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Current and Projected Distribution of the Red-Eared Slider Turtle, Trachemys scripta elegans, in the Great Lakes Basin

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ABSTRACT.—Exotic species introduced through the pet trade pose an ecological and economic threat to the Great Lakes region. *Trachemys scripta elegans*, the red-eared slider turtle, is a globally invasive species already present in the Great Lakes basin whose distribution and potential for spread is poorly known. We assembled a detailed dataset on *T. s. elegans* occurrence and establishment in the region and created a niche model to assess the potential for the spread of this species under current climate conditions and future scenarios. We found *T. s. elegans* occurs throughout the Great Lakes basin and suitable area will likely increase from 26% to 39–50% of the entire basin by 2050, with Lake Erie at greatest risk with ~95% of its total area suitable for *T. s. elegans* by 2050. These findings highlight the need for further research to assess impacts of *T. s. elegans* on native species and proactive efforts to prevent its further spread.

INTRODUCTION

Disruption of ecosystems by invasive species poses one of the greatest threats to global biodiversity. Invasive species cost the United States approximately $120 billion annually (Pimentel *et al.,* 2005) and are the second largest threat to endangered species (Wilcove *et al.,* 1998). As globalization of human commerce and industry increases, so does the risk of affecting native ecosystems with these exotic biological threats. The Laurentian Great Lakes basin has become home to more than 180 nonnative species since the 1800's (Sturtevant *et al.*, 2016). Commercial shipping is implicated as a major pathway for invasive species, especially in the Great Lakes (Horan *et al.,* 2002; Lodge *et al.,* 2006). A lesser, but still important pathway is the movement of organisms through the pet trade, which has facilitated introduction and establishment of at least 11 species in the Great Lakes basin (Rixon *et al.,* 2005). The potency of this pathway is expected to increase as the popularity of exotic pets grows and as global climate change increases climatic suitability within the basin for released exotic pets (Rixon *et al.,* 2005; Lockwood *et al.,* 2005).

A commonly introduced pet is the red-eared slider turtle, *Trachemys scripta elegans* (Kraus, 2009). *T. s. elegans* is now invasive on five continents, or six when including North America,

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which has seen native *T. s. elegans* populations of the lower Mississippi River Valley anthropogenically-transported to the Great Lakes basin, California, and many other parts of the U.S. where the turtle is not native. The movement of 52 million individuals through the pet trade has helped to make *T. s. elegans* one of the "100 worst invasive alien species" according to the International Union for Conservation of Nature (IUCN) (Lowe *et al.,* 2000; Cadi and Joly, 2003; Kikillus *et al.,* 2010). These fast-growing, long-lived turtles are often bought as small (3–4 cm) hatchlings, outgrow their welcome as pets, and are then released into local water bodies. Although the United States prohibits the sale of all turtles smaller than 10 cm in carapace length (with exceptions for scientific and educational purposes), and the European Union has outlawed the importation of any *T. s. elegans*, many online vendors continue to illegally sell inexpensive *T. s. elegans* hatchlings (U.S. FDA, 2013).

T. s. elegans threatens native turtles and aquatic ecosystems where introduced in Europe. Experimental studies in France showed declines in fitness of the European pond turtle (*Emys orbicularis*) with *T. s. elegans* introduction in mesocosms (Cadi and Joly, 2003; Cadi and Joly, 2004). In another experiment, native Spanish terrapins (*Mauremys leprosa*) avoided waters containing *T. s. elegans* chemical cues, which might help explain the displacement of endangered *M. leprosa* by *T. s. elegans* throughout the Mediterranean (Polo-Cavia *et al.,* 2009). *T. s. elegans* has also been shown to transmit parasites (Verneau *et al.,* 2011; Meyer *et al.*, 2015) and outcompete native European turtles for food and basking resources (Polo-Cavia *et al.,* 2010; Polo-Cavia *et al.,* 2011).

T. s. elegans is a known exotic in the Great Lakes basin (U.S. Geologic Survey, 2013), but the extent of its distribution and impacts on native species remain unclear. Several databases contain Great Lakes records of this species, but no single database consolidates all known records (*see* citations in Appendix B). *T. s. elegans* habitat preferences suggest that it is not likely to inhabit the Great Lakes proper but rather the shorelines and aquatic/semi-aquatic habitats within the basin. Given its troublesome history abroad and record of established exotic populations in the Great Lakes region, a thorough assessment of *T. s. elegans*' current and potential future Great Lakes distribution is warranted.

The limited resources of most conservation organizations necessitate judicious and effective allocation of effort to prevent or control invasions of non-native species. One method of providing quantitative direction for these efforts is to create species distribution models (SDMs) to highlight areas prone to invasion (Rödder *et al.*, 2009b). SDMs generate maps that assess the climatic suitability of a region for a particular species. Using species distribution data and a list of environmental conditions across a region, SDMs determine areas similar in conditions to those already known to allow the species' survival. In this way SDMs reveal the environmental landscape that most closely matches the species' niche, and therefore assess an area's risk of successful invasion should the species be introduced there.

We investigated the current and predicted distribution of *T. s. elegans* in the Great Lakes basin. Our goals were to (1) describe the current distribution of *T. s. elegans* in the U.S. states and Canadian provinces bordering the Great Lakes, (2) determine the current extent of climatically suitable area of the Great Lakes basin as well as suitable area under future climate projections, and (3) compare current and future climatic suitability among the individual Great Lake basins. We addressed these goals by accumulating occurrence and establishment records for *T. s. elegans* in the area and by developing niche models to assess the current and future threat based on climate.

METHODS

We compiled a dataset of *T. s. elegans* occurrence in the Laurentian Great Lakes region, including eight U.S. states and one Canadian province by searching relevant literature, querying private and government databases, and corresponding with turtle experts across North America (*see* Appendices A and B, Occurrence Records and Citations). In addition to latitude and longitude coordinates for each record, we also recorded city, county, state or province, watershed name/number, water body name, and establishment (*i.e.,* having evidence of reproduction) as available. There has been taxonomic confusion and inconsistency when classifying and identifying the three recognized subspecies of *Trachemys scripta* (*T. s. scripta*, *T. s. elegans*, and *T. s. troostii*), but based on the presumed geographic ranges of these subspecies, we included in our records all occurrences identified as *Trachemys scripta elegans* or simply *Trachemys scripta* with no subspecies listed (Seidel, 2002).

To assess the area currently climatically suitable for *T. s. elegans*, we used the Maximum Entropy (MaxEnt) algorithm to model the relationship between *T. s. elegans* occurrence and climate in North America (Phillips *et al.,* 2004, version 3.3.3k). For occurrence data to train the model, we combined our Great Lakes dataset with other North American occurrences (Kikillus *et al.,* 2010). For climate data, we used Worldclim's 19 bioclimatic data factors at a 2.5 arcminute ($\sim$5km^2) scale, variables based on temperature and precipitation values considered biologically relevant (The 19 variables are as follows: Annual Mean Temp, Mean Diurnal Temp Range, Isothermality, Temp Seasonality, Max Temp of Warmest Month, Min Temp of Coldest Month, Temp Annual Range, Mean Temp of Wettest Qtr, Mean Temp of Driest Qtr, Mean Temp of Warmest Qtr, Mean Temp of Coldest Qtr, Annual Precip, Precip of Wettest Month, Precip of Driest Month, Precip Seasonality, Precip of Wettest Qtr, Precip of Driest Qtr, Precip of Warmest Qtr, Precip of Coldest Qtr; www.worldclim.org/bioclim). We ran MaxEnt on its default settings, using a randomly selected 80% (391) of our Great Lakes records and other North American records to train the model and the other 20% (98) to test its performance. We measured performance as Area Under the Receiver-Operator Curve (AUC), a common performance metric of species distribution models where 0.5 indicates variables' prediction of occurrence no better than random, and 0.999 indicates a model that perfectly predicts occurrence points based on the variables. To assess the importance of each climate variable, we used two metrics: percent contribution, which is the increase in performance of the model when a given variable is added, and permutation importance, which is the decrease in performance of the model when a variable's values are randomly altered.

One issue with SDMs based on presence-only data is spatial autocorrelation of occurrences due to uneven geographical sampling effort, which can artificially inflate a model's performance measure (Veloz, 2009). When uneven sampling efforts result in clumped occurrence records that do not accurately characterize the species' true distribution, the model is both trained and tested on an unfair representation of where the species actually occurs. Therefore, the model does not perform well because the variables accurately predict occurrences, but only because the occurrences are so close to each other. To reduce this "spatial sorting bias" (Hijmans, 2012), we selected only one occurrence point per raster grid cell, placed randomly in the cell (2.5 arc min or about 5 km^2). To curb this effect and to provide an AUC more representative of the model's performance, we tested the model using only background points only as far away from the training data as the testing points are from the training data (Hijmans, 2012). This correction reduced the size of our training (391 to 90) and testing (98 to 90) data sets. This altered our training:testing ratio from 80:20 to

50:50 for the corrected model. Retaining an 80:20 ratio would have provided too few testing points (n = 22) to estimate AUC well.

To assess changes in occurrence probability under future climate scenarios, we projected the model over the current North American climate and the predicted 2050 climate under the four IPCC5 Representative Concentration Pathway (RCP) scenarios (in descending order of atmospheric CO_2 concentrations in 2050: RCP 8.5, RCP 4.5, RCP 6.0, RCP 2.6) for eight global climate models (BCC-CSM1-1, CCSM4, GISS-E2-R, HadGEM2-AO, IPSL-CM5A-LR, MR1-CGCM3, M1ROC-ESM, and NorESM1-M, downloaded from Worldclim at http://www.worldclim.org/cmip5_2.5m). To compare current and future *T. s. elegans* suitability in the basin, we calculated the percent of grid cells with >0.5 and >0.8 probability of occurrence for the current and future (2050) climate projections by individual lake basins and the entire Great Lakes basin. Basin extents were downloaded from Great Lakes Information Network (http://www.great-lakes.net/gis/data/refdata.html), and while the entirety of the basins were used to construct the model, percent area of the basins suitable for invasion was calculated excluding the areas of the Great Lakes themselves, as *T. s. elegans* is extremely unlikely to occur in such large water bodies, except at the shores.

RESULTS

We found 412 *T. s. elegans* occurrence records within eight U.S. states and one Canadian province of the broader Great Lakes region (Appendix A); 168 of these records occur within the Great Lakes basin (Fig. 1), although no records exist within any of the Great Lakes proper. Only 42 of the records in the broader region are established (i.e., reproducing) populations, 10 of which are in the basin proper, and most records (n = 370) made no note of whether or not *T. s. elegans* had established populations. See Table 2 for a summary of this information; further details are provided in Appendix B.

Analysis of the model shows good performance predicting occurrence with the full dataset (AUC = 0.909) but that spatial autocorrelation is an issue, as the AUC decreased substantially once spatial distance between presence and occurrence points was standardized (spatially-corrected AUC = 0.617). After autocorrelation correction, the four most important variables in the MaxEnt model were Mean Temperature of the Warmest Quarter, Annual Mean Temperature, Mean Diurnal Temperature Range, and Precipitation of the Driest Quarter (Table 1).

TABLE 1.—The relative contribution of the top independent variables to MaxEnt model, ordered by decreasing percent contribution. The percent contribution is the increase in regularized gain when that variable is added to the model. The permutation importance is the percent loss in AUC when the model is rerun with that variable's data permuted

Variable	% Contribution	Permutation importance
Mean Temp of Warmest Quarter	22.5	27.6
Annual Mean Temp	18.4	16.5
Mean Diurnal Temp Range (Mean of monthly (max temp – min temp))	13.8	7.1
Precipitation of Driest Quarter	10.1	0.2
Temperature Seasonality (Standard deviation of the annual mean temperature * 100)	1.7	14.6

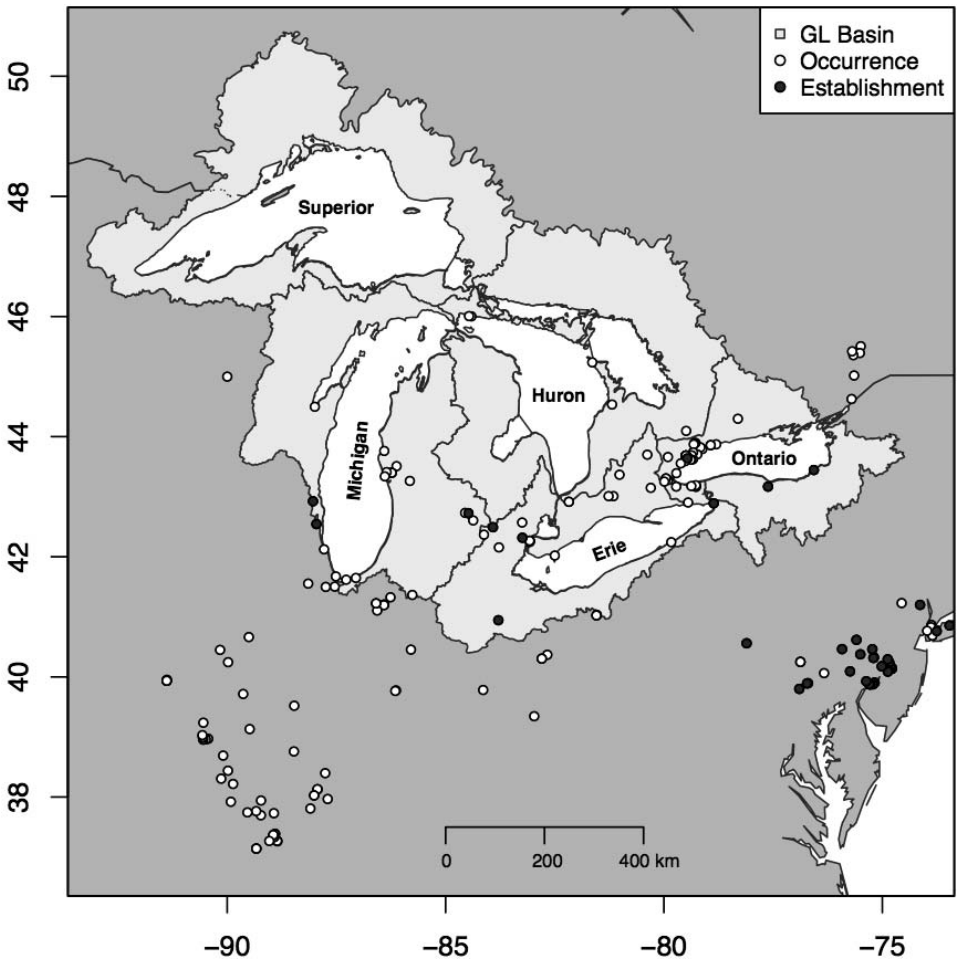

FIG. 1.—Map of occurrence (white dot) and establishment (black dot) records for *T. s. elegans*. Great Lakes basin extent is shown in grey

Model projections (after spatial autocorrelation correction) show current climate is favorable to *T. s. elegans* occurrence throughout much of the southern Great Lakes basin (Fig. 2). Across the entire basin, the percent area at risk at either the 0.5 or 0.8 probability will increase by 2050 from 25.6% to 47.4% and from 0.4% to 8.4% respectively (according to RCP 4.5, a moderate emissions scenario, averaged over all eight global climate models; Figs. 3a,b). Currently, the Lake Erie basin has the highest amount of area at risk (89.2% area at 0.5 level), followed by Ontario (39.4%), Michigan (38.5%), and Huron (16.7%) while Superior has little area at risk both now (0%) and in the future (4.1%) (also averages of all RCP 4.5 models; Fig. 3a). Most of the basins' risk assessments are sensitive to the different RCP scenarios at >0.5 probability of occurrence, with the exception of Lake Erie, which is consistently high, and Lake Superior, which is consistently low (Fig. 3b.). Regardless of RCP scenario or probability of occurrence (>0.5 or >0.8), a greater percentage of the Great

TABLE 2.—A summary of the *T.s. elegans* occurrence records in each state bordering the Great Lakes. Establishment is defined as a confirmed reproducing population. For a full, detailed list of Great Lakes occurrences, see Appendix A. Citations for this table and the Appendix A can be found in Appendix B.

State/Province	Number of total occurrences	Number of establishments	First/last year of occurrence
IL	143	20	1922/2013
IN	43	2	1940/2011
MI	26	3	1926/2012
MN	1	0	2002/2002
NY	13	8	1996/2013
OH	8	1	1951/2012
ON	126	1	1962/2013
PA	33	27	1948/2012
WI	11	2	1951/2012

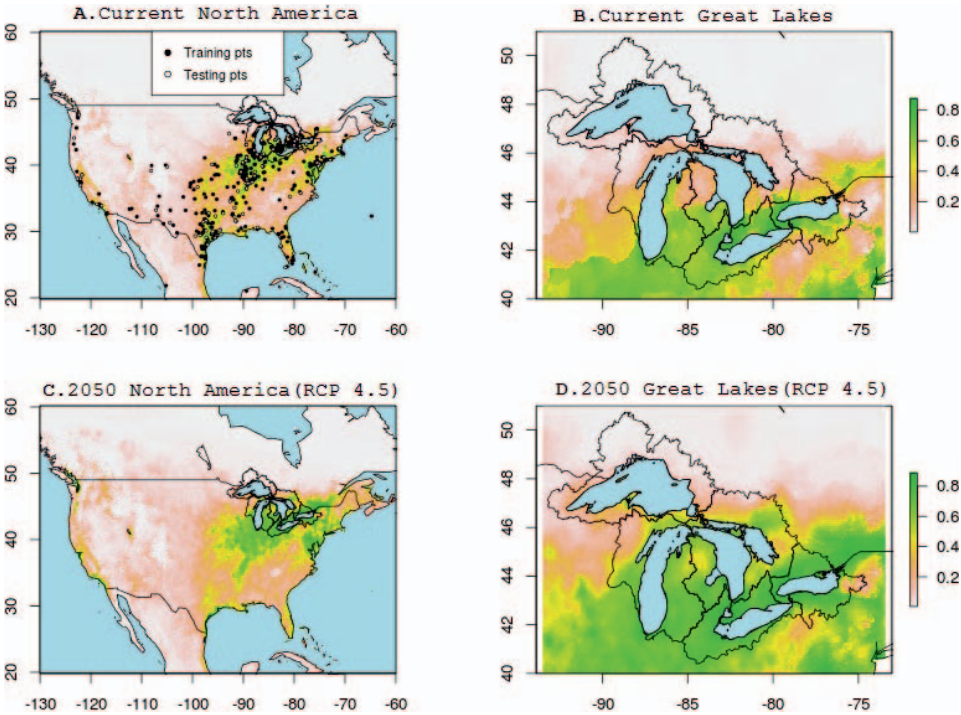

FIG. 2.—Projections of the MaxEnt model under current climate (**A, B**) and future year 2050 climate scenario (**C, D**). Greener colors represent more suitable climate for *Trachemys scripta elegans*. In map (**A**), model training (black dots) and testing (white dots) occurrence data are shown. Maps (**C**) and (**D**) display the mean occurrence probability of eight global climate model projections under the RCP 4.5 climate scenario

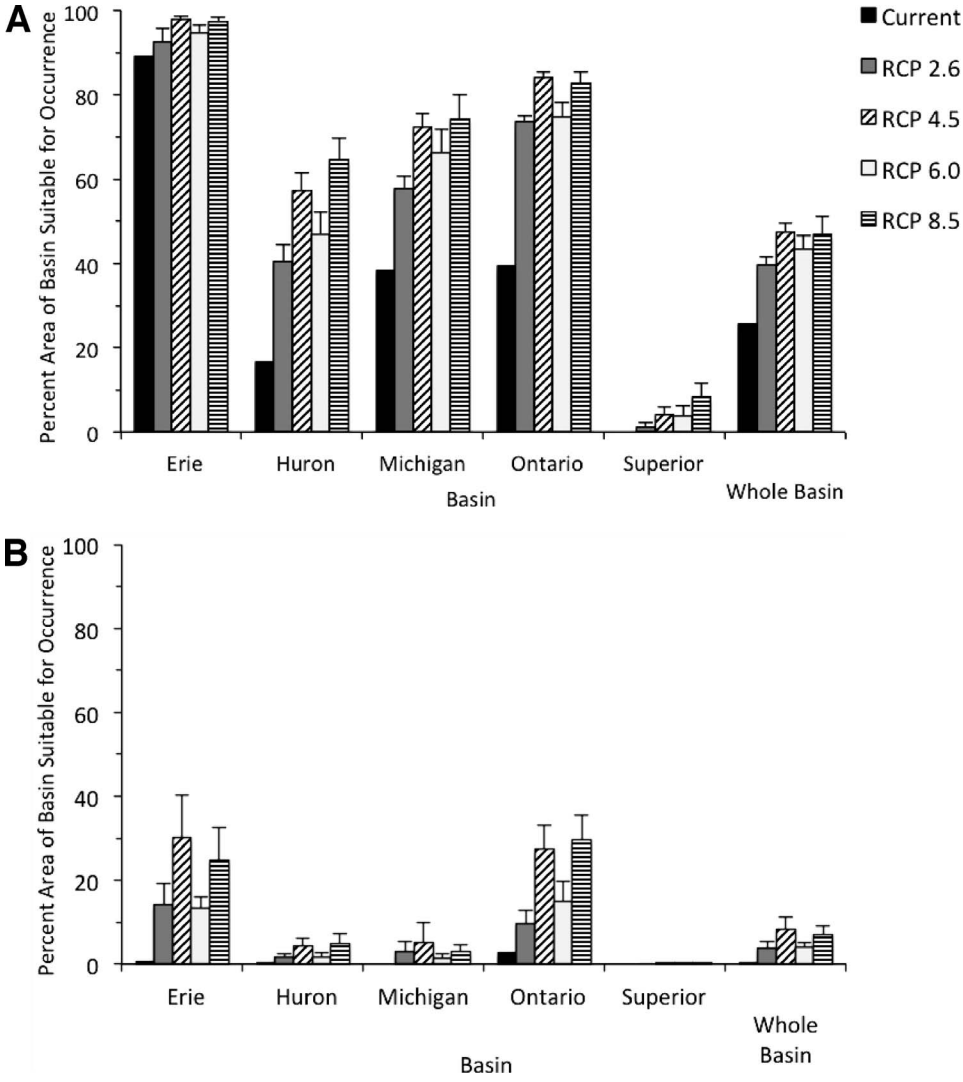

FIG. 3.—Percent area for individual lake basins and the entire Great Lakes basin that is suitable at (**A.**) >0.5 probability of occurrence and (**B.**) >0.8 probability of occurrence for *T. s. elegans* under each of the four 2050 IPCC5 RCP scenarios, averaged over eight global climate models. Error bars represent one standard deviation

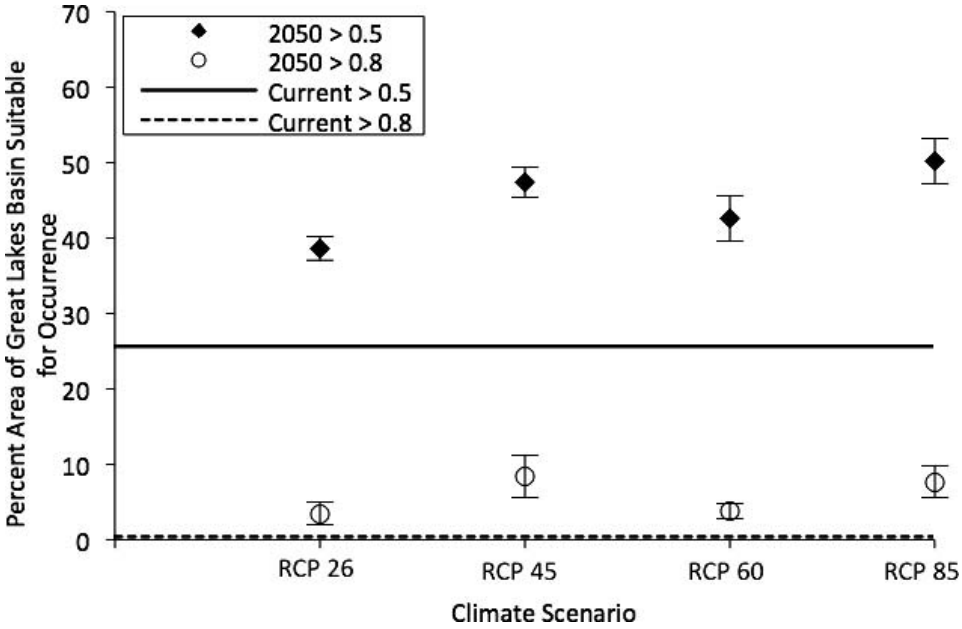

FIG. 4.—Percent area of the entire Great Lakes basin that is suitable (>0.5 and >0.8 probability of occurrence) for *T. s. elegans* under each of the four 2050 IPCC5 RCP scenarios, averaged over eight global climate models. Solid and dashed lines indicate percent of basin with >0.5 and >0.8 occurrence probability under current climate respectively. Error bars represent one standard deviation

Lakes basin will be suitable in 2050 than is currently suitable (an additional 21.8% more or 8.0% more for >0.5 and >0.8 probability respectively, based on RCP 4.5; Fig. 4).

DISCUSSION

To better understand the threat that the invasive *T. s. elegans* poses to the Great Lakes basin, we compiled known occurrences, mapped current and future climatic suitability based on those occurrences and climate data, and highlighted the individual Great Lake basins most at risk for the establishment of this exotic turtle.

Our comprehensive *T. s. elegans* occurrence dataset, which is the first published compilation focused on the Great Lakes, allows for a better assessment of the current and future threat of *T. s. elegans* in the Great Lakes basin. Including unpublished and obscure records of *T. s. elegans* occurrence, we found *T. s. elegans* occurs or has occurred in every individual lake basin and is known to have established populations in the Lake Michigan, Lake Erie, and Lake Ontario basins. From this more complete picture of the Great Lakes *T. s. elegans* distribution, the issue's scope appears more widespread than any one individual agency or data source might suggest. Further, SDMs informed by this dataset show many areas of the Great Lakes are already climatically suitable for *T. s. elegans* occurrence and that total suitable area is expected to increase under all future climate change scenarios. This suggests *T. s. elegans* distribution could increase throughout the basin, though limited dispersal ability could prevent the realization of the climatic niche expansion (Butler *et al.* 2016).

Our models show mixed congruence with other published *T. s. elegans* SDMs. Our 'current climate' model matches other predictions of optimal suitability extending from Texas to Florida in the south, with decreasing suitability northward (Kikillus *et al.*, 2010; Rödder *et al.*, 2009a; Rödder *et al.*, 2009b). However, they assign virtually no suitable area to the Great Lakes basin, likely because they lack the Great Lakes occurrence records included in our dataset. These studies' poor resolution of the Great Lakes basin prevents direct quantitative comparisons of suitable area. Most North American models don't predict to future climate scenarios. However, our 'future climate' model's contractions of suitable area in the southwest United States are consistent with Bagne *et al.*'s (2014) predictions that exotic *T. s. elegans* populations along the Rio Grande could be vulnerable to climate change.

Our model showed Mean Temperature of the Warmest Quarter to be the most important variable, which is consistent with other *T. s. elegans* SDM studies (Rödder *et al.*, 2009a; Ficetola *et al.*, 2009). This might contradict thoughts that northward expansion into the Great Lakes basin might be limited by temperature experienced during overwintering. However, Rödder *et al.*, (2009a) suggest that summer temperatures controlling egg incubation and temperature-dependent sex ratios could determine success more broadly, while winter temperatures only limit suitability regionally. This claim is supported by the regional SDM developed for the Iberian Peninsula by Banha, Gama, and Anastácio (2017), which shows winter temperatures as a top variable of importance. However, Kikillus *et al.* (2010) showed winter temperatures to be important at the global scale but that summer temperatures are important at the regional scale (New Zealand). Ficetola *et al.* (2009) demonstrated that summer temperatures are important at regional scales (Northern Italy and the Great Lakes basin). Further research should address this inconsistency. The contradictions here highlight the difficulty of resolving scale, environmental drivers, and life history into a coherent understanding of what drives species distributions.

Environmental tolerance limits for *T. s. elegans* have clear implications for reproductive success. In the severe winter climate of the Great Lakes, overwintering success may be a determining factor in reproduction and therefore establishment success. While overwintering is still considered the most daunting obstacle for *T. s. elegans* success (Ontario Nature, 2012), there is anecdotal evidence *T. s. elegans* individuals have been able to overwinter well north into Canada. Future work should determine the validity of these anecdotes, which would have major implications for future *T. s. elegans* success in the region. Overwintering *T. s. elegans* hatchlings (the most susceptible age group to cold) typically die when soil temperatures surrounding their nests (averaging 12 cm in depth) reach –0.6°C (Packard *et al.,* 1997). In relatively dry soils, an uncommon nesting habitat for this species, hatchlings can supercool and survive at temperatures as low as –4°C, but probably with low survival rates (Packard *et al.* 1997). However, some evidence suggests that cold-tolerance may be a regional adaptation (Churchill and Storey, 1992). For example, Western Illinois *T. s. elegans* hatchlings demonstrate lower supercool temperatures than Louisiana hatchlings, suggesting that hatchlings attempting to overwinter in Ontario could potentially adapt and survive the colder conditions present there (Packard *et al.,* 1997). This could mean that T.s. elegans has a larger niche than previously thought, which is supported by our study. As climate warms, the areas suitable for successful overwintering could expand northward, although more frequent extreme weather events likely to accompany climate change could result in cold spells that kill off hibernating turtles.

Given the potential range expansion of *T. s. elegans*, research on the impacts of this species to native turtles and wetland ecosystems of the Great Lakes is needed. While the European invasion of *T. s. elegans* is alarming, there is little empirical evidence *T. s. elegans* poses a

competitive threat in the Great Lakes basin. Though Peterman and Ryan (2009) showed that *T. s. elegans* shares basking substrate preferences with the native painted turtle, *Chrysemys picta*, Jaeger and Cobb (2012) show sharp differences in foraging habitat between the two species, indicating possible niche partitioning that reduces competition. Observations of Great Lakes native northern map turtles (*Graptemys geographica*) and sympatric non-native *T. s. elegans* show no evidence for competition (Haas, 2015). There is also no evidence of negative impacts of *T.s. elegans* on the endangered Blanding's turtle, *Emydoidea blandingii,* a species of conservation priority in the Great Lakes region (IUCN, 2013).

Despite lack of evidence of *T.s. elegans* impacts in the Great Lakes basin, negative impacts have been found in nearby ecosystems. Mesocosms experiments have shown that juvenile *T. s. elegans* exhibits competitive advantages over juvenile northern red-bellied cooters, *Pseudemys rubriventris,* a North American species native to the Mid-Atlantic region (Pearson *et al.*, 2015). Should *T.s. elegans* similarly affect larval success of Great Lakes natives, it could disproportionately impact *E. blandingii*, which relies on particularly high recruitment (Congdon *et al.*, 1993). However, *E. blandingii* is a microhabitat generalist showing little microhabitat overlap with *C. picta* (which overlapped with *T. s. elegans* in Peterman and Ryan, 2009) (Anthonysamy *et al.*, 2014). Parasites in native turtles and exotic *T.s. elegans* should also be monitored, as novel *T.s. elegans* parasite introductions (Oi *et al.* 2012) and transmissions to native species (Verneau *et al.*, 2011, Meyer *et al.* 2015) have occurred. Furthermore, *T. s. elegans* can carry sublethal, transmittable ranavirus infections (Brenes *et al.*, 2014), serving as a reservoir host for susceptible anurans and turtles (Johnson, *et al.*, 2007).

Previous exposure of Great Lakes turtles to *T.s. elegans* suggest that they would not be naïve to *T. s. elegans* like the European turtles for which most negative impacts are demonstrated. The turtles most vulnerable to competition from *T. s. elegans* (*C. picta, G. geographica*, and *E. blandingii*) (Terry, 2015) all show current native range overlap with the northernmost edge of *T. s. elegans*' native range (Somma *et al.*, 2017). Furthermore, there is some fossil evidence to suggest historical exposure of Great Lakes native turtles to *T. s. elegans*, which could have held a native range in Wisconsin and Michigan before a mid-Holocene contraction (Adler, 1968; Holman, 2012), though recent phylogeographic genetic investigation has shown mixed results for this claim in Michigan populations (Terry, 2015).

Potential for *T.s. elegans*' realization of its climatic niche, as well as interactions with Great Lakes basin native turtles should be contextualized by potential range shifts of the natives. Climatically suitable area in the Great Lakes basin is predicted to decrease for natives of conservation concern (King, 2013). *E. blandingii* is projected to retain climatic suitability for only 25–50% of currently occupied areas, gaining little suitability elsewhere (King, 2013). Biotic interactions can mediate species' abilities to shift ranges in a changing climate (HilleRisLambers *et al.*, 2013), so in addition to dispersal ability, the balance of interspecific interactions on a shifting landscape of suitability for all species will determine niche realization and impacts of *T. s. elegans* in the Great Lakes basin.

Future research should also prioritize determining the establishment status of *T. s. elegans* by exploring areas of known occurrence and searching for evidence of consistent reproductive success (several generations present, successful overwintering, *etc.*). Invasions are more potent when a species demonstrates the ability to establish a reproducing population. Exotic populations currently living in areas with very low suitability for reproduction could become more reproductively successful with shifts in climate. In fact, a study modeling introduced and established *T. s. elegans* populations in Northern Italy showed this is likely the case for several exotic populations (Ficetola *et al.,* 2009).

Additionally, summer temperatures emerged as their strongest predictor for *T. s. elegans* reproduction (Ficetola *et al.,* 2009), just as summer temperatures (Mean Temperature of Warmest Quarter) best-predicted occurrence in our model.

Worldwide, *T. s. elegans* has an apparent association with urban areas. We found the same pattern in our data; *T. s. elegans* occurrences were clustered around major metropolitan areas such as Chicago, Detroit, and Toronto (Fig. 1). Interestingly, this species does show sensitivities to habitat fragmentation and diversity of land-use, features common in urbanized areas (Rizkalla and Swihart, 2006). While these urban clusters likely stem from an anthropogenic invasion pathway (pet trade), future research should ask whether this high urban density is due to increased monitoring in these areas or inability to disperse from points of introduction. The latter could be exacerbated by high densities of human-subsidized nest predators surrounding urban centers of the Great Lakes basin (Broadfoot *et al.*, 2001; Prange and Gehrt, 2004; Prange *et al.*, 2004). This would limit expansion from sites of anthropogenic introduction and curb the realization of *T. s. elegans*' climatic niche. Future research into other human-associated variables that could limit ex-urban dispersal (i.e.; road density) might explain this urban clustering of occurrence.

The SDM model developed in this study can be used as a tool to identify priority areas for management or surveillance. Management strategies should focus efforts in the areas highlighted for climatic suitability, especially Lake Erie, which consistently shows the highest percentage of suitable area across the different models. For surveillance, the SDM suggests central Michigan has large areas of suitable climate for *T. s. elegans* now and in the future, and so would be a good place to begin monitoring. Any potential overlap between *T. s. elegans* suitable area and native turtle habitat should be of high monitoring and management priority as well.

Our corrections for spatial autocorrelation reveal strong spatial bias in our original model. Though our unbiased model performed well (AUC = 0.617), corrections for spatial autocorrelation reigned in an artificially inflated performance value from the biased model (AUC = 0.909), and future SDM's should similarly correct for such spatial bias. It is likely that some of the 19 Wordclim bioclimatic variables are correlated, possibly leading to over-fitting or over-parameterization of the models (Dormann *et al.* 2013). However, when eliminating collinearities, it is vital to retain variables pertinent to the species' natural history. With uncertainty surrounding the natural history of *T. s. elegans* in the Great Lakes basin (Adler, 1968; Holman, 2012; Terry, 2015), we chose to include the 19 core bioclimatic variables that might affect this species' range

One potential shortcoming of this model could result from its reliance on climate data alone for predictions of areas suitable for *T. s. elegans* invasions. The areas suitable for invasion spatially represent where an invasion could be successful provided ample introduction events (reliant on human population and pet trade activity), aquatic habitat (too local to be described by this model), and appropriate biological interaction conditions (difficult to quantify because of the limited knowledge of its interactions with Great Lakes species). Limited dispersal ability or rural introductions could limit the realization of this climate niche outside of currently occupied urban centers. We did add human population density to the model, but found reduced explanatory power. The urban-tolerant and omnivorous nature of this species likely reduces the importance of variables that might control distributions of more sensitive species, so using only biologically relevant climate data provides a useful, well-performing distribution model.

CONCLUSIONS

Our results underscore the critical need for more management of and research on *T. s. elegans* in the Great Lakes basin. Our comprehensive occurrence dataset of more than 400 Great Lakes records confirms the current presence and potential establishment of this species in the basin. The SDM provides visual and quantifiable guidance for state and provincial prevention plans, highlighting Lake Erie as the most at-risk basin but showing the new exposure of Lake Superior as climate change enables suitable area to expand northward. The percent suitable area of the Great Lakes basin as a whole will nearly double by 2050 (25.6% to 47.4% at >0.5 level for RCP 4.5). Our SDM can be used as a resource for future management strategies because it was created using a more complete understanding of the current distribution of *T. s. elegans* and was evaluated in the absence of spatial bias. It shows potential for a significant expansion of the *T. s. elegans* niche, especially northward.

European invasion impacts warrant investigation on biotic and abiotic interactions in the Great Lakes basin. We strongly encourage further research on the spread of and specific impacts that *T. s. elegans* could have in the Great Lakes basin, current and future limitations to the realization of a widespread and growing climatic niche in the region, as well as deeper exploration of management options for this species.

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APPENDIX A: *TRACHEMYS SCRIPTA ELEGANS* OCCURRENCE RECORDS IN GREAT LAKES STATES/PROVINCES

APPENDIX TABLE A1.—*Metadata*

These data are the Great Lakes occurrence records collected and used in the development of our species distribution model. Below are explanations of the categories used in the data
See Appendix A for list of sources used to compile this database

Name listed	We assumed all records of "*Trachemys scripta*" to be the subspecies "*Trachemys scripta elegans*" based on the geographic distribution of the subspecies and expert opinion of Dr. Fred Kraus, but listed here are the actual names given by the source record.
State/Province	U.S. State or Canadian Province of occurrence
Latitude	Latitude of occurrence. If not explicitly given in record, we georeferenced the center of most specific locality given (water body, park, county, *etc.*)
Longitude	Longitude of occurrence (sometimes estimated)
Year	Year of occurrence
Reproducing?	Apparent reproductive status of individual or population, indicating establishment
Source	Source of occurrence record

APPENDIX TABLE A2.—*Occurrence Records*

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	IL	38.224091	−90.233926	1922	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	41.84273782	−87.81640628	1923	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	41.84273782	−87.81640628	1923	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	40.2984	−90.0568	1923	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	41.072806	−87.807345	1924	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.01057	−89.18215	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.91221	−89.81934	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.29418	−90.06207	1931	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	41.28474	−89.36579	1932	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	41.28474	−89.36579	1932	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	41.28474	−89.36579	1932	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.377967	−89.353872	1933	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	37.377967	−89.353872	1933	Unknown	Field Museum of Natural History
Trachemys scripta	IL	37.330508	−88.732904	1933	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.289207	−88.731312	1933	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.139894	−89.332127	1936	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.446402	−88.27773	1936	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	41.182061	−89.35984	1936	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IL	37.69638889	−89.22944444	1940	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	37.73083333	−88.93	1940	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	40.35695	−90.01537	1940	Unknown	Illinois Natural History Society

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta	IL	37.697598	−89.22846	1940	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.697598	−89.22846	1940	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.697598	−89.22846	1940	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IL	37.94083333	−89.22722222	1941	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	37.745	−89.535	1941	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	39.71444444	−89.63361111	1941	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	37.76416667	−89.335	1941	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	40.348899	−90.097072	1941	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	40.259504	−90.096027	1941	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	39.00705	−87.73253	1941	Unknown	Illinois Natural History Society
Trachemys scripta	IL	37.697598	−89.22846	1941	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.732024	−89.20238	1941	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.7681	−89.3372	1941	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.7681	−89.3372	1941	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	40.518054	−91.396836	1942	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	37.266668	−89.500386	1946	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IL	40.13743	−87.74226	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.21029	−89.97519	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.21029	−89.97519	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.21029	−89.97519	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.21029	−89.97519	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.21029	−89.97519	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.21029	−89.97519	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.21029	−89.97519	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.13743	−87.74226	1947	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.09677	−87.76357	1948	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.09677	−87.76357	1948	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.09677	−87.76357	1948	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.09677	−87.76357	1948	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.09677	−87.76357	1948	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.09677	−87.76357	1948	Unknown	Illinois Natural History Society

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	IL	37.41194	−88.65992	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.41194	−88.65992	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.37504	−89.99996	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.37504	−89.99996	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.37504	−89.99996	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.37504	−89.99996	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.20045	−90.20133	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.20045	−90.20133	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	40.20045	−90.20133	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.80023	−89.64218	1950	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	38.00744	−89.32332	1951	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.85956	−88.37889	1952	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.55963	−89.43658	1953	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.56945	−89.43228	1956	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.38972	−89.34837	1958	Unknown	Illinois Natural History Society
Trachemys scripta	IL	39.210815	−89.976102	1959	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	39.210815	−89.976102	1959	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IL	42.3244	−88.45274	1962	Unknown	Illinois Natural History Society
Trachemys scripta	IL	37.13991	−89.33138	1963	Unknown	Global Biodiversity Information Facility
Trachemys scripta	IL	37.13991	−89.33138	1963	Unknown	Global Biodiversity Information Facility
Trachemys scripta	IL	38.610657	−89.398891	1963	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IL	40.650424	−88.922655	1964	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	38.21694444	−89.86611111	1979	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	38.68972222	−90.095	1990	Yes	Kikillus *et al.* 2010
Trachemys scripta	IL	40.662082	−89.503804	1992	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	41.416039	-88.146464	1993	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	41.93168	−88.76165	1993	Unknown	Illinois Natural History Society
Trachemys scripta	IL	40.841949	−89.499825	1994	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	38.43944444	−89.98361111	1995	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	39.52027778	−88.46555556	1995	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	39.9525	−91.3775	1996	Unknown	Kikillus *et al.* 2010

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	IL	39.23638889	−90.545	1996	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	37.80694444	−88.09472222	1998	Yes	Kikillus *et al.* 2010
Trachemys scripta	IL	41.502658	−87.537078	1999	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	38.7575	−88.47361111	2001	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	39.13083333	−89.48583333	2002	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	38.96972222	−90.43472222	2003	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	42.2443	−87.88329	2004	Unknown	Chris Phillips
Trachemys scripta	IL	41.553174	−88.144074	2005	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	41.497582	−87.742622	2005	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	40.2984	−90.0568	2005	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	39.47869183	−89.26332889	2005	Unknown	Illinois Natural History Society
Trachemys scripta	IL	42.123491	−87.780331	2007	Unknown	Field Museum of Natural History
Trachemys scripta	IL	41.815331	−88.067924	2009	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	41.78391	−87.582675	2009	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	40.3969	−90.0095	2010	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	37.386322	−88.90472	2011	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.262573	−88.84919	2011	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.269955	−88.854675	2011	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.334816	−88.925575	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.369347	−88.94268	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.268417	−89.03406	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.33418	−88.92566	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.334694	−88.92518	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.386185	−88.90437	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	37.369347	−88.94268	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	40.29418	−90.06207	2013	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.91221	−89.81934	2013	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.91221	−89.81934	2013	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	37.91221	−89.81934	2013	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	39.02916667	−90.5675	Unknown	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	38.96111111	−90.48888889	Unknown	Yes	Kikillus *et al.* 2010

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	IL	38.95472222	−90.54944444	Unknown	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	38.99583333	−90.55861111	Unknown	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	38.98416667	−90.55333333	Unknown	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	38.30416667	−90.13583333	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	40.24361111	−89.97888889	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	40.44916667	−90.16166667	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	IL	37.92083333	−89.91555556	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta	IL	41.851835	−88.307504	Unknown	Unknown	Field Museum of Natural History
Trachemys scripta elegans	IL	38.10194	−87.92888	Unknown	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	38.10194	−87.92888	Unknown	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	38.10194	−87.92888	Unknown	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	42.28481	−89.06727	Unknown	Unknown	Illinois Natural History Society
Trachemys scripta elegans	IL	41.50109	−90.5074	Unknown	Unknown	Illinois Natural History Society
Trachemys scripta	IL	39.9335	−91.3886	Unknown	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IL	39.935955	−91.38685	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	39.935955	−91.38685	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	39.935955	−91.38685	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	39.935955	−91.38685	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IL	39.935955	−91.38685	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta	IL	37.13991	−89.33138	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta	IN	38.31200809	−87.58566839	1940	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	38.31200809	−87.58566839	1940	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	37.822307	−87.953791	1940	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	41.117465	−86.602472	1944	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	40.811341	−86.795606	1946	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	40.809072	−86.791839	1947	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	37.822307	−87.953791	1950	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	41.135462	−86.416117	1951	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	38.877683	−86.06926	1954	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IN	41.19474	−86.41111	1958	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IN	41.10424	−86.56491	1959	Unknown	Global Biodiversity Information Facility

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta	IN	37.966873	−87.698193	1971	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IN	41.36333333	−85.76055556	1993	Unknown	Kikillus *et al.* 2010
Trachemys scripta	IN	39.856654	−86.102809	1994	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	38.942618	−85.828391	1995	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	39.848086	−86.304686	1995	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	39.843097	−86.305764	1996	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	IN	38.39805556	−87.755	2000	Yes	Kikillus *et al.* 2010
Trachemys scripta	IN	41.279722	−86.78424	2000	Unknown	Alan Resetar
Trachemys scripta	IN	41.14558	−86.964559	2000	Unknown	Alan Resetar
Trachemys scripta elegans	IN	39.77581571	−86.13387511	2001	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	IN	39.76666667	−86.14944444	2002	Unknown	Kikillus *et al.* 2010
Trachemys scripta	IN	41.572635	−87.45477	2004	Unknown	Alan Resetar
Trachemys scripta	IN	41.561194	−87.260988	2004	Unknown	Alan Resetar
Trachemys scripta	IN	41.502441	−87.260755	2004	Unknown	Alan Resetar
Trachemys scripta	IN	41.682412	−86.018583	2004	Unknown	Alan Resetar
Trachemys scripta	IN	41.672632	−87.511981	2005	Unknown	Field Museum of Natural History
Trachemys scripta	IN	41.616283	−87.274043	2008	Unknown	Alan Resetar
Trachemys scripta	IN	41.158659	−86.941535	2009	Unknown	Alan Resetar
Trachemys scripta	IN	41.616283	−87.274043	2009	Unknown	Alan Resetar
Trachemys scripta	IN	41.526398	−87.223412	2011	Unknown	Alan Resetar
Trachemys scripta elegans	IN	38.12944444	−87.935	Unknown	Yes	Kikillus *et al.* 2010
Trachemys scripta elegans	IN	41.32527778	−86.26055556	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	IN	41.20388889	−86.40555556	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	IN	41.647863	−87.053755	Unknown	Unknown	Personal correspondance: James Parham
Trachemys scripta	IN	38.294147	−86.981641	Unknown	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	38.430938	−87.714452	Unknown	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	IN	40.4544	−85.7919	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IN	41.225224	−86.59028	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IN	38.026	−88.0105	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IN	41.225224	−86.59028	Unknown	Unknown	Global Biodiversity Information Facility

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	IN	38.128265	−87.93149	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IN	38.026	−88.0105	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	IN	41.20233	−86.40359	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	MI	43.398052	−86.231945	1924	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	42.727643	−84.478477	1933	Yes	HerpNET
Trachemys scripta	MI	43.261912	−85.818326	1935	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	MI	43.29100615	−86.14965356	1936	Unknown	University of Michigan Museum of Zoology
Trachemys scripta	MI	43.398052	−86.231945	1936	Unknown	University of Michigan Museum of Zoology
Trachemys scripta elegans	MI	43.398052	−86.231945	1941	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	43.398052	−86.231945	1948	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	43.339072	−86.392149	1948	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	43.507807	−86.122096	1948	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	43.410042	−86.348674	1948	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	42.571263	−83.245499	1958	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta	MI	42.36866	−84.11914	1976	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	MI	42.155323	−83.778029	1994	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	42.317629	−83.238782	1996	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	42.60397778	−84.36819183	1997	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	MI	42.492523	−83.915265	1999	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta	MI	46.00238333	−84.40991667	2000	Unknown	Wieten and Cooper *et al.* 2012

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta	MI	46.00719	−84.46217	2000	Unknown	Wieten and Cooper *et al.* 2012
Trachemys scripta	MI	43.7612725	−86.4037375	2000	Unknown	Wieten and Cooper *et al.* 2012
Trachemys scripta elegans	MI	43.09911145	−83.22131401	2009	Unknown	Michigan Herp Atlas
Trachemys scripta elegans	MI	42.26043778	−83.83541145	2009	Unknown	Michigan Herp Atlas
Trachemys scripta elegans	MI	46.094885	−88.75237	2010	Unknown	Wisconsin Herp Atlas
Trachemys scripta elegans	MI	42.95782095	−82.69856446	2012	Unknown	Michigan Herp Atlas
Trachemys scripta elegans	MI	42.66042431	−83.38565333	2012	Unknown	Michigan Herp Atlas
Trachemys scripta elegans	MI	42.26043778	−83.83541145	2012	Unknown	Michigan Herp Atlas
Trachemys scripta elegans	MI	42.73194444	−84.55166667	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	MI	42.72333333	−84.47805556	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	MN	44.03802	−91.641597	2002	Unknown	Wisconsin Herp Atlas
Trachemys scripta elegans	NY	40.888384	−72.96722	1996	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	40.855568	−73.461966	1997	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	42.8898	−78.8597	2001	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	43.1687	−77.6158	2001	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	41.228276	−74.556015	2005	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	40.795473	−72.883398	2005	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	41.199347	−74.136324	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	40.829951	−72.709758	2007	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	40.828087	−73.884125	2010	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	NY	40.761634	−73.754443	2011	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	NY	40.689445	−73.85579	2011	Unknown	Global Biodiversity Information Facility

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	NY	40.86459	−73.87482	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	NY	40.765938	−73.974945	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	NY	43.443436	−76.568891	2013	Yes	Peter Rosenbaum
Trachemys scripta elegans	OH	40.30412663	−82.79718195	1951	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	OH	40.30412663	−82.79718195	1951	Unknown	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	OH	40.944473	−83.793189	1999	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	OH	41.033993	−81.53712	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	OH	41.02353	−81.545975	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	OH	41.0245	−81.54128	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	OH	40.36777778	−82.66944444	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta	OH	39.34584	−82.97243	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta	OH	39.78293	−84.13837	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	ON	45.37831	−75.70245	1962	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	42.40651	−81.78988	1963	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.66791	−81.68219	1965	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.21931	−80.69219	1965	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	44.54654	−78.67112	1965	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	44.64944	−79.42365	1969	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.30497	−79.952	1984	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.30497	−79.952	1985	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.30497	−79.952	1985	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.13157	−80.37421	1986	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.85445	−78.96698	1986	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.28361	−79.88334	1987	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.28361	−79.88334	1987	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.6159	−79.88589	1988	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.6159	−79.88589	1988	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.64712	−79.47118	1988	Unknown	Ontario Herpetofaunal Survey

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	ON	43.64712	−79.47118	1989	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.64712	−79.47118	1989	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.64712	−79.47118	1989	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	45.23644	−81.6421	1990	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.64712	−79.47118	1990	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.64712	−79.47118	1990	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.64802	−79.47116	1990	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.82244	−79.0949	1991	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.82246	−79.09614	1991	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.25857	−79.99961	1991	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.82593	−80.01008	1991	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1991	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	42.74425	−81.02688	1992	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	44.27938	−80.83584	1992	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.02272	−80.00836	1992	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.31606	−80.94821	1992	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	44.37862	−79.72591	1992	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.94837	−79.44354	1992	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1993	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1993	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.64712	−79.47118	1993	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.83945	−79.44513	1993	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	42.26708	−83.07458	1994	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.4755	−80.55737	1994	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43205	−80.50085	1994	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	42.265609	−83.0741	1995	Unknown	Ontario Nature
Trachemys scripta elegans	ON	42.86231	−79.57148	1995	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.69889	−80.38075	1995	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	42.02292	−82.81419	1996	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1996	Unknown	Ontario Herpetofaunal Survey

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	ON	43.43204	−80.49961	1996	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1996	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1996	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1996	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43204	−80.49961	1996	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	42.40342	−82.15438	1997	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	42.40342	−82.15438	1997	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.29282	-−0.38611	1997	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.43294	−80.49961	1997	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.640775	−79.465902	1998	Yes	Bunnell 2005
Trachemys scripta elegans	ON	43.66098092	−79.90734716	1998	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.39070598	−79.71626753	2000	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.55892	−79.6158	2000	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.6462	−79.46997	2000	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.16843	−79.71937	2002	Unknown	Ontario Herpetofaunal Survey
Trachemys scripta elegans	ON	43.17869	−79.26761	2002	Unknown	Ontario Herpetofaunal Survey
Trachemys species	ON	42.0205132	−82.5000918	2003	Unknown	Personal correspondance: M.J. Oldham
Trachemys scripta elegans	ON	44.296832	−78.305253	2004	Unknown	Personal correspondance: M.J. Oldham
Trachemys scripta elegans	ON	43.68293333	−79.49603056	2004	Unknown	Ontario Nature
Trachemys scripta	ON	45.01649	−75.64629	2005	Unknown	Ontario Nature
Trachemys scripta elegans	ON	45.35627	−75.6606	2007	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.68293333	−79.49603056	2007	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.616435	−79.378045	2007	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.68293333	−79.49603056	2007	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.68293333	−79.49603056	2007	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.68293333	−79.49603056	2007	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.68293333	−79.49603056	2007	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.68293333	−79.49603056	2007	Unknown	Ontario Nature
Trachemys scripta elegnas	ON	43.87312755	−78.80317681	2008	Unknown	Personal correspondance: M.J. Oldham
Trachemys scripta elegans	ON	43.5548	−79.615	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.2777	−79.9015	2008	Unknown	Ontario Nature

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	ON	43.6827	−79.4962	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.6827	−79.4962	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.6827	−79.4962	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.683	−79.4959	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.683	−79.4959	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.683	−79.4959	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.683	−79.4959	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.683	−79.4959	2008	Unknown	Ontario Nature
Pseudemys scripta	ON	42.90282	−79.4465	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.640051	−79.481964	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.61511111	−79.38816667	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.17808	−79.371843	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.592576	−79.512863	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.62143	−79.48127	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.62	−79.38	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.793464	−79.121604	2008	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.62272	−79.33522	2009	Unknown	Ontario Nature
Trachemys scripta elegans	ON	44.09478651	−79.4894	2009	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.6869	−79.36666	2009	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.2511	−79.9925	2009	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.0087851	−81.26718854	2009	Unknown	Ontario Nature
Trachemys scripta elegans	ON	42.265609	−83.0741	2010	Unknown	Ontario Nature
Trachemys scripta elegans	ON	42.265609	−83.0741	2010	Unknown	Ontario Nature
Trachemys scripta elegans	ON	42.24841604	−83.0682	2010	Unknown	Ontario Nature
Trachemys scripta elegans	ON	44.533472	−81.186604	2010	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.366342	−81.017625	2010	Unknown	Ontario Nature
Trachemys scripta elegans	ON	42.26581601	−83.0741	2010	Unknown	Ontario Nature
Trachemys scripta elegans	ON	45.3924	−75.5134	2011	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.14862243	−80.30308971	2011	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.85809217	−78.92955097	2011	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.16384167	−79.26542778	2011	Unknown	Ontario Nature

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	ON	43.70381687	−79.2384867	2011	Unknown	Ontario Nature
Trachemys scripta elegans	ON	44.62558	−75.70466	2011	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.61294713	−79.48686468	2011	Unknown	Ontario Nature
Trachemys scripta elegans	ON	42.9157169	−82.1745326	2012	Unknown	Personal correspondance: M.J. Oldham
Trachemys scripta elegans	ON	42.265353	−83.074247	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.89226363	−79.30355438	2012	Unknown	Ontario Nature
Pseudemys scripta elegans	ON	42.9157169	−82.1745326	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.190722	−79.273632	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.87243514	−79.31631527	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.89554849	−79.27668032	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.737271	−79.330878	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.641694	−79.458319	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.685998	−79.366264	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.6388	−79.4647	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	45.50416667	−75.49333333	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.8221	−79.1654	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.85792279	−78.92964393	2012	Unknown	Ontario Nature
Trachemys scripta elegans	ON	43.00898963	−81.15675525	2013	Unknown	Ontario Nature
Trachemys scripta elegans	ON	45.42111111	−75.69194444	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	PA	42.242676	−79.831924	1948	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	PA	40.61643793	−75.59169798	1996	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.182465	−74.997876	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.460311	−75.228717	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.242653	−74.840324	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.874364	−75.27129	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.927937	−75.365927	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	PA	40.374506	−75.502052	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.876535	−75.296833	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.893669	−76.702133	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.462917	−75.920315	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.093145	−75.737321	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.900586	−75.18529	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.902682	−75.181438	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.901426	−75.178558	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.875803	−75.211828	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.137242	−74.779199	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.113936	−74.859895	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.088633	−74.87411	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.558939	−78.10825	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.315101	−75.20464	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.324279	−75.19234	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species

APPENDIX TABLE A2.—Continued

Name listed	State/ Province	Latitude	Longitude	Year Found	Reproducing?	Source
Trachemys scripta elegans	PA	40.103705	−74.862807	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.172885	−74.816201	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.175614	−75.011447	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.151013	−74.780632	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.293069	−74.877794	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.800664	−76.899647	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	39.893009	−76.721413	2006	Yes	U.S. Geological Survey - Non-Indigenous Alien Species
Trachemys scripta elegans	PA	40.063526	−76.33406	2012	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	PA	40.24854	−76.87558	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	PA	39.88138889	−75.24194444	Unknown	Unknown	Kikillus *et al.* 2010
Trachemys scripta elegans	PA	40.24854	−76.87558	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	PA	40.24854	−76.87558	Unknown	Unknown	Global Biodiversity Information Facility
Trachemys scripta	WI	45	−90	1951	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	WI	43.08333	−89.38333	1964	Unknown	Wisconsin Herp Atlas
Trachemys scripta	WI	44.498833	−87.99482	1981	Unknown	Global Biodiversity Information Facility
Trachemys scripta elegans	WI	43.080311	−89.479155	2005	Unknown	Wisconsin Herp Atlas
Trachemys scripta	WI	42.545551	−87.955438	2009	Unknown	Field Museum of Natural History
Trachemys scripta elegans	WI	42.545747	−87.955437	2009	Yes	Herpetological Review
Trachemys scripta elegans	WI	42.924827	−88.033518	2010	Yes	Wisconsin Herp Atlas
Trachemys scripta elegans	WI	43.043032	−87.899448	2011	Unknown	Wisconsin Herp Atlas
Trachemys scripta elegans	WI	44.748856	−92.802147	2012	Unknown	Wisconsin Herp Atlas
Trachemys scripta elegans	WI	44.053003	−91.56287	2012	Unknown	Wisconsin Herp Atlas
Trachemys scripta elegans	WI	44.498947	−87.994812	Unknown	Unknown	Wisconsin Herp Atlas
Trachemys scripta elegans	WI	46.342403	−91.343668	Unknown	Unknown	Wisconsin Herp Atlas

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