which has also been documented in the case of national parks (Rivard and Seady, 2003; Rivard *et al.*, 2000), results in high road densities in many southern Ontario parks. These high road densities effectively make park boundaries permeable to many of the threats that cause the regional extirpations of reptile populations. This permeability decreases the capacity of parks to protect reptiles, especially those SAR whose distributions fall primarily in such areas. In fact, parks with higher road densities than the surrounding region may result in increased human activity and road mortality and act as regional population sinks.

While conservation reserves may expose reptile populations to fewer threats resulting from roads and human activity, their small size and limited distribution throughout southern Ontario restricts their ability to offer protection to many species. Most species had a very small proportion of their distribution fall within these relatively road-free areas, and the Eastern ratsnake did not occur in any conservation reserves. While the spiny softshell (*Apalone spinifera*), Butler's gartersnake (*Thamnophis butleri*), blue racer (*Coluber constrictor foxi*), and the queen snake (*Regina septemvittata*) were not included in this analysis, it is known that they are found only in southwestern Ontario where conservation reserves do not occur.

Regional characteristics can also directly influence species extinctions in protected areas (Rivard, *et al.*, 2000; Weirsma *et al.,* 2003). In fact, Rivard *et al.* (2000) demonstrated that extinctions within Canadian National parks were more closely related to regional patterns of extinctions than to park characteristics, suggesting that, at least in some cases, parks are not capable of retaining species that are being extirpated from the surrounding region. As a result, even protected areas with low road densities may not be able to protect Ontario's SAR reptiles from the threats associated with high levels of regional development in southern Ontario.

The small size and high disturbance regimes associated with most protected areas in southern Ontario, as well as the high levels of regional development that surrounds them, may result in the inability of protected areas to prevent the further decline of reptiles within southern Ontario. Nevertheless, this potential inadequacy of protected areas to prevent reptile extirpations does not imply that the current system of protected areas is of no value to reptile conservation. Rather, as Nudds (this volume) suggests, it is a first step in the conservation process and provides a unique opportunity to gain a better understanding of the processes that cause extirpations in protected areas.

This information, if incorporated into future planning, would result in continually improving protected areas networks that, over time, will reduce the risk of reptile extirpations and provide a powerful tool for the conservation of reptiles in Ontario.

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