

Modeling Habitat Suitability of the Eastern Hognose Snake in Southern Ontario: Assessing Current and Future Suitability Under an IPCC Projected Emissions Scenario

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Introduction and Content

Among the animal classes, reptiles such as the Eastern Hognose Snake, are the most susceptible to climate change because their bodies are regulated by air temperature. Although some research has been conducted to assess the effects of climate on the Eastern Hognose Snake, there is still a need for further studies in Southern Ontario to understand differences between this snake species in Canada and the USA. Therefore, the overall purpose of this project is to understand how climate change will affect habitat suitability for the Eastern Hognose Snake in Southern Ontario.

Purpose

We used Esri's ArcGIS Pro software to understand the spatial dimension of habitat suitability for the Eastern Hognose Snake in order to visualize the impact of climate change on their habitat. A multi-criteria evaluation (MCE) allowed us to input various environmental criteria that are essential for the snake's habitat, producing an output of suitability scores that indicated which regions of Southern Ontario have the most optimal conditions for Eastern Hognose Snake habitat. Producing these results under current and projected climatic conditions derived by the IPCC provided insight into how habitat distribution would be altered in the future. The projected climate scenario, called the RCP 4.5, models a moderate emissions scenario (IPCC, 2021).

Methods

Three steps on how we used an MCE to create a habitat suitability model for the Hog-nosed Snake that assigned suitability scores, considered environmental conditions in Southern Ontario:

1. Identify the factors and constraints that contribute to a suitable habitat for the Eastern Hognose Snake.
 - a. These criteria included low mean annual precipitation, high mean annual temperature, sandy soils, proximity to bodies of water, and ideal land cover, while avoiding roads entirely.
2. Standardize the criteria and develop a habitat suitability model using a weighted MCE based on the factors and constraints identified in Step 1.
3. Determine the current and future impacts of climate change on the Eastern Hognose Snake habitat using current and projected climatic variables derived from the IPCC in the model, and then compare the results.

Results and Discussion

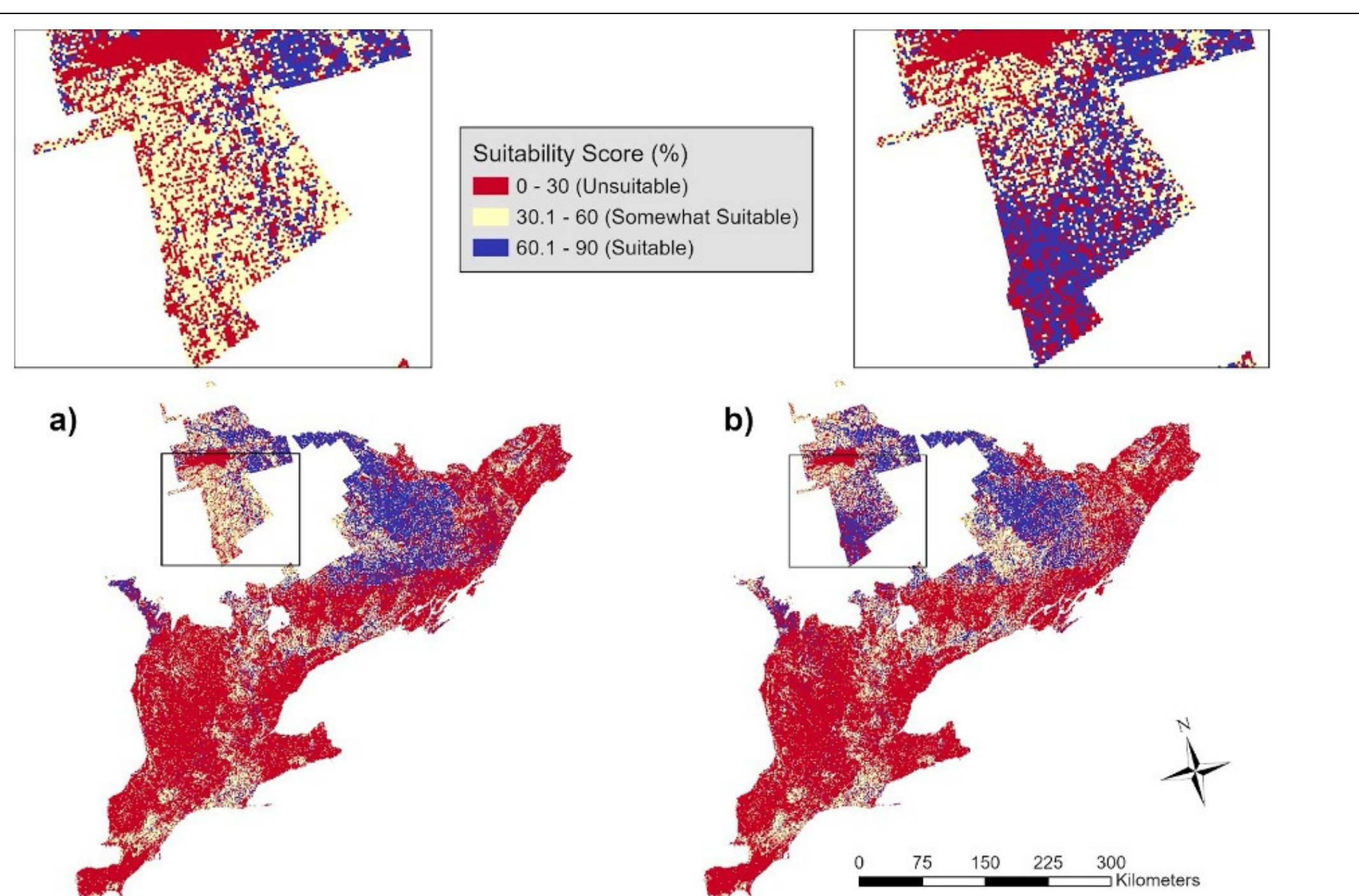


Figure 1: Map of suitability scores for the a) current climate scenario, and the b) future climate scenario.

The highest suitability score for Eastern Hognose Snake habitat in Southern Ontario was ~86% under the current climate scenario (Figure 1a), and ~87% in the future climate scenario (Figure 1b). Zoomed in extents of the Parry Sound region at the top of the figure help to visualize some of the changes in suitability over time. There is a concentration of suitable sites in the northern region of our study area, while most of the southern half of Southern Ontario is unsuitable (Figure 1).

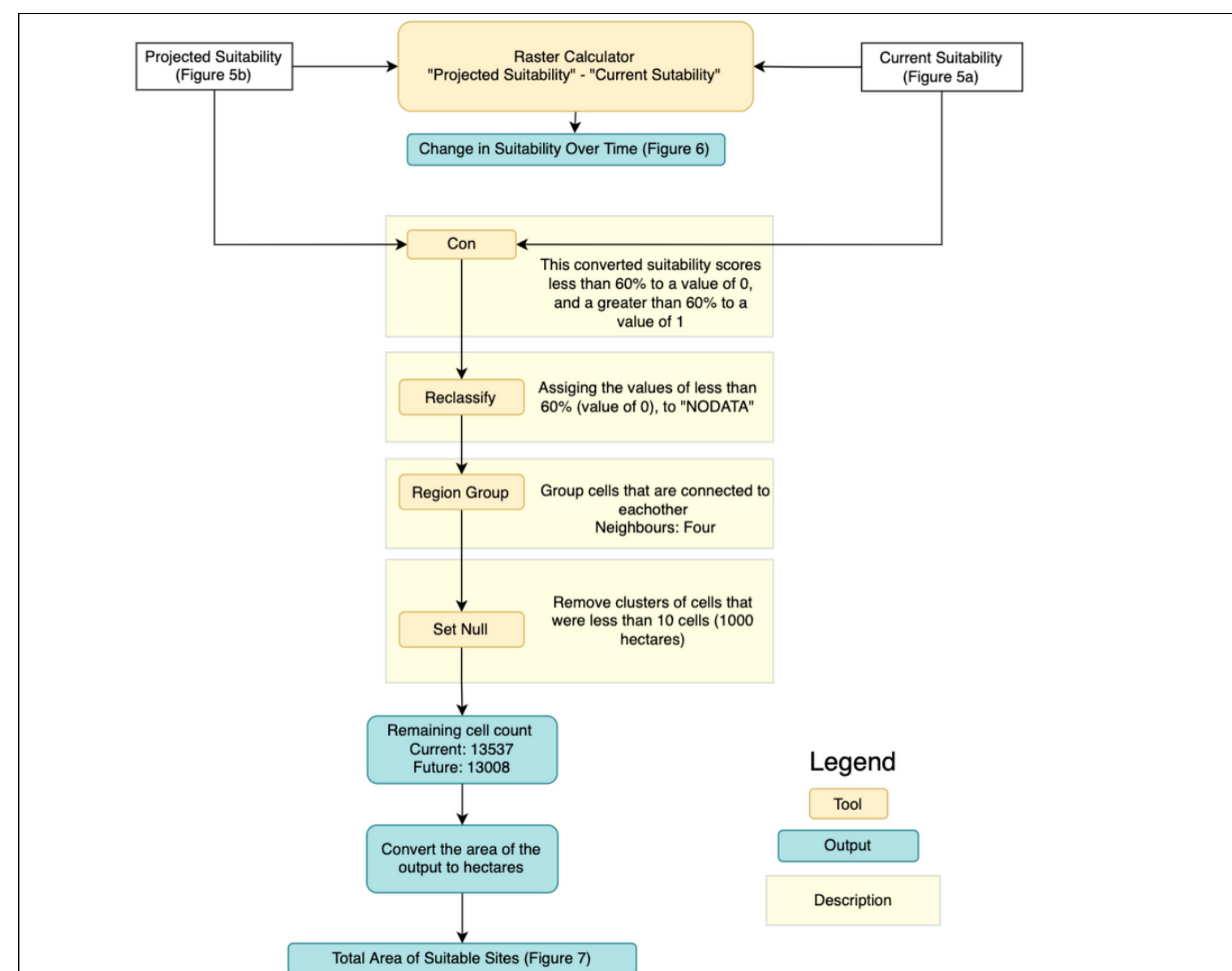


Figure 2: Flowchart outlining the steps taken to find changes in the suitability scores over time (Figure 6 in the report) and the difference in total area of suitable habitat between climate scenarios (Figure 3).

To gauge how the availability of suitable habitat would be impacted by climate change, we found the total area of suitable habitats that were at least 1000ha. Essentially, we isolated all cells with a suitability score above 60%, removed any clusters of data that were smaller than 1000ha, and then added up the area of the remaining data.

Limitations of the MCE

Considering we could only use open-access spatial data, we had to work around the limitations of this data. Soil texture data was missing from a large area including Algonquin Park and the region south of it. Since soil texture was weighted as the most important habitat criterion along with land cover type, we could not consider this region in our model. The current and projected temperature and precipitation data we used contained mean values for two 19-year periods, 2001-2020 for the current model and 2041-2060 for the future model. Averaging temperature and precipitation data over a 19-year interval removed any short-interval fluctuations in data and only gave us a general idea of current and future climatic conditions.

Conclusions and Future Considerations

We ran two habitat suitability models using MCE with weighted habitat criteria and climatic conditions for the present and the future, assuming climate change would alter suitability between these time periods. Total suitable habitat area decreased by ~53,000ha in the future, suggesting the Eastern Hognose Snake will have a harder time finding habitat as the climate continues to change.

Furthermore, the limitations of our project indicate that further research needs to be done to holistically encapsulate the habitat needs of the Eastern Hognose Snake now, and in the future when climate change has further progressed. Anthropogenic disturbances should also be studied, as Southern Ontario's population is projected to increase in the future (Ontario.ca, 2021)

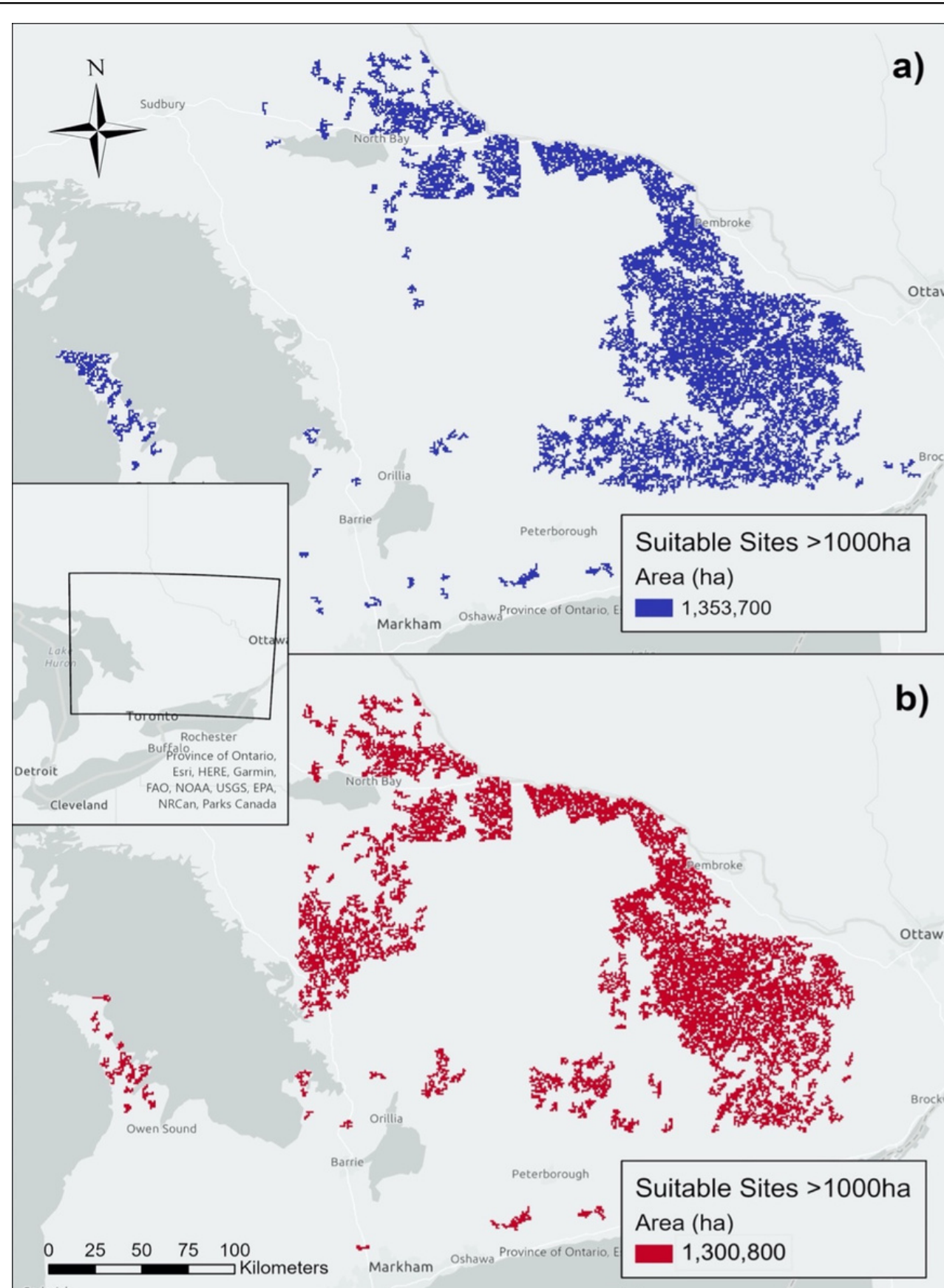


Figure 3: Map showing the combined area of all suitable habitat sites (suitability score >60%) that are at least 1000ha for the a) current climate scenario and the b) future climate scenario.

To understand how the amount of suitable habitat differed over the 20-40 years between climate scenarios, we isolated all suitable sites (suitability score >60%) that were 1000ha or greater, and then calculated the combined area of these sites (Figure 3). Combined suitable habitat area was 1,353,700ha for the current climate scenario (Figure 3a), and 1,300,800ha in the future climate scenario. Visible changes between the two climate scenarios can be seen in Figure 3.

References

IPCC. (2021). Climate change widespread, rapid and intensifying - IPCC. Retrieved from <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>

Ontario.ca. (2021, August 12) *Eastern Hognose snake*. ontario.ca. Retrieved January 28, 2022, from <https://www.ontario.ca/page/eastern-Eastern-Hognose-snake>