Assessing the Potential Impact of Bill 23 on Blanding's Turtle Habitat in Southern Ontario

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Abstract:

Ontario's Bill 23, passed in November 2022, eliminates, and restricts environmental protections against urban sprawl. The impacts of Bill 23 will affect all wildlife, agricultural lands, protected environments, and urban developments in Ontario, though its impact has yet to be modeled. The endangered Blanding's turtle (*Emydoidea blandingii*) is highly susceptible to road mortality, habitat loss, and pollution, protection against which has been reduced or eliminated by Bill 23. Here, we model suitable Blanding's turtle habitat and urban development land in Southern Ontario with Multi-Criteria Evaluation Models. The Blanding's turtle model uses the turtles' preferred habitat qualities, and the urban development model uses provincial recommendations for site suitability. Highly suitable development locations coincide with highly suitable Blanding's turtle habitat in many instances. The potential developments permitted by Bill 23 directly impact 21% or 31517 hectares of suitable Blanding's turtle habitat in Southern Ontario, with a potential for even higher downstream impacts. Bill 23 threatens Blanding's turtles and other species at risk with extinction or extirpation and should be re-evaluated or revoked.

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Introduction

Bill 23, the “More Homes Built Faster Act, 2022” was passed in November 2022 (GO_d, 2022). This bill includes modifications to several sections of the Planning Act (GO_a, 1990) and the Conservation Authorities Act (GO_b, 1990), eliminating and restricting environmental protections (such as the Greenbelt Act (GO_c, 2005)) against unsustainable urban sprawl developments that may cause damage to habitats and water systems (Golba et al., 2022). The impacts of Bill 23 will affect all wildlife, agricultural lands, and protected environments in Ontario.

Our project focused on Blanding's turtles (Emydoidea blandingii), a freshwater semi-aquatic turtle with a recognizable domed shell and bright yellow jaw. They are one of eight native turtle species in Ontario and are currently listed as endangered through their range (Environment Canada, 2016). Though Blanding’s turtles do not fill a keystone niche, their designation as a Specially Protected Reptile under the Ontario Fish and Wildlife Conservation Act protects known habitats and all of the species that live therein, making these turtles important to locate and conserve (GO_e, 1997). Many of the factors contributing to the decline in their populations relate to their high susceptibility to habitat loss, alteration, and pollution, along with increased rates of road mortality caused by urbanisation (Environment Canada, 2016). While many species would be able to bounce back with proper care, Blanding’s turtles have a very slow maturation rate, only reaching sexual maturity between 14 and 20 years of age (Congdon et al., 1993). This period lengthens in colder climates such as Ontario’s (Litzgus et al., 2011). Additionally, mature female Blanding’s turtles only produce a clutch of eggs (4 - 20 eggs) every 1 to 3 years with temperature-dependent sex determination limiting how many will become female (Heppell, 1998). The successful hatchlings are further constrained due to survival rates for hatchlings (0 yrs) being 0.261, juveniles (1-3 yrs) 0.783, subadults (7 - 13 yrs) 0.783, and adults 0.960 (Heppell, 1998). This endangered species requires a lot of time to replace itself in the population due to low hatchling survival rates and is likely to be severely impacted by the urban sprawl intended to result from the implementation of Bill 23, as more habitat is lost and even fewer individuals survive to maturity.

The known extent of research on Blanding's turtles included factors that determine suitable habitat, the optimal regions for recovery and conservation, the impact of connectivity, biological traits, and survival likelihoods of Blanding's turtles. Ontario's Recovery Strategy identified the important regional extents and features, threats leading to population decline, and suggested actions to promote the population to healthy numbers (Environment Canada, 2016). Stryszowska et al. (2016) ran several models from populations in the United States comparing different modelling techniques to observational data to create predictive habitat models that provide evidence of which factors are highly correlated with good habitat and which are less important. Many studies examined Blanding's turtles' biological traits and lifestyles, qualifying their needs and quantifying their demographics and survival likelihoods (Congdon et al., 1993; Heppell, 1998). In New Hampshire, Walston et al. (2015) conducted a study to determine the spatial ecology factors that impact Blanding's turtles' movement, including the sex-based vulnerability to roads due to gravid females' movement patterns. They used connectivity modeling to look at the pathways and corridors through protected habitats and greenspace that Blanding's turtles can use to migrate and move across habitat range. In the USA, Hamilton et al. (2018) found that the turtles' populations might move too slowly and eventually get caught in climate changed-caused unhabitable zones as their optimal temperature range shifts. Mui et al. (2017) evaluated three connectivity approaches and estimated the fragmentation due to agriculture of overland movement routes and the importance of migration movement for the turtles over two seasons. Head start programs in Canada and the USA have run suitability habitat models and determined the most optimal and essential habitats for conservation and restoration of Blanding's turtles with detailed population and observational data, but they are not publicly available in order to shield the species from threats such as poaching by protecting habitat location information (Golba et al., 2022; Green, 2015).

Given that Blanding's turtle habitat suitability in Ontario is privately well studied, the project's focus relates to the threat of development to and around Blanding's turtle habitat. This is a crucial problem to study due to the forecasted impact of Bill 23 and its future implications on previously protected and development-restricted lands (Crombie

et al., 2022). On that account, this project focused spatially on the Greenbelt and land previously protected by the Greenbelt Act (GO_c, 2005) and the Conservation Authorities Act (GO_b, 1990). However, all Southern Ontario was assessed in our Blanding's turtle habitat suitability map. Since the locations of the areas to be developed under Bill 23 are currently unknown, this project will consider the targeted hypothetical locations through a simple development suitability map. In this suitability map, a speculative map of suitable Blanding's Turtle habitat affected by development will be determined.

Research Objectives

The following are our project's outlined objectives for the evaluation of this problem:

Objective 1: Identify factors and constraints important for Blanding's turtle habitat from the literature and collect data.

Objective 2: Build and run Multi-criteria Evaluation Model based on the factors and constraints important for Blanding's turtle habitat. Classify the model into suitable areas: high, medium, and low suitability; and unsuitable areas.

Objective 3: Identify basic factor and constraint requirements needed for development sites from provincial/municipal guidelines and mandates.

Objective 4: Build and run Multi-Criteria Evaluation Model to predict potential development sites within our study area. Determine most suitable locations and overlay with the categorized Blanding Turtles suitable habitat map to analyze the coincidences and impact.

Study Area

Our area of interest for this study is Southern Ontario as defined by Figures 1 and 2. We chose this area because it contains the Ontario Greenbelt and the other protected areas that are covered by the Greenbelt Act (GO_c, 2005), in which various regions are sanctioned by Bill 23 for development (GO_d, 2022). Southern Ontario has a high clustering of recorded Blanding's turtle observation data which is collected through citizen science and research projects that are compiled by the Global Biodiversity Information Facility (GBIF, 2022). While our study area covers a substantial portion of the Blanding's turtle population extent in Ontario, it does not represent their full range across Ontario and instead is a subset of their range throughout Canada and the United States (Environment Canada, 2016). Furthermore, Southern Ontario is composed of important tributaries, wetlands, marshes, and inland ponds along with cropland, deciduous forests, and pasture which are important semi-aquatic and terrestrial elements that Blanding's turtles need for appropriate habitat (MNRF Ecoregions, 2022; Fyson and Blouin-Demers, 2021; Walston et al., 2015). Being semi-aquatic, it is important for their habitat to have access to wetlands and surrounding terrestrial habitats that are undisturbed forests or grasslands, not urban areas (Fyson and Blouin-Demers, 2021).

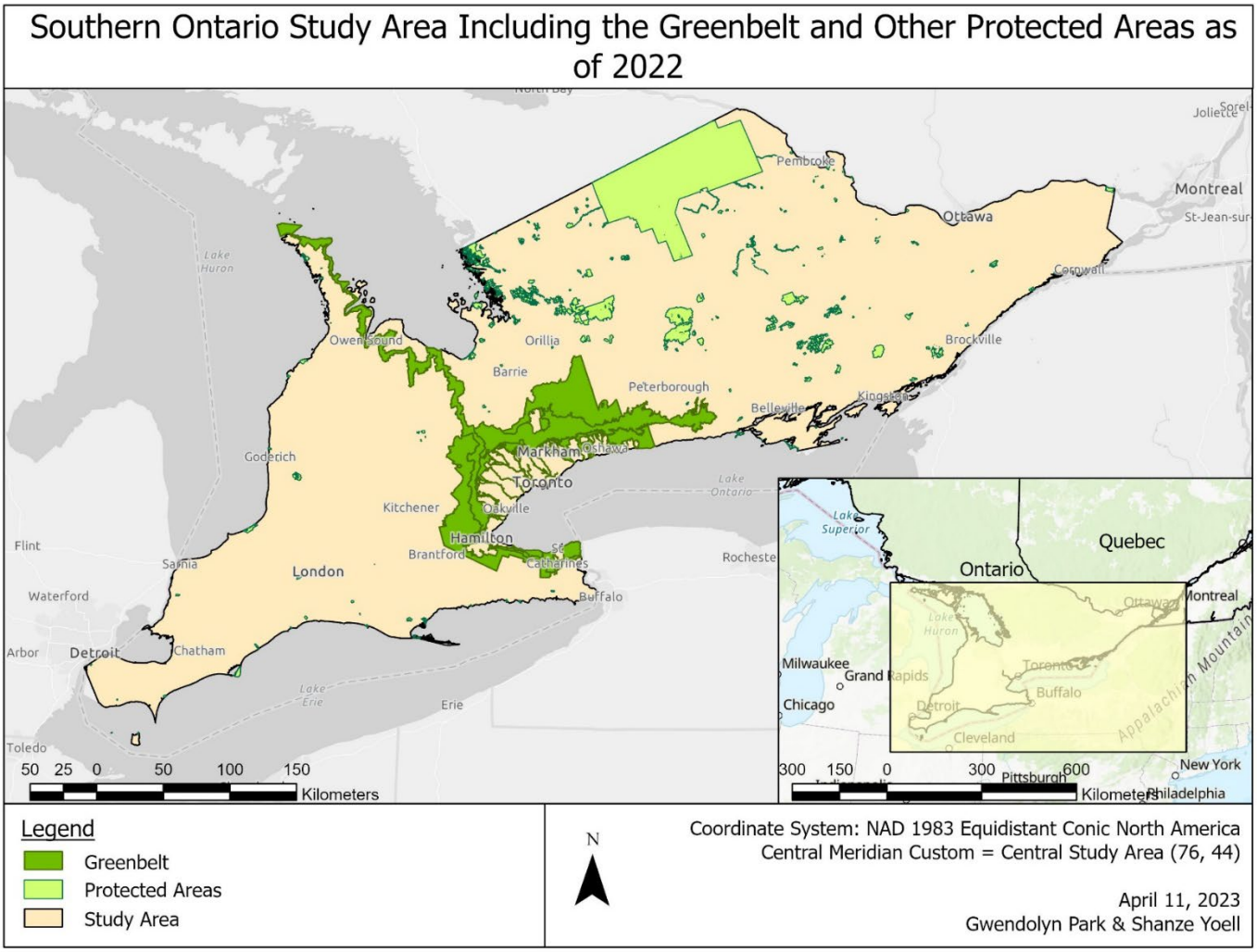

Figure 1: Study area with protected areas

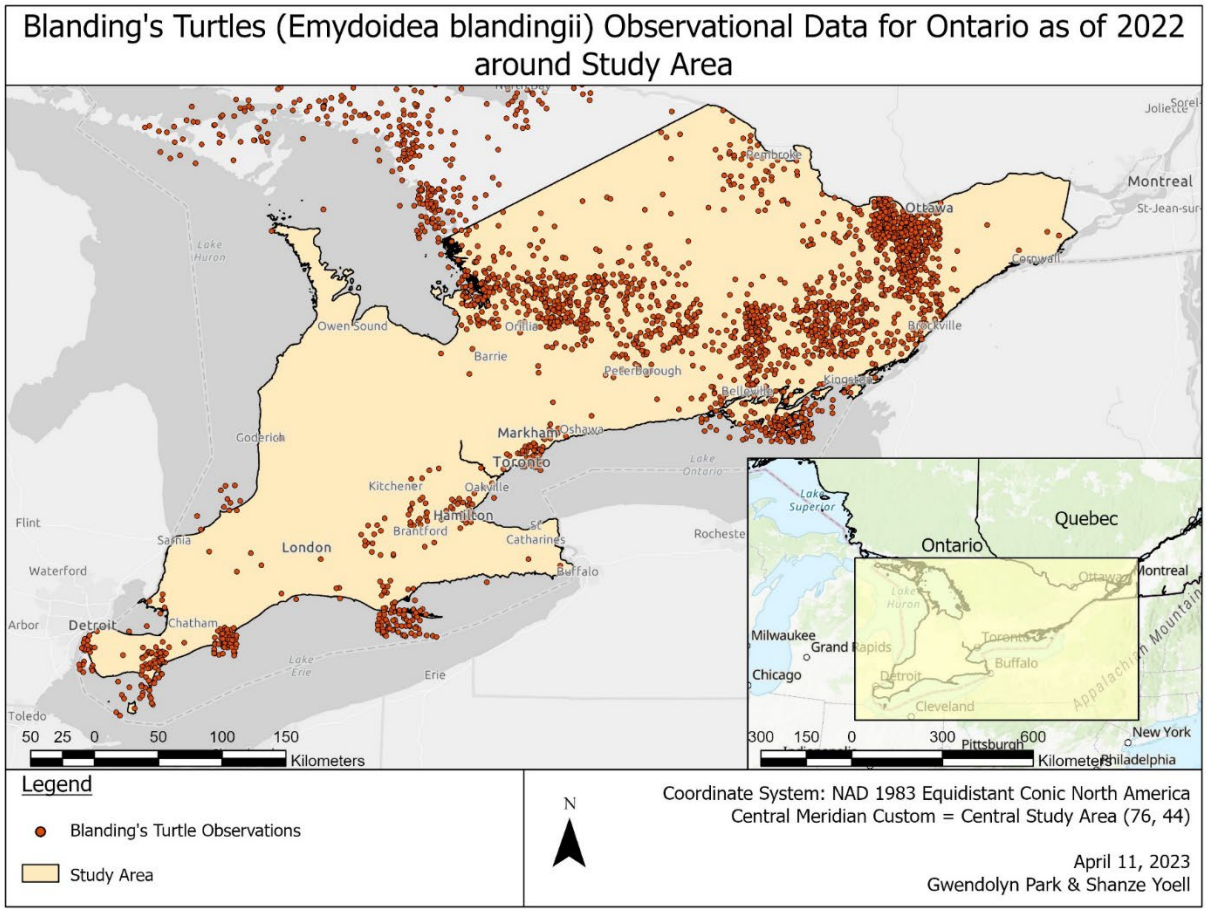

Figure 2: Study area with Blanding's turtle observations

Data Source

The data chosen to define the boundaries of our study area (**Table 1)** were primarily based on the location of the Greenbelt, Blanding's turtle observation clusters, and Southern Ontario's ecoregions. The locations of conservation areas and other protected areas impacted the choice of study area as well, as they continue to provide protected habitat for Blanding's turtles.

Many of the utilized datasets (**Table 2)** were required for the factors and constraints identified as important for suitable Blanding's turtle habitats for our Multi-Criteria Evaluation Model (MCE). A study by Markle and Chow-Fraser (2014) provided insight into identifying important habitat for nesting, overwintering, and breeding. They

noted a positive correlation with proximity to beaver dams for successful Blanding's turtle habitat, suggesting commensalism in their coexistence with beavers (Chow-Fraser and Markle, 2014). We chose to prioritize the habitat specifications preferred by gravid (egg-carrying) females, as male, immature, and non-gravid female Blanding's turtles' habitats fall within the gravid females' range (Hamilton et al., 2018). These habitats require specific conditions and types of land cover, including ephemeral and permanent bodies of water, upland forest, agricultural cover, and grassland cover (Environment Canada 2016). Additionally, other studies have identified steep slopes, the presence of roads, railroads, trails, and urban landcover as factors that have negative impacts on the suitability of the habitat (Environment Canada, 2016; Stryszowska et al., 2016; Waltson et al., 2015).

The remaining datasets were chosen for our simple development MCE **(Table 3).** While knowing which specific regions will be planned or allocated for development in accordance with Bill 23 would be optimal for impact analysis on Blanding's turtle habitat, there is an absence of published data on these areas. We defined a very simple development area predictive Multi-Criteria Evaluation Model through reviewing the MMAH (Ministry of Municipal Affairs and Housing) Site Plan Control Guide*,* which contains recommendations for developments (MMAH, 2022). These included proximity to existing utility lines, waste facilities, major cities, and access to major roads. Development constraints eliminated regions of water bodies, existing developments, slopes of 11° or steeper (City of Ottawa, 2013), and regions outside the study area.

Table 1. Study Area Data Sources

Data	Source	Measurement & Resolution	Description
Blanding's Turtle Observation Points	Global Biodiversity Information Facility	Not Listed	Observational data for Blanding's turtle sightings in Ontario from 2015-2022. Has geographical location based on iNaturalist and other research-grade observation datasets compiled into Holbrook 1838
Greenbelt	Ontario Ministry of Municipal Affairs and Housing	Not Listed	Represents the current extent of Ontario that was protected under the Ontario Greenbelt Act.
Ontario Boundary	Government of Canada	Not Listed	Provincial land boundaries with province labels.

Table 2. Turtle MCE Data Sources

Data	Source	Measurement & Resolution	Description
Wetlands	Ontario Ministry of Natural Resources	Variable accuracy, 99% within 50m, 25% within 10m	Provides a spatial representation and attribute information for Ontario wetlands.
Beaver Dam Locations	Ontario Ministry of Natural Resources	Accuracy ± 5m	Spatial location of beaver dams in Ontario as of 2015.
DEM of Ontario	Ontario Ministry of Natural Resources	30x30m Accuracy ± 5 meters	Digital Elevation model of Ontario raster mosaiced tiles for Southern Ontario and transformed to slope parameters.
Roads	Ontario Ministry of Natural Resources	Accuracy ± 10 meters	Line shapefile containing major and secondary highways along with urban and country roads covering southern Ontario.

Data	Source	Measurement & Resolution	Description
Land Cover (SOLRIS 3.0 and Ontario Provincial Landcover)	Science and Research Branch, Ministry of Northern Developments, Mines, Natural Resources & Forestry and Land Information Ontario	0.5 ha and 15x15 meters	Raster classified into landcover type with 27 (Provincial Landcover) and 250 (SOLRIS). Focus on **Undeveloped land** for the grasslands (tail grass-wood, prairie, savannah) and upland forested areas. As well as **Urban Areas** such cities, neighbourhoods, commercial areas.
Regulated Provincial Parks	Ontario Ministry of Natural Resources	Not Listed	Areas of protected greenspace including provincial parks, conservations, and wildlife reserves that provide habitat stability.
Temperature Data	Department of Environment and Natural Resources	By station	Monthly averages of temperature data from various stations ranging over Southern Ontario.
Trails	Ontario Ministry of Natural Resources	Positional accuracy ± 500 meters	Trail segments defined as a line feature for a linear corridor through the environment used for hiking, biking, ATV, horseback riding, or snowmobiling.
Railroads	Ontario Ministry of Natural Resources	Accuracy within 10 Meters	Line feature representing the Ontario Railway Network train tracks.
Agriculture Cover	Agriculture and Agri-Food Canada (AAFC)	Accuracy 30 m	Categorized annual crop inventory raster for Ontario containing various agricultural fields (crop, livestock, orchards, etc).

Table 3. Development MCE Data Needs

Data	Source	Measurement & Resolution	Description
Hydro Lines	Ontario Ministry of Natural Resources and Forestry	Horizontal: +/- 10 m Vertical: +/- 5 m	Utility lines (hydro, communication, internet, sewage, etc.) cover Southern Ontario and supplies current infrastructure.
Waste Management Sites	Land Information Ontario	Not listed	Spatial point feature of municipal waste facility infrastructure.
DEM of Ontario	Ontario Ministry of Natural Resources	30x30m Accuracy 5 meters	Digital Elevation model of Ontario raster mosaiced tiles for Southern Ontario and transformed to slope parameters.
Roads	Ontario Ministry of Natural Resources	Accuracy within 10 meters	Line shape file containing major and secondary highways along with urban and country roads covering southern Ontario.
Landcover (SOLRIS 3.0 and Provincial Landcover)	SRB, Ministry of Northern Developments, Mines, Natural Resources & Forestry and Land Information Ontario	0.5 ha and 15x15 meters	Raster classified into landcover type with 27 (Provincial Landcover) and 250 (SOLRIS). Focus on **Urban Areas** such cities, neighbourhoods, commercial areas and waterbodies.

Methods

Our first objective was to identify the factors and constraints important for Blanding's turtle habitat and collect the relevant data. We read research papers and recovery strategies to understand Blanding's turtles' habitat requirements and condition preferences. Once the factors were collected, we compiled relevant open-source data, and preprocessed it using ArcGIS Pro software. This included reprojecting the data to NAD 1983 Equidistant Conic North America projection with the central meridian at latitude 76° and longitude 44°. The data was then clipped to our study extent, examined

for errors and inconsistencies, and transformed to 25x25 m raster cells, the finest common spatial resolution.

Next, the preprocessed data were categorized into constraints (Boolean suitable or unsuitable) and factors (relative weightings based on the impact on suitability). The constraints were standardized with a value of suitable (1) or unsuitable (0) areas (Appendix 1a). These were multiplied together using a raster calculator to determine possible Blanding's turtle habitat limits as shown in the workflow chart (**Figure 3)**. Each factor was standardized on a common scale of 0 to 100. The factors relating to proximity used a reclassification of Euclidian distance. Beneficial proximity used 100 within or closest to the factor, whereas costs used 0 within or closest to the factor. Factors relating to specific land types were reclassified to the common scale where the most beneficial were valued at 100 and decreased depending on importance.

In fulfilling Objective 2, the factors were weighted by importance using Saaty's pairwise confusion matrix. All factor weights were placed on a scale between 0 and 1 with a final total equal to 1.0 (Appendix 1b). Once all weighting tables were calculated and verified, the standardized datasets were input into the MCE Model tool in ArcGIS Pro. The outputted suitability raster was evaluated for errors in logic, inputs, and readjusted to check for factor sensitivity. Following the suitability model, a new map was created to classify the outputs into high, medium, and low suitability and unsuitable habitat (≥50%, ≥65%, ≥80%, and ≤50%) (Figure 4).

For objectives 3 and 4, we defined a simple development prediction MCE Model to examine the impact that development would have on suitable Blanding's Turtle habitat which infers the impact of future Bill 23 developments. Following a literature review, we defined constraints and factors that are important for what plots of land are more suitable for development than others (MMAH, 2022). With these factors and constraints, we performed the same preprocessing, categorization, and weighting steps as for the Blanding's turtle habitat MCE (Appendix 2a, b). The factors and constraints were input into our Development MCE Model. It was examined for errors in logic and input. Following the suitability model, a new map was created by selecting for pixels

with a suitability of ≥90%. Four regions of high suitability clustering were selected to compare against the Blanding's turtle habitat suitability classes for further analysis: Essex, Hamilton, Simcoe, and Renfrew-Ottawa regions.

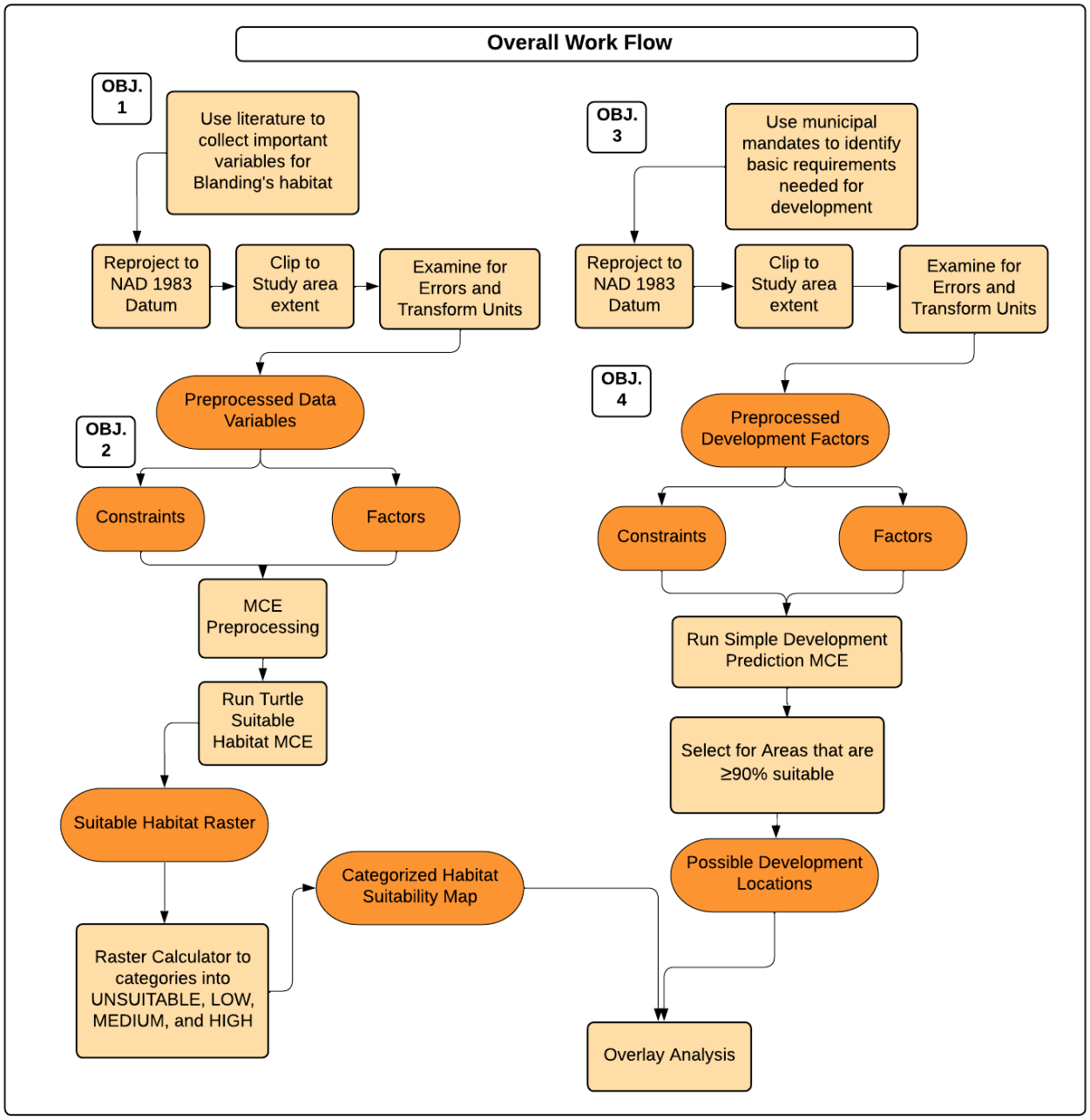

Figure 3: Workflow chart of objectives 1-4

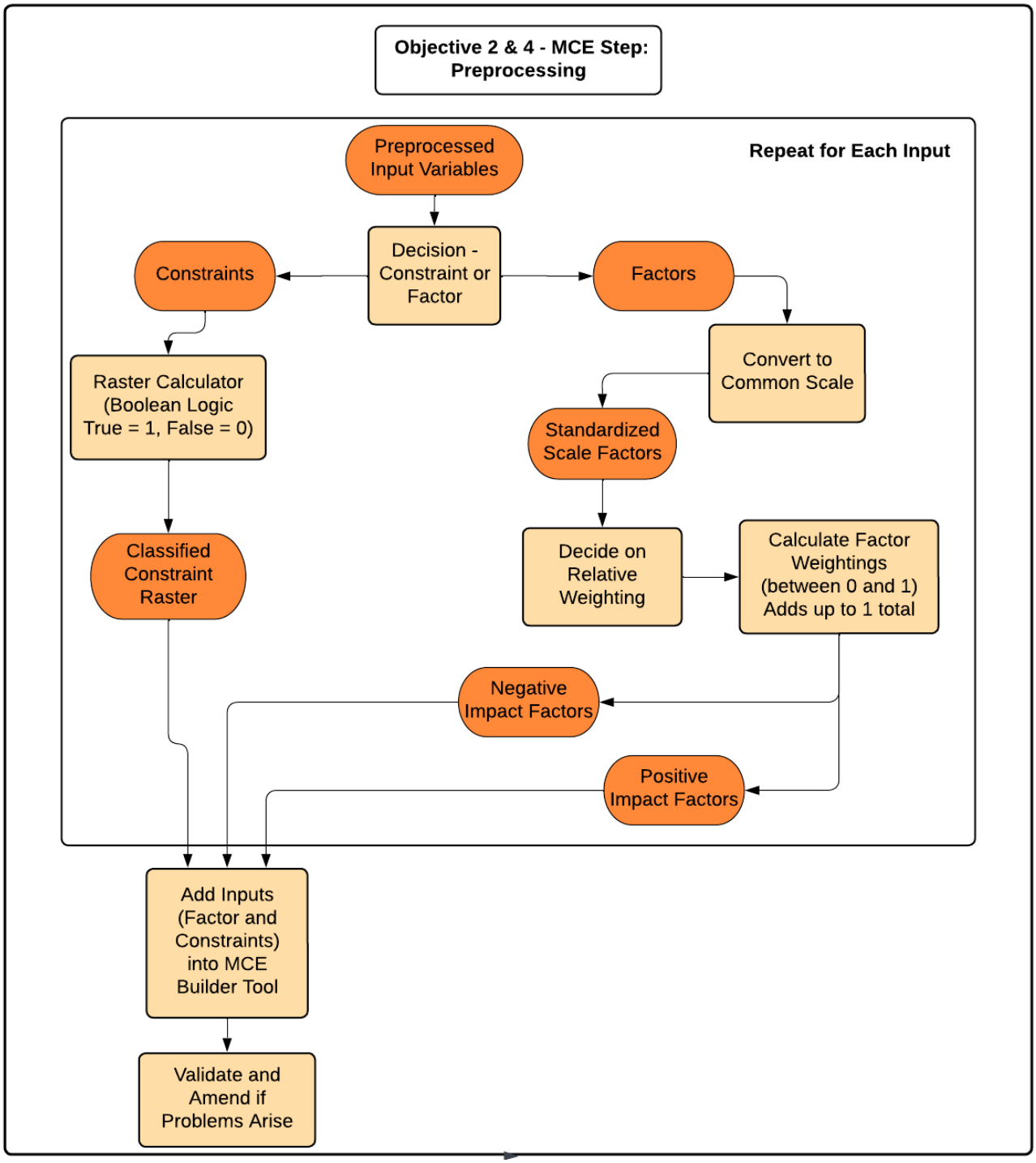

Figure 4: Workflow call out of objectives 2 & 4

Results and Discussion

The results of the Blanding's Turtle Suitability MCE (Figure 5) indicate suitability. These are visually corroborated by the concentrated areas of Blanding's turtle observations. However, there is a noticeable difference between some regions of suitable habitats and observed Blanding's turtles.

The discrepancy between suitable habitats and observation data may be explained twofold. The observation's bias for urban locations and open-source input reflects the greater likelihood of a Blanding's turtle being spotted and reported several times in populated urban areas. As well, our MCE modelled the most suitable and safe locations. Urban areas isolate Blanding's turtles, restricting their movement and increasing risks of road and urban mortality. Blanding's turtles in an urban area may have no way of finding safer, more suitable habitats or returning to their habitual environments and thus may remain in the urban setting despite the danger. Further research in this area could identify methods or factors that increase the safety and suitability of urban or suburban regions for conservation and species recovery.

The habitat suitability (Figure 6) categorized into low (50-65%), medium (65-80%), and high (≥ 80%) indicate the regions in which Blanding's turtles would be reasonably safe by our MCE's standards.

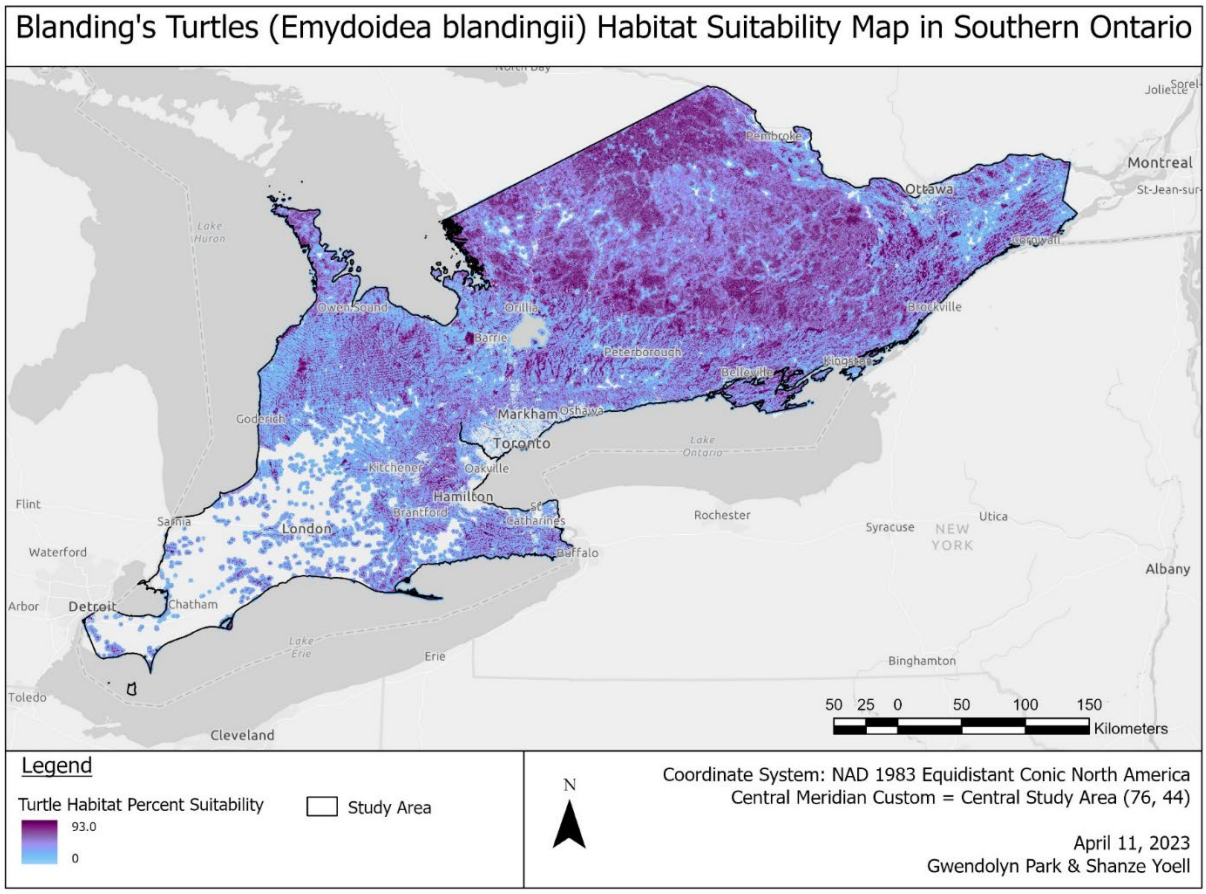

Figure 5: Blanding's turtle habitat suitability map

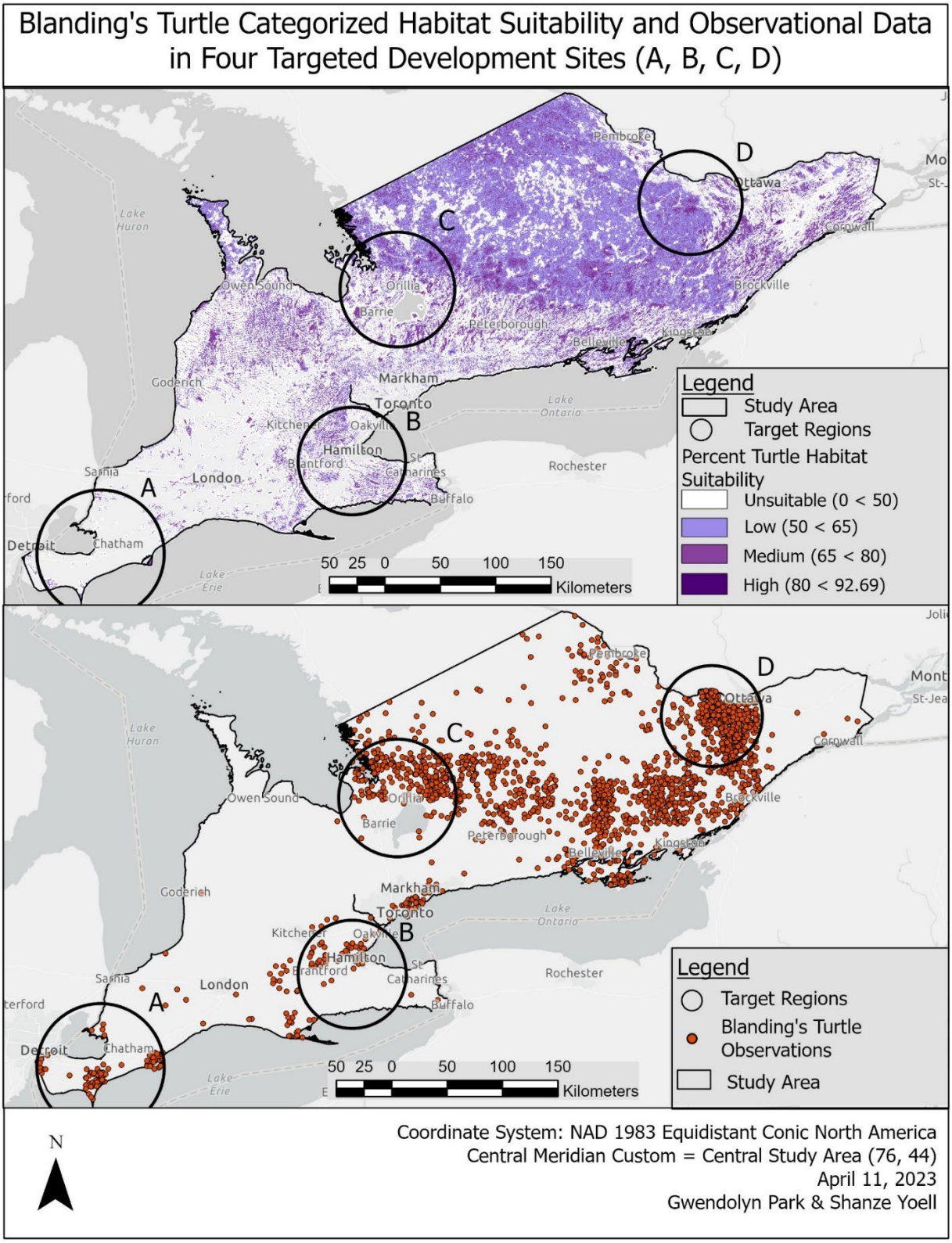

Figure 6: Categorized Blanding's turtle habitat and observational data

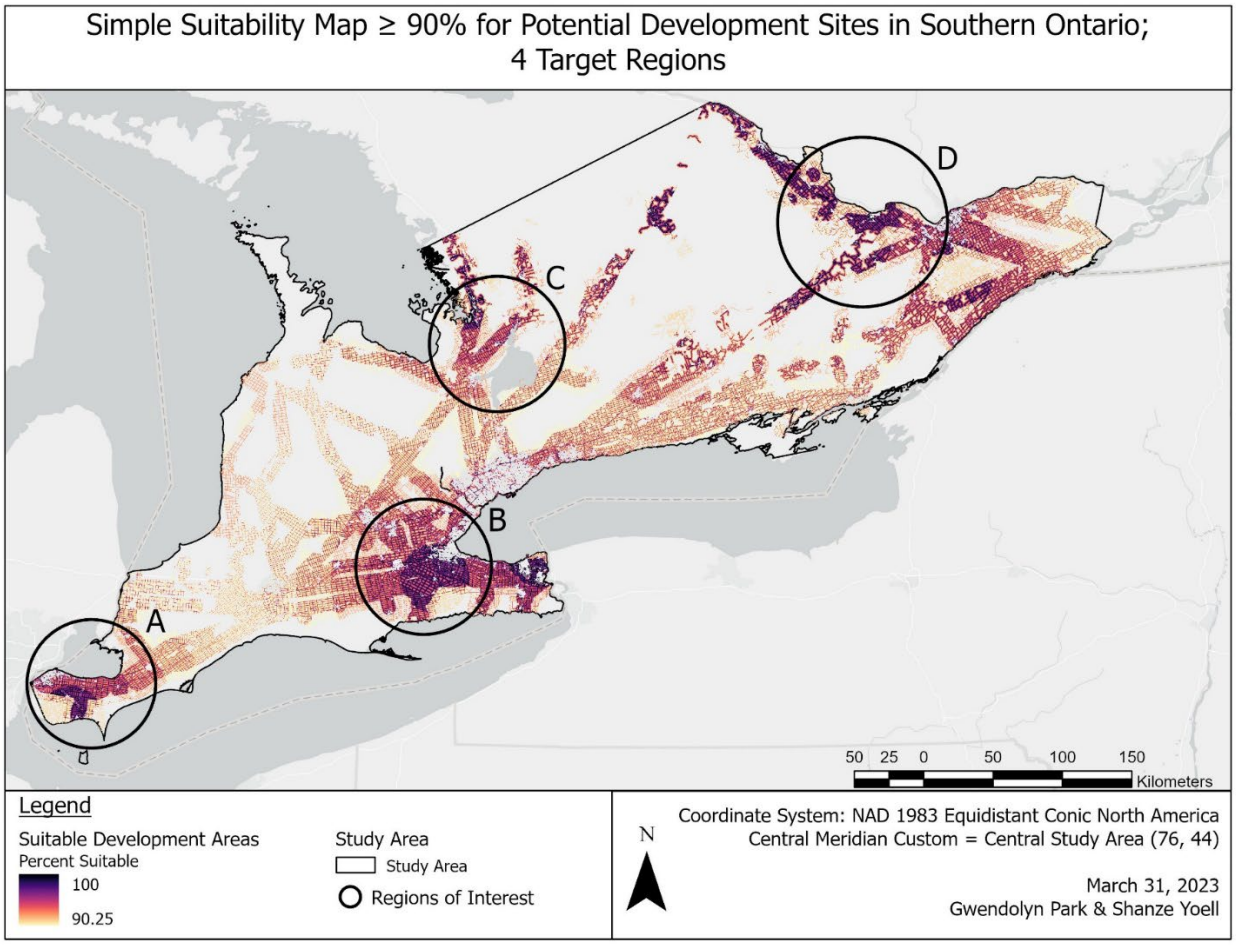

Figure 7: Potential development sites with a ≥90% suitability

The results of the Development Suitability MCE (Figure 7) demonstrate a simple representation of what areas are most likely to be selected by developers. Focusing only on areas of ≥90% suitability identifies four regions to be targeted for commercial or urban development (Essex, Hamilton, Simcoe, and Renfrew-Ottawa). From what has been published, portions of region B have been sanctioned for urban expansion, providing validation for our simple development site model and forecasting a pertinent impact on Blanding's turtle habitat and populations (Hristova, 2022).

Contrary to Bill 23's self-promoting title, the "More Homes Built Faster Act, it removes coordinated regional planning sustainable land use requirements by removing the need for government permission to develop conserved areas (Crombie *et al.,* 2022).

Bill 23 removes the previously mandated environmental impact surveys on potential development sites if the purchases are sanctioned for 'provincial or municipal infrastructure' and actively prohibits Conservation Authorities from consulting with developers to reduce impacts on wetlands (GO_d). Many areas that were previously protected or unused, such as the Greenbelt, will only be conserved until developers want to purchase them (GO_d). This means endangered species populations like the Blanding's turtle will be at risk despite legislation like the Species at Risk Act (SARA) enacted to protect their habitats (Crombie *et al.,* 2022; GO_d).

In performing an overlay analysis of the Blanding's turtle habitat and potential development maps, it is obvious that the suitable locations overlap. This overlap covers a total of 31517 hectares or 20.99% of all viable habitat (Figure 8, Appendix 3). Figure 9 shows the Blanding's turtle habitat locations lost. However, this does not include the downstream effects nor the required wetland draining for construction. Ontario Nature reported that that less than 30% of Ontario's original wetlands remain in Southern Ontario, the highest cause of which is land conversion for development (Ontario Nature, 2023).

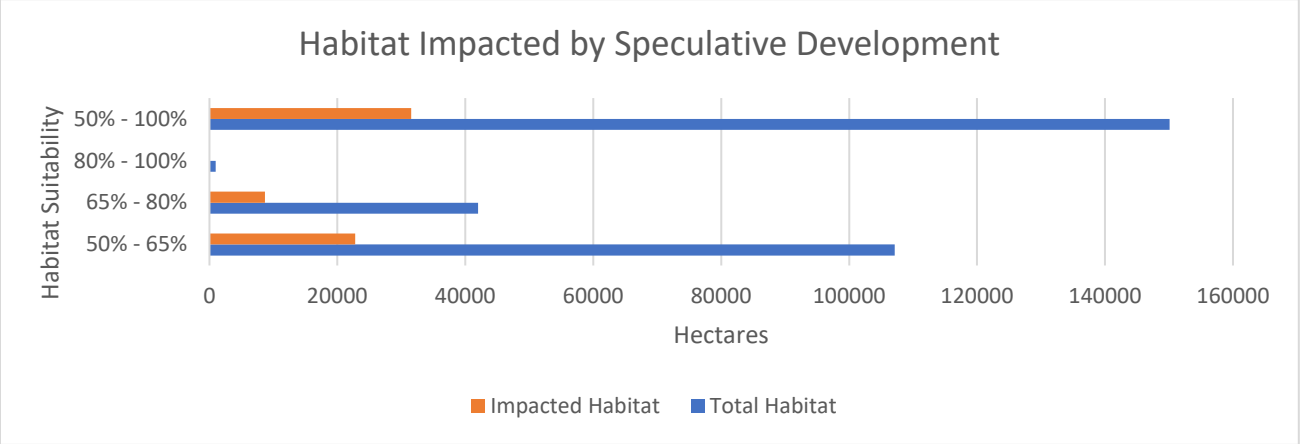

Figure 8: Habitat impacted by speculative development bar graph.

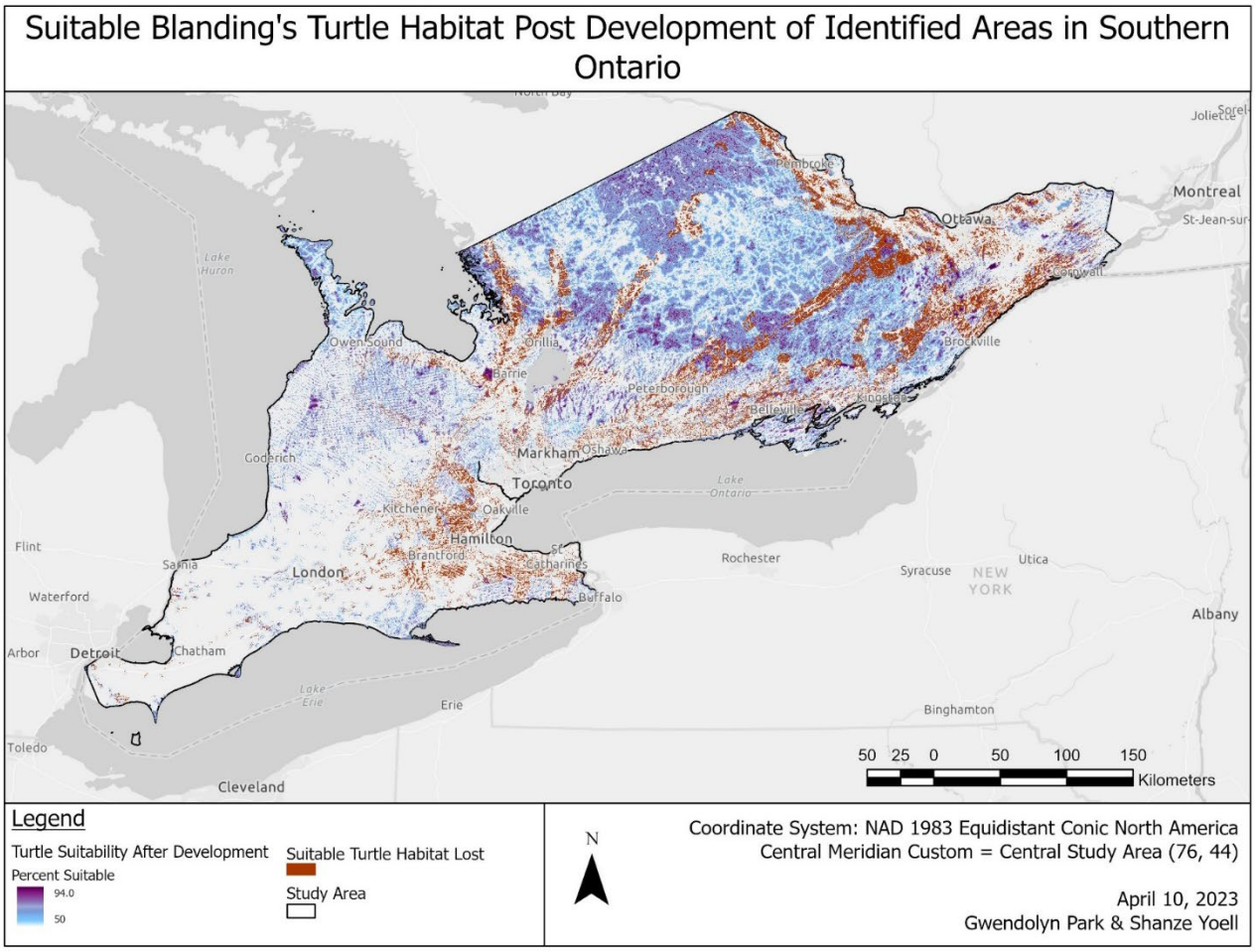

Figure 9: Suitable Blanding's turtle habitat post-development of identified areas in Southern Ontario

The four focus areas are (A) Essex, (B) Hamilton, (C) Simcoe, and (D) Renfrew-Ottawa. Each of these locations has sites of relevance in habitat suitability, observations, and development suitability.

Essex (Figure 10, A) has two main large habitats – Point Pelee and Rondeau Park. These sites are important for the Ontario population of Blanding's turtles as their temperatures are the warmest within our study area. As Blanding's turtles have temperature-based sex determination, warm climates are important for female sex determination (COSEWIC, 2005). The suitable developments in Essex, while not overlapping with these habitats, may have an unforeseen downstream effect.

Hamilton (Figure 11, B) boasts a provincially significant wetland which has one of the highest levels of biodiversity per hectare in Canada (City of Hamilton, 2020). Hamilton was forced by the provincial government to expand its urban boundaries (Hristova, 2022) into much of the highly suitable development area as seen in Map 8. This forced urban boundary expansion cuts into important Greenbelt and wetland lands.

Simcoe (Figure 12, C) is on the southern edge of the East-West provincial band of suitable Blanding's turtle habitat. The highly suitable habitat and development overlap. The wetland draining that would be required for development in this area would heavily impact the wetland systems, causing a larger impact than that of the isolated sites of development alone.

Renfrew-Ottawa (Figure 13, D) has the largest cluster of Blanding's turtle observations and the most suitable habitats within our study area. The highly suitable development locations around Renfrew-Ottawa pose a great danger to Blanding's turtle habitat because of how much they directly overlap.

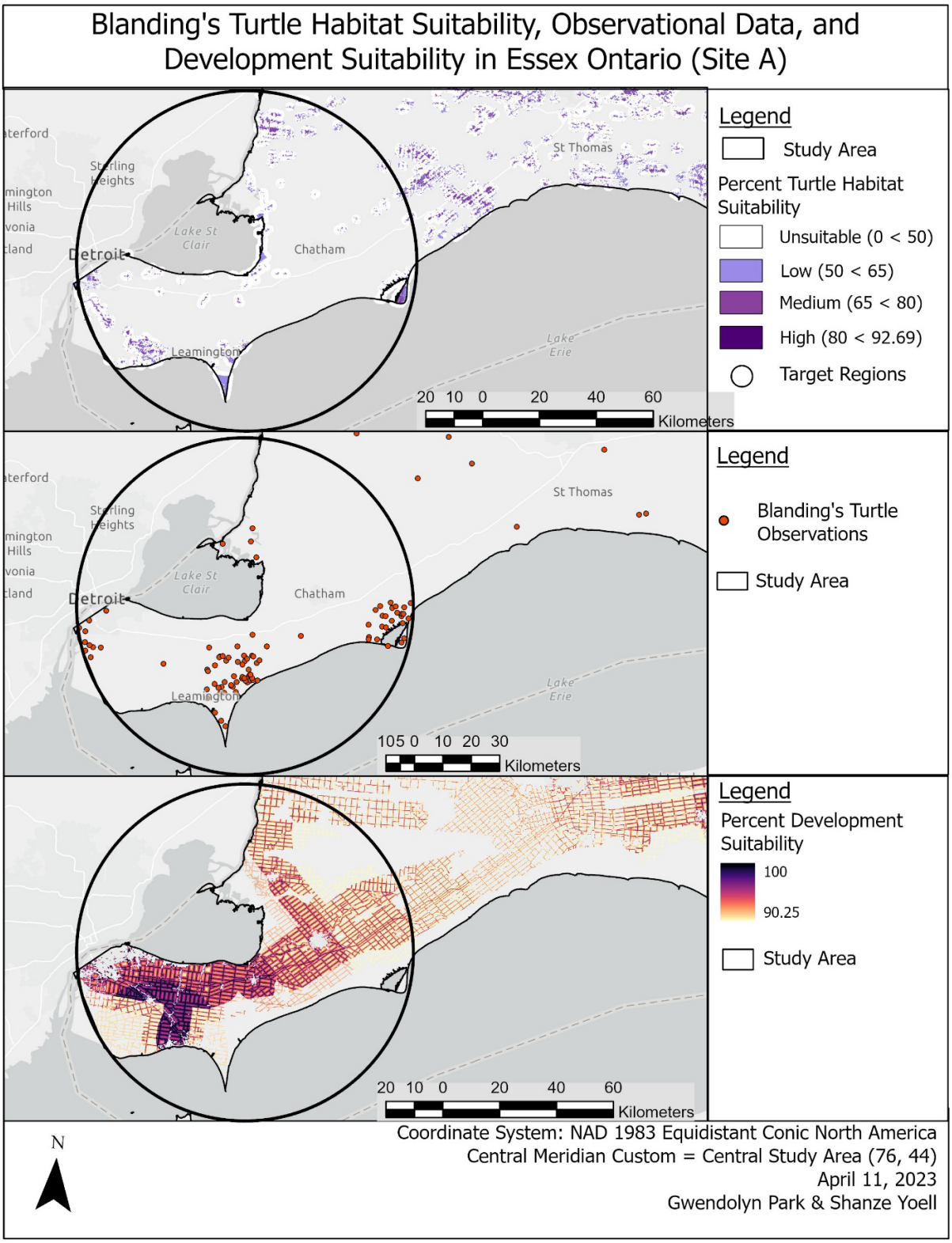

Figure 10: Map of Blanding's turtle habitat suitability, observation data, and development suitability in Essex, Ontario.

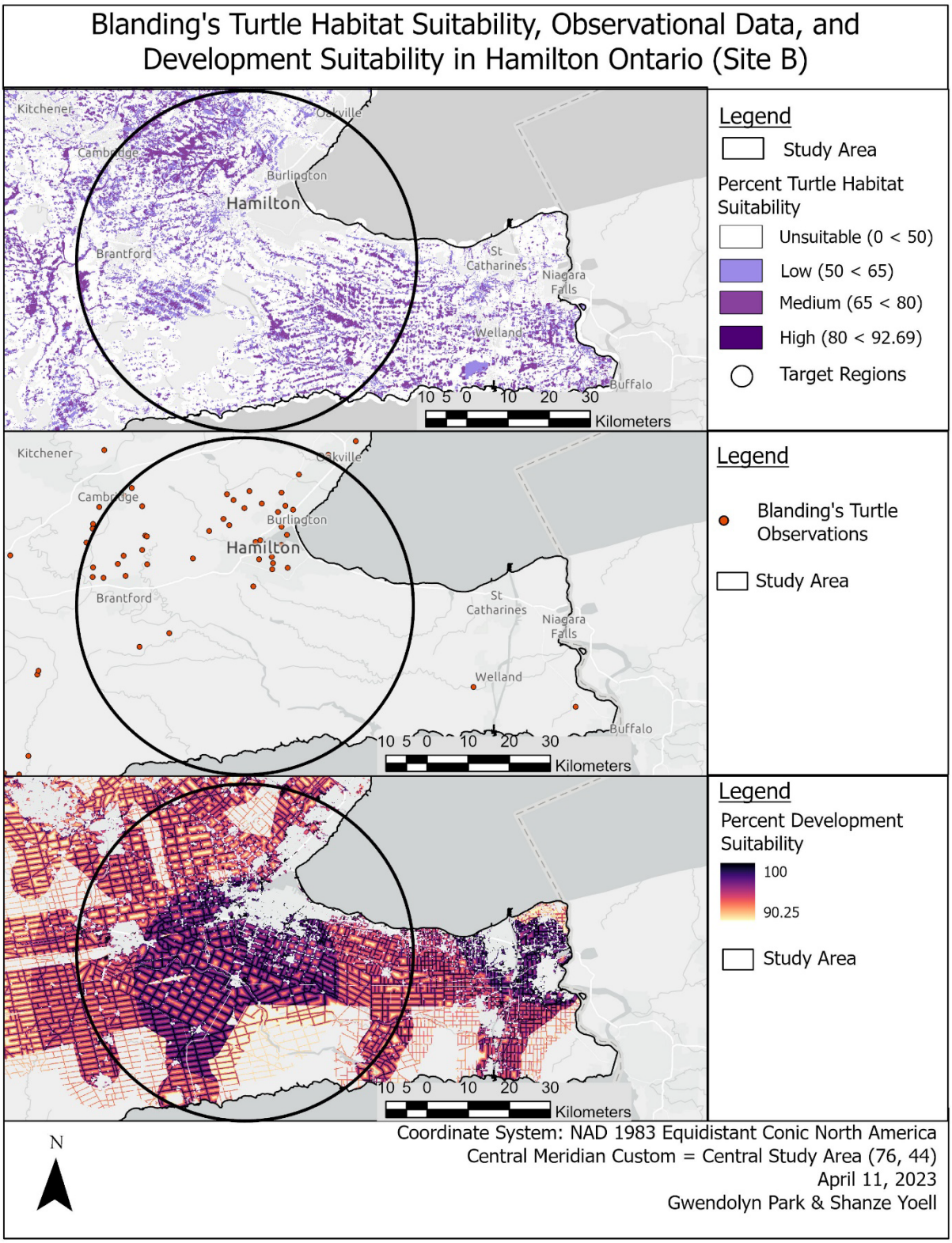

Figure 11: Map of Blanding's turtle habitat suitability, observation data, and development suitability in Hamilton, Ontario

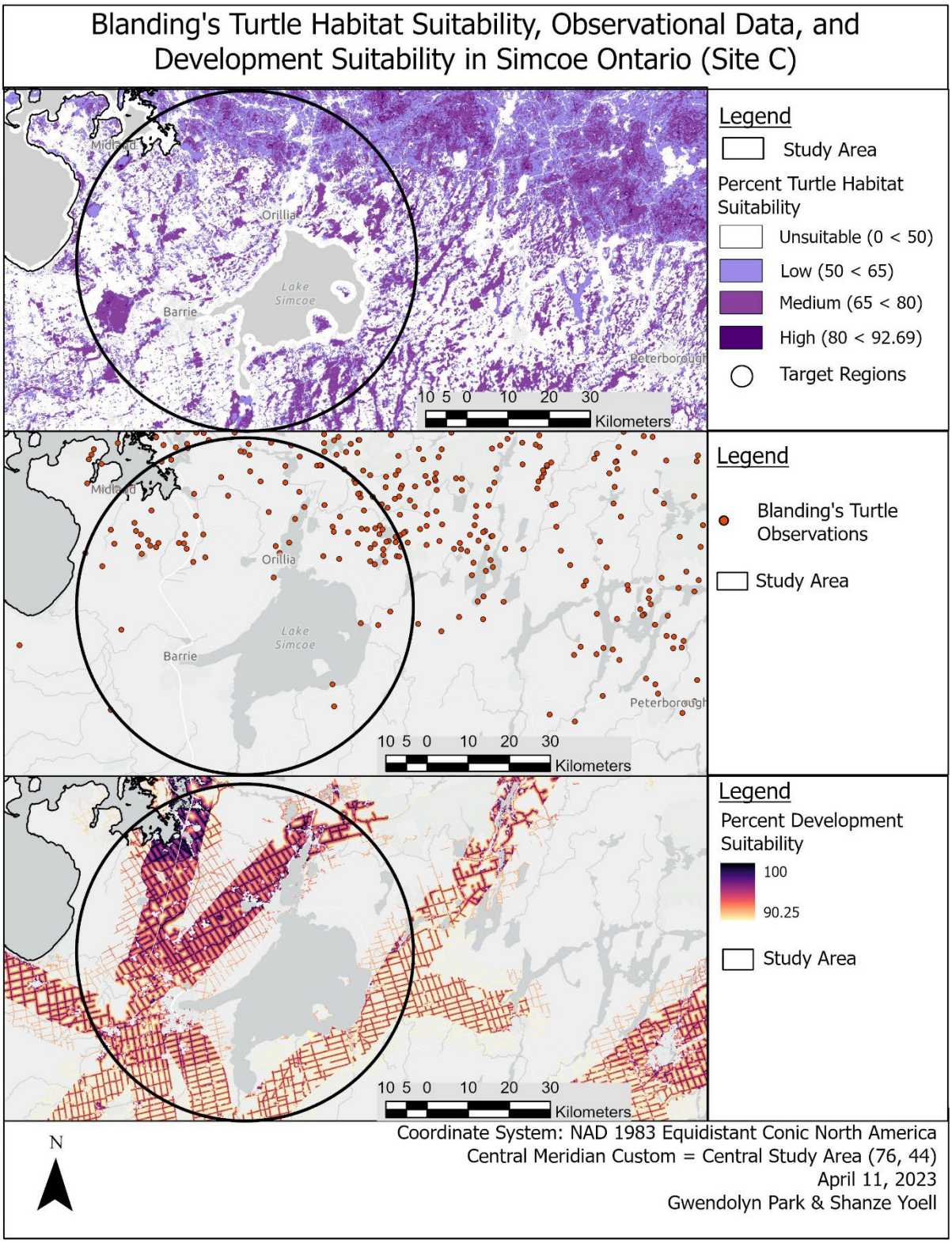

Figure 12: Map of Blanding's turtle habitat suitability, observation data, and development suitability in Simcoe, Ontario

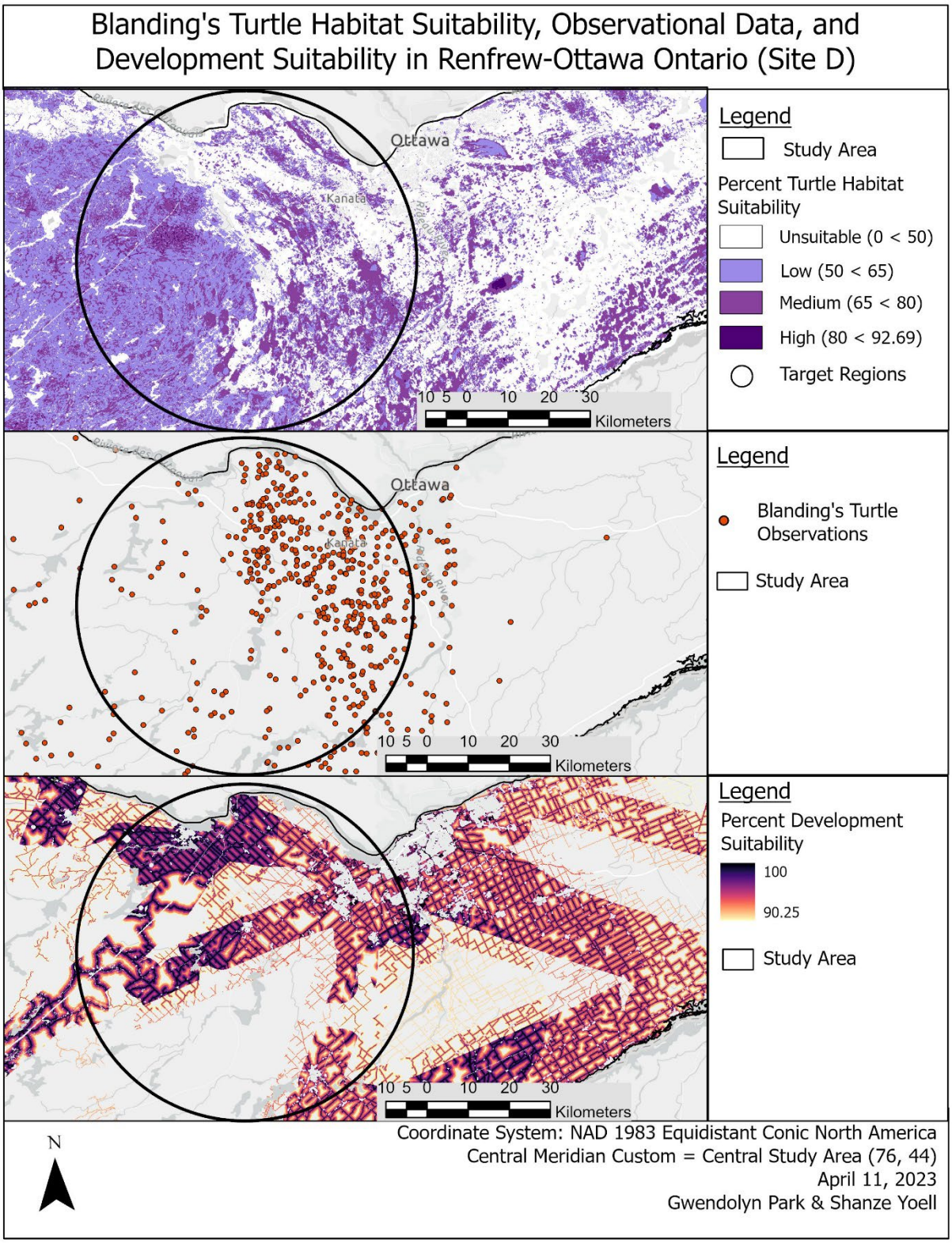

Figure 13: Map of Blanding's turtle habitat suitability, observation data, and development suitability in Renfrew-Ottawa, Ontario

The limitations of our MCE models were mostly due to data constraints. Data on factors such as stream networks and bathymetry, where water bodies of less than 2 m in depth increase the habitat's suitability, were sparce and did not cover most of Southern Ontario's water bodies. Several other desired factors, including changes in water management, poaching, and invasive species concentration are not publicly available datasets, if existent at all. The DEM used to compute slope had a coarse resolution that smoothed out the sheer slopes such as the Niagara escarpment. These known sheer slopes were calculated by ArcGIS to be between 20º and 25º. This known threshold was chosen instead of the 40º slope Strszowska *et al.* (2016) identified. As such, the constraint of steep slopes was limited to sheer slopes.

Conclusions

In conclusion, our Multi-Criteria Evaluation Models for suitable Blanding's turtle habitat and our simple development sites provide insight into the impacts of Bill 23 on Blanding's turtle habitat. While our development sites are only hypothetical due to the limitations of access to the locations of Bill 23-correlated development sites, it does provide insight into what may occur and groundwork for future models once locations are known. This highlights the necessity of research into the effects of urban development and wetland draining on downstream wetlands and how human interventions could make urban and suburban areas safer for mature female turtles. The endangered Blanding's turtles may be extirpated from Southern Ontario without action to protect their habitats and recover their populations. Additionally, this study accentuates the need for publicly accessible biophysical datasets and the protection of continued public and conservation authority input in proposed developments. Until now, the Conservation Authorities Act and Greenbelt Act have been crucial in protecting important natural areas and informing municipal regulations (GO_b, 1990; GO_c, 2005). Bill 23 dismantles this beneficial symbiosis, restricting environmentally informed decision-making. It must be re-evaluated or revoked to get provincial land use on track.

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Appendices

Appendix 1a: Blanding's Turtle Habitat Suitability Constraints

Binary Constraint	Requirement	Presence (1) or Absence (0)
Wetland Proximity	Within 1.5 km	1
Urban Areas	Impermeable Urban Environment - 203 (SOLRIS 3.0) and 3 (Provincial Land Cover)	0
Research Limit	Southern Ontario as defined by the study area	1
Slopes	Greater than 40°	0

Appendix 1b: Blanding's Turtle Habitat Suitability Weighted Factors

Weighted Factors	Requirement	Cost or Benefit	Weight (_/1.0)
Wetlands	Marsh/Open Water (Ponds): 100% Others (Swamp, Fen, Bog, unknown): 80%	Benefit	0.237
SOLRIS Vegetated Landcover	Upland Forests: 100% Fields and Grasslands: 70% Urban Permeable (Parks): 40%	Benefit	0.214
Roads	Within 1500 m (top average distance travelled from water) graded on a gradient	Cost	0.153
Temperature	Preferred Average Temperature: 24.8°C	Benefit	0.101
Wetland-Wetland Proximity	Wetland connections within 2000 m	Benefit	0.097
Agriculture Landcover	Pastures: 100% Orchards: 80% Other Fruits: 65% Vegetables: 45% Grains: 30% Others: 20%	Benefit	0.077
Railways	Within 1500 m (top average distance travelled from water) graded on a gradient	Cost	0.046
Regulated Provincial Areas	Within Protected Regions (Provincial Parks, Greenbelt)	Benefit	0.030
Beaver Dams	Within 300m, on a gradient	Benefit	0.025
Trails	Within 1500m	Cost	0.020

Appendix 2a: Development Suitability Constraints

Binary Constraint	Requirement	Presence (1) or Absence (0)
Urban Areas	Impermeable Urban Environment - 203 (SOLRIS 3.0) and 3 (Provincial Land Cover)	0
Bodies of Water	Within waterbody	0
Research Limit	Southern Ontario as defined by the study area	1
Slopes	Greater than 11°	0

Appendix 2b: Development Suitability Weighted Factors

Weighted Factors	Requirement	Cost or Benefit	Weight (_/1.0)
Urban Areas	Graded on a proximity gradient	Benefit	0.35
Utility Lines	Graded on a proximity gradient	Benefit	0.35
Waste Management Sites	Graded on a proximity gradient	Benefit	0.15
Roads	Graded on a proximity gradient	Benefit	0.15

Appendix 3: Habitat Impacted by Speculative Development

Blanding's Turtle Habitat Suitability	Total Area (Hectares)	Impacted Area (Hectares)	Percentage Impacted
50% - 65%	107123.17	22800.51	21.28%
65% - 80%	41999.11	8689.62	20.69%
≥80%	973.025	26.90	2.76%
50% - 100%	150095.31	31517.03	20.99%