MANAGING SPECIES OF CONSERVATION NEED IN THE FACE OF CLIMATE CHANGE: A LANDSCAPE AND TRAIT-BASED APPROACH

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ABSTRACT

Wildlife management agencies need to adapt management plans to include the potential effects of climate change in order to minimize extinction risk and ensure that future management actions provide long-term benefits for focal species. Climate change vulnerability assessments can help management agencies incorporate climate change into their management plans. Here, I attempt to overcome many of the limitations of existing vulnerability assessments by (1) developing a new method to measure climate change that accounts for changes in multiple weather variables and multiple statistics of climate that are known to be important to the ecology and evolution of species and (2) taking a spatial approach and using expert knowledge to obtain information on rare and poorly studied species. I utilize the spatial aspects of the vulnerability assessment to provide management recommendations for biodiversity and for 113 New York State Species of Greatest Conservation Need in the northeastern United States.

In the first chapter, I present a novel index of climate change (climate overlap) that synthesizes changes in multiple weather variables and multiple statistics of climate. Most climate change studies and vulnerability assessments focus only on changes in the means of weather variables. Focusing only on changes in the means could be misleading because the variation, probability of extremes, and correlation between weather variables are known to affect the biology, abundance, diversity, and evolution of organisms. I estimate the overlap between multivariate normal probability distributions representing historical and current or projected future climates. The index is interpreted as the similarity in weather between historical and projected future time periods and is scaled between zero and one, where zero represents completely novel future weather and one represents completely similar future weather. I apply climate overlap to show that current local climates in the continental United States have an

average of overlap of 0.442 with historical climates. Much of the change between current and historical climates is due to changes in the variation within and correlation between weather variables. I show that on average the northeastern United States will experience novel local weather (climate overlap < 0.01) by 2054 with 98.9% of the northeastern United States experiencing novel local weather by the end of the century. I also incorporate climate overlap into estimates of climate change velocity to produce the first estimates of climate change velocity to account for changes in multiple weather variables and statistics of climate. Incorporating climate overlap into estimates of climate change velocity decreases estimates of velocity by 59%, when compared to estimates made using only changes in the mean of mean annual temperature. My results demonstrate the importance of accounting for multiple statistics of climate to accurately characterize the magnitude and spatial variation of climate change.

In the second chapter, I map spatial indicators of the vulnerability of biodiversity to climate change in the northeastern United States. These spatial indicators combine to describe the amount of climate change predicted for a region and the degree to which landscape features in the region will inhibit species ability to adapt to that change. I then extend this spatial model to rank the relative vulnerability of 113 New York State Species of Greatest Conservation Need to climate change. I combine the relative vulnerability of all the focal species to identify areas on the landscape where decreasing landscape resistance (i.e., decreasing the effect of dispersal barriers) or reducing non-climate threats could help reduce the vulnerability of a large number of focal species and I identify factors that may influence the long-term benefit of species-specific management actions under climate change (i.e., climate-smart management considerations). Last, I use the New England cottontail as a detailed example of how my results can be used to guide species-specific management.

My results suggest that biodiversity in the northeastern United States is likely to be most vulnerable to climate change in Delaware and least vulnerable in Maine, but that much can be done across all the northeastern United States to reduce vulnerability. Highly vulnerable species (i.e., the top 10%) are vulnerable because their dispersal ability will not allow them to keep pace with climate change velocity and they occur in regions with low local landscape resistance relative to other species. The least vulnerable species (i.e., the lowest 10%) tended to be habitat and dietary generalists and occur in areas where the magnitude of climate change is expected to be low relative to other regions of the northeastern United States. The Hudson Valley of New York State is a hotspot in the northeastern United States for both decreasing landscape resistance and reducing non-climate threats in areas with diverse topoclimates to reduce the vulnerability of the most species included in our analysis. I provide species-specific vulnerability results and management recommendations in Appendix VIII for each of the 113 focal species.

BIOGRAPHICAL SKETCH

Christopher Nadeau received his Bachelor of Science in Landscape Analysis in the Department of Natural Resources at the University of Arizona in 2009 and a Fish and Wildlife Technician Diploma from Sir Sandford Fleming College in 2000.

I wish to dedicate this work to my wife, Joanna Nadeau, who never gets tired of my endless desire to talk science;

To my parents, Paul and Linda Nadeau, and brother Jeremy Nadeau, whose support provided the safety net necessary for me to pursue my dreams;

And to Dr. Courtney Conway for always encouraging me to bite off more than I can chew and for giving me the confidence to pursue a career in science.

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I would like to thank my committee Dr. Patrick Sullivan and Dr. Dan Rosenblatt for their support and guidance. I would also like to thank my advisor, Dr. Angela Fuller, for her mentoring and support. Last, I would like to thank my wife and family for their boundless encouragement and support.

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CHAPTER 1

ACCOUNTING FOR MULTIPLE CLIMATE COMPONENTS WHEN ESTIMATING THE MAGNITUDE AND VELOCITY OF CLIMATE CHANGE

Climate change is expected to cause major ecological change (Thomas et al. 2004, Intergovernmental Panel on Climate Change 2007b, Jetz et al. 2007, Bellard et al. 2012). Consequently, predicting where species are likely to be most vulnerable to climate change has become a major focus of contemporary ecology and natural resource management. The effect of climate change on species will likely be related to the magnitude (Chen et al. 2011) and velocity (i.e., the speed at which species will need to move to track changing local climates in different landscapes; Loarie et al. 2009) of climate change at local and regional scales. Maps of climate change magnitude and velocity are therefore critical to assessing the vulnerability of species to climate change. However, current methods used to measure climate change are not necessarily relevant to how species experience changes in climate. Therefore existing maps of climate change magnitude and velocity could be misleading.

Climate is a complex multidimensional quantity composed of multiple weather variables and multiple statistics of climate, and climate change is expected to differ across each of these components (Intergovernmental Panel on Climate Change 2007a). Recent studies have demonstrated the need to account for changes in multiple weather variables when evaluating the ecological effects of climate change (McCain and Colwell 2011, VanDerWal et al. 2013) and have urged practitioners to account for multiple statistics of climate (Katz and Brown 1992, Meehl et al. 2000, Parmesan et al. 2000, Jentsch et al. 2007). However, most climate change studies and vulnerability assessments focus only on changes in the means (Jentsch et al. 2007) of weather variables summarized annually, with a large proportion of studies focusing only on changes in the mean of annual temperature. Focusing only on changes in the means could be misleading because the variation, probability of extremes, and correlation between weather variables have strong ecological effects, including effects on the biology (Janzen 1994, Parmesan et al. 2000), abundance (Brown 1984, Parmesan et al. 2000), diversity (Willig et al. 2003), distribution (Whittaker 1970), and evolution of species (Huey and Kingsolver 1989, Holt 2004). Focusing on annual summaries of weather variables ignores important climatic differences among seasons that affect species ability to persist in particular locations. And, focusing on only one weather variable could cause researchers to overlook important interactions among weather variables that affect how species may respond to climate change (McCain and Colwell 2011, Smith 2013, VanDerWal et al. 2013).

Focusing on changes in only the means of weather variables could also misrepresent the sensitivity of many species to climate change (Huey and Kingsolver 1989, Deutsch et al. 2008). For example, tropical ectotherms are expected to be much more vulnerable to climate change than temperate ectotherms, despite predictions of moderate climate change in the tropics (Deutsch et al. 2008, Tewksbury et al. 2008). This is because temperate ectotherms have evolved broader physiological tolerances and acclimation abilities to adapt to more variable climates (Janzen 1967, Ghalambor et al. 2006, Deutsch et al. 2008, Tewksbury et al. 2008). Correlation between physiological tolerances of ectotherms and environmental variation has also been observed on much smaller spatial scales within species (Hirshfield et al. 1980, Feminella and Matthews 1984, Huey and Kingsolver 1989) and predicted by theoretical models (Lynch and Gabriel 1987, Huey and Kingsolver 1989, Angilletta Jr. et al. 2002). Thermal tolerances of endotherms are not as well described, but some evidence suggests that endotherms from more variable environments also have broader physiological tolerances (Scholander et al. 1950, Huey et al. 2012). Current estimatess of the magnitude and velocity of climate change do not capture this sensitivity to historical climate variation and therefore do not suggest that species from less variable climates will be more vulnerable (Tewksbury et al. 2008).

Here, I present an index of climate change (i.e., climate overlap) that synthesizes changes in the means, variation, probability of extremes, and correlation between multiple weather variables into one easily interpretable index (Fig. 1.1). The index is interpreted as the similarity in weather between historical and projected future time periods and is scaled between zero and one, where zero represents completely novel future weather and one represents completely similar future weather. Climate overlap is sensitive to the historical weather variation in a region (Figs. 1.1 and 1.2) and therefore captures the expected sensitivity of organisms to climate change in a particular location. I apply climate overlap to evaluate the overlap between historical and current climates in the continental United States (US) to identify areas that have already experienced significant climate change. I then evaluate the overlap between historical and projected future climates in the northeastern US. I focus on the northeastern US for future projections to utilize higher resolution climate projections available for this region. I present the year in which I expect local climates in the northeastern US to have an overlap <0.01 with historical climates (i.e., novel local weather), which will help identify where adaptation strategies should be implemented the soonest. Last, I use climate overlap to provide the first estimates of climate change velocity to take into account multiple weather variables and multiple statistics of climate and I compare the results to estimates of climate change velocity calculated using only changes in the mean of annual temperature.

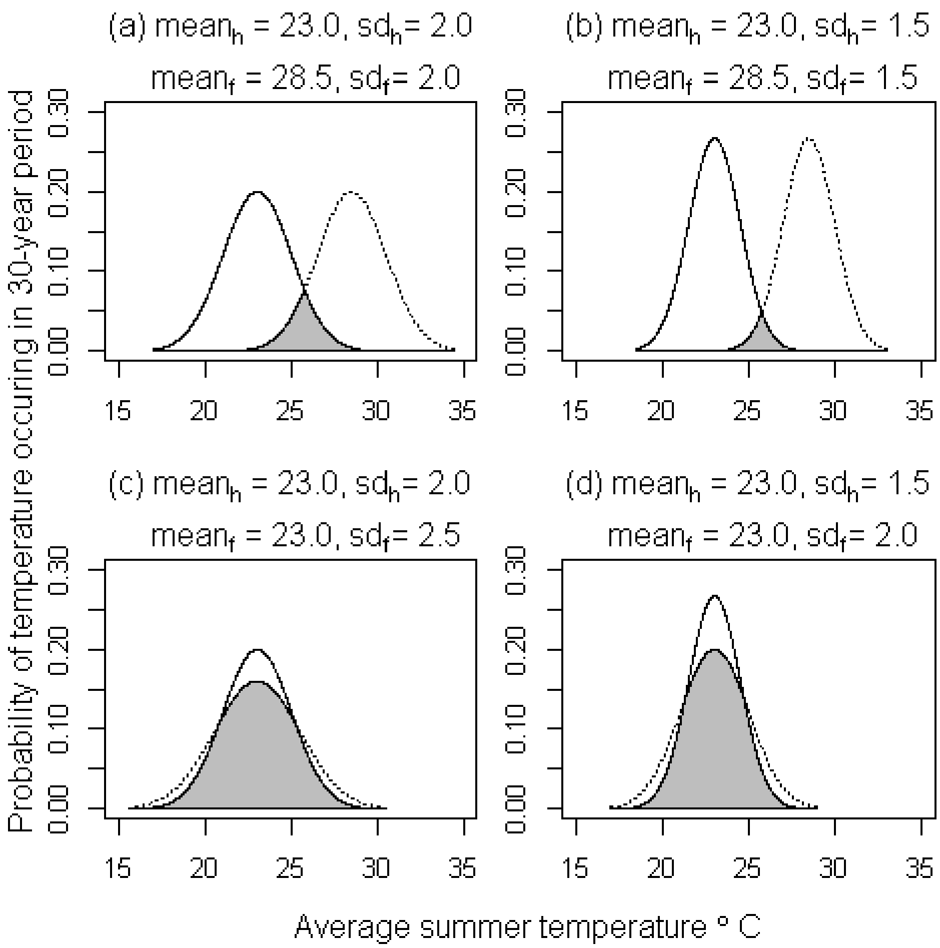

Figure 1.1. Univariate examples of climate overlap (shaded area) between different historical climates (solid line, subscripted h in title) and future climate (dotted line, subscripted f in title) showing the sensitivity of climate overlap to the historical variation in weather. Climate overlap is equal to (a) 0.39, (b) 0.19, (c) 0.95, and (d) 0.92. These examples are easily extended to include multiple weather variables by making the probability distributions multivariate.

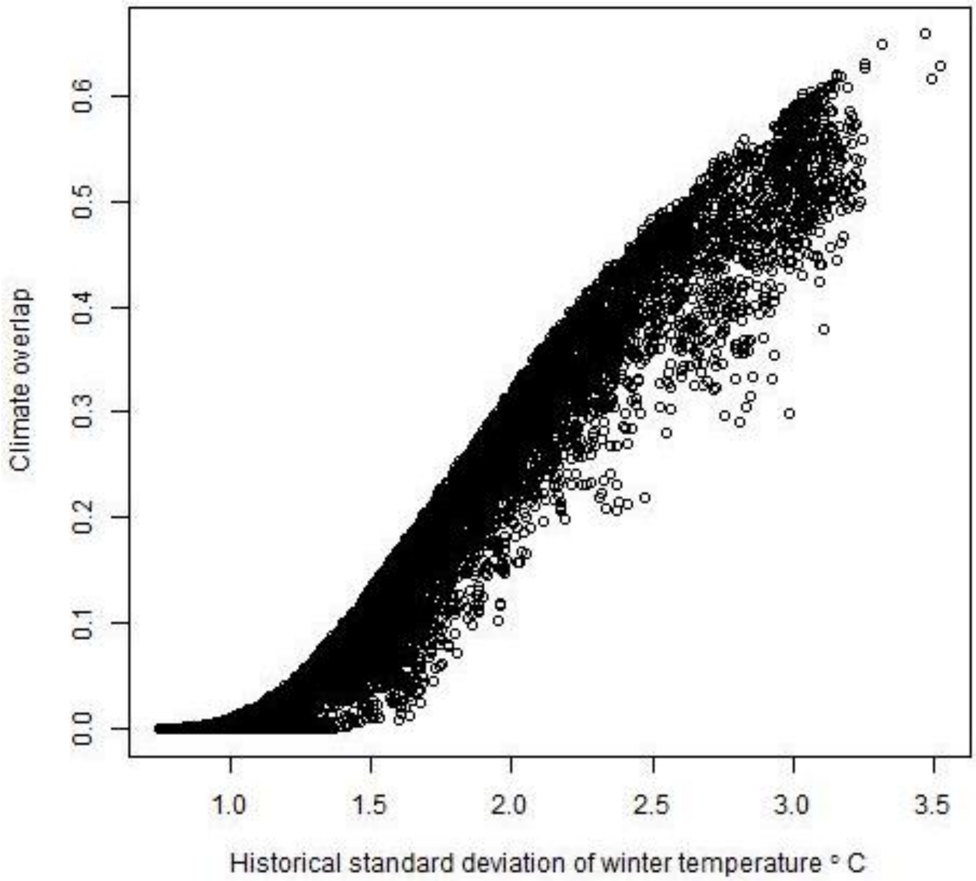

Figure 1.2. The sensitivity of climate overlap to the initial standard deviation of the historical climate (1971-2000) at 10000 randomly selected locations in the United States. We defined climate as a multivariate normal distribution of mean daily minimum winter temperature, total winter precipitation, mean daily maximum summer temperature, and total summer precipitation. Each data point represents climate overlap between the historical climate (1971-2000) at each of 10000 randomly selected locations in the continental United States and the historical climate with a 6°C increase in the mean of mean daily minimum winter temperature. We left the other three climate variables constant. We randomly selected the 10000 historical climates from PRISM climate data. The scatter in this plot is due to the historical variation in the other three climate variables.

Methods

Climate Data:

I represent climate as the 30-year joint probability of mean daily minimum winter (December, January, February) temperature (˚C), total winter precipitation (mm), mean daily maximum summer (June, July, and August) temperature (˚C), and total summer precipitation (mm). I chose these variables because (1) they constrain many plants and animals (Williams et al. 2007), (2) seasonal mean values are robust measures from climate models (Williams et al. 2007), (3) these metrics correlate well with other variables that act as constraints to plants and animals (Williams et al. 2007), and (4) these variables are available over space and time from most common climate models. Note, however, that climate overlap applies to climates defined using any set of weather variables summarized over any spatial or temporal scale.

I used PRISM 0.042˚ resolution climate data (PRISM Climate Group 2013) to analyze the overlap between historical (1971-1990) and current (1993-2012) climates. I used 20-year intervals to calculate the overlap between historical and current climate so that the data for the two intervals was independent. I used data from climate models statistically downscaled to 0.125˚ (Hayhoe et al. 2008) to analyze the overlap between historical (1971-2000) and projected future (2070-2099) climates. I used data from climate models to represent the historical climate (rather than interpolated data such as PRISM data) so that any bias in the climate models did not affect the results. The downscaled models are based on three of the Intergovernmental Panel on Climate Change AR4 global coupled atmospheric-ocean-general-circulation-models (AOGCM; see Hayhoe et al. 2008 for details). In all analyses I averaged the results across the three AOGCMs, but I present the results for each AOGCM in Figs. 1.5, 1.7, and 1.9. The future simulations were forced with the A1Fi emissions scenario, which is a high emissions scenario that assumes the world will remain highly dependent on fossil fuels (Intergovernmental Panel on Climate Change 2000). I chose a high emissions scenario so that the results would represent the worst case scenario from the options available in the climate model dataset.

Climate Overlap:

I used a modified version of Matusita's measure of distributional overlap (Lu et al. 1989) to calculate the overlap between multivariate normal probability distributions representing historical and current or projected future climates. I used a normal probability distribution because (1) parametric probability distribution functions are statistically efficient with low sample sizes (Scherrer et al. 2005), (2) others have shown that seasonal weather means are often distributed normally (Scherrer et al. 2006), (3) Matusita's overlap has a closed-form solution for multivariate-normal distributions (Lu et al. 1989), and (4) climate overlap is robust to realistic violations of the normality assumptions (Appendix I). I used piecewise detrending (Scherrer et al. 2005) to remove the temporal trend associated with each variable in each time period prior to estimating the variance for the probability distributions. For multivariate normal distributions, Matusita's overlap is defined as:

$$\rho = (Q * R)$$

where Q is a measure of the change in the variance-covariance matrix and R is a measure of a change in the means (Lu et al. 1989). Q and R are defined as:

$$Q = \frac{|\Sigma_1 \Sigma_2|^{1/4}}{\left|\frac{1}{2}(\Sigma_1 + \Sigma_2)\right|^{1/2}}$$

$$R = \exp[-\frac{1}{4}(\mu_1 - \mu_2)' (\Sigma_1 + \Sigma_2)^{-1}(\mu_1 - \mu_2)]$$

where Σ is a variance-covariance matrix, μ is a vector of means, and 1 and 2 are the historical and changed climates, respectively. I modified Matusita's overlap to make it more sensitive to changes in variation, as follows:

$$\rho' = (Q^4 * R) \qquad \text{(eqn 1)}$$

This modification makes climate overlap similar to the proportional similarity constant (Appendix II); a measure of distributional overlap that is more sensitive to changes in the variation but that is not easily extended to multivariate distributions (Lu et al. 1989). Hence, this modification allowed climate overlap to be more sensitive to changes in the variation without changing the interpretation of the index.

Climate Change Velocity:

I modified methods in Loarie et al. 2009 to calculate climate change velocity using climate overlap. I used the statistically downscaled climate data described above to calculate both the spatial and temporal gradients in climate. I used data from 1971-2000 for the spatial gradient. I modified the average maximum technique to estimate the spatial rate of change in climate overlap (*dρ/dz*) as follows:

$$\frac{d\rho}{dz} = \sqrt{\frac{d\rho}{dx}^2 + \frac{d\rho}{dy}^2}$$

$$\frac{d\rho}{dx} = \frac{\rho\left(C_{i-1,j+1}, C_{i-1,j-1}\right) + 2\rho\left(C_{i,j+1}, C_{i,j-1}\right) + \ \rho\left(C_{i+1,j+1}, C_{i+1,j-1}\right)}{8\ w_x}$$

$$\frac{d\rho}{dy} = \frac{\rho\left(C_{i-1,j-1}, C_{i+1,j-1}\right) + 2\rho\left(C_{i-1,j}, C_{i+1,j}\right) + \ \rho\left(C_{i-1,j+1}, C_{i+1,j+1}\right)}{8\ w_y}$$

where, *dρ/dx* and *dρ/dy* are the rate of change in climate overlap in the x- and y-directions (respectively), *C* is a three by three matrix of climate values centered on the focal cell ($C_{i,i}$), *ρ(a, b)* is climate overlap between climates *a* and *b*, and *w* is the cell width (km) in the x- or y-direction. I only estimated the spatial rate of climate change in pixels where I had climate data for all eight neighbors. I used a linear regression with annual mean temperature as the response variable and year (1971 – 2099) as the explanatory variable to estimate the temporal gradient in annual mean temperature. I also used a linear regression to estimate the temporal gradient in climate overlap; however, I used the overlap between the historical climate (1971-2000) and 30-year climates at three year intervals up to 2070-2099 as the response variable. I report geometric mean velocities and display all velocity surfaces using a log-transformed scale due to the highly skewed distribution of velocity (Loarie et al. 2009). I used a paired Wilcoxon signed rank test (Bauer 1972, Hollander and Wolfe 1973) to test whether velocity differed between climate change velocity calculated using climate overlap and the method using only the mean of temperature.

Results

Current climates in the continental US have an average overlap of 0.442 (SD = 0.143) with historical climates, although overlap ranges between 0.001– 0.904 (Fig. 1.3a). Current climates in two areas on the California coast have the least overlap with historical climates (Fig. 1.3a). In general, mountainous areas have the least overlap between historical and current climates (Fig. 1.3a), likely due to a lessoning of the snow-albedo feedback (Giorgi et al. 1997). Changes in the variation and correlation between weather variables (Q_{mean} = 0.490, Fig. 1.3c) contributed more to the dissimilarity between historical and current climates than changes in the mean (R_{mean} = 0.854, Fig. 1.3b).

On average, novel local weather is projected for the northeastern US by 2056 (SD = 4.8 years) under the A1fi emissions scenario, however the year varies between 2048 and >2100 (Fig. 1.4). Climates in the northern part of the region are expected to have novel local weather soonest due to a lessoning of the snow-albedo feedback (Hayhoe et al. 2007, Rawlins et al. 2012) and projected changes in atmospheric circulation patterns (Hayhoe et al. 2008). Local weather in 98.9% of the northeastern US is expected to be novel by the end of the century (Figs. 1.4 and 1.6a). End-of-the-century climates are projected to be least similar in northern New York State and Vermont (Fig. 1.6a) and most similar in southern New York State, Connecticut, New Jersey, and eastern Pennsylvania. These results depend on the AOGCM used (Figs. 1.5 and 1.7). The dissimilarity between historical and end-of-the century climates in the northeastern US is driven primarily by changes in temperature because (1) temperature is expected to change more than precipitation (Hayhoe et al. 2007, Rawlins et al. 2012) and (2) temperature is less variable than precipitation, therefore climate overlap is more sensitive to temperature changes. However, changes in precipitation contribute to the spatial variation in climate overlap. Changes in the mean of the four weather variables (R_{mean} = 0.007, Fig. 1.6b) contributed substantially more to the dissimilarity between historical and future climates than changes in the variation and correlation between weather variables (Q_{mean} = 0.579, Fig. 1.6c); however, the variation and correlation between variables are also expected to change substantially (Fig. 1.6c).

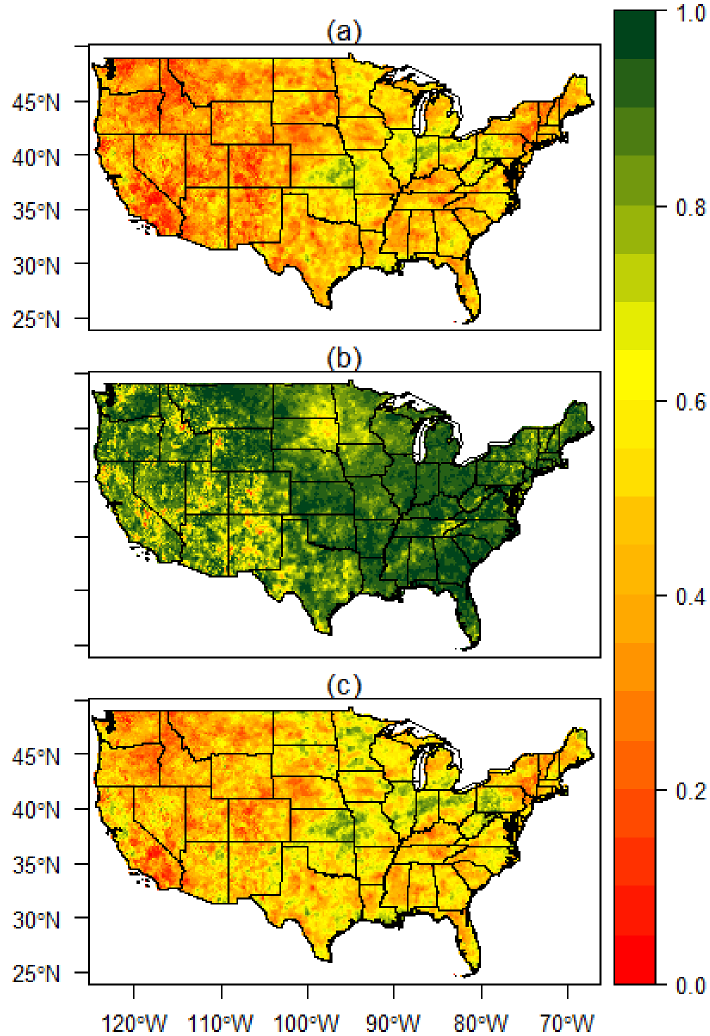

Figure 1.3. (a) Overlap between historical (1971 - 1990) and current (1993 - 2012) climates in the continental United States, and the contribution of changes in (b) the means and (R in eqn. 1) and (c) the variation and correlation between weather variables (Q in eqn. 1).

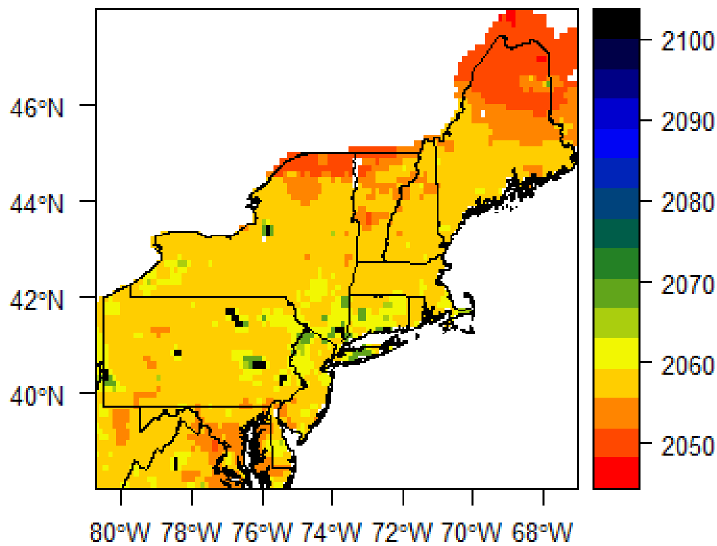

Figure 1.4. The year during which locations in the northeastern United States will experience completely novel local weather (i.e., climate overlap < 0.01) based on the average climate overlap from three AOGCMs forced with the A1fi emissions scenario. Areas colored black are areas that are expected to have overlap >0.01 until at least 2100.

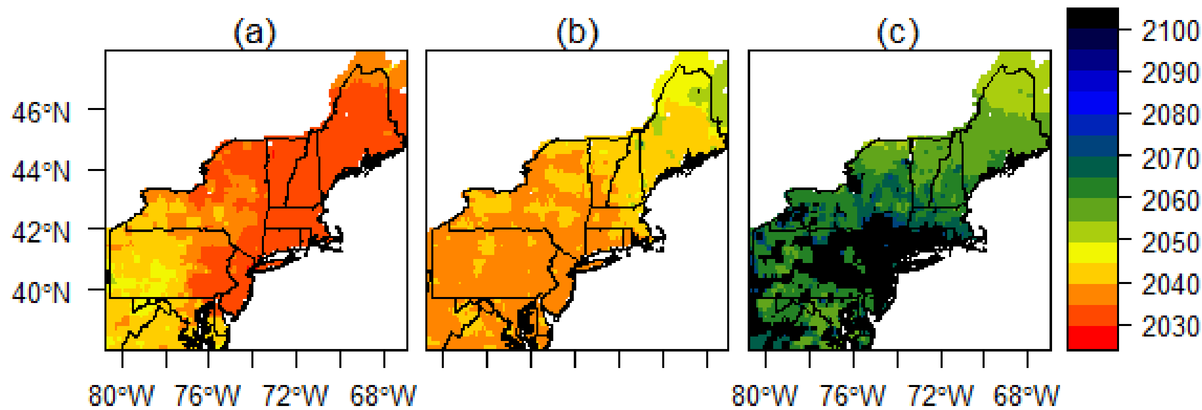

Figure 1.5. The year during which locations in the northeastern United States will experience completely novel weather (i.e., climate overlap < 0.01) based on data from the (a) United Kingdom Meteorological Office Hadley Centre Climate Model version 3 (Pope et al. 2000), (b) United States National Oceanographic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory CM2.1 (Delworth et al. 2006), and (c) United States Department of Energy/National Center for Atmospheric Research Parallel Climate Model (Washington et al. 2000). Each model was forced with the A1fi emissions scenario. Areas colored black are areas that are expected to have overlap > 0.01 until at least 2100. On average, novel local weather is projected for the northeastern US by (a) 2037 (SD = 4.7 years), (b) 2041 (SD = 5.4 years), or (c) 2078 (SD = 19.7 years), if all the areas in black are treated as year 2100, depending on the AOGCM.

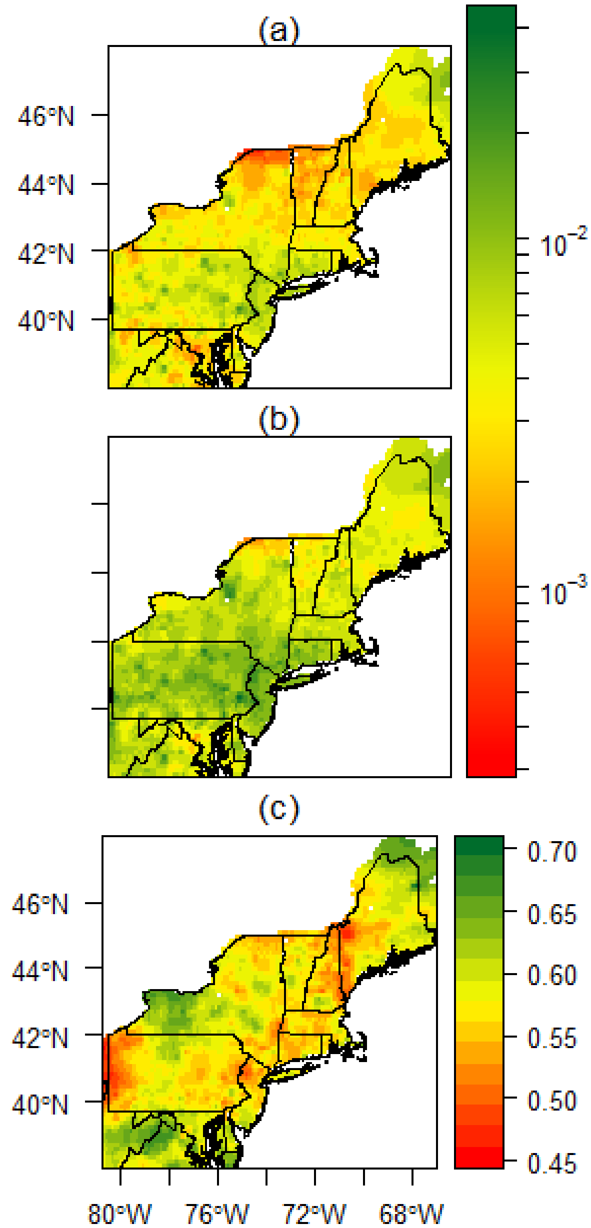

Figure 1.6. (a) Overlap between historical (1971 – 2000) and projected future (2070 – 2099) climates in the northeastern United States, and the contribution of changes in (b) the means (R in eqn. 1) and (c) the variation and correlation between weather variables (Q in eqn. 1). (a) and (b) are presented on a log scale to highlight the spatial variation in climate overlap. These data are the average of climate overlap across three AOGCMs forced under the A1fi emissions scenario.

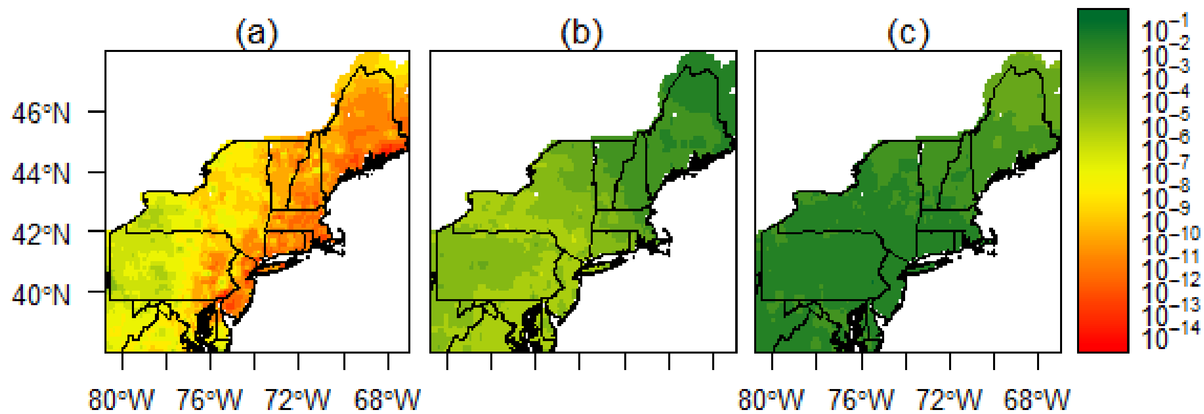

Figure 1.7. Overlap (log scale) between historical (1971 – 2000) and projected future (2070 – 2099) climates in the northeastern United States based on data from the (a) United Kingdom Meteorological Office Hadley Centre Climate Model version 3 (Pope et al. 2000), (b) United States National Oceanographic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory CM2.1 (Delworth et al. 2006), and (c) United States Department of Energy/National Center for Atmospheric Research Parallel Climate Model (Washington et al. 2000). Each model was forced with the A1fi emissions scenario. Novel weather is expected in (a) 100%, (b) 91.5%, or (c) 58.2% of the northeastern United States by the end of the century, depending on the AOGCM.

The geometric mean velocity of climate change was 0.75 km/yr when estimated using climate overlap and 1.81 km/yr when estimated using only the change in mean temperature (Fig. 1.8). Hence, accounting for multiple weather variables and multiple statistics of climate resulted in 59% ($p < 0.001$) lower estimate of mean climate change velocity. The spatial pattern in climate change velocity was similar across the two methods (Fig. 1.8) and across AOGCMs (Fig. 1.9). Velocity was generally highest in areas with little diversity in large-scale topography, including the Alleghany region of northern Pennsylvania and southwestern New York, west of the Adirondack and Catskill Mountains in New York, and northern and northeastern Maine (Fig. 1.8).

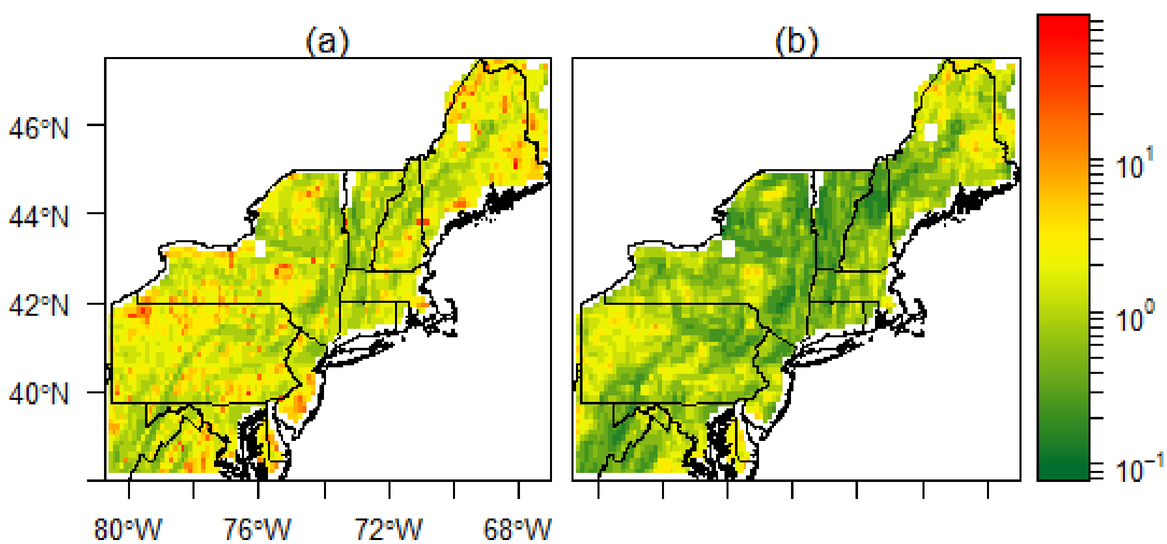

Figure 1.8. Climate change velocity (km/yr) in the northeastern United States estimated using two measures of climate change: (a) change in only mean of temperature, and (b) climate overlap. These data are the average of climate change velocity calculated using data from three AOGCMs forced under the A1fi emissions scenario.

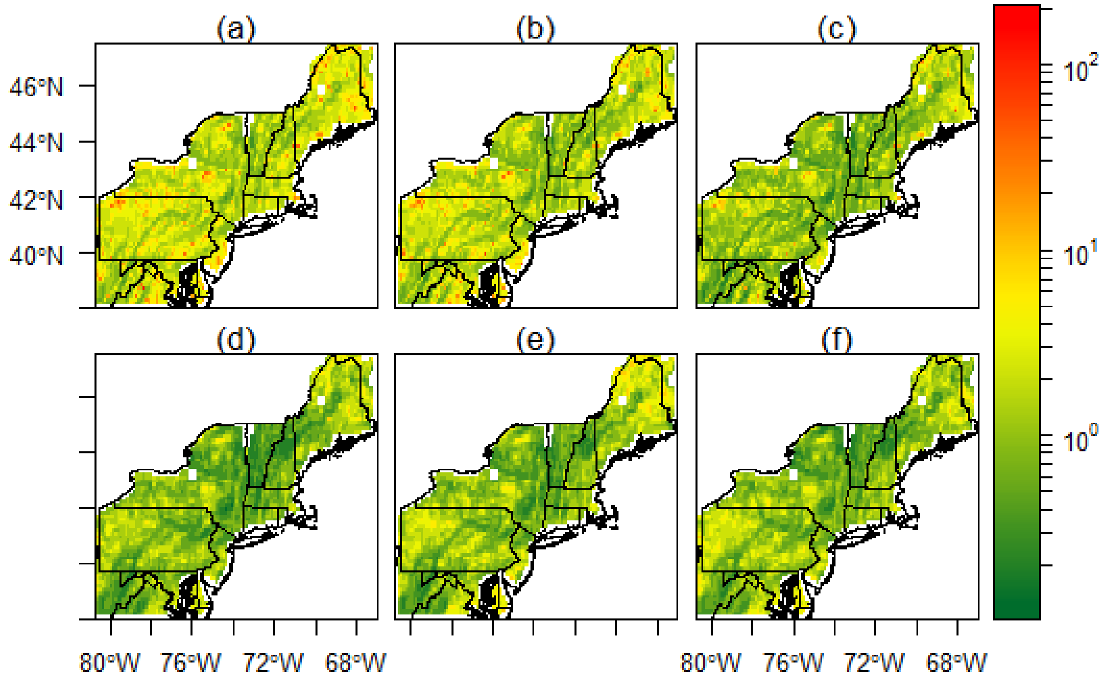

Figure 1.9. Climate change velocity (km/yr, log-scale) in the northeastern United States estimated using two measures of climate change: (a, b, c) change in only the mean temperatures, and (c, d, e) climate overlap. We computed the spatial and temporal gradient of climate change based on data from the (a, d) United Kingdom Meteorological Office Hadley Centre Climate Model version 3 (Pope et al. 2000), (b, e) United States National Oceanographic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory CM2.1 (Delworth et al. 2006), and (c, f) United States Department of Energy/National Center for Atmospheric Research Parallel Climate Model (Washington et al. 2000). Each model was forced with the A1fi emissions scenario. The geometric mean of climate change velocity in the northeastern United States is (a) 2.38, (b) 1.88, (c) 1.15, (d) 0.59, (e) 0.72, or (f) 0.85 depending on the AOGCM.

Discussion

Climate overlap is the first index to simultaneously synthesize changes in the means, variation, probability of extremes, and correlation between multiple weather variables. My results demonstrate the importance of accounting for multiple statistics of climate to accurately characterize the magnitude and spatial variation of climate change. Indeed, changes in the variation and correlation between weather variables contributed most to the overlap between historical and current climates. This could explain why many species are not responding to climate change as predicted (Zuckerberg et al. 2009, Chen et al. 2011), given that predictions are often based on changes in only the mean of weather variables. Changes in the variation and correlation between weather variables also contributed to the spatial variation in projected future climate change. Contrary to other studies (Diffenbaugh et al. 2008), however, my results suggest that mean changes will contribute most to the overlap between historical and future climates.

In addition to accounting for multiple statistics of climate, climate overlap is more sensitive to climate change in areas with low historical climate variability, which corresponds to the expected sensitivity of many organisms to climate change. Historical climate variability may moderate the effects of climate change on species in numerous ways other than affecting their physiological tolerances. For example, species may be better able to evolve adaptations to change in locations with moderate environmental variability (Holt 2004). Climate variability may also moderate competitive exclusion of native organisms by invaders that have shifted their distribution to track favorable climates by allowing invaders and natives to coexist via the storage effect (Chesson and Warner 1981). Climate overlap also has other properties that make it useful in mapping the magnitude of climate change for use in vulnerability assessments. Simulations suggest that locations with similar climate overlap values may experience similar changes in the abundance of a climatically-sensitive species, regardless of which statistic of climate changes (Appendix IV). This is an ideal property of a climate change index because the index value will correlate with the change in abundance of a species in response to climate change.

By incorporating climate overlap into estimates of climate change velocity, I provide the first climate change velocity estimates to account for multiple weather variables and multiple statistics of climate. I am aware of only one other study (VanDerWal et al. 2013) that attempts to estimate multivariate climate change velocity. The advantage of my method is that (1) it accounts for changes in multiple statistics of climate and (2) it is not species specific. Species-specific estimates of climate change velocity require knowledge of the species' climatic tolerances. Climatic tolerances are unknown for most species and correlative approaches used to estimate climatic tolerances are unlikely to provide accurate results for many species (Pearson and Dawson 2003, Guisan and Thuiller 2005, Heikkinen et al. 2006, Austin 2007, Dormann 2007, Sinclair et al. 2010). My estimates of climate change velocity were higher than previous estimates of 0.35 km/yr for the temperate broadleaf and mixed forests biome that encompasses most of the northeastern US (Loarie et al. 2009), regardless of the method I used. I estimated faster velocities because the climate data I used was generated under a higher emissions scenario and had a different resolution than that used in previous studies. Indeed, the choice of climate data affects estimates of climate change velocity, but does not change the spatial pattern of velocity or the conclusion that estimating velocity using climate overlap decreases velocity estimates (Appendix III). My estimates of climate change velocity were less than the mean of 1.27 km/yr estimated by evaluating the shift in suitable climate-space for birds in Australia (VanDerWal et al. 2013). Contrary to the results in Australia (VanDerWal et al. 2013), however, my results suggest that multivariate climate change velocity is slower than climate change velocity calculated using changes in mean temperature alone. More research is needed to determine if this contradiction is regional or methodological.

I am the first to compare the overlap between probability distributions representing climates from two time periods in order to measure the magnitude of climate change; however, this method is similar to recently developed climate stability method (Iwamura et al. 2013) used to compare climates over space. Other authors have evaluated changes in the probability distribution function of weather using quantiles (Ferro et al. 2005, Reich 2012). Although quantile analysis has the advantage of being non-parametric (Ferro et al. 2005, Scherrer et al. 2005), the pitfall is that quantiles are not necessarily biologically meaningful and the results could be affected by the choice of the quantiles. Hence, the interpretation of changes in quantiles is difficult. Furthermore, the estimation of quantiles is inefficient when using small datasets, such as those from seasonal 30-year means (Scherrer et al. 2005) and quantiles are not easily extended to account for multiple climate variables simultaneously. Other studies have shown that seasonal weather means are often distributed normally (Scherrer et al. 2006). Furthermore, climate overlap is robust to violations of the normality assumptions typical of what might be expected throughout the continental United States (Appendix I). For these reasons, my methods offer significant advantages over the use of quantiles.

Climate overlap is a natural way to characterize climate change that has many advantages over existing climate change indices. Existing indices of climate change do not account for multiple statistics of climate (Giorgi and Mearns 2002, Williams et al. 2007, Tebaldi et al. 2011) and are presented in non-intuitive units and scales (Giorgi 2006, Diffenbaugh et al. 2008). Non-intuitive indices (e.g. unitless indices scaled between zero and infinity), provide no frame of reference on which to base interpretation, which can lead policymakers to be less concerned about potential changes. Climate overlap has an intuitive scale between zero and one that is accessible to non-climatologists because it can be interpreted in terms of the similarity between historical and future weather. This interpretation is more in-line with the non-climatologist's mental model of climate (Weber and Stern 2011). Presenting the year in which a location is likely to experience completely novel weather may also help people perceive climate change as a more immediate threat than studies that only present changes predicted for the end of the century (Weber and Stern 2011). Indeed, my results suggest that some locations in the northeastern US may experience novel local weather as soon as 2047. These characteristics of climate overlap could help bridge the divide between climatologists' and non-climatologists' understanding of climate change and bolster public and policymaker support for action (Weber and Stern 2011).

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CHAPTER 2

MANAGING SPECIES OF CONSERVATION NEED IN THE FACE OF CLIMATE CHANGE: A LANDSCAPE AND TRAIT-BASED APPROACH

Climate change is expected to cause major ecological change, including: local and global species extinctions, changes in the composition and location of biological communities, and changes in the timing of species behaviors (Thomas et al. 2004, Jetz et al. 2007, Bellard et al. 2012). Indeed, twenty global extinctions have already been linked to recent climate change through the intensification of drought, extreme storms, or disease (see Table S1 in Cahill et al. 2013). Recent climate change has also caused species to shift their ranges 16.9 km/decade poleward or 11.0 m/decade up in elevation (Chen et al. 2011), and springtime events (e.g., flowering) to occur 2.3 days/decade earlier (Parmesan and Yohe 2003). Recent ecological changes have occurred in response to only minor changes in climate relative to projected future climate change (Intergovernmental Panel on Climate Change 2007). Hence, ecological responses to climate change are likely to intensify in the future as climate change intensifies. Wildlife management agencies need to adapt management plans to include the potential effects of climate change in order to minimize extinction risk and ensure that current and future management actions will provide a long-term benefit for focal species. However, it is logistically and financially impractical for wildlife management agencies, tasked with managing hundreds of species, to evaluate how each species will be affected by climate change. Indeed, the enormity of climate change has many management agencies feeling at a loss for how to adapt, and most recommendations in the published literature are too vague to offer much help (Heller and Zavaleta 2009).

Climate change vulnerability assessments (hereafter vulnerability assessments, Glick et al. 2011, Rowland et al. 2011) can help management agencies address climate change by identifying priority species and areas on the landscape to focus adaptation efforts. Vulnerability assessments attempt to estimate the relative vulnerability of species or locations to climate change by capturing the major factors that could contribute to their vulnerability in a way that is general enough to be applied across a large group of species. Numerous vulnerability assessments have been developed recently, ranging from bottom-up assessments of particular species to top-down assessments of landscape change (Glick et al. 2011, Rowland et al. 2011). Many of these assessments, however, suffer from a similar set of limitations. First, the information required for the assessment is often too specific for many rare and poorly studied species (Williams et al. 2008, Klausmeyer et al. 2011, Schlesinger et al. 2011). Therefore, rare and poorly studied species are not assessed, which is an especially serious problem because these species are often of greatest conservation concern. Second, the results of many vulnerability assessments are not easily used to help inform adaptation strategies (Klausmeyer et al. 2011, Mclaughlin and Zavaleta 2012). The output of most vulnerability assessments is a list of species ranked in order of their vulnerability and a summary of the attributes that make them vulnerable. The attributes listed are often intrinsic to the species and are therefore very difficult or impossible to manipulate in order to reduce vulnerability. Last, and perhaps most importantly, most vulnerability assessments are not spatial in nature, which limits the accuracy of the assessment and its utility to management agencies.

Climate change vulnerability is an inherently spatial problem (Ackerly et al. 2010). The magnitude of climate change is expected to vary greatly over space due to changes in atmospheric circulation patterns (Intergovernmental Panel on Climate Change 2007, Hayhoe et al. 2008) and climate change feedbacks (Hayhoe et al. 2007, Intergovernmental Panel on Climate Change 2007, Manning et al. 2010, Rawlins et al. 2012). Moreover, spatial variation in landscape features will affect how species will respond to climate change. For example, local topographic diversity (i.e., the local variety of landforms and range in elevation) can decrease the rate at which species will need to move to track suitable climates (Loarie et al. 2009) and provide climate refugia where local climates and species may persist (Luoto and Heikkinen 2008, Randin et al. 2009, Rull 2009, Anderson et al. 2012). In contrast, fragmented landscapes and elevational peaks can limit the ability of species to move to track suitable climates (Peters and Darling 1985). Each of these landscape features can also affect genetic diversity or dispersal limited organisms, which will affect the ability of species to evolve adaptations to climate change (Vellend and Geber 2005). Ignoring spatial heterogeneity in climate change or landscape features could significantly affect assessments of species vulnerability. Indeed, excluding topoclimate heterogeneity from models has been cited as one reason why scientists are predicting much higher extinction rates than have been observed in past climate changes (i.e., the Quaternary conundrum; Botkin et al. 2007, Randin et al. 2009). Excluding the spatial aspects of vulnerability also limits the utility of vulnerability assessments to management agencies because they are unable to determine where on the landscape species will be most vulnerable, where species may be resilient, and where to focus adaptation efforts and future management actions.

Here I attempt to overcome many of the limitations of existing vulnerability assessments by taking a spatial approach and using expert knowledge to obtain information on rare and poorly studied species. In the first section of this chapter, I map spatial indicators of the vulnerability of biodiversity to climate change in the northeastern United States and I combine these indicators to produce a spatial index of the vulnerability of biodiversity. The spatial index describes the amount of climate change predicted for a region and the degree to which landscape features in the region will inhibit species ability to adapt to that change. The metric does not apply to all species, but is relevant to the vast majority of terrestrial biodiversity (e.g., many invertebrates, plants, and small mammals). I also provide guidance for climate-smart management of biodiversity under climate change based on the magnitude of climate change and combination of landscape features in each region of the landscape. In the second section of this chapter, I extend the model developed in the first section to rank the relative vulnerability of 113 species of greatest conservation need in New York State to climate change. Most of the species included in this section of this chapter have traits (e.g., they are insensitive to dispersal barriers such as urban areas) that separate them from the vast majority of biodiversity. I modify the model developed in the first section of this chapter to account for the influence of these traits on the species ability to adapt to climate change. I then combine the relative vulnerability of all the focal species to identify areas on the landscape where decreasing landscape resistance (i.e., decreasing the effect of dispersal barriers) or reducing non-climate threats could help reduce the vulnerability of a large number of focal species (i.e., priority management areas for focal species) and I identify factors that may influence the long-term benefit of species-specific management actions under climate change (i.e., climate-smart management considerations). In the last section of this chapter I use the New England cottontail as a detailed example of how my results can be used to guide species-specific management.

Study Area

I focus my analysis in the northeastern United States, including the 14-state region from central West Virginia and Virginia north to Maine (Fig. 2.1). The boundaries of my study area correspond to the highest resolution climate projections available for this region. I focus much of my results on New York State because the species I evaluated are species of greatest conservation need in New York State. I included states other than New York State so that I could provide a regional perspective on the vulnerability species to climate change. My study area excluded coastal and island locations (e.g., long island) because the vulnerability in these regions will be greatly affected by sea level rise; a variable that I did not include in my models. Also, I was only able to estimate climate change velocity (a spatial indicator of vulnerability) in landscape cells that had nine neighbors with available climate data. Coastal and island locations do not meet this criteria, and were therefore excluded from my analysis.

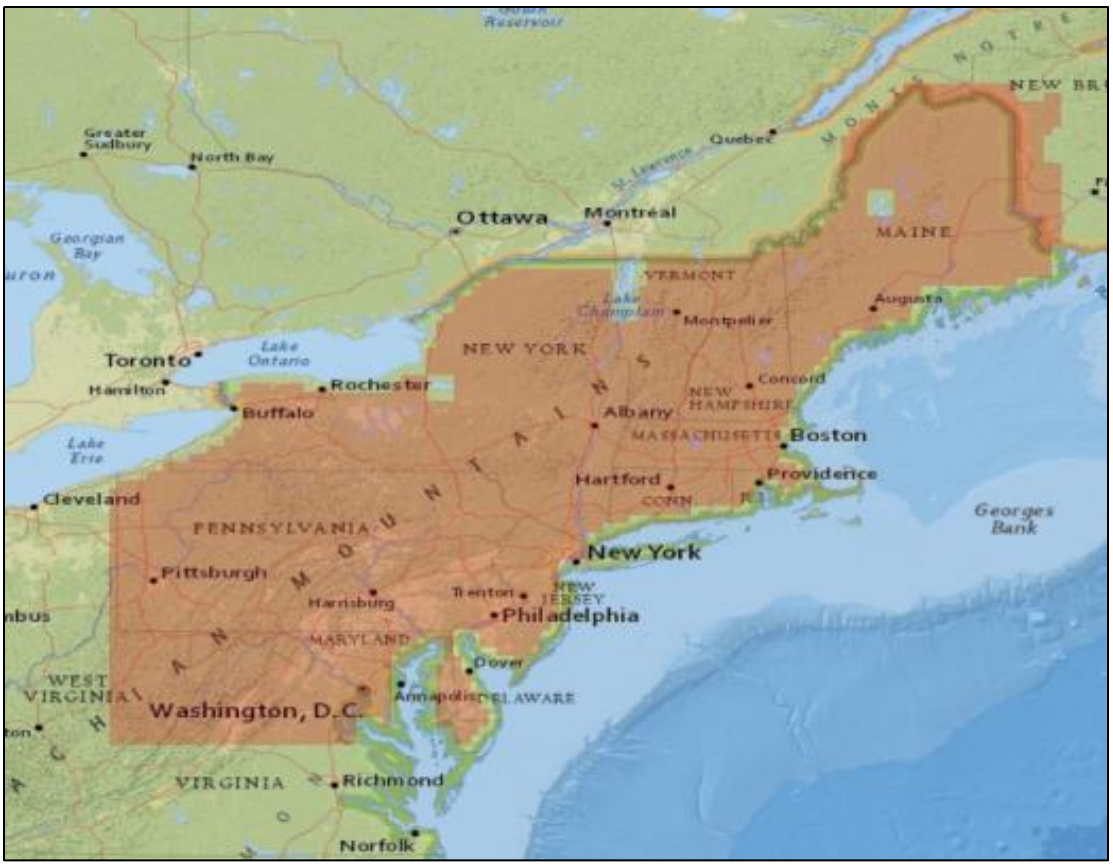


Figure 2.1. Study area highlighted in red. The boundaries of my study area correspond to the highest resolution climate projections available for this region. Holes in the study area occur over large lakes where climate projections are unavailable.

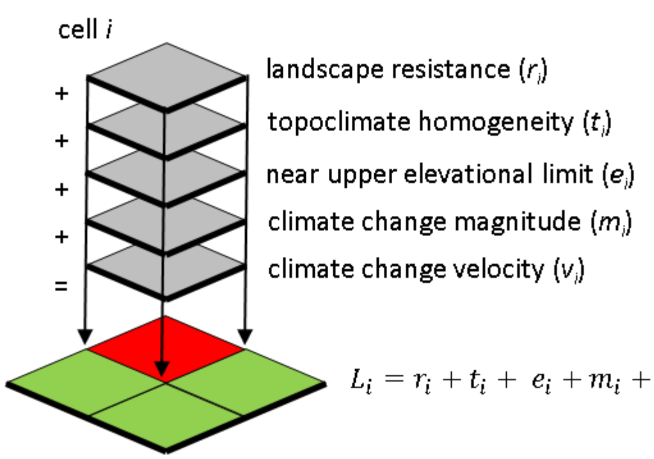
Section I: Spatial Indicators of the Vulnerability of Biodiversity

Mapping Vulnerability:

Areas of the landscape where climate change is likely to affect the vast majority of terrestrial biodiversity are likely those that (1) will experience the greatest amount of climate change, (2) have a history of low variability in climate (Huey and Kingsolver 1989, Deutsch et al. 2008, Tewksbury et al. 2008), and (3) have landscape features that constrain the ability of species to respond to climate change (Ackerly et al. 2010, Klausmeyer et al. 2011). I combined maps of five spatial indicators that address these three criteria to map an index of the vulnerability of biodiversity throughout the northeastern United States (Box 1, Fig. 2.2). These

Box 1: Calculating A Spatial Index of the Vulnerability of Biodiversity

Step 1: calculate spatial index of vulnerability (L_i) in each landscape cell (i)



$$L_i = r_i + t_i + e_i + m_i + v_i$$

Key Uncertainties

1. Uncertainty in climate change magnitude and velocity due to differences in the atmospheric-ocean-general-circulation models used to make climate predictions (see Fig. 2.4).
2. Equal weighting of each spatial indicator. We change this weighting for particular species (see Box 2).
3. Landscape resistance is relevant primarily to species that disperse terrestrially because the primary dispersal barriers include roads and developed areas. Hence, this index is less pertinent to aquatic or semi-aquatic species (see Species Selection).

methods are similar to those used to determine landscape-scale indicators of biodiversity's vulnerability in California (Klausmeyer et al. 2011). I address the first two criteria using the index of climate change magnitude developed in the first chapter: climate overlap. I address the third criteria using maps of (1) climate change velocity, (2) local landscape resistance, (3) topoclimate homogeneity, and (4) whether a location is near the upper-elevational limit of the northeastern United States.

Climate overlap is an index of the magnitude of local climate change that synthesizes changes in the means, variation, probability of extremes, and correlation between multiple weather variables into one easily interpretable measure. Climate overlap has a value of one if the projected future climate is identical to the historical climate in a region and zero if the projected future climate is completely dissimilar to the historical climate. Climate overlap is ideal for use in evaluating the vulnerability of biodiversity because it: (1) accounts for potential changes in multiple statistics of climate and (2) is most sensitive to climate change in locations with low historical climate variability, which corresponds to the expected sensitivity of many species to climate change because species from more variable climates often have broader physiological tolerances (Huey and Kingsolver 1989, Deutsch et al. 2008, Tewksbury et al. 2008, Tomanek 2008) and are better able to evolve adaptations to change (Holt 2004). I defined climate as a multivariate normal probability distribution describing the joint probability of mean daily minimum winter (December, January, February) temperature (˚C), total winter precipitation (mm), mean daily maximum summer (June, July, and August) temperature (˚C), and total summer precipitation (mm). I chose these variables because (1) they constrain many plants and animals (Williams et al. 2007), (2) seasonal mean values are robust measures from climate models (Williams et al. 2007), (3) these metrics correlate well with other variables that constrain plants and animals (Williams et al. 2007), and (4) these variables are available over space and time from most common climate models. I calculated climate overlap between historical (1971-2000) and projected future (2070-2099) climates using data from three atmospheric-ocean-general-circulation-models (AOGCMs) statistically downscaled to a 0.125˚ resolution (~13 km, Hayhoe et al. 2008) and forced with the A1fi emissions scenario (Fig. 2.2b). The A1fi emissions scenario is a high emissions scenario that assumes the world will remain highly dependent on fossil fuels (Intergovernmental Panel on Climate Change 2000). I chose a high emissions scenario so that the vulnerability assessment will represent the worst case scenario from the options available in the climate model dataset. Also, there is some evidence that current emissions are exceeding fossil-fuel intensive emission scenarios (Raupach et al. 2007), and therefore the A1Fi emissions scenario may not be unrealistic. I averaged the climate overlap results across the three AOGCMs when calculating the index of vulnerability; however, I also present the differences among individual AOGCMs (Fig. 2.4d, e, f).

Table 2.1. Data sources.

Variable	**Source**
landscape resistance	Anderson et al. 2011
topoclimate homogeneity	Anderson et al. 2011
climate overlap	Nadeau and Fuller, in review; Hayhoe et al. 2008
climate change velocity	Nadeau and Fuller, in review; Hayhoe et al. 2008
elevation	USGS GTOPO 30 dataset
species trait data	expert opinion
species distribution data	Patterson et al. 2007, Ridgely et al. 2007, NatureServe 2008, IUCN et al. 2004

Climate change velocity is the speed at which organisms will need to move across the landscape to track suitable climates (Loarie et al. 2009). It is calculated as a ratio of the change in climate over space to the change in climate over time within each landscape cell. Locations with high climate change velocity will constrain the ability of dispersal-limited organisms to track suitable climates. I calculated climate change velocity throughout the northeastern United States using climate overlap and the same definition of climate as above to account for projected changes in multiple variables and multiple statistics of climate (Fig. 2.2c). I mapped climate change velocity at a 0.125˚ resolution using the same climate data as described above for both the spatial and temporal gradient. I averaged the velocity estimates across the three AOGCMs; however, I also present the differences among individual AOGCMs (Fig. 2.4g, h, i).

Local landscape resistance (i.e., the complement of landscape permeability) is a measure of the number of dispersal barriers encountered when trying to move out of a focal landscape cell to any neighboring cell. Locations with high local landscape resistance will constrain the ability of species (especially those that are encumbered by dispersal barriers) to track suitable climates. Here, I use an existing map of local landscape resistance with a 90-m resolution (Anderson et al. 2012) that was produced using a resistance-kernel estimator (Compton et al. 2007) with a 3-km kernel (Fig. 2.2d). The resistance-kernel estimator is a combination of kernel-density estimation and least-cost path estimation; two common methods in applied ecology (Compton et al. 2007). Local landscape resistance assumes that species will encounter the least resistance when moving through natural areas (i.e., forests, scrub/shrub, grasslands, and wetlands) without dispersal barriers (e.g., roads, developed areas) and the most resistance when moving through highly developed areas. This measure is not species specific and treats all natural habitats equally. Hence, the measure assumes that habitat requirements for dispersal are much less specific than breeding requirements (Anderson et al. 2012), which is supported by studies that have shown corridors to be used by a wide variety of species from multiple taxa (Haddad et al. 2003, Gilbert-Norton et al. 2010, Doerr et al. 2011).

Topoclimate homogeneity is an estimate of the number of small-scale climates within a region. Topoclimate is the effect of landforms, such as slope or aspect, on climate at 0.01-1.00 km scales (Ackerly et al. 2010). Many researchers have suggested that diverse topoclimates could moderate the effects of climate change by allowing species to move short distances to track their suitable climates (Luoto and Heikkinen 2008, Randin et al. 2009, Anderson et al. 2011). Moreover, regions with more diverse topoclimates often maintain greater genetic diversity due to local genetic adaptations (Jump and Peñuelas 2005, Vellend and Geber 2005). Hence, locations with a large number of potential topoclimates could moderate the effects of climate change. Here, I use an existing map of topoclimate homogeneity that summarizes the number of landforms (e.g., dry flat, southeast sideslope), the range in elevation, and the wetland density within a 40.5-ha circle surrounding each 30-meter cell on the landscape (Anderson et al. 2012, Fig. 2.2e). Landform is a compound measure of elevation, slope, aspect, surface curvature, and upslope-catchment area, which play a key role in the variation of topoclimates and species distributions (Anderson et al. 2012). Landform variety is a count of the number of landforms within a 40.5-ha circle surrounding the focal landscape cell. Elevation range is included to further differentiate landform variety, and wetland density helps capture small-scale topographic diversity and freshwater accumulation in flat landscapes (Anderson et al. 2012).

Last, I mapped whether each 1-m cell of the landscape was within the upper 10% of elevations in my study area using the U.S. Geological Survey's GTOPO30 dataset (Fig. 2.2f). Locations near the upper-elevational limit of a region often have unique biological communities adapted to more extreme climates relative to the surrounding area. For example, in the northeastern United States high-elevation locations are often occupied by alpine and boreal species more typical of locations much farther north. Locations near the upper-elevational limit of a region are particularly vulnerable to climate change because species are already near the summit of mountains and the nearest suitable climate could be hundreds of miles away through valleys with drastically different climates and biological communities. Moreover, the area on mountain peaks is small relative to low lying areas and therefore supports smaller populations with fewer species (Peters and Darling 1985). Hence, native high-elevation species might be less genetically diverse, more prone to stochastic extinctions, and could be negatively affected by competition from invading species shifting their distribution up in elevation to track suitable climates.

I combined the five spatial indicators of the vulnerability to produce a spatial index of the vulnerability of biodiversity. Before combining the five spatial indicators, I first resampled each indicator to a 0.125˚ cell resolution and rescaled each indicator to range between zero and one, where zero is least likely to have a negative effect on biodiversity (e.g., low landscape resistance, low topoclimate homogeneity) and one is the most likely to have a negative effect on biodiversity (e.g., little climate overlap, fast climate change velocity). Hereafter, I refer to the rescaled climate overlap variable as climate change magnitude to differentiate this from climate overlap presented in its natural scale. I summed the five spatial indicators in each landscape cell to map vulnerability of biodiversity (Box 1). The index is scaled between zero and five, where zero suggests that climate change will have relatively small effects on biodiversity and five suggests climate change will have large effects on biodiversity.

Results:

New York State ranked tenth of 14 northeastern states (where 14 is the least vulnerable) with respect to the mean value of the vulnerability index, despite less overlap between historical and projected future climates (i.e., greater climate change) in New York State than seven other states (Figs. 2.2 and 2.3a, Appendix V). Biodiversity in New York State is relatively less vulnerable because the varying topography in New York State provides low topoclimate homogeneity (i.e., high topoclimate diversity). The topoclimate homogeneity score in New York State is 25% smaller than the average of 0.376 across all states (Appendix V). Also, the Adirondack and Catskill mountains provide low landscape resistance (Fig. 2.2e) and low climate change velocity (Fig. 2.2c). The landscape resistance score in New York State is 11% smaller than the average of 0.747 across all states (Appendix V). Note, however, that biodiversity in high peaks of the Adirondack, Catskill, and Alleghany mountains is expected to be highly vulnerable (Fig. 2.2a). Biodiversity in Regions 2 and 8 of the New York State Department of Environmental Conservation (NYSDEC) is expected to be most vulnerable to climate change due to high landscape resistance and high topoclimate homogeneity (Fig. 2.3b, Appendix V). The landscape resistance and topoclimate homogeneity scores for Region 2 are 36% and 59% larger than the average of 0.738 and 0.312 (respectively) across all NYSDEC Regions (Appendix V). The landscape resistance and topoclimate homogeneity scores for Region 8 are 19% and 17% larger than the average across all NYSDEC Regions (Appendix V). Climate change velocity in Region 8 is also high; average climate change velocity in Region 8 is 1.09 km/year compared to an average of 0.75 km/yr across all NYSDEC Regions (Fig. 2.3b, Appendix V). Biodiversity in Region 3 is expected to be least vulnerable because climate change magnitude and velocity are expected to be lower relative to other regions of the state (Fig. 2.3b, Appendix

V). Climate change magnitude in Region 3 is 57% less than the average of 0.004 across all NYSDEC Regions (Appendix V) and climate change velocity is 0.46 km/year.

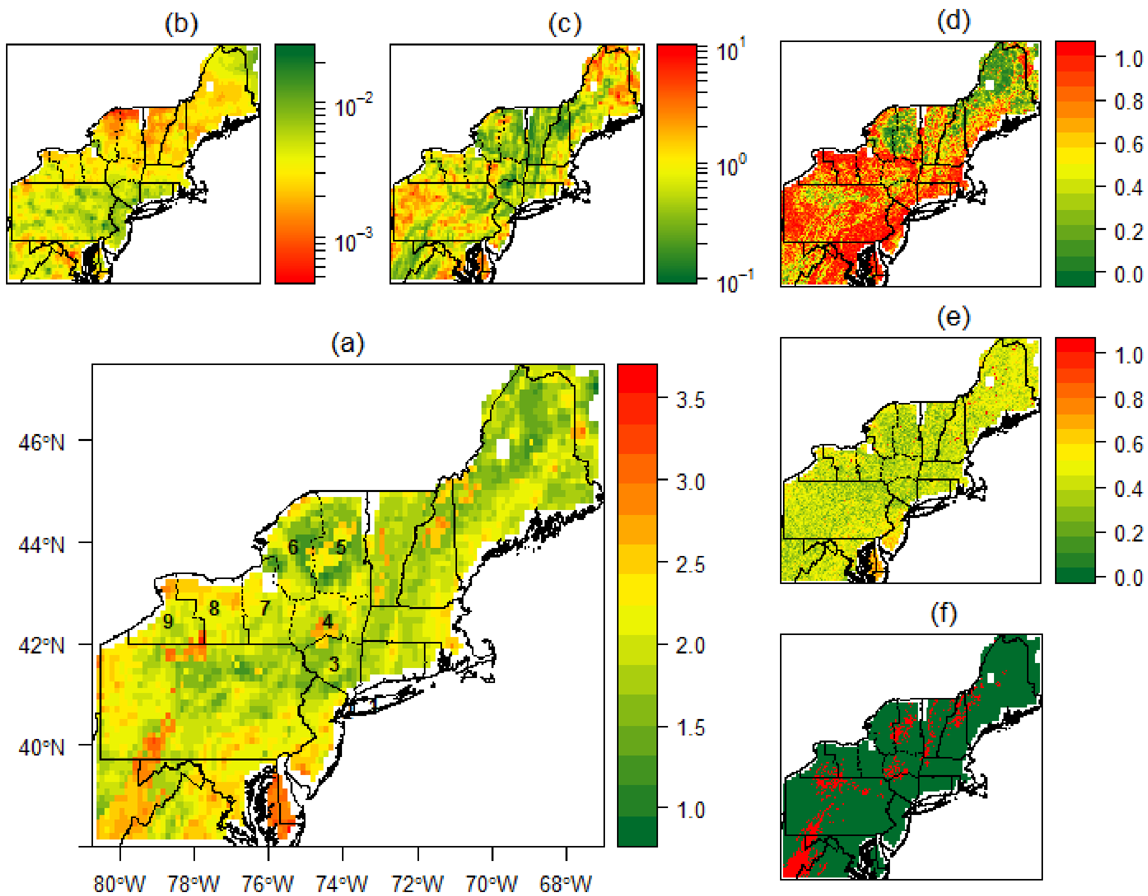


Figure 2.2. (a) A spatial index of the vulnerability of biodiversity to climate change in the northeastern United States and the individual indicators of vulnerability: (b) overlap between historical and projected future climates (log scale, low overlap suggests higher climate change magnitude), (c) climate change velocity (i.e., the rate at which species will have to move to track suitable climates; log scale, km/year), (d) local landscape resistance, (e) topoclimate homogeneity, and (f) areas within the tenth percentile of elevation in the northeastern United States (red areas). On all maps, red indicates areas of high vulnerability and green indicates areas of low vulnerability to climate change. Black solid lines outline states and black dotted lines and numbers in New York State show New York State Department of Environmental Conservation regions.

In the northeastern United States, biodiversity is most vulnerable on the Delmarva Peninsula and at many locations that occur within the upper 10% of elevations (Fig. 2.2a), despite moderate climate change predictions in many of these regions (Fig. 2.2b). The Delmarva Peninsula is particularly sensitive to climate change because it has high climate change velocity, high landscape resistance, and high topoclimate homogeneity (Fig. 2.2). Biodiversity in Delaware and Maryland is expected to be most vulnerable relative to other northeastern states (Fig. 2.3a) due largely to the vulnerability of the Delmarva Peninsula (Fig. 2.2a). Biodiversity is expected to be least vulnerable in areas that do not have high-density urban development throughout the northeastern United States (Fig. 2.2a). These areas have low landscape resistance and are often mountainous, which results in low climate change velocity and low topoclimate homogeneity (Fig. 2.2). Biodiversity is expected to be least vulnerable in Maine for this reason (Fig. 2.3a). See Appendix V for specific values of each spatial indicator in each state.

The AOGCM used to produce the climate overlap and climate change velocity maps had minimal effect on the spatial pattern of vulnerability (Fig. 2.4); however, the magnitude of vulnerability did vary depending on the AOGCM used (Fig. 2.4). The effect of the AOCGM was most pronounced on estimates of climate overlap, with minimal effects on climate change velocity (Fig. 2.4). This uncertainty had minimal effect on the ranking of states or NYSDEC Regions in terms of their vulnerability to climate change; at most the ranking changed by two positions between the minimum and maximum estimates of climate change across AOGCMs (Fig. 2.3).

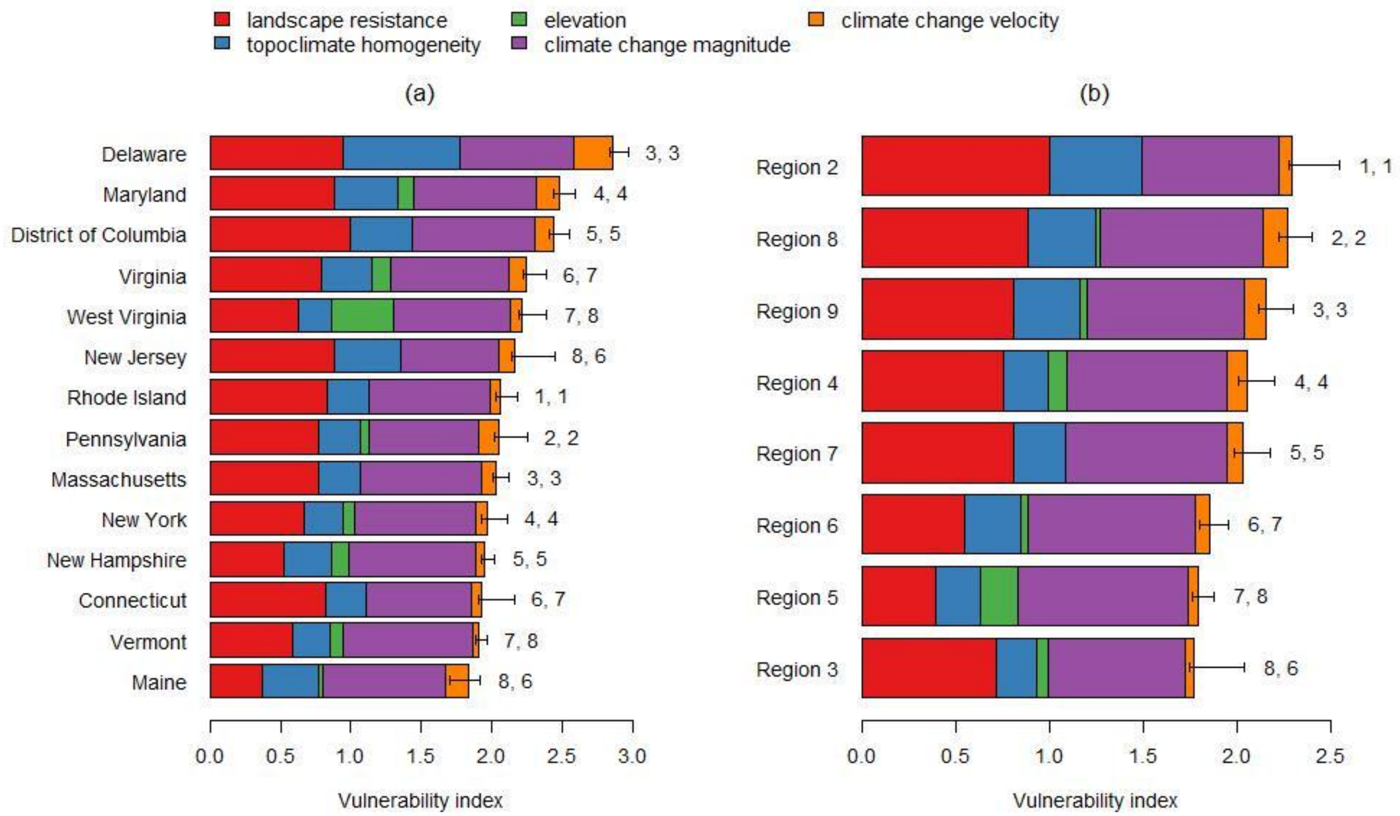


Figure 2.3. Mean vulnerability index values in (a) each of 14 states in the study area and (b) each of the New York State Department of Environmental Conservation Regions in the study area. Region 1 is excluded because it falls outside of my study area. The error bars represent the average vulnerability index value in the state using the minimum and maximum value of climate change magnitude and velocity across the three AOGCMs in each landscape cell. The numbers next to each plot represent the minimum and maximum rank given the uncertainty caused by differences among AOGCMs, where high numbers are the least vulnerable state or region.

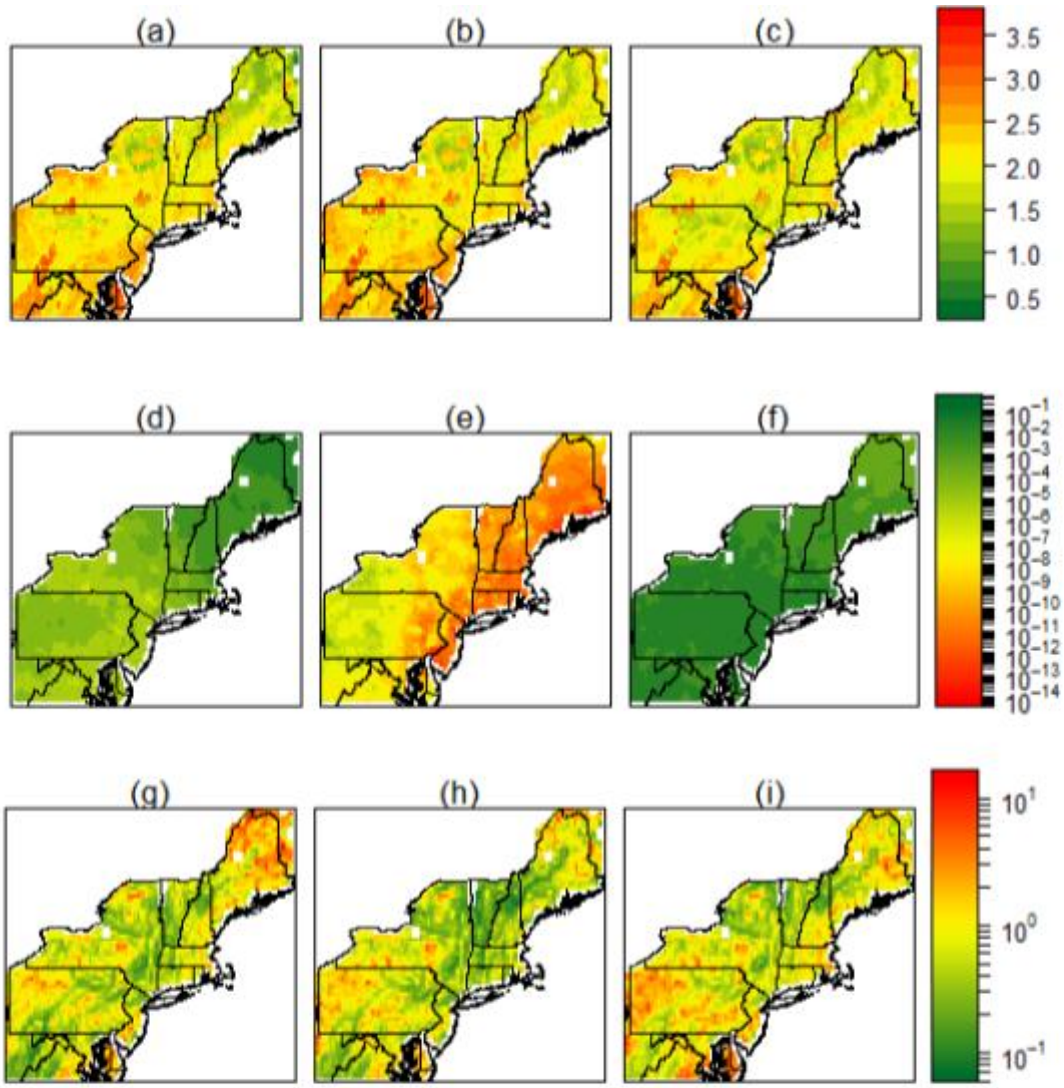


Figure 2.4. Differences among the three AOGCMs used to define (a, b, c) the spatial index of the vulnerability of biodiversity, (d, e, f) overlap between historical and projected future climates (log scale, low overlap suggests higher climate change magnitude), and (g, h, i) climate change velocity (log scale, km/year). On all maps, red indicates areas of high and green indicates areas low vulnerability to climate change. Climate models include (a, d, g) United Kingdom Meteorological Office Hadley Centre Climate Model version 3 (Pope et al. 2000), (b, e, h) United States National Oceanographic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory CM2.1 (Delworth et al. 2006), and (c, f, i) United States Department of Energy/National Center for Atmospheric Research Parallel Climate Model (Washington et al. 2000). Each model was forced with the A1fi emissions scenario.

Climate-Smart Management Considerations for Biodiversity:

Climate change is only one of many threats to wildlife species and wildlife managers are already overwhelmed with day-to-day crises and management needs (Lawler et al. 2010). Thus, it is unlikely that many management agencies will make drastic changes to their current management strategies, except where climate change may have the most extreme and immediate consequences. Here, I offer guidance on how and where management strategies already in use by management agencies (or those expected to be used in the future) could provide long-term benefits for biodiversity under climate change. I refer to this guidance as climate-smart management considerations. Following this guidance will help ensure that current investments in biodiversity management will maintain value in a changing climate without having to make drastic changes to management plans. I acknowledge that my climate-smart management considerations may not allow species to persist in northeastern United States in perpetuity. But, these considerations may increase the long-term benefit of current management actions and help species adapt to changing climates. Moreover, implementing current management actions in a climate-smart manner may help buy time while scientists reduce uncertainty in climate change and species responses to climate change. This may be the best management approach for many species given strong uncertainty in climate change and the response of species to climate change.

I identified six possible climate-smart management considerations based on the combination of landscape features in each cell (Klausmeyer et al. 2011, Table 2.2): (1) movement possible, (2) movement limited, (3) high topoclimate diversity, (4) low exposure, (5) high elevation, or (6) no feasible consideration (see Table 2.3 for more detailed descriptions). To produce a manageable set of landscape-feature combinations, I reclassified the climate change magnitude, climate change velocity, landscape resistance, and topoclimate homogeneity maps into high and low values, where high values are likely to have negative effects on biodiversity. I considered low values those below the 50th percentile of each variable in the northeastern United States (Klausmeyer et al. 2011). I then assigned climate-smart considerations given unique combinations of high and low landscape values in each cell (Table 2.2). I only considered movement possible or limited in areas with low climate change velocity and areas below the upper 10% of elevations in the northeastern United States because species are more likely to be able to track suitable climates in these areas.

Table 2.2. Combinations of high (H) and low (L) landscape-feature values used to define the climate-smart management considerations based on the landscape features in each landscape cell. Separation of high and low values was either: (1) the 50th percentile for biodiversity considerations, or (2) a threshold value based on species traits for species-specific considerations. Y and N indicate yes or no, and dashes indicate that the landscape feature is not applicable to the consideration.

	Landscape Features				
Climate-smart Management Consideration	**Climate Change Magnitude**	**Climate Change Velocity**	**Near Upper Elevational Limit**	**Landscape Resistance**	**Topoclimate Homogeneity**
movement possible	-	L	N	L	-
movement limited	-	L	N	H	-
high topoclimate diversity	-	-	-	-	L
low exposure	L	L	-	-	-
high elevation	-	-	Y	-	-
no feasible consideration	-	H	-	-	H
no feasible consideration	H	-	Y	-	H

Table 2.3. Descriptions of climate-smart management considerations. Climate-smart management considerations are not specific management actions. Rather, they offer guidance on how and where future management actions could provide long-term benefits for the species under climate change.

Management Consideration	Description
Movement possible	Landscape resistance is currently low relative to other locations in the northeastern United States and climate change velocity is expected to be low relative to either (1) other locations in the northeastern United States (management considerations for biodiversity) or (2) the dispersal ability of the focal species (species-specific management considerations). Species in these areas already have some resilience to climate change because they are likely able to adapt to climate change by moving to track suitable climates. Management actions in these areas could provide long-term benefits to the population by promoting short-term population persistence that provides a source population capable of moving in the future. Moreover, low landscape resistance in these areas could help species recover from local extinctions (e.g., those caused by extreme weather) by allowing individuals from source populations to recolonize the extirpated site. Maintaining low landscape resistance by limiting fragmentation in these areas is important. This management consideration is only relevant to species for which movement may be limited by dispersal barriers (e.g., roads, urban areas).
Movement limited	Landscape resistance is currently high relative to other locations in the northeastern United States and climate change velocity is expected to be low relative to either (1) other locations in the northeastern United States (management considerations for biodiversity) or (2) the dispersal ability of the focal species (species-specific management considerations). Species may be vulnerable to climate change in these areas if their movement is limited by dispersal barriers (e.g., roads, urban areas) because moving to track suitable climates may be costly or impossible. However, if resistance was decreased in these areas, species would likely be able to adapt to climate change by moving to track changing local climates. Moreover, decreasing resistance between patches of a species habitat could help species to recover from local extinctions (e.g., those caused by extreme weather) by allowing individuals from source populations to recolonize the extirpated site. Hence, management actions in areas where movement is limited will be most beneficial if they are coupled with attempts to decrease resistance (e.g., create underpasses, restore natural vegetation along riparian corridors).

Management Consideration	Description
High topoclimate diversity	Topoclimate homogeneity is low. Species in these areas already have some resilience to climate change because (1) topoclimate could provide refuge during periods of extreme weather, (2) species may only need to move a short distance to track suitable climates, (3) topoclimates could provide permanent or temporary refugia, and (4) genetic diversity may be higher in these areas facilitating population persistence and adaptation. For these reasons, species may be able to persist in these areas and therefore management actions (e.g., habitat enhancement, reintroduction, protection) that are implemented across multiple topoclimates may provide a long-term benefit to species in these areas.
Low exposure	Climate change magnitude is expected to be low relative to other locations in the northeastern United States and climate change velocity is expected to be low relative to either (1) other locations in the northeastern United States (management considerations for biodiversity) or (2) the dispersal ability of the focal species (species-specific management considerations). Species in these areas may be resilient to climate change simply because these areas will not experience as much climate change as is expected in other locations. These areas may also be refugia for species persistence due to low exposure. Hence, management actions in these areas may have long-term benefits under climate change. Management actions specifically related to reducing climate change vulnerability (e.g., assisted migration) should receive low priority in these areas due to low climate change exposure.
High elevation	Areas within the upper 10% of elevation in the northeastern United States. Species in these areas are likely vulnerable to climate change because they are unlikely to be able to move to track suitable climates. This is especially true of high elevation endemics. If this consideration is not combined with other considerations, then management actions specific to a given species may not have long-term benefits (hence the consideration is changed to no feasible consideration). However, when combined with low exposure or high topoclimate diversity these areas may be particularly important for population persistence and therefore management actions in these areas may be very beneficial to high elevation endemics. This management consideration is never combined with either movement considerations because species are unlikely to be able to move to track suitable climates. However, when combined with high topoclimate diversity, small-scale landscape resistance (0.01-1 km scales) may be important to allow species to move to suitable topoclimates.

Management Consideration	Description
No feasible consideration	Climate change magnitude and topoclimate homogeneity is high, and the area is within the upper 10% of elevation in the northeastern United States or climate change velocity is expected to be high relative to either (1) other locations in the northeastern United States (management considerations for biodiversity) or (2) the dispersal ability of the focal species (species-specific management considerations). Species in these areas are expected to be highly vulnerable because climate change is expected to be high in these regions and the landscape will inhibit adaptation. Decreasing or maintaining landscape resistance in these regions is unlikely to be successful because species are unlikely to be able to move to track suitable climates. Moreover, there is little topoclimate diversity to moderate the effects of climate change. Little can be done to reduce the vulnerability of species in these areas and any future management implemented in these areas may not provide a long-term benefit to species.

Differences in climate change magnitude and velocity among AOGCMs could cause uncertainty in the management consideration in each landscape cell. I accounted for this uncertainty in the management considerations by creating a separate management consideration map for each AOGCM and identifying differences in the climate-smart management considerations between these maps and the map produced using the climate data averaged across AOGCMs. I treated the low exposure consideration as a special consideration in the estimates of uncertainty because this consideration is most often combined with other considerations and changes in exposure only affect the priority given to each of the other considerations (see Table 2.3 for details). Thus, I had three categories of uncertainty: (1) the exposure or one of multiple climate-smart management considerations other than exposure differed among the four maps, (2) each of the climate-smart management considerations recommended in a landscape cell (other than low exposure) differed among the four maps, or (3) exposure and the climate-smart management considerations other than exposure differed among the four maps.

Results:

The diverse landscape in New York State allowed for numerous climate-smart management considerations when planning future management actions to conserve biodiversity (e.g., invasive species removal, herbivore control, open-space planning) in the state (Fig. 2.5). My models suggest that: (1) high topoclimate diversity could moderate the effects of climate change across 70% of the state allowing future management actions that are implemented across multiple topoclimates to provide a long-term benefit to species; (2) decreasing local landscape resistance in conjunction with other management actions could increase the benefit of future management actions across 32% of the state (i.e., the movement limited consideration); and (3) management actions across 26% of the state could provide long-term benefits by promoting short-term population persistence that provides a source population capable of moving in the future (i.e., the movement possible consideration) (see Table 2.3 for more detailed descriptions). The total is >100% because I suggest >1 management consideration in some cells. I was unable to suggest a climate-smart management consideration (i.e., no feasible consideration) on only 10% of the landscape in New York State, suggesting that climate-smart management can be applied throughout much of the state to promote the long-term benefit of management actions to biodiversity. This is not true in other large states such as Maine and Pennsylvania (Fig. 2.5). In fact, I was unable to suggest a climate-smart management consideration for 31% of the northeastern United States. Areas without a climate-smart management consideration were concentrated in the southeastern portion of the study region (Virginia, Maryland, Delaware, New Jersey, and eastern Pennsylvania), western Pennsylvania and New York State, and northern and eastern Maine. These areas have high topoclimate homogeneity (Fig. 2.2e), have high climate change velocity (Fig. 2.2c), and high landscape resistance (Fig. 2.2d), which may preclude many species from tracking their suitable climates. I was able to recommend the following climate-smart management considerations in the northeastern United States: high topoclimate diversity (51% of the landscape), movement limited (20% of the landscape), and movement possible (23% of the landscape) (Fig. 2.5, Table 2.3).

Differences among AOGCMs affected the climate-smart management considerations on 63% of the landscape in New York State; however 88% of the uncertain area was only affected by uncertainty in exposure or one of the two climate-smart management considerations other than low exposure (Figs. 2.5 and 2.6). New York State had a similar percent of uncertain area as the northeastern United States (Fig. 2.5). Fifty-nine percent of the landscape in the northeastern United States was affected by uncertainty in the climate-smart management consideration and 75% of the uncertain area in the northeastern United States was affected only by uncertainty in exposure or one of the two climate-smart management considerations other than exposure (Figs. 2.5 and 2.6).

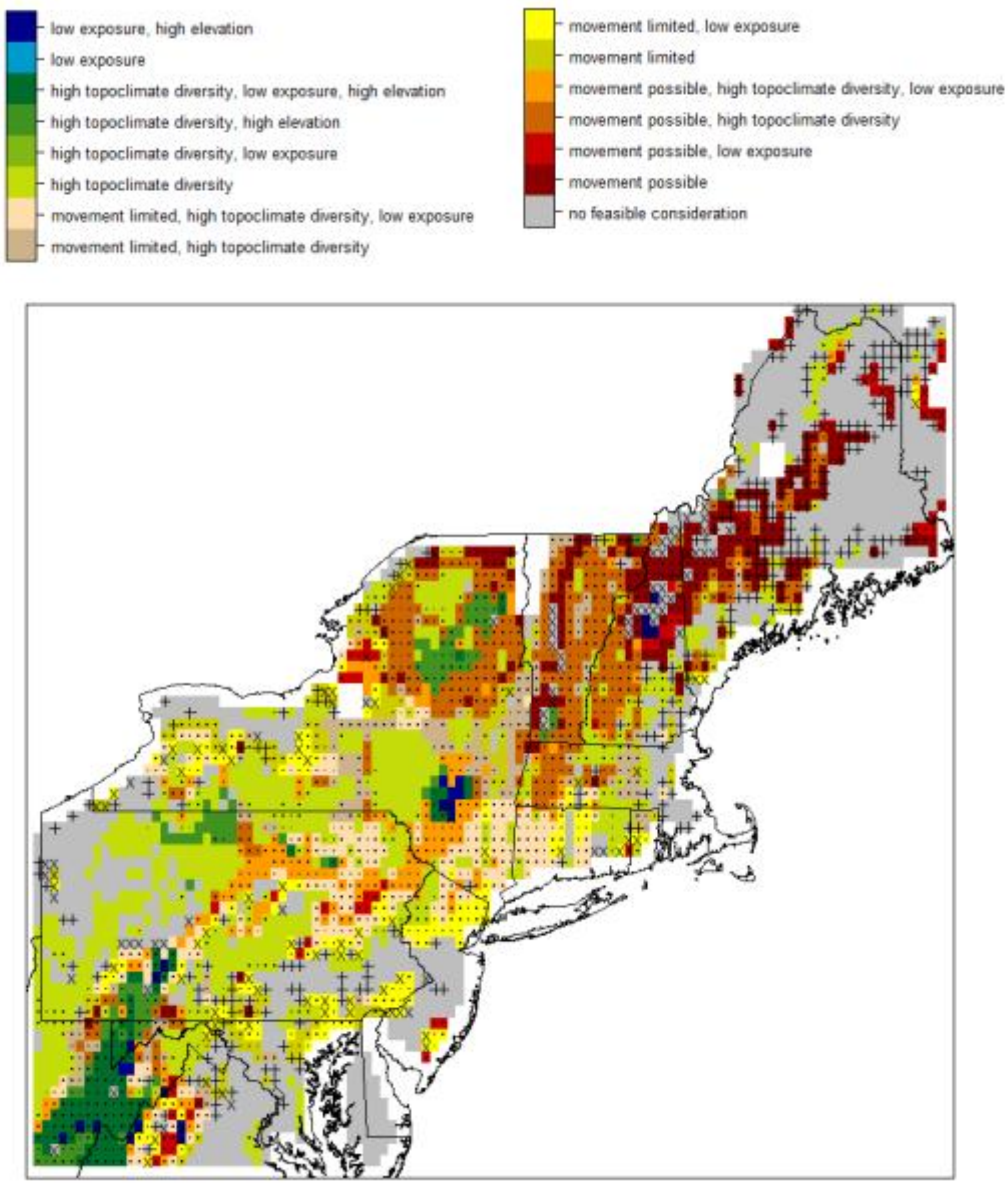


Figure 2.5. Climate-smart management considerations for biodiversity in the northeastern United States. Climate-smart management considerations are factors that may influence the long-term benefit of management actions for biodiversity under climate change. See Tables 2.2 and 2.3 for definitions of each management consideration. Stippling in each landscape cell represents three levels of uncertainty caused by differences among AOGCMs used to map climate change magnitude and velocity: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

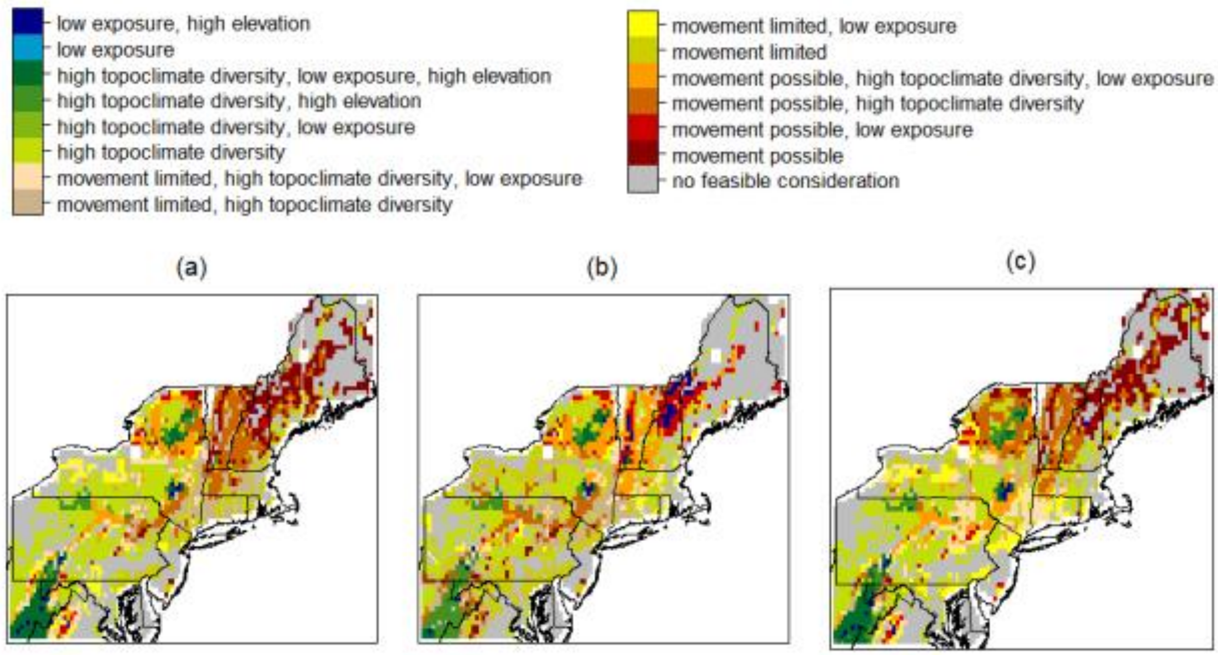


Figure 2.6. Climate-smart management considerations for the northeastern United States using three different AOGCMs. Climate-smart management considerations are factors that may influence the long-term benefit of management actions under climate change. See Tables 2.2 and 2.3 for definitions of each management consideration. Climate models include (a) United Kingdom Meteorological Office Hadley Centre Climate Model version 3 (Pope et al. 2000), (b) United States National Oceanographic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory CM2.1 (Delworth et al. 2006), and (c) United States Department of Energy/National Center for Atmospheric Research Parallel Climate Model (Washington et al. 2000). Each model was forced with the A1fi emissions scenario.

Section II: Relative Vulnerability and Management of Focal Species

Species Selection:

I evaluated the vulnerability of terrestrial and semi-aquatic species of greatest conservation need in New York State that (1) do not occur primarily in marine or coastal environments, (2) are aquatic for the minority of their life, and (3) have mapped distributions. This included 12 mammals, 72 birds, and 29 herpetofauna, representing 21% of the 537 species of greatest conservation need in New York State. I excluded moths and butterflies from my analysis because I was unable to get species-trait information for most species. I excluded marine, coastal, and aquatic species because the relative vulnerability of these species to climate change will be highly dependent on factors that are not currently captured by my modeling framework. Specifically, my modeling framework does not account for changes in ocean temperature or currents, sea level rise, stream and lake temperature (which may not be correlated with air temperature, especially in deeper lakes and rivers), topoclimate homogeneity in aquatic systems, and changes in local hydrology (which are likely to be influenced by changes in temperature and precipitation at a watershed scale). I included a few herpetofauna for which the importance of terrestrial habitat is unknown (e.g., northern cricket frog) or that are primarily aquatic, but commonly use terrestrial habitat (e.g., snapping turtle).

Relative Species Vulnerability:

Species that are likely to be most vulnerable to climate change are those that (1) occur in areas where climate change is expected to be high and the landscape features could inhibit the ability of the species to adapt (i.e., spatial indicators of the vulnerability of biodiversity, Box 1), (2) have species-specific traits that make them sensitive to the spatial indicators of vulnerability, and (3) have traits unrelated to climate or landscape features that will further limit their adaptive capacity (e.g., dietary specificity). I used these criteria to rank the relative vulnerability of the focal species (Box 2). Ranking the relative vulnerability of species helps to prioritize the species that will benefit most from climate-smart management.

I used scores for six species traits that I did not reference spatially (Table 2.4) to address criteria 2 and 3 above: (1) non-climate habitat specificity, (2) dietary specificity, (3) physiological tolerance to climate change, (4) sensitivity to dispersal barriers, (5) average natal dispersal distance, and (6) life history strategy. I acknowledge that these traits likely vary spatially, but the extent of spatial variation is unknown for most rare or poorly studied species. Non-climate habitat specificity and dietary specificity relate to a species reliance on non-climatic factors, sensitivity to changes in the local biological community, and ability to move to track suitable climates. Physiological tolerance to climate change quantifies the likely physiological response (i.e., negative, none, positive) of a species to climate change. Sensitivity to dispersal barriers and average natal dispersal distance relate to a species ability to move to track suitable climates. Life history strategy is a combination of the number of offspring per successful reproductive event, number of successful reproductive events in the lifetime of a reproductive individual, and lifespan. These life history traits combine to describe how many offspring are produced over an individual's lifetime and are related to the degree to which an individual of a species will be exposed to changes in climate, the time necessary for the species to recover from population reductions, and the rate of genetic adaptations. I calculated life history as the number of offspring multiplied by the number of reproductive events, divided by the species lifespan. I rescaled life history scores across species to be between zero and one, where zero is a species that produces many offspring over the course of a short lifespan (i.e., a r-selected species) and one is a species that produces few offspring over the course of a long lifespan (i.e., a K-selected species).

Table 2.4. Definition of variable types and categories used to define species traits. I elicited data from experts on each variable for each species.

Variable	Type	Category	Definition
Non-climate habitat specificity	Categorical	1	Able to adapt to a large number of biotic and abiotic conditions
		2	Requires a specific set of biotic or abiotic conditions (e.g., a forest type)
		3	Requires a specific species, geologic formation, or other single abiotic condition
Dietary specificity	Categorical	1	Utilizes a variety of food types (e.g., fruit, insects, AND small mammals)
		2	Requires a single but diverse and abundant type of food (e.g., insects only, mast only)
		3	Requires a particular species OR rare food type
Physiological tolerance	Categorical	1	Likely to be positively affected
		2	Likely to be unaffected
		3	Likely to be negatively affected
Sensitivity to dispersal barriers	Categorical	1	Unimpeded by barriers
		2	Slowed by barriers
		3	Unable to move in the presence of barriers
Average natal dispersal distance	Continuous		
Number of offspring produced per successful reproductive event	Continuous		
Number of successful reproductive events in the lifetime of a reproductive individual	Continuous		
Lifespan	Continuous		

I defined the non-spatial species traits as either continuous or three-category categorical variables (Table 2.4). I defined the categories to highlight major differences among species, but kept the categories general enough to ensure that I could categorize rare and poorly studied species. I used a formal expert elicitation process to elicit expert knowledge on non-spatial species traits for each species. I elicited knowledge from 43 species experts from state and federal agencies, non-profit natural resource agencies, and universities in the northeastern United States (Appendix VI) using an online survey (Appendix VII). Many experts provided knowledge on more than one species; an average of 2.8 (SD = 1.9, min = 1, max = 9) experts provided information for each of the species included in my analysis. I used expert knowledge for two reasons: (1) information on many of the species was scant, and (2) working with experts got many management professionals engaged in the process. Each question in the survey allowed experts to express uncertainty and variation within a species, which allowed experts to provide scores for rare and poorly studied species for which information may be lacking. I used the Speirs-Bridge four-step method of expert elicitation (Speirs-Bridge et al. 2010) for continuous variables, which asks experts to define the lowest realistic value, the highest realistic value, their best estimate, and provide a score for their confidence that their best estimate falls within the low-high interval they provided (Appendix VII). This method significantly reduces expert overconfidence (Speirs-Bridge et al. 2010). I used an average of best estimates across experts as the final score for each species and the average of the low and high scores to create uncertainty bounds. For categorical variables, I asked experts to distribute a total of 10 points among the three categories to reflect their uncertainty and variation within a species (Appendix VII). I assigned scores of 0.33, 0.66, and 1.00 to categories 1, 2, and 3 of the physiological tolerance trait (Table 2.4). I assigned scores of 0.00, 0.50, and 1.00 to categories 1, 2, and 3 of all other categorical species traits (Table 2.4). These scores reflect how the trait will affect the vulnerability of the species to climate change, where 0.00 is the least vulnerable and 1.00 is the most vulnerable. I used different scores for the physiological tolerance trait because I used this trait to weight the climate change magnitude variable (Box 2). I did not want the climate change magnitude variable to be zero because even if a species is likely to benefit physiologically from climate change, other factors (e.g., changes in biological interactions) could still affect the species in areas of high climate change. I used the score from the category for which the expert assigned the highest number of points as the best estimate of the score for each species. If the expert assigned five points to two categories, I used the average of the two scores for those categories as the best estimate score for each species. I calculated low and high uncertainty bounds using an average of the scores in the first and second category (low bound) or the second and third category (high bound) weighted by the number of points assigned to each of the two categories. If the low bound was greater than the best estimate score or the high bound was less than the best estimate score I assigned the best estimate score to the low or high bound. For example, if an expert assigned 1, 2, and 7 points to categories 1, 2 and 3 of the habitat specificity variable, I set the best estimate score to 1.00 (because the majority of the points were in the third category), I estimated the low bound as (1*0.00 + 2*0.50)/(1 + 2) = 0.33 (where 0.00 and 0.50 are the scores assigned to categories 1 and 2), and I estimated the high bound as 1.00 (because a weighted average of the scores in categories 2 and 3 is less than the best estimate score). If the expert only put points in two categories, I used the average of the two categories weighted by the number of points in each category as the low or high bound (depending on which two categories the points were in) and the score for category with the majority of points as the other bound For example, if the expert assigned 8, 2, and 0 points to categories 1, 2, and 3 of the physiological tolerance variable, I set the best estimate score and the low bound to 0.33 (because the majority of points were in the first category) and I estimated the high bound as (8*0.33 + 2*0.66)/(8 + 2)

= 0.40 (where 0.33 and 0.66 are the scores assigned to categories 1 and 2 of the physiological tolerance variable).

I estimated a relative vulnerability score for each species by modifying the model developed in Section I to produce a spatial index of species vulnerability. I modified the model in Section I in three ways (Box 2). First, I identified landscape cells that fell within the historical distribution of each species in the northeastern United States. I buffered the species distribution to include landscape cells adjacent to the distribution because species will need to move through these cells to shift their distribution and therefore climate change and landscape features in these cells will likely affect the species adaptive capacity. I buffered the distribution by one landscape cell (i.e., 13 km) for species with natal dispersal distances <19.5 km (i.e., the resolution of 1.5 landscape cells) or by two landscape cells for species with natal dispersal distances >19.5 km. I did not buffer the species distribution by more than one or two landscape cells because I was only trying to include landscape cells that the species would need to pass through to shift their distribution. I was not trying to predict species range shifts. Buffering the distribution by more than two landscape cells would increase the likelihood of including areas of the landscape that the species will never occur in or travel through. I did not buffer the distribution directionally (e.g., poleward) because recent evidence suggests that species will move in multiple directions depending on their climatic tolerances (VanDerWal et al. 2013). I obtained species distribution information from NatureServe (Patterson et al. 2007, Ridgely et al. 2007, NatureServe 2008) and the International Union for the Conservation of Nature (IUCN et al. 2004). I verified the accuracy of the distribution data (and modified the distributions where necessary) for 50% of mammals and 49% of herpetofauna using expert knowledge and for 100% of birds using expert knowledge, data from both the New York State Breeding Bird Atlases (Andrle and Carroll 1988, McGowan and Corwin 2008), and/or descriptions of bird distributions in Levine 1998. I used historical distributions, rather than estimates of current distributions, for multiple reasons: (1) the current distribution of many species is unknown, (2) there is insufficient data to estimate the current distribution, and (3) habitat restoration efforts and reintroductions are occurring within the historical distribution of many species and therefore I wanted my vulnerability scores and climate-smart management considerations to include these areas. Despite my efforts to verify the species distribution maps, I acknowledge that some of the distributions may include areas where the species is not known to occur or omit areas where it is known to occur. Moreover, experts vary in their assessment of the distribution of some species. Errors in the distribution data could affect my assessments of relative species vulnerability and priority management areas. Small errors (e.g., those that cover only a few 13 km cells) are likely to be most common and are unlikely to have a large effect on the results. Errors in the distribution will not affect my species-specific maps of vulnerability or my climate-smart management considerations, except to include/exclude errant cells.

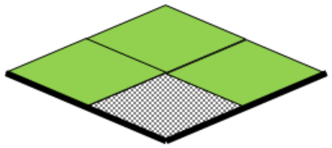
Second, I used the species trait data to weight or reclassify three of the climate and landscape components in the model to account for the species sensitivity to these components. I weighted the climate change magnitude map within each species distribution by the physiological tolerance score for the species to account for species sensitivity to climate change exposure. I weighted the local landscape resistance map within the species distribution by the sensitivity to dispersal barriers score. I also reclassified the climate change velocity map within the buffered species distribution to identify areas where the average natal dispersal distance is less than the climate change velocity. This identifies areas where the species may not be able to move fast enough to track suitable climates. Last, I calculated the relative vulnerability of each species (including low and high bounds of uncertainty) by summing the mean value of each weighted and unweighted spatial indicator within the buffered species distribution and scores for the three species traits that were not used to weight the spatial indicators (Box 2). The relative vulnerability score for each species was scaled between zero (i.e., least vulnerable) and eight (i.e., most vulnerable).

Results:

Uncertainty in the species-trait information and how that translated into relative vulnerability scores varied greatly among species (Figs 2.7 and 2.8). The uncertainty bounds for 22% of the species (5 mammals, 15 birds, and 6 herpetofauna) spanned the upper and lower 25% of the vulnerability scores calculated using the experts' best estimates of species traits, suggesting that the species trait data was too uncertain to determine the relative vulnerability for these species in New York State (Fig. 2.7). Uncertainty was greater for the northeastern United States; uncertainty bounds for 35% of the species (8 mammals, 23 birds, and 8 herpetofauna) spanned the upper and lower 25% of the vulnerability scores calculated using the experts' best estimates of species traits. Uncertainty was greatest in the species ability to keep pace with climate change velocity and species habitat specificity (Table 2.5, Fig. 2.8). Manageable components of vulnerability were less uncertain for most species; topoclimate homogeneity and landscape resistance accounted for an average of 0.9% and 9.7% of the uncertainty across species (Table 2.5). Note, that this uncertainty information only inhibits my ability to rank the relative vulnerability of species because ranking the relative vulnerability of species requires me to summarize the spatial variation in uncertainty. Uncertainty varies across space for many spatial indicators of vulnerability. Hence, I am still able to identify locations on the landscape where the uncertainty is small enough to make climate-smart management considerations.

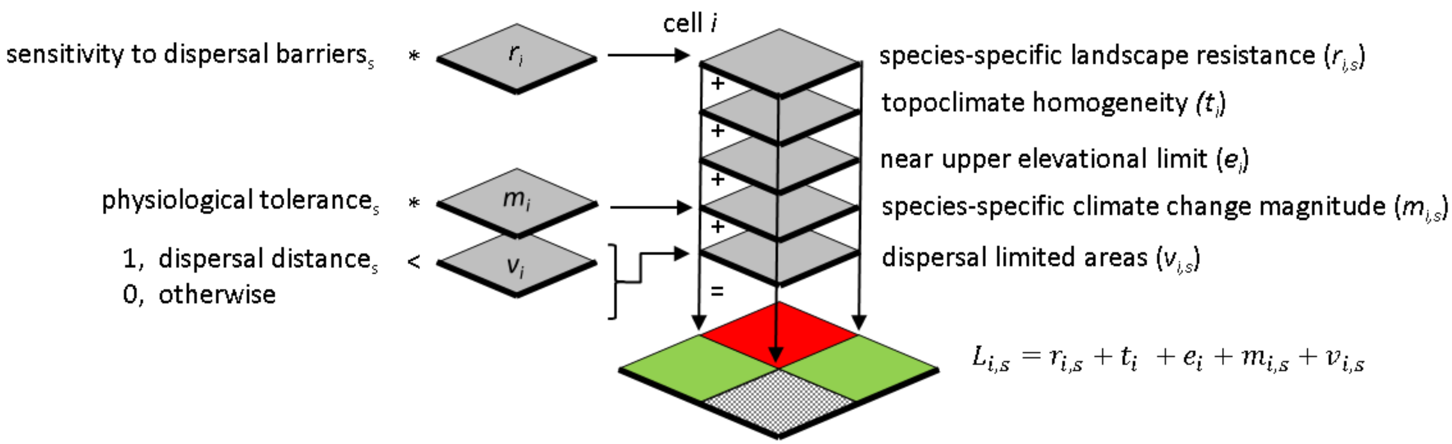
Box 2: Calculating Relative Species Vulnerability (see box 1 for variable definitions)

Step 1: identify landscape cells (i) in species distribution ($i \varepsilon N_s$) for each species ($s \varepsilon S$)



Let N_s be the set of landscape cells in the species distribution (green cells) and let n be the total number of landscape cells in the species distribution.

Step 2: calculate spatial index of species vulnerability ($L_{i,s}$) for each species



$$L_{i,s} = r_{i,s} + t_i + e_i + m_{i,s} + v_{i,s}$$

Step 3: calculate species relative vulnerability (V_s) using spatial ($V_{s,spatial}$) and nonspatial ($V_{s,nonspatial}$) indicators

$$V_{s,nonspatial} = habitat\ specificity_s + dietary\ specificity_s + life\ history_s$$

$$V_{s,spatial} = \frac{1}{n}\sum_{i \in N_s} L_{i,s}$$

$$V_s = V_{s,spatial} + V_{s,nonspatial}$$

Key Uncertainties (see Box 1 for additional uncertainties)

1. Uncertainty in scores assigned by experts to the six species traits used to calculate relative species vulnerability (see Figs. 2.7 and 2.8 and Appendix VIII) and uncertainty in the species distribution (see Relative Species Vulnerability).

Of the 78% of species for which the uncertainty did not span the upper and lower 25% of the vulnerability scores, the three most vulnerable species in New York State were worm snake (*Carphophis amoenus*), four-toed salamander (*Hemidactylium scutatum*), and least shrew (*Cryptotis parva*) and the three least vulnerable were horned grebe (*Podiceps auritus*), eastern box turtle (*Terrapene carolina*), and snapping turtle (*Chelydra serpentina*) (Fig. 2.7). On average, highly vulnerable species (i.e., the top 10% without high uncertainty) are vulnerable because their dispersal ability will not allow them to keep pace with climate change velocity and they occur in regions with low local landscape resistance relative to other species (Table 2.5, Fig. 2.7). The least vulnerable species (i.e., the lowest 10% without high uncertainty) tended to be habitat and dietary generalists and occur in areas where the magnitude of climate change is expected to be low relative to other regions of the northeastern United States (Table 2.5, Fig. 2.7). Interestingly, the least vulnerable species also tended to occur in areas with high topoclimate homogeneity (Table 2.5, Fig. 2.7). This component of their vulnerability was outweighed by other factors.

In general, species in New York State occur in landscapes with higher resistance, have more of their distribution near the upper elevational limit of the northeastern United States, and are likely to experience higher climate change magnitude relative to their distributions in the northeastern United States (Table 2.5). These differences translated into differences in the vulnerability scores between New York State and the northeastern United States of -0.17 – 0.58, where negative values indicate higher scores in New York State (see Appendix VIII for differences between New York State and the northeastern United States for individual species). Ten species were more vulnerable in New York State than in the northeastern United States: least weasel (*Mustela nivalis*), coal skink (Plestiodon anthracinus), Bicknell's thrush (*Catharus* *bicknelli)*, Tennesse warbler (*Vermivora peregrina*), Cape May warbler (*Dendroica tigrina*), Henslow's sparrow (*Ammodramus henslowii*), bay-breasted warbler (*Dendroica castanea*), olive-sided flycatcher (*Contopus cooperi*), common loon (*Gavia immer*), and upland sandpiper (*Bartramia longicauda*) (listed in order of decreasing difference). However, the difference between vulnerability scores in New York State and the northeast United States ranged between 0.00 – 0.17, suggesting that the differences are very minor relative to the species overall vulnerability.

Differences in the vulnerability score among all focal species were due in large part to differences in the scores for their ability to keep pace with climate change (SD = 0.30, higher SD suggests larger differences among species), dietary specificity (SD = 0.18), habitat specificity (SD = 0.16), and the effect of landscape resistance (SD = 0.14). Scores for the other components of species vulnerability contributed much less to the differences among species: climate change magnitude (SD = 0.06), whether the species occurred in locations near the elevational limit of the northeastern United States (SD = 0.06), topoclimate homogeneity (SD = 0.04), and life history strategy (SD = 0.02).

Table 2.5. Mean differences between vulnerability scores in New York State (NY) and the northeastern United States (NE) and uncertainty in the scores for all 113 species assessed. RMSD is the root-mean-squared-difference, $z_{top\ 10\%}$ is the mean z-score for the 10% of most vulnerable species, and $z_{bottom\ 10\%}$ is the mean z-score for the 10% of least vulnerable species. I only included species in the definition of most or least vulnerable if uncertainty in their vulnerability score did not span the upper and lower 25% of vulnerability scores. Negative z-scores suggest that the species is less vulnerable than the average of the 113 species, and vise-versa. The value for vulnerability under Percent of Uncertainty in NY is the average range of uncertainty in the vulnerability score in New York State.

Vulnerability component	**RMSD in Score between NY and NE**	**Number of Species with Higher Score in NY relative to NE**	**Percent of Uncertainty in NY**	**$Z_{top\ 10\%}$**	**$Z_{bottom\ 10\%}$**
climate change velocity	0.11	4	36.3	1.90	-0.17
habitat specificity	0.00	0	28.6	0.43	-0.42
climate change magnitude	0.03	90	14.1	-0.07	-0.40
landscape resistance	0.02	31	9.7	1.47	-0.05
dietary specificity	0.00	0	8.5	0.21	-0.19
Elevation	0.05	28	1.4	0.66	-0.05
topoclimate homogeneity	0.07	3	0.9	-0.31	0.70
life history	0.00	0	0.5	0.07	0.15
Vulnerability	0.16	11	0.8	2.15	-0.38

Figure 2.7. The relative vulnerability score (and component scores) for each of 113 species of greatest conservation need evaluated in New York State. For species that do not have distributions in New York State I provide the vulnerability score for their distribution in the northeastern United States. The name for these species is followed by "(NE)". Each component has a maximum value of one (most vulnerable); hence the maximum vulnerability score is eight. The error bars represent the range of uncertainty given low and high values for species traits provided by experts. The numbers to the right of the error bars are the rank of the species vulnerability (where one is most vulnerable) given experts' best, low, and high trait scores, respectively. Species flagged with an asterisk have uncertainty that spans the upper and lower 25% of vulnerability scores; hence there is too much uncertainty in species traits to rank the relative vulnerability of these species.

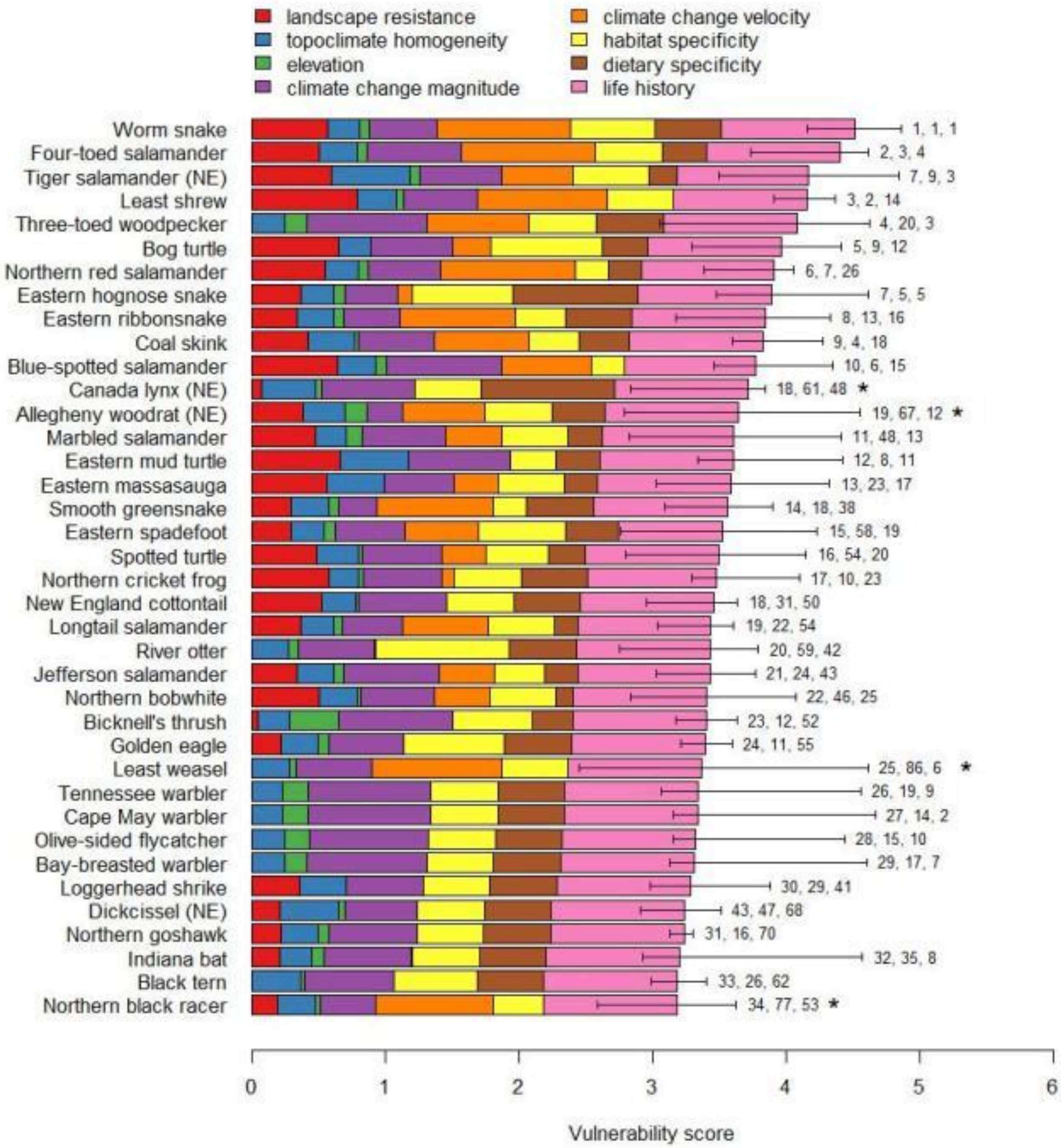

landscape resistance
topoclimate homogeneity
elevation
climate change magnitude
climate change velocity
habitat specificity
dietary specificity
life history
Worm snake 1, 1, 1
Four-toed salamander 2, 3, 4
Tiger salamander (NE) 7, 9, 3
Least shrew 3, 2, 14
Three-toed woodpecker 4, 20, 3
Bog turtle 5, 9, 12
Northern red salamander 6, 7, 26
Eastern hognose snake 7, 5, 5
Eastern ribbonsnake 8, 13, 16
Coal skink 9, 4, 18
Blue-spotted salamander 10, 6, 15
Canada lynx (NE) 18, 61, 48 ★
Allegheny woodrat (NE) 19, 67, 12 ★
Marbled salamander 11, 48, 13
Eastern mud turtle 12, 8, 11
Eastern massasauga 13, 23, 17
Smooth greensnake 14, 18, 38
Eastern spadefoot 15, 58, 19
Spotted turtle 16, 54, 20
Northern cricket frog 17, 10, 23
New England cottontail 18, 31, 50
Longtail salamander 19, 22, 54
River otter 20, 59, 42
Jefferson salamander 21, 24, 43
Northern bobwhite 22, 46, 25
Bicknell's thrush 23, 12, 52
Golden eagle 24, 11, 55
Least weasel 25, 86, 6 ★
Tennessee warbler 26, 19, 9
Cape May warbler 27, 14, 2
Olive-sided flycatcher 28, 15, 10
Bay-breasted warbler 29, 17, 7
Loggerhead shrike 30, 29, 41
Dickcissel (NE) 43, 47, 68
Northern goshawk 31, 16, 70
Indiana bat 32, 35, 8
Black tern 33, 26, 62
Northern black racer 34, 77, 53 ★
0
1
2
3
4
5
6
Vulnerability score

Figure 2.7 Continued.

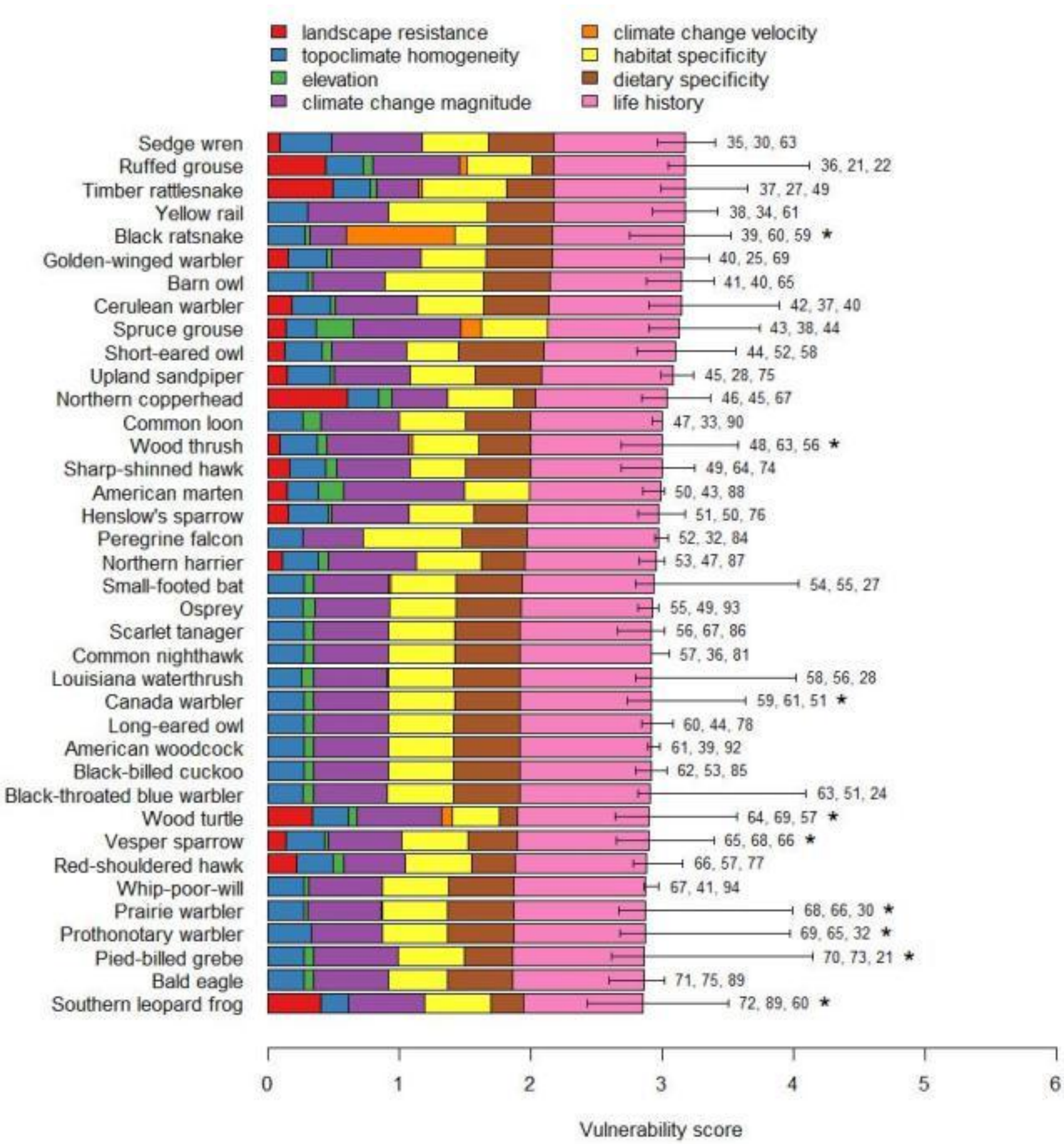


Figure 2.7 Continued.

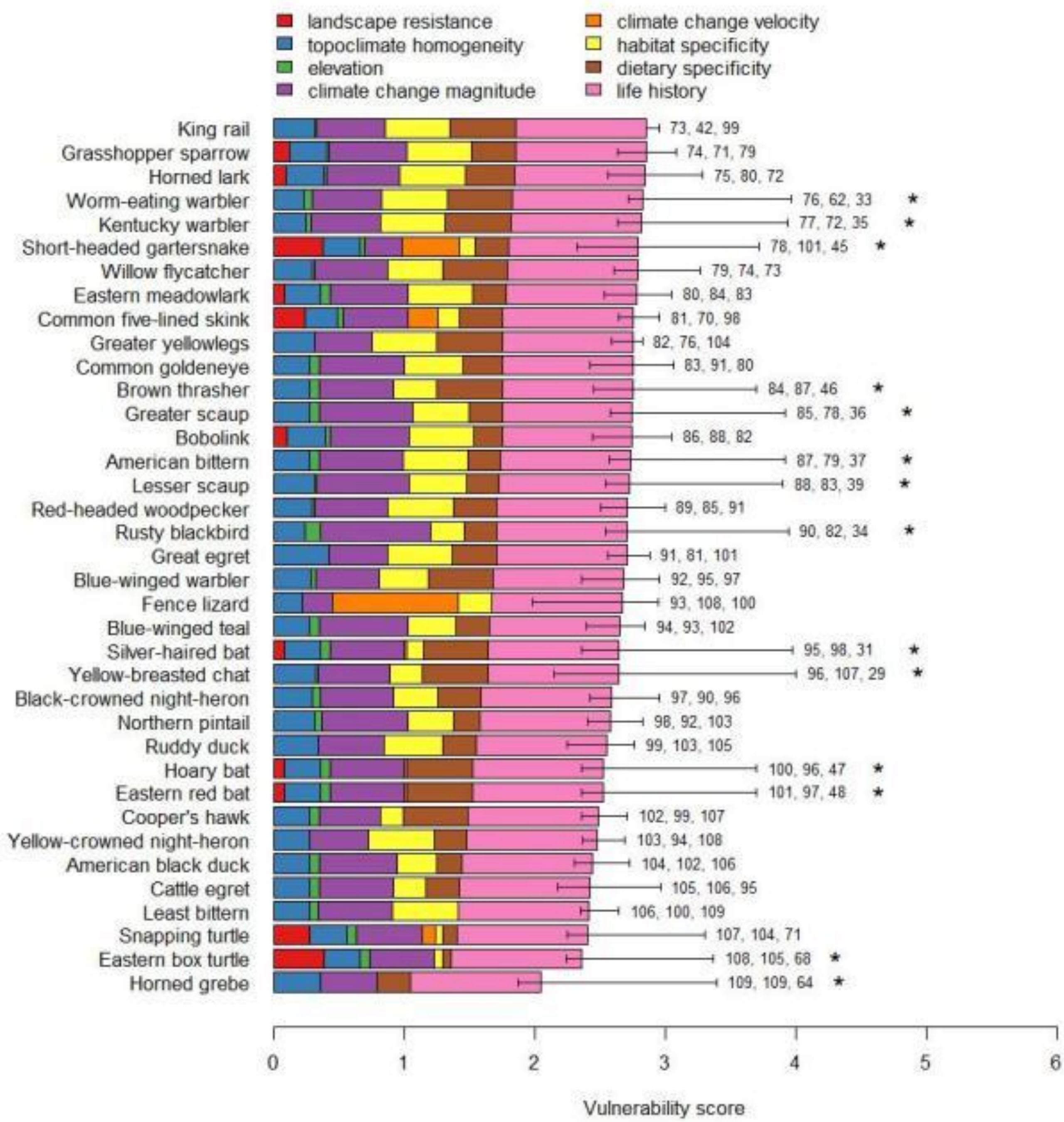


Figure 2.8. Uncertainty in vulnerability scores and component scores for each of 113 species of greatest conservation need evaluated in New York State. For species that do not have distributions in New York State I provide the range of uncertainty in the vulnerability score for their distribution in the northeastern United States. The name for these species is followed by "(NE)". The maximum amount of uncertainty for each component is one; hence the maximum total uncertainty is eight.

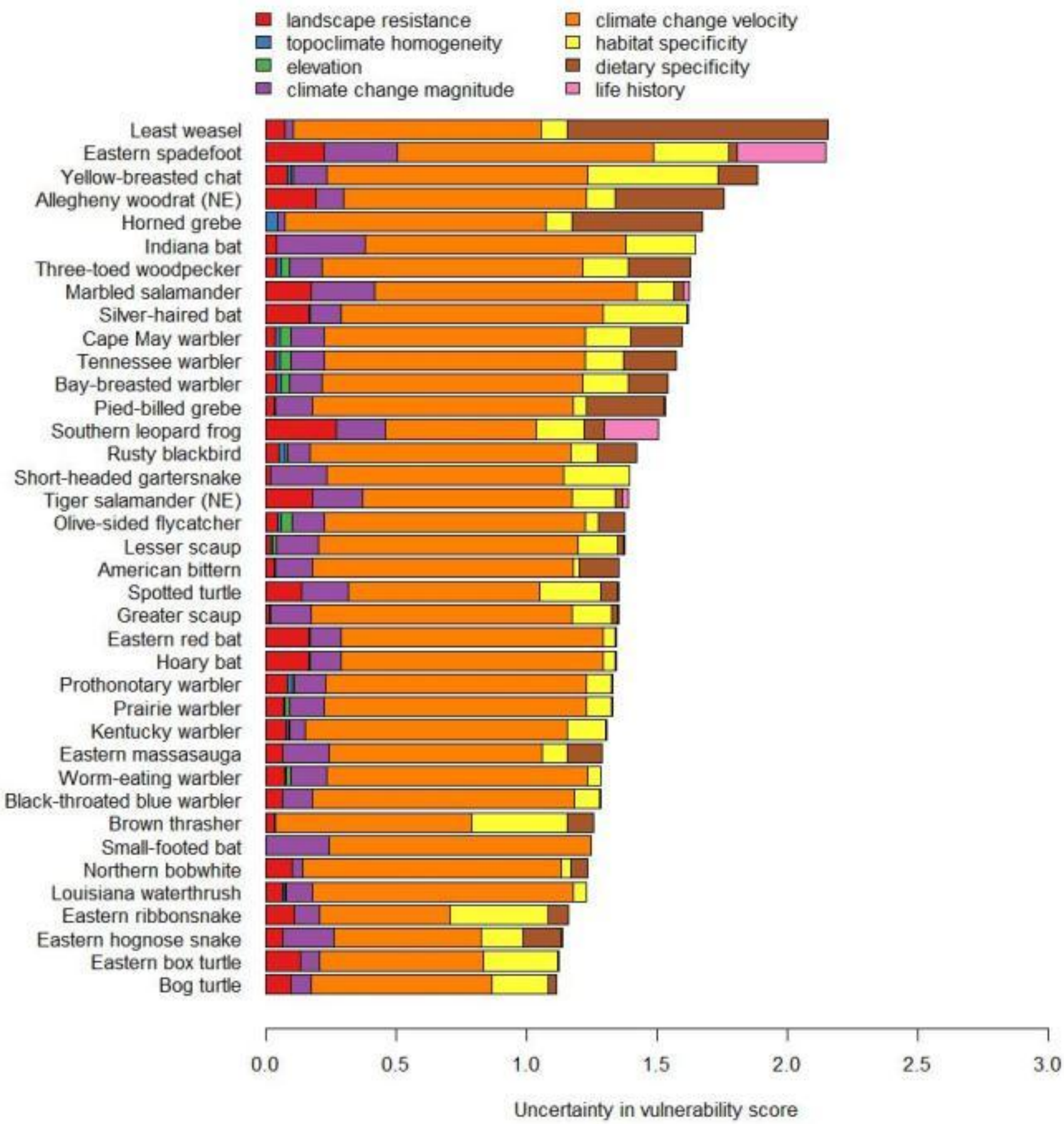

landscape resistance
topoclimate homogeneity
elevation
climate change magnitude
climate change velocity
habitat specificity
dietary specificity
life history
Least weasel
Eastern spadefoot
Yellow-breasted chat
Allegheny woodrat (NE)
Horned grebe
Indiana bat
Three-toed woodpecker
Marbled salamander
Silver-haired bat
Cape May warbler
Tennessee warbler
Bay-breasted warbler
Pied-billed grebe
Southern leopard frog
Rusty blackbird
Short-headed gartersnake
Tiger salamander (NE)
Olive-sided flycatcher
Lesser scaup
American bittern
Spotted turtle
Greater scaup
Eastern red bat
Hoary bat
Prothonotary warbler
Prairie warbler
Kentucky warbler
Eastern massasauga
Worm-eating warbler
Black-throated blue warbler
Brown thrasher
Small-footed bat
Northern bobwhite
Louisiana waterthrush
Eastern ribbonsnake
Eastern hognose snake
Eastern box turtle
Bog turtle
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Uncertainty in vulnerability score

Figure 2.8 Continued.

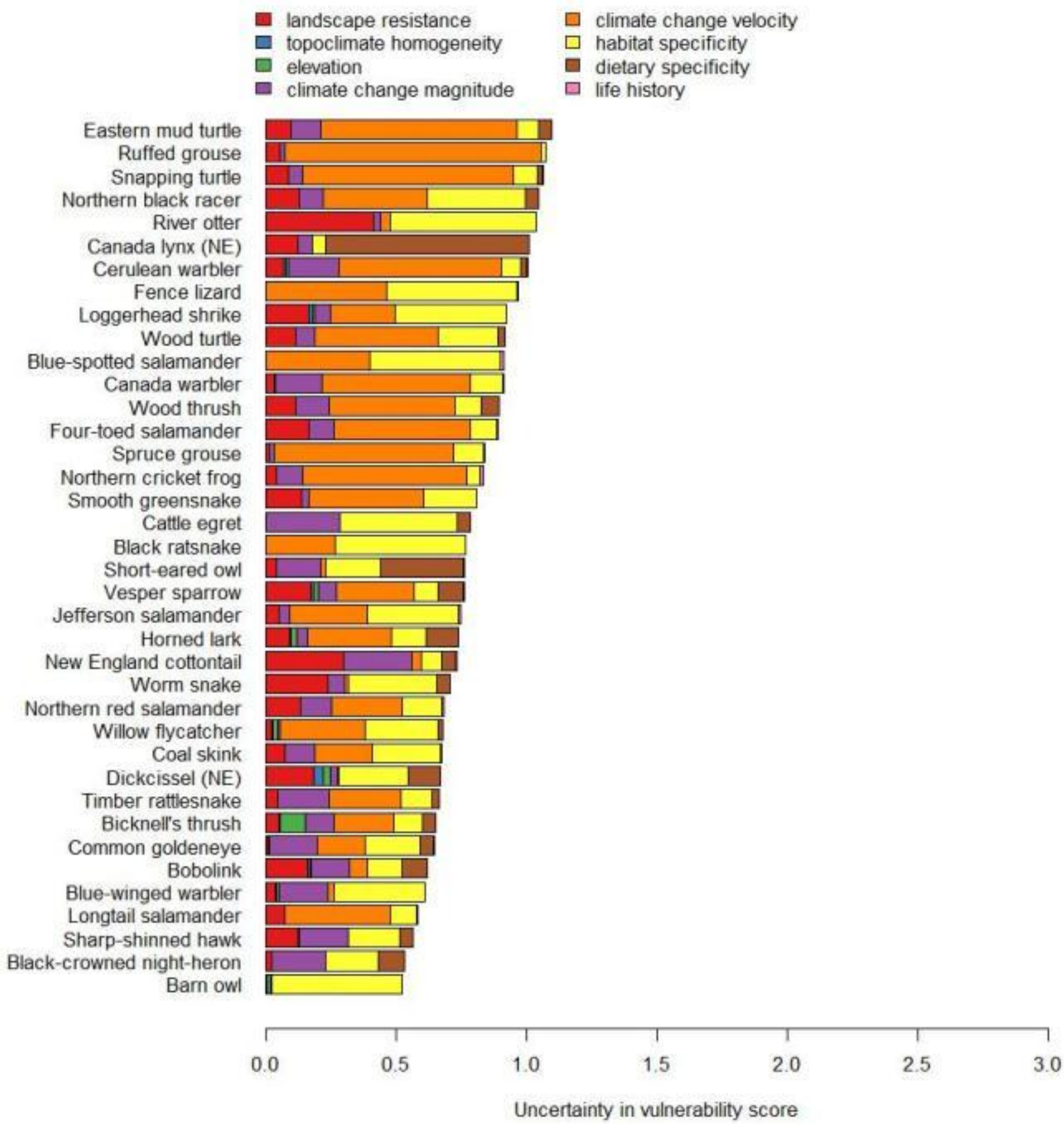
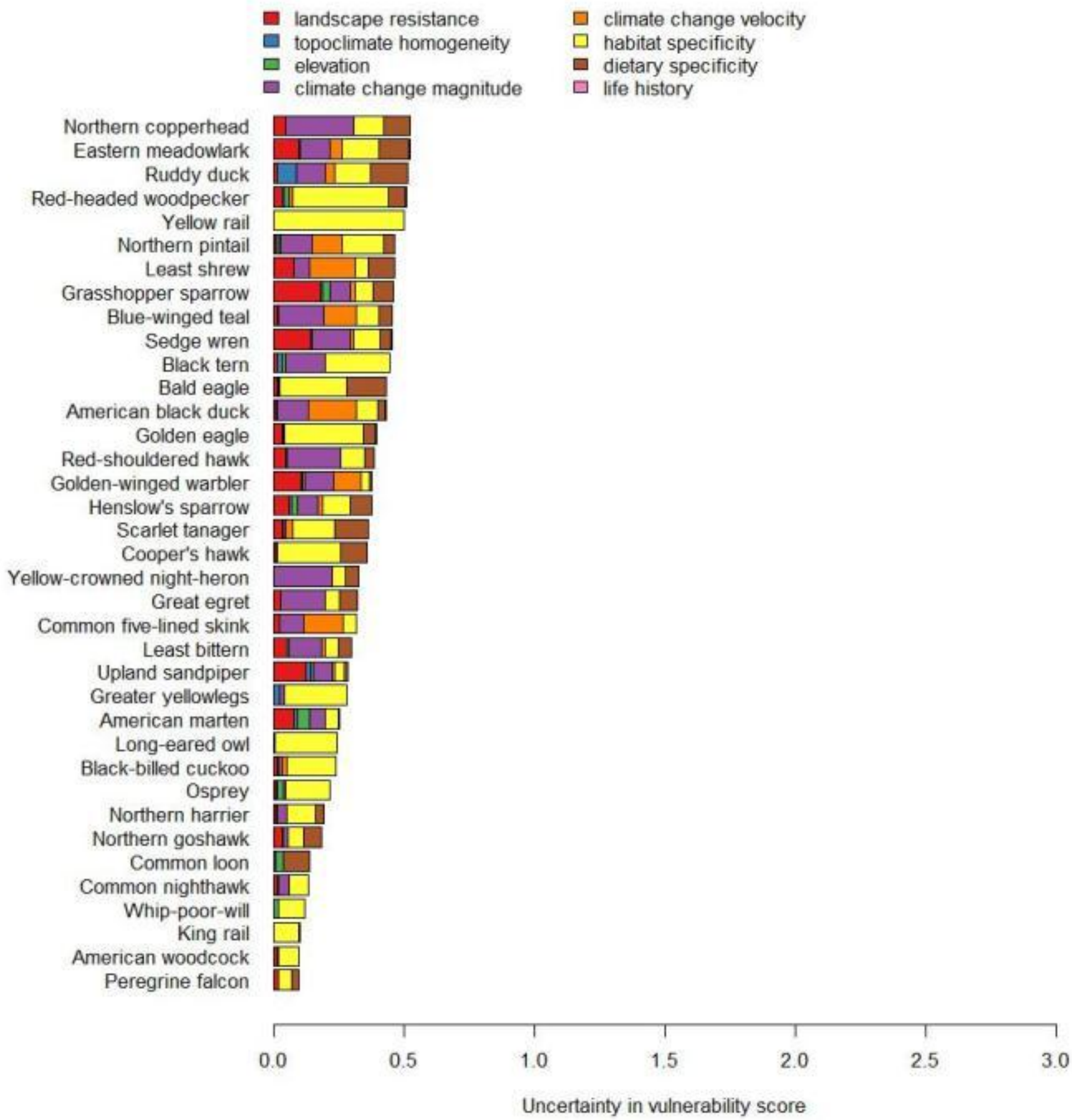


Figure 2.8 Continued.



Priority Management Areas for Focal Species:

I identified two types of priority management areas that could reduce the vulnerability of many focal species. First, I identified areas where decreasing landscape resistance (e.g., restoring natural vegetation in riparian corridors) could reduce vulnerability for the greatest number of species (i.e., landscape-resistance management areas, Box 3). See the *Discussion* for more examples of actions to decrease landscape resistance. Management actions to increase resistance will differ in each area of the landscape depending on the factors limiting species movement. I identified areas where decreasing landscape resistance would reduce vulnerability by first removing areas within each buffered species distribution where the species will not be able to move fast enough to track suitable climates; hence, decreasing landscape resistance in those areas is unlikely to be useful for the species. I then summed the weighted local resistance values for each species in each landscape cell and rescaled the values between zero and one to identify priority resistance management areas. I evaluated uncertainty by repeating the above methods using low and high estimates of species traits and calculating the range of values in each landscape cell. I weighted the resistance management areas map by the range of uncertainty in each landscape cell to create a final map that incorporated uncertainty. High values in the final resistance-management areas map identify areas where decreasing resistance would reduce the vulnerability for a large number of species that were restricted by resistance in that area.

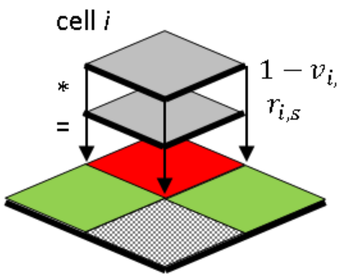
Second, I identified areas with low topoclimate homogeneity that are within the distribution of a large number of highly vulnerable species (i.e., topoclimate-diversity management areas, Box 4). Reducing non-climate threats in these areas (e.g., by including the area in an open-space plan) could help maintain the resilience of a large number of highly vulnerable species *in situ*. See the *Discussion* for more examples of actions to reduce non-climate threats in areas with diverse topoclimates. I identified topoclimate-diversity management areas by multiplying topoclimate homogeneity by weighted species richness in each landscape cell. I calculated weighted species richness by summing the relative vulnerability scores for each species that occurred in each landscape cell. High values in the final topoclimate-diversity management areas map identified areas where there are a large number of highly vulnerable species, yet the landscape may moderate the effects of climate change by providing suitable topoclimates where the species may persist.

Results:

Decreasing landscape resistance (see *Discussion* for examples of specific actions) will benefit the largest number of species in the Hudson River Valley in New York State (Fig. 2.9a). Indeed, the Hudson River Valley is a hotspot for decreasing resistance in the northeastern United States (Fig. 2.9a). Other hotspots in the northeastern United States include northern New Jersey, western Pennsylvania, and northwestern Maryland (Fig. 2.9a). These regions are hotspots because a large number of species have historically occurred in these regions (Fig. 2.9b), climate change velocity is less than the dispersal ability of many species (Fig. 2.2c), and the landscape currently restricts the movement of many species in these regions (Fig. 2.2e). Areas in western New York State are less likely to benefit from decreasing resistance (despite high landscape resistance, Fig. 2.2e) because climate change velocity is expected to exceed the dispersal ability of many species in western New York State (Figs. 2.2c and 2.9a).

BOX 3: IDENTIFYING LANDSCAPE-RESISTANCE MANAGEMENT AREAS (SEE BOXES 1 AND 2 FOR VARIABLE DEFINITIONS)

Step 1: set species-specific resistance to 0 in cells where the species dispersal distance is < climate change velocity

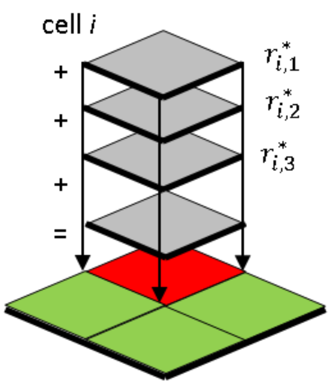


$1 - v_{i,s}$

$r_{i,s}$

$$r^*_{i,s} = (1 - v_{i,s}) * r_{i,s}$$

Step 2: sum the species-specific resistance for each species ($s \varepsilon S$)



$r^*_{i,1}$

$r^*_{i,2}$

$r^*_{i,3}$

$$r\_mang^*_i = \sum_{s \in S} r^*_{i,s}$$

Step 3: scale between 0 and 1 for interpretability

$$r\_mang_i = \frac{r\_mang_i - \min(r\_mang)}{\max(r\_mang) - \min(r\_mang)}$$

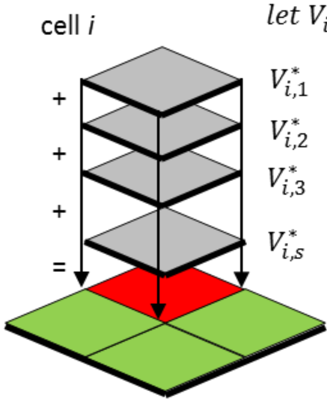
Key Uncertainties (see Boxes 1 and 2 for additional uncertainties)

1. Uncertainty in expert knowledge of the species dispersal distance (see Priority Management Areas for Focal Species).
2. Uncertainty in climate change velocity (see Fig. 2.4, we did not account for this uncertainty because uncertainty was minor).

Box 4: Identifying Topoclimate-diversity Management Areas (see Boxes 1 and 2 for variable definitions)

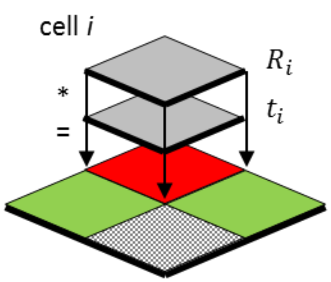
Step 1: calculate weighted species-richness (R_i) in each landscape cell

$$let\ V^*_{i,s} = \begin{cases} V_{i,s}, & if\ i \in N_s \\ 0, & otherwise \end{cases}$$



$$R_i = \sum_{s \in S} V^*_{i,s}$$

Step 2: multiply weighted-species richness by topoclimate homogeneity in each landscape cell



$$t\_mang^*_i = R_i * t_i$$

Step 3: scale between 0 and 1 for interpretability

$$t\_mang_i = \frac{t\_mang_i - \min(t\_mang)}{\max(t\_mang) - \min(t\_mang)}$$

Key Uncertainties (see Boxes 1 and 2 for additional uncertainties)

1. Uncertainty in the relative vulnerability score of each species.

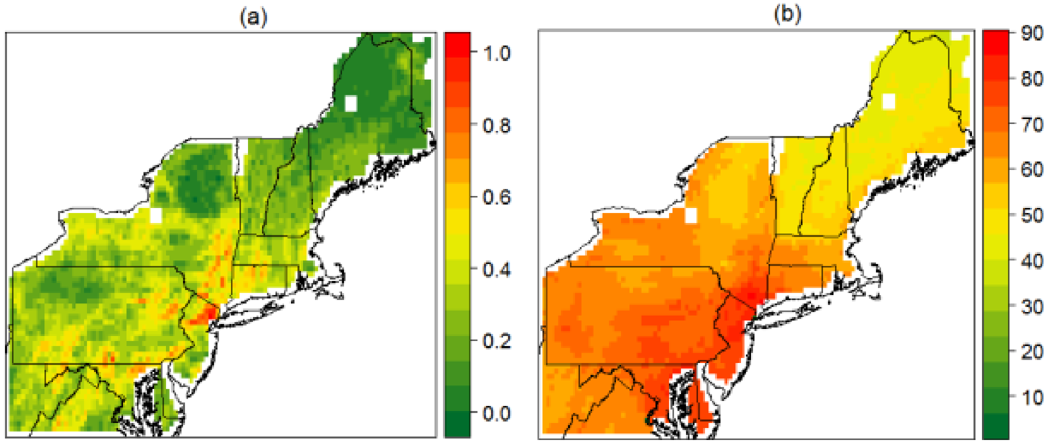


Figure 2.9. (a) Priority management areas for decreasing landscape resistance for the 113 species of greatest conservation need included in my analysis. Areas with values approaching one have (1) a high number of species limited by dispersal barriers, (2) climate change velocities less than the dispersal ability of the species that occur there, but (3) currently have dispersal barriers limiting species movement. Hence, decreasing resistance in these regions will benefit a large number of species. This map also incorporates uncertainty due to expert uncertainty in species ability to keep pace with climate change velocity and sensitivity to dispersal barriers. I reduced the value in each landscape cell proportional to the uncertainty in the cell. (b) Count of the number of the 113 focal species that occur in each cell (i.e., species richness).

Southern New York State is a priority topoclimate-diversity management area in the northeastern United States (Fig. 2.10a). Reducing non-climate threats (see *Discussion* for examples of specific actions) in southern New York State may benefit a large number of highly vulnerable species (Fig. 2.10b*) in situ* because diverse topoclimates could moderate the effects of climate change in this area. Other priority topoclimate-diversity management areas in the northeastern United States include northwestern New Jersey and much of the central Appalachian Mountains in Pennsylvania (Fig. 2.10a). The Catskills, Adirondacks, and mountains in New England are ranked as less important areas to protect topoclimate diversity because fewer vulnerable species occur in these regions (Fig. 2.10b).

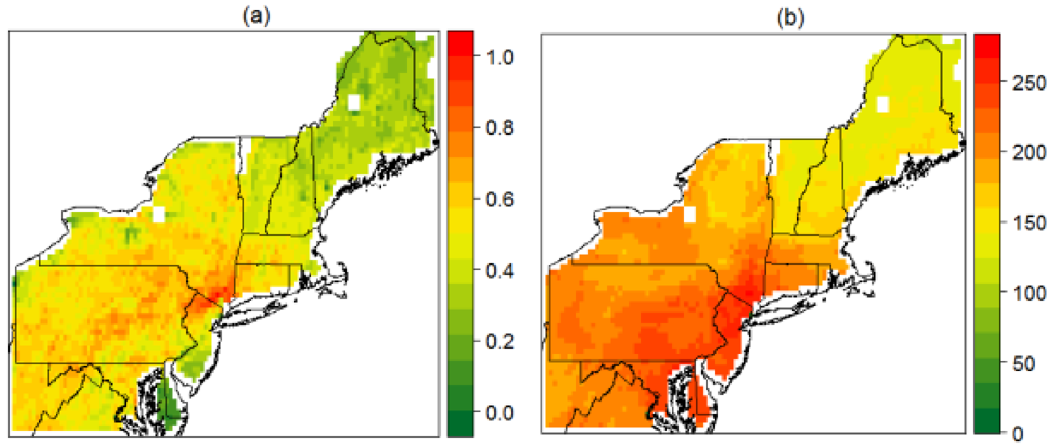


Figure 2.10. (a) Priority topoclimate-diversity management areas for the 113 species of greatest conservation need included in my analysis. Areas with values approaching one have a large number of highly vulnerable species and low topoclimate homogeneity. Hence, reducing non-climate threats in these areas could moderate the effects of climate change for a large number of highly vulnerable species. (b) The sum of the relative vulnerability scores for each of the 113 species that occur in each landscape cell (i.e., weighted species richness).

Climate-Smart Management Considerations for Focal Species:

I used the same six climate-smart management considerations described in the first section of this chapter for focal species (Tables 2.2 and 2.3). However, for species-specific management considerations, I used the score assigned to the species physiological tolerance and sensitivity to dispersal barriers to calculate a percentile used to define the threshold that separated low and high values of climate change magnitude and local landscape resistance. For example, if a species had a weight of 0.73 for sensitivity to dispersal barriers (suggesting that its movement is limited by dispersal barriers) the threshold applied to the landscape resistance map resulted in 73% of the map being classified as high resistance. This resulted in the movement limited consideration being important across more of the landscape for the species. Similarly, if a species had a score of 0.82 for physiological tolerance (suggesting that climate change will have a negative effect on the species physiology) the threshold applied to the climate change magnitude map resulted in 82% of the map being classified as high climate change magnitude. This resulted in less of the landscape being considered as low exposure. I used the species dispersal ability as the threshold for climate change velocity and I used the 50th percentile as the threshold for the topoclimate homogeneity. I then assigned climate-smart management considerations given unique combinations of high and low landscape values in each cell (Table 2.2). I only considered movement possible or limited in areas with low climate change velocity and areas below the upper 10% of elevations in the northeastern United States because species are more likely to be able to track suitable climates in these areas. I also accounted for expert uncertainty in the species-trait information by creating species-specific management consideration maps for low and high estimates of each species trait and evaluated whether the climate-smart management considerations differed among the three maps. I divided uncertainty into the same three categories as listed for the general management considerations.

Results:

I was able to provide climate-smart management considerations for all species with certainty, despite expert uncertainty in species traits. High topoclimate diversity was the most frequently recommended climate-smart management consideration across all species because this consideration does not depend on expert uncertainty in species traits and applies to species that are not very sensitive to dispersal barriers (e.g., migratory birds). High topoclimate diversity was considered important for all species on an average of 46% of the landscape within each species distribution. This suggests that high topoclimate diversity could moderate the effects of climate change on many species, allowing future management actions that are implemented across multiple topoclimates to provide a long-term benefit to the species. I recommended the movement possible consideration and the movement limited consideration (see Table 2.3 for descriptions) within the distribution of 72 and 58 species, respectively. However, I did not recommend these considerations on a large percentage of the landscape for most species. On average, I recommended movement possible on 17% and movement limited on 5% of the landscape within each species distribution. I recommended these considerations less frequently with certainty due to expert uncertainty in the ability of species to keep pace with climate change velocity and sensitivity to dispersal barriers. Almost all species (102 of 113) had areas of the landscape where I was unable to recommend a climate-smart management consideration, suggesting that management in some areas may not provide a long-term benefit for the species. However, I suggested that there was no feasible climate-smart management consideration on an average of only 6% of the landscape within each species distribution. This suggests that climate-smart management throughout much of the distribution of many species could provide long-term benefits for the species in the face of climate change. I present species-specific results for each of the 113 focal species in Appendix VIII.

Section III: Applying Species-Specific Results

Here I present species-specific results for New England cottontail (*Sylvilagus transitionalis*) as an example of how to interpret and apply species-specific results. The New England cottontail is a species that has suffered dramatic population declines and a range contraction in recent decades (Litvaitis et al. 2006). The species is therefore a candidate species for listing under the Endangered Species Act and a species of conservation concern throughout New England and New York State. Populations are thought to be declining primarily due to habitat loss from development and forest succession and competition with the introduced eastern cottontail (*Sylvilagus floridanus,* Fuller and Tur 2012). New England cottontail occupy early successional habitat characterized by dense understory vegetation (Barbmy and Litvaitis 1993). This habitat specificity is reflected in the habitat specificity scores (0.45 – 0.53, Table 2.6) used in my models (a habitat specificity score of 0.50 is defined as "requires a specific set of biotic or abiotic conditions (e.g., a forest type)", Table 2.4).

Table 2.6. Estimates of trait scores for New England cottontail provided by experts. The values presented are averaged across experts. The first five traits are scaled between zero (making the species least vulnerable) and one (making the species most vulnerable).

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Dispersal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.78	0.75	1.00	1.75
low	0.45	0.50	0.61	0.32	1.00	1.05
high	0.53	0.55	0.92	0.69	0.99	11.00

Changes in populations of New England cottontail under climate change are likely to be complex. New England cottontail is likely to benefit from decreased snow cover projected for the northeastern United States (Fuller and Tur 2012); however, the effect of warmer summers is unknown. The scores for physiological tolerance in my models (0.61 – 0.92, Table 2.6) reflect this uncertainty (a physiological tolerance score of 0.33 suggests the species is likely to be positively affected, a score of 0.66 suggests the species will be unaffected, and a score of 1.00 suggests the species is likely to be negatively affected, Table 2.4). Climate change may also have indirect impacts on New England cottontail through changes in the abundance and distribution of competitors and the abundance and community composition of predators. For example, the abundance and distribution of eastern cottontail may currently be limited by high energy demands at low temperatures (Fuller and Tur 2012). Hence, climate change could change the distribution and abundance of eastern cottontail causing further declines in New England cottontail. The climate change magnitude variable in my model indirectly captures the threat of increased competition by eastern cottontail because competition by eastern cottontail is more likely to increase where climate change is higher.

The New England cottontail ranked as the 18th most vulnerable species to climate change in New York State given experts' best estimates of species traits (Table 2.6, Fig. 2.11), suggesting that it is a high priority for implementing climate-smart management. However, this ranking varied between 18th and 50th, depending on the estimates of species traits used in the model. Uncertainty in the vulnerability score for New England cottontail is due primarily to uncertainty in its sensitivity to dispersal barriers (which translates into uncertainty in the effect of landscape resistance) and physiological tolerance to climate change (which translates into uncertainty in the effect of climate change magnitude) (Table 2.6, Fig. 2.11). Hence, improving knowledge of these traits for New England cottontail could improve estimates of its vulnerability to climate change. High uncertainty in the natal dispersal distance of New England cottontail (Table 2.6) did not translate into large uncertainty in the ability of the species to track suitable climates (Fig. 2.11) because climate change velocity is less than the low estimate of natal dispersal distance throughout much of the northeastern United States (Fig. 2.2c).

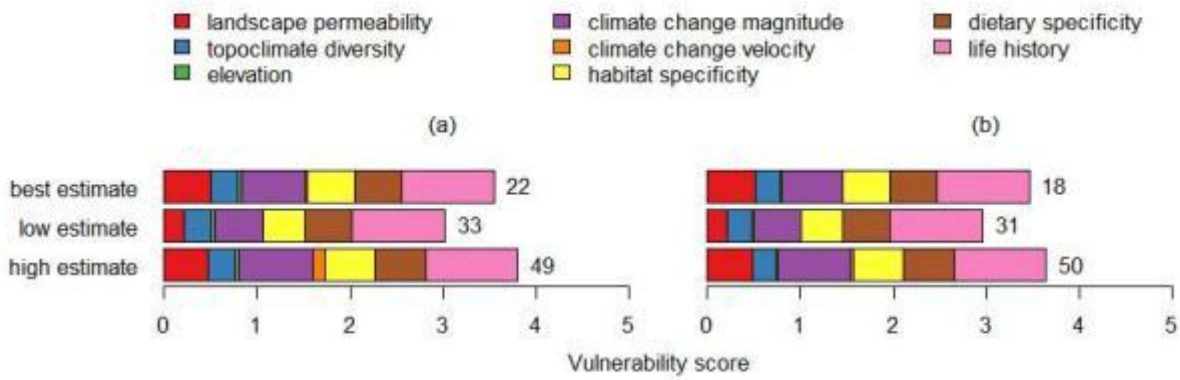


Figure 2.11. The relative vulnerability score (and component scores) for New England cottontail in (a) the northeastern United States and (b) New York State. Each component has a maximum value of one (most vulnerable); hence the maximum vulnerability score is eight. The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for New England cottontail relative to the other 113 species evaluated (where one is the most vulnerable species).

Despite uncertainty in the vulnerability score for New England cottontail, maps of species-specific vulnerability still help determine where New England cottontail is likely to be most vulnerable and most resilient (Fig. 2.13). Remnant populations of the New England cottontail are thought to occur in five clusters within its historical distribution (Litvaitis et al. 2006, Fig. 2.12): (1) the seacoast region of southern Maine and New Hampshire, (2) Merrimack River valley of New Hampshire, (3) Cape Cod, Massachusetts, (4) east of the Connecticut River and Rhode Island, and (5) southeastern New York State, western Connecticut, and southwestern Massachusetts. The two clusters in New Hampshire and Maine both contain areas where New England cottontail is expected to be highly vulnerable to climate change given both experts' best and high estimates of species traits (Fig. 2.13a, c). New England cottontails in these two clusters will likely be vulnerable to climate change due to high climate change magnitude and velocity (Fig. 2.14). Note, that climate change magnitude is high in the northern part of the species range despite being down weighted using the experts' best and high estimate of the physiological tolerance of New England cottontail to climate change (Fig. 2.14). The cluster in southeastern New York State, western Connecticut, and southwestern Massachusetts is expected to be least vulnerable to climate change regardless of uncertainty in species traits (Fig. 2.13) due to low climate velocity (Fig. 2.14) and low topoclimate homogeneity (Fig. 2.2e) in this region.

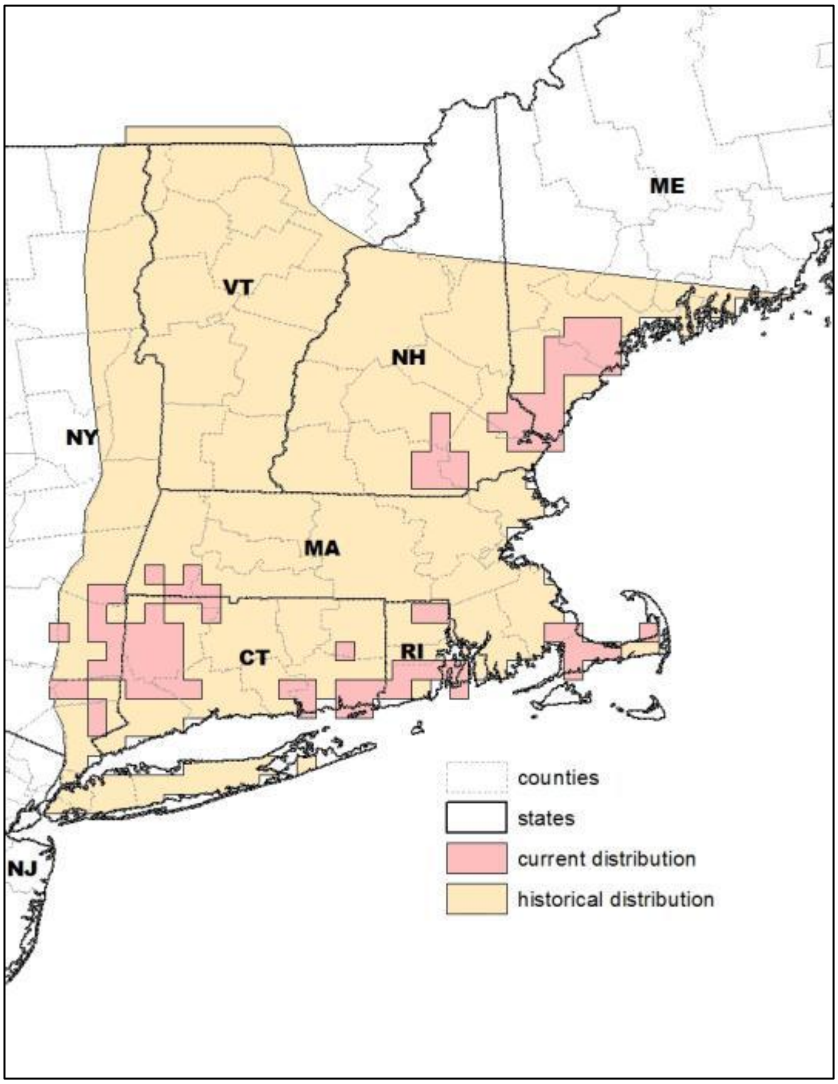


Figure 2.12. Current and historical distribution of New England cottontail. Reproduced from Litvaitis et al. 2006. The current distribution is represented by the USGS quadrangles where New England cottontail was detected during a survey throughout much of its historical distribution.

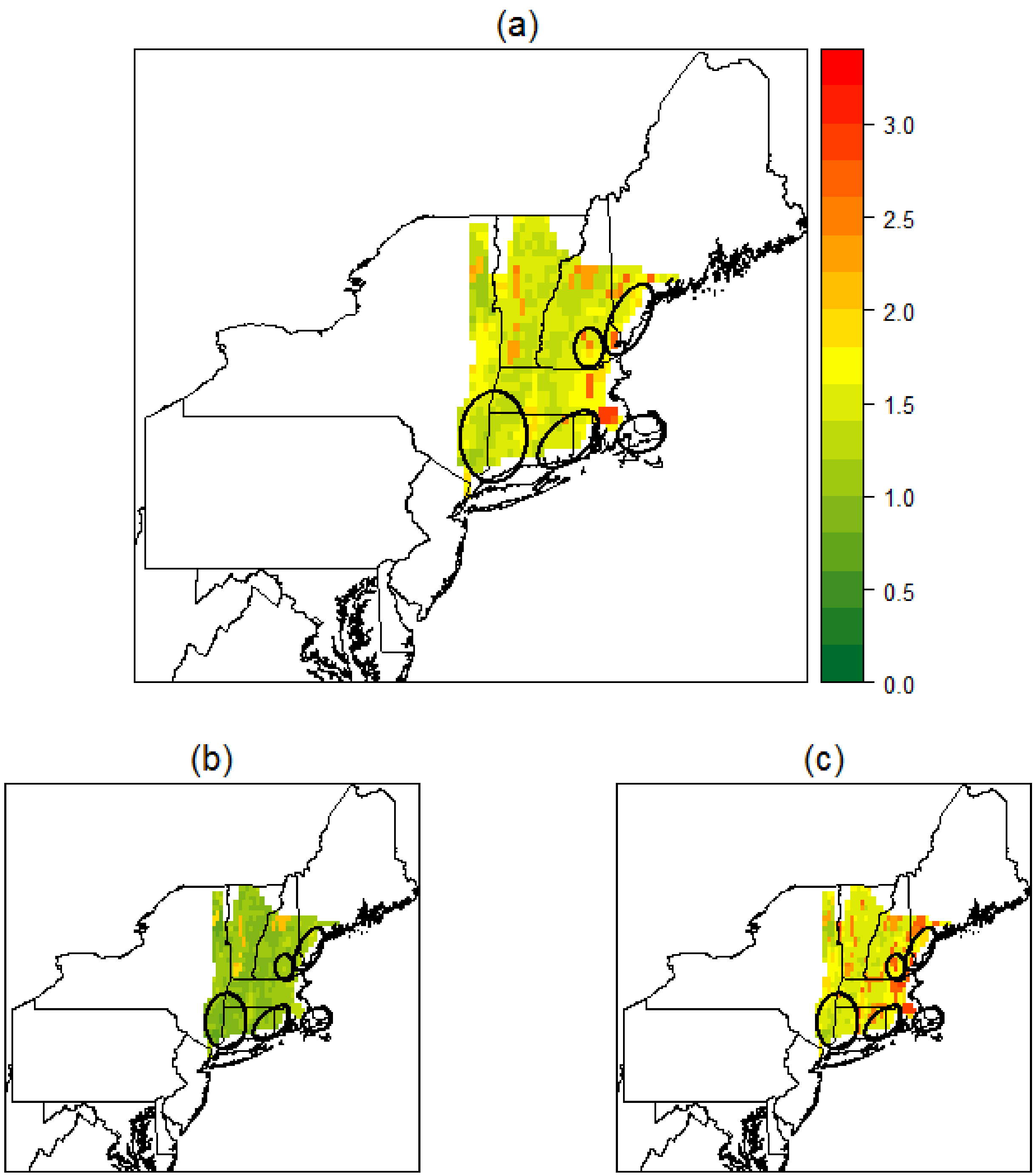


Figure 2.13. Species-specific vulnerability within the historical distribution of New England cottontail based on experts': (a) best, (b) low, and (c) high estimates of species traits. High vulnerability scores indicate that the areas where New England cottontail is most vulnerable to climate change. The five black circles in each panel are the current distribution of New England cottontail.

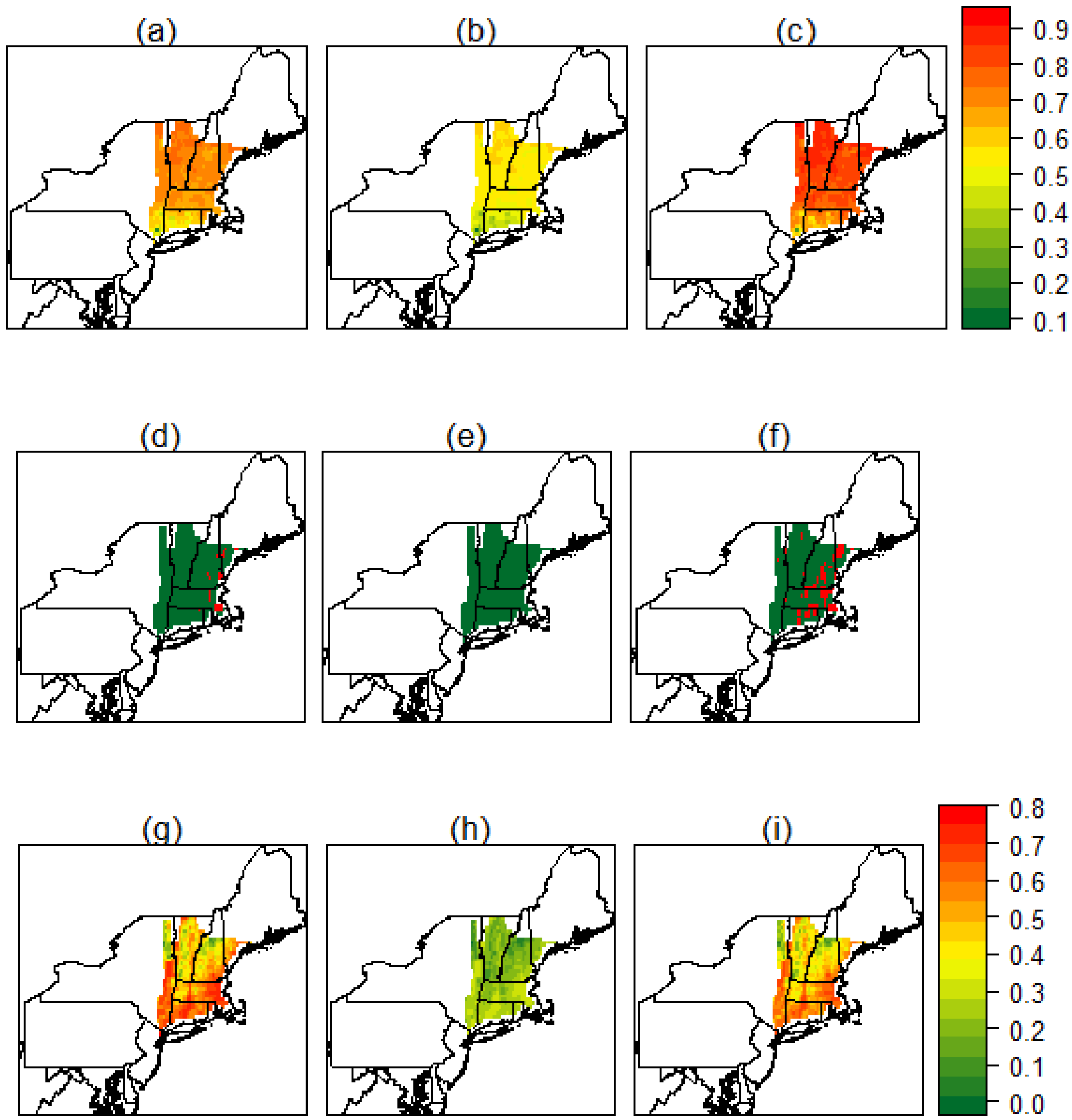


Figure 2.14. Components of vulnerability that rely on species-trait data for New England cottontail, including: (a, b, c) climate change magnitude weighted by the species physiological tolerance, (d, e, f) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (g, h, i) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g) best, (b, e, h) low, and (c, f, i) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability

Current and planned future management actions for New England cottontail focus primarily on restoring early successional vegetation and translocating individuals to establish new populations (Tash and Litvaitis 2007, Arbuthnot 2008, Fuller and Tur 2012). My climate-smart management considerations can help guide these actions to ensure that management will provide a long-term benefit for New England cottontail in the future (Fig. 2.15). For example, my models suggest that high topoclimate diversity throughout much of the New England cottontails range could moderate the effects of climate change (Fig. 2.15). Therefore, restoration and translocation sites should either span multiple topoclimates (if the site is large enough to do so) or should encompass multiple sites within different topoclimates. This will serve numerous purposes. First, sites located in warmer topoclimates with less snow cover will allow increased winter survival (Tash and Litvaitis 2007). This is especially important for the near future when snow cover is likely to vary dramatically among years. Second, sites located in cooler topoclimates could prolong the negative effects of warming, including the possibility of increased competition from eastern cottontails and the physiological effects of warmer summers. Although winter survival will vary in cooler topoclimates in the near future (due to annual variation in snow cover), establishing populations in cooler topoclimates early may reduce future competition with eastern cottontail via an inhibitory priority effect (i.e., exclusion of competitors due to prior establishment on a site; Young et al. 2001, Litvaitis et al. 2008). Moreover, given that weather is likely to vary greatly over the next few decades, having populations in multiple topoclimates could be beneficial by allowing high survival in a portion of occupied sites in all years.

In addition to considering high topoclimate diversity, I suggest that movement is limited by dispersal barriers throughout much of the New England cottontail's historical range (Fig.

2.15). Therefore decreasing local landscape resistance in conjunction with habitat restoration and translocations, especially among patches of suitable habitat, will likely benefit the species by allowing them to move to track suitable climates. Decreasing local landscape resistance will also allow sites where the species has gone locally extinct (e.g., due to a severe winter) to get recolonized by source populations (i.e., the rescue effect; Brown and Kodric-Brown 1977, Litvaitis et al. 2008). Indeed, decreasing local landscape resistance is already a high priority for New England cottontail for this same reason (Litvaitis et al. 2006). Landscape resistance for New England cottontail could be decreased in numerous ways, including: (1) creating buffers of suitable habitat between agricultural fields and forests (Arbuthnot 2008), and (2) ensuring suitable habitat exists along existing human created corridors (e.g., power-line rights-of-way, margins of roads and railroads; Litvaitis et al. 2006, Litvaitis et al. 2008). Note, however, that the value of decreasing resistance will depend on the ability of New England cottontail to overcome dispersal barriers, as indicated by the uncertainty in the management considerations I recommended (Figs. 2.15 and 2.16). If New England cottontail is able to move in the presence of dispersal barriers (e.g., roads) then decreasing landscape resistance will have less value.

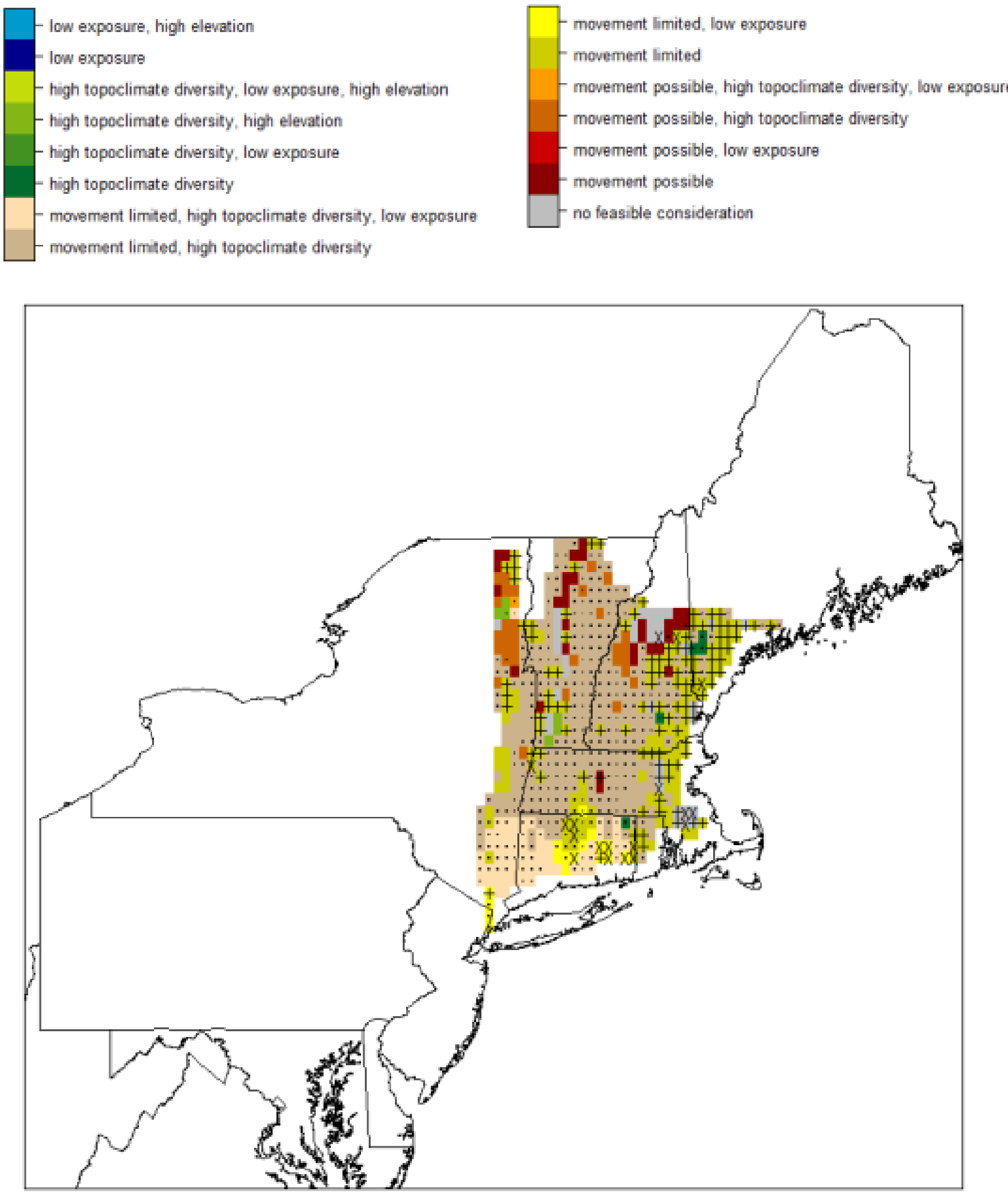


Figure 2.15. Climate-smart management considerations for New England cottontail given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits (Fig. 2.16): (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

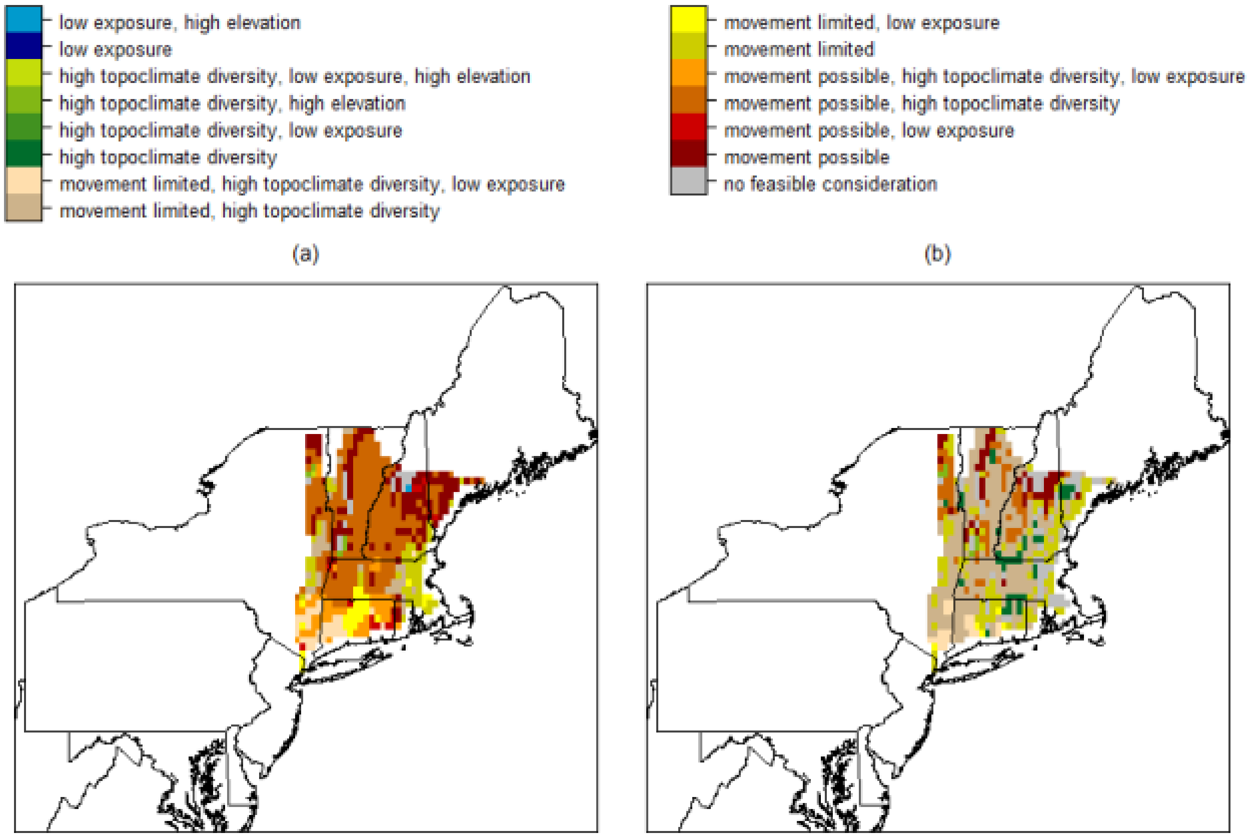


Figure 2.16. Climate-smart management considerations for New England cottontail given experts' (a) low and (b) high estimate of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

Discussion

One of the greatest challenges for fish and wildlife management under climate change is uncertainty in the magnitude and spatial pattern of climate change (Lawler et al. 2010). Attempting to predict how species or populations will respond to climate change further increases that uncertainty because where a species can persist is a complex interaction between abiotic factors (e.g., climate), biotic factors (e.g., competition), and the ability of the species to reach suitable abiotic and biotic conditions (Soberon and Peterson 2005). Each of these three components is unknown for most species, especially rare or poorly studied species such as those included in this study. Moreover, correlative approaches used to estimate these factors are unlikely to provide accurate results for many species (Pearson and Dawson 2003, Guisan and Thuiller 2005, Heikkinen et al. 2006, Austin 2007, Dormann 2007, Sinclair et al. 2010). In the presence of great uncertainty, science is often better at identifying major vulnerabilities of systems than predicting the future (Polasky et al. 2011). For this reason, I made no attempt to predict where species are likely to occur in the future or how a species will respond to climate change. Rather, I identified major vulnerabilities and opportunities for resiliency for species and landscapes under climate change. Uncertainty about the magnitude and spatial variation of climate change had minimal impact on my results, but uncertainty in species-trait data did affect my ability to determine which species will be most vulnerable to climate change. However, I was able to explicitly account for this uncertainty when identifying areas on the landscape where the species is expected to be most vulnerable, priority management areas for focal species, and climate-smart management considerations. Hence, uncertainty should not preclude action.

The ecological impact of climate change in New York State will be less severe than most other northeastern states, despite predictions that the climate will change more in New York State than other states. Indeed, the ecological impact of climate change in all states north of and including Connecticut is expected to be less severe than southern states despite predictions of high climate change in northern states. This does not mean that New York State (and other northern states) is immune to climate change. Ecological changes consistent with expectations under climate change are already occurring in New York State (Gibbs and Breisch 2001, Zuckerberg et al. 2009, Warren et al. 2012, Kujala et al. 2013). My results suggest, however, that decreasing landscape resistance or reducing non-climate threats in areas with diverse topoclimates can reduce the vulnerability or maintain the resiliency of many vulnerable species in the state. In fact, the Hudson Valley of New York State is a hotspot in the northeastern United States for both decreasing landscape resistance and reducing non-climate threats in areas with diverse topoclimates to reduce the vulnerability of the most species included in my analysis. Other studies have also identified the Hudson Valley as a hotspot for animal movement and have shown that suitable habitat may persist in the Hudson Valley under climate change for many of the species that currently occur there (Howard and Schlesinger 2012), likely due to the low topoclimate homogeneity. Land-cover data (Fry et al. 2011) for the Hudson Valley suggests that the area is dominated by agriculture and forest and includes a major interstate (i.e., I87) and numerous secondary highways and small roads. Therefore, actions to decrease landscape resistance could include: installing wildlife crossings on roads (Clevenger and Wierzchowski 2006, Bissonette and Adair 2008), restoring natural vegetation in riparian corridors (Machtans et al. 1996, Gillies and St. Clair 2008), controlling herbivore populations in retired farmlands and riparian areas to promote forest regeneration (Opperman and Merenlender 2000), and encouraging farmers to leave buffer zones around croplands for natural vegetation (Bennett et al. 1994). Actions to reduce non-climate threats in areas with diverse topoclimates could include: including areas with intact habitat in an open-space plan, limiting development, limiting the effects of over abundant herbivores (Chollet S. 2013, Tymkiw et al. 2013), and restoring natural vegetation and disturbance regimes (Nuttle et al. 2013). Each of these actions should be implemented over multiple topoclimates, either by implementing the action across a large area or across multiple areas with different topoclimates.

Employing species-specific management actions (e.g., habitat enhancement) in a climate-smart manner can also ensure that species will gain long-term benefits from the management action. Each of the climate-smart management considerations that I identified are wise management considerations regardless of the realized magnitude of climate change. For example, focusing management efforts (e.g., protection, habitat enhancement) in areas with diverse topoclimates is increasingly recognized as a method to preserve biodiversity in the absence of environmental stationarity (Hunter et al. 1988, Nichols et al. 1998, Anderson and Ferree 2010, Beier and Brost 2010, Groves et al. 2012). For example, high-elevation ecosystems in New York State are unique due to unique climatic and geophysical properties, including an array of topoclimates. Hence, protecting habitats in these regions is likely to provide protection for a unique ecosystem in the future, regardless of whether the current community persists.

High topoclimate diversity was the climate-smart management consideration I recommend most frequently for all species in New York State and the northeastern United States. For many species high topoclimate diversity was the only climate-smart management consideration recommended without uncertainty caused by expert uncertainty in species traits. High topoclimate diversity is a highly overlooked landscape feature in climate change related analyses (Luoto and Heikkinen 2008, Randin et al. 2009, Logan et al. 2013), despite its great promise to help moderate the ecological effects of climate change (Pearson 2006, Rull 2009, Dobrowski 2011). Using my climate-smart management maps to concentrate management actions in areas that include multiple topoclimates can moderate the effects of climate change (therefore providing a long-term benefit to the species) in four primary ways. First, topoclimate diversity can provide suitable climates during periods of extreme weather (Peters and Darling 1985). For example, endangered checkerspot butterflies (*Euphydryas editha bayensis*) in California persist only in patches with north and south facing slopes that provide suitable host plants for larval survival across both wet and dry years (Peters and Darling 1985, Wilcox and

Murphy 1985). Second, topoclimate diversity can allow species to move only a short distance to track their suitable climates (Peters and Darling 1985). Elevational range shifts have occurred in numerous species in response to contemporary (Parmesan and Yohe 2003, Chen et al. 2011) and historical (Guralnick 2007) climate change. This effect of topoclimate diversity is especially important for dispersal limited species because species will have to move much shorter distances to track suitable climates across elevational compared to latitudinal climate gradients (Jansson and Dynesius 2002, Guralnick 2007). Third, topoclimate diversity could provide climates where species can persist throughout climate change. It is well known that large-scale climatic refugia harbored species through climate changes during the last glacial maximum (Jackson and Overpeck 2000, Dobrowski 2011). However, small-scale refugia were also likely (Rull 2009). Indeed, trees in the northern hemisphere may have persisted in small patches of suitable climate during the last glacial maximum, which may explain the discrepancy between the dispersal ability of trees and the rate of post-glacial recolonization (i.e., Reid's paradox; Pearson 2006, Rull 2009, Dobrowski 2011). The presence of topoclimate refugia may be especially important to mid- to high-elevation species that are at a high risk of upward displacement (Rull 2009). This makes continuing to limit development and other non-climate threats in areas with high topoclimate diversity especially important in the Adirondack and Catskill mountains. Temporary topoclimate refugia may also be important to allow species time to adapt to changing climates either *in*- or *ex-situ*. For example topoclimate diversity could allow a species native to a location to coexist with an invading competitor with different climatic tolerances by providing suitable climates in some years for both species (i.e., the storage effect; Chesson and Warner 1981). Similarly, topoclimate refugia could stop competitors from invading and competing with native species, as has been predicted for *Anolis* lizards in Honduras (Logan et al. 2013). Last, genetic diversity is often higher in areas of high topoclimate diversity, which could be critical for species to adapt or persist under changing local climates (Jump and Peñuelas 2005). Hence, open-space plans that include multiple topoclimates are likely to preserve genetic diversity, especially for dispersal limited species.

Decreasing landscape resistance is the most recommended management strategy in the published literature on climate change (Heller and Zavaleta 2009). However, my results suggest that decreasing landscape resistance as a climate-smart management consideration (i.e, movement limited) is very uncertain for many species due to the uncertainty in the species ability to move fast enough to track suitable climates and the sensitivity of species to dispersal barriers. Others have also cautioned against decreasing landscape resistance as the primary management strategy in the face of climate change (Hodgson et al. 2009, Doerr et al. 2011) and have suggested that species may not be able to move fast enough to track suitable climates (Malcolm et al. 2002, Loarie et al. 2009, Schloss et al. 2012). Decreasing landscape resistance should be assessed on a species by species basis and my climate-smart management consideration maps offer guidance in this regard for each species (Appendix VIII).

I used estimates of the species average natal dispersal distance to evaluate whether species will be able to keep pace with climate change; a significant improvement over the plethora of models that assume unlimited dispersal (see Table 1 in Urban et al. 2013). However, the mean dispersal distance of a species may significantly underestimate the ability of species to track their suitable climates due to infrequent long-distance dispersal events (Urban et al. 2013). Rare long distance dispersal events are another possible solution to Reid's paradox (Pearson 2006). Unfortunately, incorporating long-distance dispersal events into models requires detailed knowledge of the dispersal kernel of a species (Urban et al. 2013), which requires detailed study with very large sample-sizes not available for rare species. Moreover, the infrequency of long-distance dispersal may preclude establishment of new populations beyond the existing range of the species. For example, species may require the presence of other individuals of the species for both reproductive and non-reproductive reasons (i.e., the Allee effect). Also, establishment in a new biological community often requires repeated attempts to invade (Veltman, C. J., Nee, S., Crawley,M.J., 1996, Sax and Brown 2000, Korniss and Caraco 2005), which may be unlikely if long-distance dispersal is too infrequent. Hence, attempting to incorporate rare long-distance dispersal into my model would only increase the uncertainty.

My estimates of the species ability to track their suitable climates may also be underestimated because there is some evidence that dispersal kernels (and therefore mean dispersal distance) have evolved during past climate change and recent biological invasions (Phillips et al. 2008, Travis et al. 2013, Urban et al. 2013). For example, cane toads (*Bufo marinus*) historically expanded their range in Australia at a rate of 10 km/year, but now expand their range at more than 55 km/year (Phillips et al. 2008). Toads on the expanding front tend to move more often, move farther, and follow straighter paths compared to those in the core of the population (Phillips et al. 2008). Dispersal behaviors are thought to evolve through segregation of long-distance dispersers from the core of the population (Phillips et al. 2008, Urban et al. 2013). Evolution of dispersal, and evolution to climate change in general, has thus far been largely overlooked, but may allow many species to overcome the challenge of coping with climate change (Parmesan 2006, Alberto et al. 2013). Attempting to account for evolutionary responses to climate change is beyond the scope of a climate change vulnerability assessment. Note, however, that models that account for evolution, population growth, and dispersal ability are possible (e.g., Norberg et al. 2012) and could be developed for species of interest while accounting for uncertainty in the population parameters.

Climate change offers a unique opportunity to learn about long-term viability of my management practices in light of inevitable environmental change. Climate and weather vary across all time-scales from days to millennia and many of these changes have effects on the biology (Janzen 1994, Parmesan et al. 2000), abundance (Brown 1984, Parmesan et al. 2000), diversity (Willig et al. 2003), and evolution of organisms (Holt 2004). Indeed, many of the effects of climate change are expected to occur due to the increased frequency of extreme events (Parmesan et al. 2000, Cahill et al. 2013). Many of these events would also occur in the absence of climate change (albeit less frequently). Hence, it is important that current management practices are resilient to climate and weather variability even in the absence of climate change. The outcome of current management practices (e.g., abundance or survival of the focal organism) combined with predictions of resiliency to climate and weather variation (such as I have provided here) offer a great opportunity to learn which management actions are most robust to climate and weather variation. I recommend funding research on this topic. This research could be completed in two ways: (1) by evaluating the effect of different management practices over the same variation in climate (e.g., before and after a hurricane) or (2) by evaluating the effectiveness of the same management practice in locations with different predictions about resiliency to climate and weather variation. Data for such studies likely exists already, but is not always utilized in this way. Specifically, I recommend testing the efficacy of topoclimate diversity to moderate the effects of environmental change in New York State given strong variation in snow cover and depth over the last decade and hurricanes Irene and Sandy. Data from monitoring of any species across locations with a range of topoclimate diversity could be used in such a study. Results from such a study would reduce uncertainty in the efficacy of topoclimate diversity in moderating the effects of climate change.

Many difficult management decisions are likely to arise under climate change (e.g., whether to keep managing for a species that is extremely vulnerable to extinction or extirpation under climate change). Decisions are made even more difficult by political and legal considerations often overlooked by scientists offering management advice. My results offer some guidance to help aide and justify difficult decisions. For example, continuing to implement management actions for an extremely vulnerable species across multiple topoclimates may continue to be fruitful for many years. Other methods, such as structured decision making (Keeney 1996), may also be useful to address specific challenging decisions because it provides an evaluation of trade-offs of multiple objectives (e.g., ecological, social). Indeed, structured decision making is becoming increasingly common in the climate change literature (Ohlson et al. 2005, Polasky et al. 2011). Regardless of the approach taken, methods used to answer difficult questions related to climate change must be statistically sound and ecologically relevant. Although this statement seems obvious, many climate change studies do not meet these criteria (Pearson and Dawson 2003, Guisan and Thuiller 2005, Heikkinen et al. 2006, Austin 2007, Dormann 2007, Sinclair et al. 2010). Society is looking to ecologists and fish and wildlife managers to determine how best to conserve biodiversity under climate change. Thus far, attempts to answer these questions have overlooked many important landscape features, species traits, and ecological phenomenon (e.g., competition) that could affect how a species may respond to climate change (Soberon and Peterson 2005, Soberon 2010). Indeed, many of the current estimates of species extinction rates may be overestimated due to this oversight (Botkin et al. 2007, Randin et al. 2009). We must ensure that future attempts to estimate the biological impacts of climate change include as many relevant factors as possible to ensure that money is not wasted on management actions that are not likely to provide a long-term benefit to species. Moreover, research must be conducted in a way that directly informs management. Although there is always room for improvement, I believe that my methods make a major stride in these directions.

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APPENDIX

Appendix I: Robustness of Climate Overlap to Violations of the Normality Assumption:

We tested the robustness of climate overlap to violations in the normality assumption by simulating total summer precipitation data from 10000 different gamma distributions for a 30-year period. A gamma distribution is commonly used to represent precipitation data, which often do not fit a normal distribution (Meehl et al. 2000). We chose the different gamma distributions by estimating the rate and shape parameters from total annual summer precipitation between 1971-2000 at 10000 randomly selected locations in the continental United States using PRISM climate data (PRISM Climate Group 2013). We estimated the rate and shape parameters using maximum likelihood methods (Venables and Ripley 2000) from real climate data to help ensure that our tests of robustness were representative of violations of normality that might be encountered using real data. We simulated 10000 different 30-year precipitation datasets using the rate and shape parameters from each gamma distribution. We did not simply use the raw data from the 10000 randomly selected locations because we wanted to be sure that the simulated data came from a gamma distribution (hence we knew the true distribution of the simulated data). We simulated a second 30-year total summer precipitation dataset after adding 0.1 to the rate parameter of each of the 10000 gamma distributions. We calculated the true climate overlap between the two datasets (i.e., with the correct parameters and the correct distribution) using the parameters of the gamma distributions used to simulate the two datasets and numerical integration of $\rho = \int \sqrt{f_1(x) f_2(x)}\, dx$, where $f_1(x)$ is the original distribution and $f_2(x)$ is the distribution after adding 0.1 to the rate parameter. We also calculated climate overlap assuming a normal distribution by substituting the mean and variance of the two simulated datasets into the climate overlap equations. We used the Matusita's overlap (not our modified version) to allow for a fair comparison between the two measures of climate overlap. We then compared the true climate overlap to the climate overlap calculated assuming a normal distribution to quantify the error caused by assuming a normal distribution when in fact the data were gamma distributed.

Climate overlap was robust to violations of the normality assumption. The mean of the true climate overlap (i.e., climate overlap calculated with the parameters of the true gamma distributions) was 0.30 (SE = 0.002). The mean of the absolute difference between the true climate overlap and the climate overlap assuming a normal distribution was 0.08 (SE = 0.0006). Hence, the mean change greatly exceeded the mean error, suggesting that climate overlap is robust to violations of the normality assumption. The mean of the difference between the two measures of climate overlap was 0.01, suggesting that the errors caused by a violation of the normality assumption were unbiased.

Appendix II: Choosing the optimal variation inflation

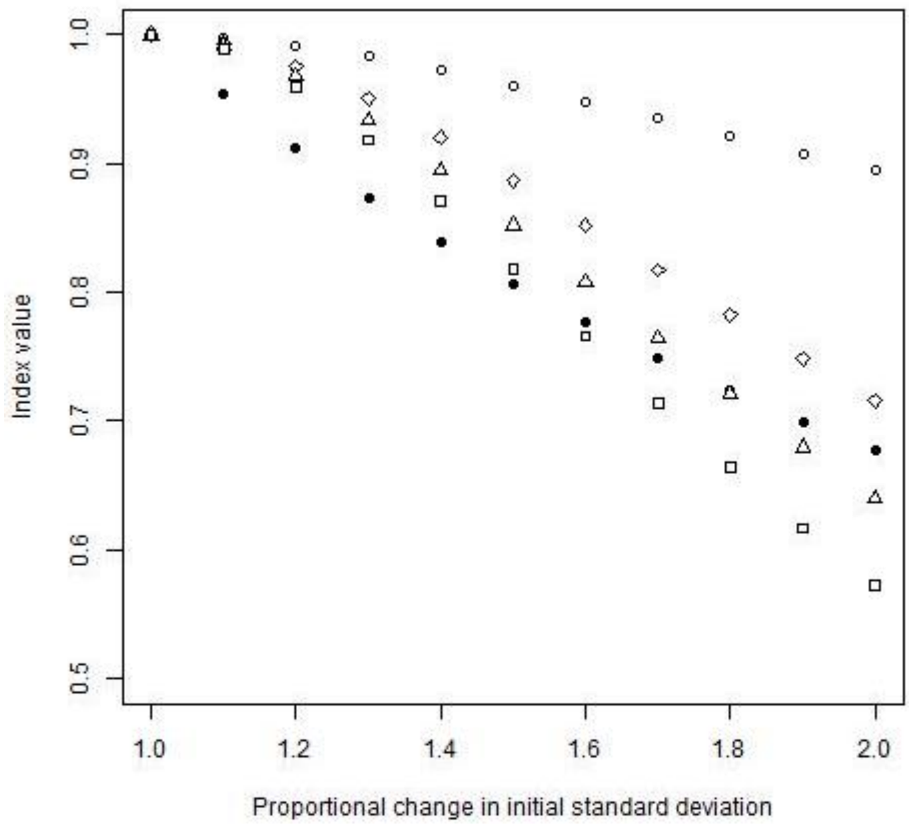

Figure AII.1. Mean Matusita's overlap (open circles), modified Matusita's overlap with different values of variation inflation (open diamonds = 3, open triangles = 4, open squares = 5), and the proportional similarity index (closed circles) measuring the overlap between a normal probability distribution of mean daily minimum winter (December, January, and February) temperature and a normal probability distribution with proportional changes in the standard deviation of mean daily minimum winter temperature. Each data point is the mean of 10000 index values comparing the historical climate (1971-2000) at 10000 randomly selected locations in the United States to the historical climate with a modified standard deviation in mean daily minimum winter temperature (as specified on the x-axis). We chose a variation inflation factor of 4 because this minimized the root-mean-squared-difference (RMSD) between climate overlap and the proportional similarity constant. The RMSD for each variation inflation factor was: $RMSD_1$ = 0.15, $RMSD_3$ =0.06 , $RMSD_4$ = 0.04 , $RMSD_5$ = 0.05.

Appendix III: The Dependence of Climate Change Velocity on the Choice of Climate Data

Table AIII.1. Estimates of climate change velocity in the northeastern United States using four different datasets to calculate the spatial component of velocity: (1) WorldClim data (0.008˚ resolution), (2) PRISM data (0.008˚ resolution), PRISM data (0.042˚ resolution), and (3) statistically downscaled AOGCM results (0.125˚ resolution). We calculated velocity using two methods: (1) change in only the mean of temperature (univariate mean change), and (2) the overlap between four-variable probability distributions of climate defined as a multivariate normal distribution of mean daily minimum winter temperature, total winter precipitation, mean daily maximum summer temperature, and total summer precipitation (climate overlap). We used two temperature variables in the univariate mean change method: (1) minimum temperature, and (2) mean temperature. The means presented are geometric means.

Climate Change Metric	Climate Data used for Spatial Gradient	Temperature Variable	Climate Change Velocity Estimates			
			Mean	**Min**	**Max**	**SD**
univariate mean change	WorldClim	minimum	1.59	0.11	78.03	1.94
univariate mean change	WorldClim	Mean	1.25	0.09	348.50	1.95
univariate mean change	PRISM 0.008˚	minimum	1.46	0.08	52.47	1.93
univariate mean change	PRISM 0.042˚	minimum	3.65	0.39	152.68	5.17
univariate mean change	AOGCMs	minimum	1.50	0.23	73.66	2.95
univariate mean change	AOGCMs	Mean	1.81	0.26	56.69	3.46
climate overlap	PRISM 0.042˚		0.73	0.04	16.58	1.02
climate overlap	AOGCMs		0.75	0.12	7.62	0.90

Table AIII.2. Wilcoxon signed rank tests to evaluate whether using different climate datasets to calculate the spatial component of climate change velocity affect estimates of climate change velocity in the northeastern United States. We compared estimates of velocity calculated using WorldClim data (0.008˚ resolution), PRISM data (0.008˚ resolution), and PRISM data (0.042˚ resolution) to estimates calculated using statistically downscaled AOGCM results (0.125˚ resolution) for the spatial component of velocity. We calculated velocity using two methods: (1) change in only the mean of temperature (univariate mean change), and (2) the overlap between four-variable probability distributions of climate defined as a multivariate normal distribution of mean daily minimum winter temperature, total winter precipitation, mean daily maximum summer temperature, and total summer precipitation (4-variable climate overlap). We used two temperature variables in the univariate mean change method: (1) minimum temperature, and (2) mean temperature. The differences presented are pseudomedian differences (i.e., a nonparametric estimate of the difference).

Climate Data used for Spatial Gradient	**Climate Change Metric**	**Temperature Variable**	**Comparison to Velocity with Spatial Gradient Calculated using Statistically Downscaled AOGCM Results**		
			Difference	**95% CI**	***p*-value**
WorldClim	univariate mean change	mean	-0.419	-0.453 - -0.385	<0.0001
WorldClim	univariate mean change	minimum	0.131	0.096 - 0.167	<0.0001
PRISM 800 m	univariate mean change	minimum	0.034	-0.000 - 0.068	0.054
PRISM 4 km	univariate mean change	minimum	1.843	1.777 - 1.910	<0.0001
PRISM	climate overlap		0.002	-0.017 - 0.023	0.813

Appendix IV: Assessing whether Climate Overlap Relates to the Response of a Species to Climate Change

We used dynamic models to determine whether the proportion of a simulated population remaining after 100 years would be similar under two different climate change scenarios (1) constant temperature variability, but an increasing mean of temperature that resulted in a predetermined amount of overlap between initial and final climates (hereafter mean-change scenario) and (2) constant mean temperature, but increasing temperature variability that resulted in the same amount of overlap between initial and final climates (hereafter variation-change scenario). We compared the two climate change scenarios across the full range of climate overlap values. We modeled abundance as:

$$N_{t+1} = s_t N_t + b_t N_t$$

where N_t is the abundance, b_t is the birth rate, and s_t is the survival rate, in time t. The survival rate was related to temperature via a quadratic relationship:

$$s_t = \frac{1}{1 + e^{c+a(T_t - T_{opt})^2}}$$

where T_t is the temperature in time t, T_{opt} is the optimal temperature for the species (which was fixed throughout the simulation at the mean of the initial temperature distribution), c controls the maximum survival rate, and a controls the width of the species thermal tolerance. We compared population dynamics for six types of species: an r-selected species, K-selected species, and a species with moderate birth and survival rates each with two thermal tolerance widths (Table

AIV.1). We modeled six types of species to evaluate the robustness of the biological relevance; we did not expect similar proportions of the populations to remain across species. We drew annual birth rates in each time step from uniform distributions. We chose minimum and maximum birth rates so that each species would have zero population growth on average under a constant temperature distribution (Table AIV.1). Temperature varied randomly among years according to a normal distribution with an initial mean of 20 and an initial variation of 1.5. The mean or variation of temperature changed linearly over a 100-year period to achieve the desired amount of climate overlap in year 100. We repeated simulations 1000 times for each species and each climate change scenario.

The proportion of the population remaining after 100 years was similar among the two climate change scenarios for all six species across the range of climate overlap values (Fig. AIV.1). The 95% confidence intervals of the proportion of the population remaining for the two climate change scenarios overlapped for all climate overlap values in all but one species (Fig. AIV.1). The 95% confidence intervals for the K-selected species with a wide thermal tolerance did not overlap between 11 and 21% climate overlap (Fig. AIV.1). The root-mean-squared-difference of the proportion of the population remaining between the two climate change scenarios across all species was 0.07.

Table AIV.1. Parameters used in abundance models. Species a-f refer to the species represented in Fig.AIV.1. *a* controls the width of the species thermal tolerance, *c* controls the maximum survival rate, and b_{min} and b_{max} are the minimum and maximum birth rates.

	Species					
Parameter	**a**	**b**	**C**	**d**	**e**	**f**
a	-0.1	-0.04	-0.1	-0.04	-0.1	-0.04
c (s_{max})	0 (0.50)	0 (0.50)	3 (0.95)	3 (0.95)	-2 (0.12)	-2 (0.12)
b_{min}	0.488	0.460	0.051	0.043	0.849	0.829
b_{max}	0.062	0.585	0.073	0.061	0.950	0.950

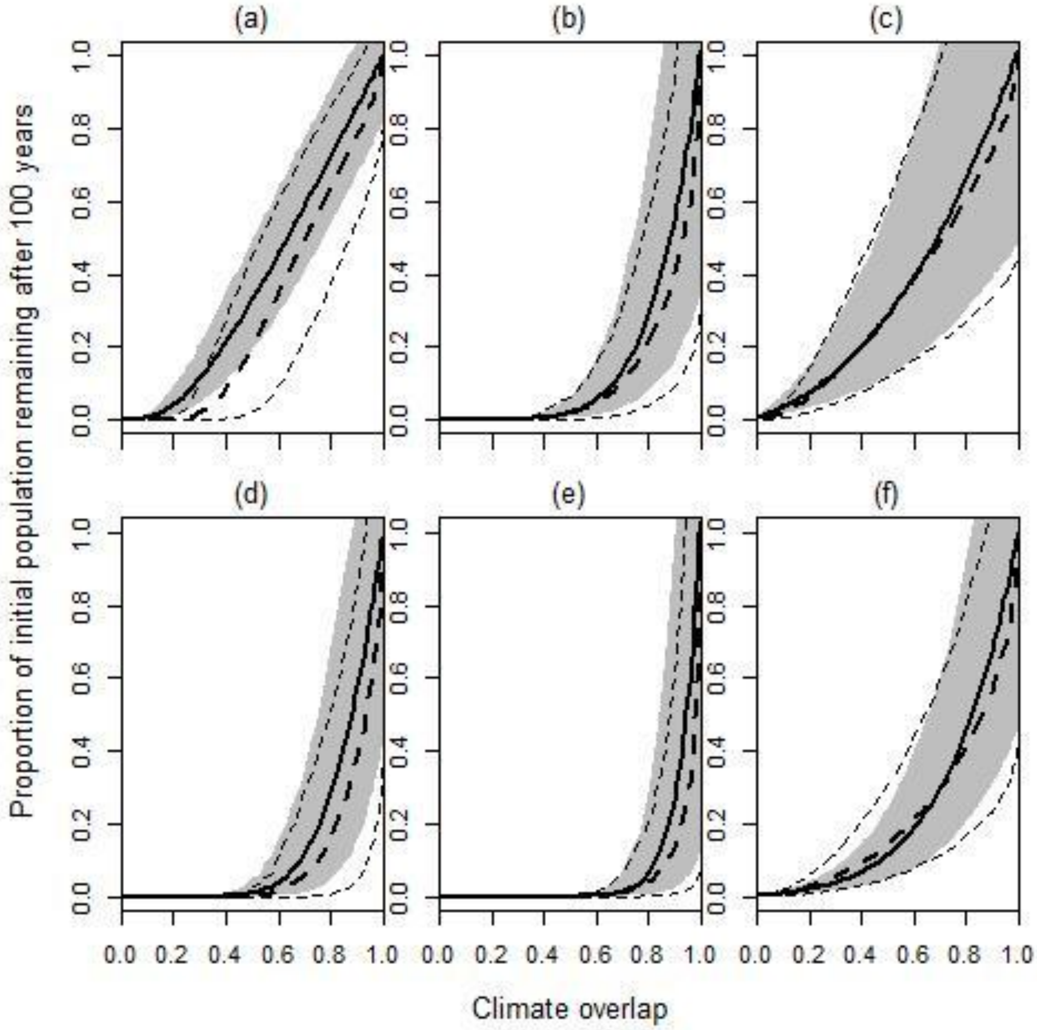

Figure AIV.1. The proportion of the original population remaining after 100 years under two climate change scenarios for six types of simulated species: (a, d) K-selected species, (b, e) moderate-birth rates and moderate survival, (c, f) r-selected species. Species a, b, and c have a wide thermal tolerance and species d, e, and f have a narrow thermal tolerance. See Table AIV.1 for a list of parameter values. The solid line and shaded area represent the mean and 95% confidence interval for 1000 simulations where the variation of temperature was constant over the 100-year period and the mean of temperature changed to produce the amount of climate overlap specified on the x-axis. The bold dashed line and thin dashed lines represents the mean and 95% confidence interval for 1000 simulations where the mean of temperature was constant over the 100-year period and the mean of temperature changed to produce the amount of climate overlap specified on the x-axis. Note, we do not expect the proportion of the population remaining to be similar across species.

Appendix V: Spatial Indicators of the Vulnerability of Biodiversity for Northeastern States and NYSDEC Regions

Table AV.1. Mean vulnerability index values for each of the 14 states included in our study area. Climate overlap and climate change velocity are presented in their natural scale (as opposed to being scaled between 0 and 1) and were averaged across three AOGCMs (see Table AV.3 for values associated with each AOGCM). The vulnerability index is scaled between 0 (least vulnerable) and 5 (most vulnerable). All other scores are scaled between 0 (least vulnerable) and 1 (most vulnerable).

State	Vulnerability Index	Landscape Resistance	Topoclimate Homogeneity	Elevation	Climate Overlap	Climate Change Velocity
Delaware	2.857	0.945	0.825	0.000	4.41E-03	2.183
Maryland	2.482	0.886	0.452	0.111	3.27E-03	1.366
District of Columbia	2.435	0.991	0.449	0.000	3.33E-03	1.106
Virginia	2.249	0.791	0.359	0.129	3.71E-03	1.057
West Virginia	2.218	0.623	0.239	0.441	4.13E-03	0.798
New Jersey	2.167	0.882	0.475	0.000	6.82E-03	1.014
Rhode Island	2.056	0.827	0.304	0.000	3.39E-03	0.596
Pennsylvania	2.048	0.769	0.297	0.064	5.05E-03	1.165
Massachusetts	2.027	0.771	0.292	0.000	3.34E-03	0.874
New York	1.970	0.667	0.281	0.077	3.37E-03	0.750
New Hampshire	1.945	0.527	0.332	0.128	2.67E-03	0.583
Connecticut	1.929	0.820	0.291	0.000	5.73E-03	0.668
Vermont	1.905	0.585	0.271	0.087	2.03E-03	0.381
Maine	1.836	0.373	0.401	0.031	3.20E-03	1.326

Table AV.2. Mean vulnerability index values for DEC Regions 2-9. Region 1 is excluded because it does not occur in our study area. Climate overlap and climate change velocity are presented in their natural scale (as opposed to being scaled between 0 and 1) and were averaged across three AOGCMs (see Table AV.4 for values associated with each AOGCM). Landscape vulnerability is scaled between 0 (least vulnerable) and 5 (most vulnerable). All other scores are scaled between 0 (least vulnerable) and 1 (most vulnerable).

DEC Region	**Vulnerability Index**	**Landscape Resistance**	**Topoclimate Homogeneity**	**Elevation**	**Climate Overlap**	**Climate Change Velocity**
Region 2	2.293	1.000	0.496	0.000	6.01E-03	0.613
Region 8	2.272	0.881	0.366	0.020	3.11E-03	1.091
Region 9	2.155	0.809	0.356	0.038	3.85E-03	0.966
Region 4	2.054	0.753	0.238	0.105	3.54E-03	0.894
Region 7	2.031	0.810	0.275	0.000	3.44E-03	0.778
Region 6	1.853	0.543	0.302	0.039	2.66E-03	0.662
Region 5	1.795	0.389	0.244	0.195	2.35E-03	0.532
Region 3	1.767	0.716	0.217	0.062	6.11E-03	0.459

Table AV.3. Mean vulnerability index values, climate overlap, and climate change velocity for each of three AOGCMs used to determine historical and future climate data in the 14 states included in our study area. Climate overlap and climate change velocity are presented in their natural scale (as opposed to being scaled between 0 and 1). The vulnerability index is scaled between 0 (least vulnerable) and 5 (most vulnerable). GFDL is the United States National Oceanographic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory CM2.1 (Delworth et al. 2006), HADCM3 is the United Kingdom Meteorological Office Hadley Centre Climate Model version 3 (Pope et al. 2000) and PCM is the United States Department of Energy/National Center for Atmospheric Research Parallel Climate Model (Washington et al. 2000). Each model was forced with the A1fi emissions scenario.

	GFDL			HADCM3			PCM		
State	**Vulnerability Index**	**Climate Overlap**	**Climate Change Velocity**	**Vulnerability Index**	**Climate Overlap**	**Climate Change Velocity**	**Vulnerability Index**	**Climate Overlap**	**Climate Change Velocity**
Connecticut	2.158	8.36E-05	0.049	2.160	6.85E-11	0.049	1.912	1.71E-02	0.074
Delaware	2.911	1.26E-05	0.141	2.969	1.54E-08	0.199	2.866	1.32E-02	0.305
District of Columbia	2.517	1.21E-05	0.078	2.551	5.39E-09	0.112	2.405	9.99E-03	0.124
Maine	1.701	8.36E-03	0.162	1.910	2.39E-10	0.105	1.885	1.25E-03	0.098
Maryland	2.533	9.71E-06	0.085	2.581	1.34E-07	0.135	2.469	9.81E-03	0.176
Massachusetts	2.111	5.03E-04	0.064	2.121	1.24E-10	0.058	2.023	9.51E-03	0.111
New Hampshire	1.955	2.53E-03	0.049	2.020	1.64E-09	0.033	1.962	5.47E-03	0.061
New Jersey	2.433	1.26E-05	0.076	2.443	9.32E-10	0.086	2.148	2.04E-02	0.118
New York	2.077	7.64E-05	0.055	2.106	2.20E-07	0.085	1.930	1.00E-02	0.065
Pennsylvania	2.197	3.21E-05	0.068	2.249	8.99E-07	0.133	2.026	1.51E-02	0.137
Rhode Island	2.179	9.89E-05	0.051	2.167	3.30E-12	0.035	2.033	1.01E-02	0.061
Vermont	1.932	1.33E-03	0.033	1.963	7.79E-10	0.021	1.897	4.76E-03	0.029
Virginia	2.338	7.57E-06	0.059	2.377	5.82E-08	0.099	2.243	1.11E-02	0.141
West Virginia	2.337	2.26E-05	0.034	2.383	8.95E-07	0.094	2.202	1.24E-02	0.096

Table AV.4. Mean vulnerability index values, climate overlap, and climate change velocity for each of three AOGCMs used to estimate historical and future climate data in DEC Regions 2-9. Region 1 is excluded because it does not occur in our study area. Climate overlap and climate change velocity are presented in their natural scale (as opposed to being scaled between 0 and 1). The vulnerability index is scaled between 0 (least vulnerable) and 5 (most vulnerable). GFDL is the United States National Oceanographic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory CM2.1 (Delworth et al. 2006), HADCM3 is the United Kingdom Meteorological Office Hadley Centre Climate Model version 3 (Pope et al. 2000) and PCM is the United States Department of Energy/National Center for Atmospheric Research Parallel Climate Model (Washington et al. 2000). Each model was forced with the A1fi emissions scenario.

	GFDL			HADCM3			PCM		
State	**Vulnerability Index**	**Climate Overlap**	**Climate Change Velocity**	**Vulnerability Index**	**Climate Overlap**	**Climate Change Velocity**	**Vulnerability Index**	**Climate Overlap**	**Climate Change Velocity**
Region 2	2.545	5.77E-06	0.050	2.527	6.88E-13	0.031	2.278	1.80E-02	0.070
Region 3	2.019	1.62E-05	0.023	2.037	2.23E-09	0.042	1.750	1.83E-02	0.047
Region 4	2.158	4.11E-05	0.063	2.202	1.13E-08	0.105	2.012	1.06E-02	0.083
Region 5	1.864	2.53E-04	0.044	1.874	6.62E-09	0.046	1.763	6.80E-03	0.042
Region 6	1.944	6.28E-05	0.063	1.951	2.13E-08	0.068	1.801	7.92E-03	0.043
Region 7	2.142	1.62E-05	0.057	2.182	2.68E-08	0.097	1.983	1.03E-02	0.062
Region 8	2.342	9.75E-06	0.075	2.403	2.32E-07	0.139	2.223	9.31E-03	0.103
Region 9	2.262	1.24E-05	0.058	2.302	1.77E-06	0.127	2.114	1.15E-02	0.093

Appendix VI: List of Experts who Provided Species-trait Information

Table AVI.1. A list of the species experts that provided expert knowledge of species-trait information for ≥1 species using our online survey. We were unable to use data from some experts because distribution data for the species was not available.

Name	Affiliation
Tom Bell	New York State Department of Environmental Conservation
Alvin Breisch	New York State Department of Environmental Conservation (retired)
Mike Burger	Audubon New York
Russell Burke	Hofstra University
Andrea Chaloux	New York Natural Heritage Program
Lance Clark	New York State Department of Environmental Conservation
Scott Crocoll	New York State Department of Environmental Conservation
Susan Elbin	New York City Audubon
Joseph F. Merritt	University of Illinois
Jeremy Feinberg	Rutgers University
Angela Fuller	U.S. Geological Survey, Cornell University
James Gibbs	SUNY College of Environmental Science and Forestry
Michale Glennon	Wildlife Conservation Society
Tim Green	Brookhaven National Laboratory
W. H. Martin	Catoctin Land Trust & IUCN Viper Specialist Group
Kelly Hamilton	New York State Department of Environmental Conservation
Carl Herzog	New York State Department of Environmental Conservation
Allan J. Lindberg	Nassau County (NY) Museum (retired)
Marcelo J. del Puerto	New York State Department of Environmental Conservation
Joseph Jannsen	The Nature Conservancy
Mark Kandel	New York State Department of Environmental Conservation
Roland Kays	North Carolina Museum of Natural Sciences
Heidi Kennedy	New York State Department of Environmental Conservation
Jeremy Kirchman	New York State Museum
Allen Kurta	Eastern Michigan University
Dan Lambert	High Branch Conservation Services
Tom Langen	Clarkson University
John Litvaitis	University of New Hampshire
Angelena M Ross	New York State Department of Environmental Conservation
Janet Mihuc	Paul Smith's College
Michael Morgan	New York State Department of Environmental Conservation
Robyn Niver	U.S. Fish and Wildlife Service
Christopher Norment	SUNY College at Brockport,
Kathleen O'Brien	New York State Department of Environmental Conservation

Name	Affiliation
John O'Connor	New York State Department of Environmental Conservation
Michael P. Losito	SUNY Cobleskill
David Patrick	Paul Smith's College
Ellen Pehek	New York City Parks & Recreation
Kelly Perkins	New York Natural Heritage Program
Allen Peterson	New York State Electric and Gas
Milo Richmond	U.S. Geological Survey, Cornell University (retired)
William S. Hoffman	New York State Department of Environmental Conservation
Michael Schiavone	New York State Department of Environmental Conservation
Matt Schlesinger	New York Natural Heritage Program
Scott Smith	New York State Department of Environmental Conservation
Theresa Swenson	New York State Department of Environmental Conservation
Bryan Swift	New York State Department of Environmental Conservation
Valorie Titus	Wildlife Conservation Society
Mike Wasilco	New York State Department of Environmental Conservation

Appendix VII: Expert Elicitation Survey

TRAITS OF NEW YORK SPECIES OF GREATEST CONSERVATION NEED - MAMMALS

WELCOME
Please enter your contact information

Name:*

____

Affiliation:*

____

Email Address:*

____

SPECIES SELECTION

On the following pages you will be asked to provide information on: (1) non-climate habitat specificity, (2) dietary specificity, (3) physiological tolerance to climate change, (4) sensitivity to dispersal barriers, (5) number of offspring, (6) number of lifetime reproductive events, (7) lifespan, and (8) natal dispersal distance. Don't worry, many of these questions are multiple choice or otherwise allow you to express your uncertainty. Which species do you think you can provide this information for?

Note: click the link at the bottom of your screen if you would like to save your survey and return to finish it later.

Check the species that you will provide expert knowledge for.*

[ ] Gray wolf (*Canis lupus*)
[ ] Allegheny woodrat (*Neotoma magister*)
[ ] Canada lynx (*Lynx canadensis*)
[ ] Eastern cougar (*Felis concolor cougar*)
[ ] New England cottontail (*Sylvilagus transitionalis*)
[ ] American marten (*Martes americana*)
[ ] Least weasel (*Mustela nivalis*)
[ ] River otter (*Lontra canadensis*)
[ ] Least shrew (*Cryptotis parva*)
[ ] Eastern red bat (*Lasiurus borealis*)
[ ] Hoary bat (*Lasiurus cinereus*)
[ ] Indiana bat (*Myotis sodalis*)
[ ] Silver-haired bat (*Lasionycteris noctivagans*)
[ ] Small-footed bat (*Myotis leibii*)

Categorical Traits

Instructions: For the species that you have knowledge of, distribute a total of 10 points between the 3 categories to reflect your uncertainty and variation within the species. For example, if you are completely certain that one category describes the species, put a 10 in the category you are certain describes the species. If 50% of the population fits in one category and 50% fits in another category, put a 5 in each of the two categories. Or, if you are not sure exactly which category the species fits into, distribute the points to reflect your uncertainty. When complete, all the rows should add up to 10.

Note: click the link at the bottom of your screen if you would like to save your survey and return to finish it later.

Non-climate habitat specificity*

Species	**Able to adapt to a large number of biotic and abiotic conditions**	**Requires a specific set of biotic or abiotic conditions (e.g., a forest type)**	**Requires a specific species, geologic formation, or other single abiotic condition**

Dietary specificity*

Species	**Utilizes a variety of food types (e.g., fruit, insects, AND small mammals)**	**Requires a single but diverse and abundant type of food (e.g., insects only, mast only)**	**Requires a particular species OR rare food type**

Physiological Tolerance to Climate Change*

Species	**Likely to be positively affected**	**Likely to be unaffected**	**Likely to be negatively affected**

Sensitivity to Dispersal Barriers (e.g., agriculture, roads, urban areas, lakes)*

Species	**Unimpeded by barriers**	**Slowed by barriers**	**Unable to move in the presence of barriers**

CONTINUOUS TRAITS

Instructions: For the species that you have knowledge of, provide the most likely value (i.e., your best guess), low bound of most likely value, high bound of most likely value, and confidence that the low-high interval captures the true value. The low and high bounds on the most likely value represent your uncertainty on the most likely value, not the lowest and highest values that have ever been observed or could ever occur for the species. If the species is currently extirpated from New York State, enter the value you would expect if the species was currently present and breeding in the state. If the value varies between populations (e.g., due to harvesting) please enter an average value across populations in the state.

Note: click the link at the bottom of your screen if you would like to save your survey and return to finish it later.

Average number of offspring produced per successful reproductive event (must be >0)*

Species	Most likely estimate (best guess)	Low bound on most likely estimate	High bound on most likely estimate	Confidence that low-high interval captures true value (0-100%)

Average number of successful reproductive events in the lifetime of a reproductive individual*

Species	Most likely estimate (best guess)	Low bound on most likely estimate	High bound on most likely estimate	Confidence that low-high interval captures true value (0-100%)

Average lifespan (years)*

Species	Most likely estimate (best guess)	Low bound on most likely estimate	High bound on most likely estimate	Confidence that low-high interval captures true value (0-100%)

Average distance of natal dispersal (lowest of males or females if sex dependent) (km)*

Species	Most likely estimate (best guess)	Low bound on most likely estimate	High bound on most likely estimate	Confidence that low-high interval captures true value (0-100%)

I will be using species range boundaries and distribution data gathered from various sources as part of my analysis. Are you willing to help verify these data (to the best of your ability) for the list of species you provided information for during this survey. If so, I will send you a map showing the distribution data for each species in the northeastern United States.

[ ] Yes, I am willing to help verify the distribution data.

Please enter any comments or feedback.

____
____
____
____

THANK YOU!

Thank you for providing your expert knowledge. Your response will significantly improve our ability to determine how New York Species of Greatest Conservation Need will be affected by climate change. For more information about this process please contact Chris Nadeau (cpn28@cornell.edu).

Appendix VIII: Species-specific Results

CONTENTS

1 Birds

1.1 Common loon (*Gavia immer*)

Table AVIII. 1.1.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	50.00
low	0.50	0.40	0.66	0.00	1.00	5.00
high	0.50	0.50	0.66	0.00	1.00	500.00

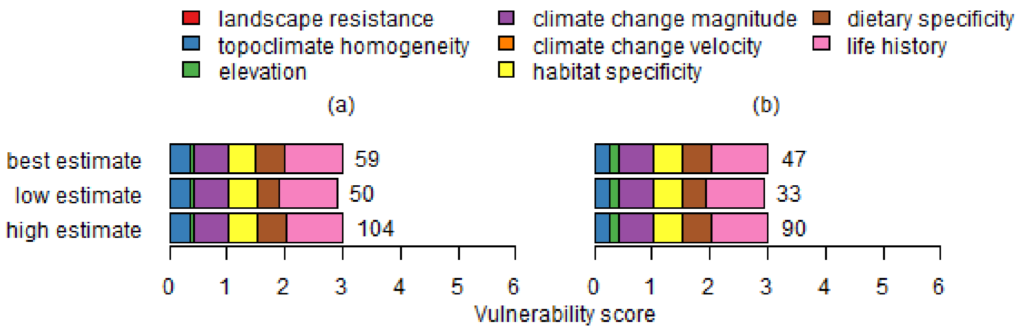

Figure AVIII. 1.1.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

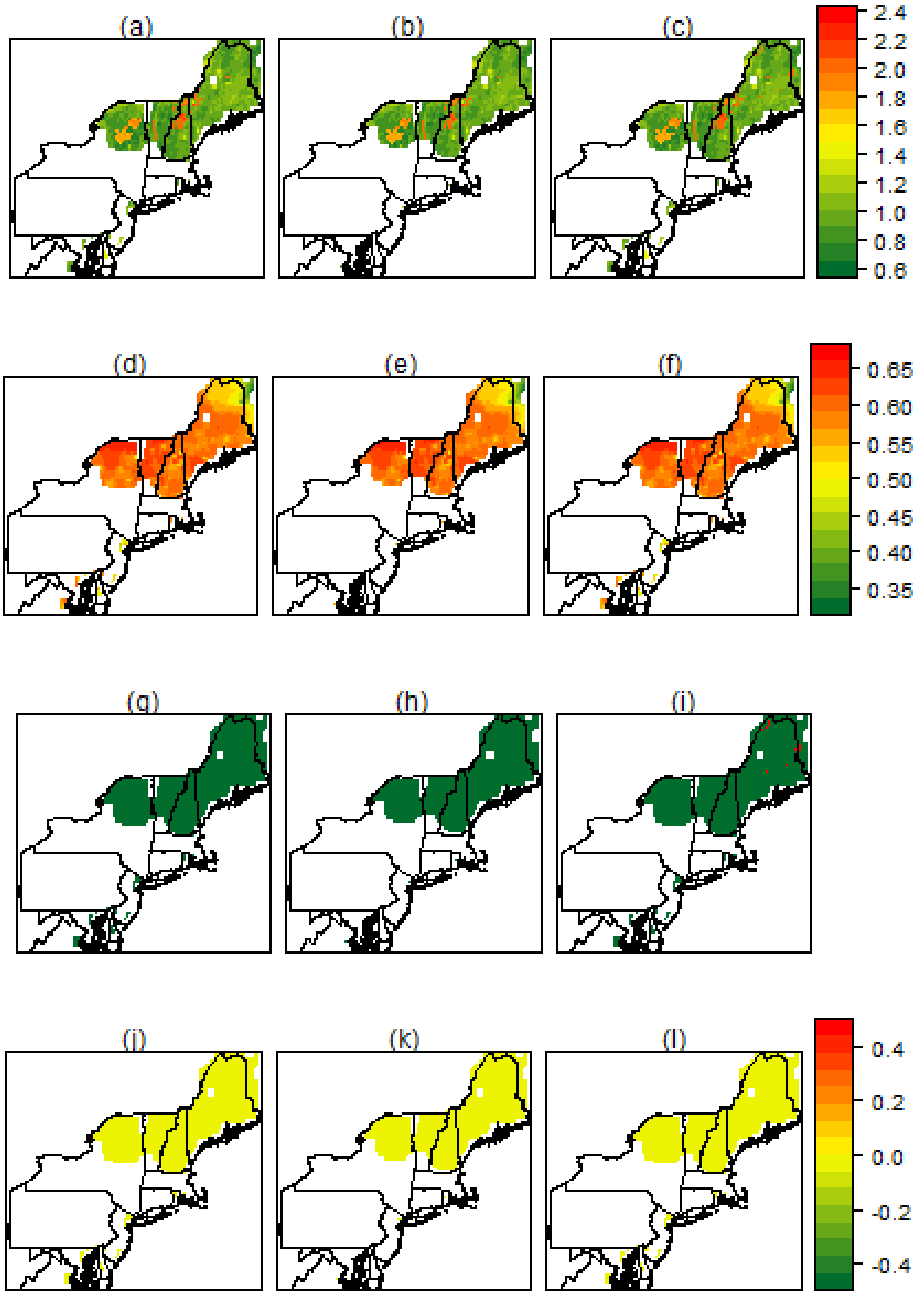

Figure AVIII. 1.1.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

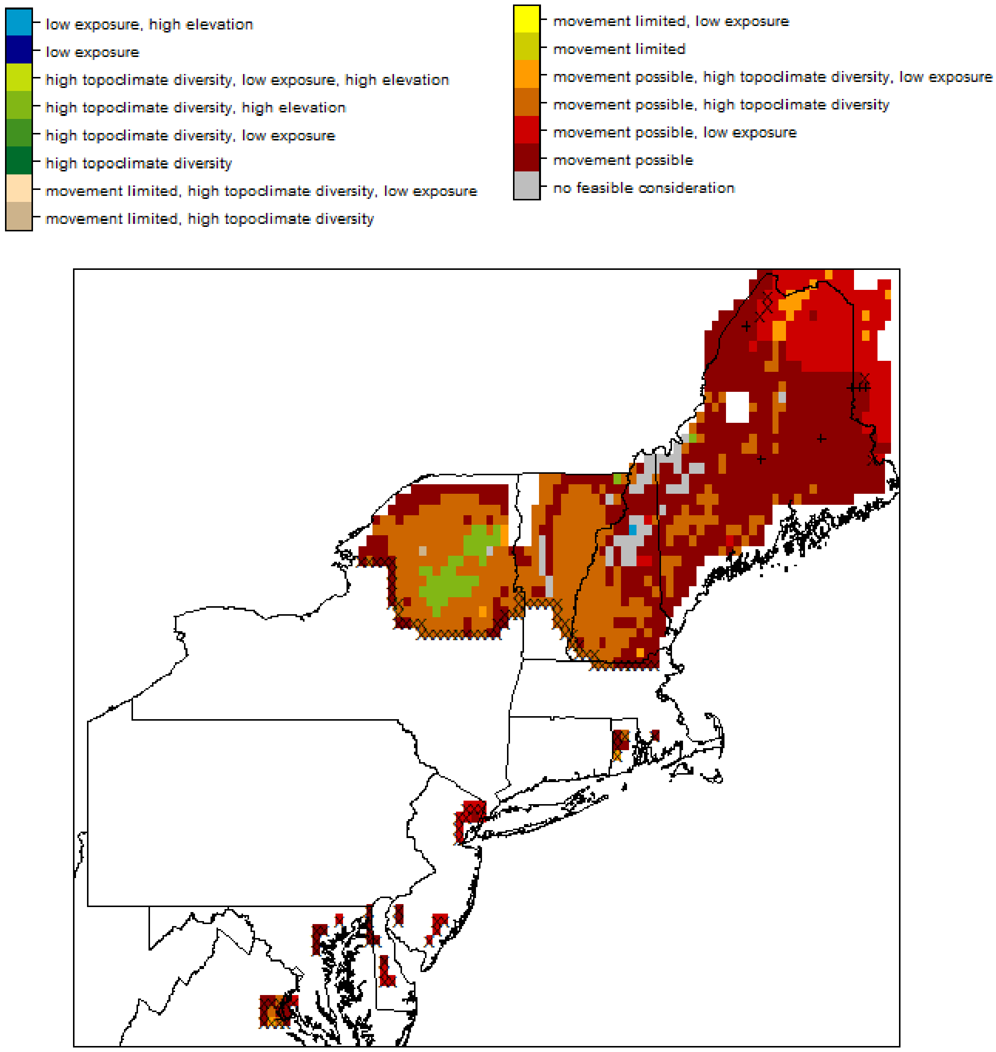

Figure AVIII. 1.1.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

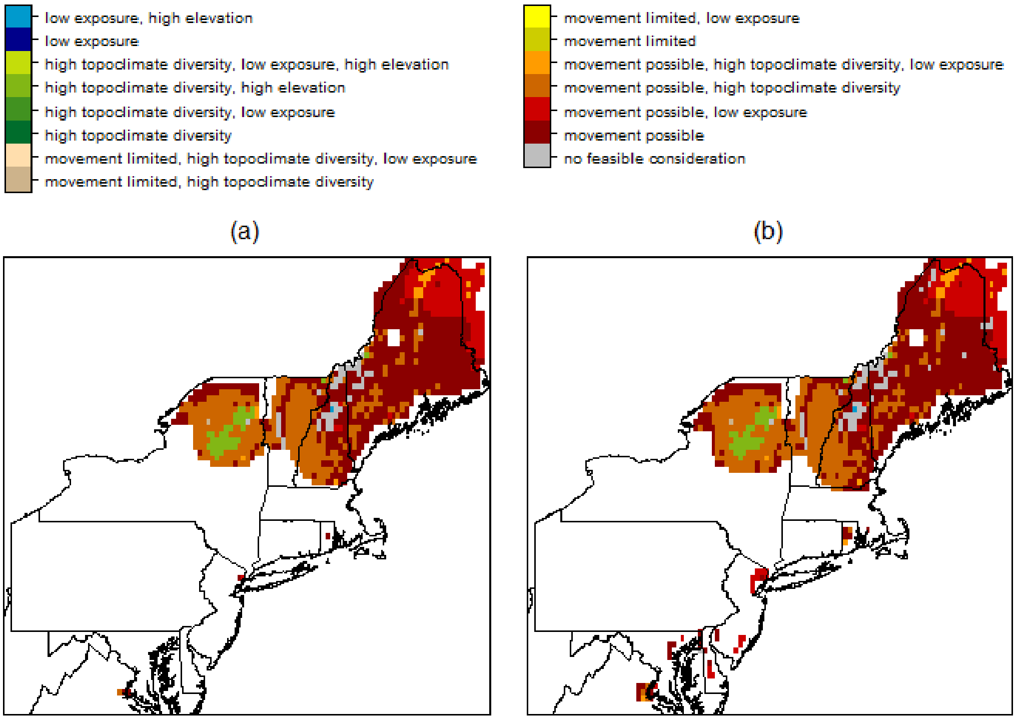

Figure AVIII. 1.1.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.2 Horned grebe (*Podiceps auritus*)

Table AVIII. 1.2.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.00	0.25	0.66	0.00	1.00	50.00
low	0.00	0.00	0.66	0.00	1.00	0.00
high	0.10	0.50	0.66	0.00	1.00	200.00

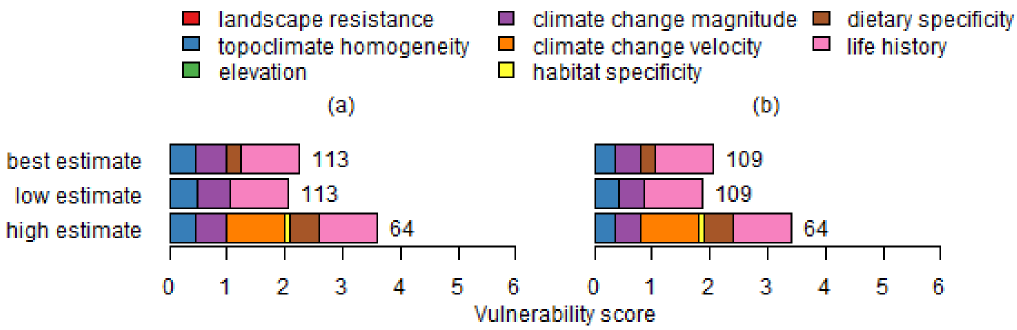

Figure AVIII. 1.2.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

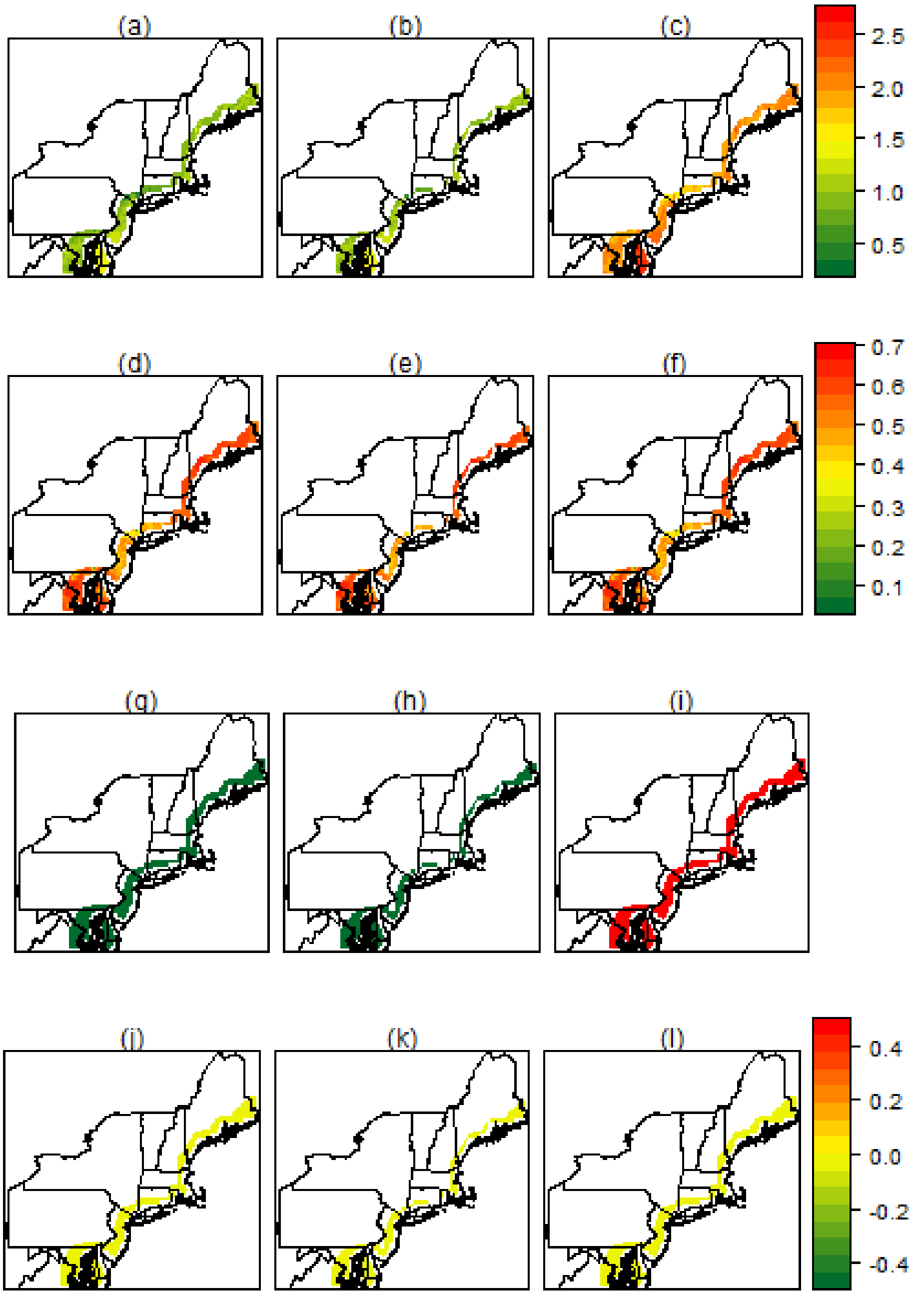

Figure AVIII. 1.2.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

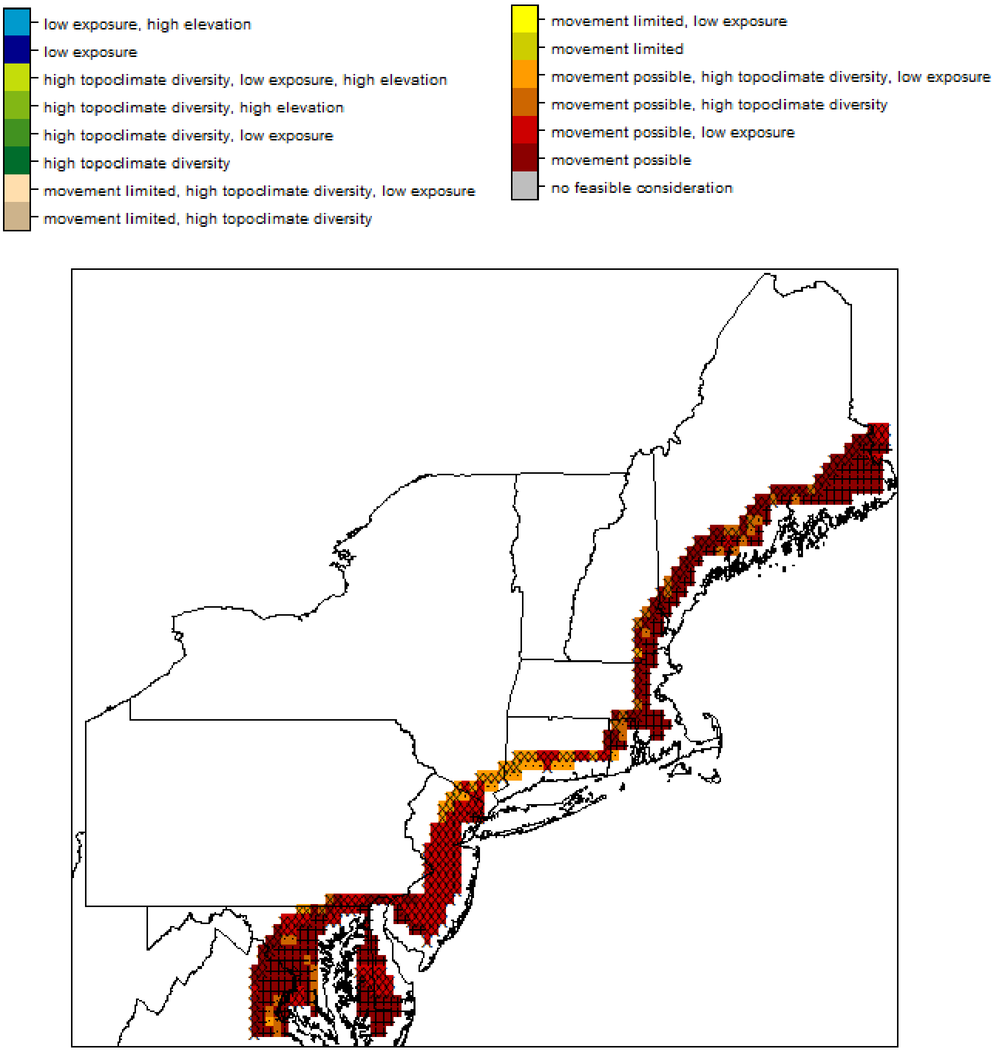

Figure AVIII. 1.2.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

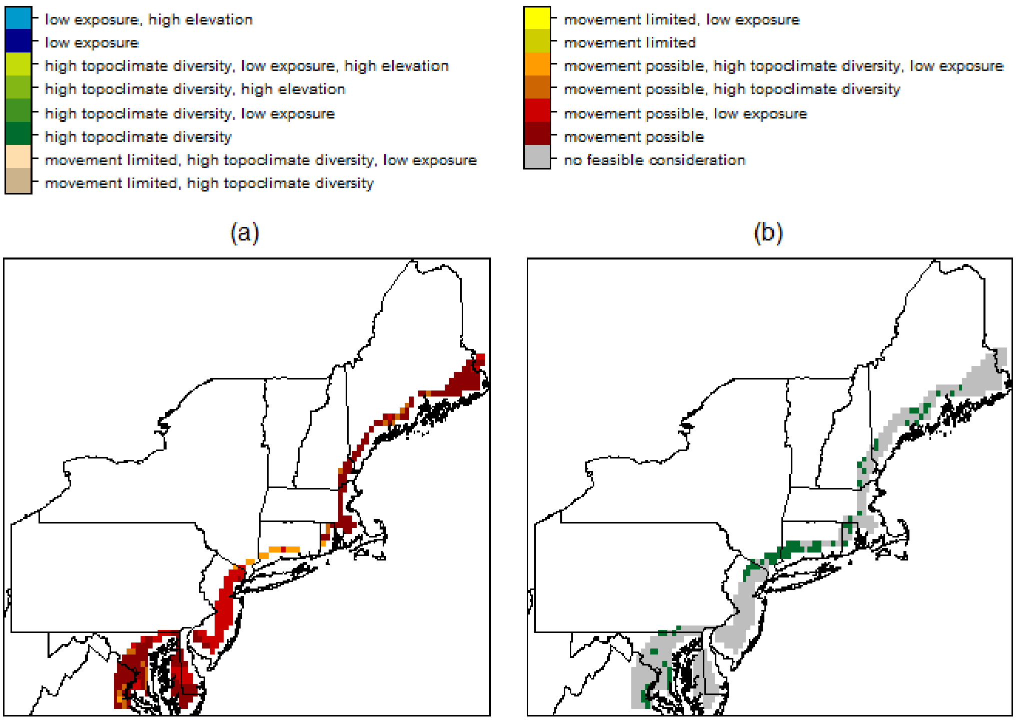

Figure AVIII. 1.2.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.3 Pied-billed grebe (*Podilymbus podiceps*)

Table AVIII. 1.3.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.38	0.75	0.00	1.00	10.00
low	0.50	0.20	0.66	0.00	1.00	0.00
high	0.55	0.50	0.83	0.05	1.00	75.00

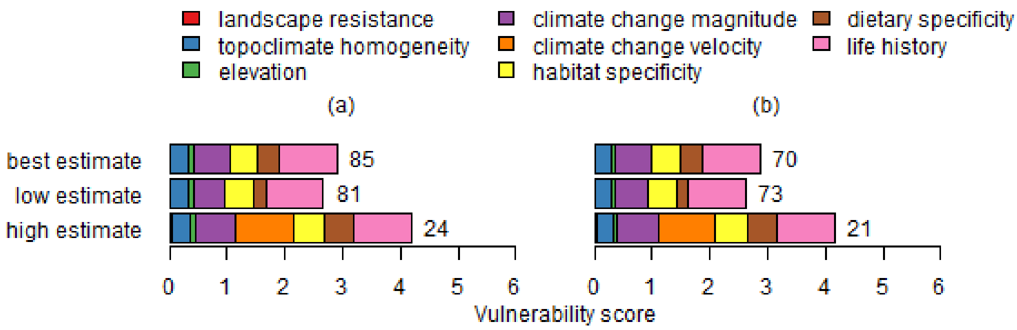

Figure AVIII. 1.3.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

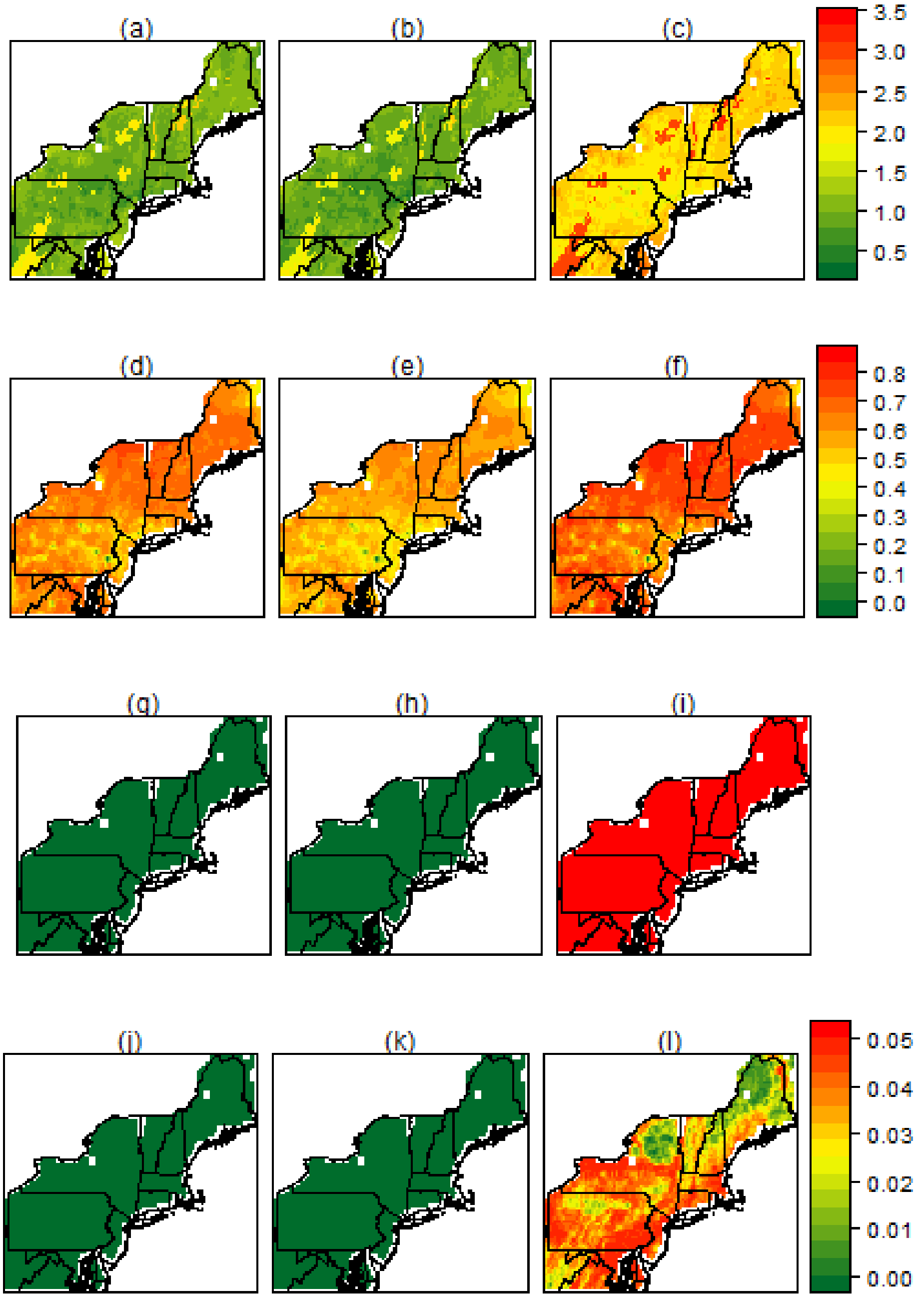

Figure AVIII. 1.3.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

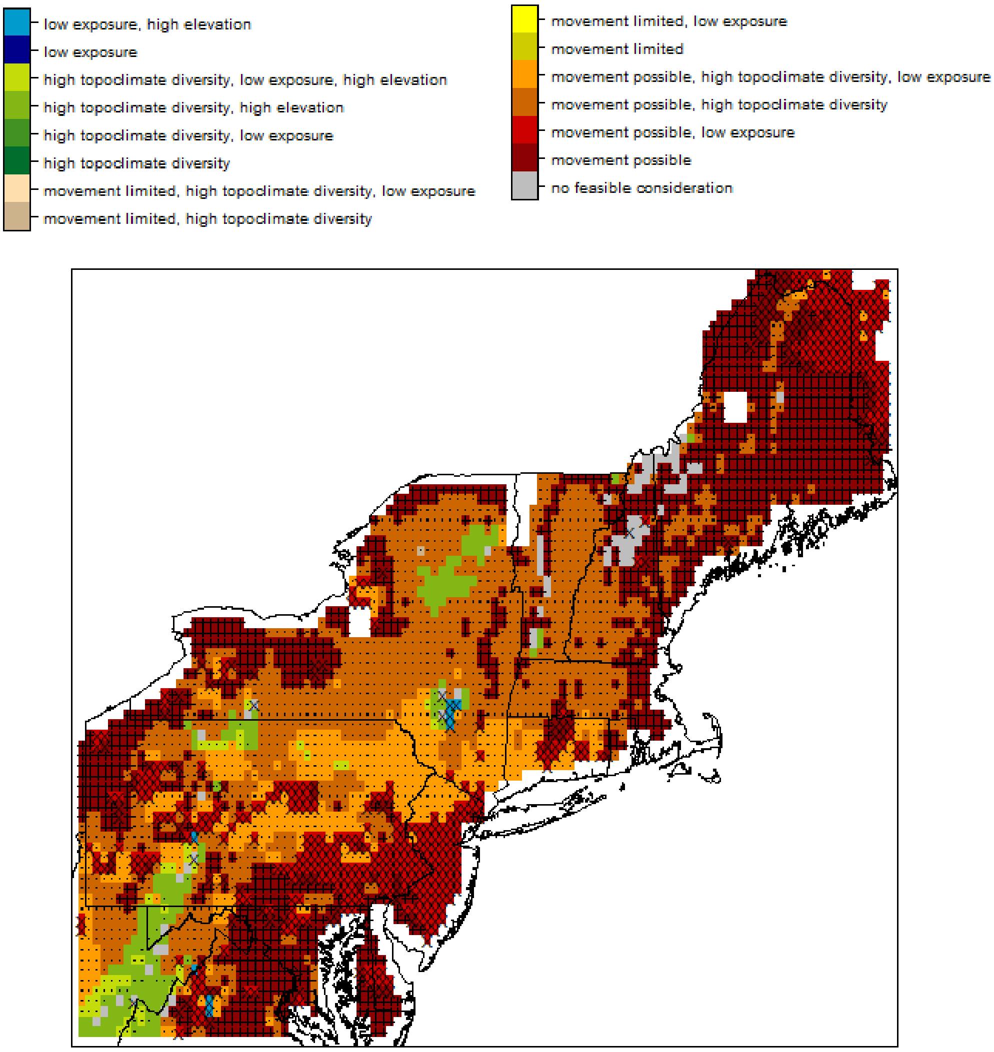

Figure AVIII. 1.3.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

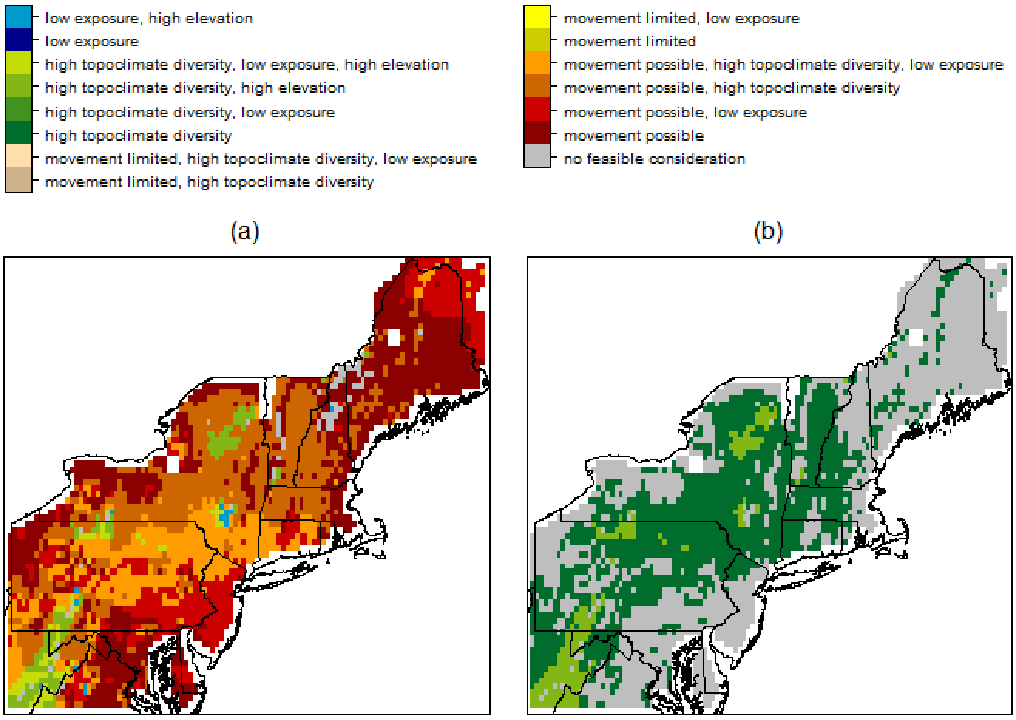

Figure AVIII. 1.3.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.4 Great egret (*Ardea alba*)

Table AVIII. 1.4.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.33	0.66	0.00	1.00	356.67
low	0.46	0.30	0.55	0.00	1.00	258.33
high	0.52	0.37	0.80	0.03	1.00	616.67

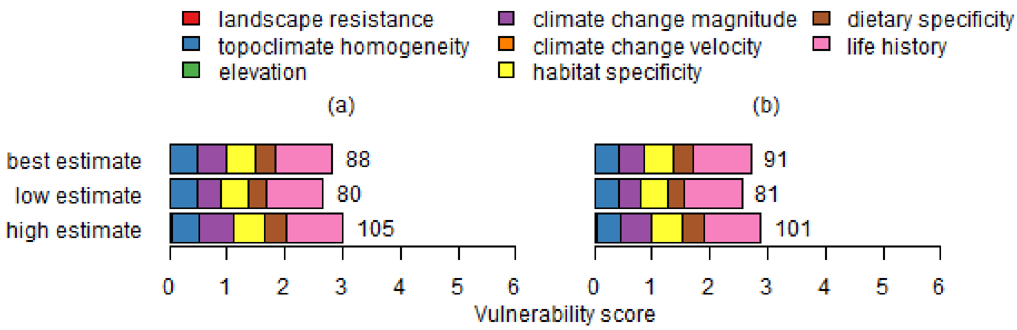

Figure AVIII. 1.4.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

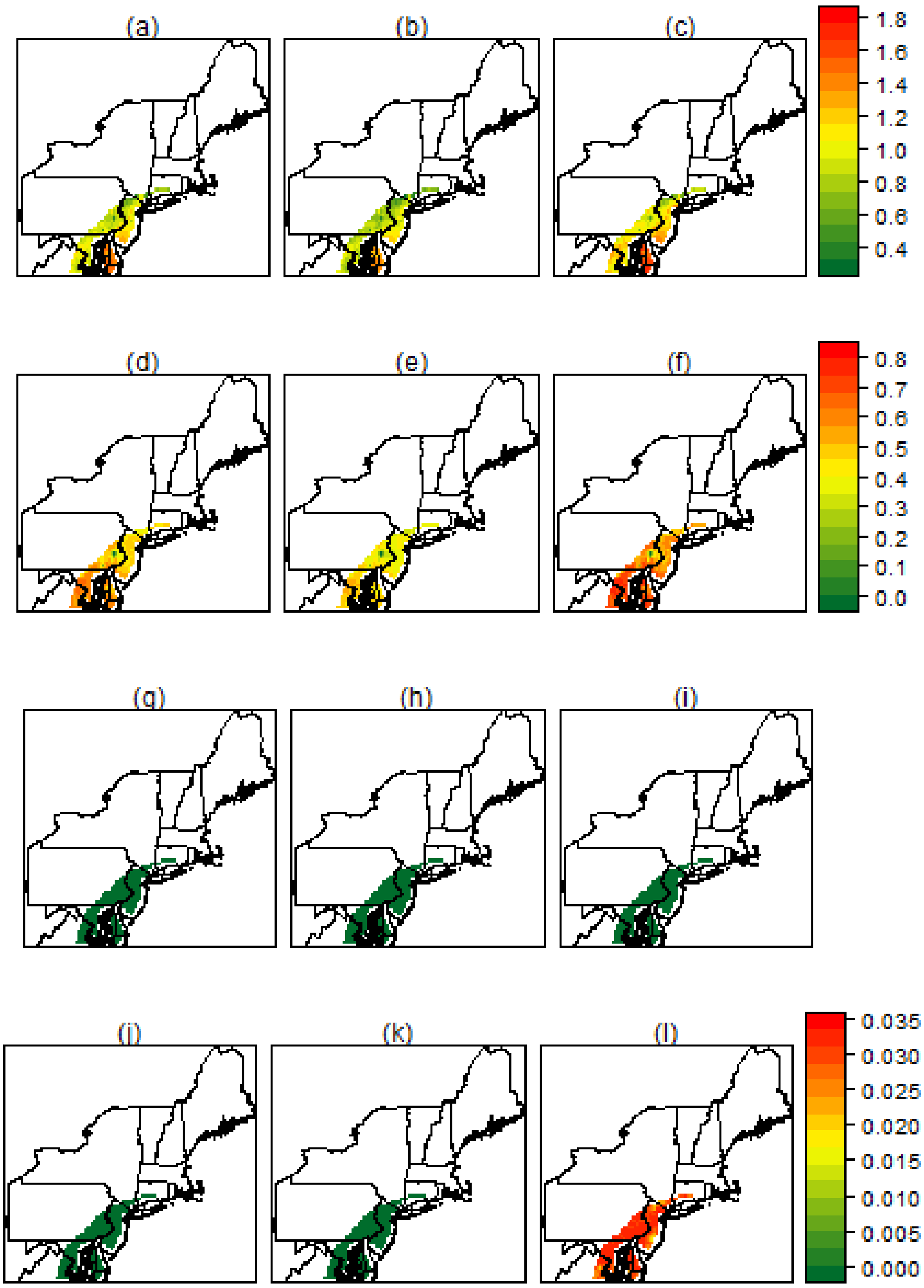

Figure AVIII. 1.4.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

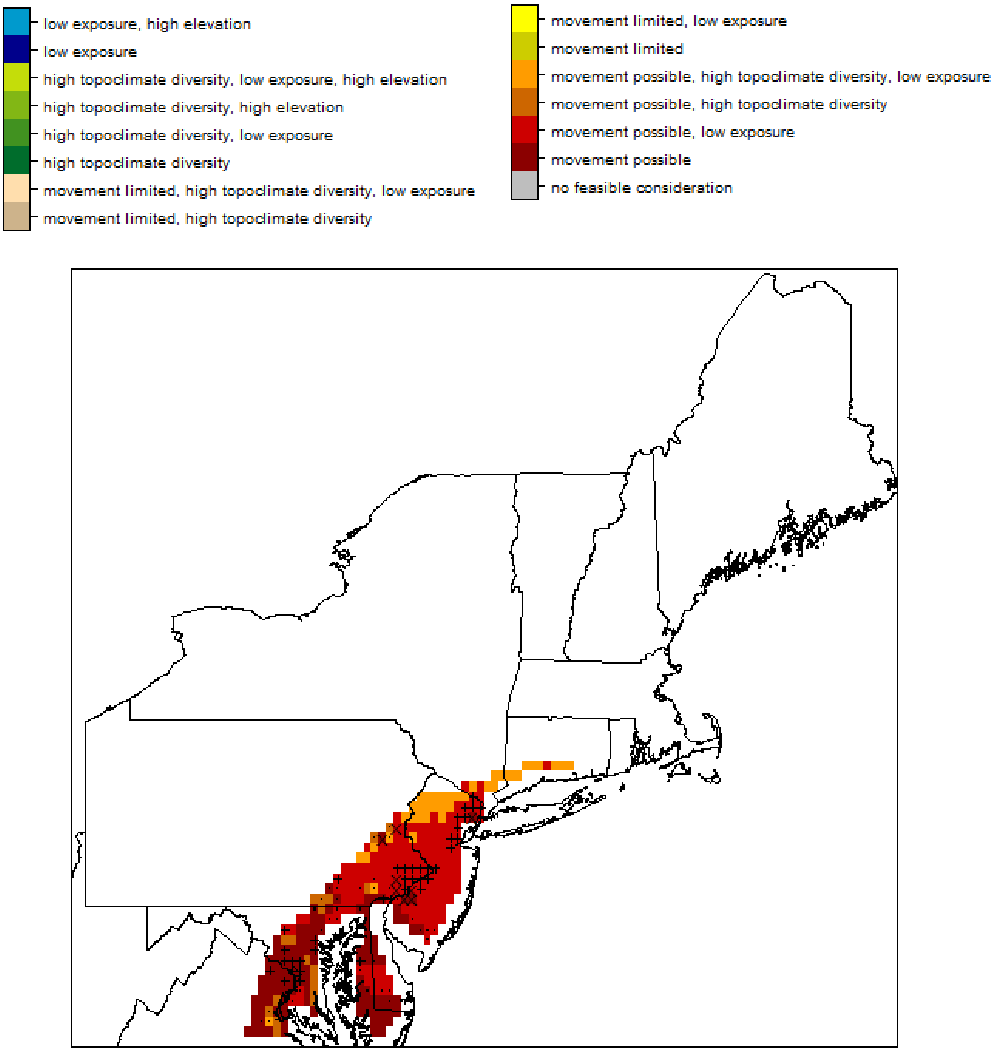

Figure AVIII. 1.4.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

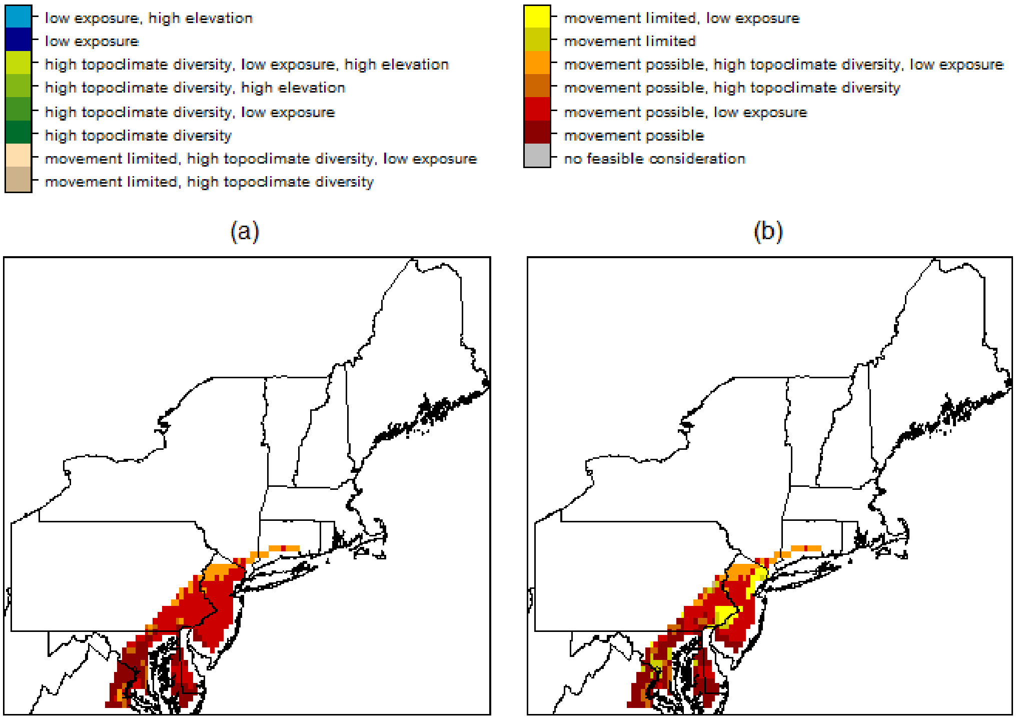

Figure AVIII. 1.4.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.5 American bittern (*Botaurus lentiginosus*)

Table AVIII. 1.5.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.25	0.75	0.00	1.00	22.50
low	0.50	0.15	0.66	0.00	1.00	0.00
high	0.52	0.30	0.83	0.05	1.00	150.00

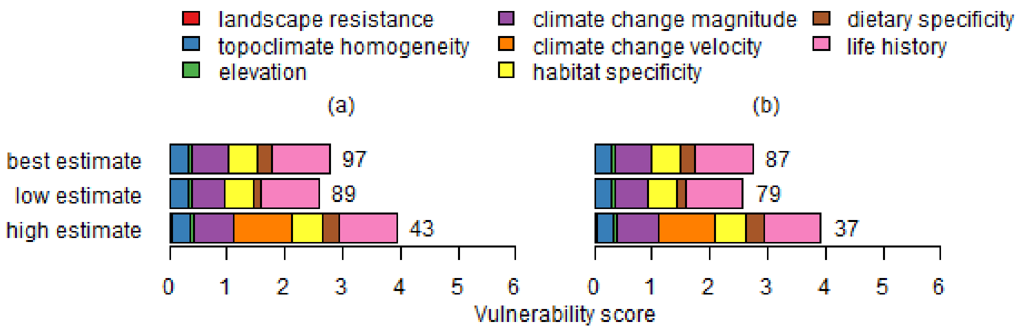

Figure AVIII. 1.5.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

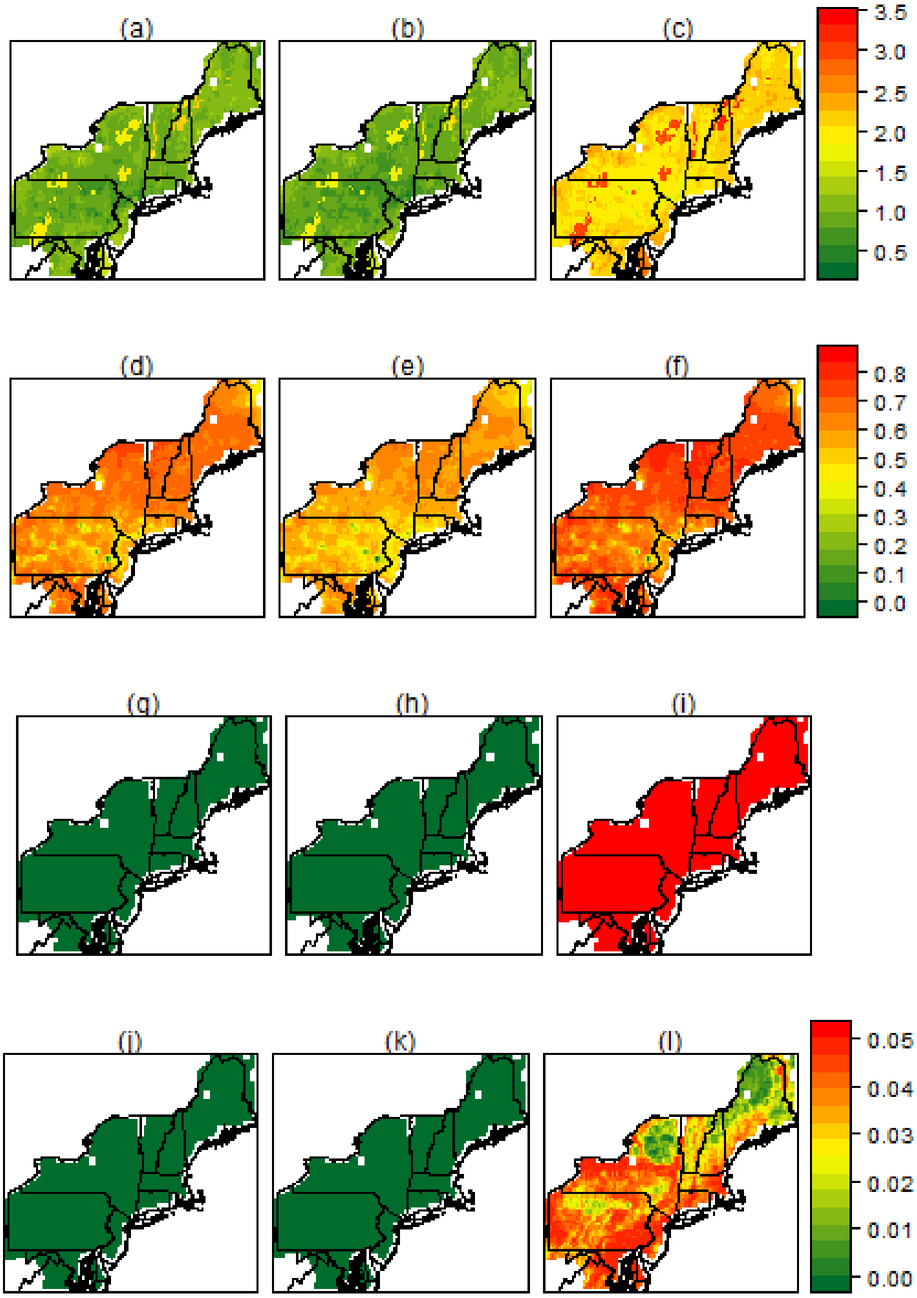

Figure AVIII. 1.5.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

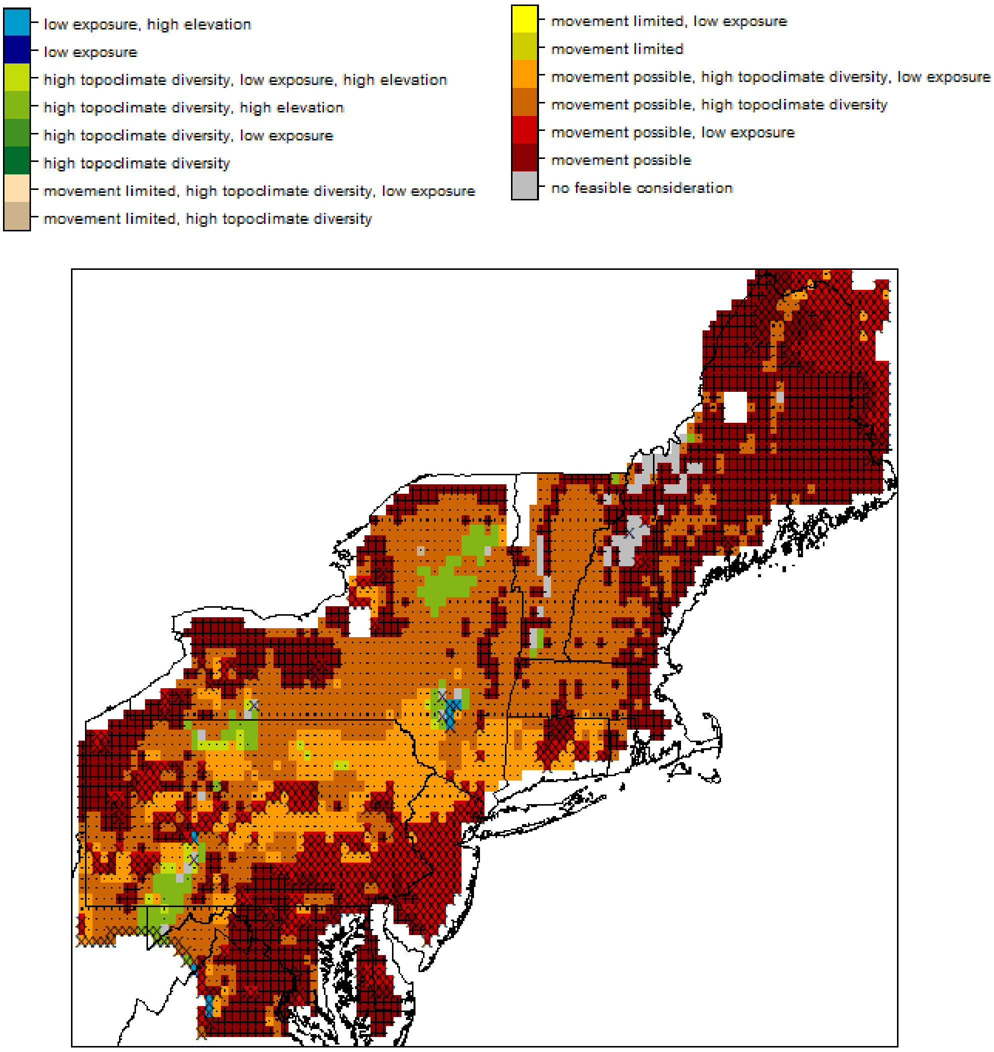

Figure AVIII. 1.5.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

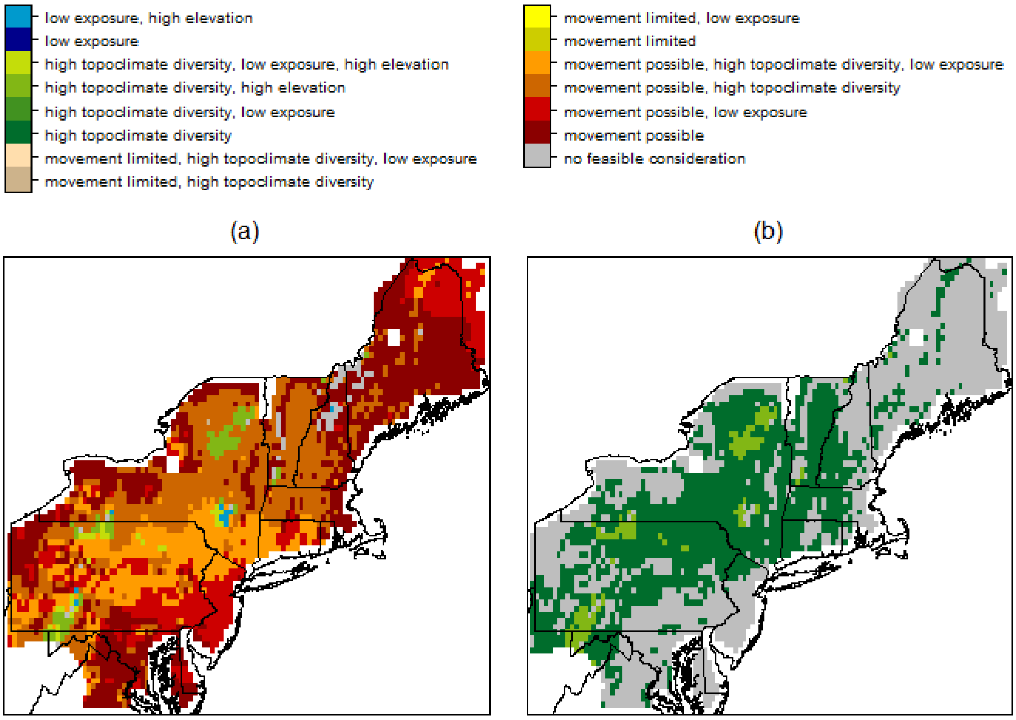

Figure AVIII. 1.5.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.6 Cattle egret (*Bubulcus ibis*)

Table AVIII. 1.6.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.25	0.66	0.00	1.00	505.00
low	0.15	0.25	0.49	0.00	1.00	375.00
high	0.60	0.30	0.83	0.00	1.00	850.00

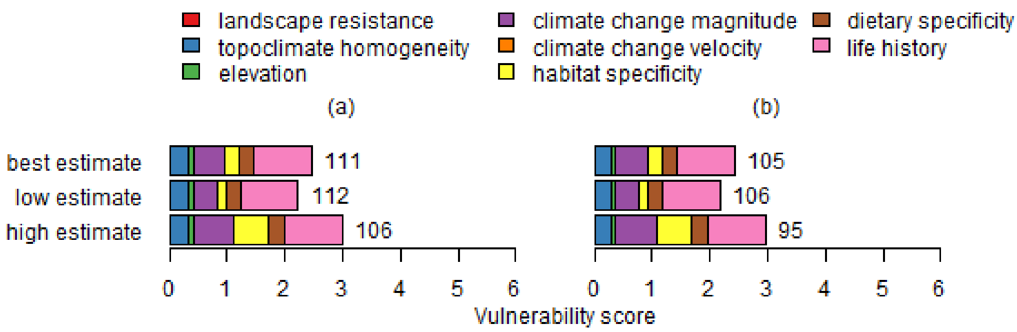

Figure AVIII. 1.6.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

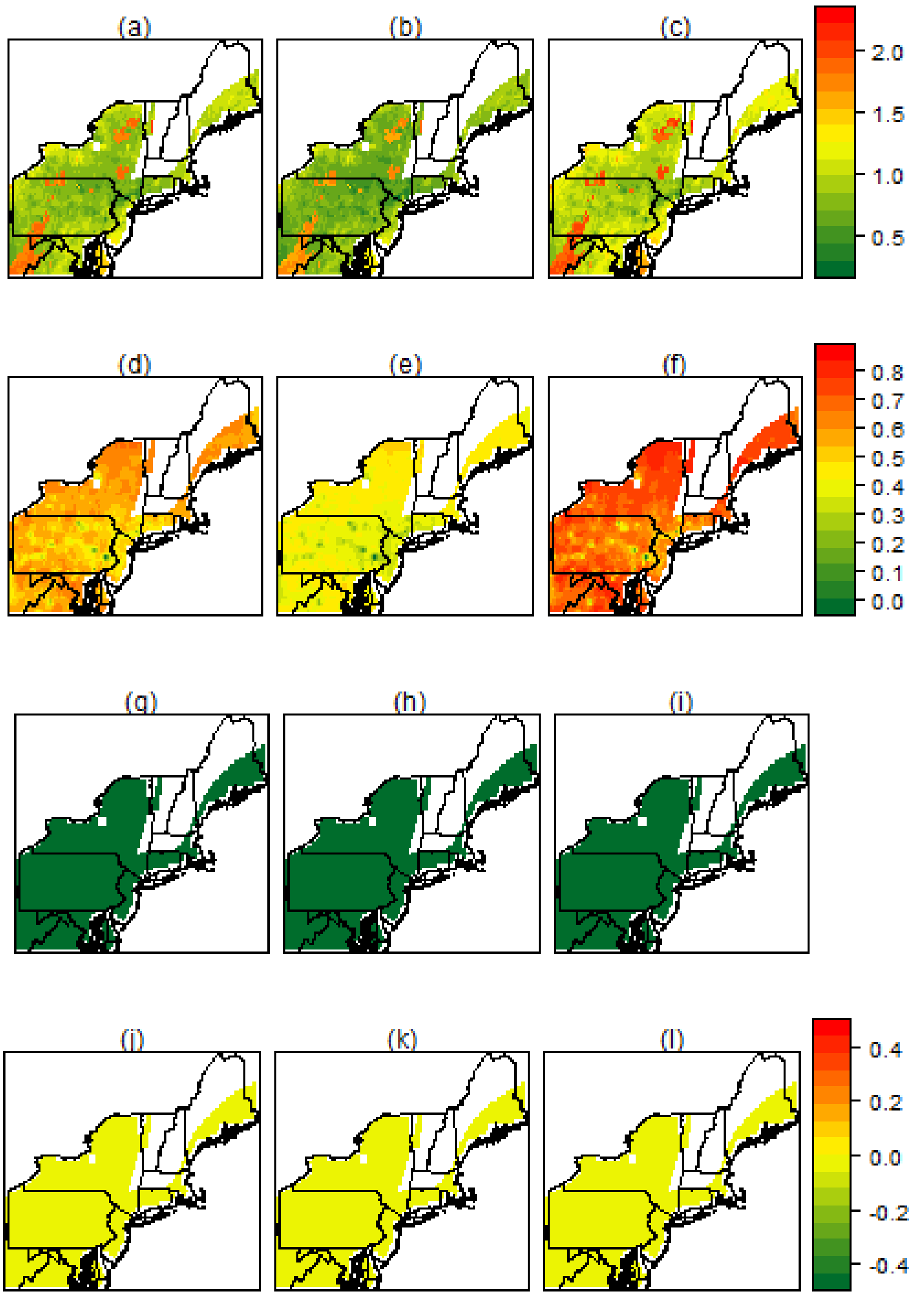

Figure AVIII. 1.6.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

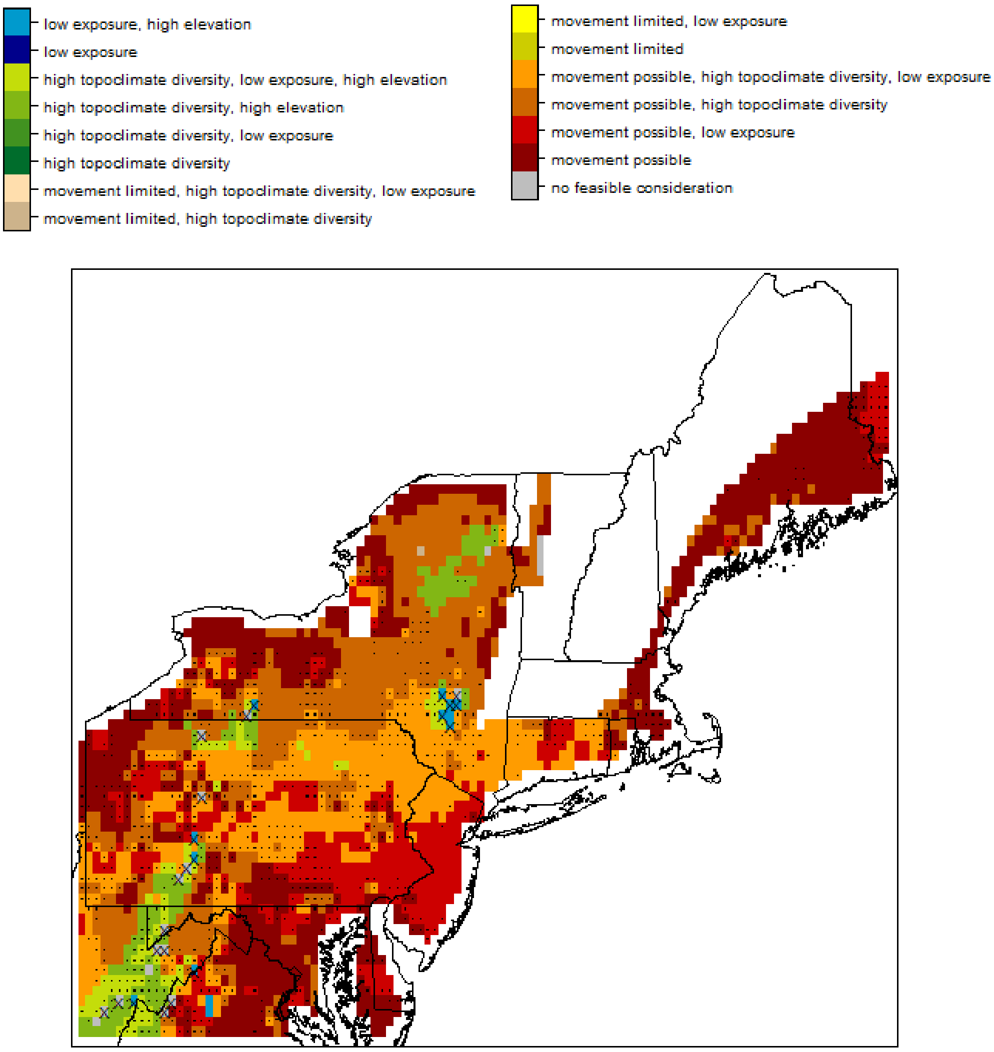

Figure AVIII. 1.6.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

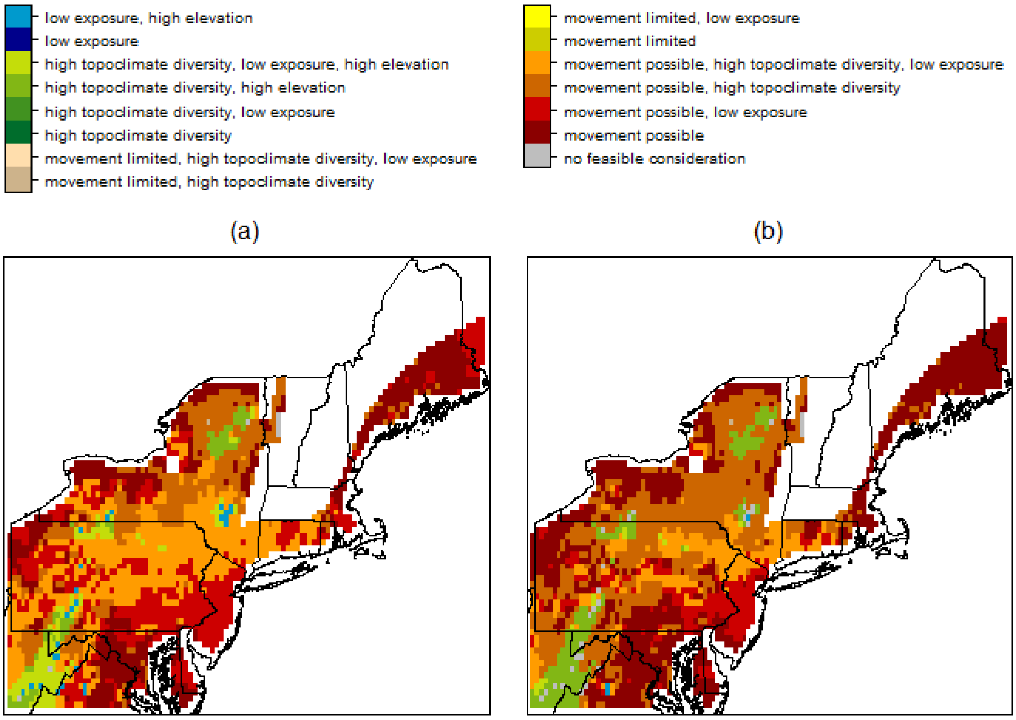

Figure AVIII. 1.6.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.7 Least bittern (*Ixobrychus exilis*)

Table AVIII. 1.7.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.00	0.66	0.00	1.00	7.50
low	0.50	0.00	0.59	0.00	1.00	3.00
high	0.55	0.05	0.73	0.07	1.00	35.00

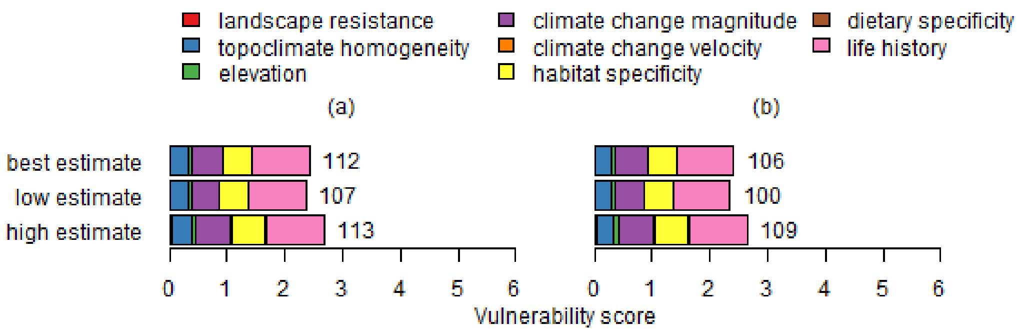

Figure AVIII. 1.7.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

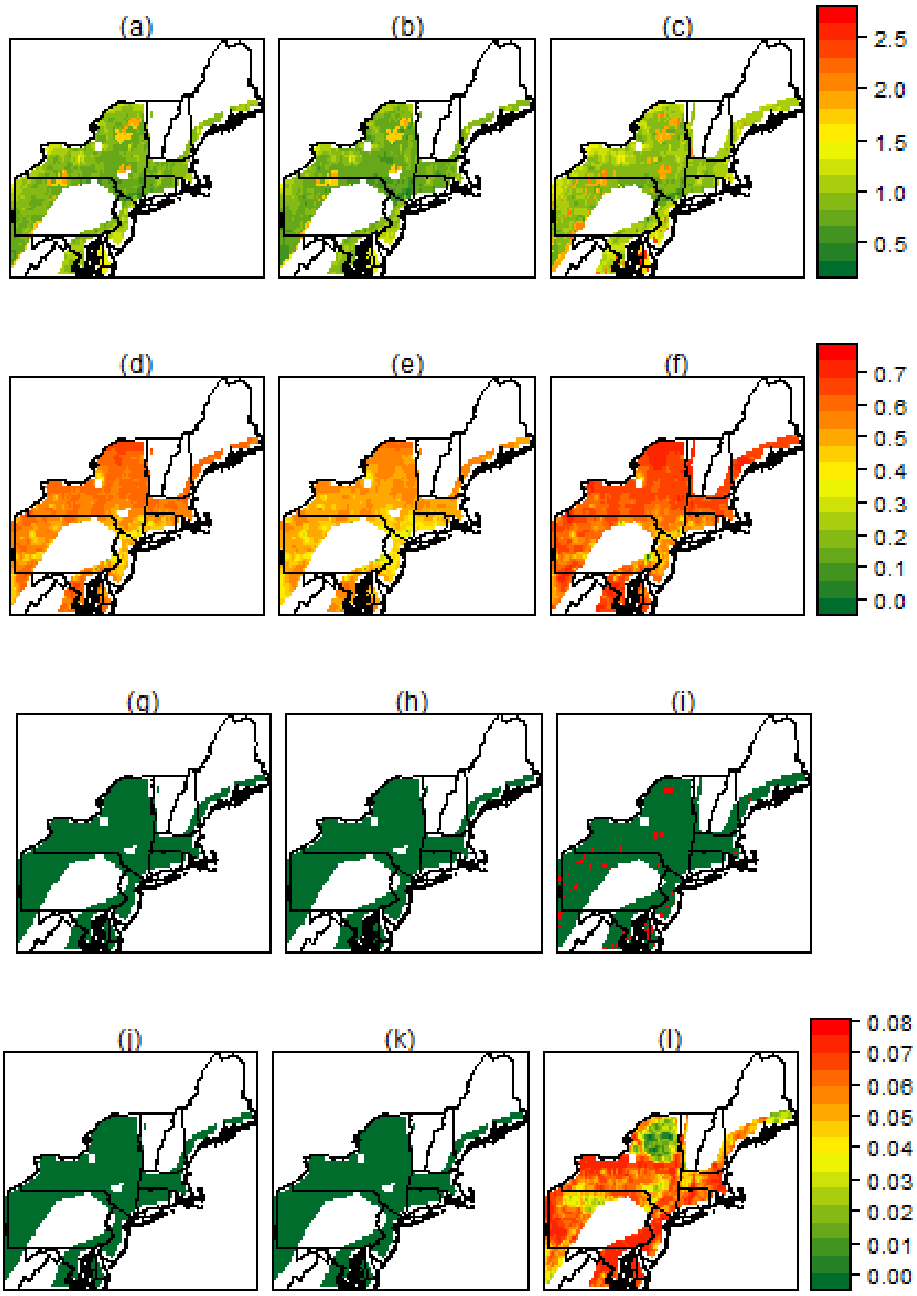

Figure AVIII. 1.7.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

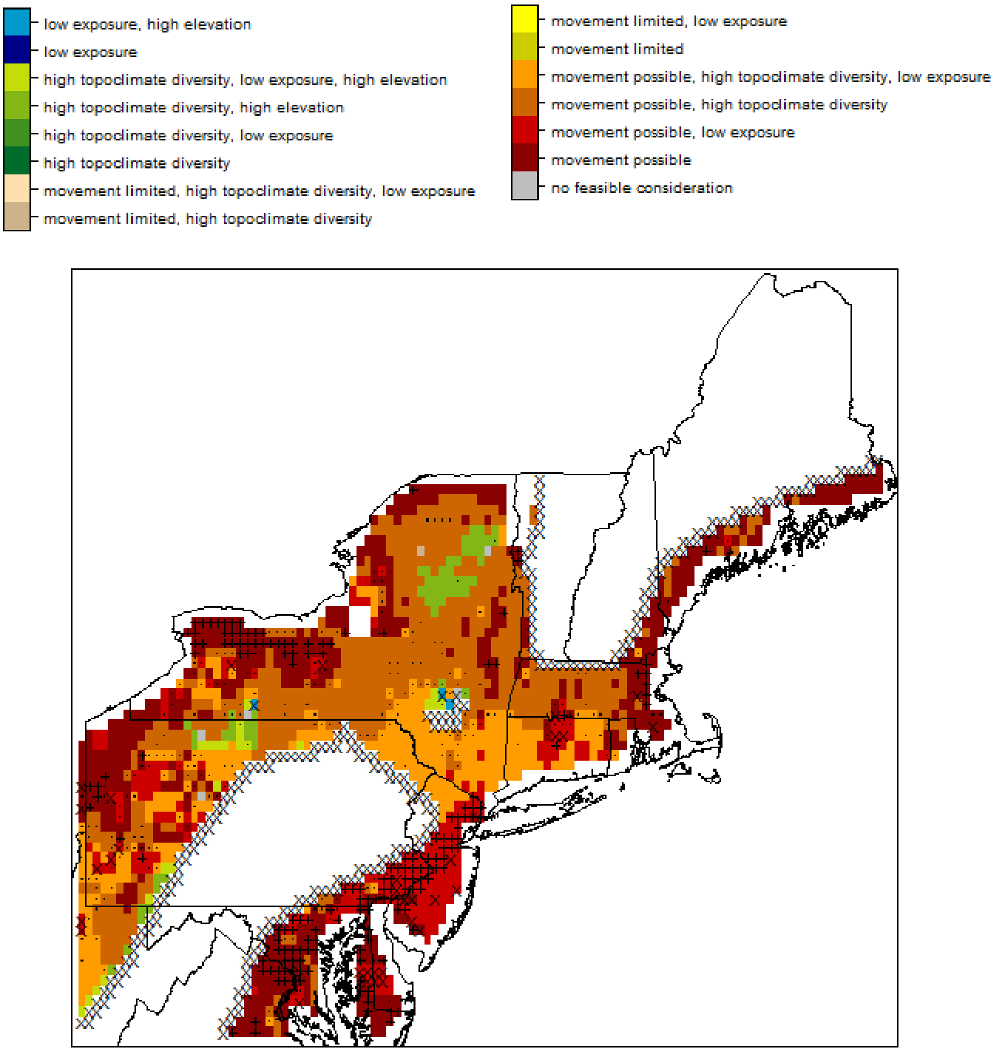

Figure AVIII. 1.7.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

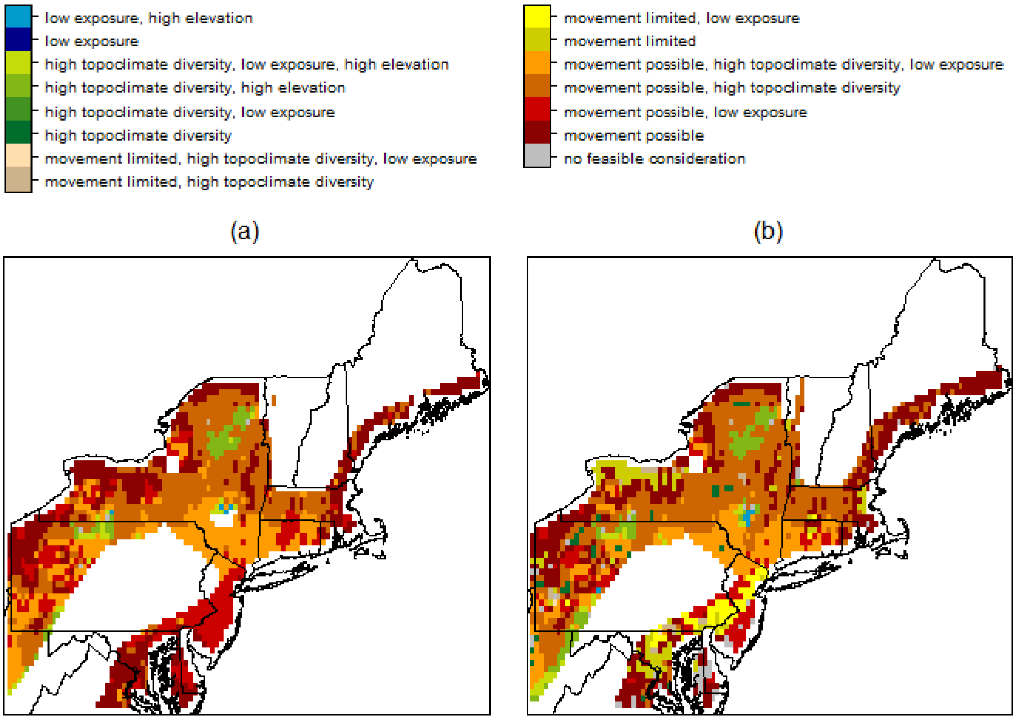

Figure AVIII. 1.7.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.8 Yellow-crowned night-heron (*Nyctanassa violacea*)

Table AVIII. 1.8.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.25	0.66	0.00	1.00	505.00
low	0.50	0.25	0.49	0.00	1.00	375.00
high	0.55	0.30	0.83	0.00	1.00	800.00

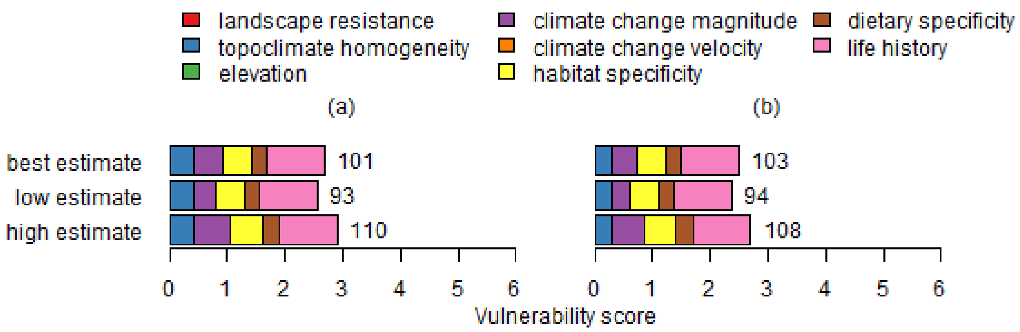

Figure AVIII. 1.8.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

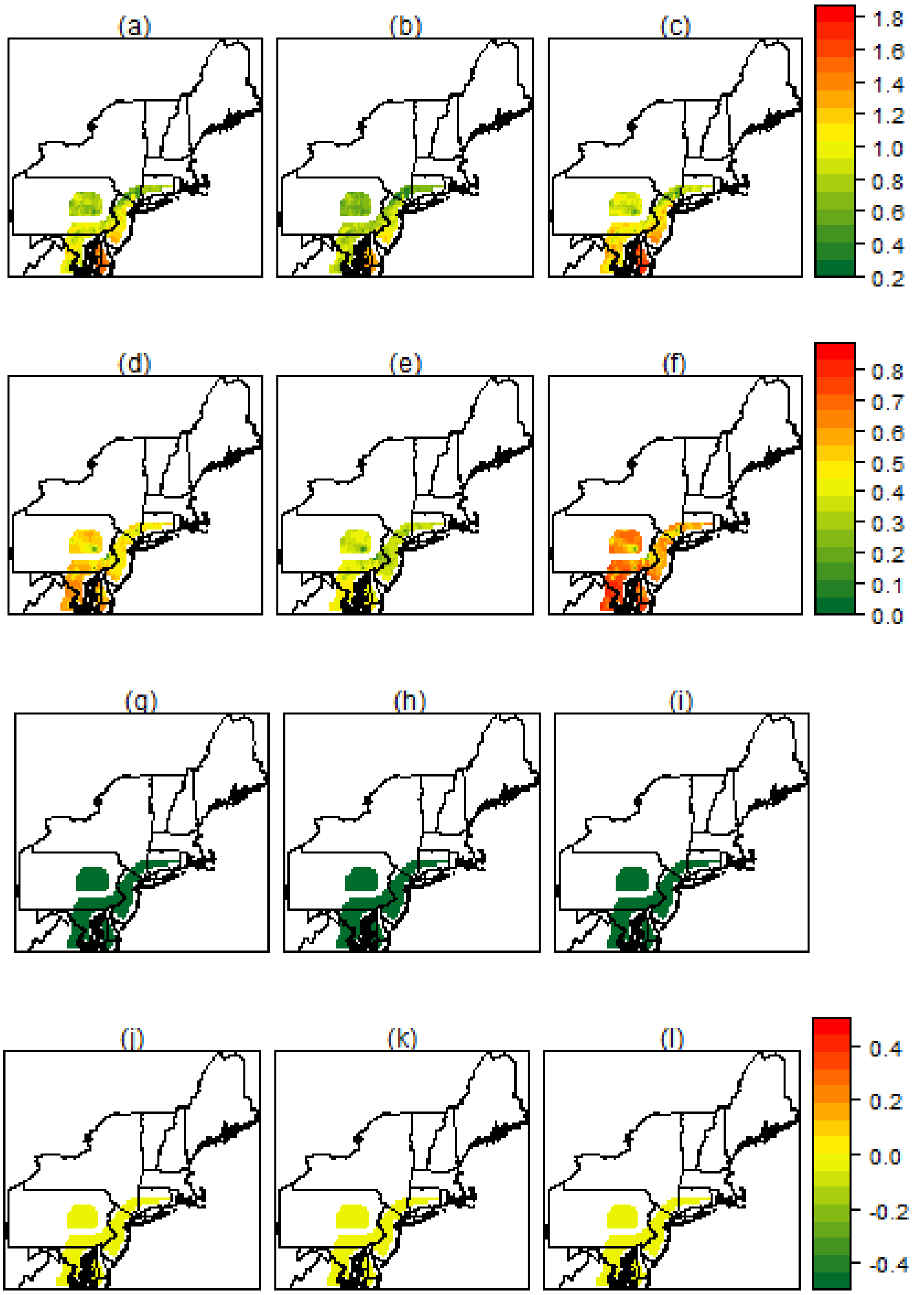

Figure AVIII. 1.8.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

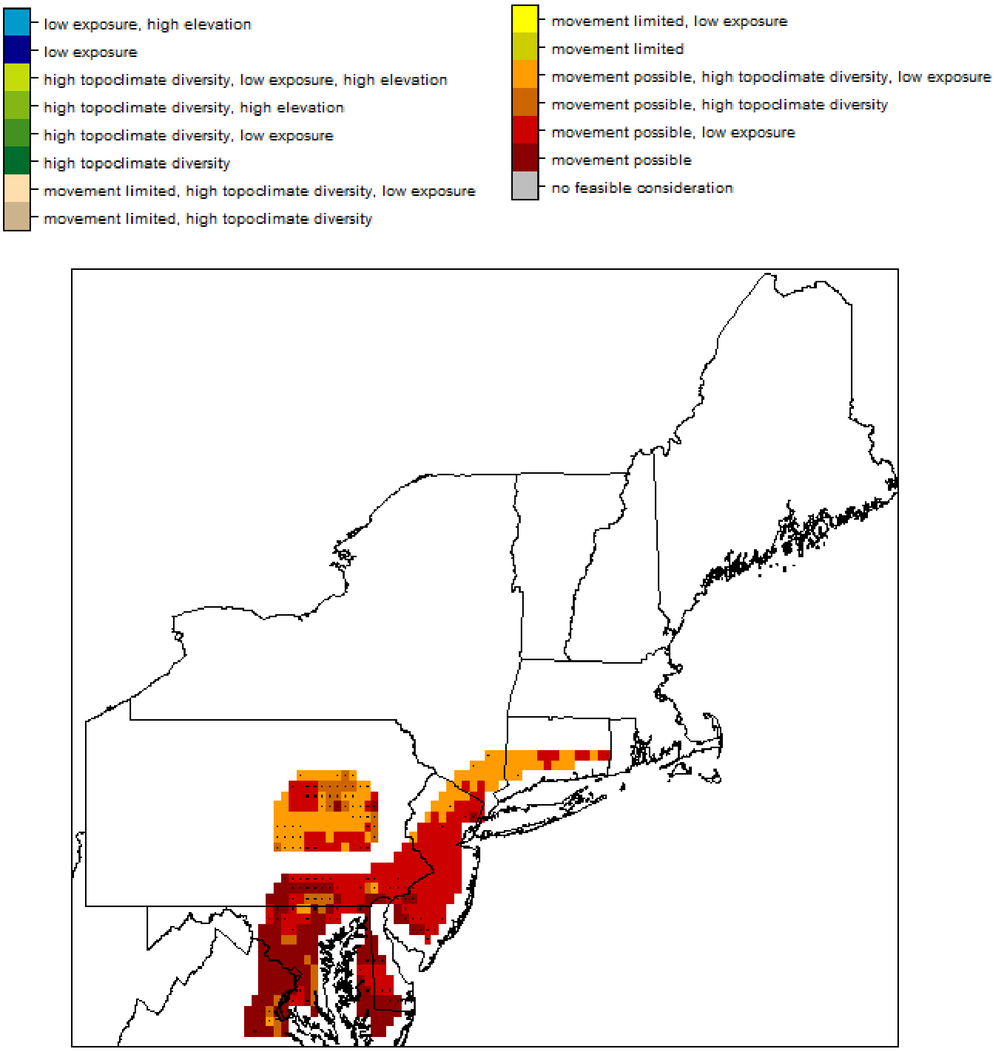

Figure AVIII. 1.8.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

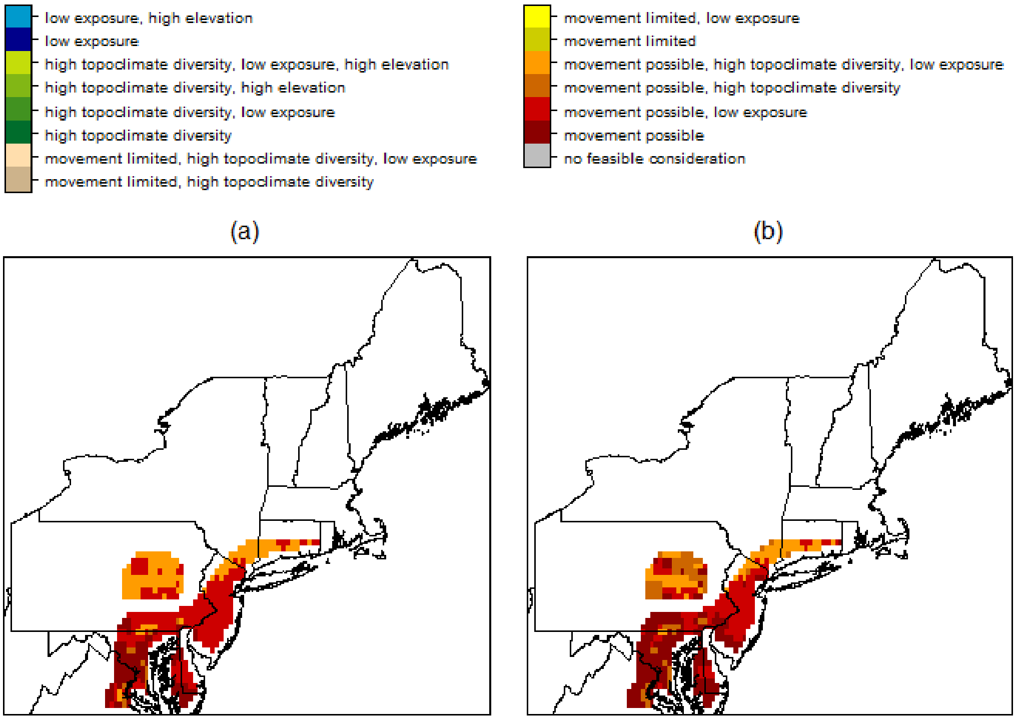

Figure AVIII. 1.8.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.9 Black-crowned night-heron (*Nycticorax nycticorax*)

Table AVIII. 1.9.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.33	0.33	0.66	0.00	1.00	341.67
low	0.33	0.27	0.55	0.00	1.00	250.00
high	0.53	0.37	0.80	0.03	1.00	566.67

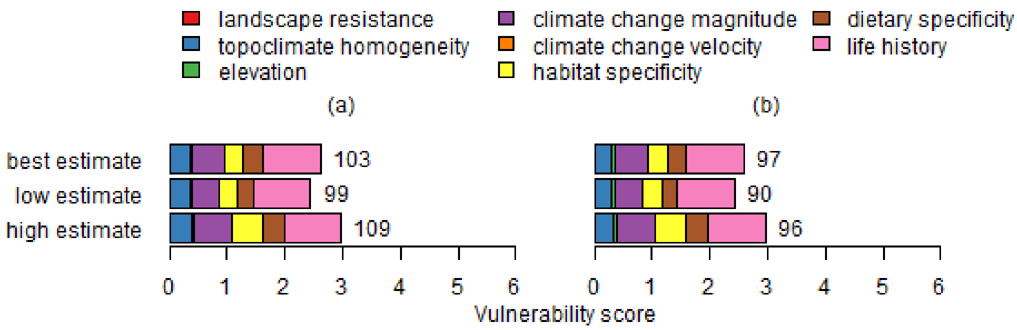

Figure AVIII. 1.9.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

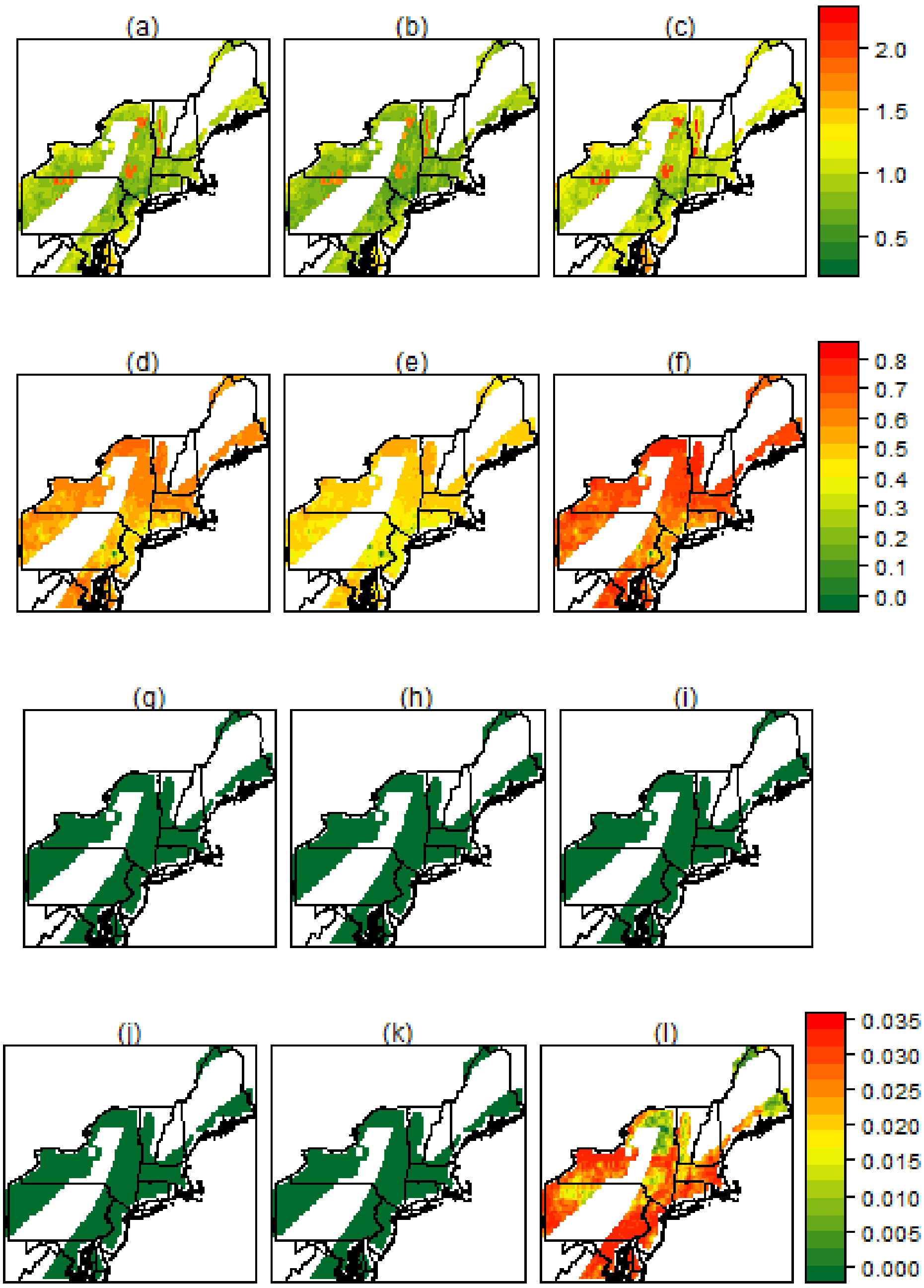

Figure AVIII. 1.9.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

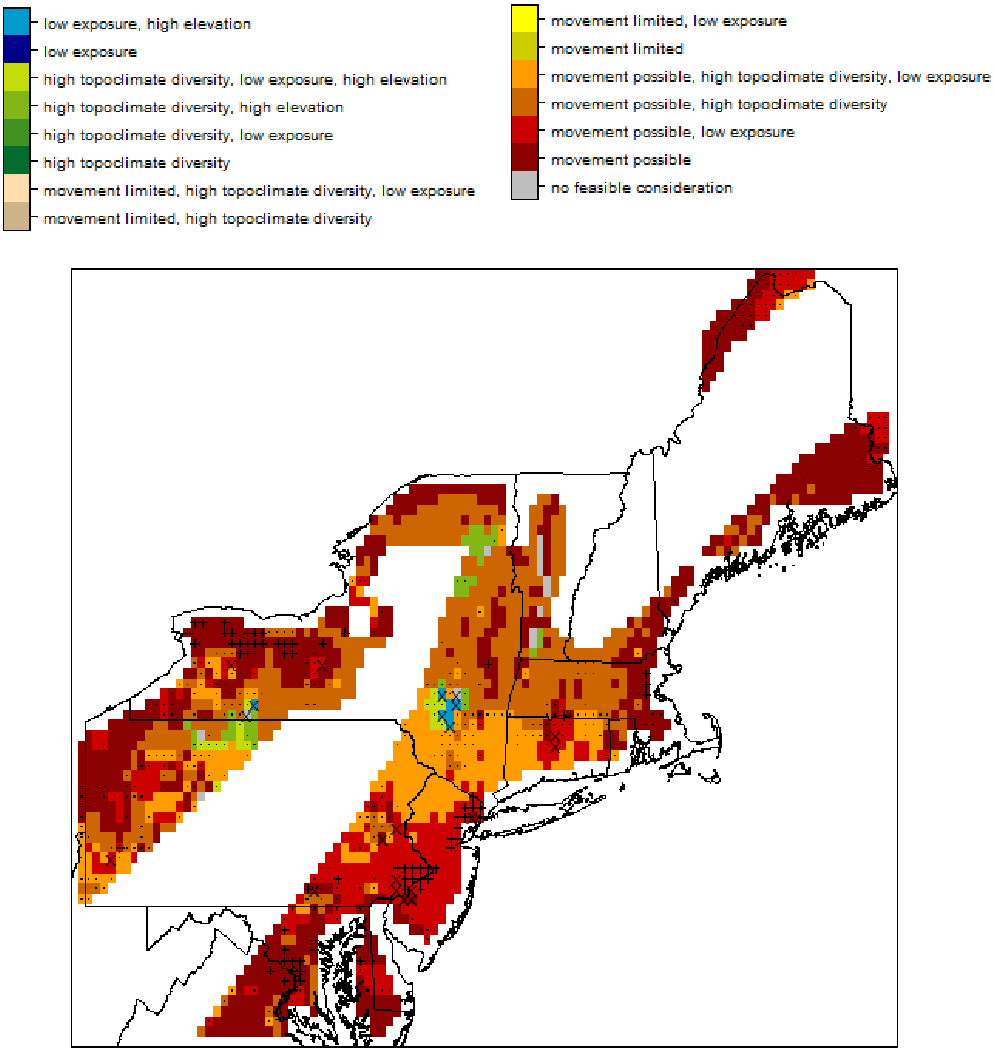

Figure AVIII. 1.9.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

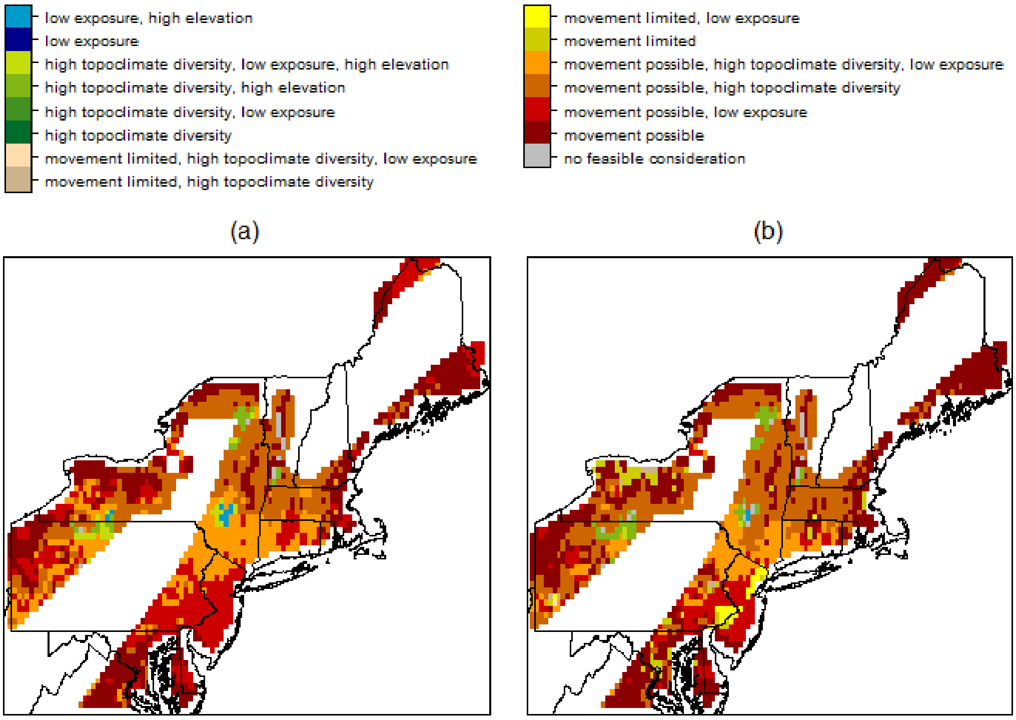

Figure AVIII. 1.9.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.10 Northern pintail (*Anas acuta*)

Table AVIII. 1.10.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.35	0.20	0.76	0.00	1.00	26.20
low	0.26	0.16	0.69	0.00	1.00	1.10
high	0.42	0.20	0.83	0.02	1.00	172.00

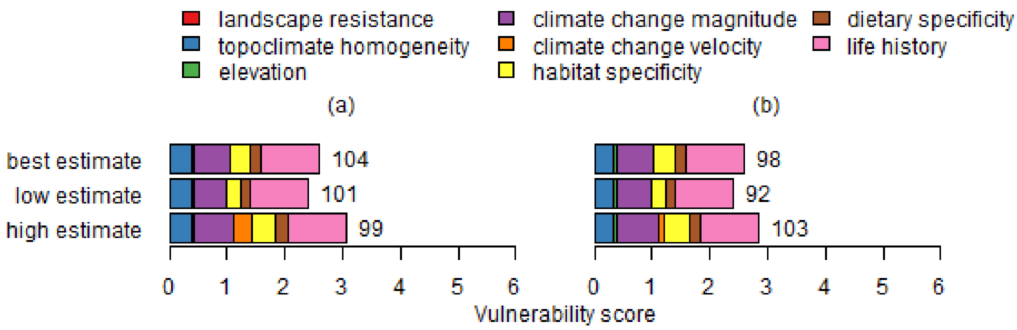

Figure AVIII. 1.10.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

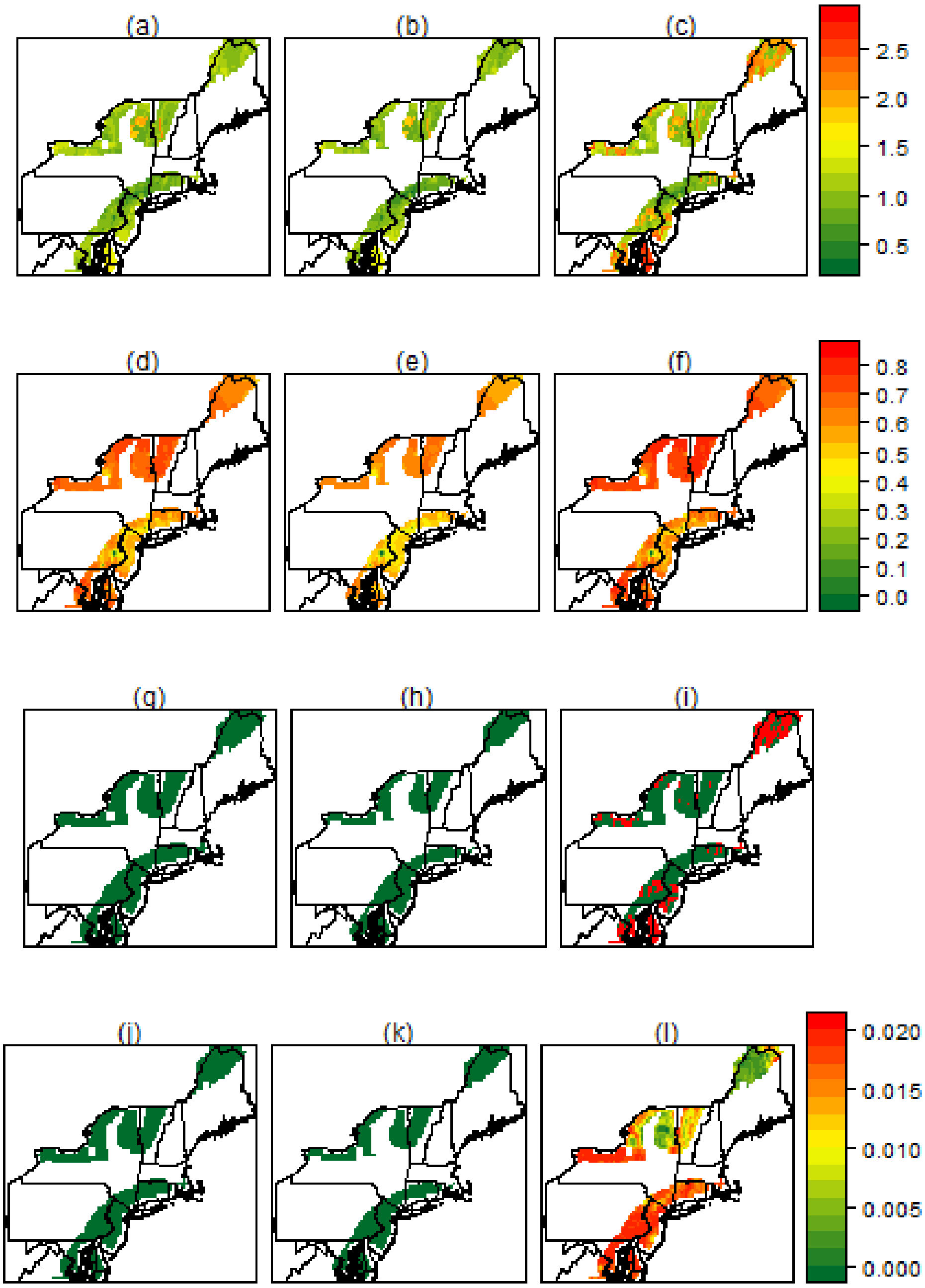

Figure AVIII. 1.10.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

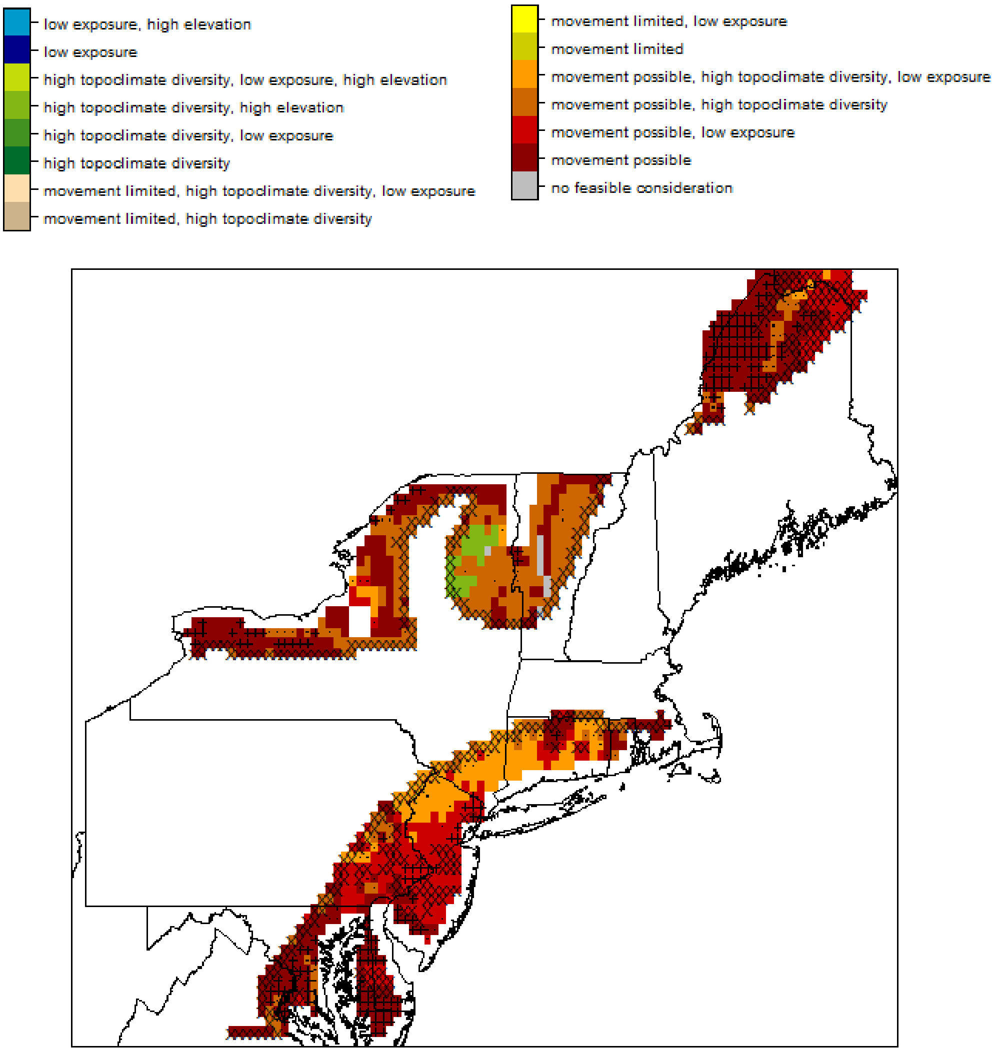

Figure AVIII. 1.10.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

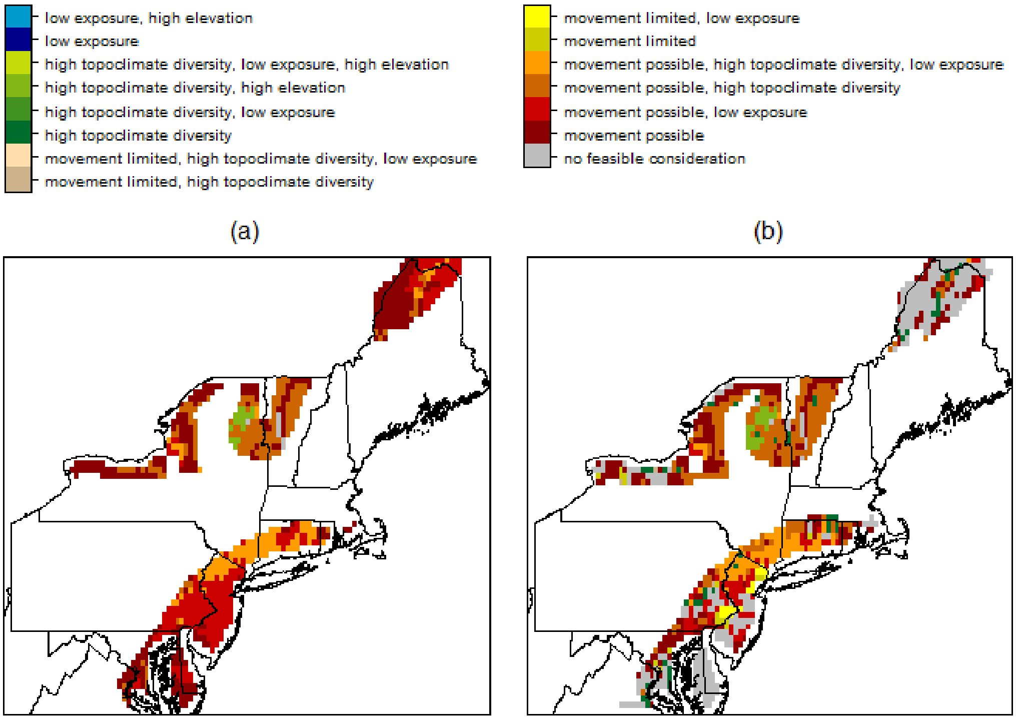

Figure AVIII. 1.10.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.11 Blue-winged teal (*Anas discors*)

Table AVIII. 1.11.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.38	0.25	0.79	0.00	1.00	30.25
low	0.31	0.20	0.62	0.00	1.00	1.38
high	0.40	0.25	0.83	0.02	1.00	177.50

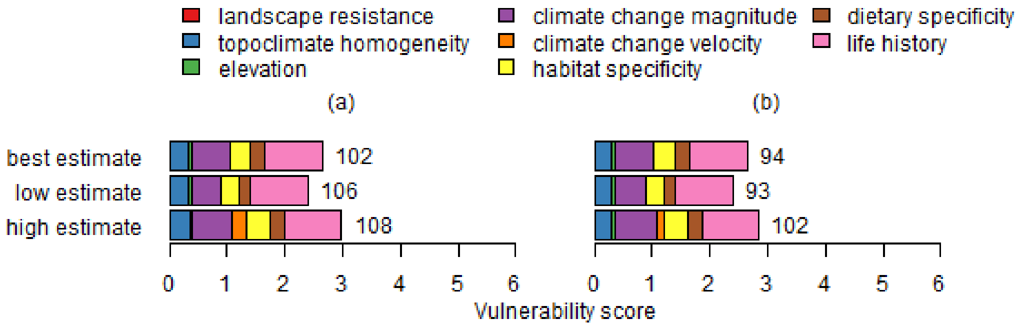

Figure AVIII. 1.11.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

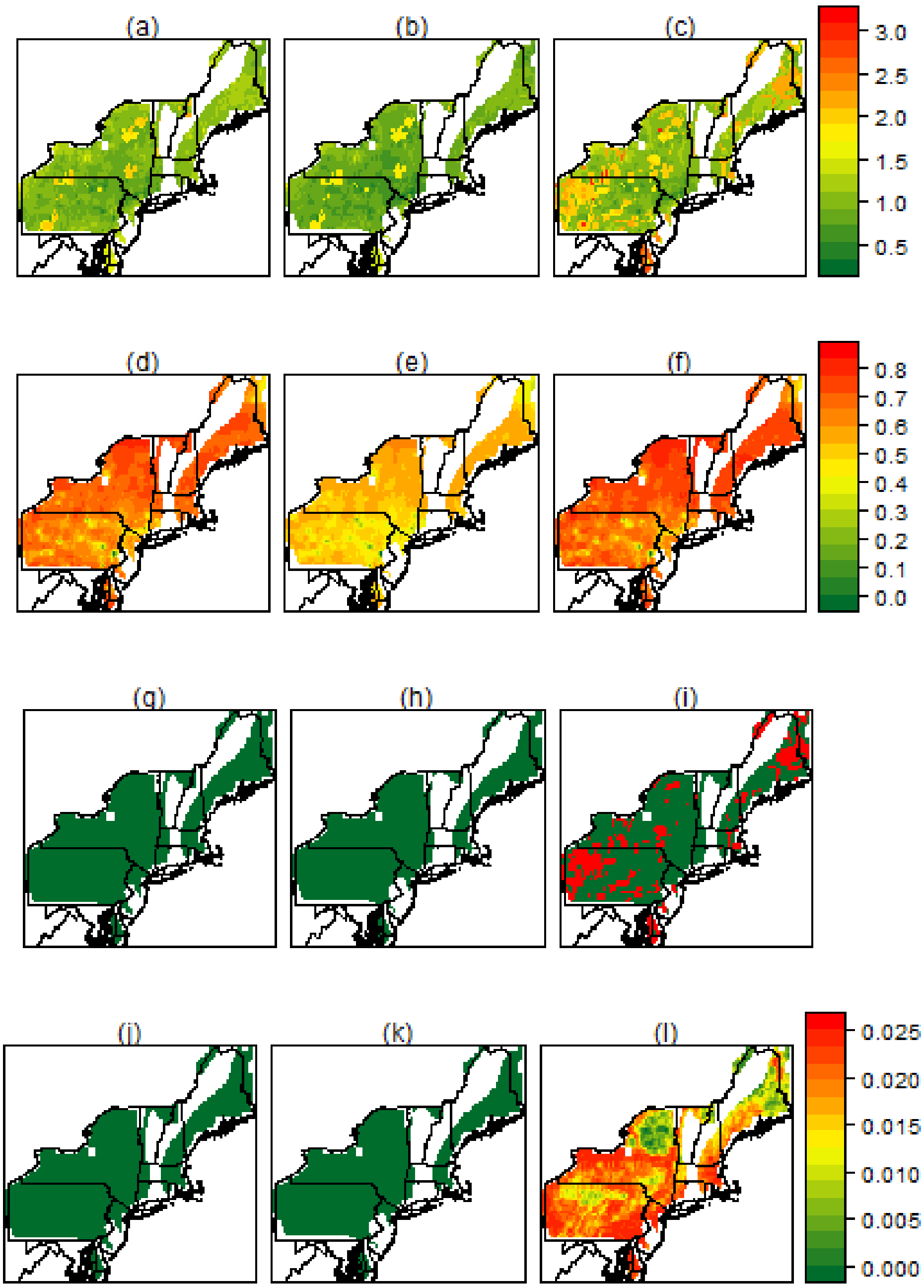

Figure AVIII. 1.11.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

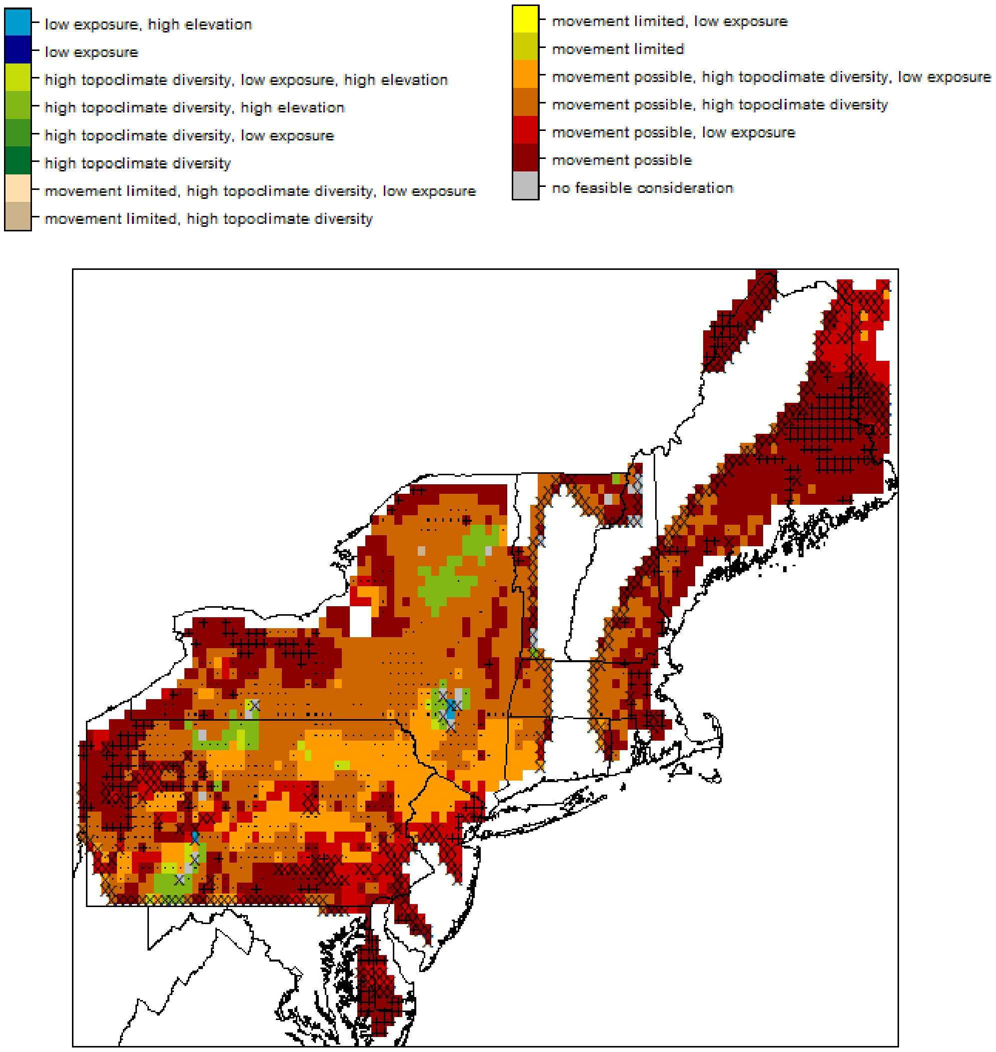

Figure AVIII. 1.11.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

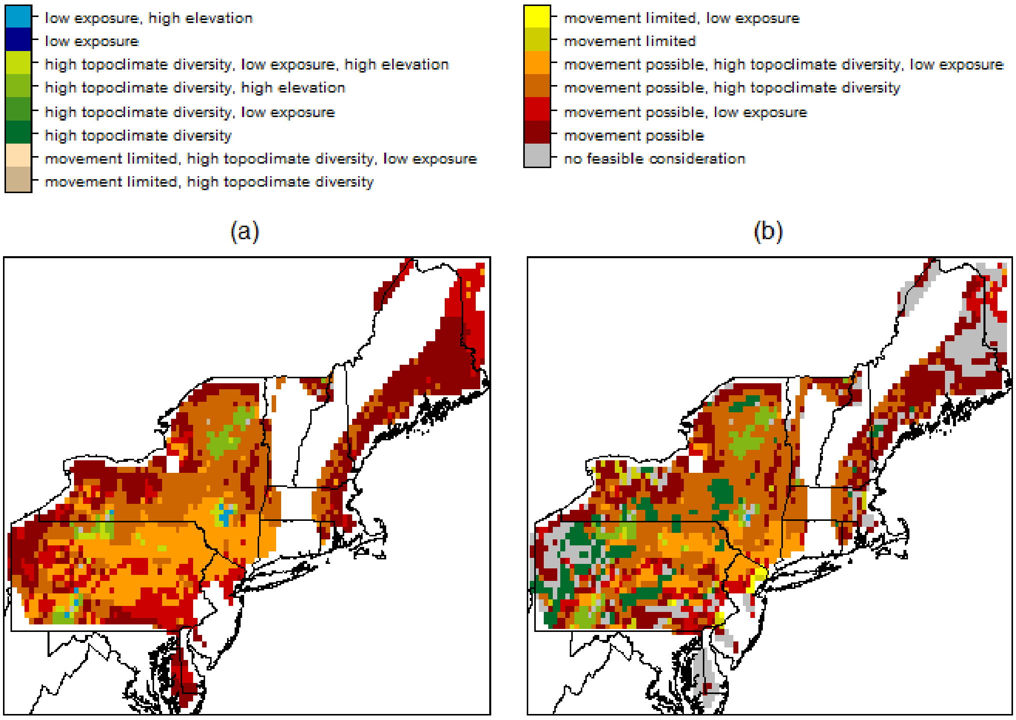

Figure AVIII. 1.11.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.12 American black duck (*Anas rubripes*)

Table AVIII. 1.12.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.30	0.20	0.69	0.00	1.00	24.60
low	0.24	0.17	0.63	0.00	1.00	1.10
high	0.32	0.20	0.77	0.02	1.00	144.00

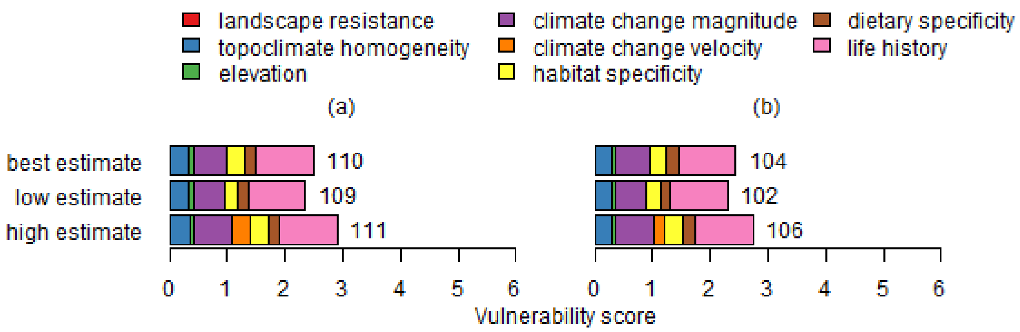

Figure AVIII. 1.12.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

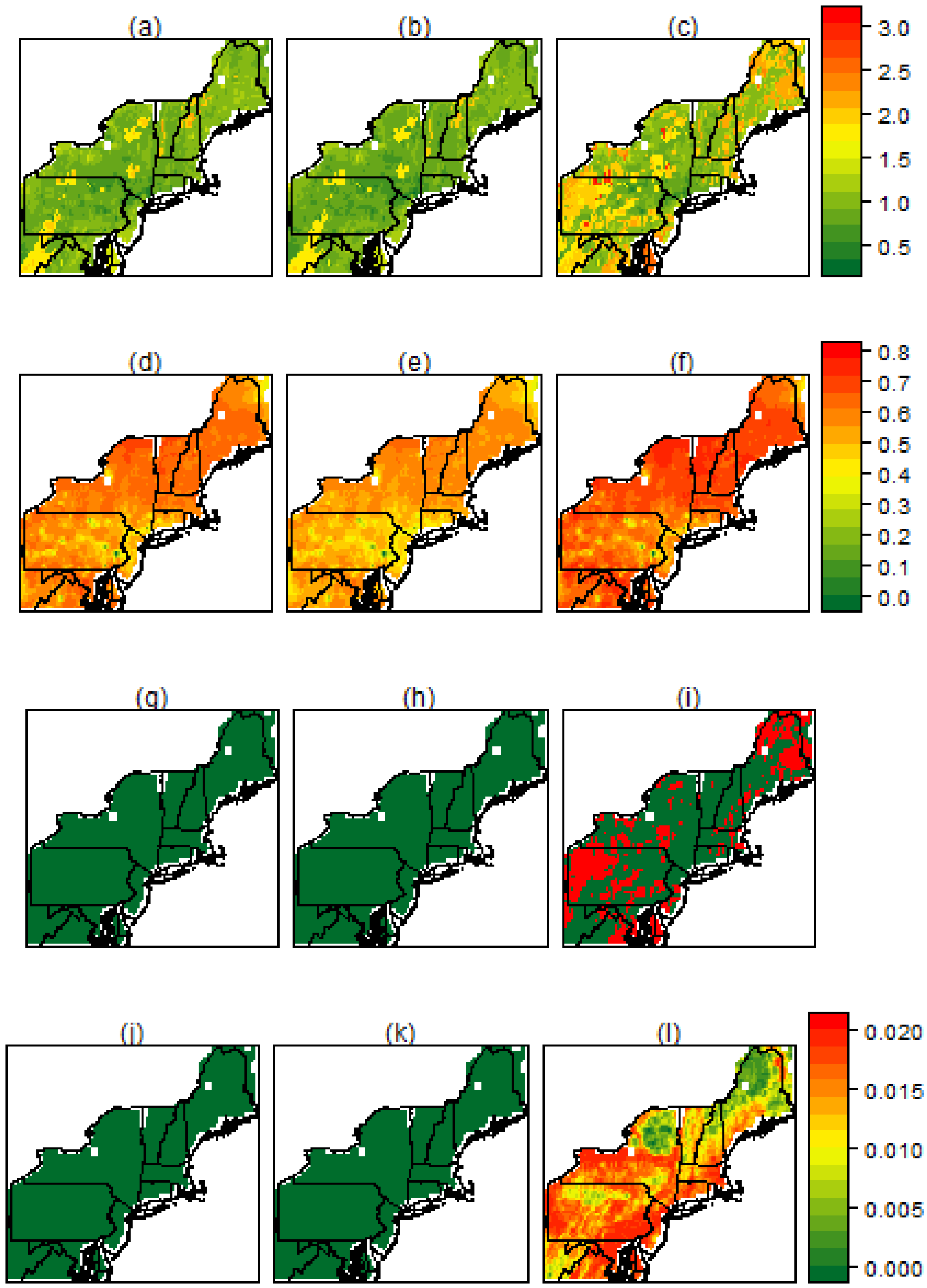

Figure AVIII. 1.12.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

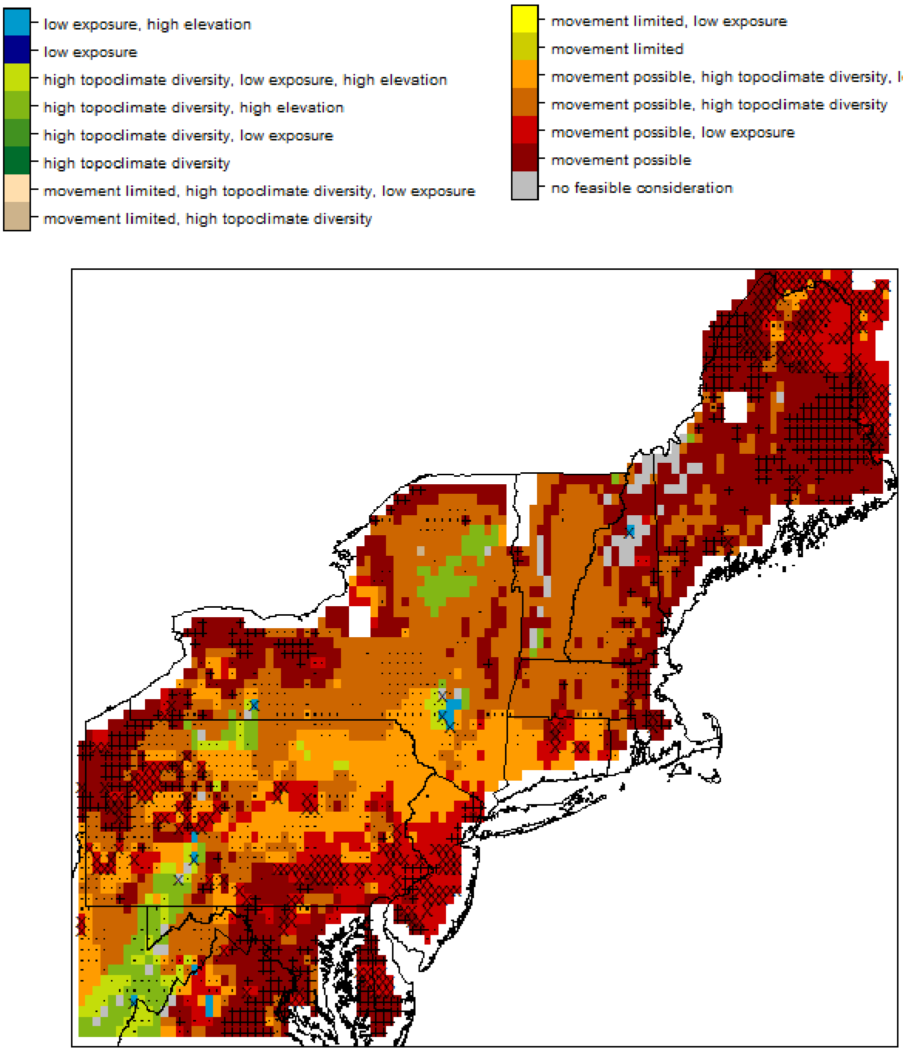

Figure AVIII. 1.12.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

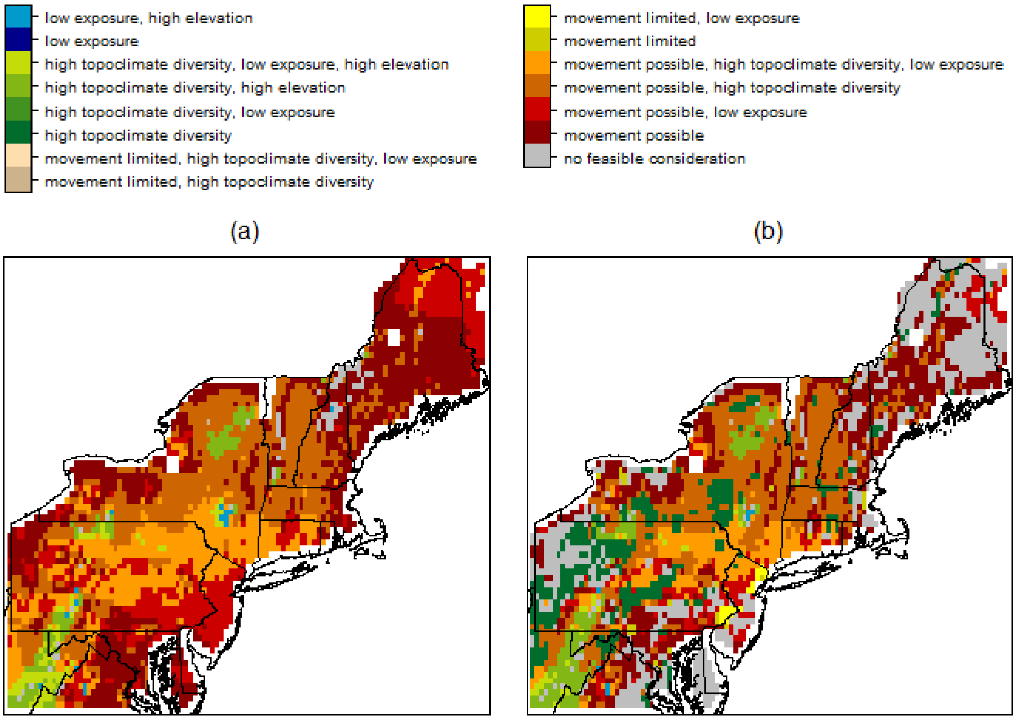

Figure AVIII. 1.12.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.13 Lesser scaup (*Aythya affinis*)

Table AVIII. 1.13.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.44	0.25	0.83	0.00	1.00	33.00
low	0.38	0.22	0.73	0.00	1.00	0.12
high	0.52	0.25	0.92	0.02	1.00	202.50

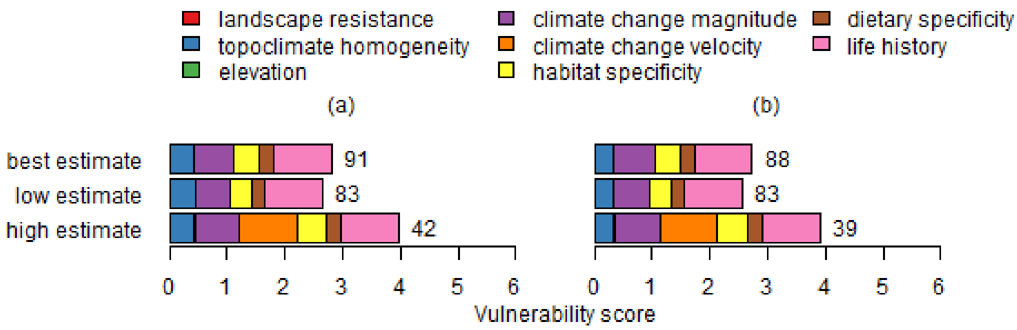

Figure AVIII. 1.13.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

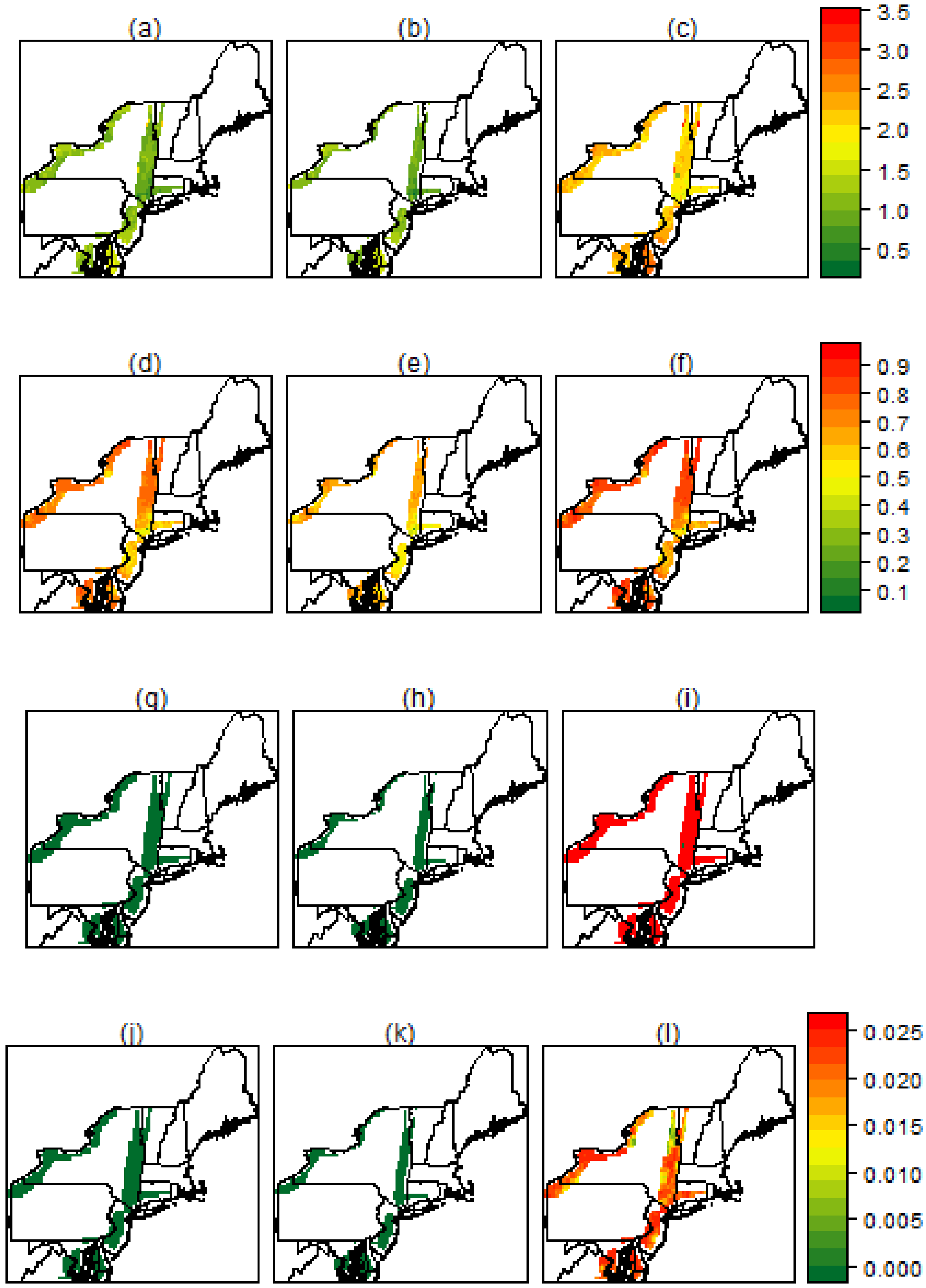

Figure AVIII. 1.13.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

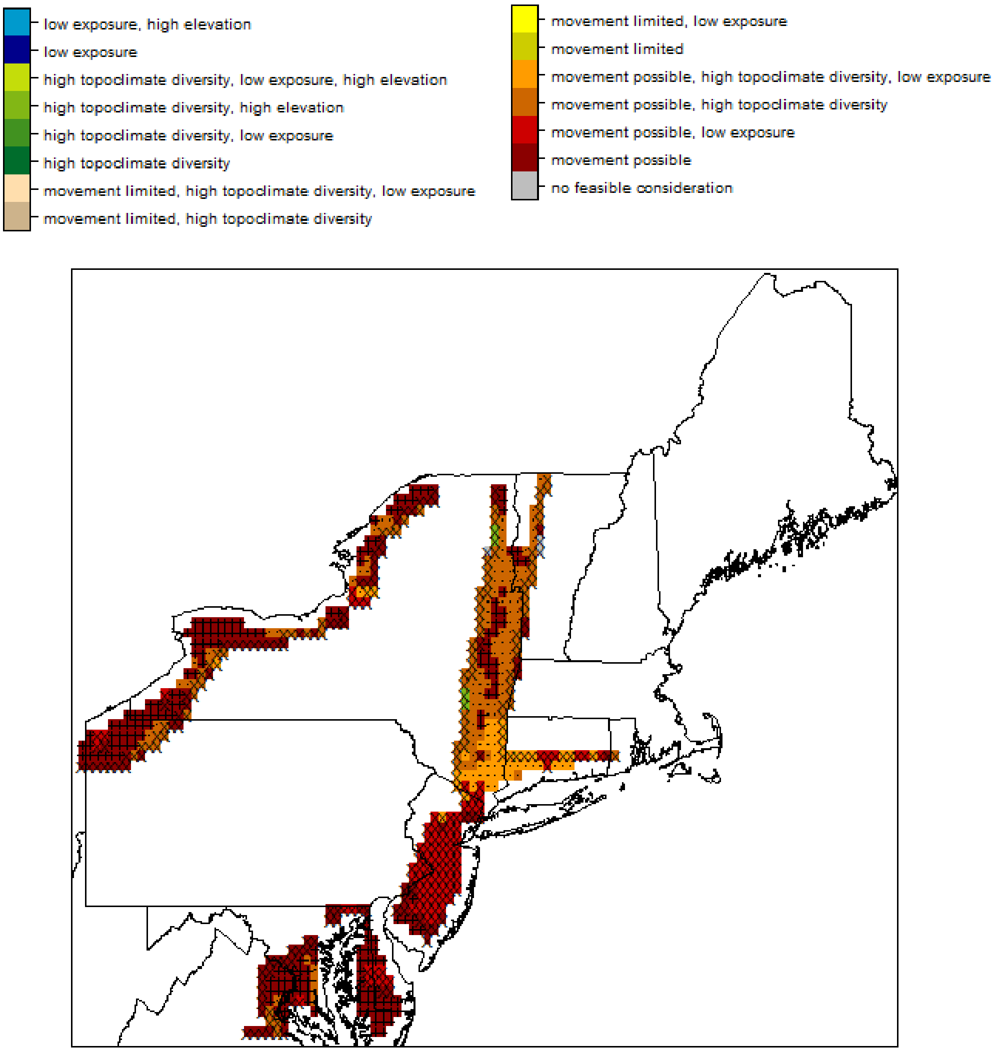

Figure AVIII. 1.13.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

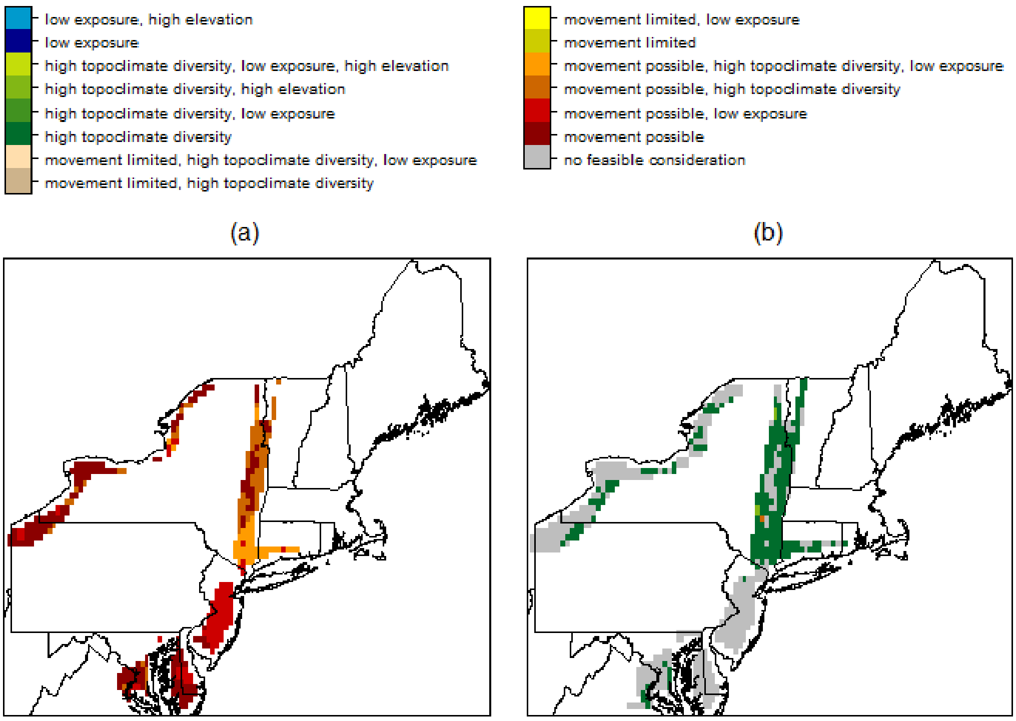

Figure AVIII. 1.13.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.14 Greater scaup (*Aythya marila*)

Table AVIII. 1.14.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.44	0.25	0.83	0.00	1.00	33.00
low	0.38	0.22	0.73	0.00	1.00	0.12
high	0.52	0.25	0.92	0.02	1.00	202.50

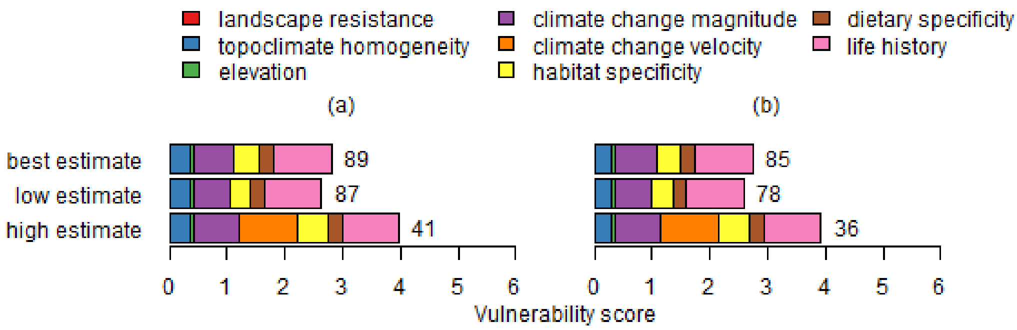

Figure AVIII. 1.14.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

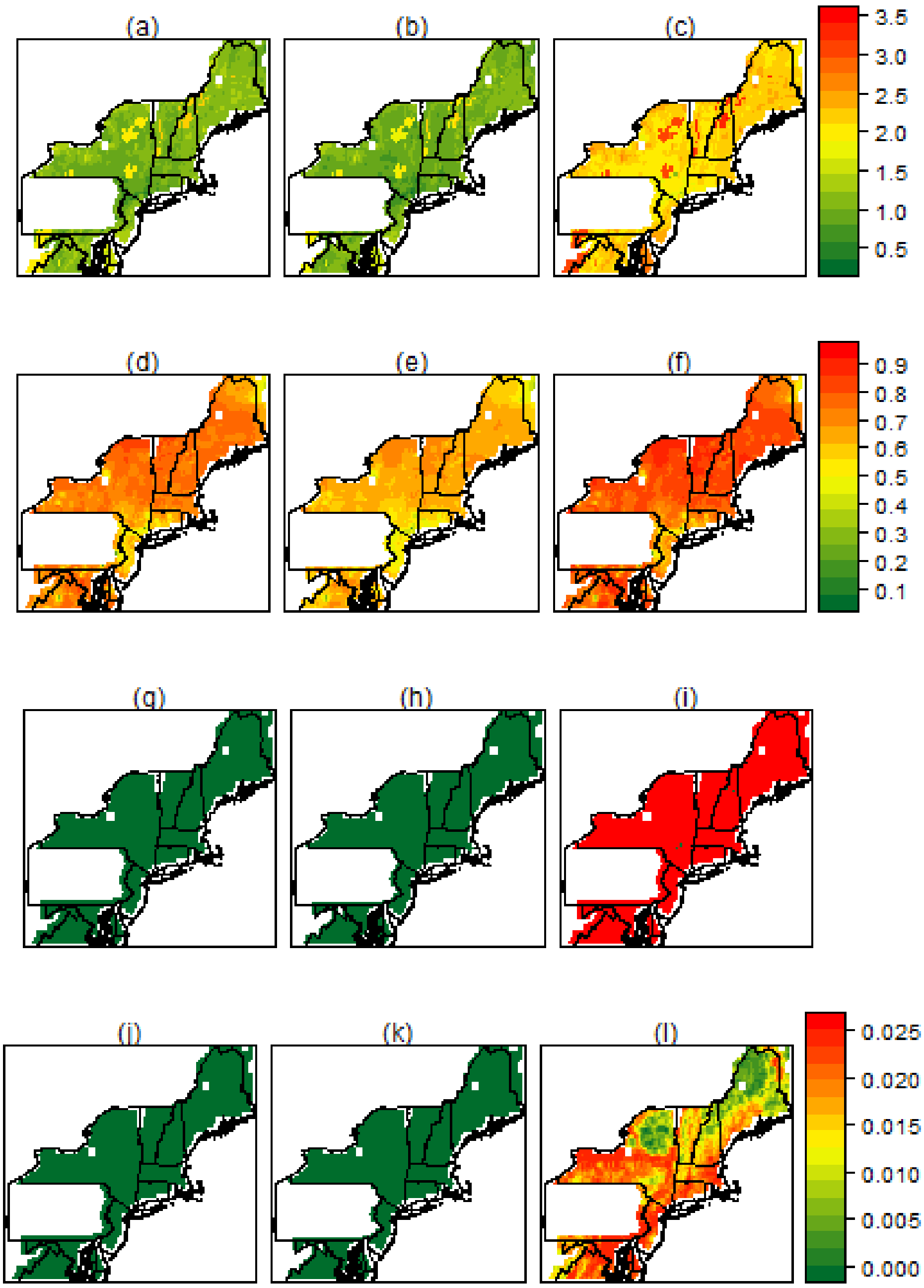

Figure AVIII. 1.14.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

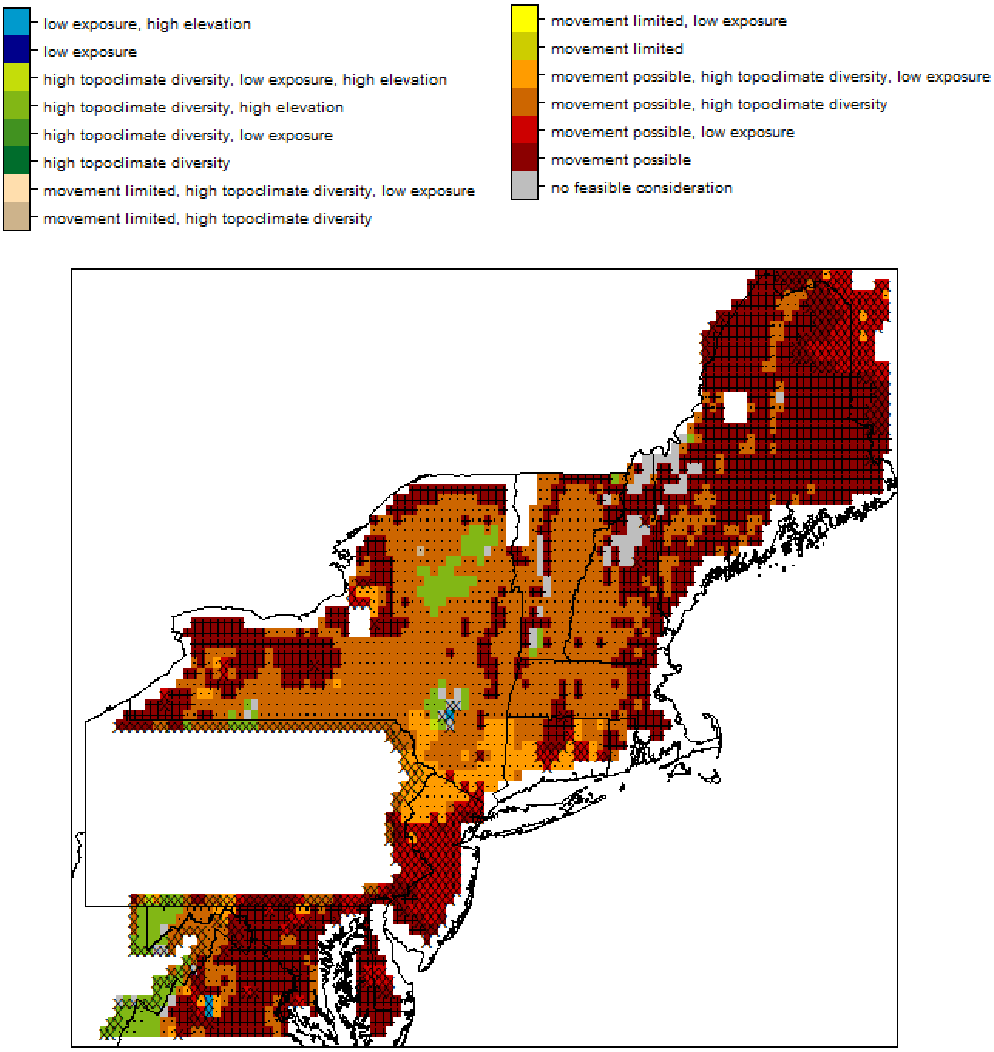

Figure AVIII. 1.14.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

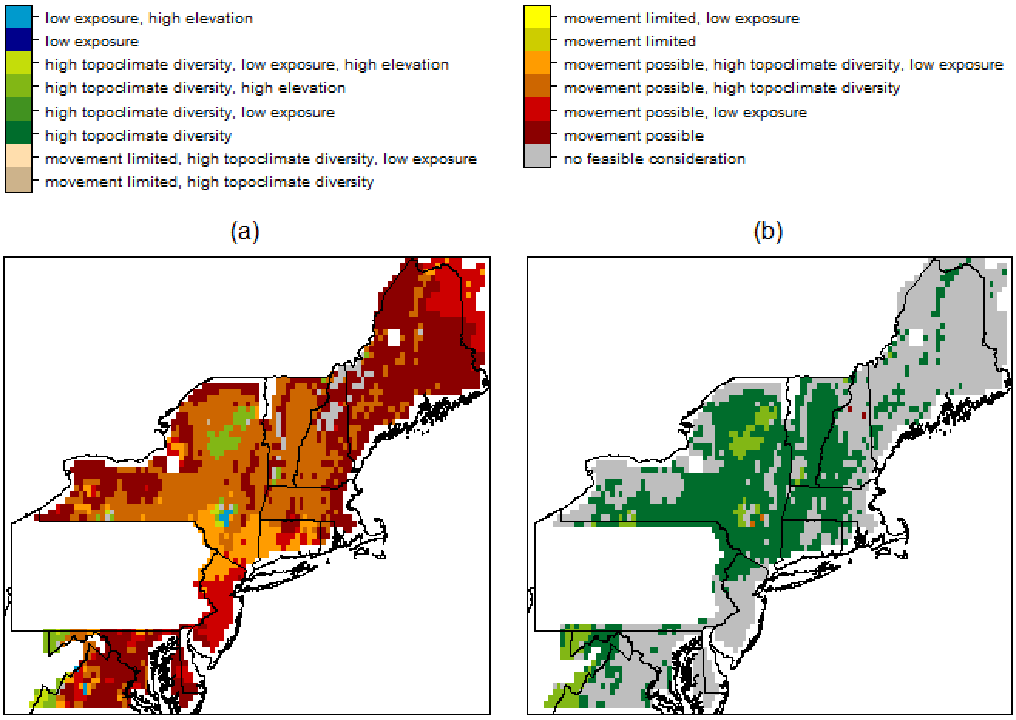

Figure AVIII. 1.14.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.15 Common goldeneye (*Bucephala clangula*)

Table AVIII. 1.15.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.45	0.30	0.76	0.00	1.00	25.20
low	0.31	0.25	0.59	0.00	1.00	1.10
high	0.52	0.30	0.81	0.02	1.00	162.00

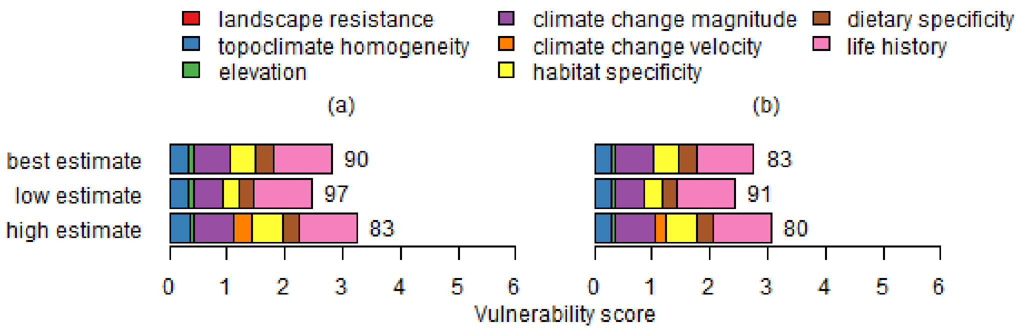

Figure AVIII. 1.15.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

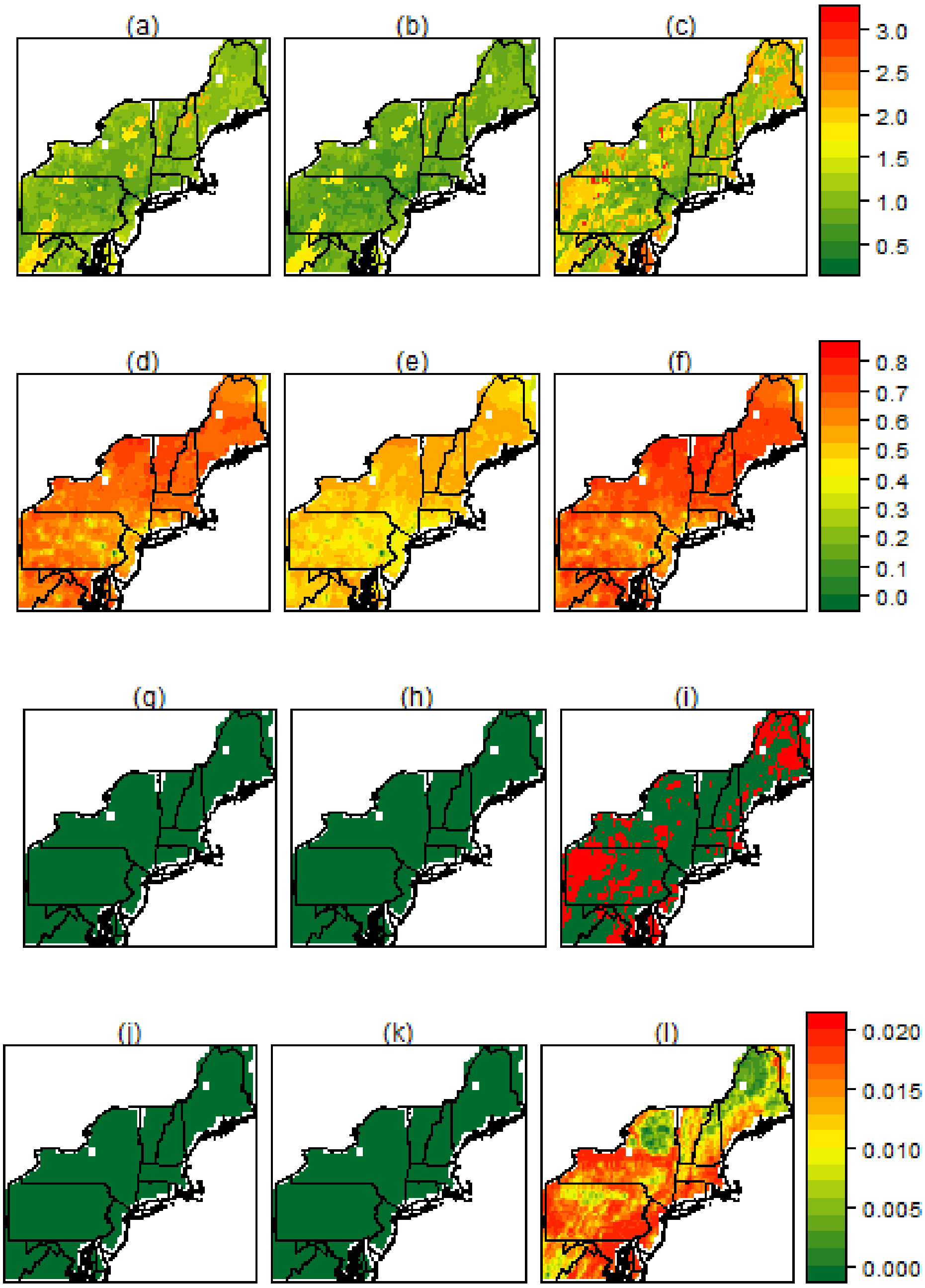

Figure AVIII. 1.15.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

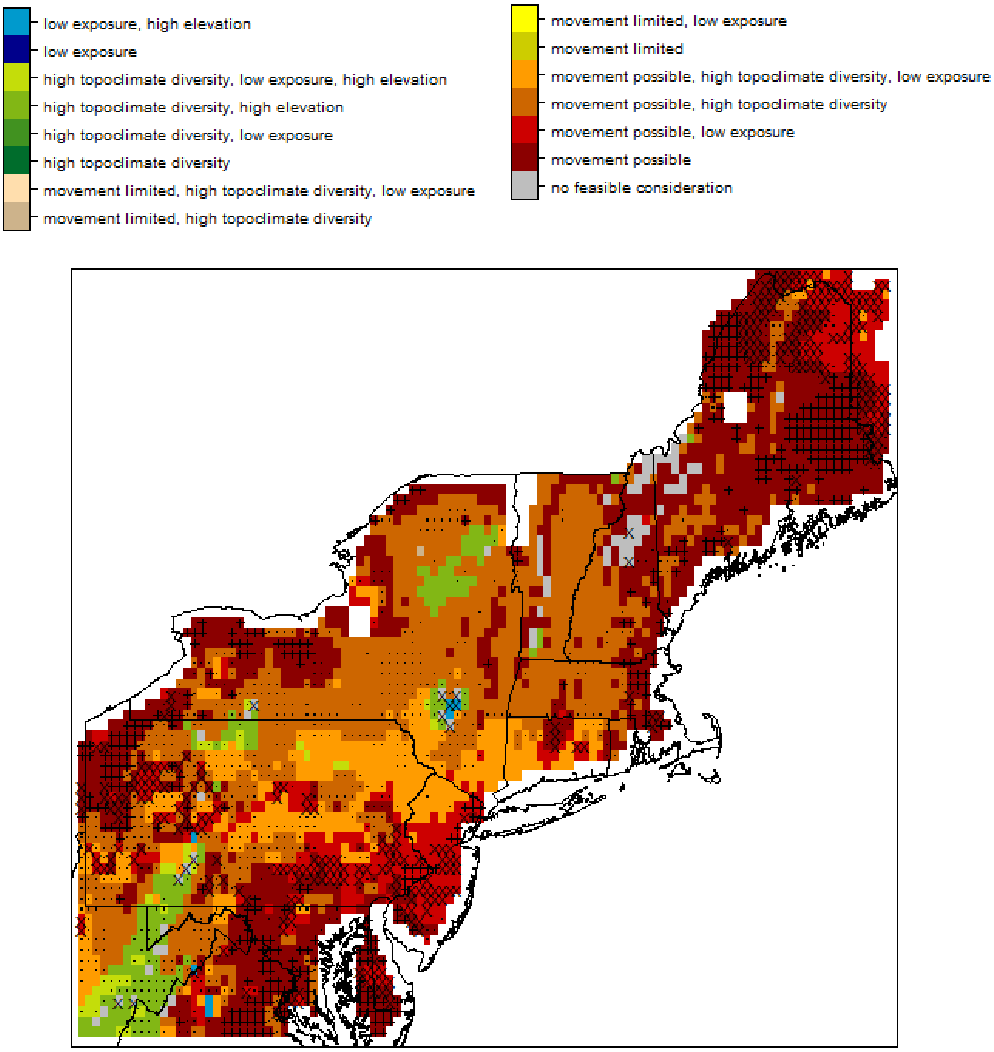

Figure AVIII. 1.15.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

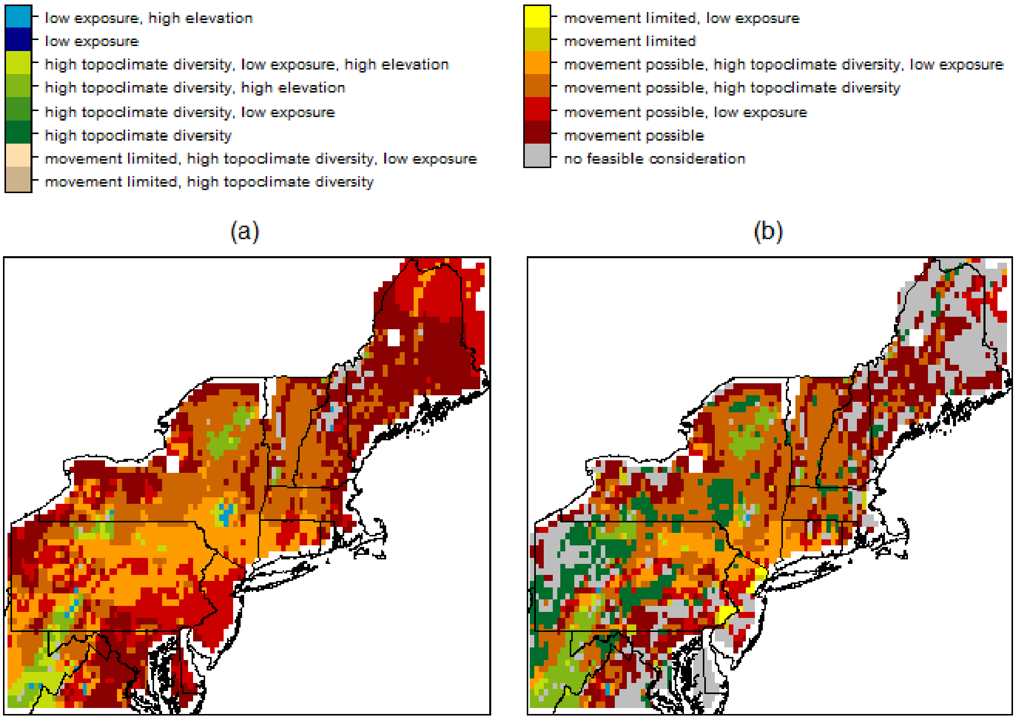

Figure AVIII. 1.15.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.16 Ruddy duck (*Oxyura jamaicensis*)

Table AVIII. 1.16.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.45	0.25	0.76	0.00	1.00	26.20
low	0.38	0.16	0.67	0.00	1.00	1.10
high	0.52	0.30	0.83	0.02	1.00	162.00

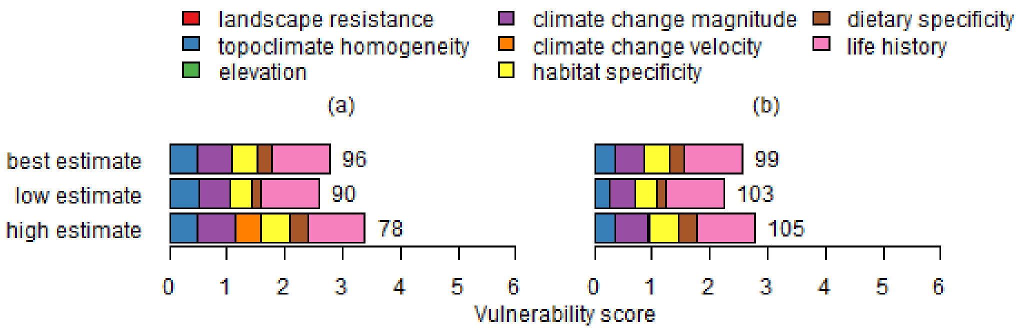

Figure AVIII. 1.16.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

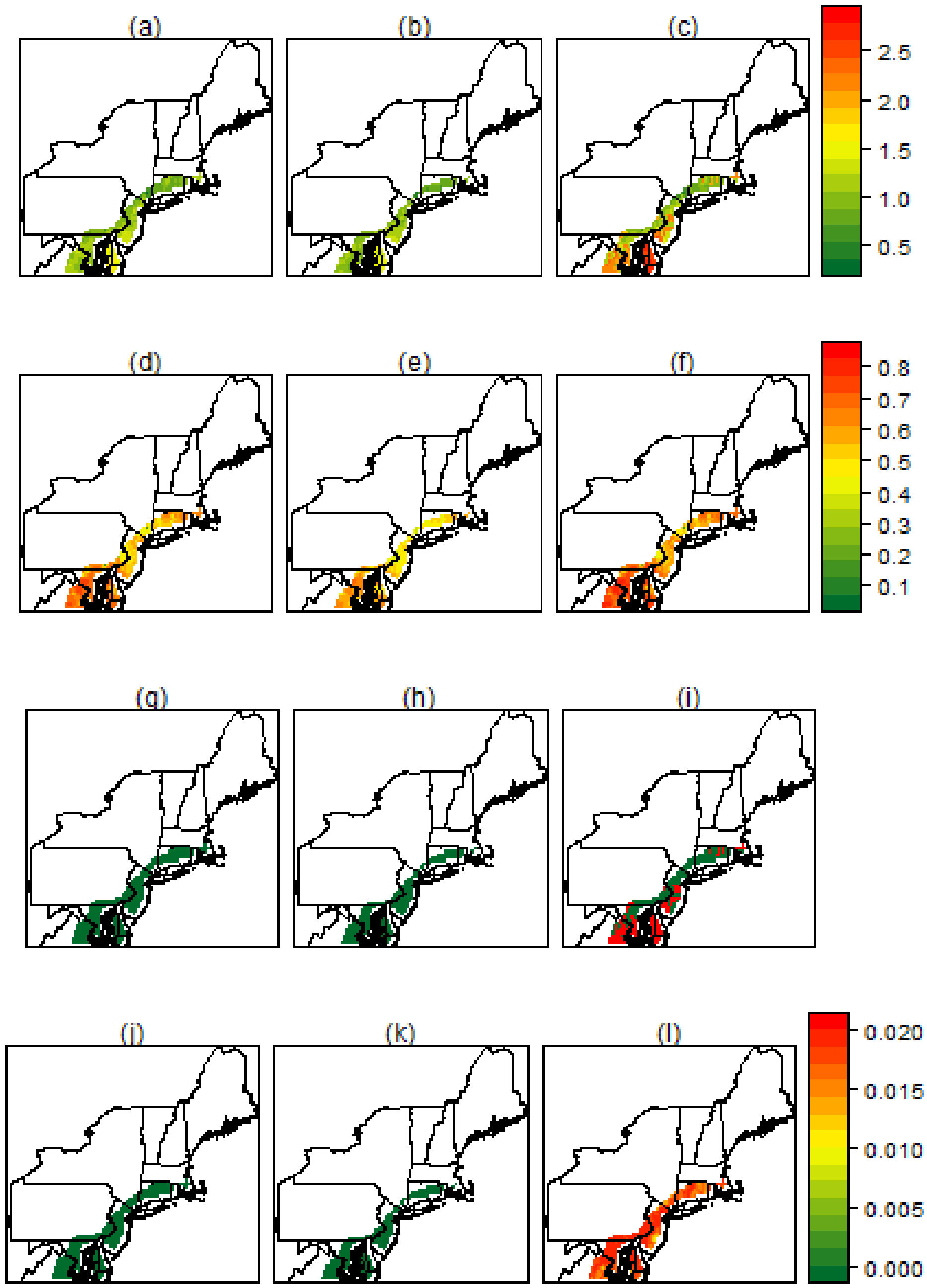

Figure AVIII. 1.16.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

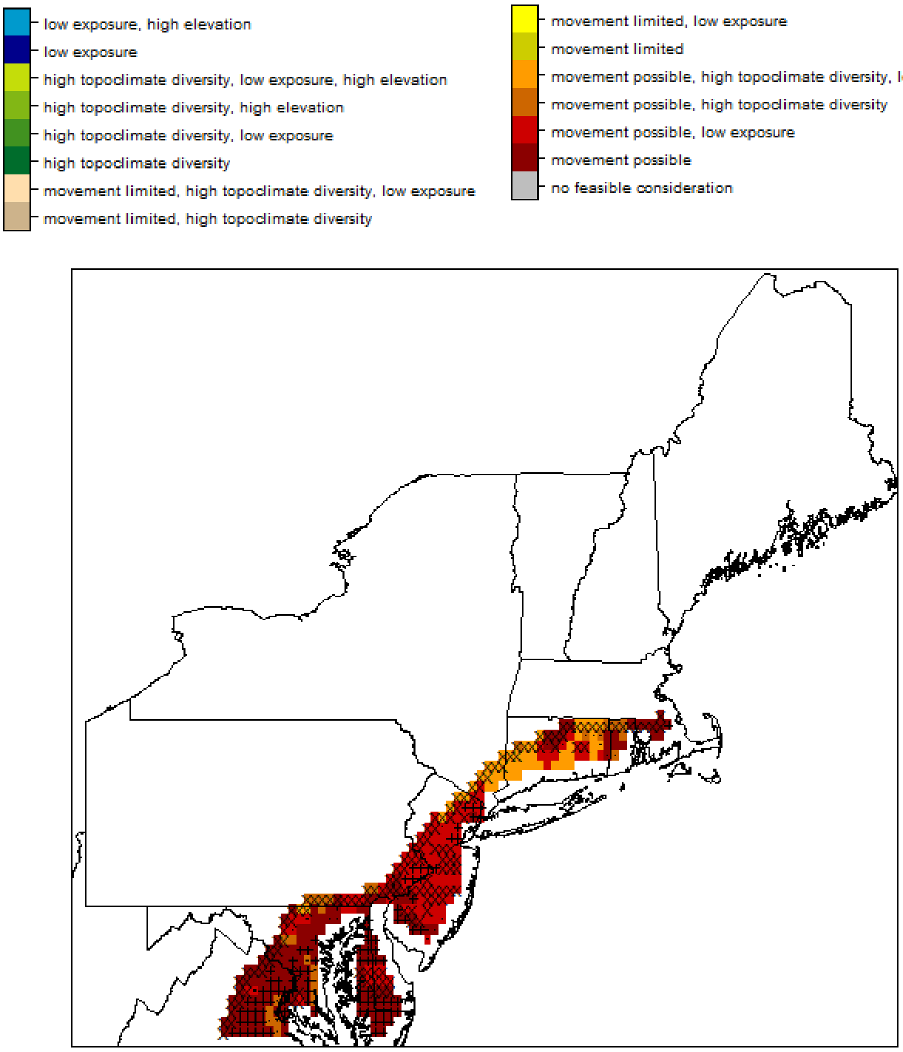

Figure AVIII. 1.16.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

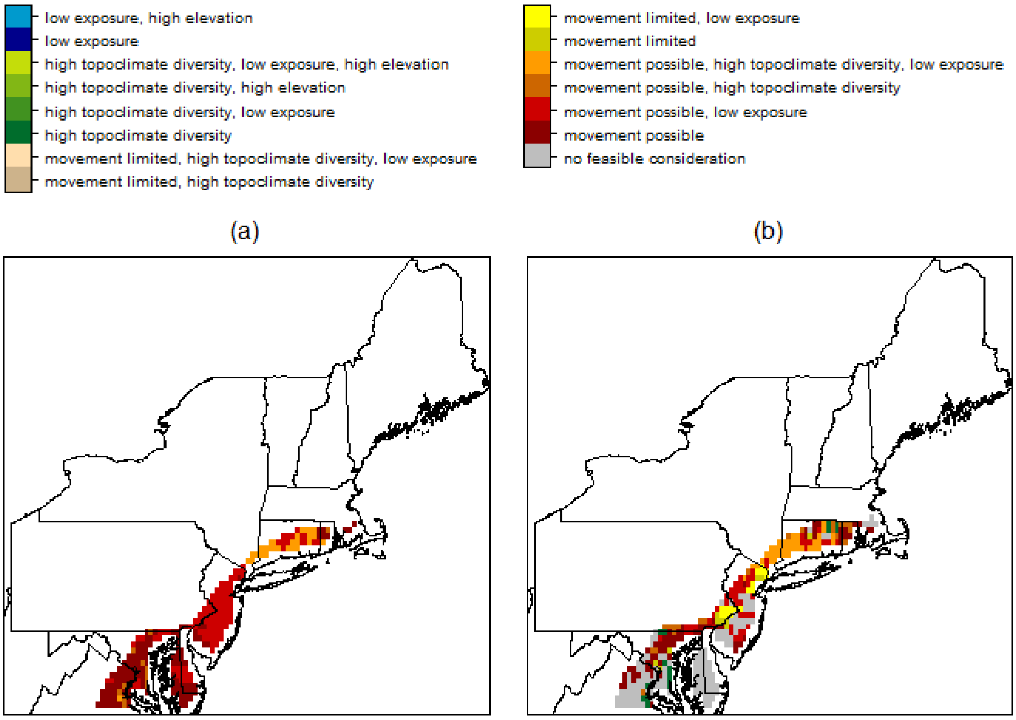

Figure AVIII. 1.16.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.17 Cooper's hawk (*Accipiter cooperii*)

Table AVIII. 1.17.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.17	0.50	0.55	0.00	1.00	29.00
low	0.13	0.40	0.55	0.00	1.00	7.33
high	0.38	0.50	0.55	0.02	1.00	128.33

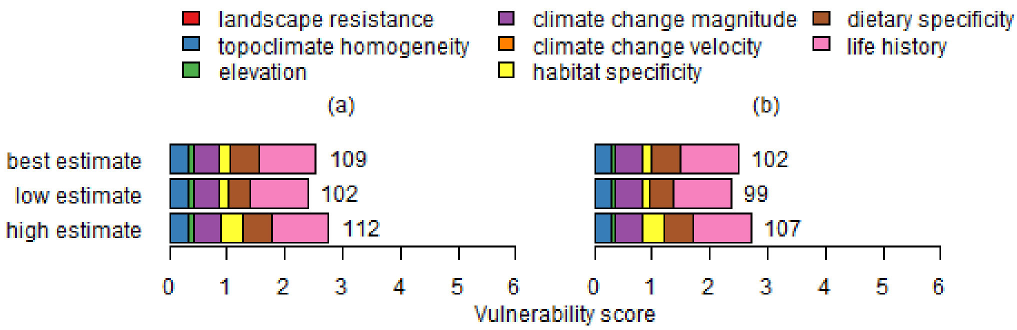

Figure AVIII. 1.17.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

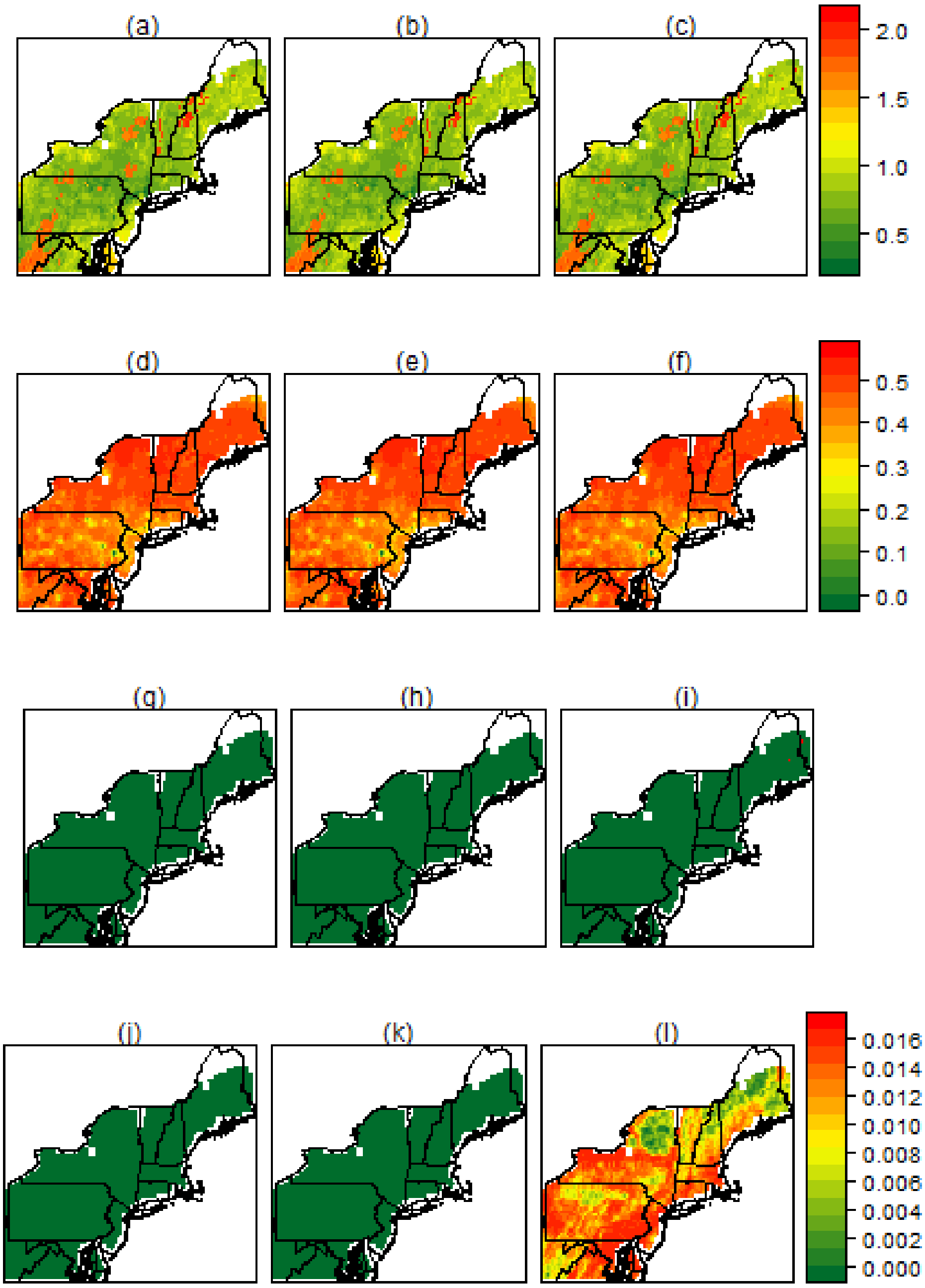

Figure AVIII. 1.17.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

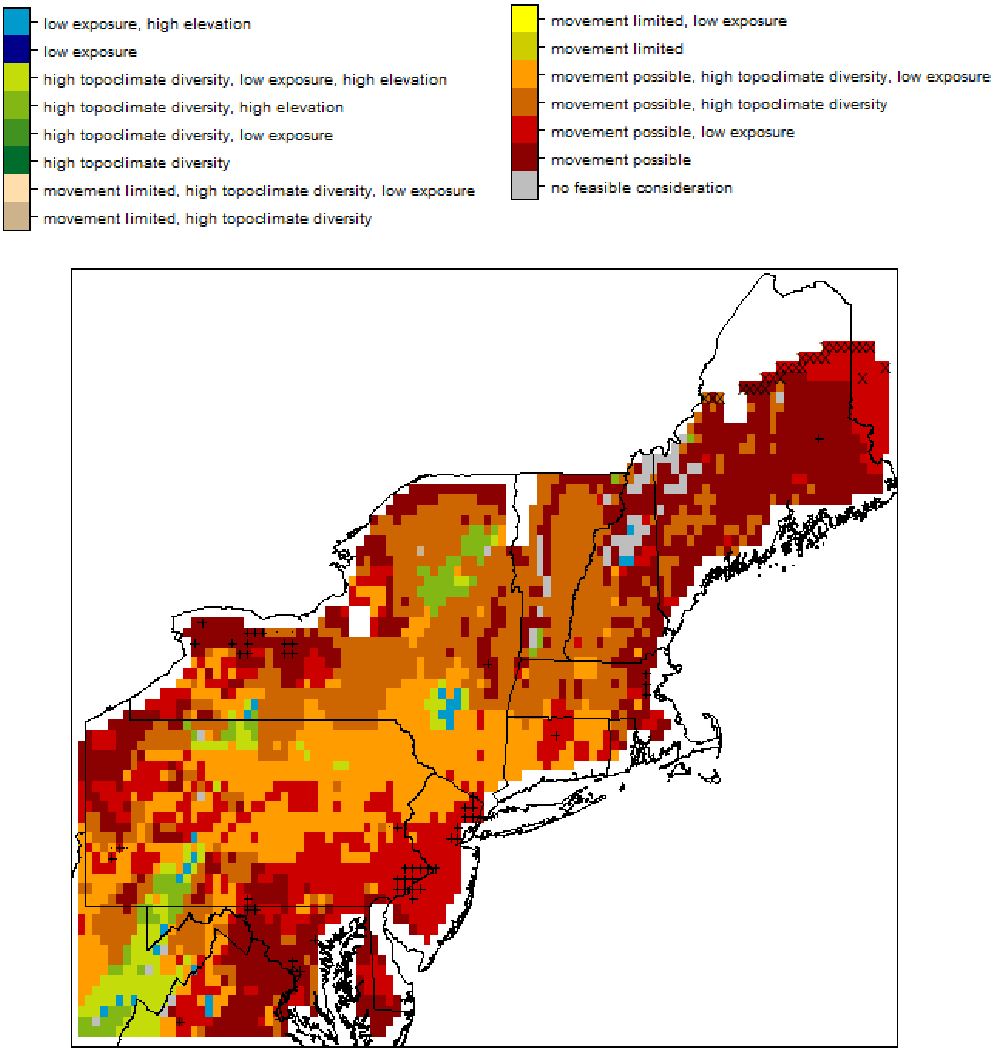

Figure AVIII. 1.17.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

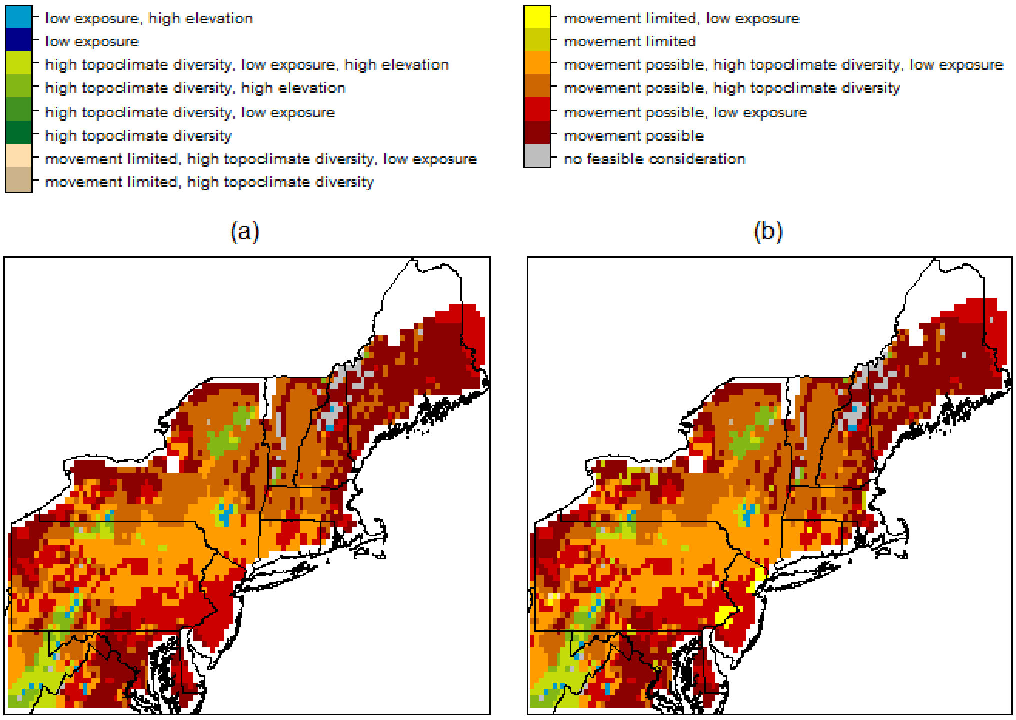

Figure AVIII. 1.17.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.18 Northern goshawk (*Accipiter gentilis*)

Table AVIII. 1.18.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.77	0.33	1.00	40.00
low	0.48	0.43	0.77	0.30	1.00	9.33
high	0.54	0.50	0.80	0.35	1.00	225.00

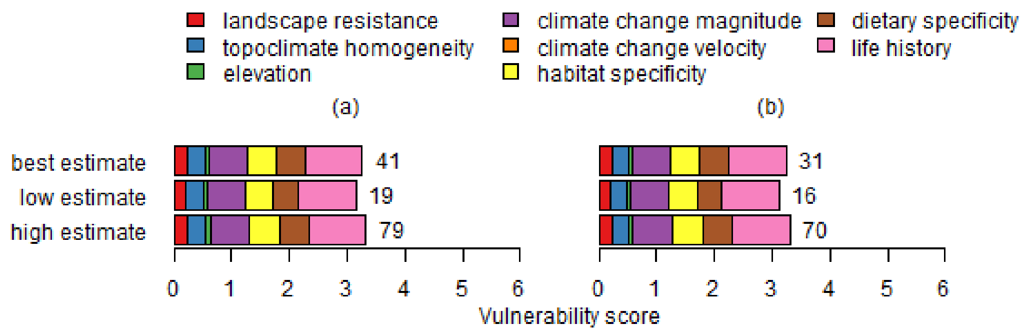

Figure AVIII. 1.18.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

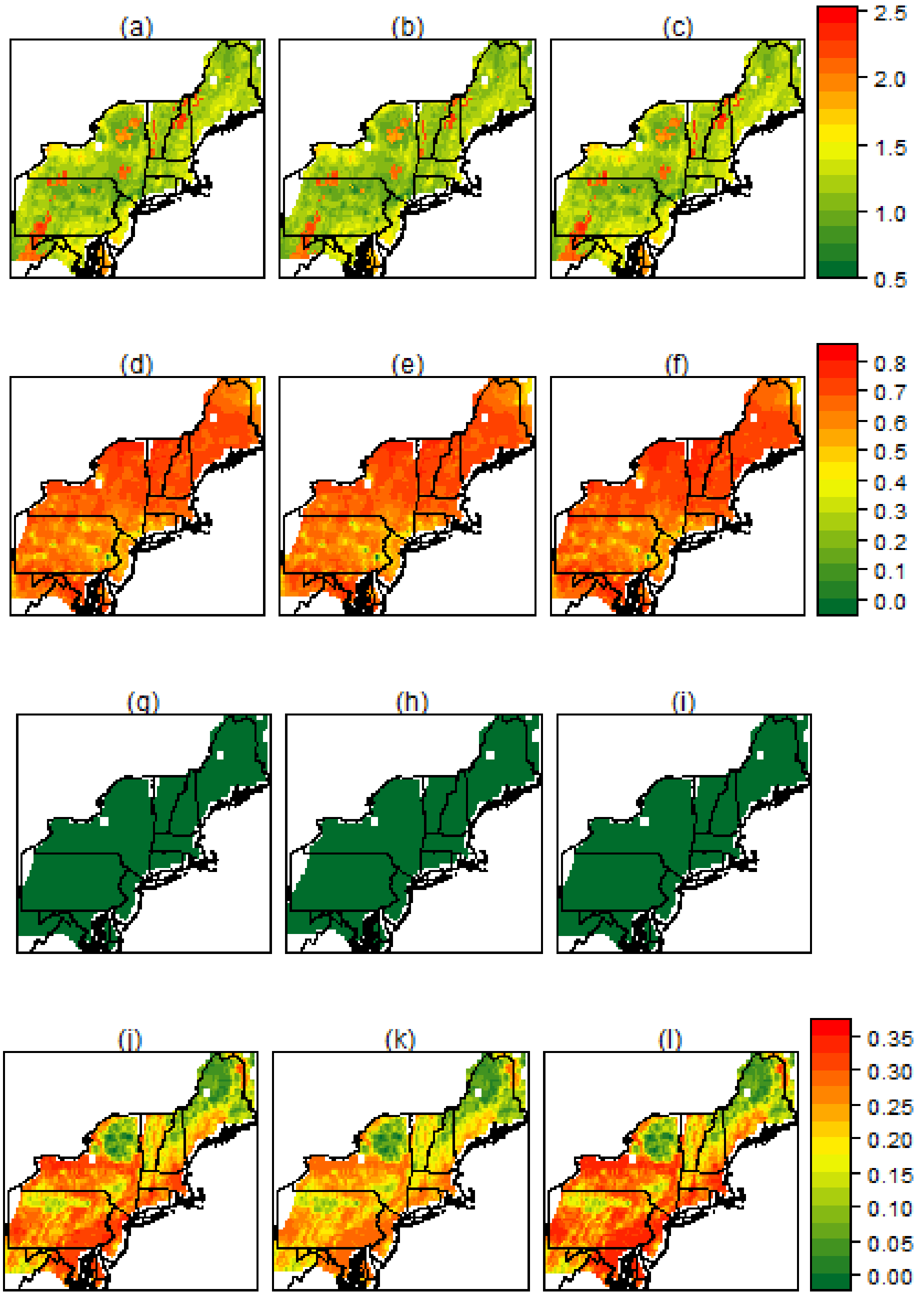

Figure AVIII. 1.18.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

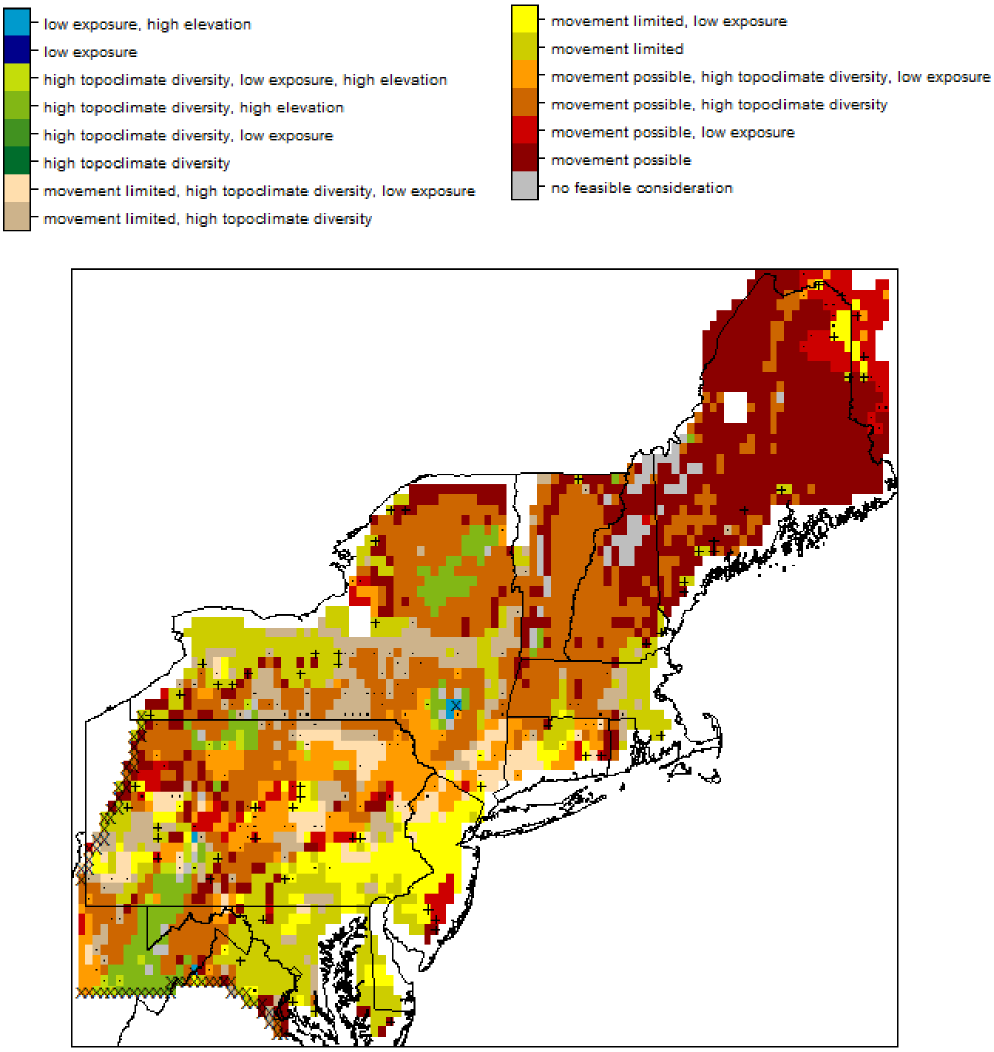

Figure AVIII. 1.18.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

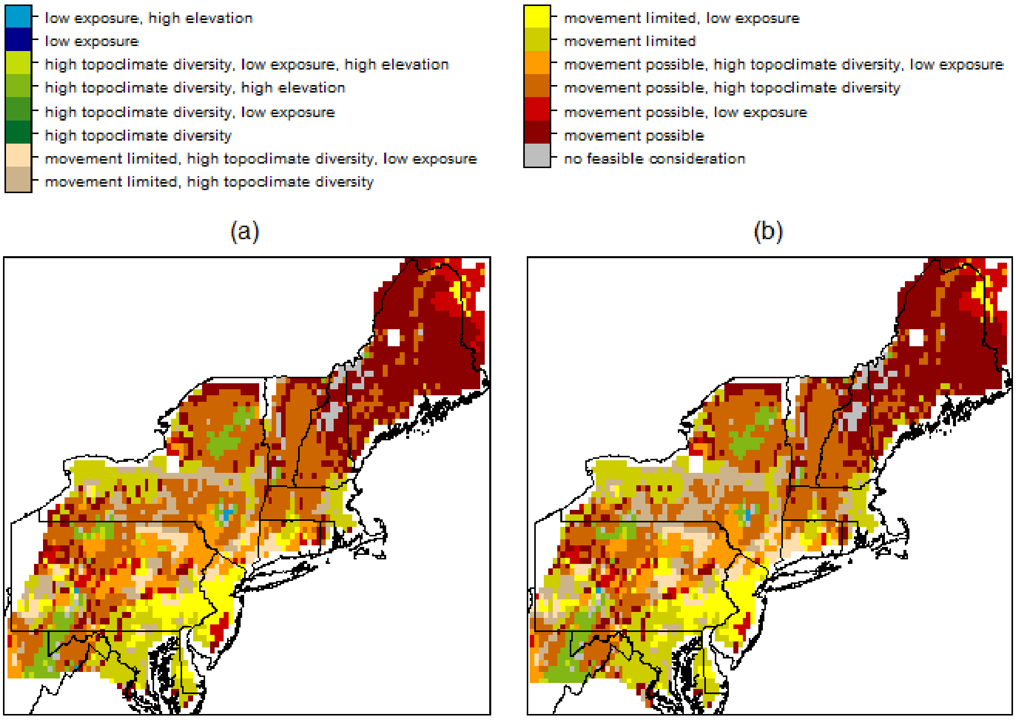

Figure AVIII. 1.18.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.19 Sharp-shinned hawk (*Accipiter striatus*)

Table AVIII. 1.19.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.42	0.50	0.66	0.25	1.00	25.00
low	0.30	0.45	0.55	0.17	1.00	5.33
high	0.50	0.50	0.77	0.35	1.00	143.33

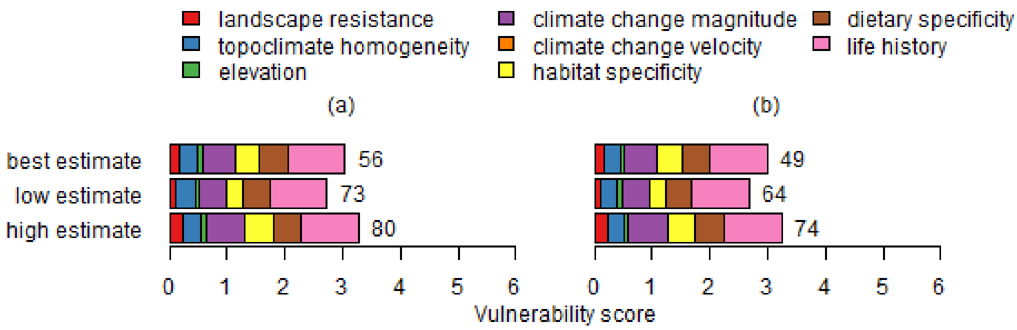

Figure AVIII. 1.19.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

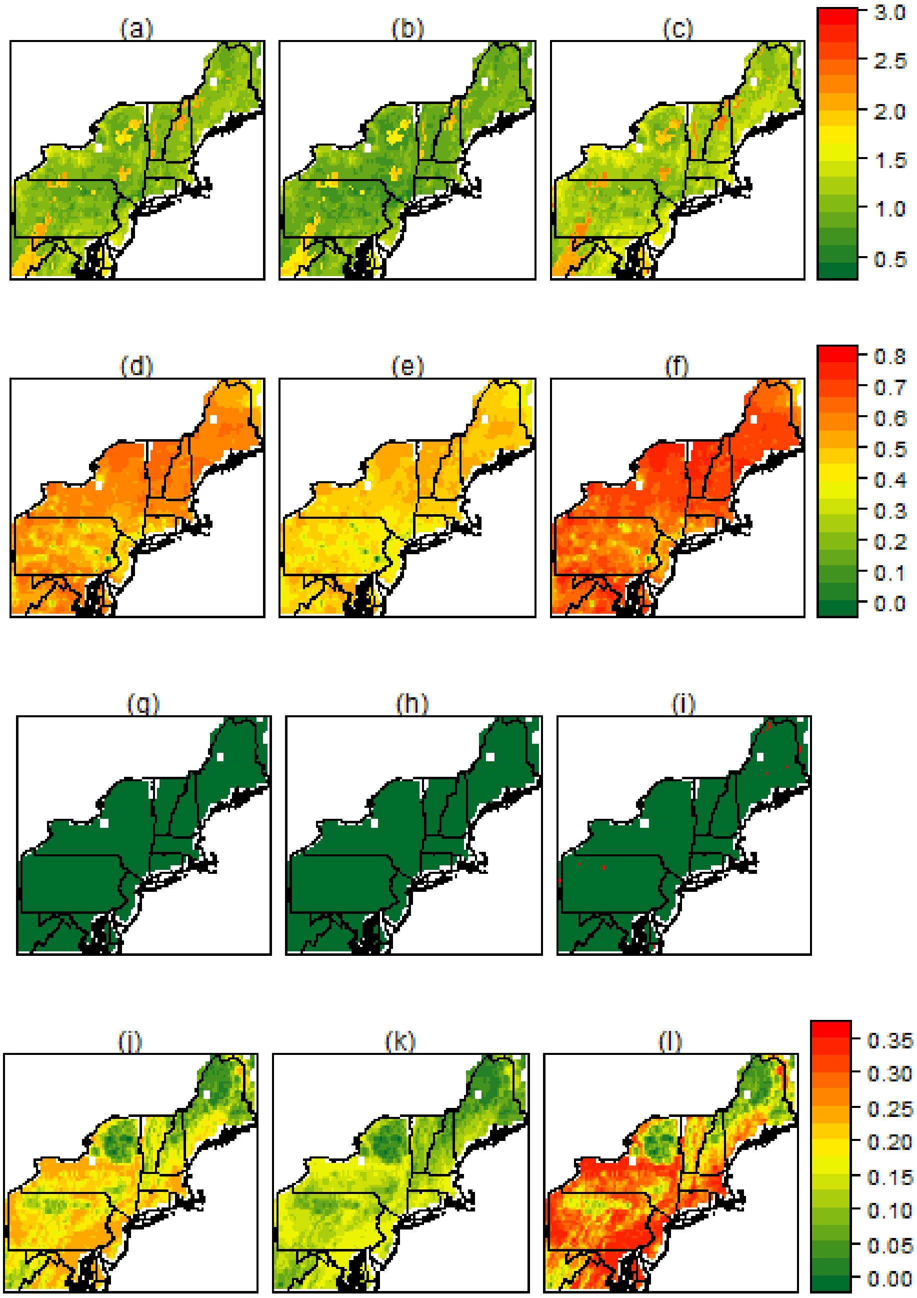

Figure AVIII. 1.19.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

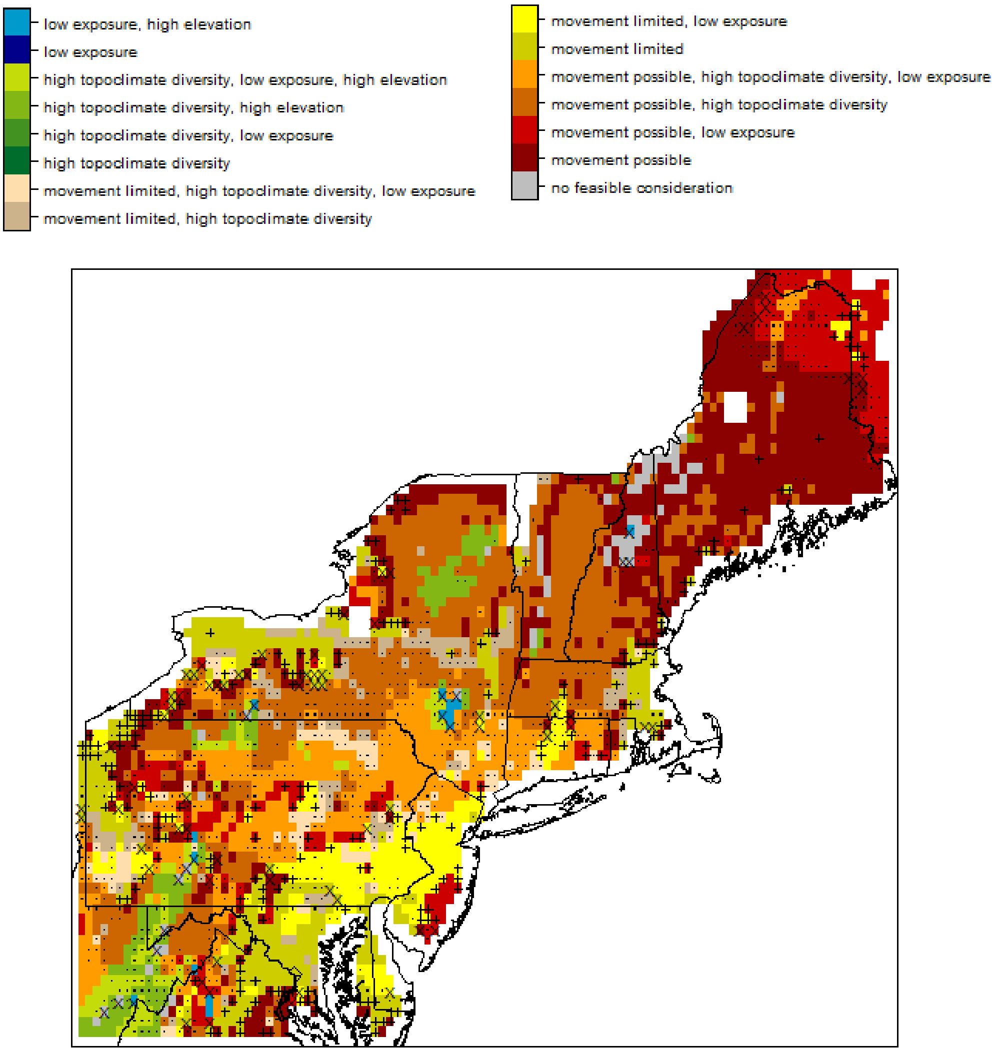

Figure AVIII. 1.19.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

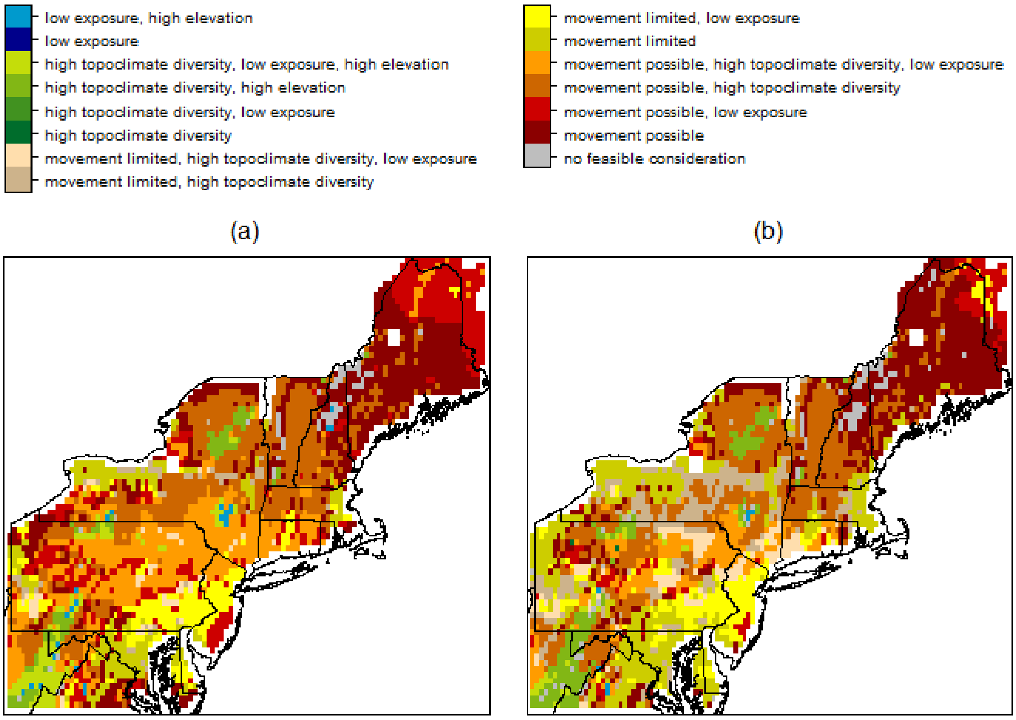

Figure AVIII. 1.19.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.20 Golden eagle (*Aquila chrysaetos*)

Table AVIII. 1.20.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.75	0.50	0.66	0.33	1.00	80.00
low	0.61	0.48	0.66	0.30	1.00	12.33
high	0.91	0.53	0.66	0.35	1.00	255.00

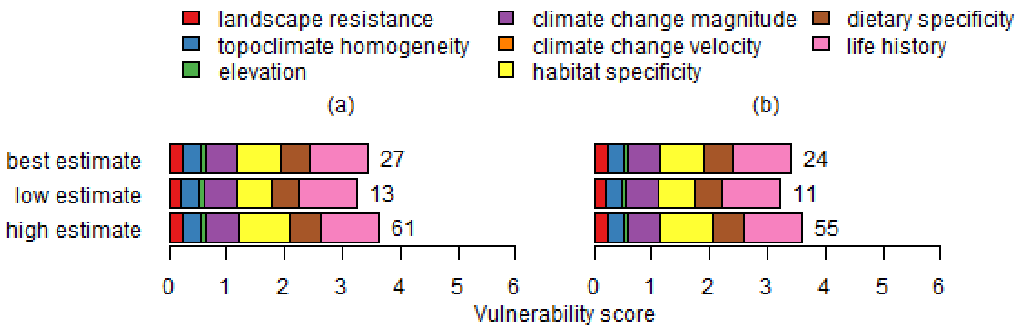

Figure AVIII. 1.20.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

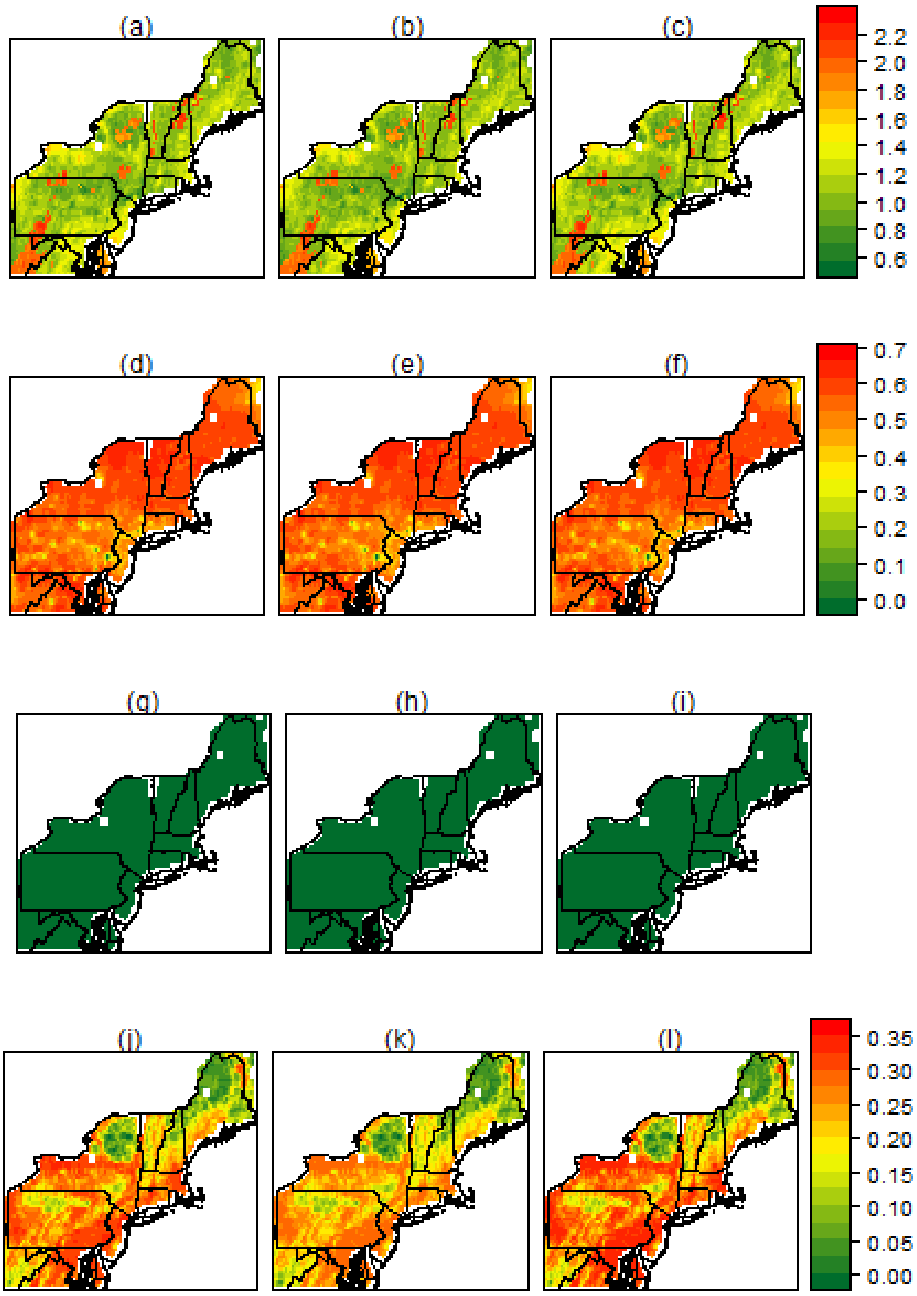

Figure AVIII. 1.20.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

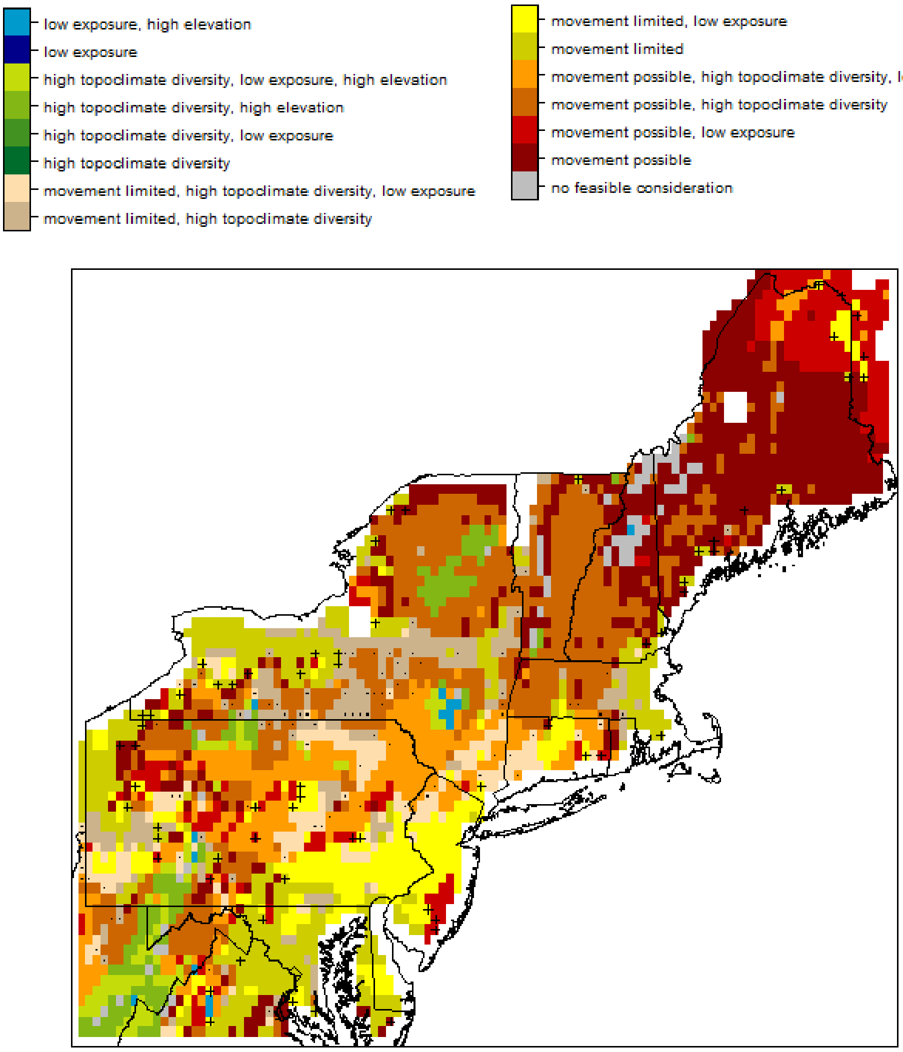

Figure AVIII. 1.20.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

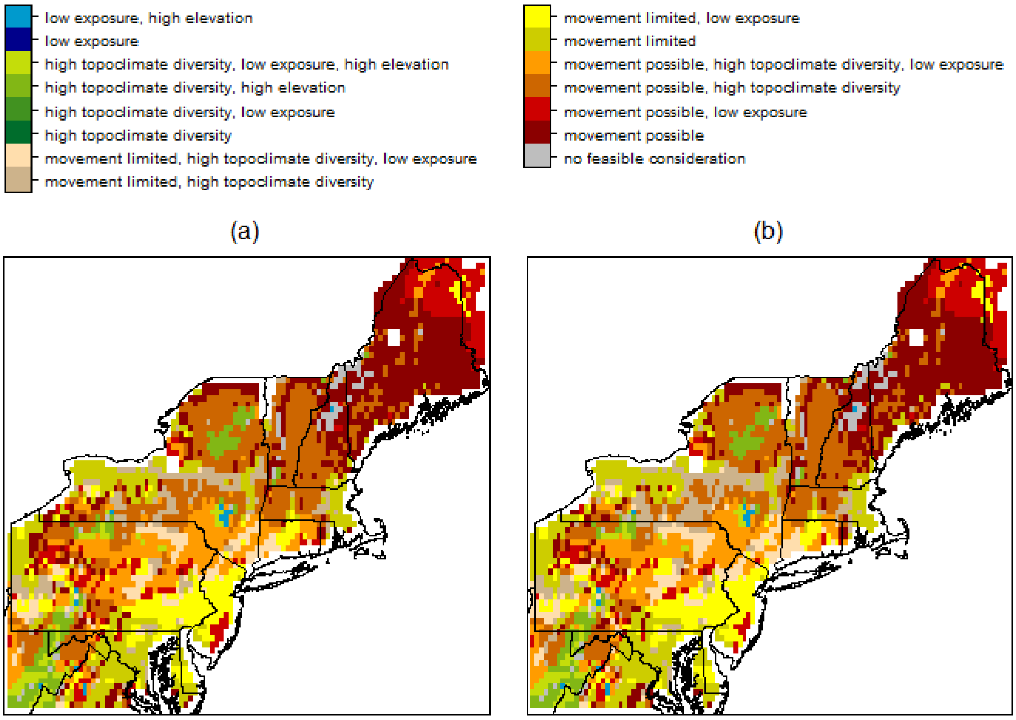

Figure AVIII. 1.20.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.21 Red-shouldered hawk (*Buteo lineatus*)

Table AVIII. 1.21.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.33	0.55	0.33	1.00	28.33
low	0.46	0.30	0.55	0.28	1.00	5.33
high	0.55	0.33	0.80	0.35	1.00	173.33

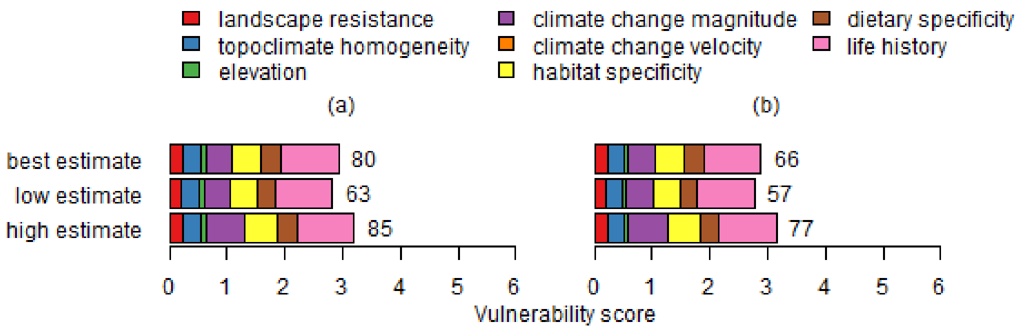

Figure AVIII. 1.21.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

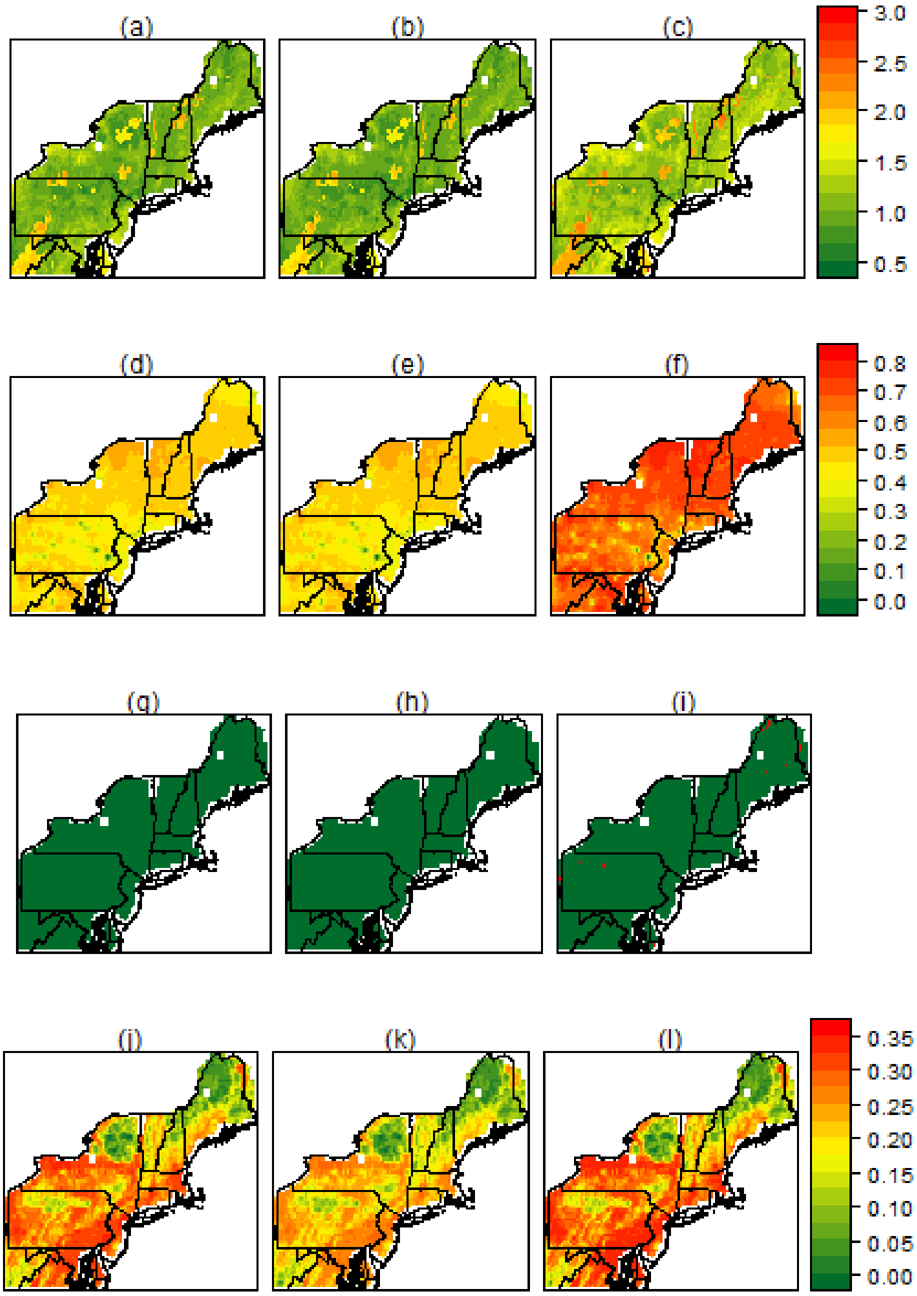

Figure AVIII. 1.21.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

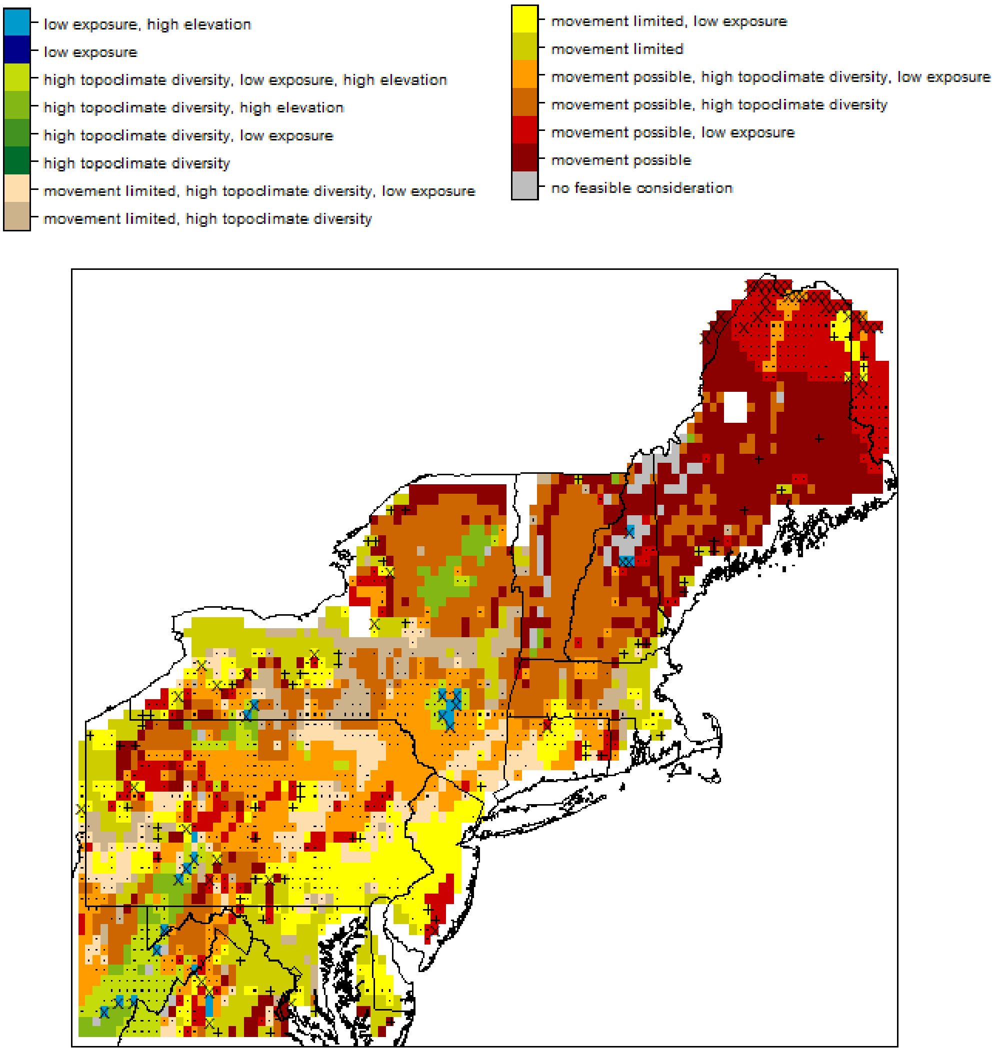

Figure AVIII. 1.21.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

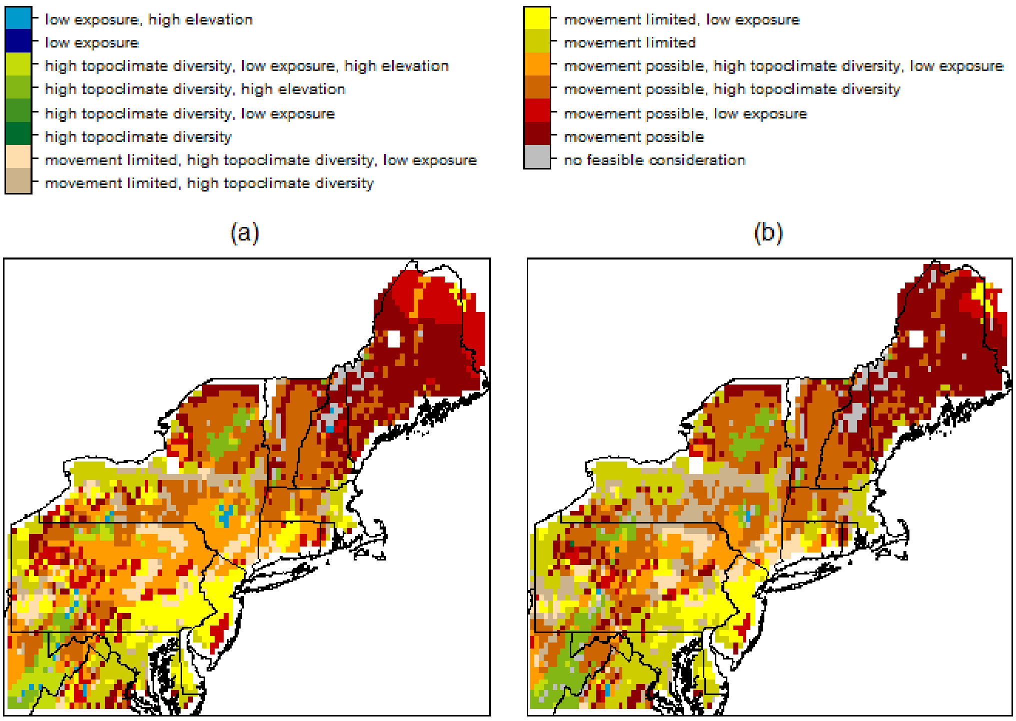

Figure AVIII. 1.21.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.22 Northern harrier (*Circus cyaneus*)

Table AVIII. 1.22.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.33	0.77	0.17	1.00	30.00
low	0.44	0.30	0.73	0.17	1.00	7.50
high	0.55	0.33	0.77	0.18	1.00	225.00

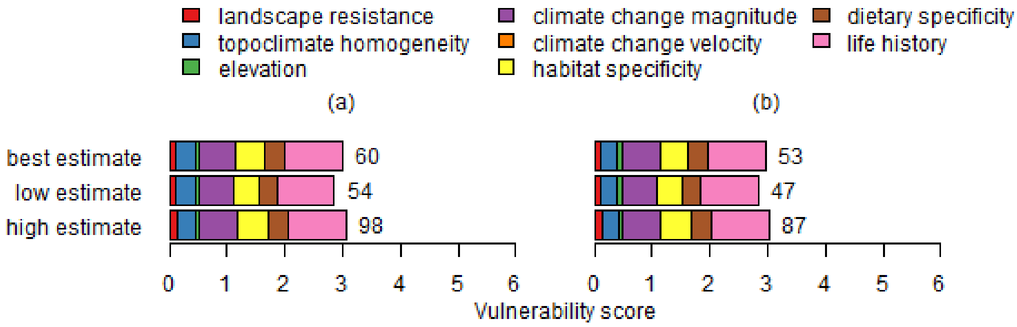

Figure AVIII. 1.22.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

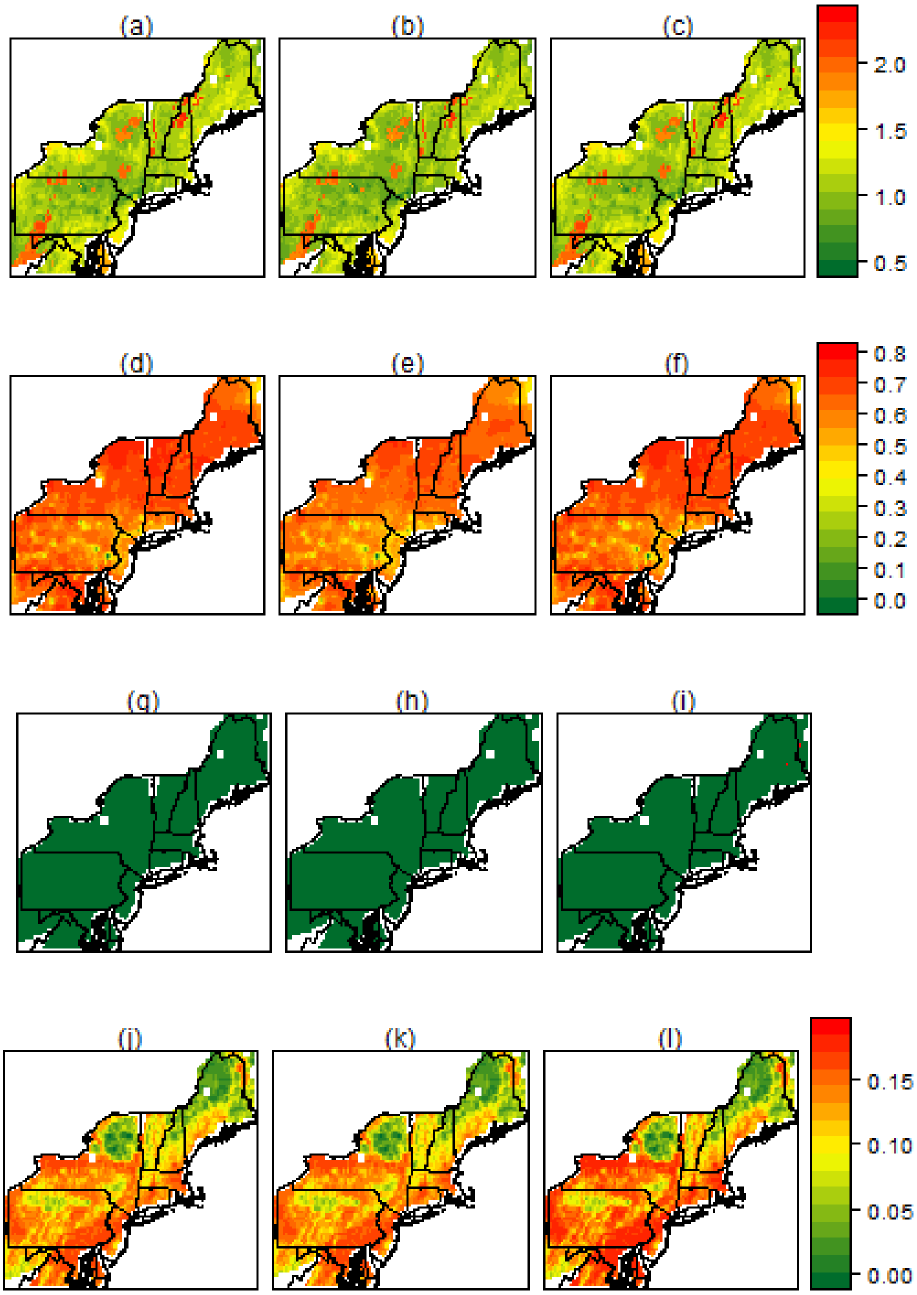

Figure AVIII. 1.22.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

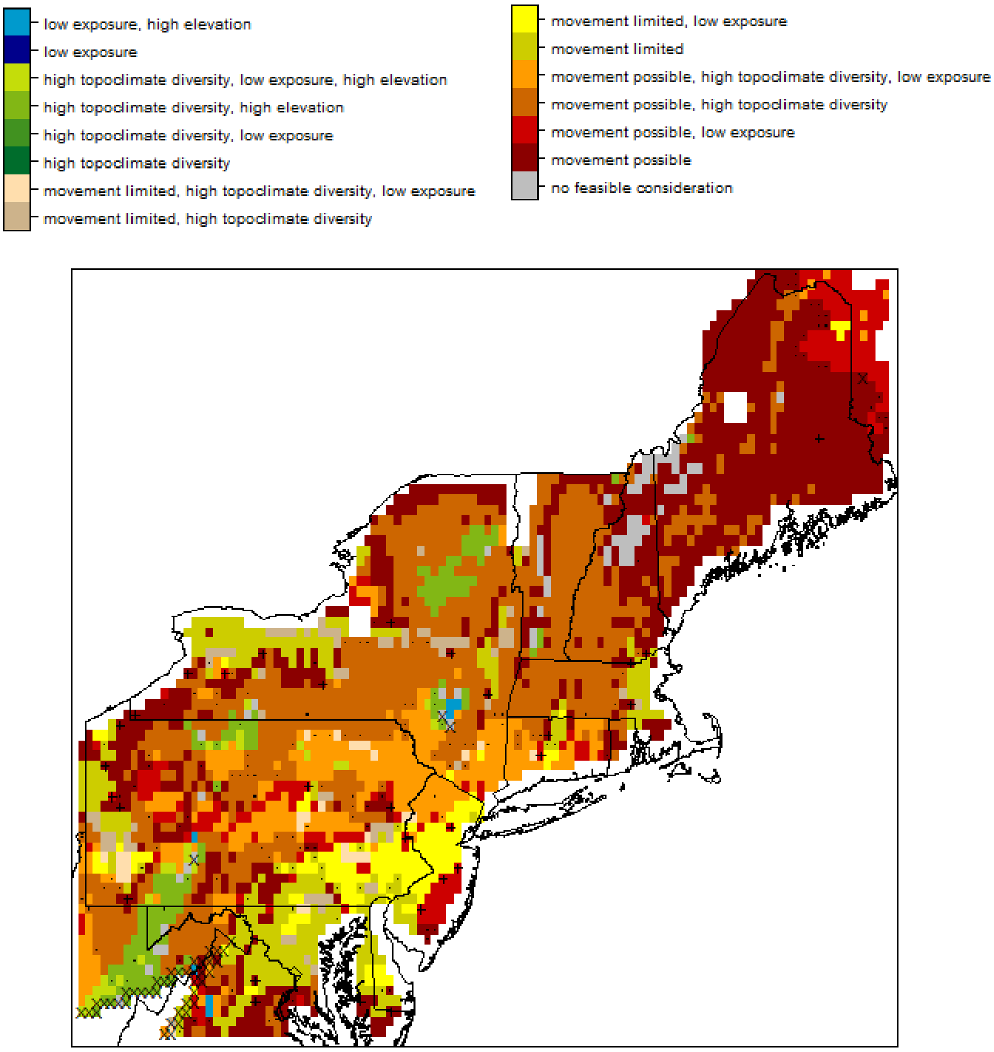

Figure AVIII. 1.22.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

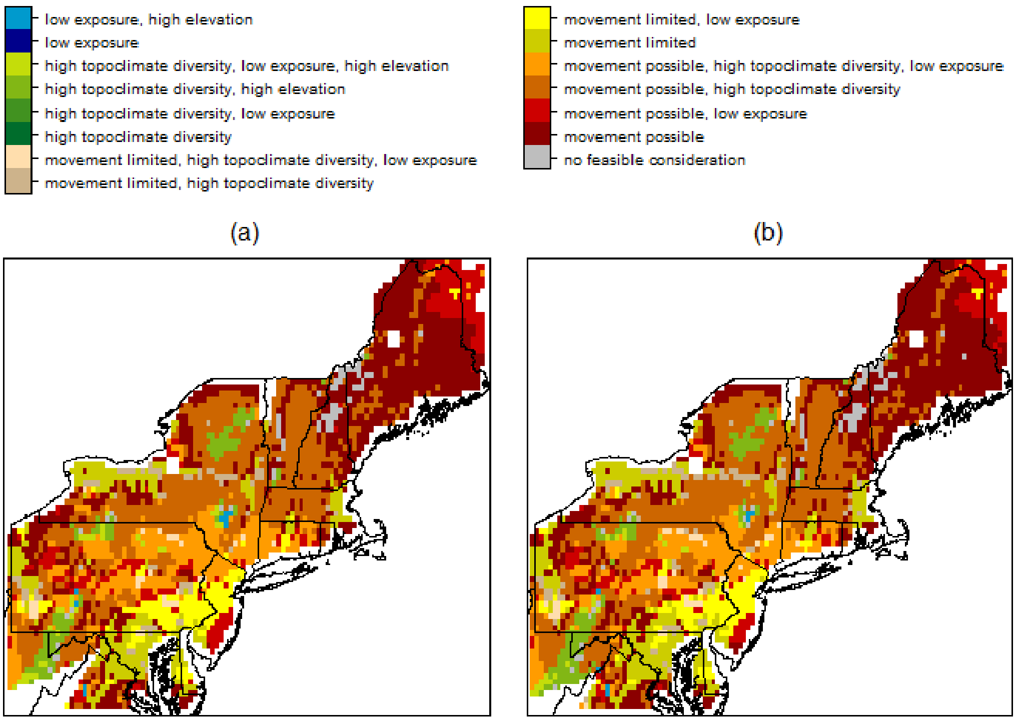

Figure AVIII. 1.22.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.23 Bald eagle (*Haliaeetus leucocephalus*)

Table AVIII. 1.23.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.45	0.50	0.66	0.00	1.00	85.00
low	0.32	0.35	0.66	0.00	1.00	10.00
high	0.58	0.50	0.66	0.02	1.00	300.00

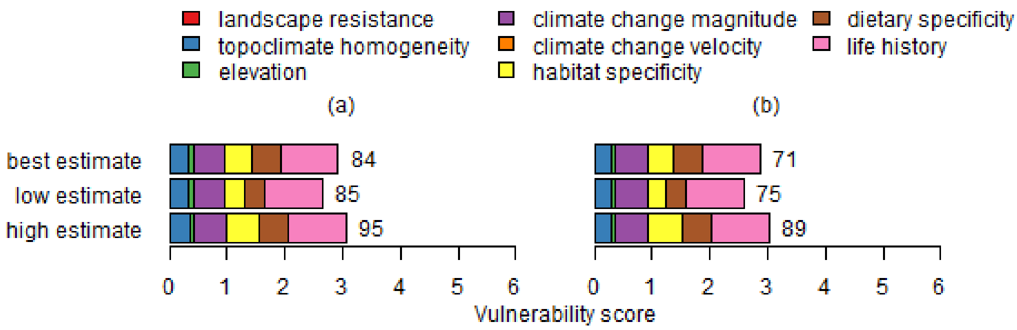

Figure AVIII. 1.23.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

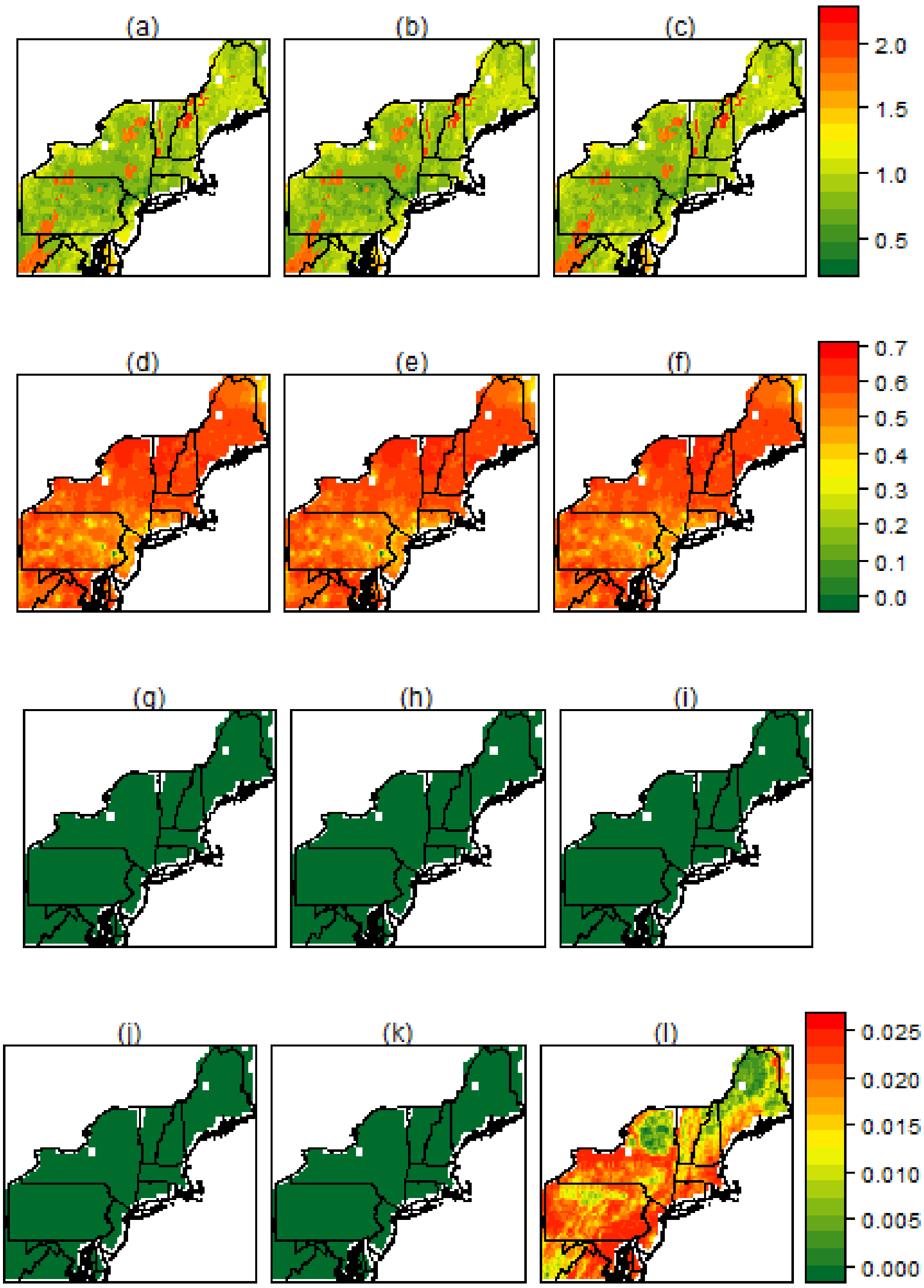

Figure AVIII. 1.23.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

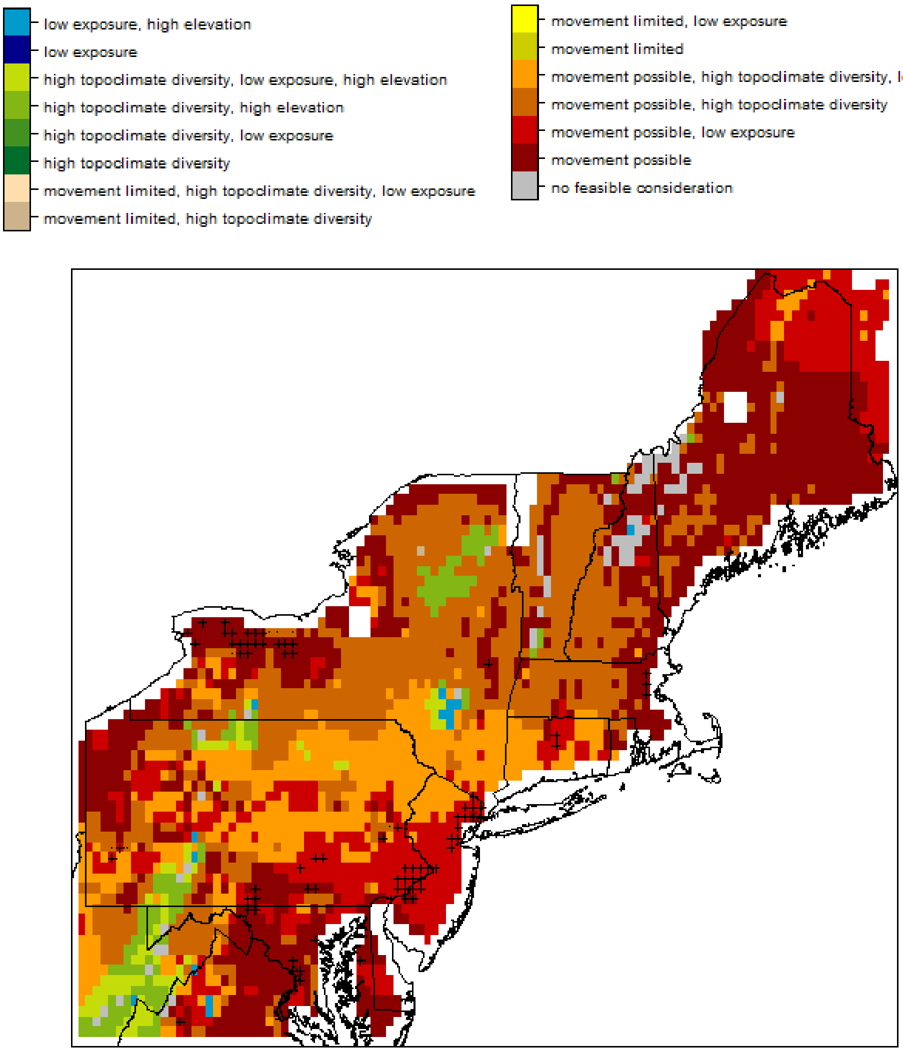

Figure AVIII. 1.23.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

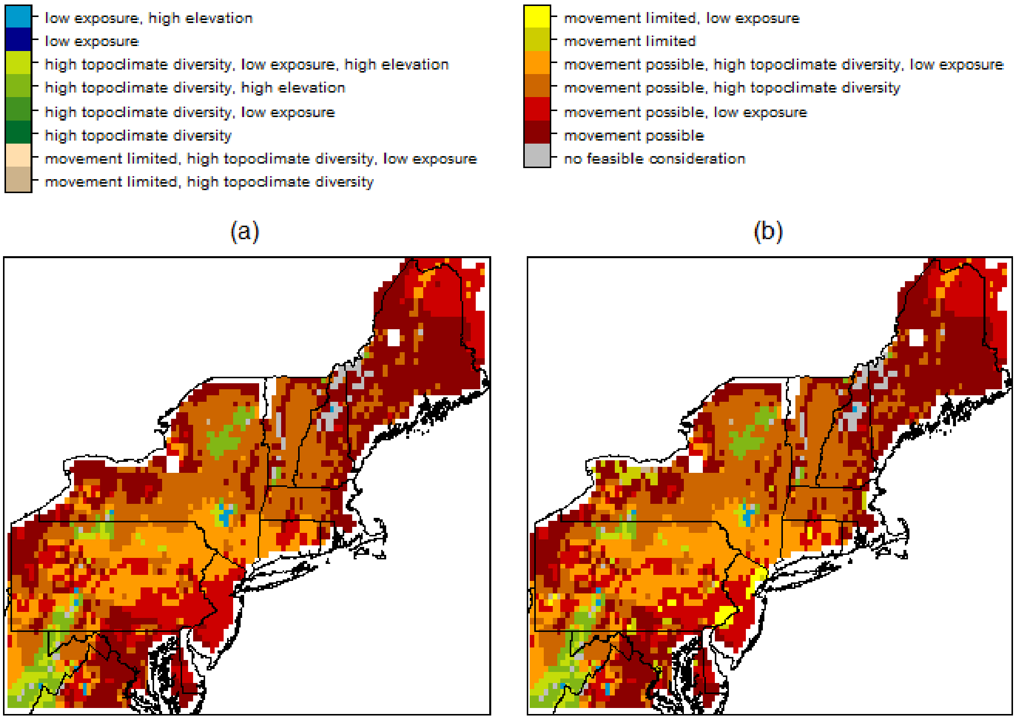

Figure AVIII. 1.23.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.24 Osprey (*Pandion haliaetus*)

Table AVIII. 1.24.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	50.00
low	0.37	0.50	0.66	0.00	1.00	10.00
high	0.54	0.50	0.66	0.02	1.00	225.00

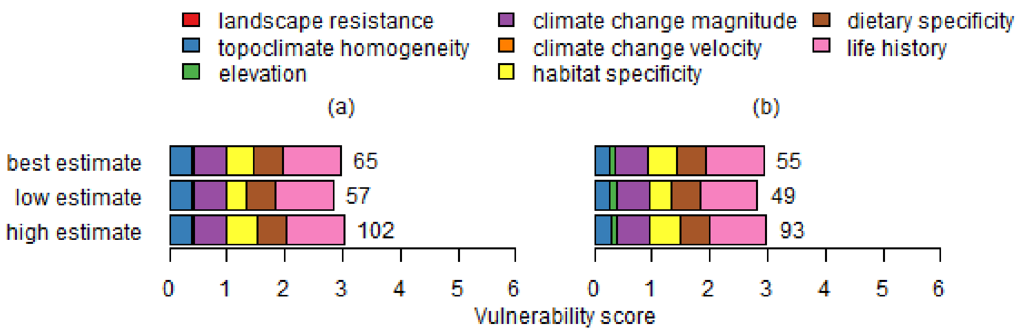

Figure AVIII. 1.24.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

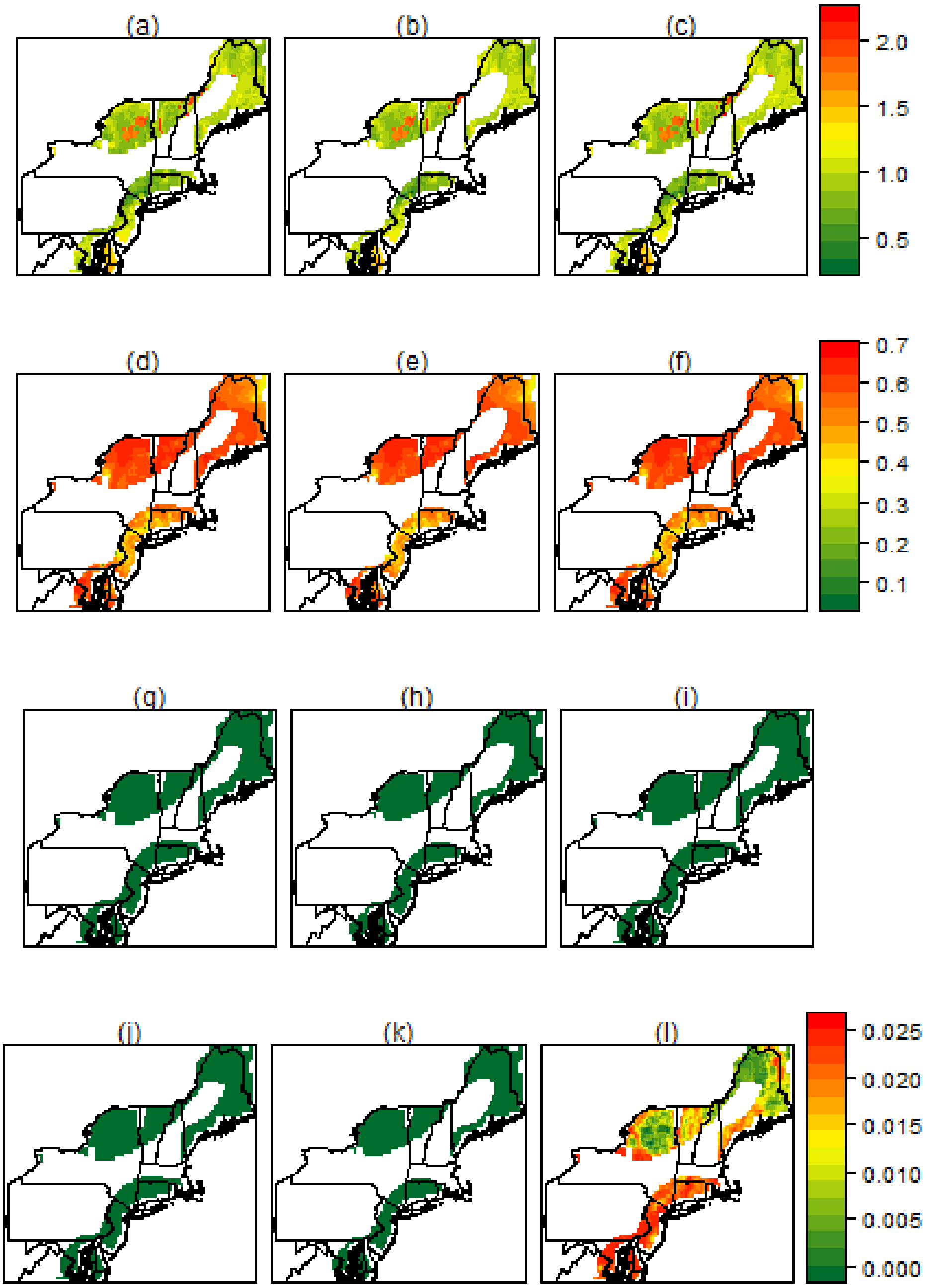

Figure AVIII. 1.24.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

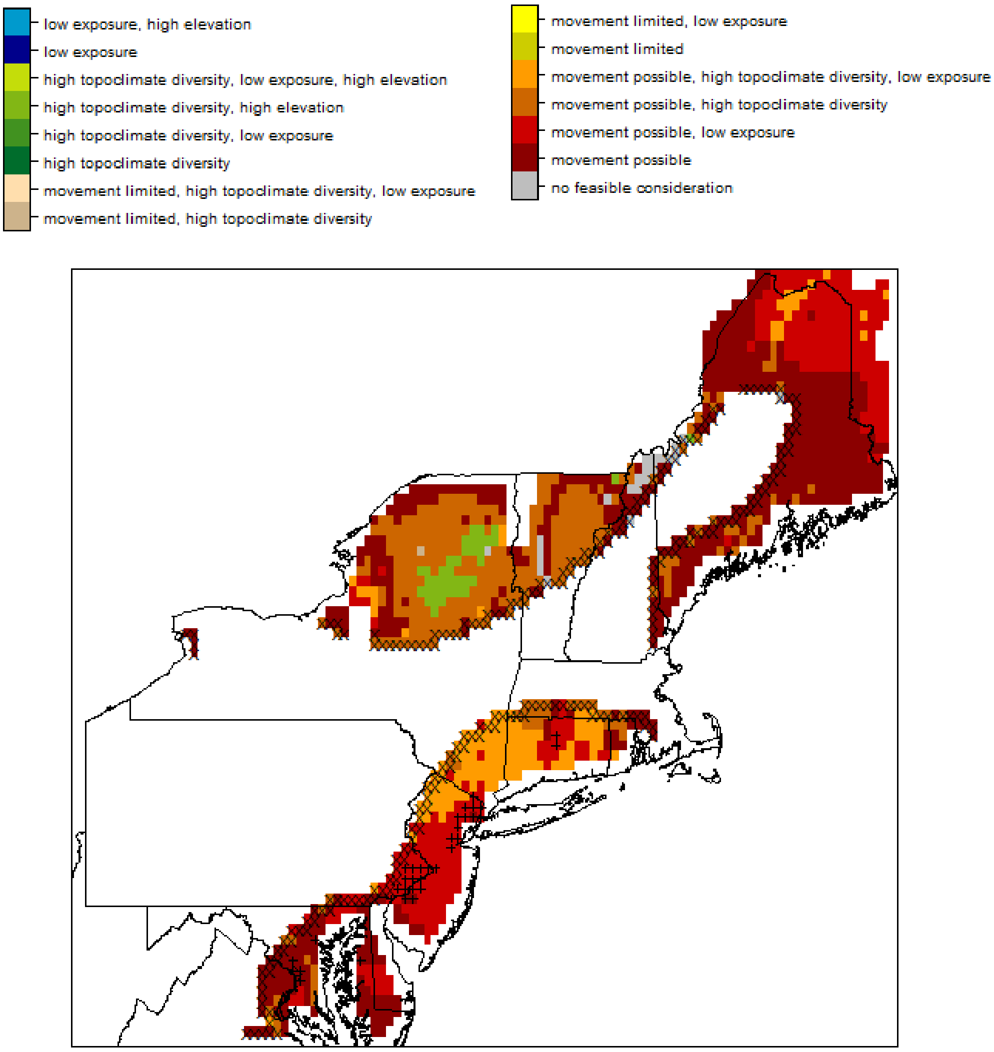

Figure AVIII. 1.24.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

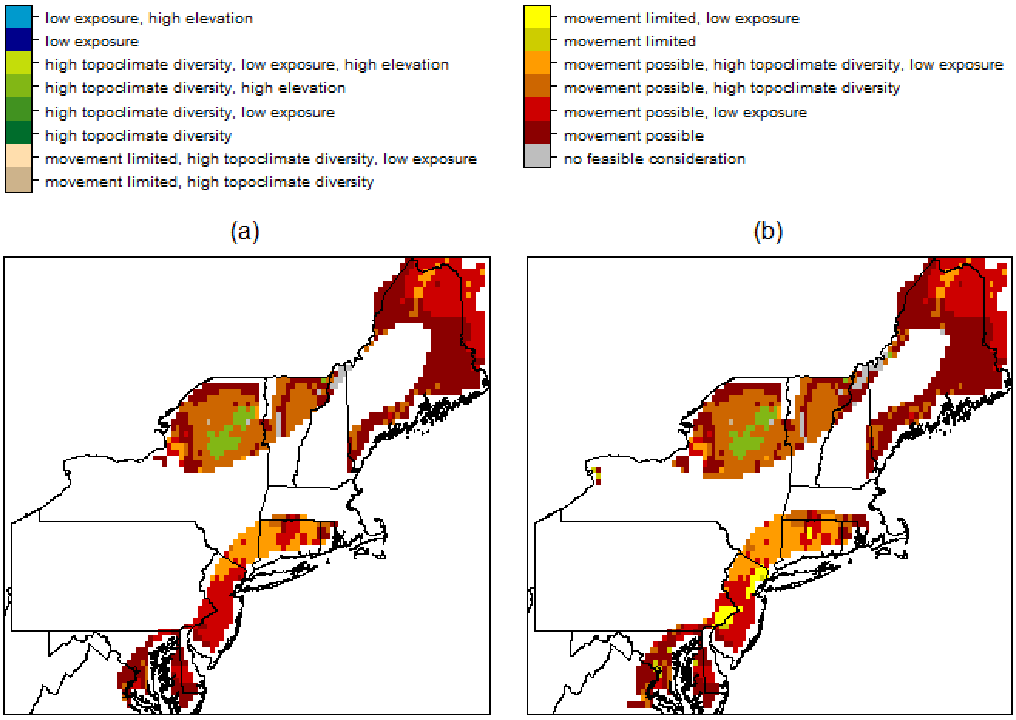

Figure AVIII. 1.24.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.25 Peregrine falcon (*Falco peregrinus*)

Table AVIII. 1.25.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.75	0.50	0.66	0.00	1.00	125.00
low	0.75	0.47	0.66	0.00	1.00	50.00
high	0.80	0.50	0.66	0.02	1.00	500.00

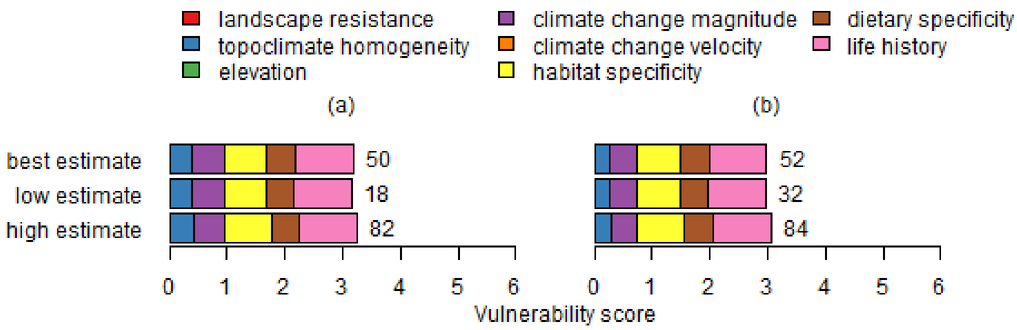

Figure AVIII. 1.25.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

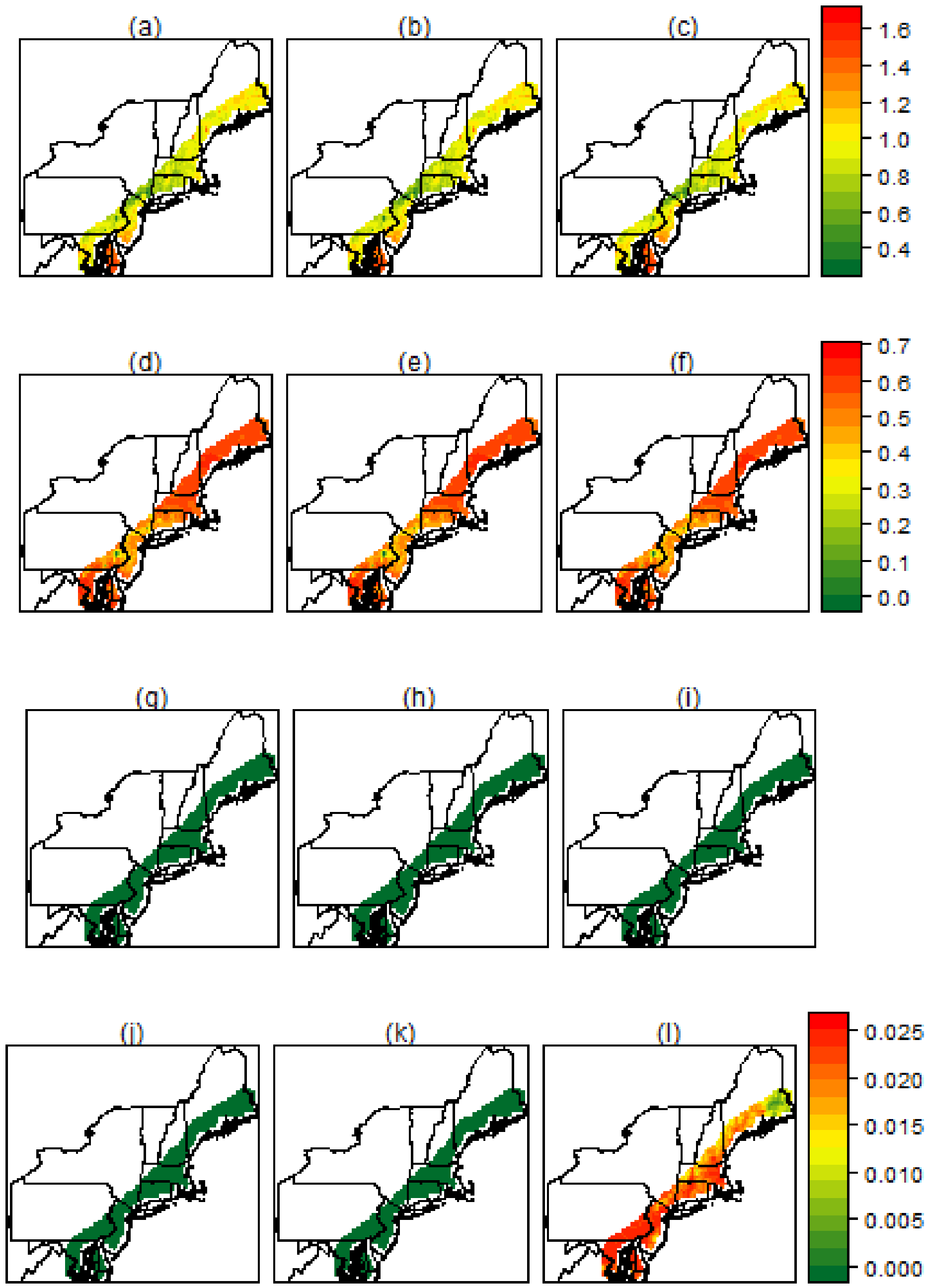

Figure AVIII. 1.25.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

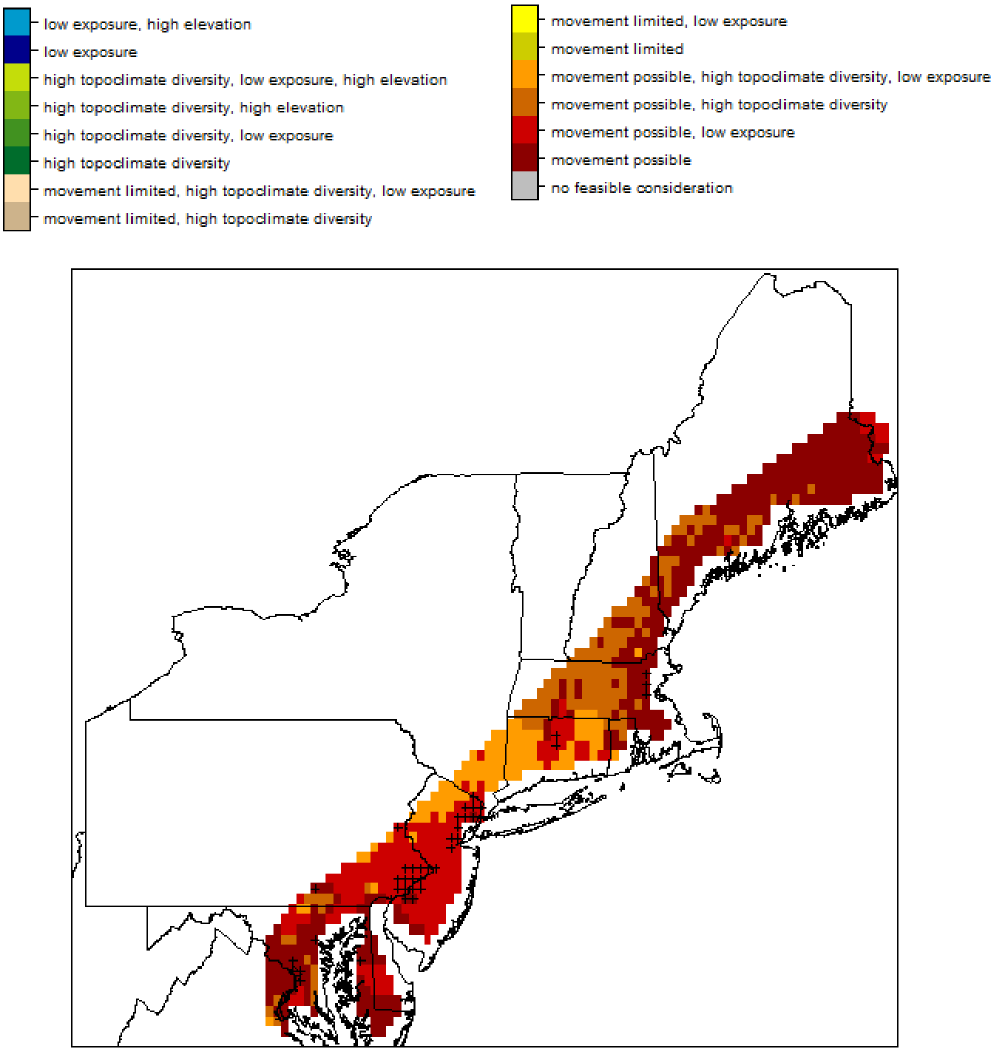

Figure AVIII. 1.25.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

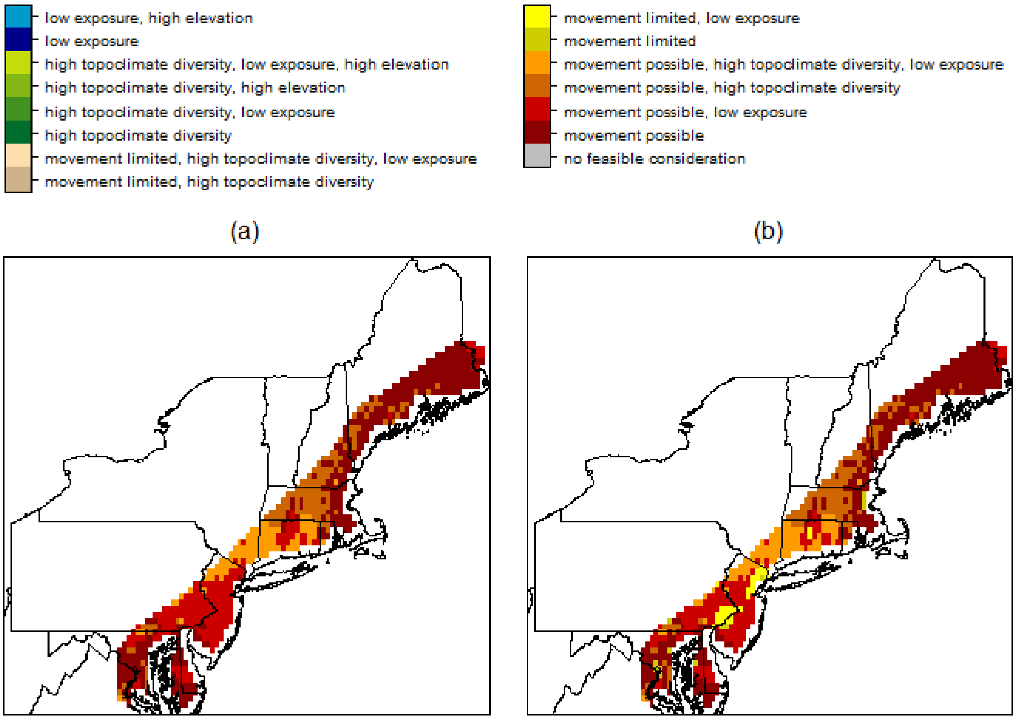

Figure AVIII. 1.25.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.26 Northern bobwhite (*Colinus virginianus*)

Table AVIII. 1.26.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.12	0.66	0.62	1.00	0.81
low	0.46	0.10	0.65	0.52	1.00	0.15
high	0.50	0.16	0.70	0.65	1.00	5.25

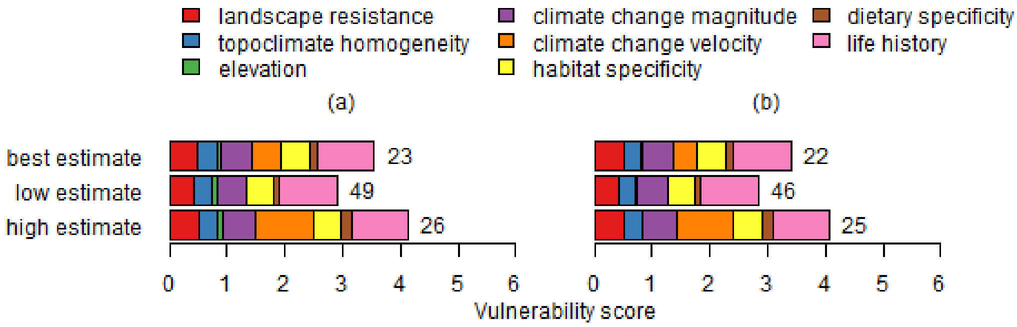

Figure AVIII. 1.26.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

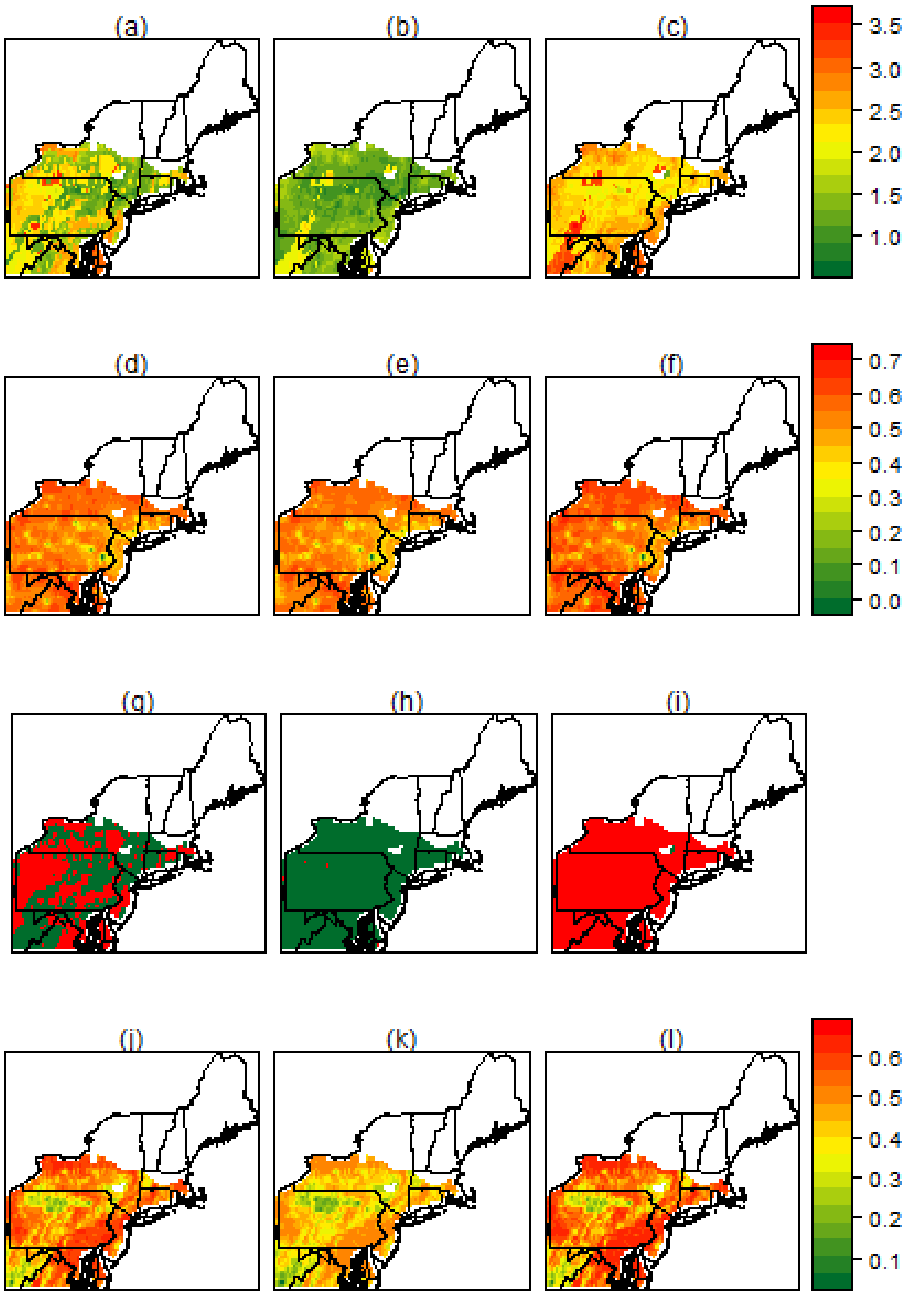

Figure AVIII. 1.26.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

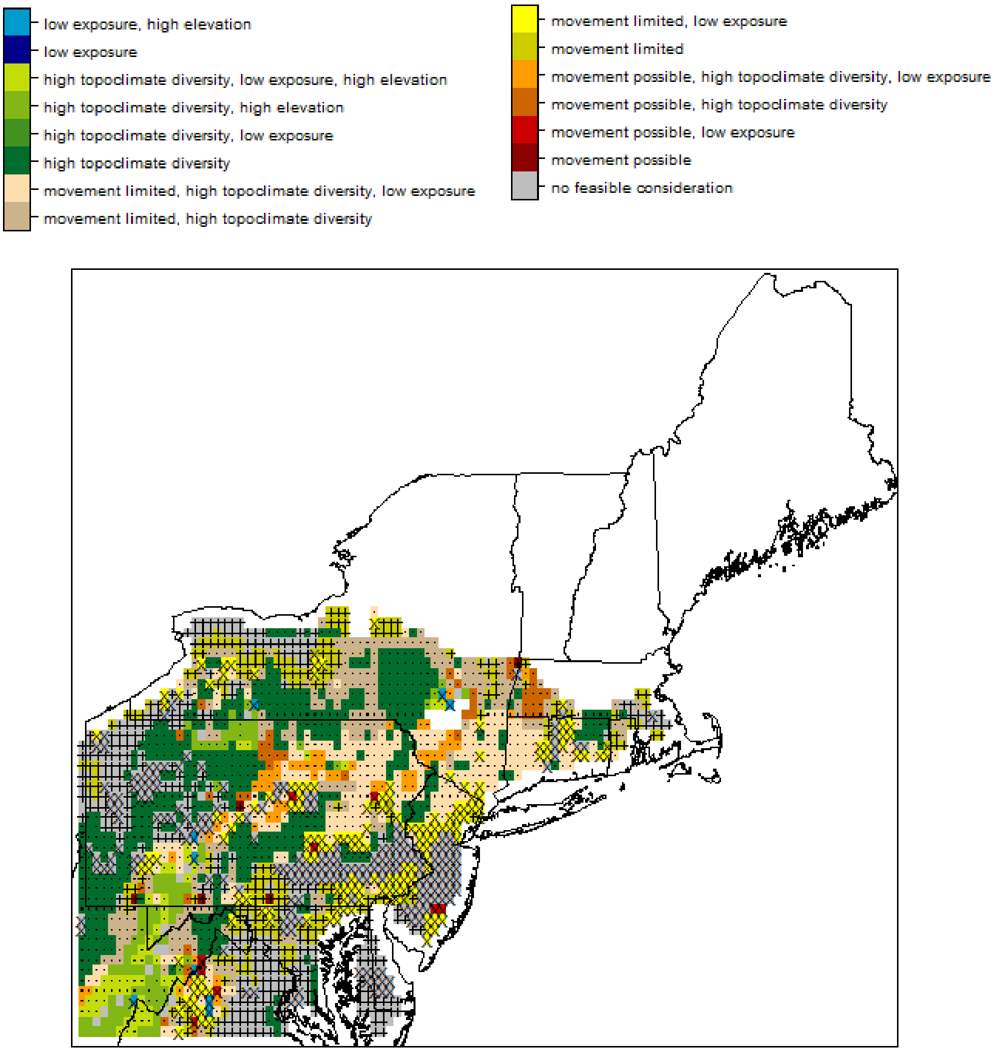

Figure AVIII. 1.26.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

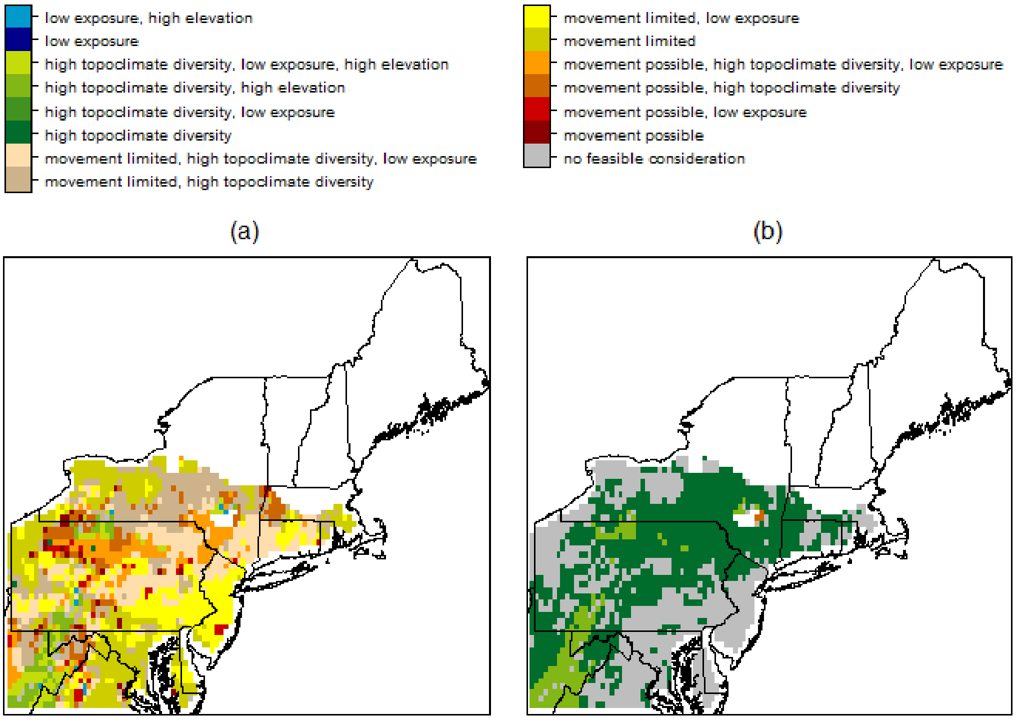

Figure AVIII. 1.26.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.27 Ruffed grouse (*Bonasa umbellus*)

Table AVIII. 1.27.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.17	0.77	0.67	1.00	1.83
low	0.48	0.17	0.75	0.60	1.00	0.17
high	0.50	0.17	0.77	0.68	1.00	7.33

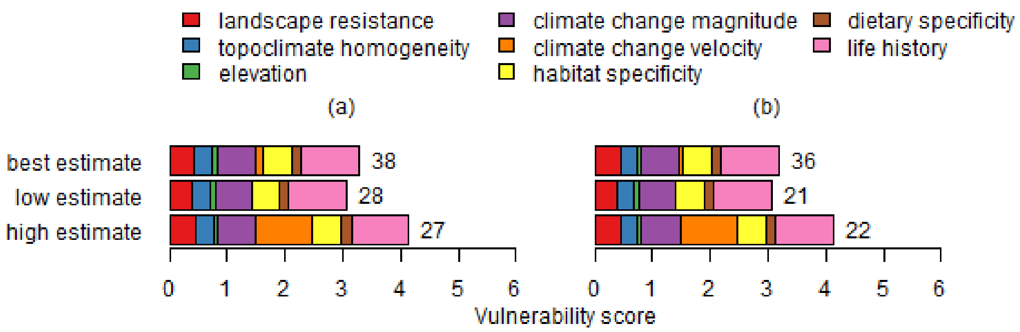

Figure AVIII. 1.27.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

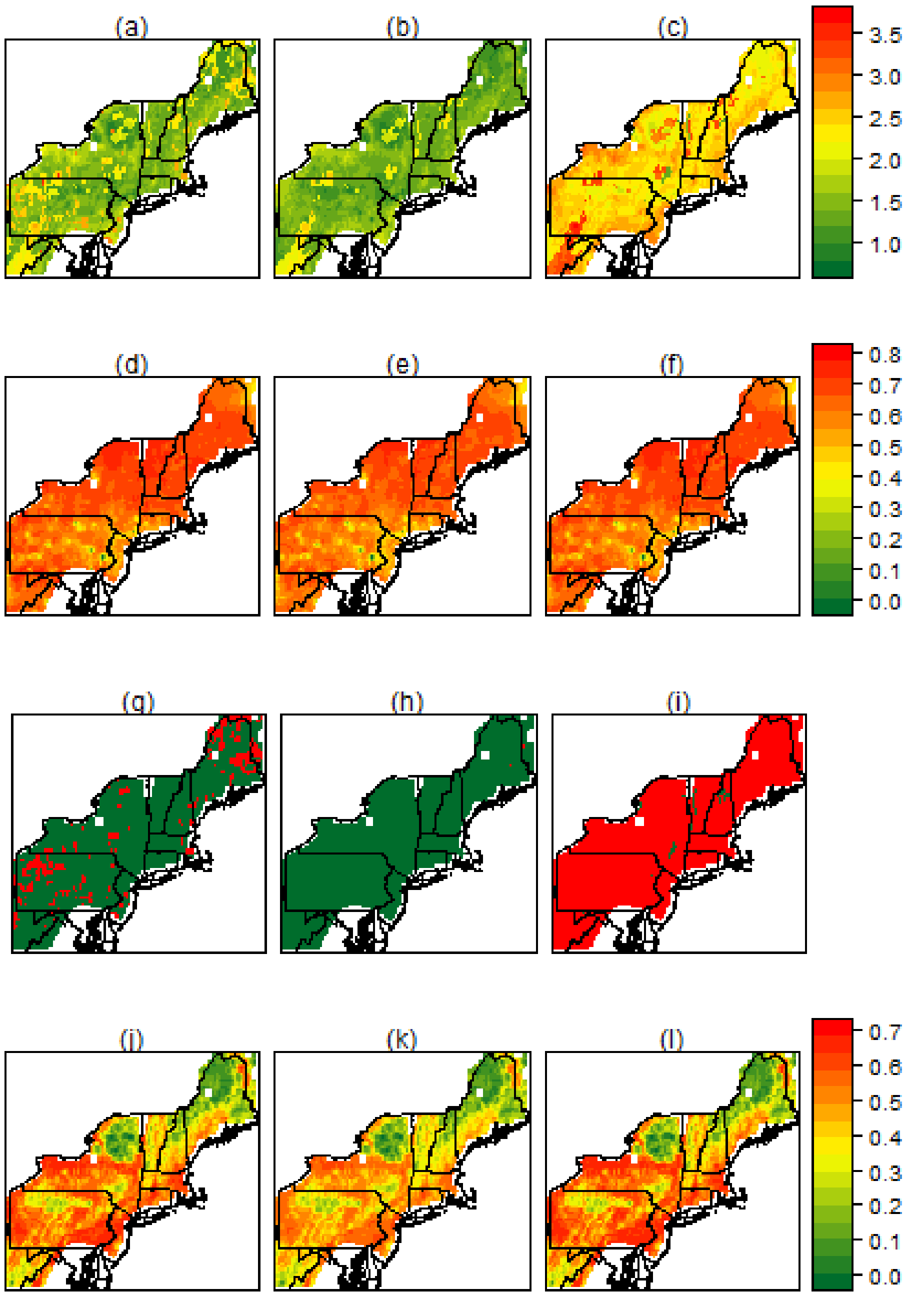

Figure AVIII. 1.27.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

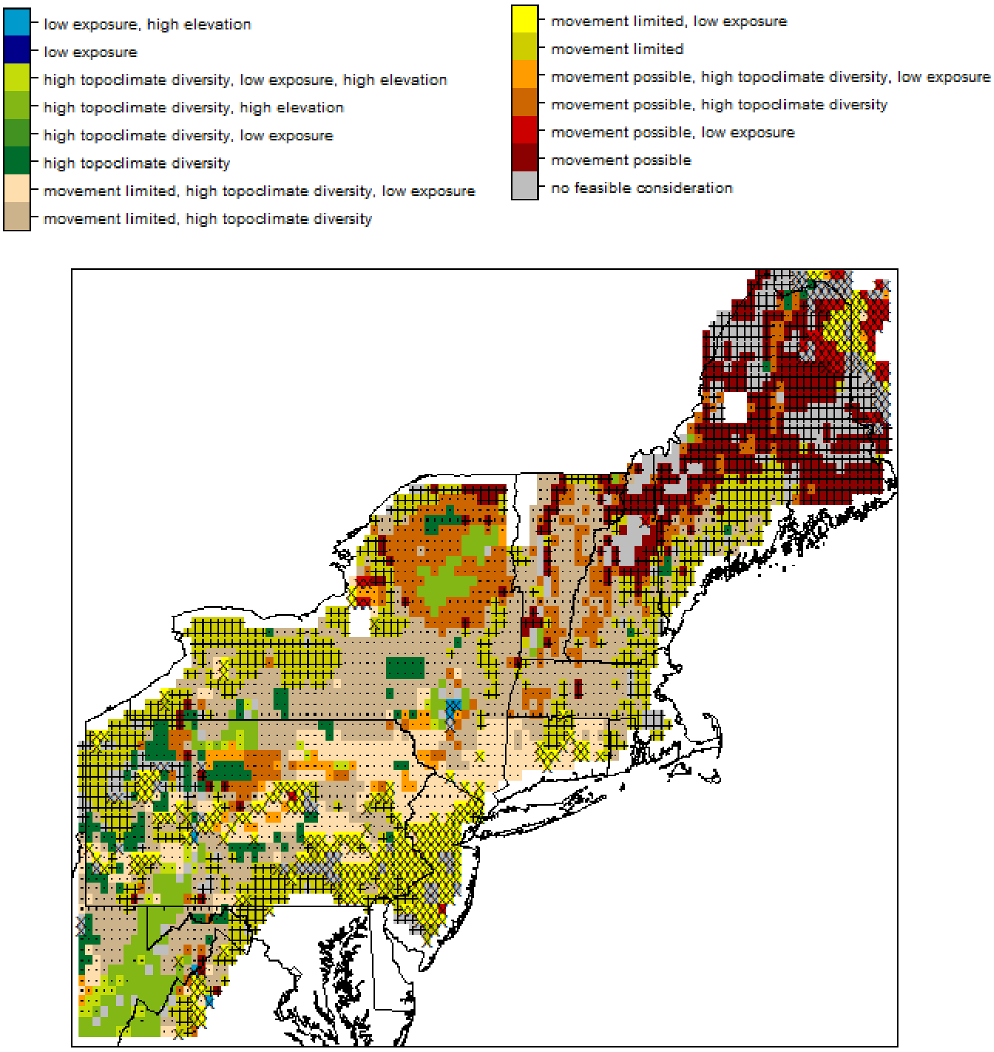

Figure AVIII. 1.27.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

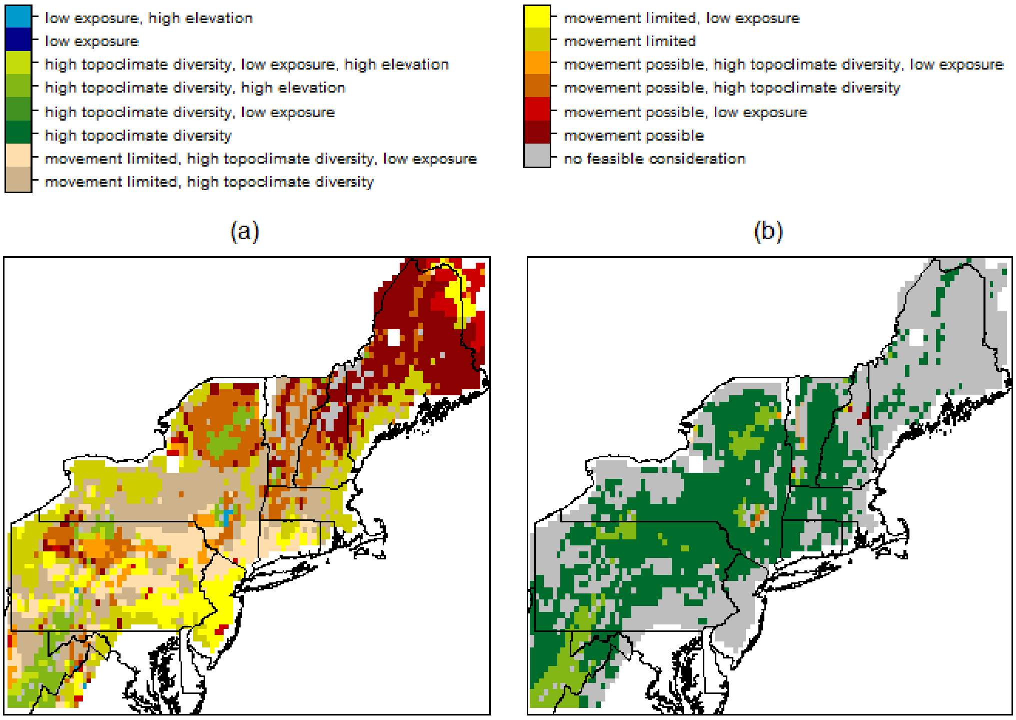

Figure AVIII. 1.27.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.28 Spruce grouse (*Falcipennis canadensis*)

Table AVIII. 1.28.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.00	0.89	0.67	1.00	1.50
low	0.46	0.00	0.86	0.67	1.00	0.37
high	0.57	0.00	0.89	0.73	1.00	8.67

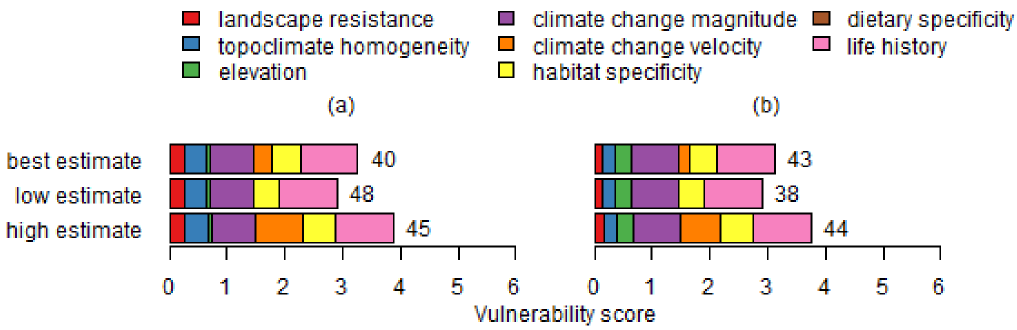

Figure AVIII. 1.28.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

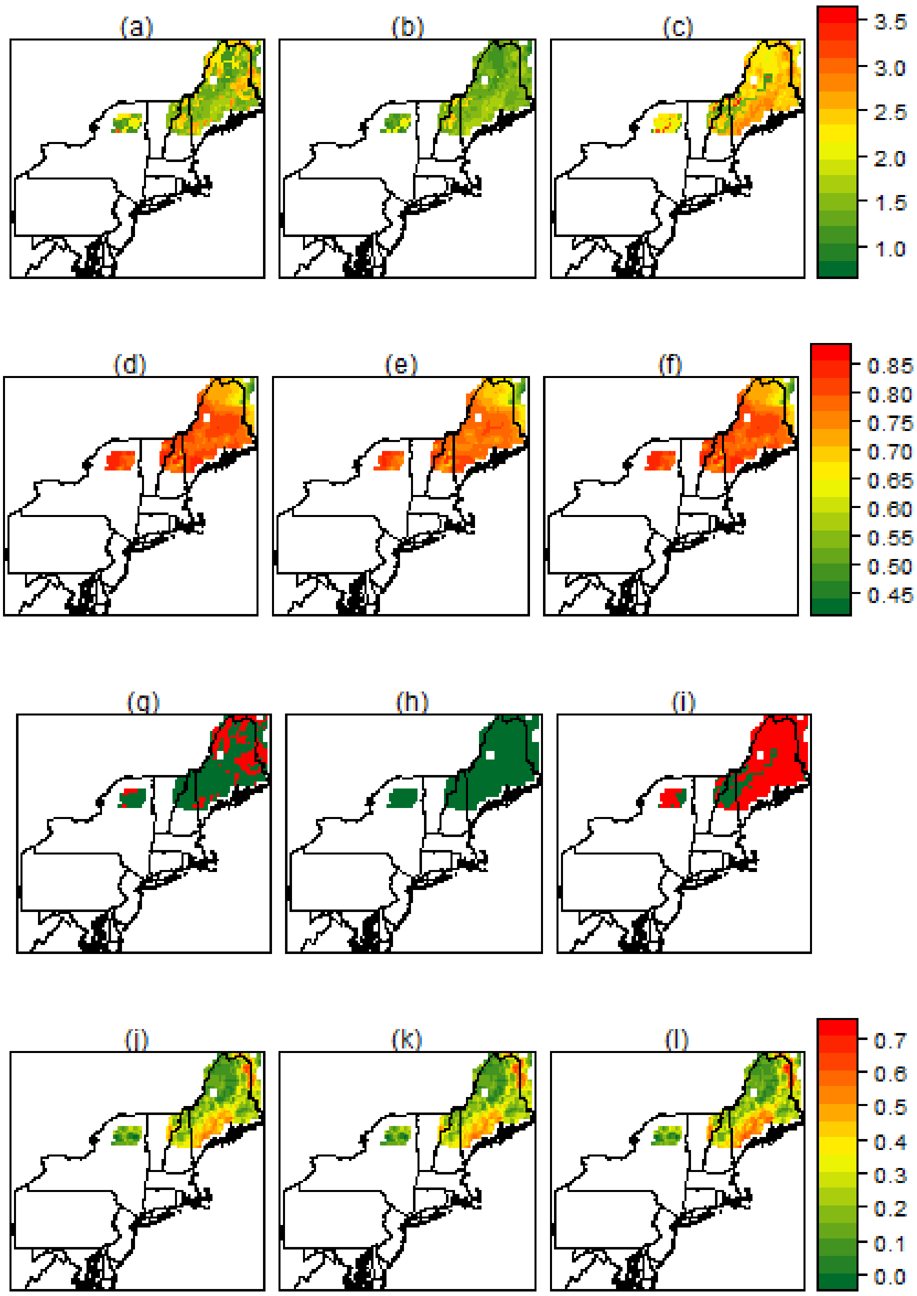

Figure AVIII. 1.28.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

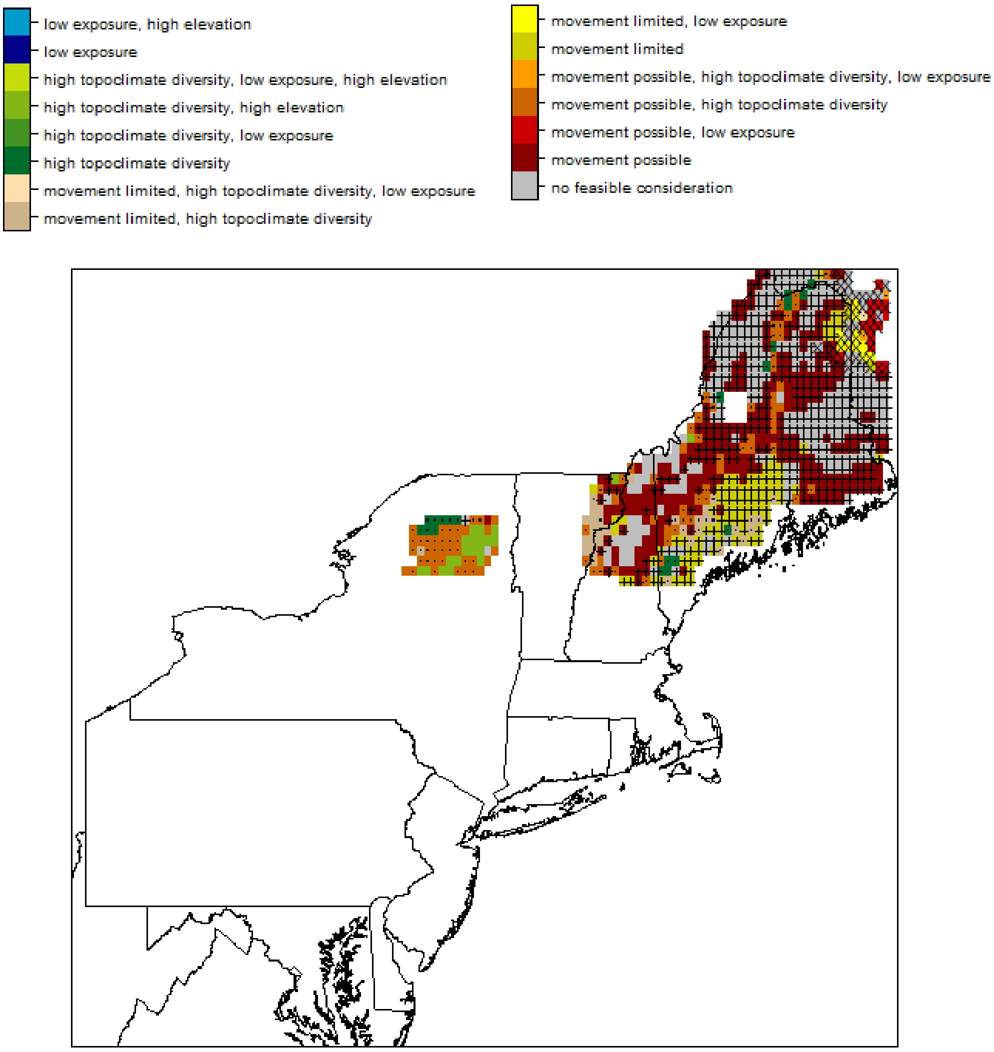

Figure AVIII. 1.28.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

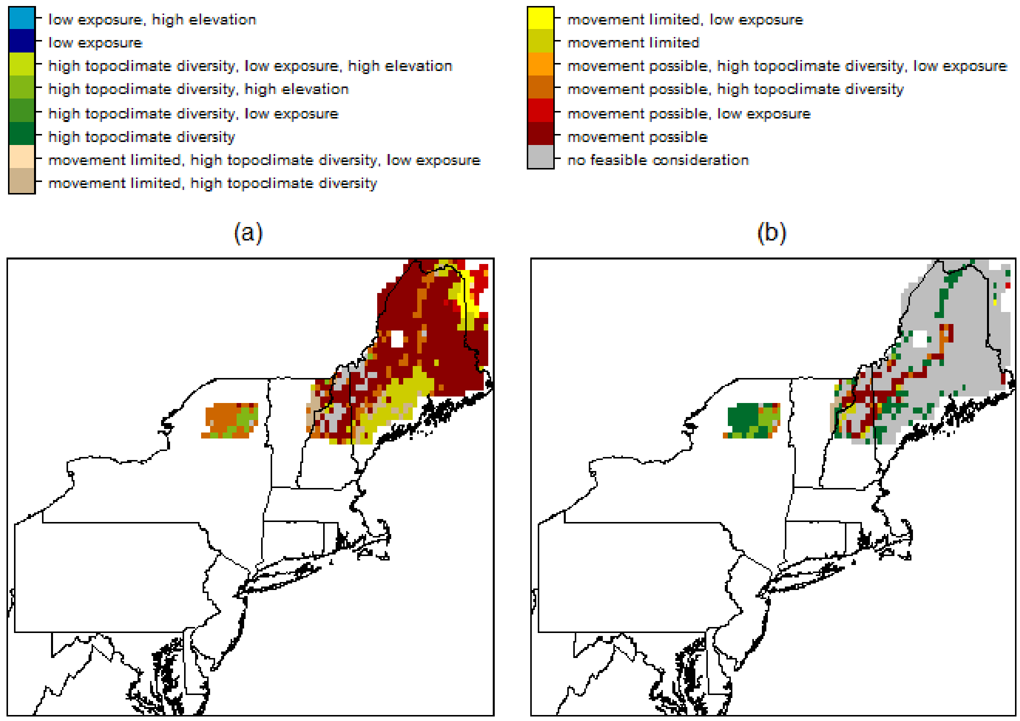

Figure AVIII. 1.28.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.29 Yellow rail (*Coturnicops noveboracensis*)

Table AVIII. 1.29.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.75	0.50	0.66	0.00	1.00	50.00
low	0.50	0.50	0.66	0.00	1.00	20.00
high	1.00	0.50	0.66	0.00	1.00	200.00

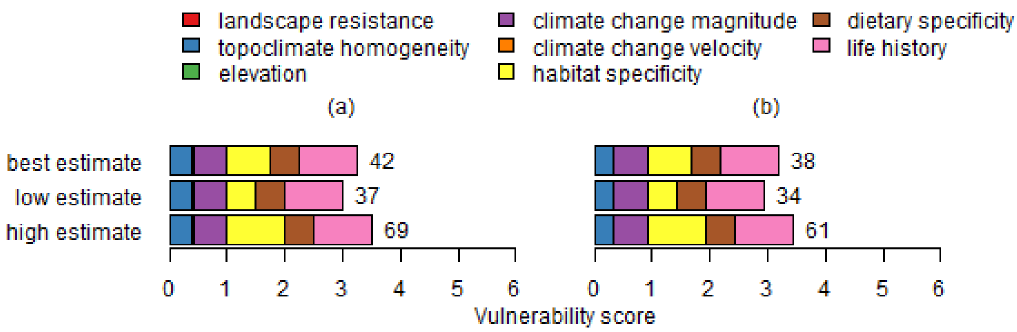

Figure AVIII. 1.29.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

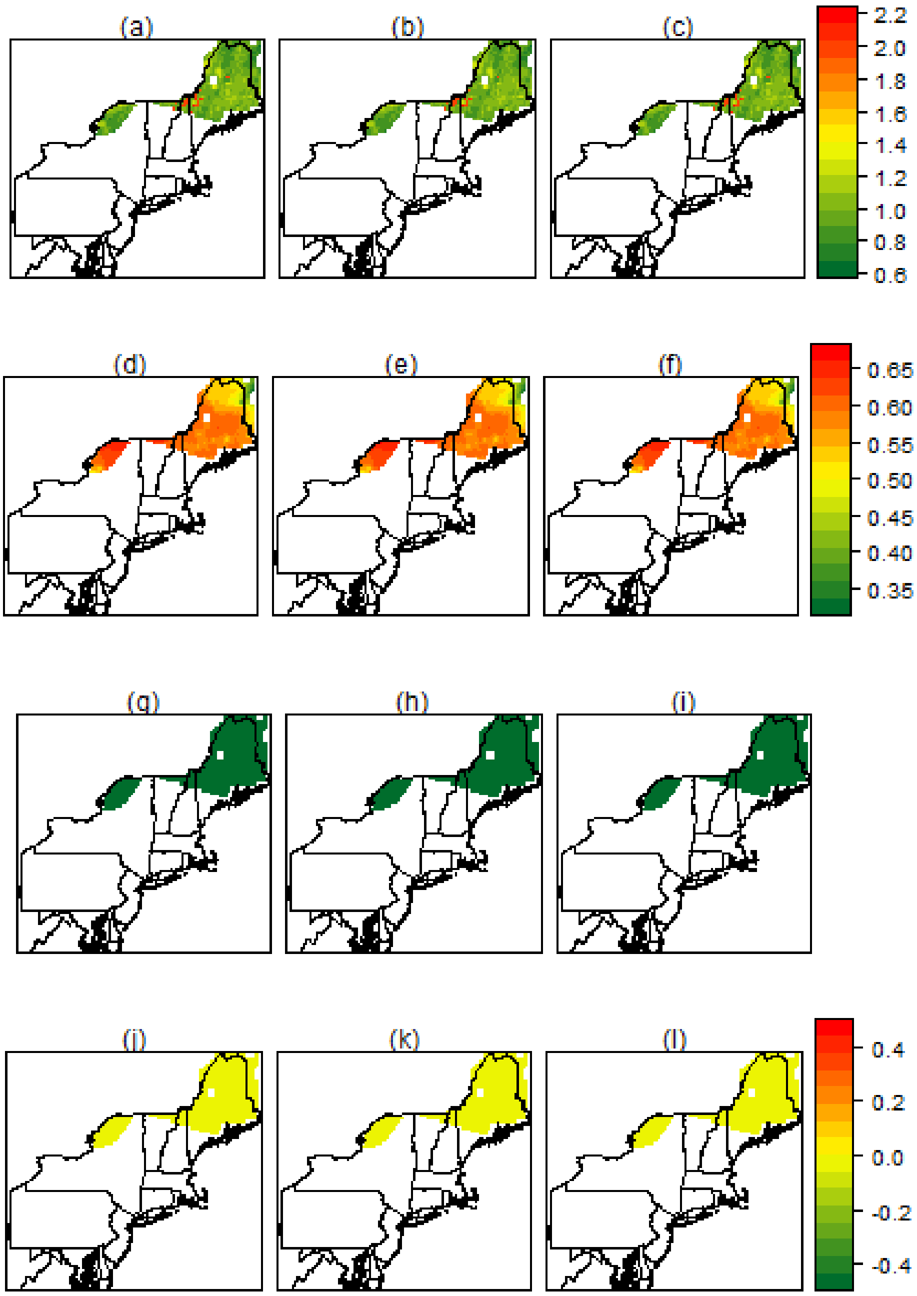

Figure AVIII. 1.29.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

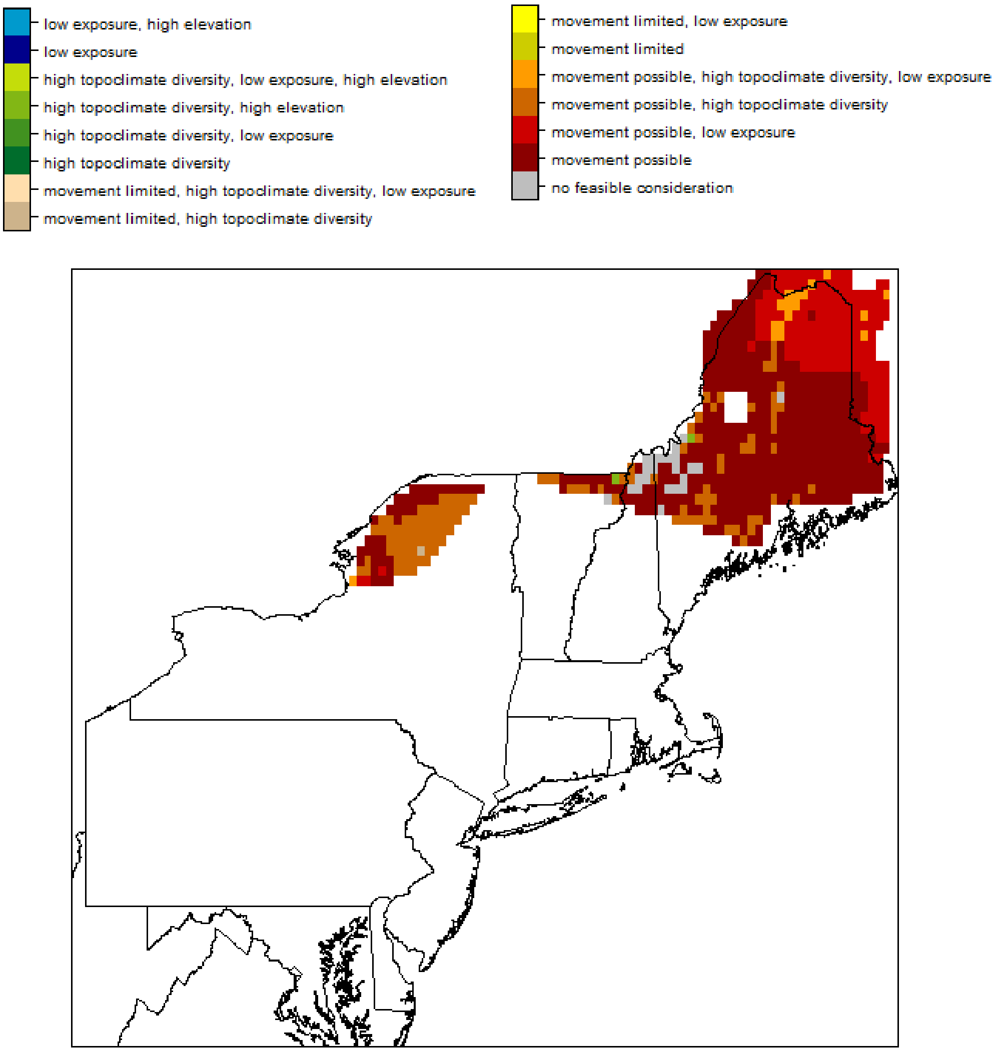

Figure AVIII. 1.29.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

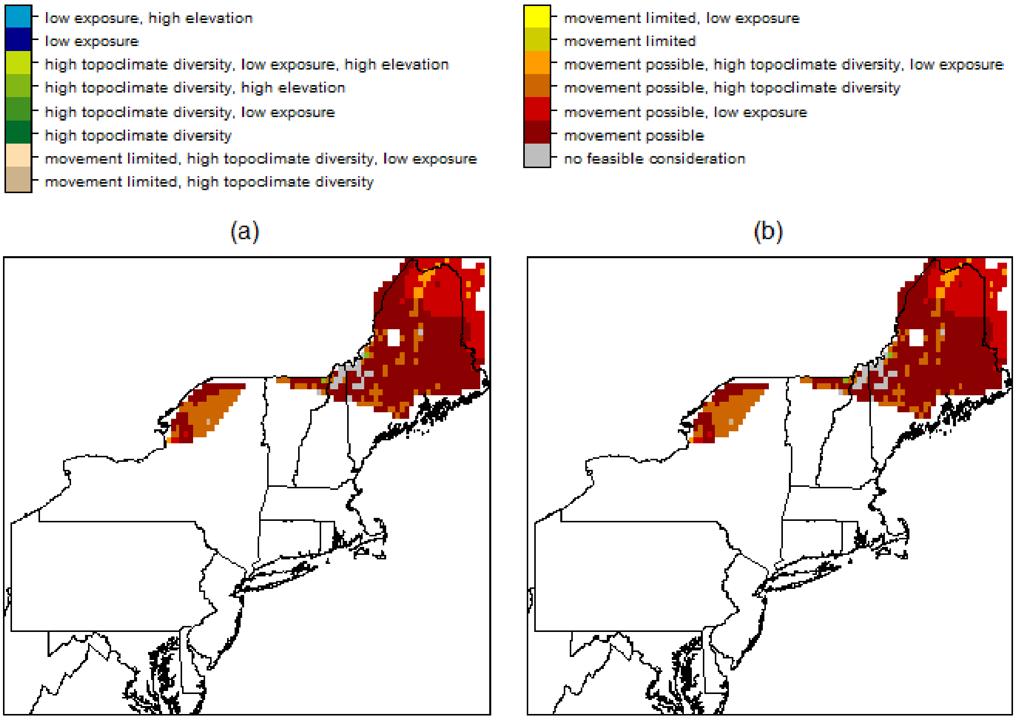

Figure AVIII. 1.29.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.30 King rail (*Rallus elegans*)

Table AVIII. 1.30.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	100.00
low	0.50	0.50	0.66	0.00	1.00	20.00
high	0.60	0.50	0.66	0.00	1.00	200.00

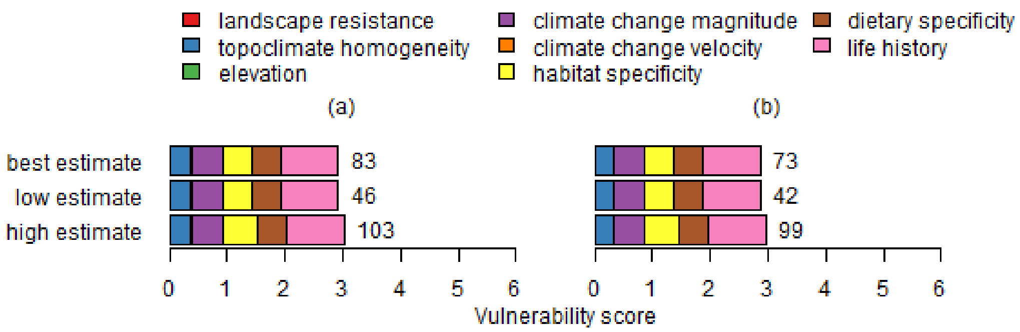

Figure AVIII. 1.30.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

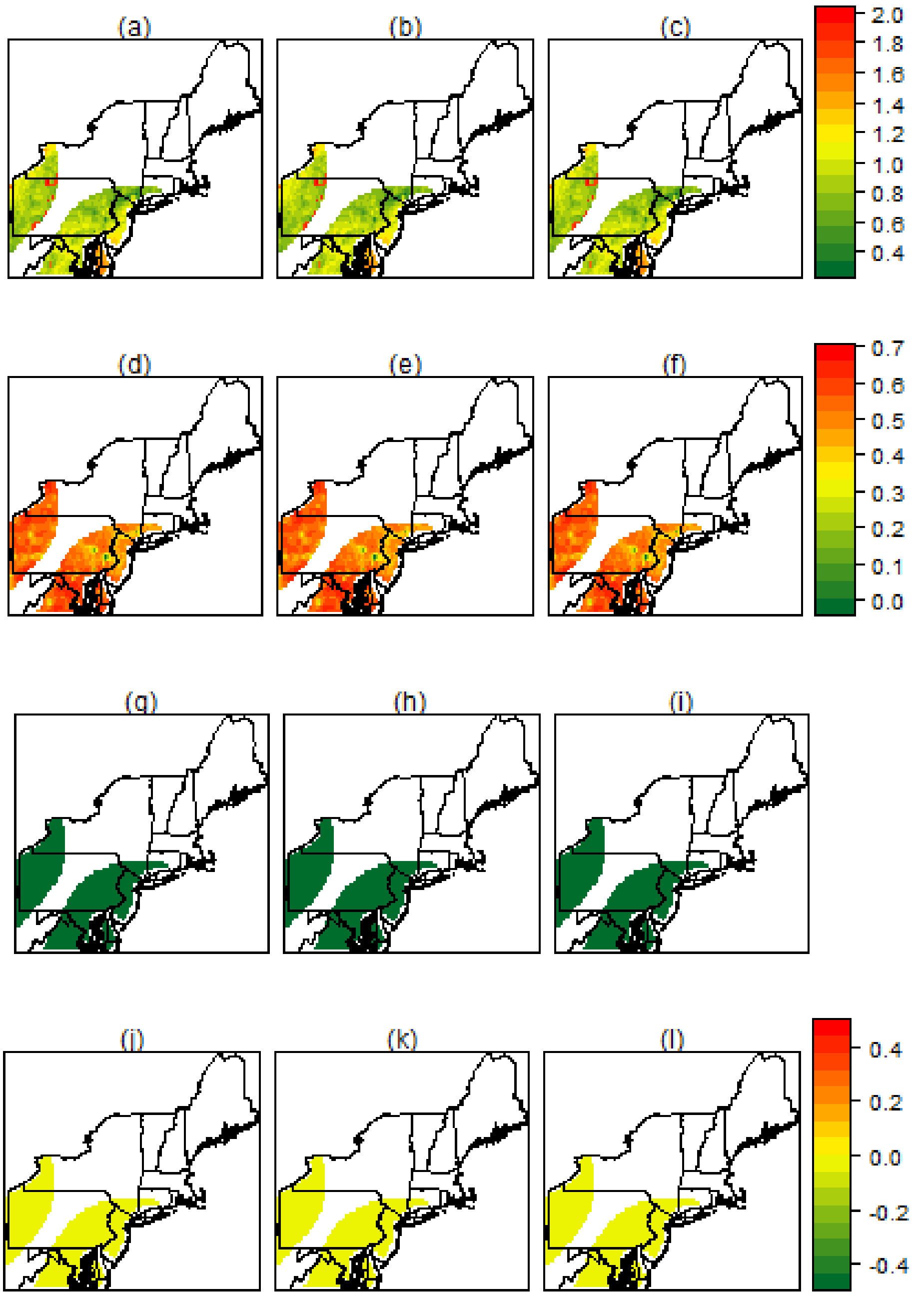

Figure AVIII. 1.30.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

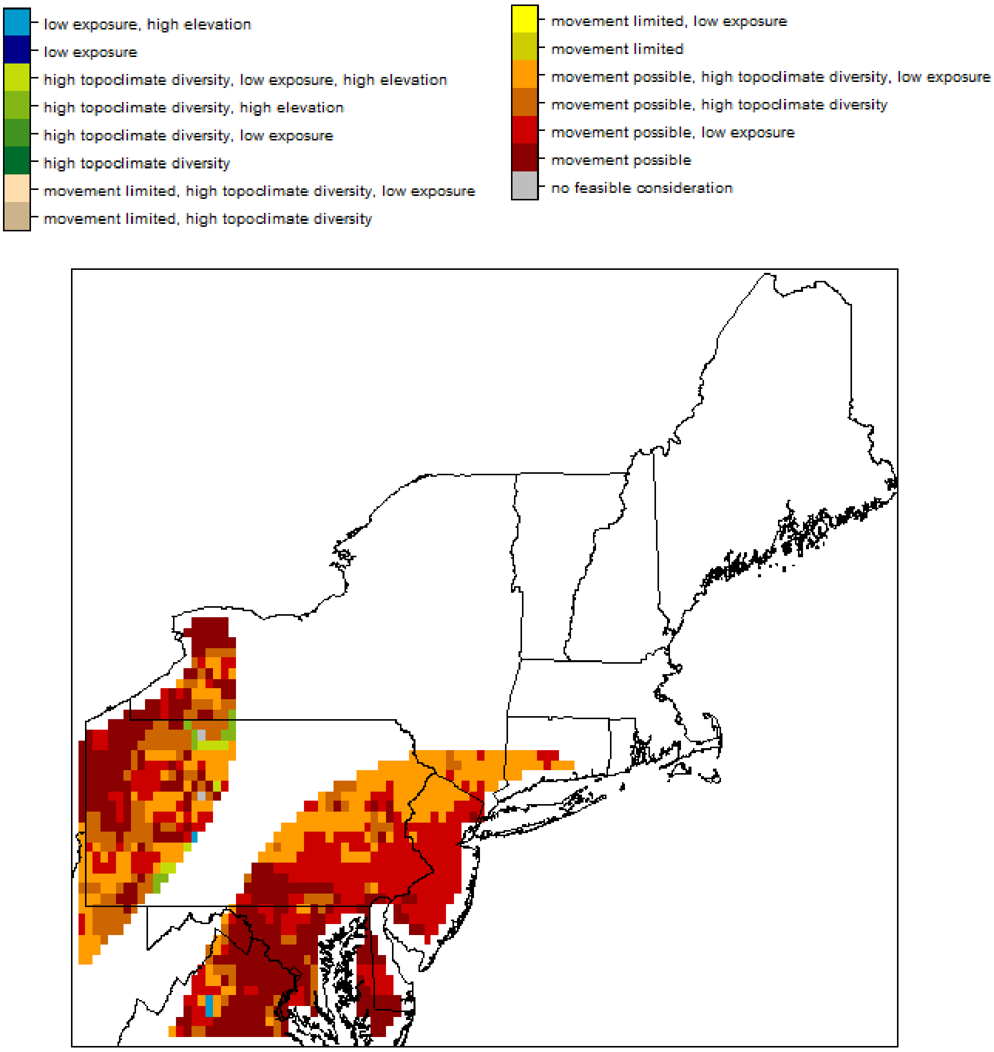

Figure AVIII. 1.30.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

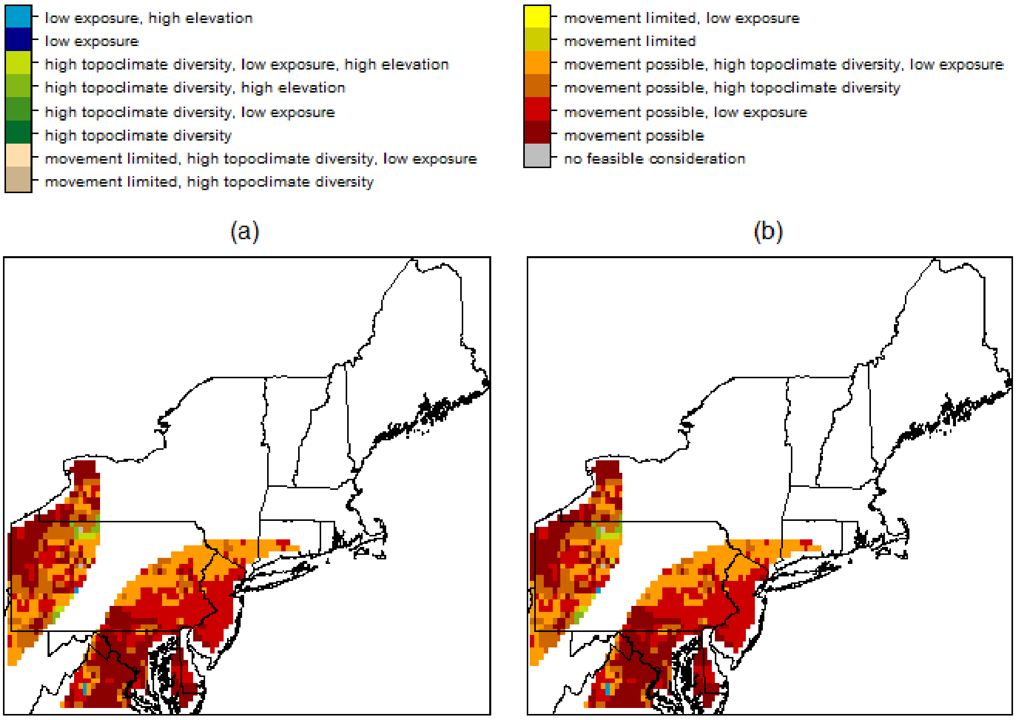

Figure AVIII. 1.30.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.31 Black tern (*Chlidonias niger*)

Table AVIII. 1.31.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.62	0.50	0.75	0.00	1.00	25.00
low	0.50	0.50	0.66	0.00	1.00	5.50
high	0.75	0.50	0.83	0.02	1.00	150.00

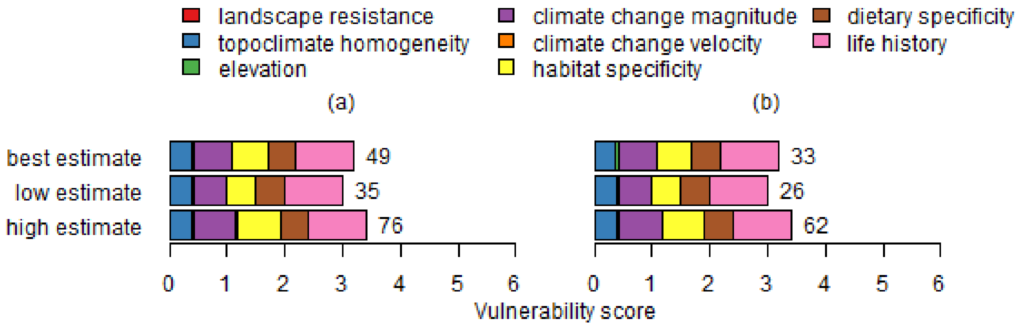

Figure AVIII. 1.31.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

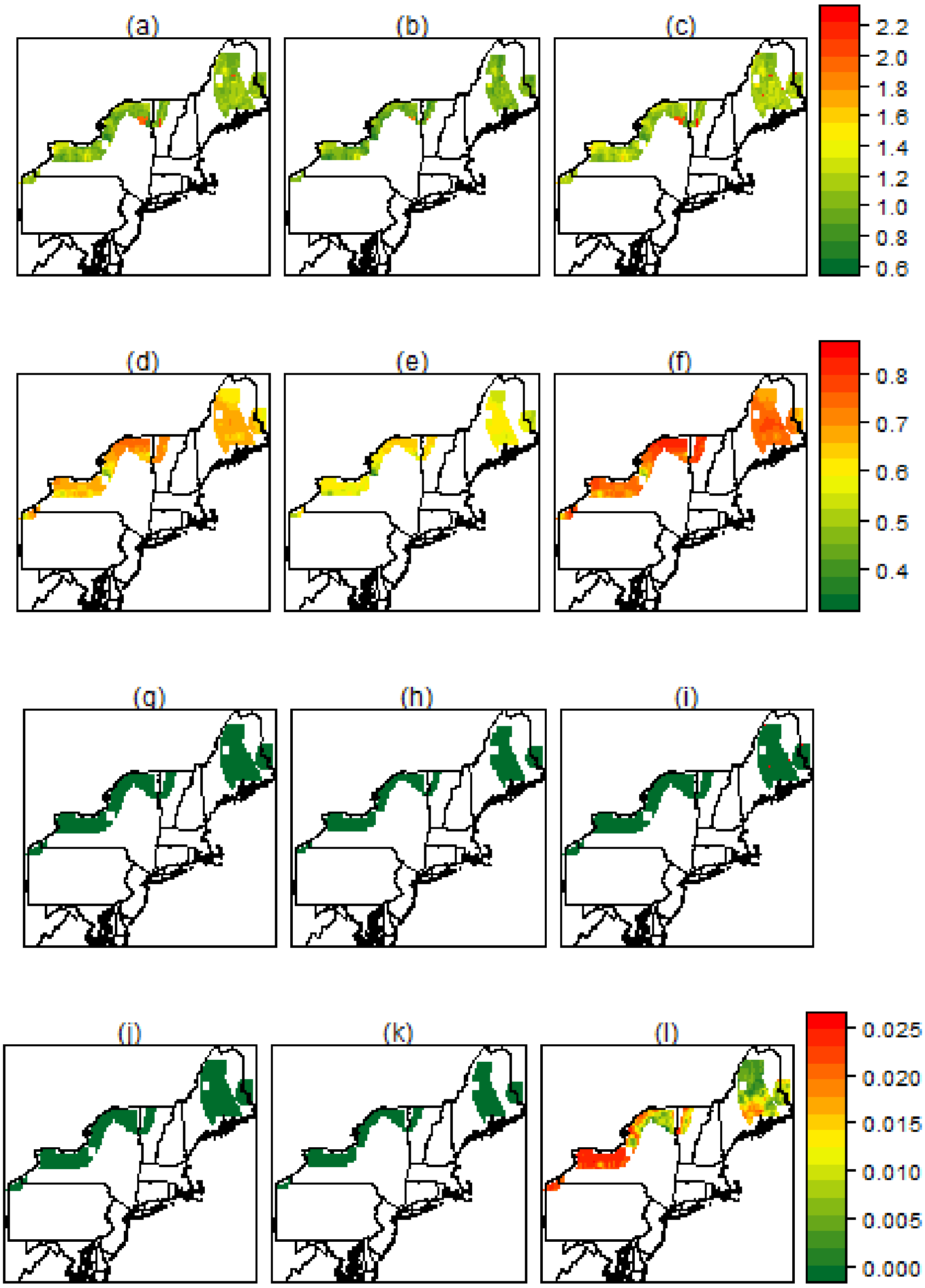

Figure AVIII. 1.31.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

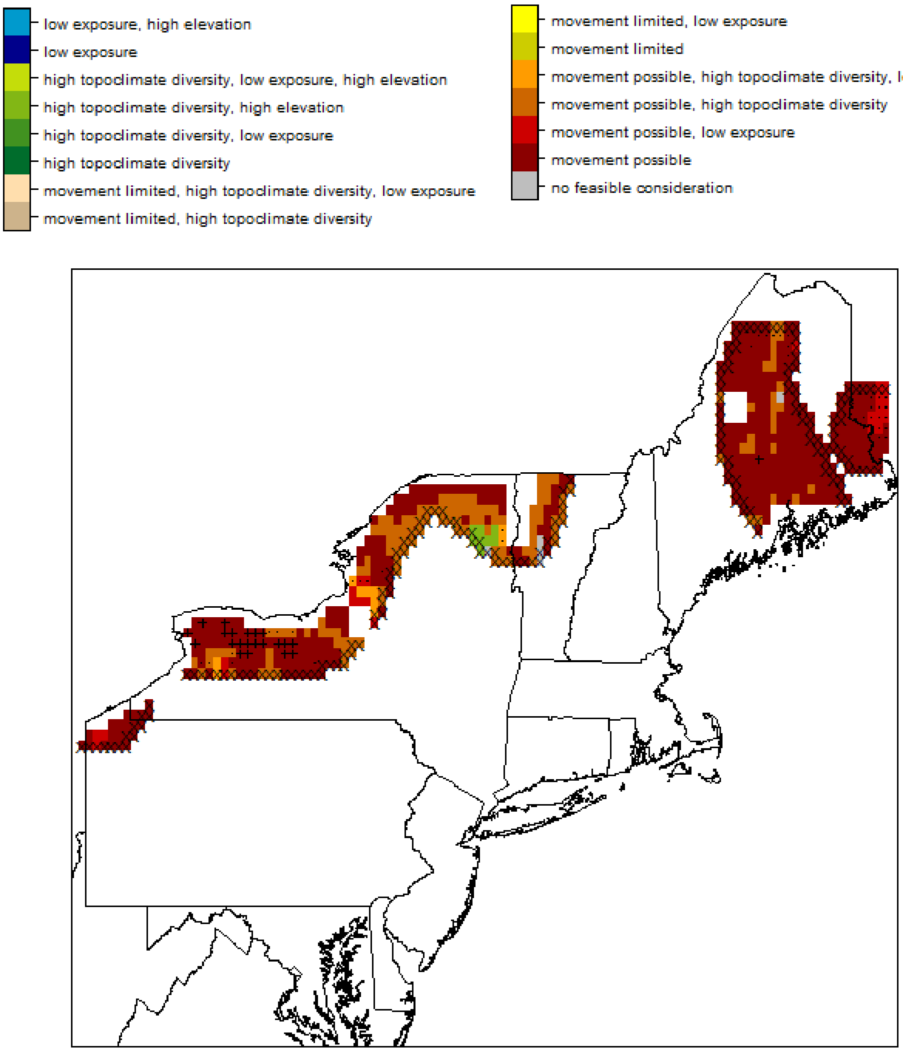

Figure AVIII. 1.31.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

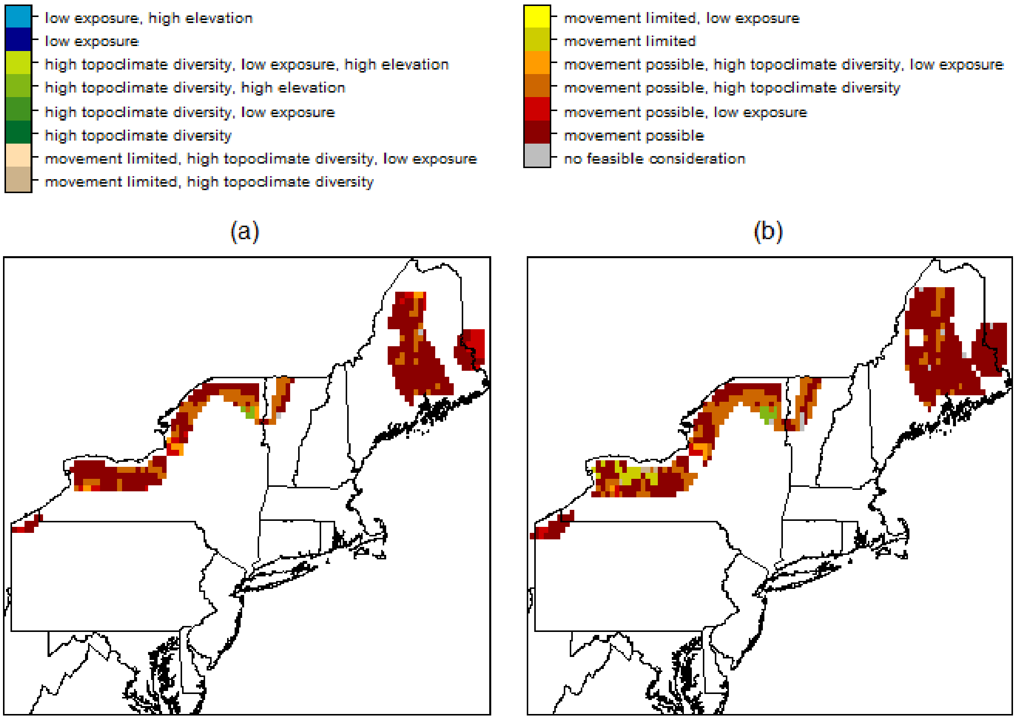

Figure AVIII. 1.31.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.32 Upland sandpiper (*Bartramia longicauda*)

Table AVIII. 1.32.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.19	1.00	16.25
low	0.50	0.49	0.63	0.12	1.00	3.25
high	0.54	0.50	0.72	0.30	1.00	117.50

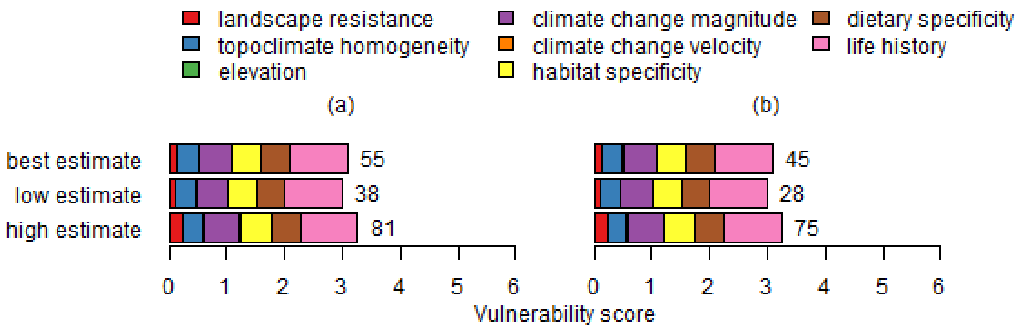

Figure AVIII. 1.32.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

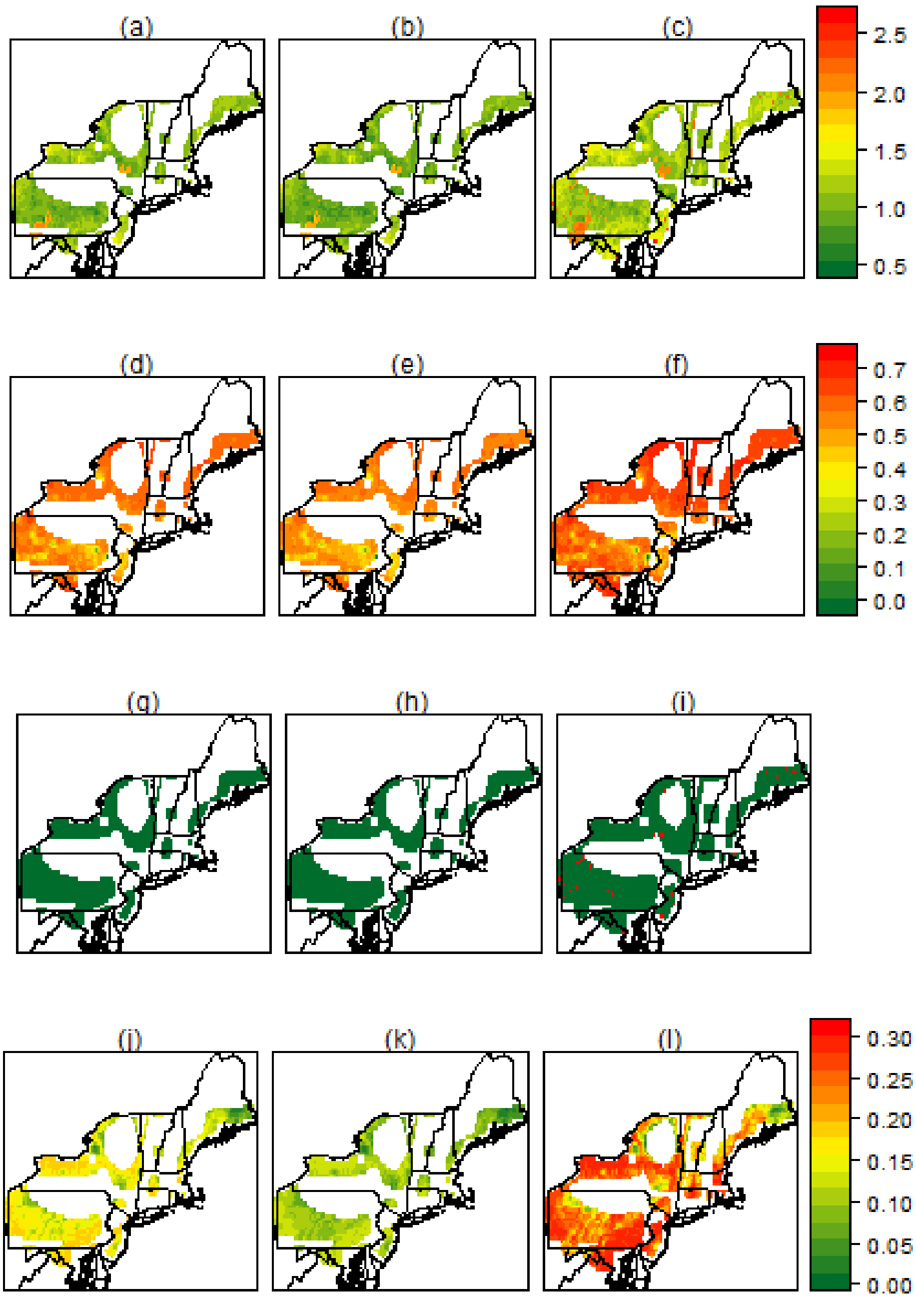

Figure AVIII. 1.32.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

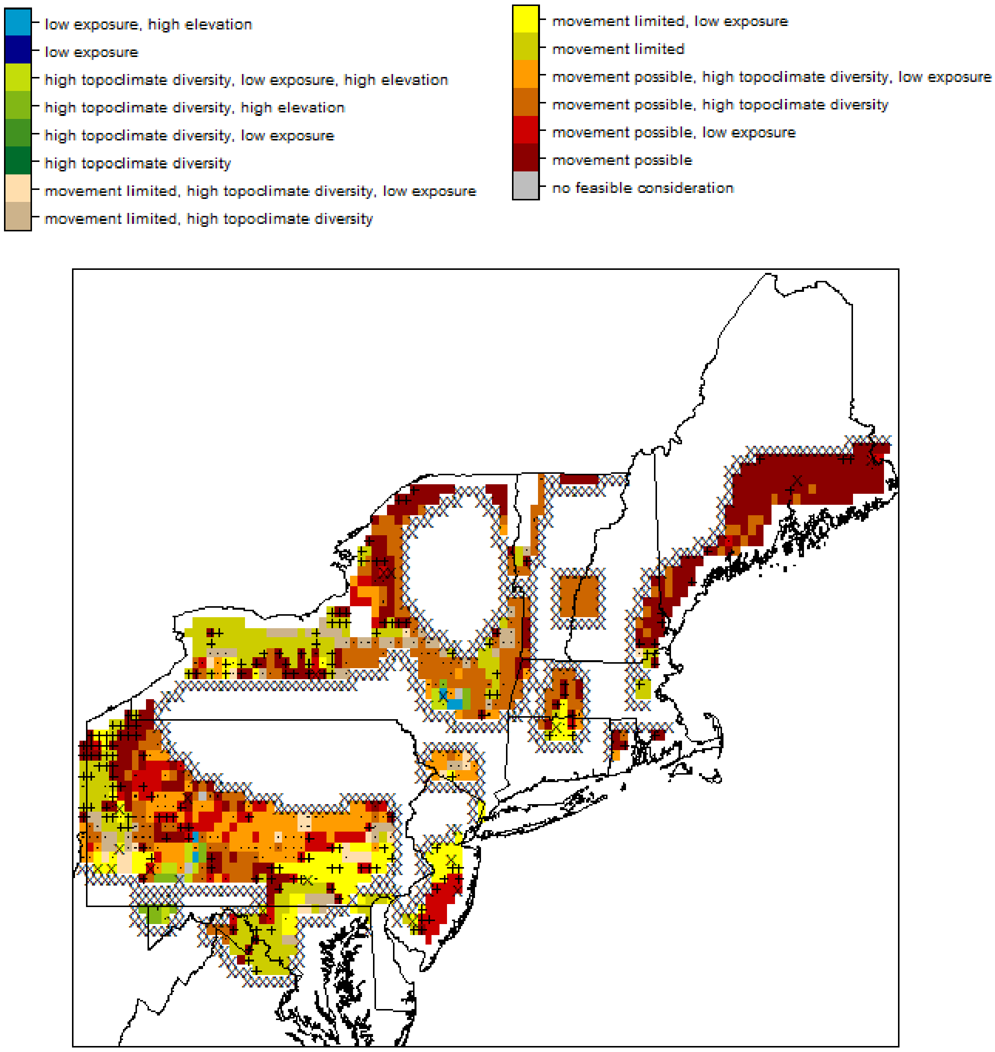

Figure AVIII. 1.32.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

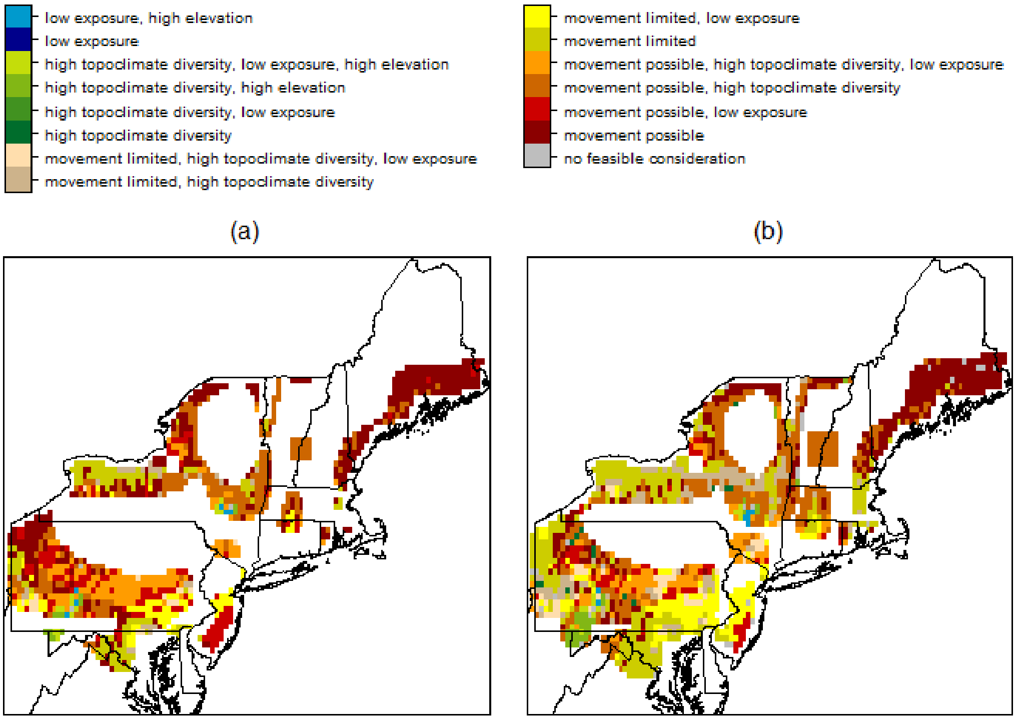

Figure AVIII. 1.32.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.33 American woodcock (*Scolopax minor*)

Table AVIII. 1.33.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	27.50
low	0.47	0.50	0.66	0.00	1.00	10.50
high	0.55	0.50	0.66	0.02	1.00	175.00

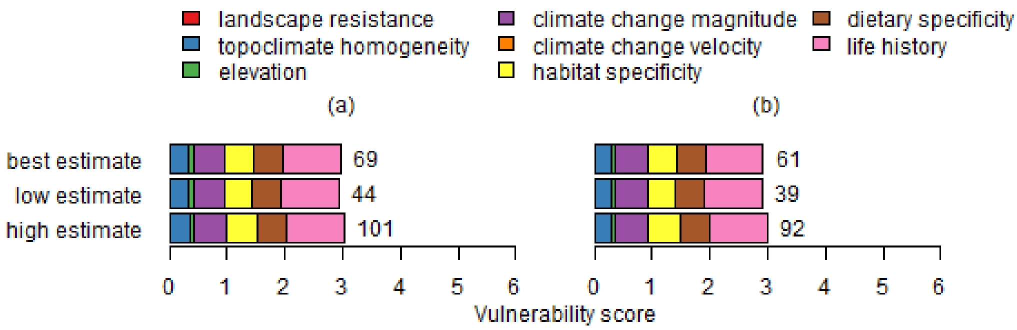

Figure AVIII. 1.33.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

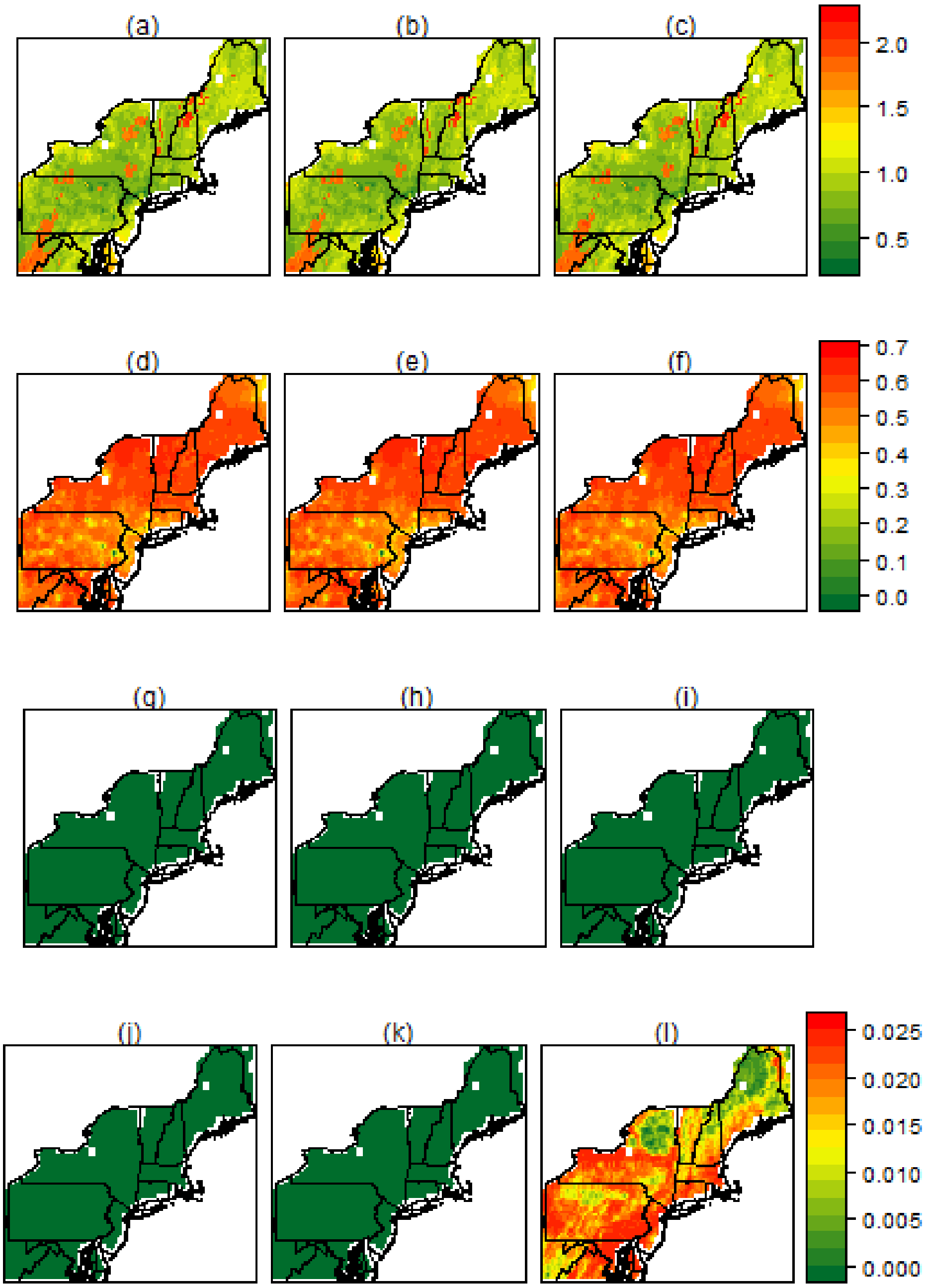

Figure AVIII. 1.33.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

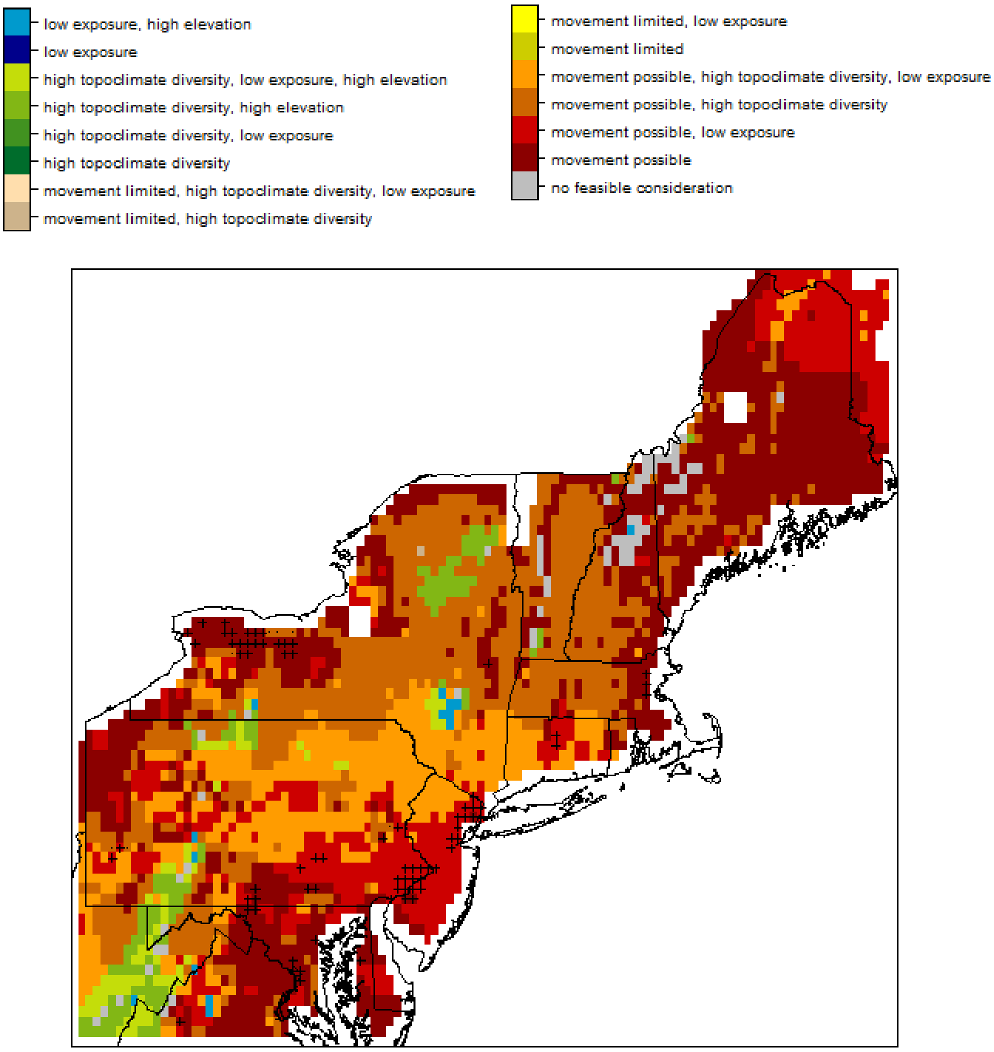

Figure AVIII. 1.33.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

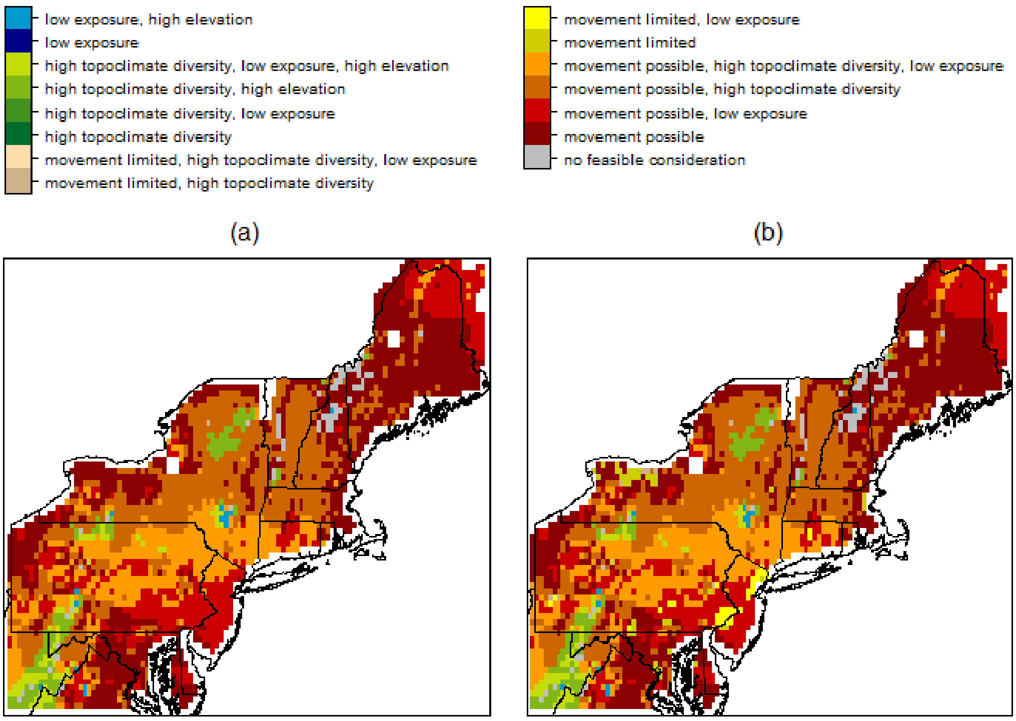

Figure AVIII. 1.33.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.34 Greater yellowlegs (*Tringa melanoleuca*)

Table AVIII. 1.34.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	50.00
low	0.33	0.50	0.66	0.00	1.00	10.00
high	0.57	0.50	0.66	0.00	1.00	300.00

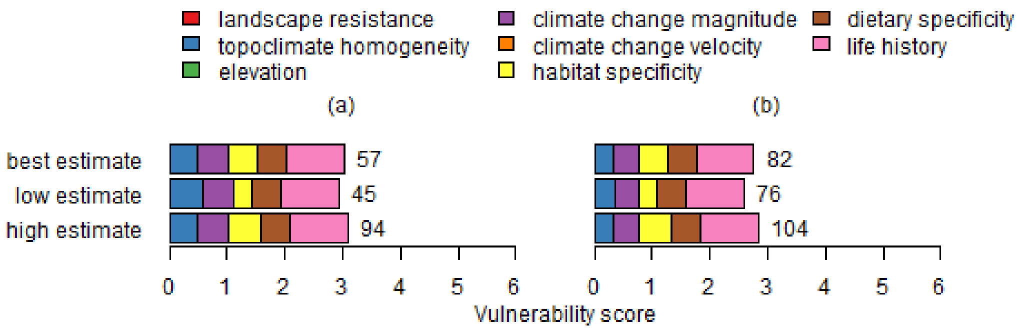

Figure AVIII. 1.34.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

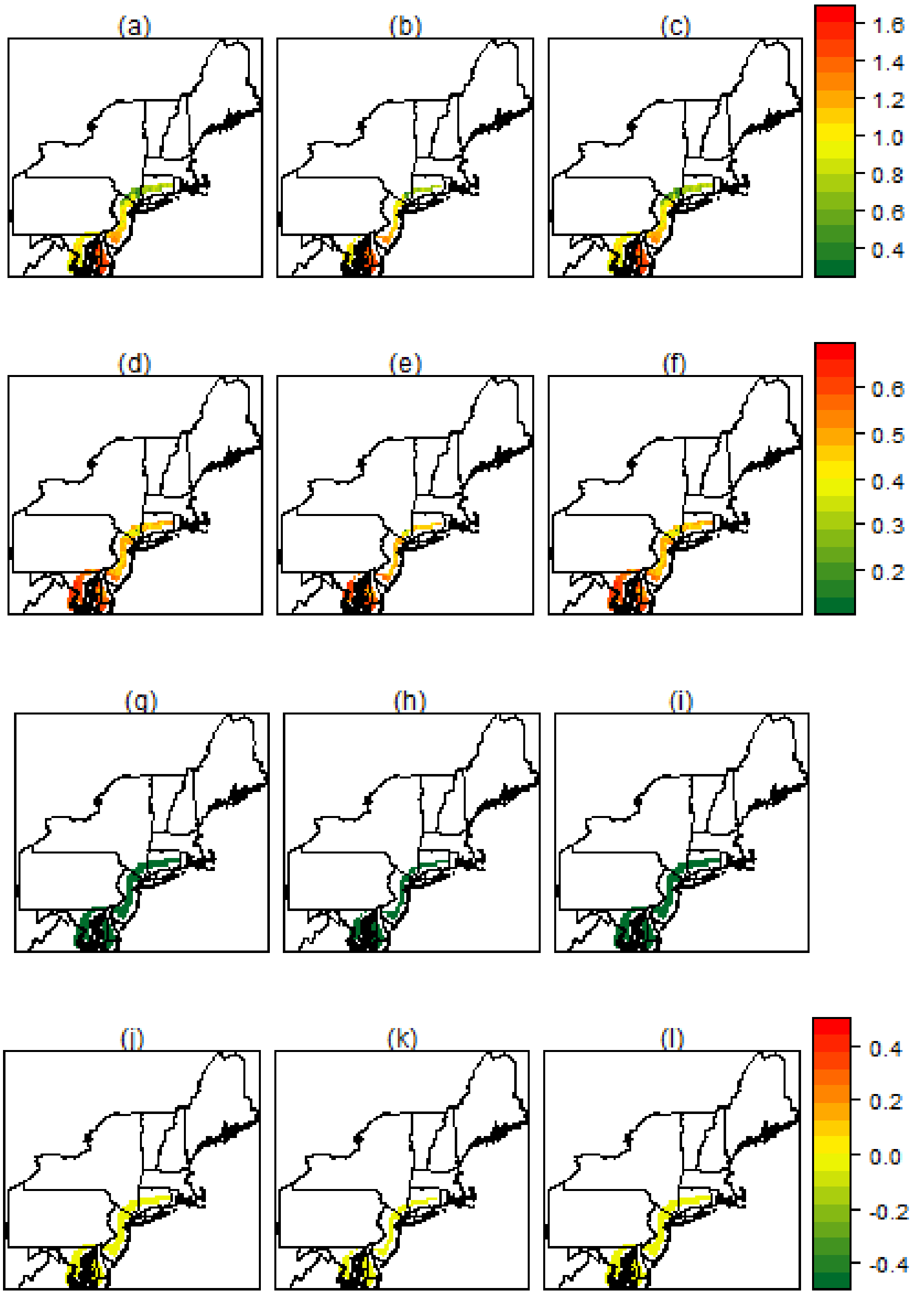

Figure AVIII. 1.34.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

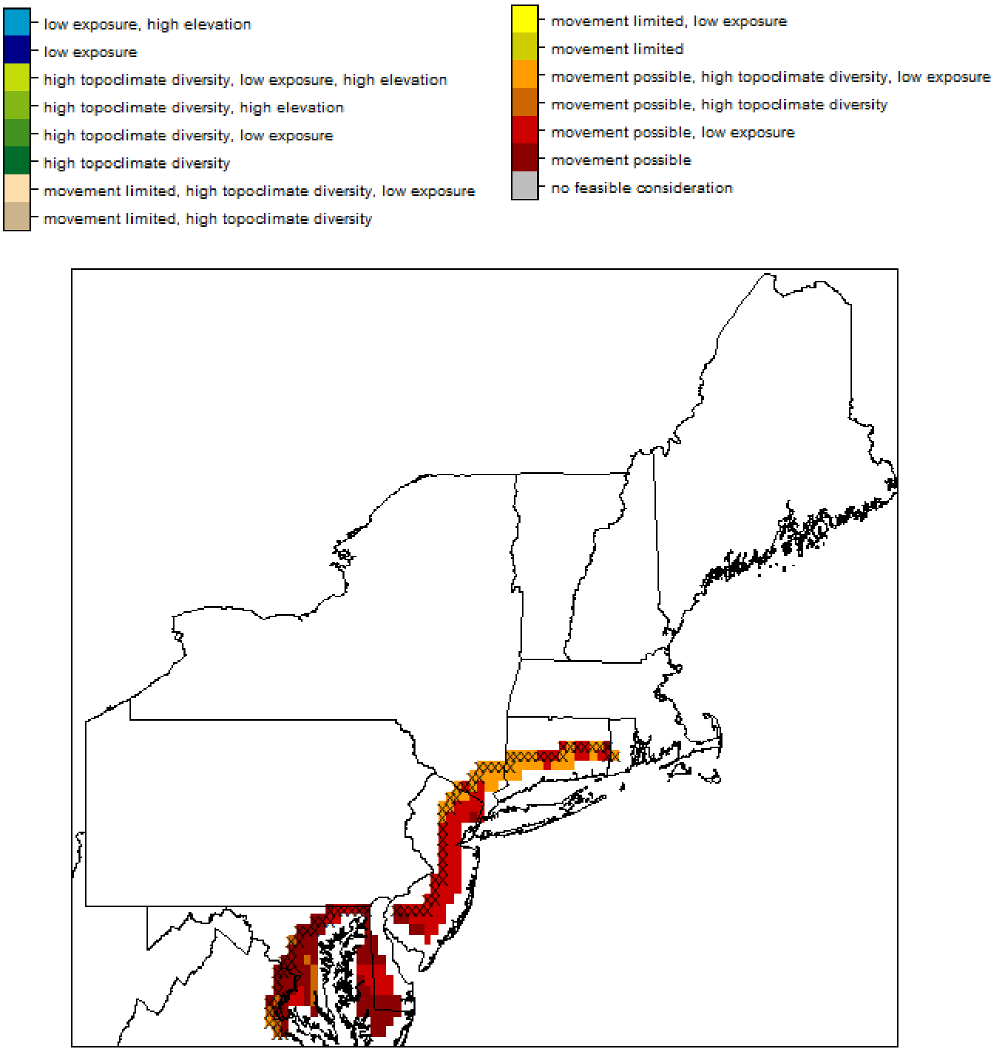

Figure AVIII. 1.34.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

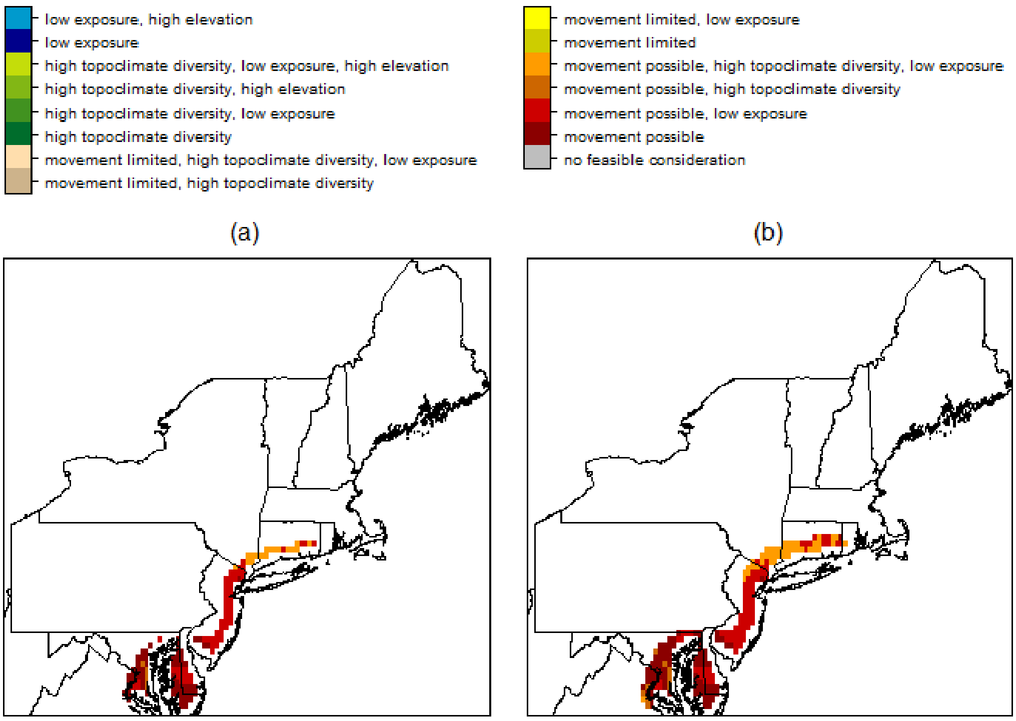

Figure AVIII. 1.34.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.35 Short-eared owl (*Asio flammeus*)

Table AVIII. 1.35.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.40	0.65	0.66	0.20	1.00	17.50
low	0.39	0.38	0.64	0.20	1.00	3.02
high	0.60	0.70	0.84	0.26	1.00	412.50

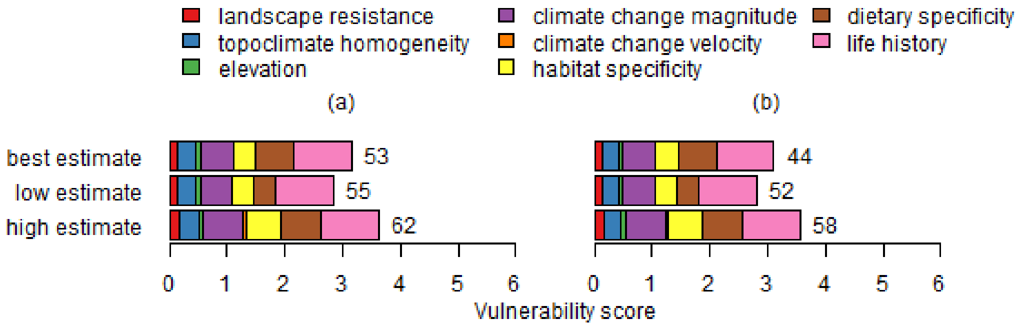

Figure AVIII. 1.35.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

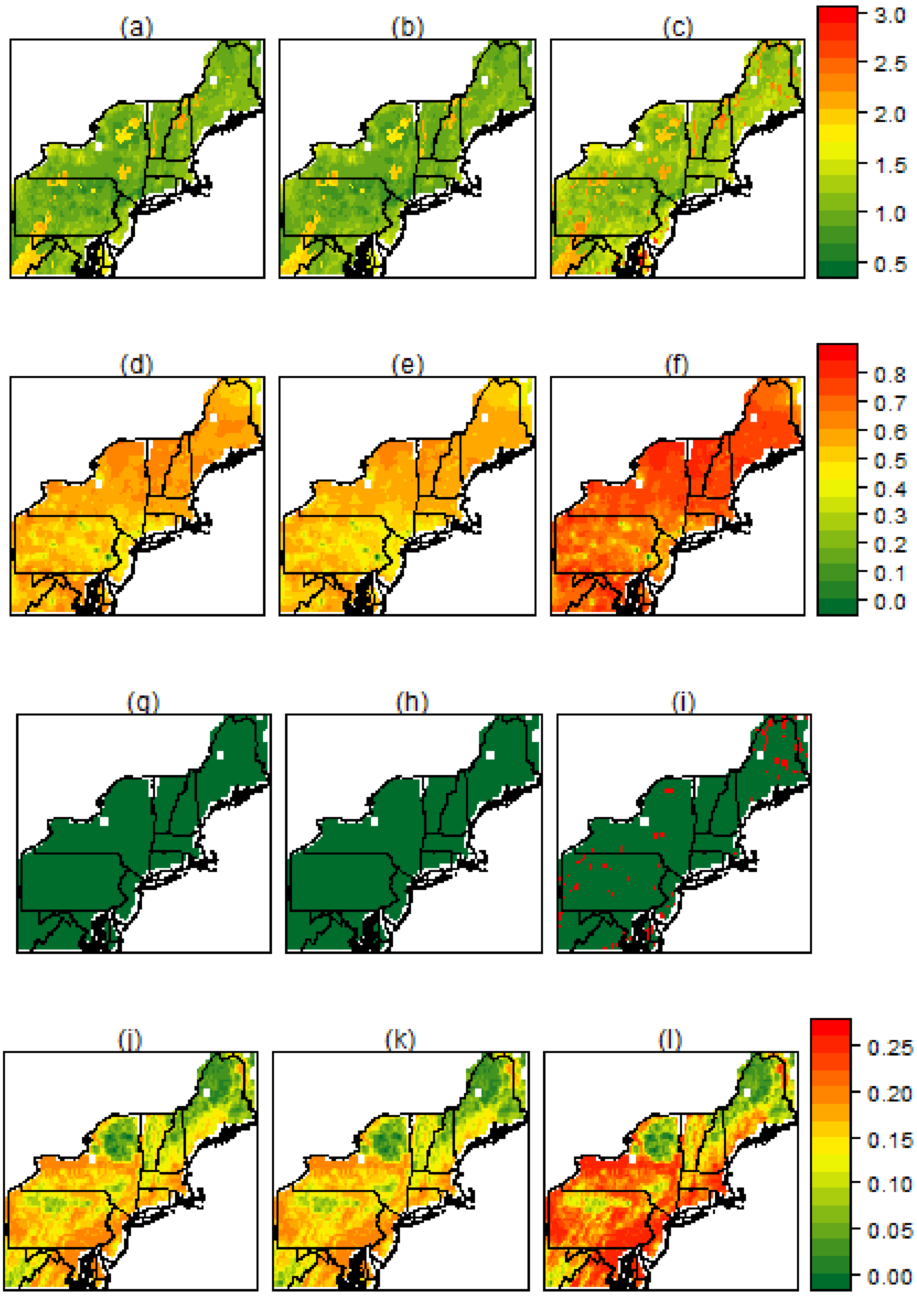

Figure AVIII. 1.35.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

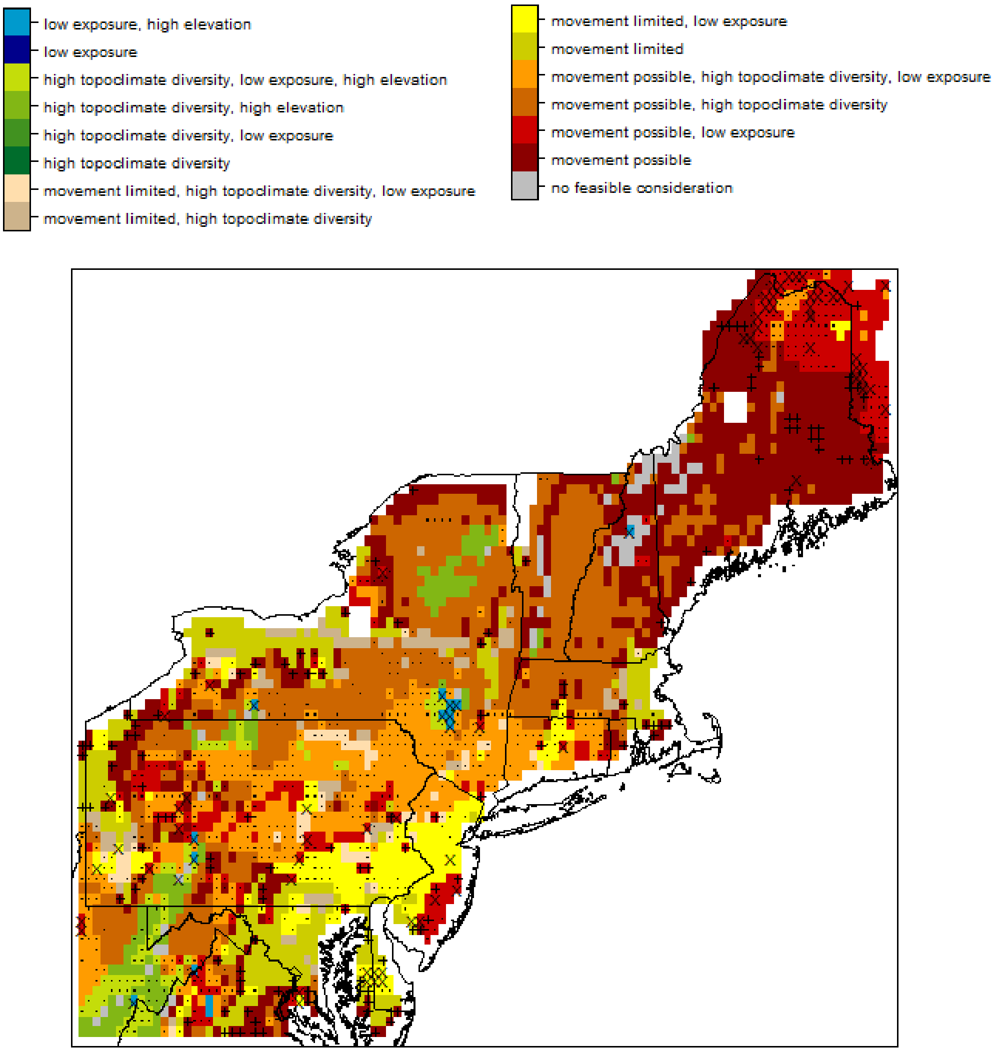

Figure AVIII. 1.35.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

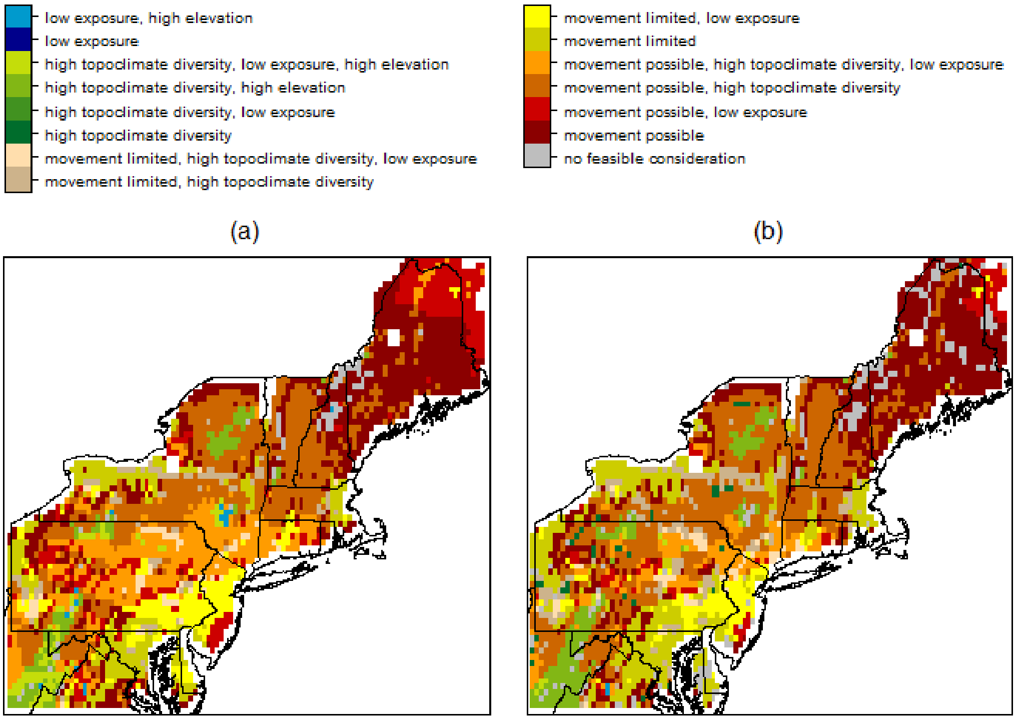

Figure AVIII. 1.35.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.36 Long-eared owl (*Asio otus*)

Table AVIII. 1.36.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	25.00
low	0.43	0.50	0.66	0.00	1.00	10.00
high	0.67	0.50	0.66	0.00	1.00	100.00

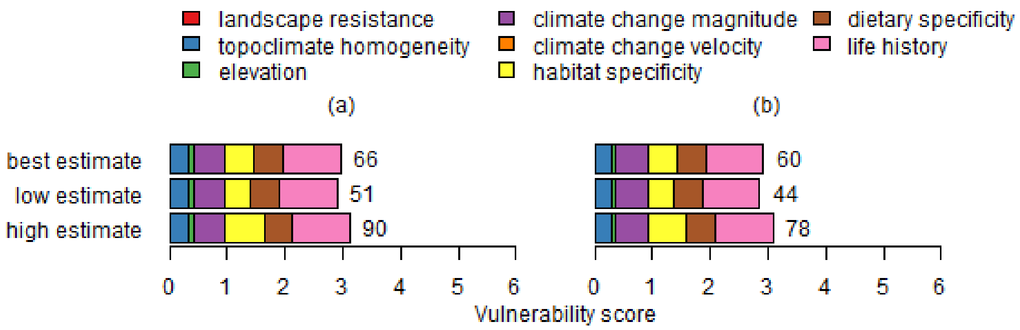

Figure AVIII. 1.36.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

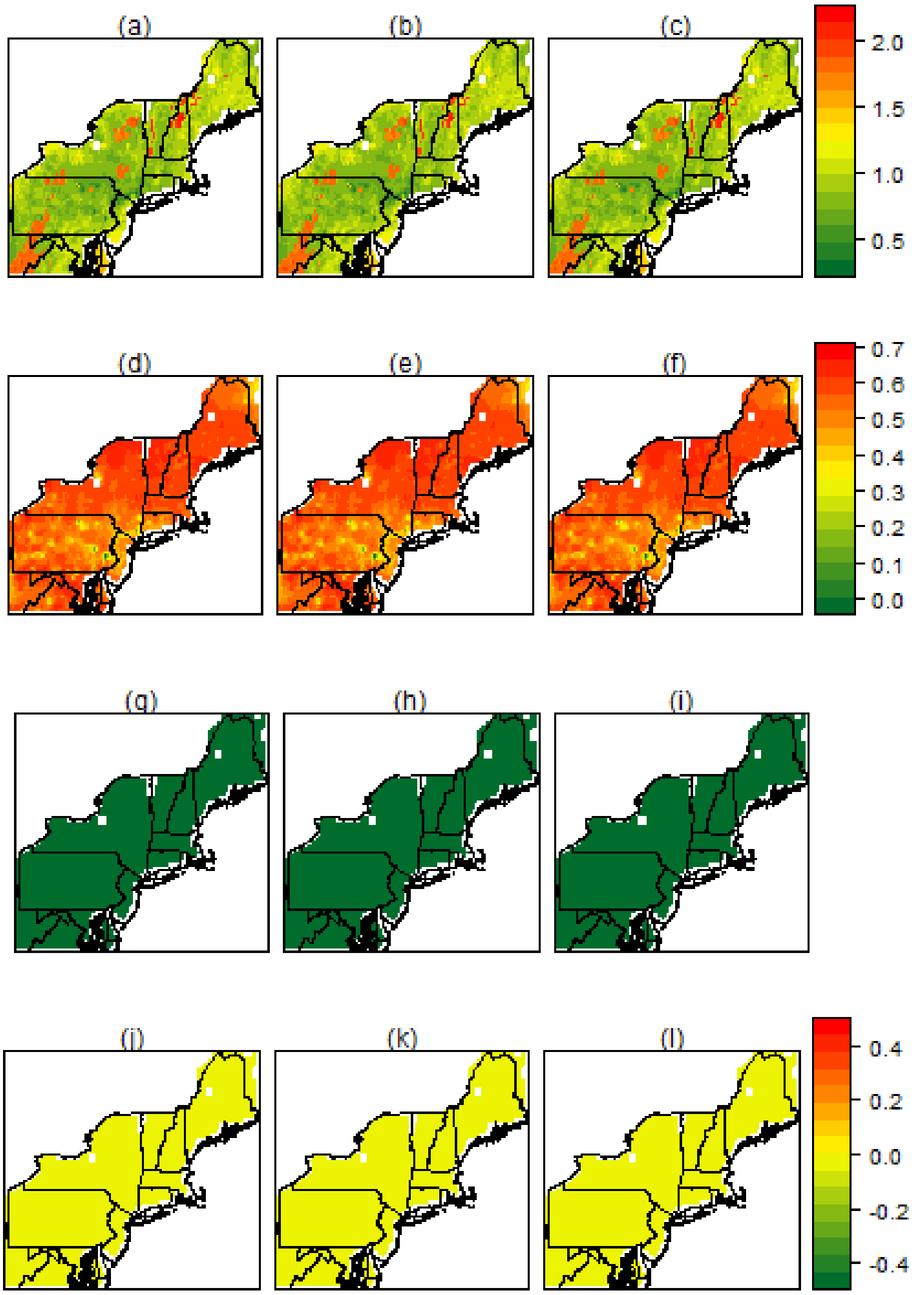

Figure AVIII. 1.36.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

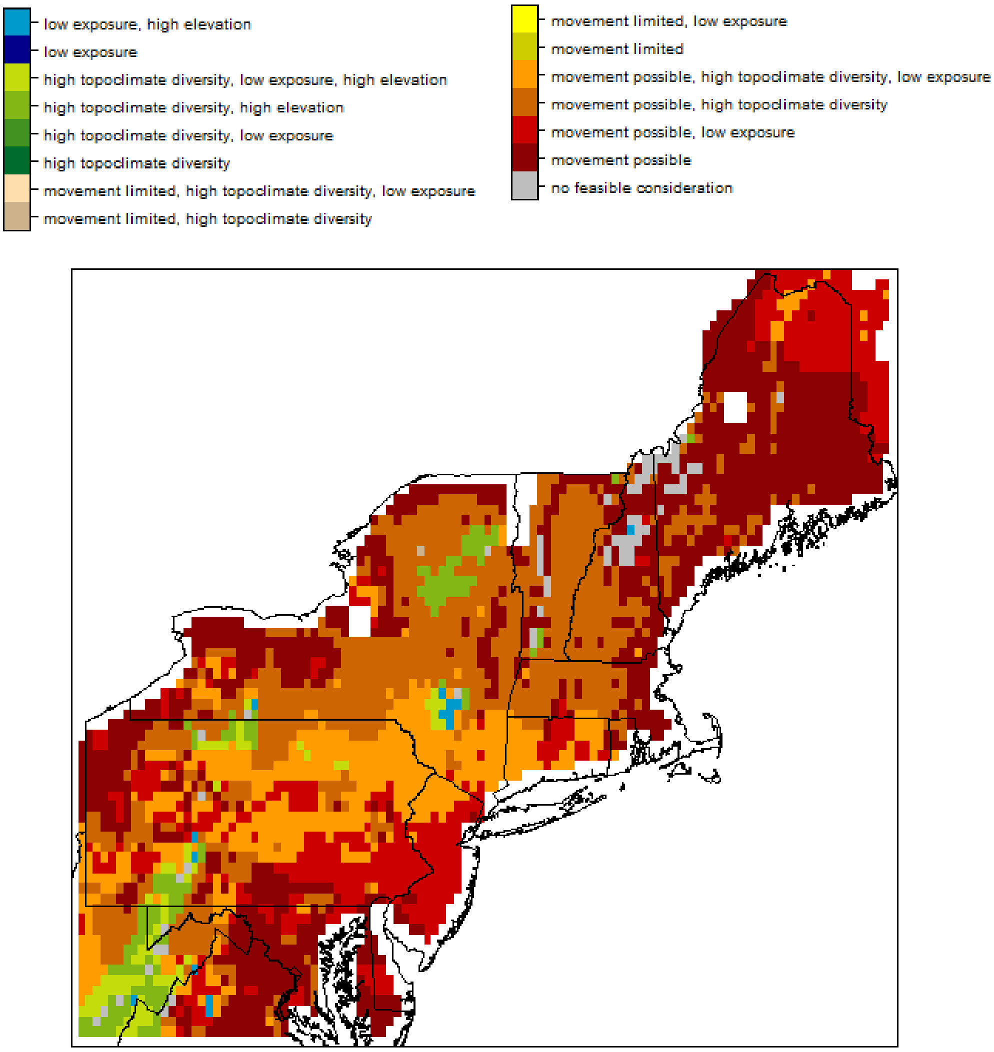

Figure AVIII. 1.36.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

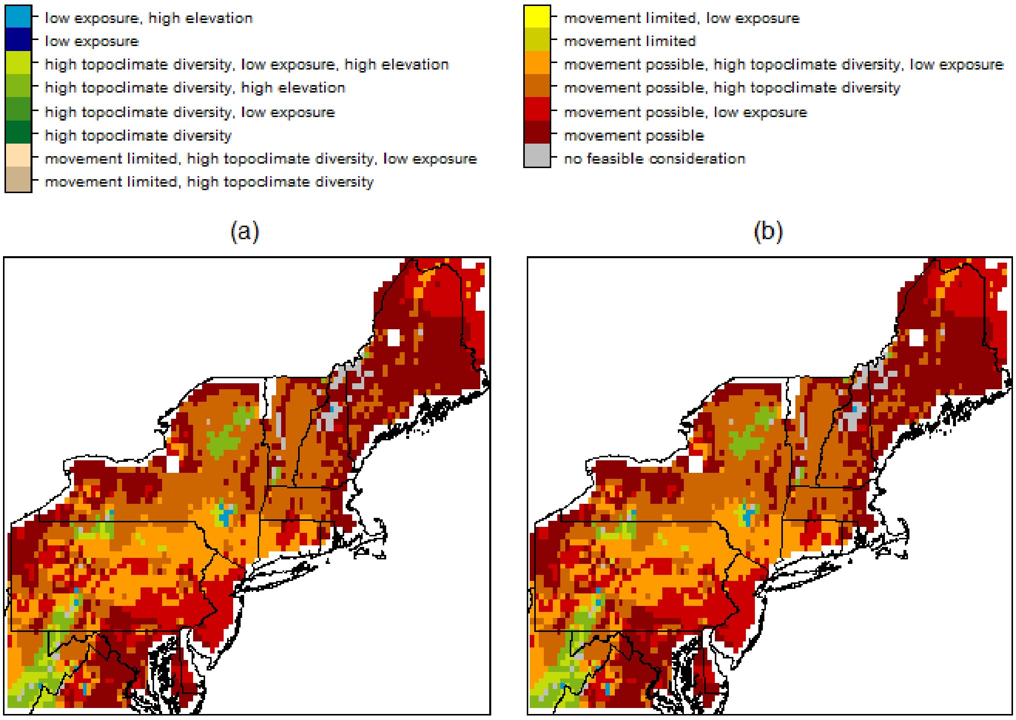

Figure AVIII. 1.36.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.37 Barn owl (*Tyto alba*)

Table AVIII. 1.37.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.75	0.50	0.66	0.00	1.00	25.00
low	0.50	0.50	0.66	0.00	1.00	10.00
high	1.00	0.50	0.66	0.00	1.00	60.00

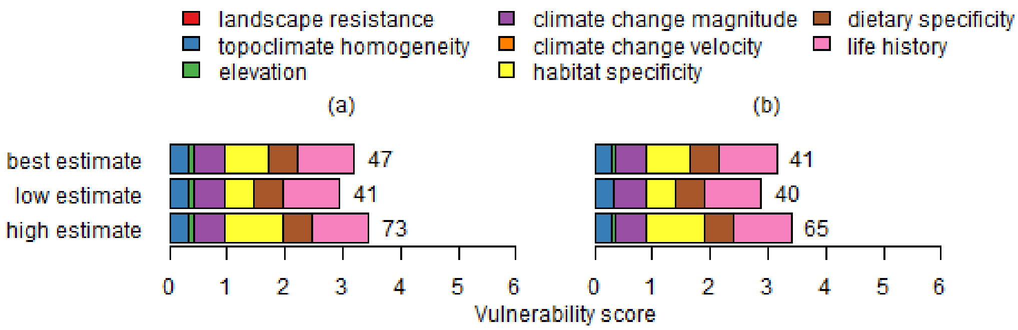

Figure AVIII. 1.37.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

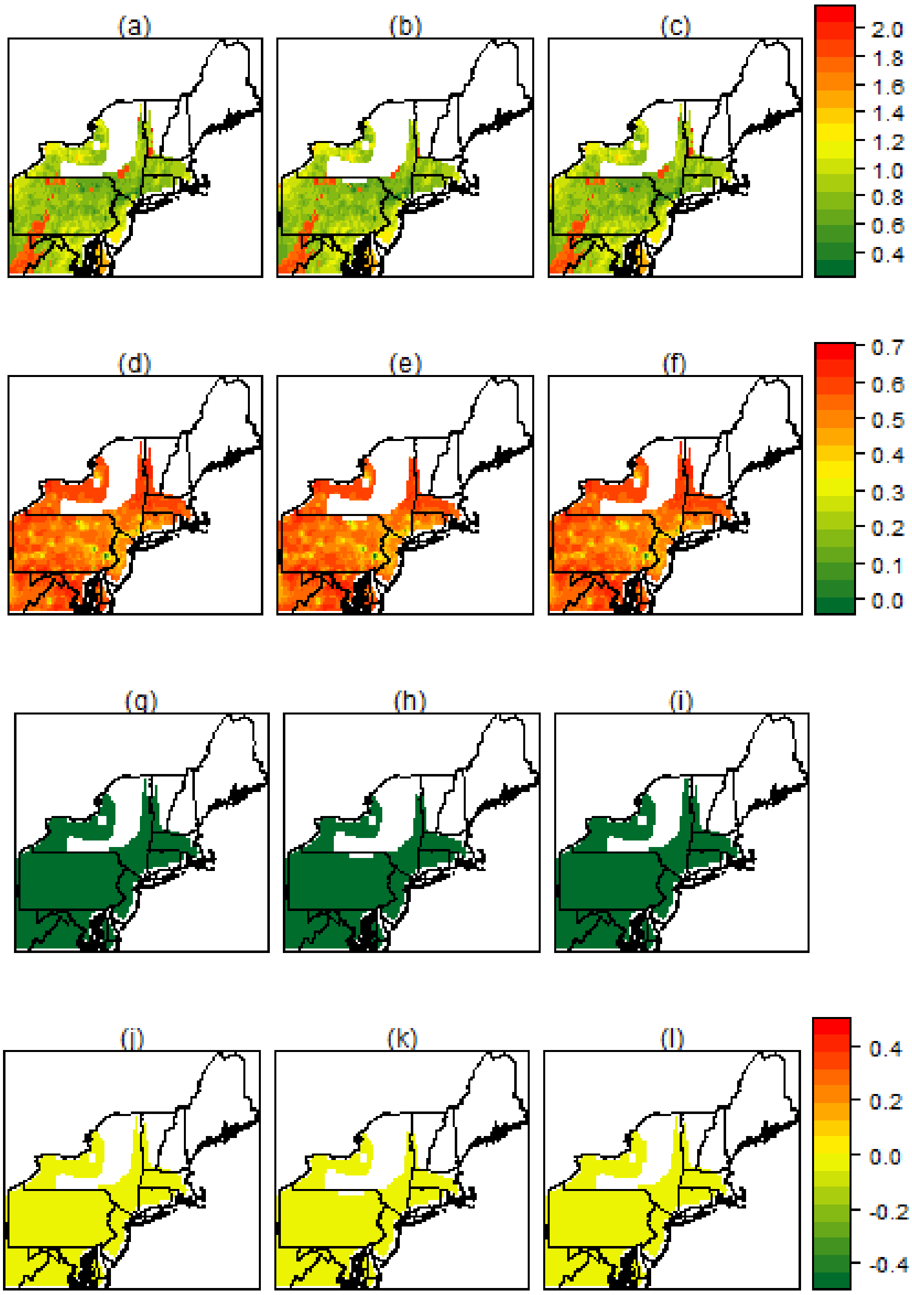

Figure AVIII. 1.37.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

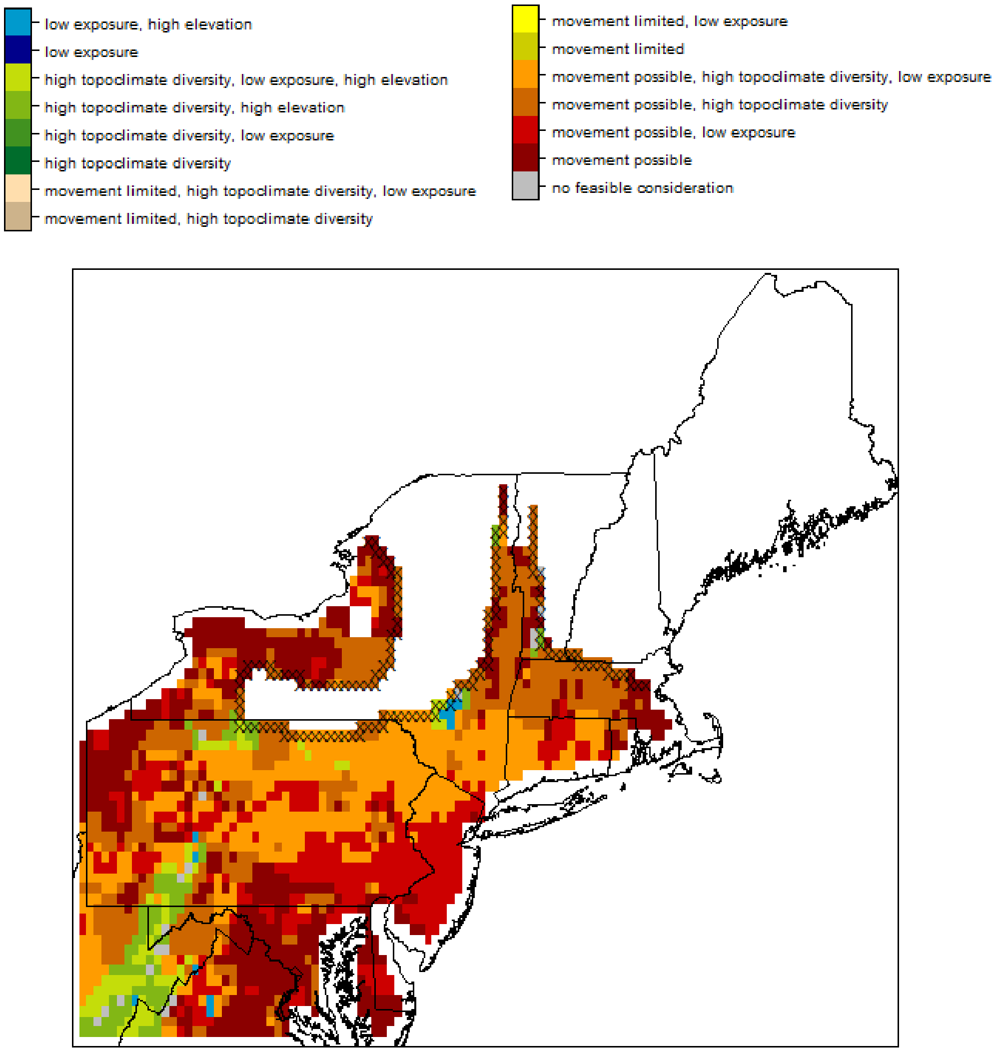

Figure AVIII. 1.37.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

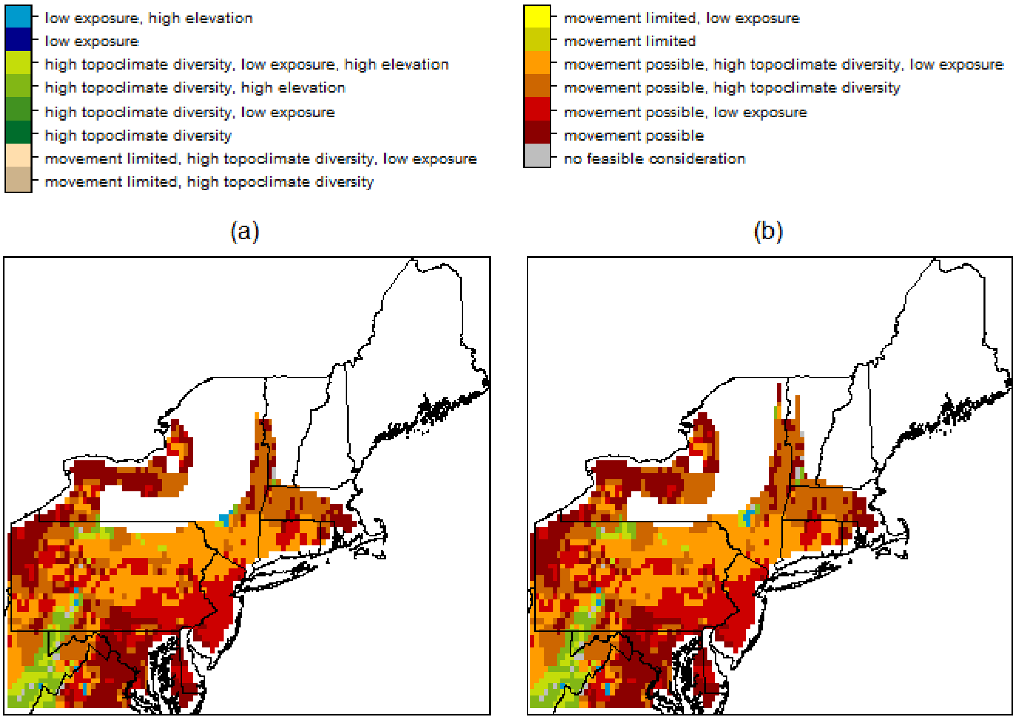

Figure AVIII. 1.37.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.38 Whip-poor-will (*Caprimulgus vociferus*)

Table AVIII. 1.38.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	20.00
low	0.50	0.50	0.66	0.00	1.00	10.00
high	0.60	0.50	0.66	0.00	1.00	150.00

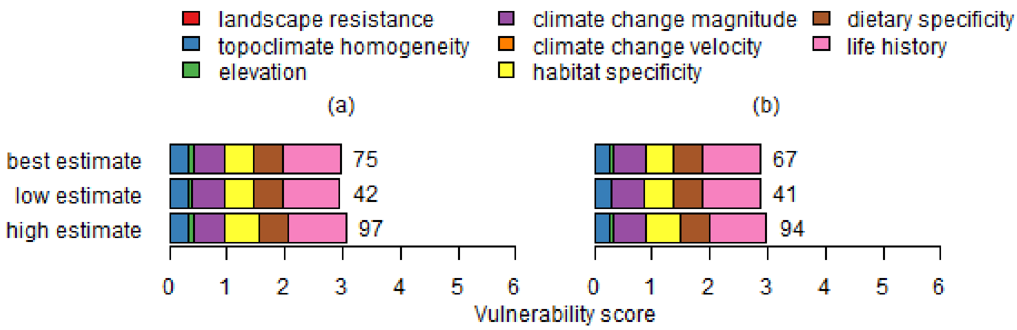

Figure AVIII. 1.38.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

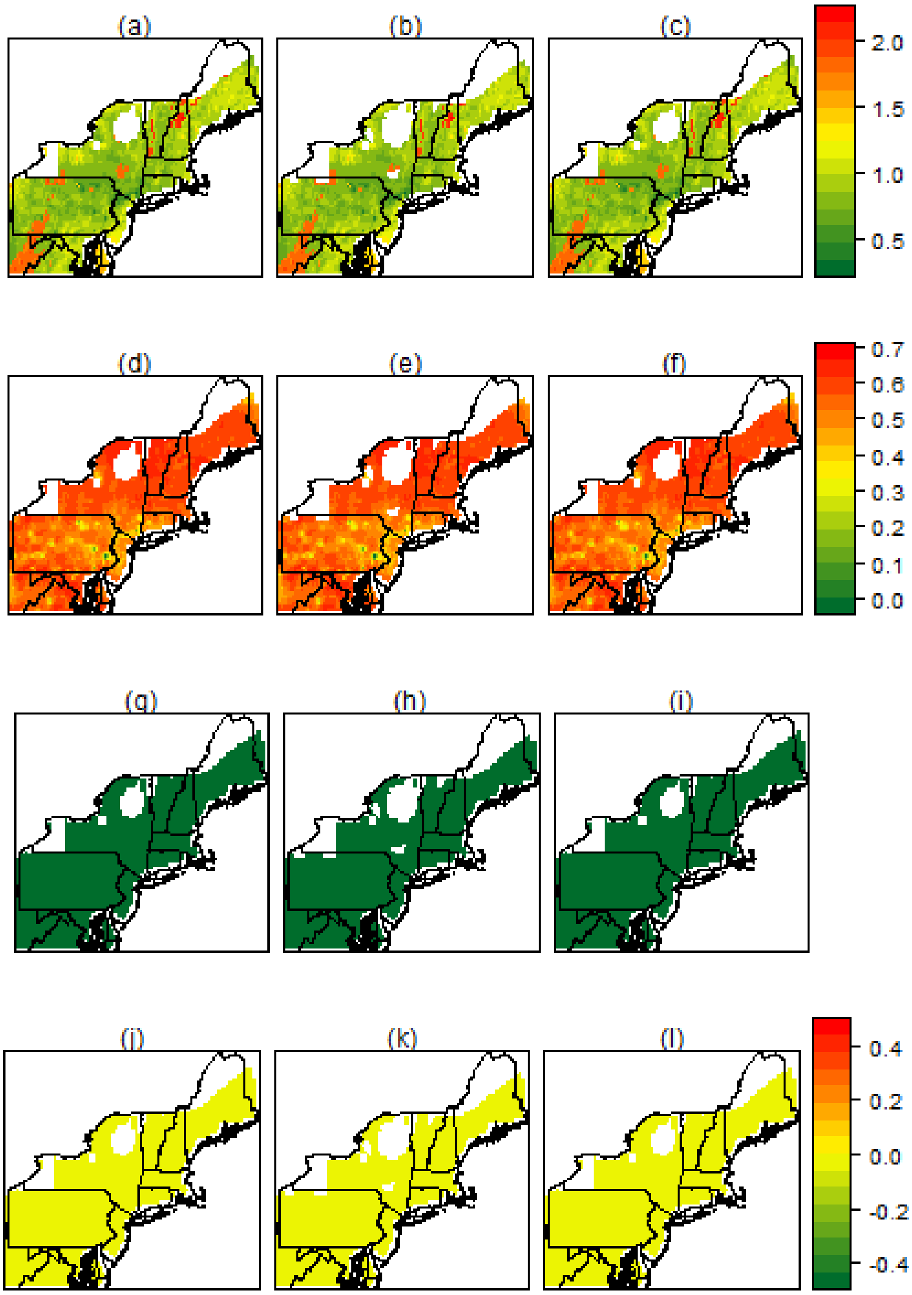

Figure AVIII. 1.38.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

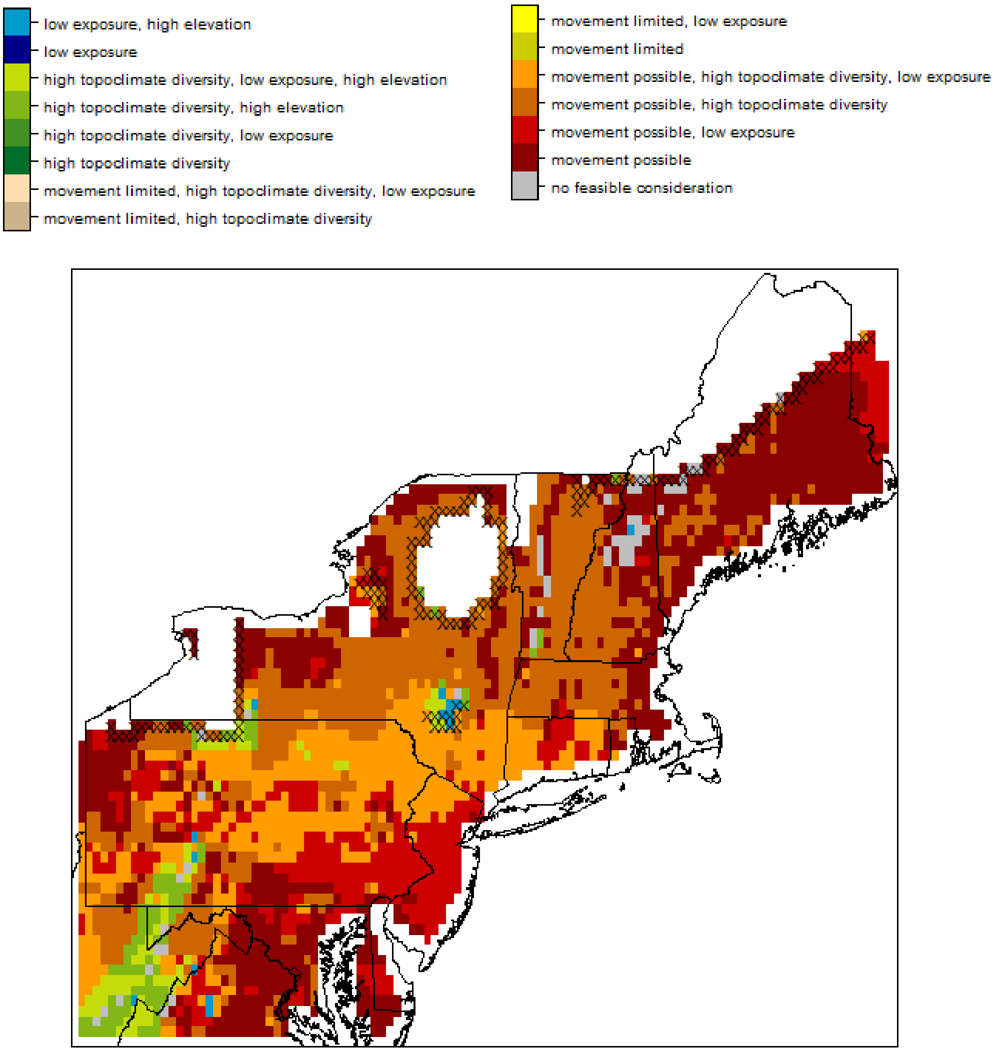

Figure AVIII. 1.38.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

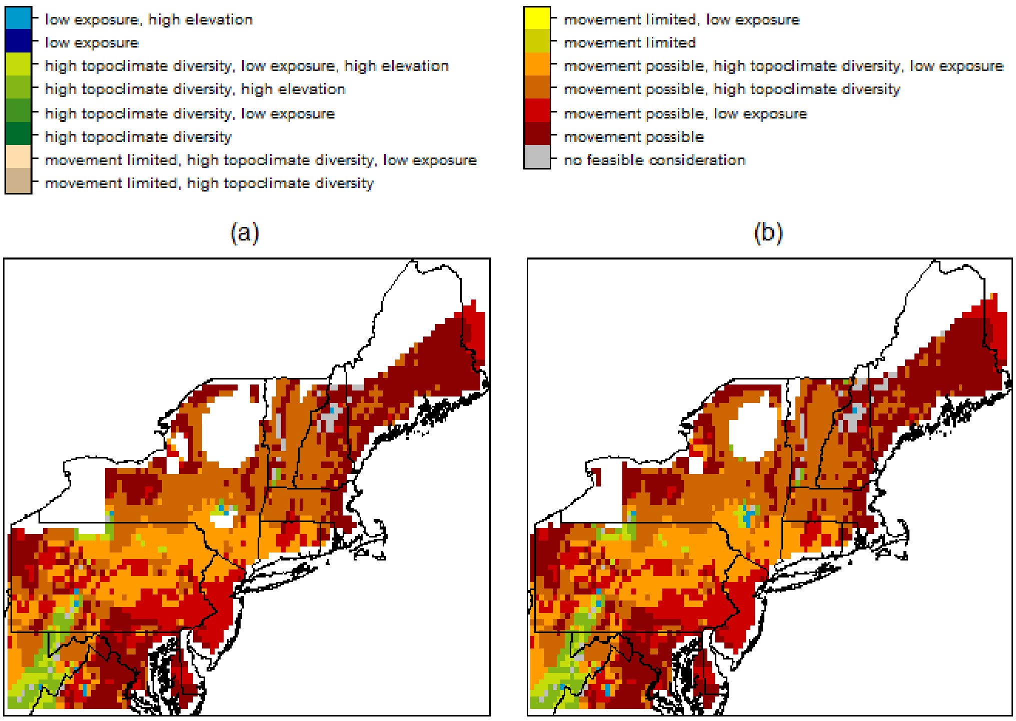

Figure AVIII. 1.38.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.39 Common nighthawk (*Chordeiles minor*)

Table AVIII. 1.39.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	12.50
low	0.50	0.50	0.66	0.00	1.00	5.50
high	0.57	0.50	0.71	0.02	1.00	175.00

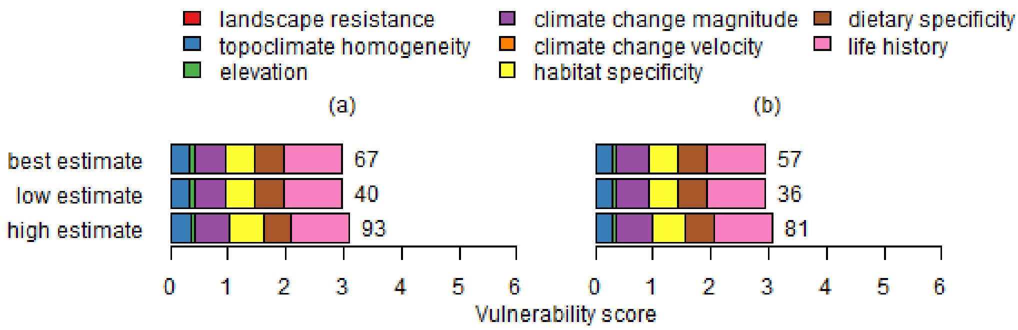

Figure AVIII. 1.39.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

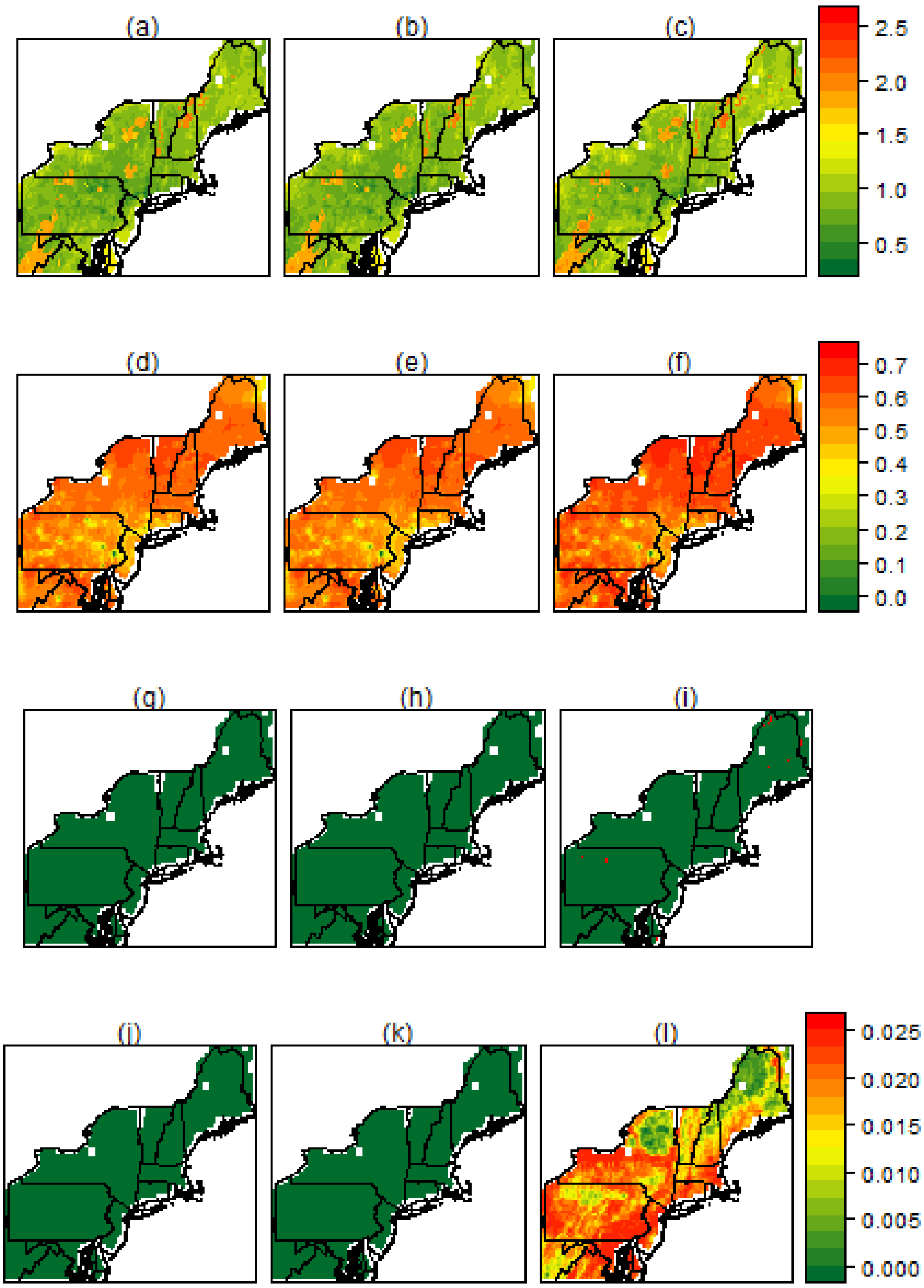

Figure AVIII. 1.39.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

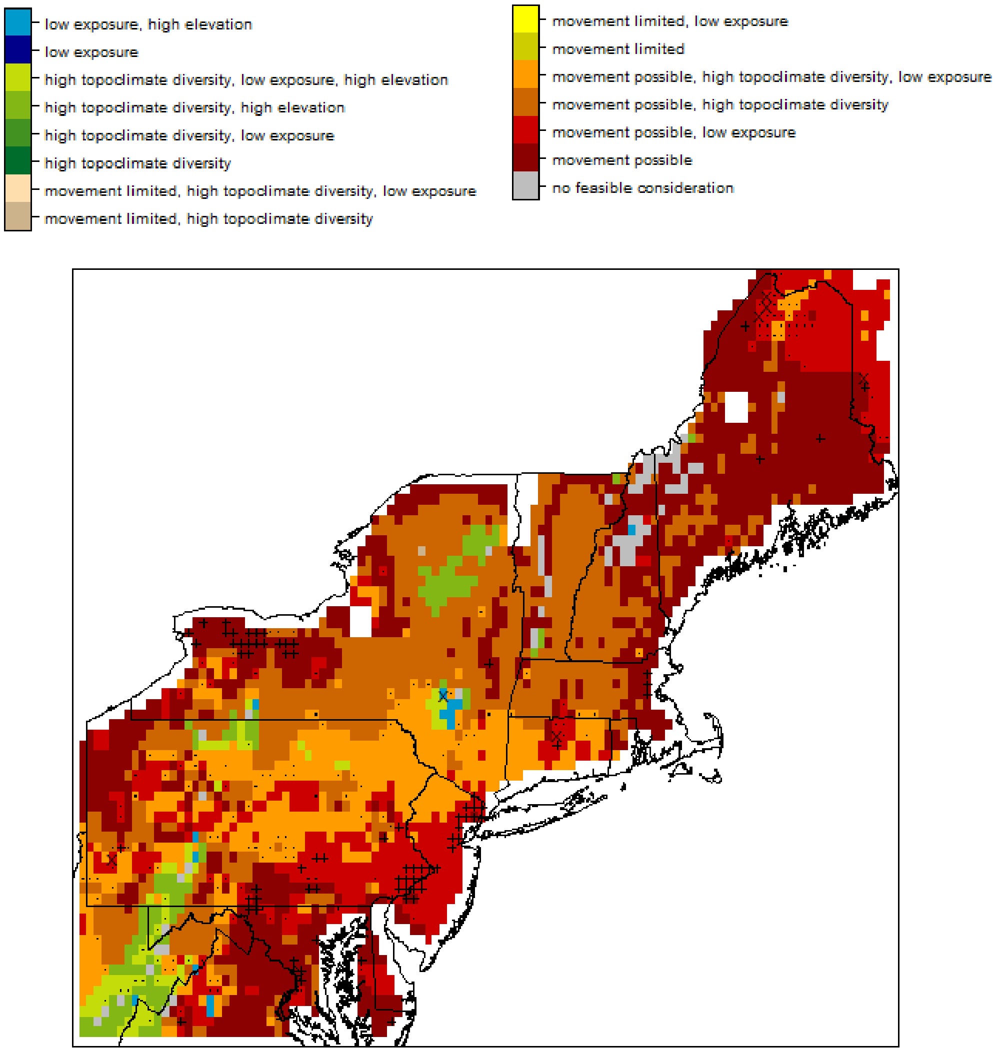

Figure AVIII. 1.39.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

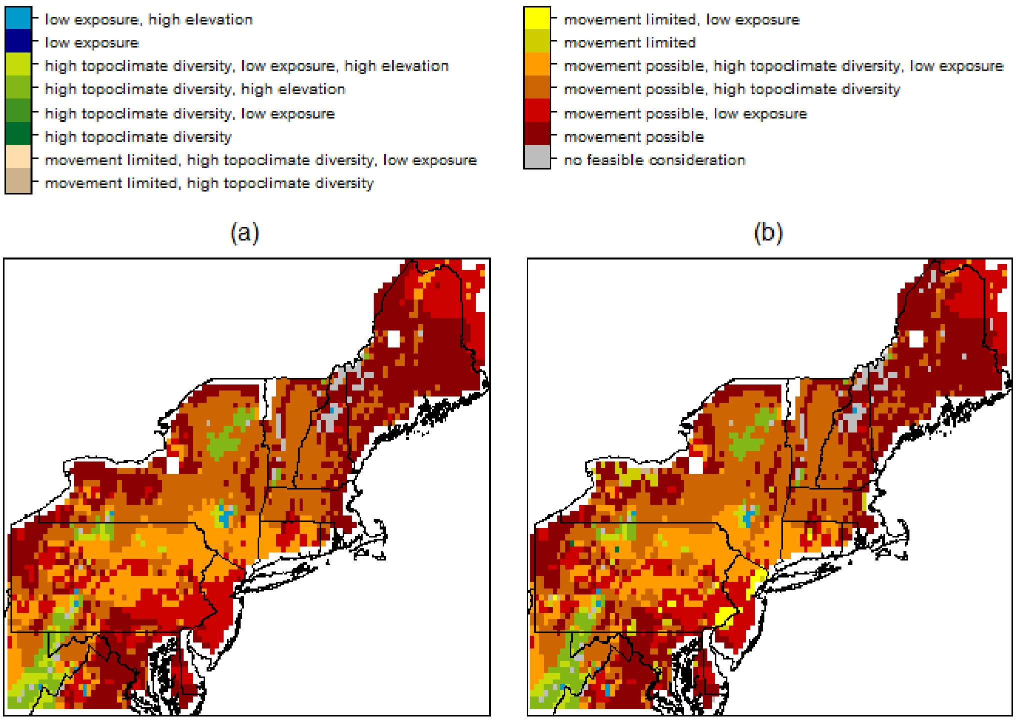

Figure AVIII. 1.39.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.40 Red-headed woodpecker (*Melanerpes erythrocephalus*)

Table AVIII. 1.40.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.33	0.66	0.00	1.00	10.17
low	0.30	0.33	0.66	0.00	1.00	3.75
high	0.67	0.40	0.66	0.05	1.00	85.00

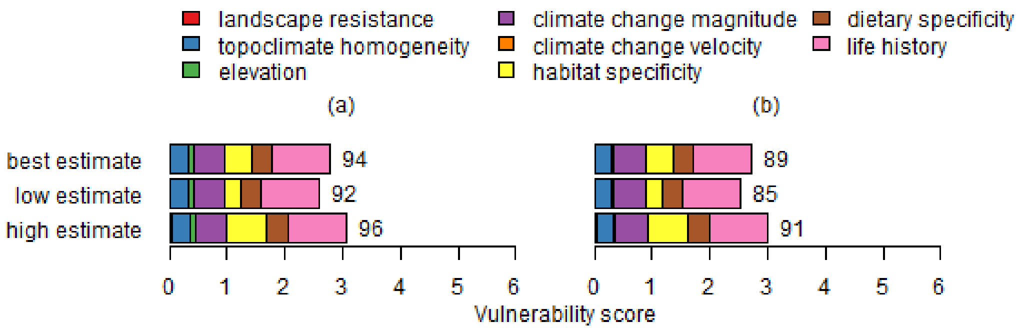

Figure AVIII. 1.40.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

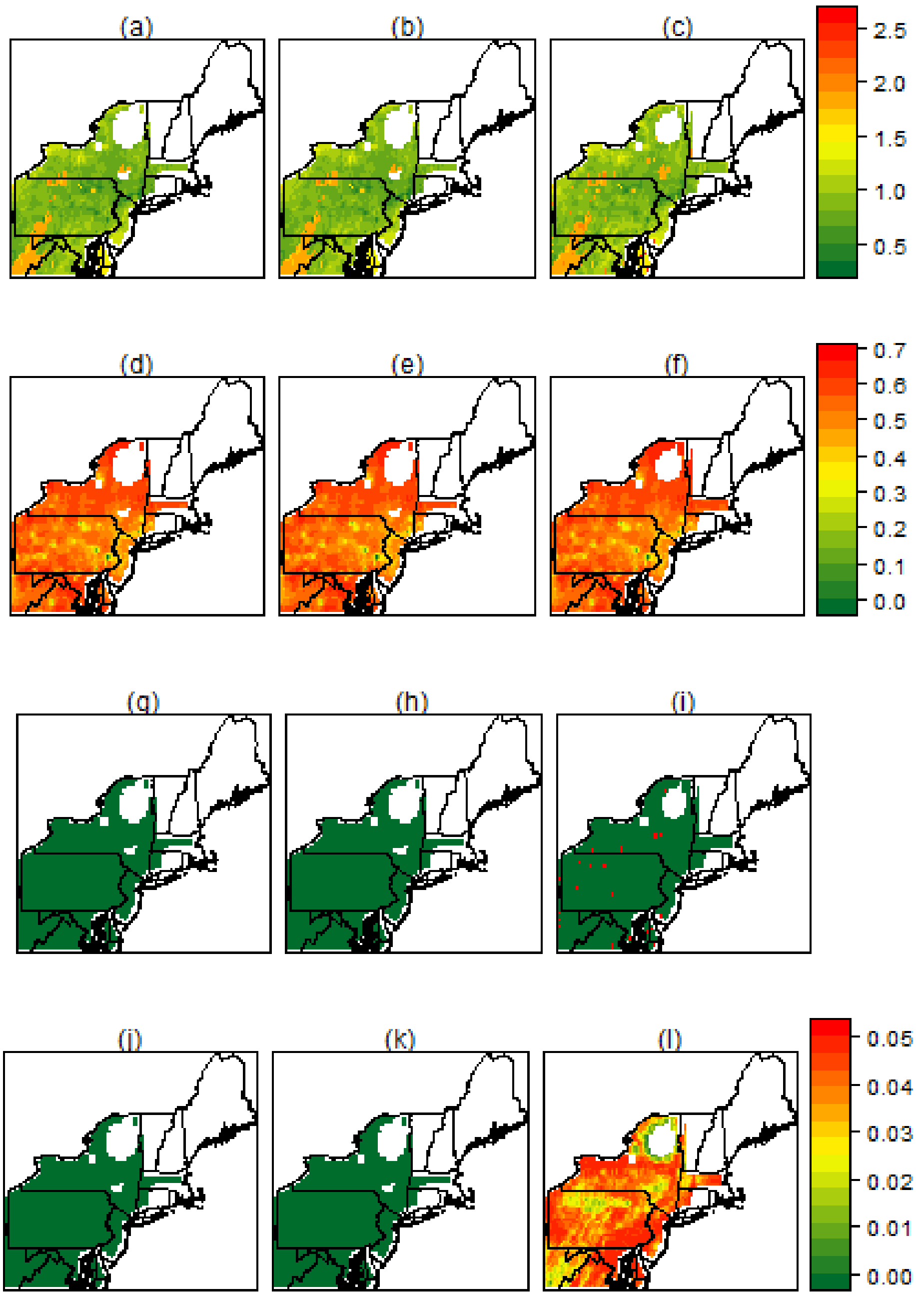

Figure AVIII. 1.40.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

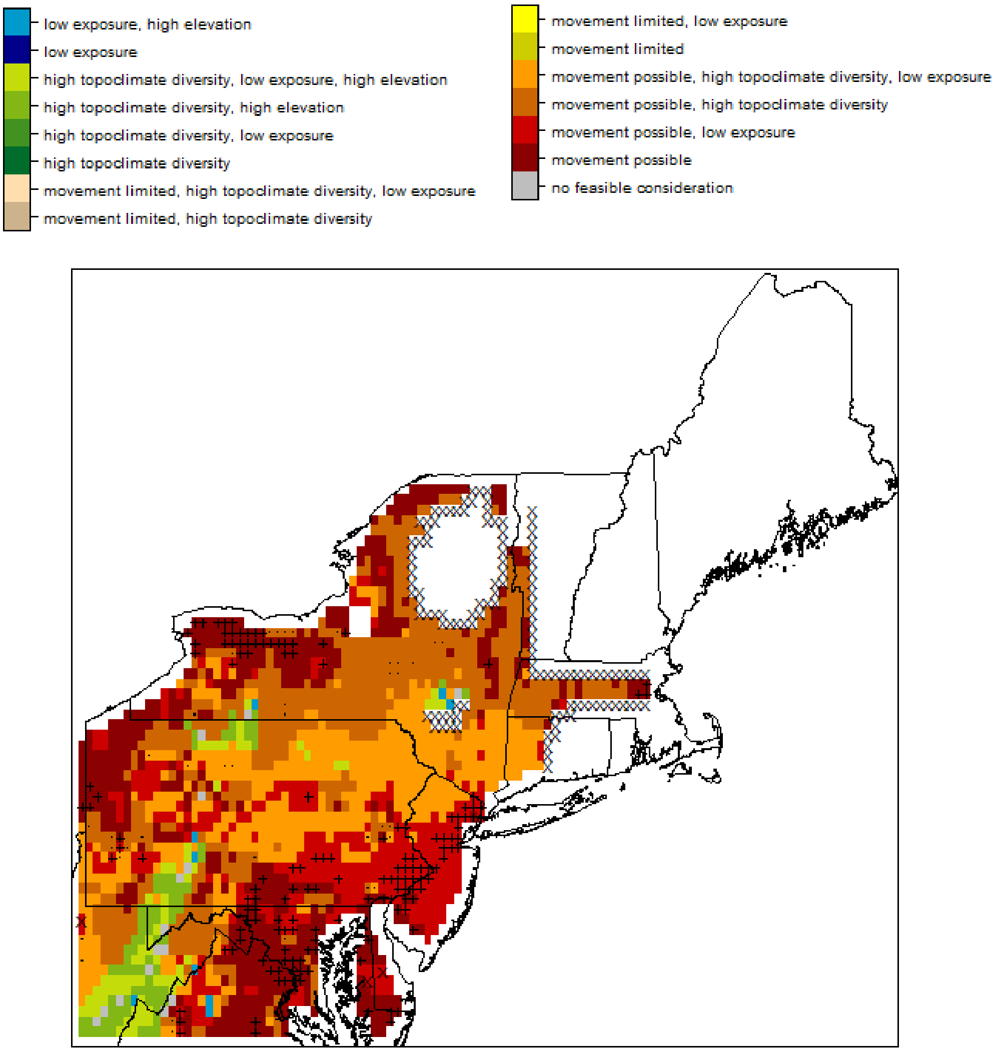

Figure AVIII. 1.40.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

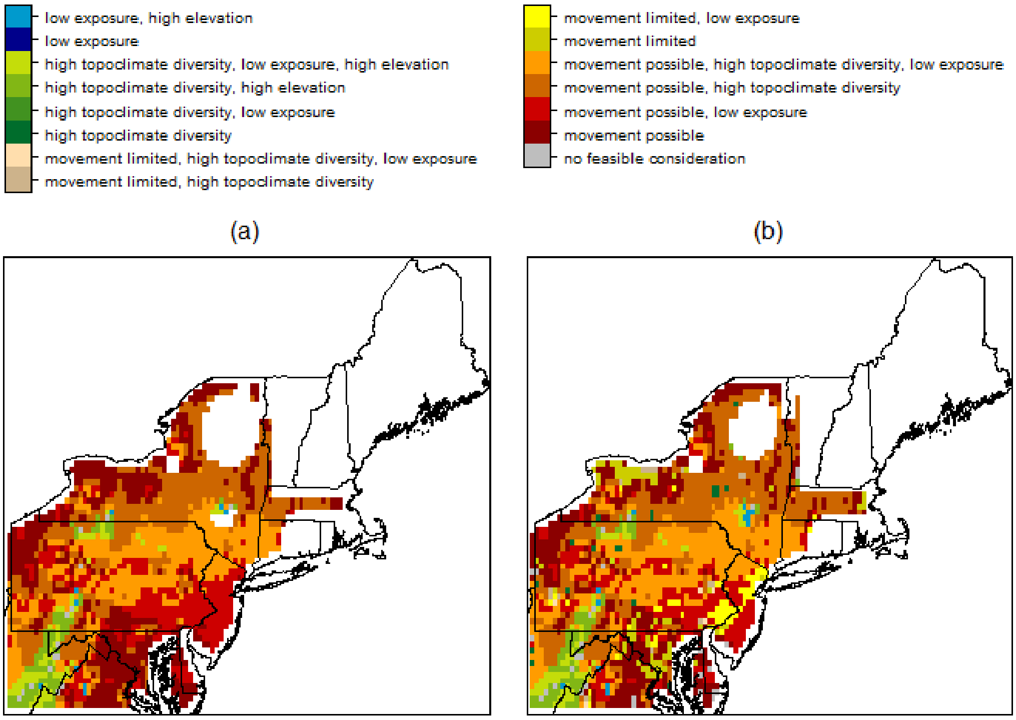

Figure AVIII. 1.40.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.41 Three-toed woodpecker (*Picoides dorsalis*)

Table AVIII. 1.41.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	1.00	0.00	1.00	0.25
low	0.44	0.43	0.86	0.00	1.00	0.00
high	0.61	0.67	1.00	0.10	1.00	20.00

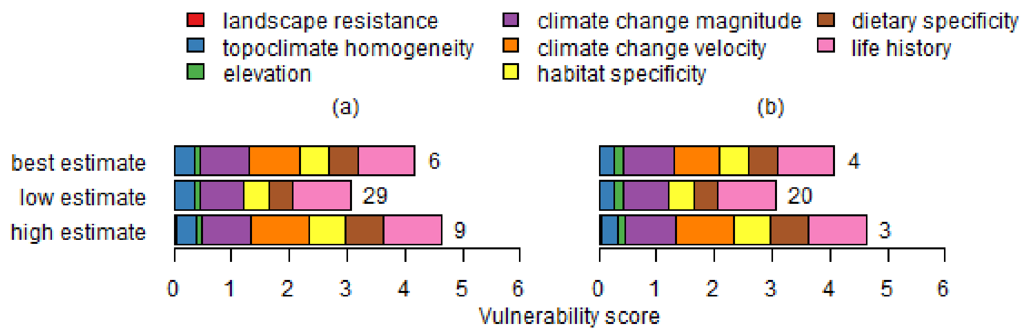

Figure AVIII. 1.41.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

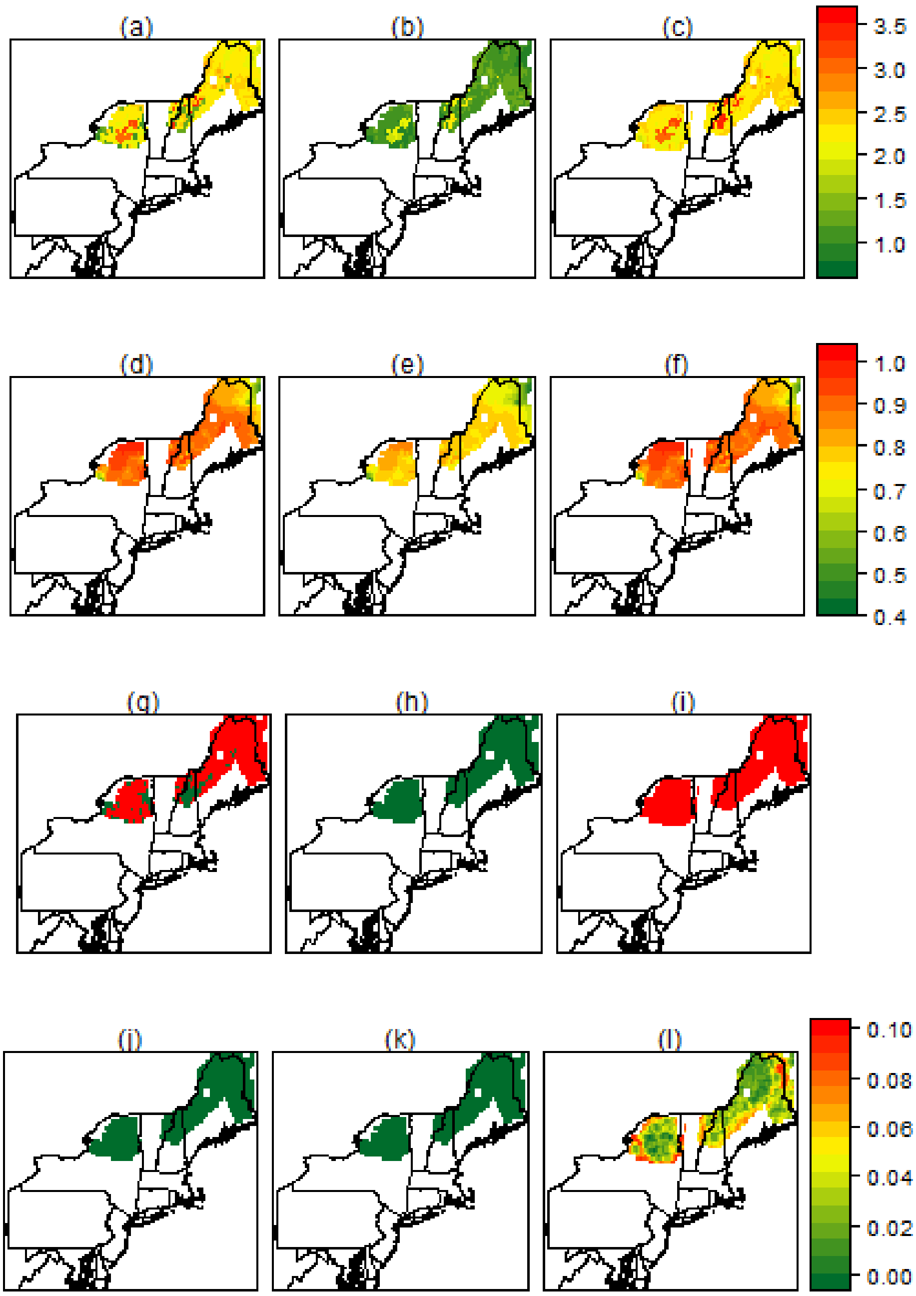

Figure AVIII. 1.41.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

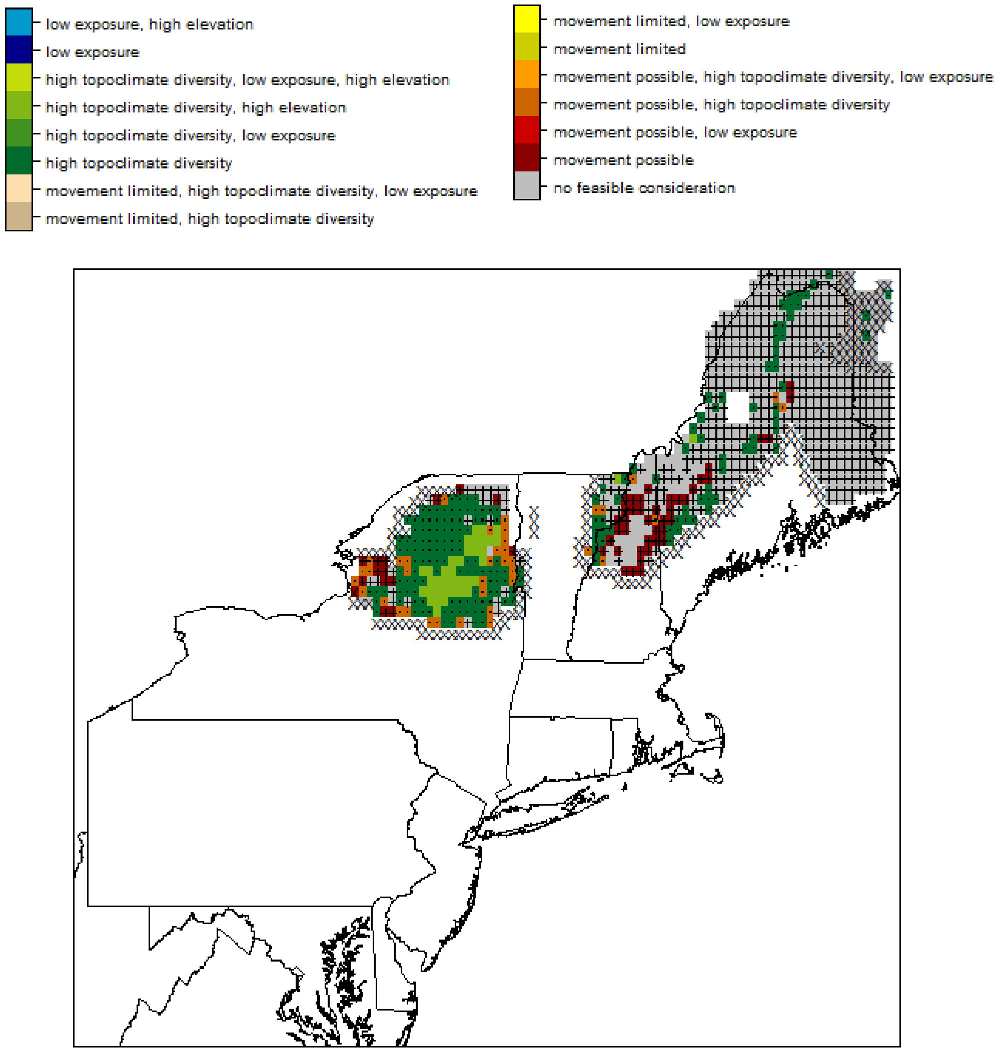

Figure AVIII. 1.41.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

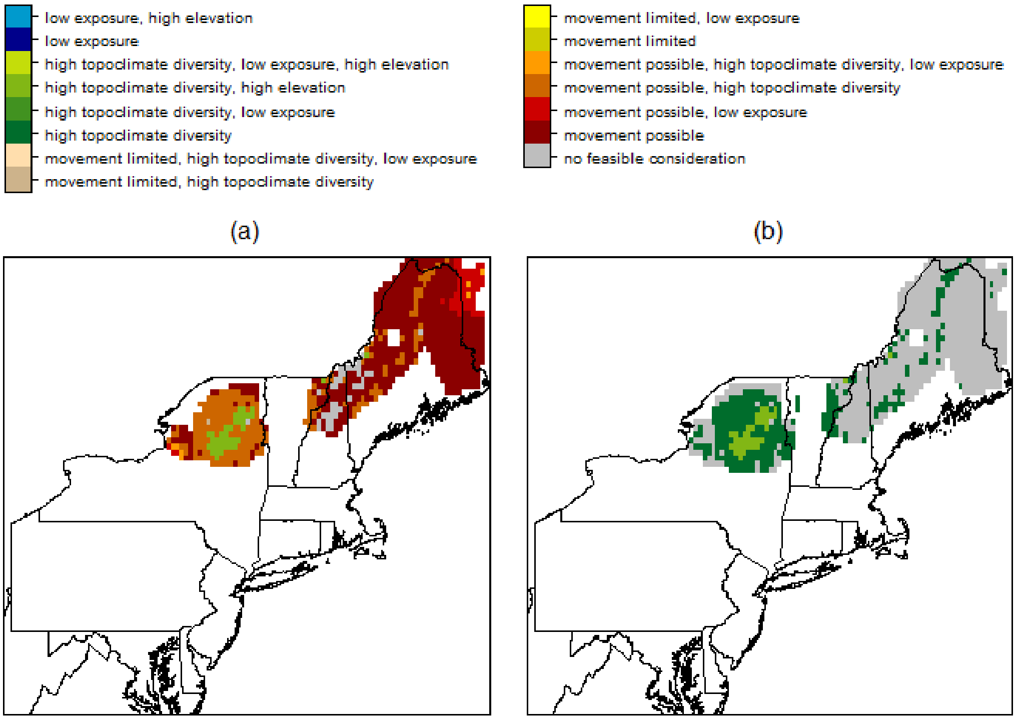

Figure AVIII. 1.41.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.42 Horned lark (*Eremophila alpestris*)

Table AVIII. 1.42.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.38	0.66	0.12	1.00	5.50
low	0.40	0.25	0.64	0.07	1.00	0.83
high	0.53	0.38	0.69	0.20	1.00	45.00

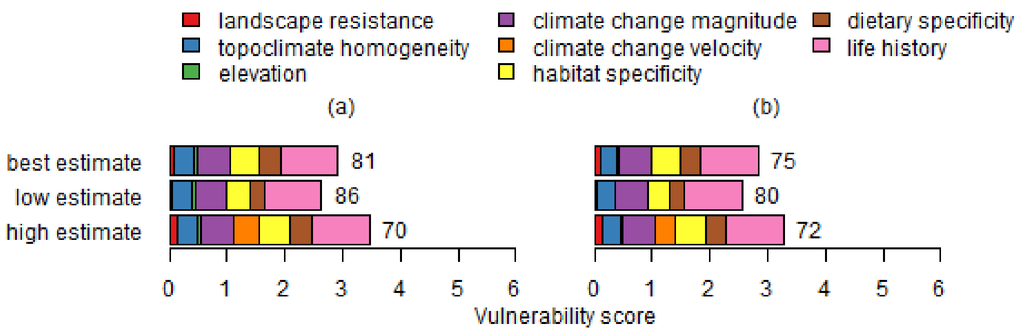

Figure AVIII. 1.42.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

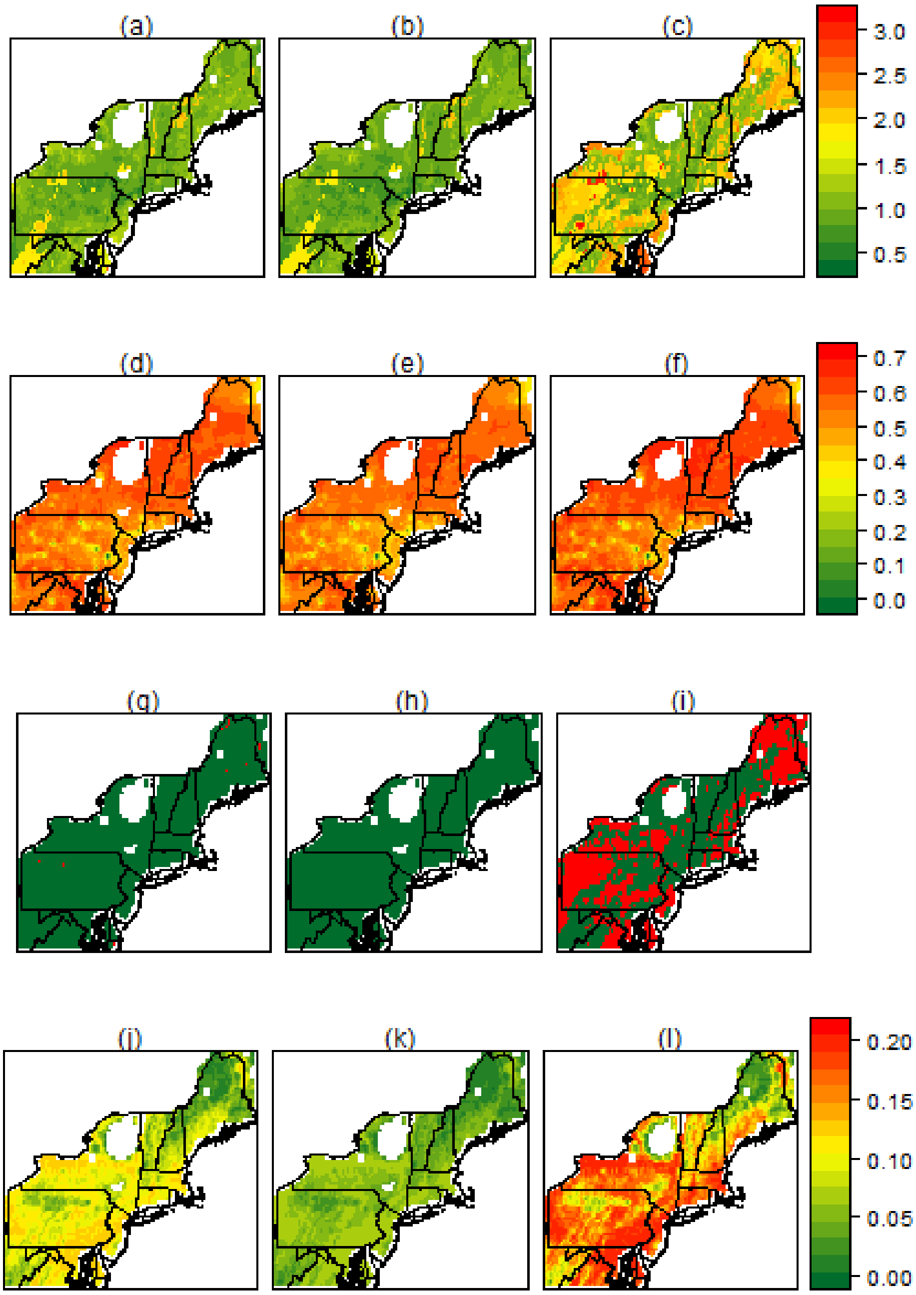

Figure AVIII. 1.42.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

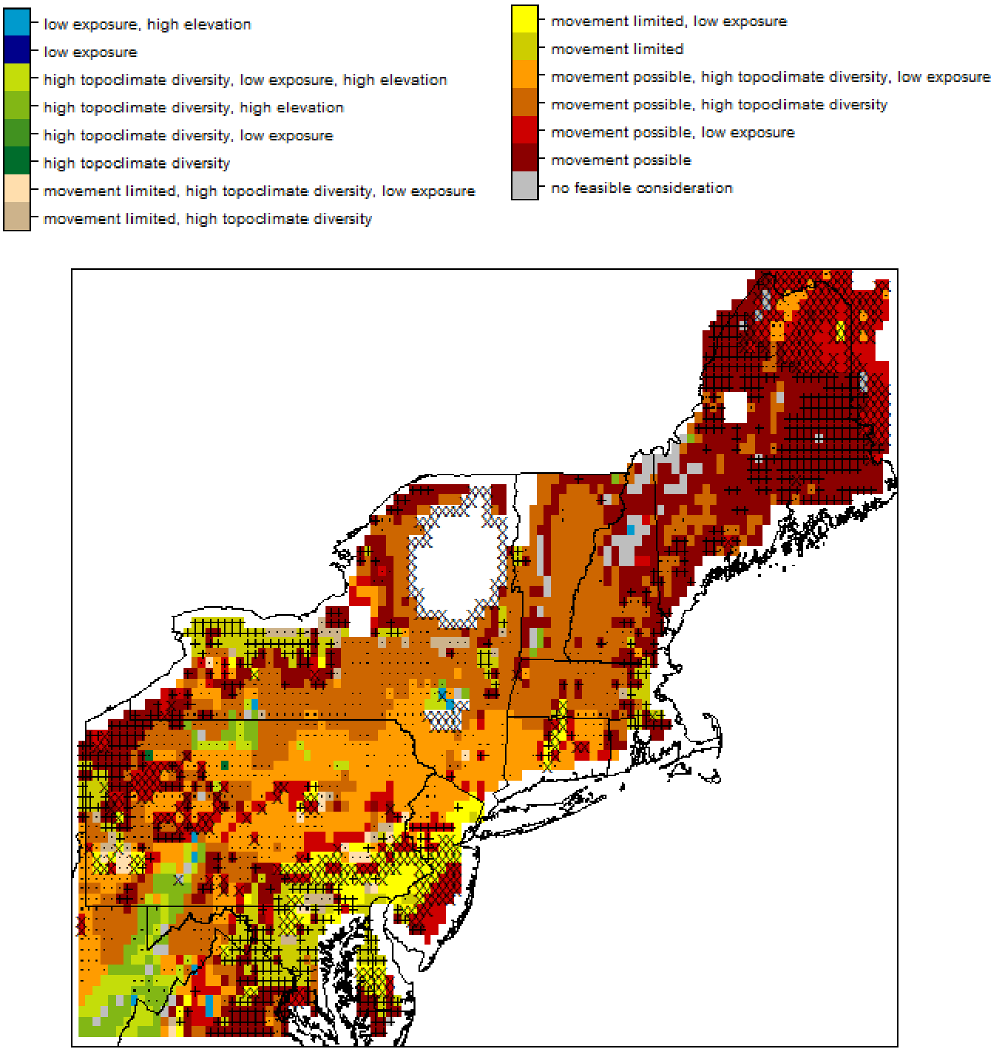

Figure AVIII. 1.42.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

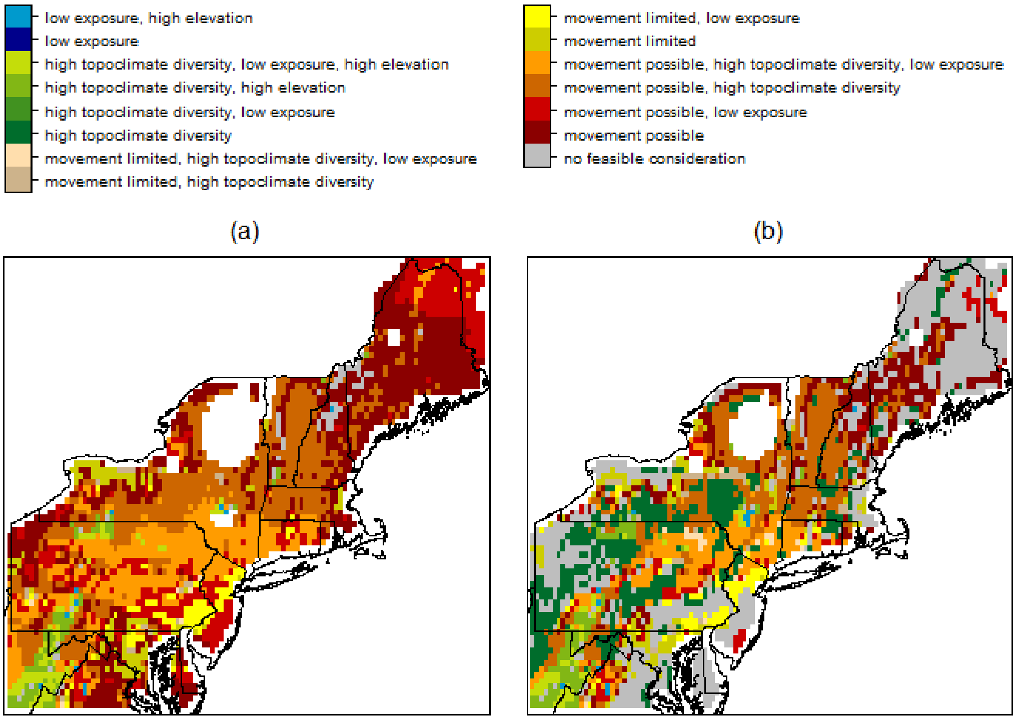

Figure AVIII. 1.42.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.43 Scarlet tanager (*Piranga olivacea*)

Table AVIII. 1.43.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	12.50
low	0.37	0.38	0.66	0.00	1.00	2.50
high	0.53	0.50	0.68	0.05	1.00	192.50

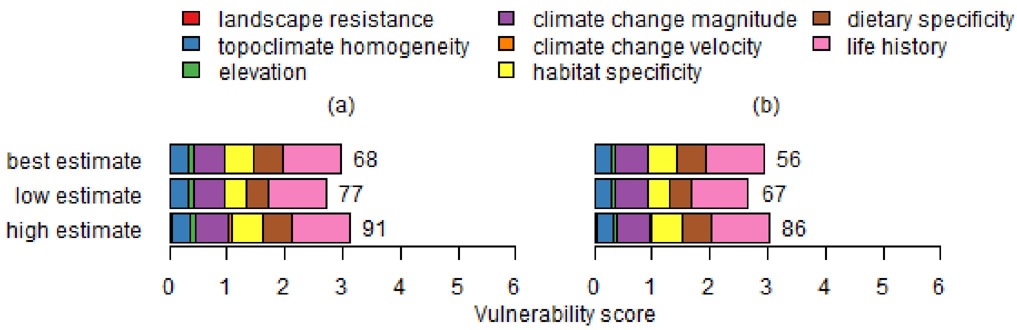

Figure AVIII. 1.43.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

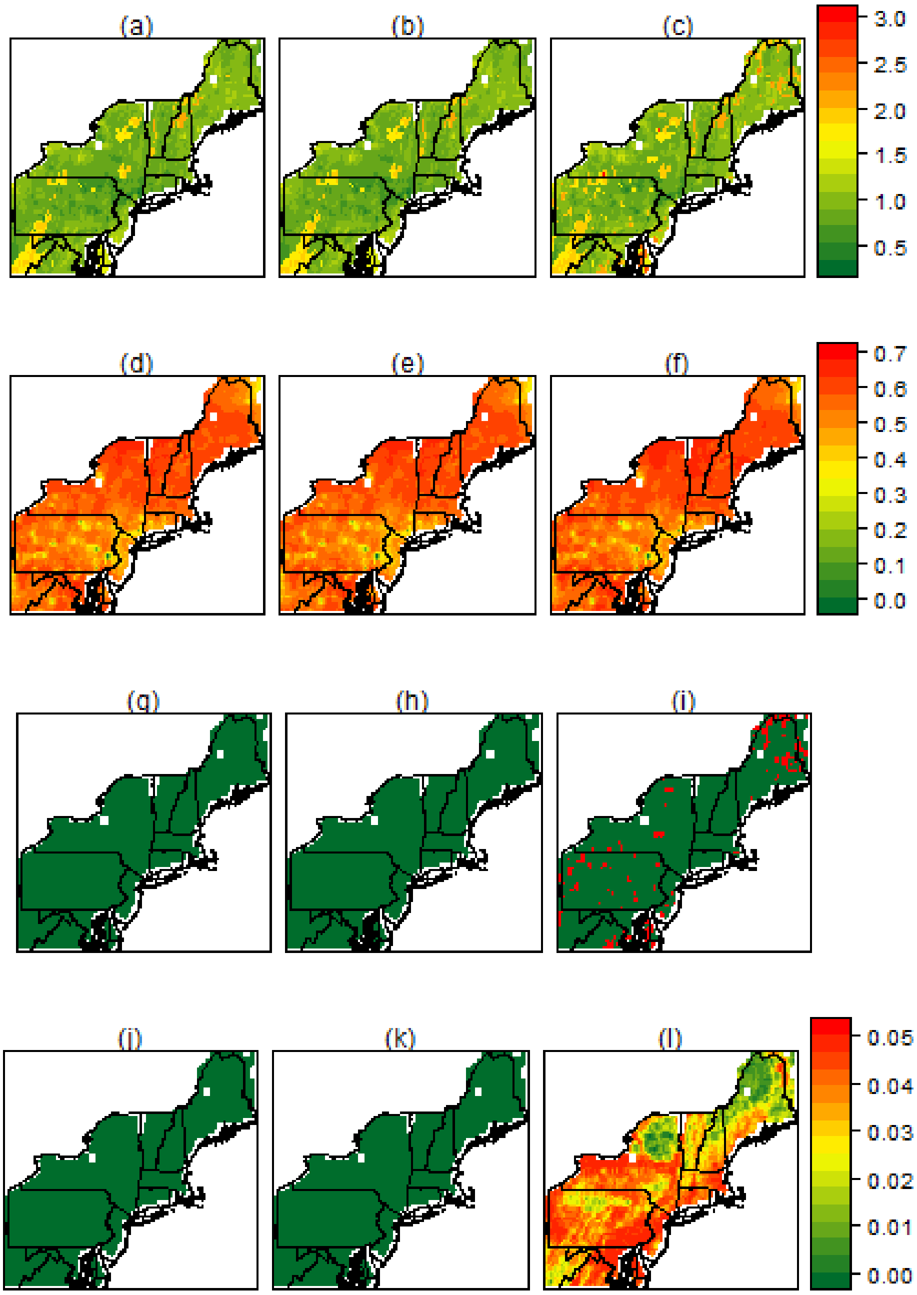

Figure AVIII. 1.43.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

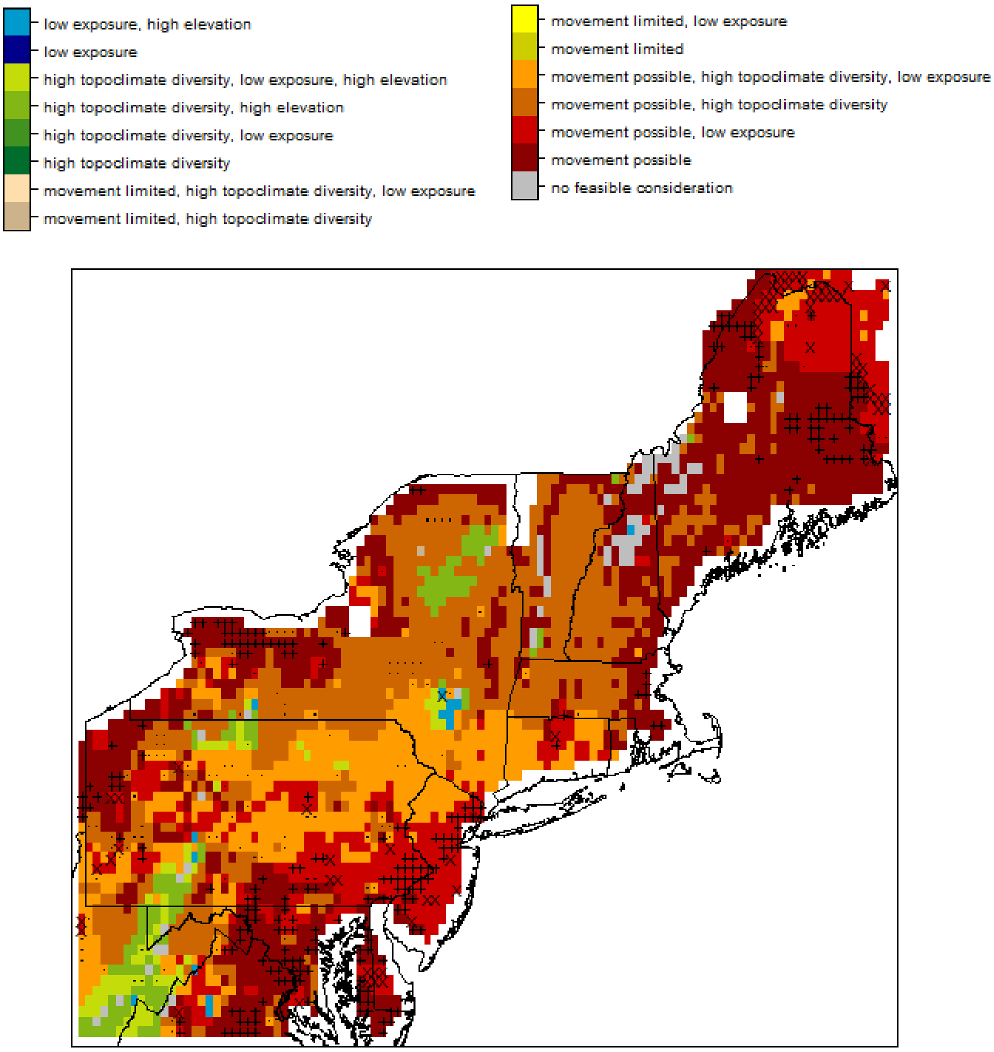

Figure AVIII. 1.43.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

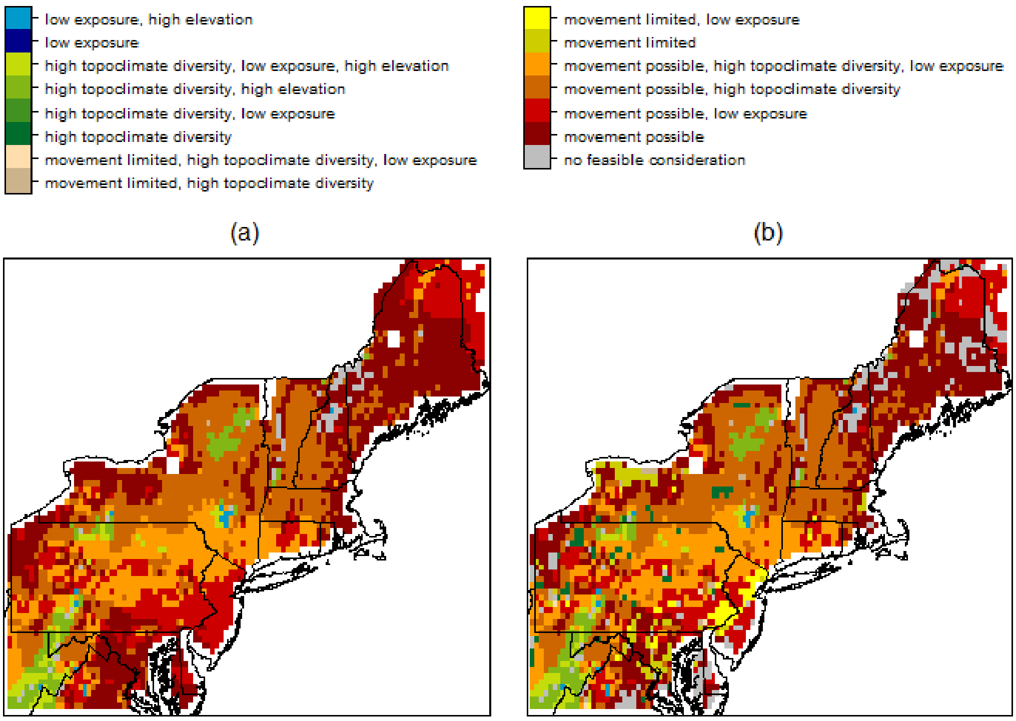

Figure AVIII. 1.43.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.44 Dickcissel (*Spiza americana*)

Table AVIII. 1.44.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.25	1.00	27.50
low	0.39	0.38	0.64	0.14	1.00	5.50
high	0.66	0.50	0.68	0.36	1.00	200.00

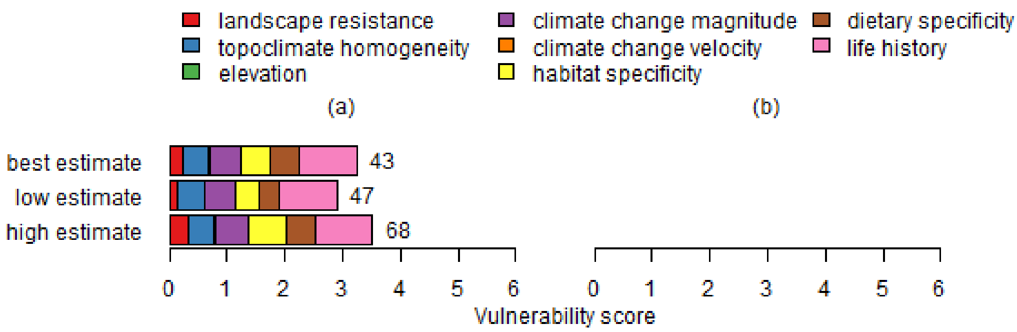

Figure AVIII. 1.44.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

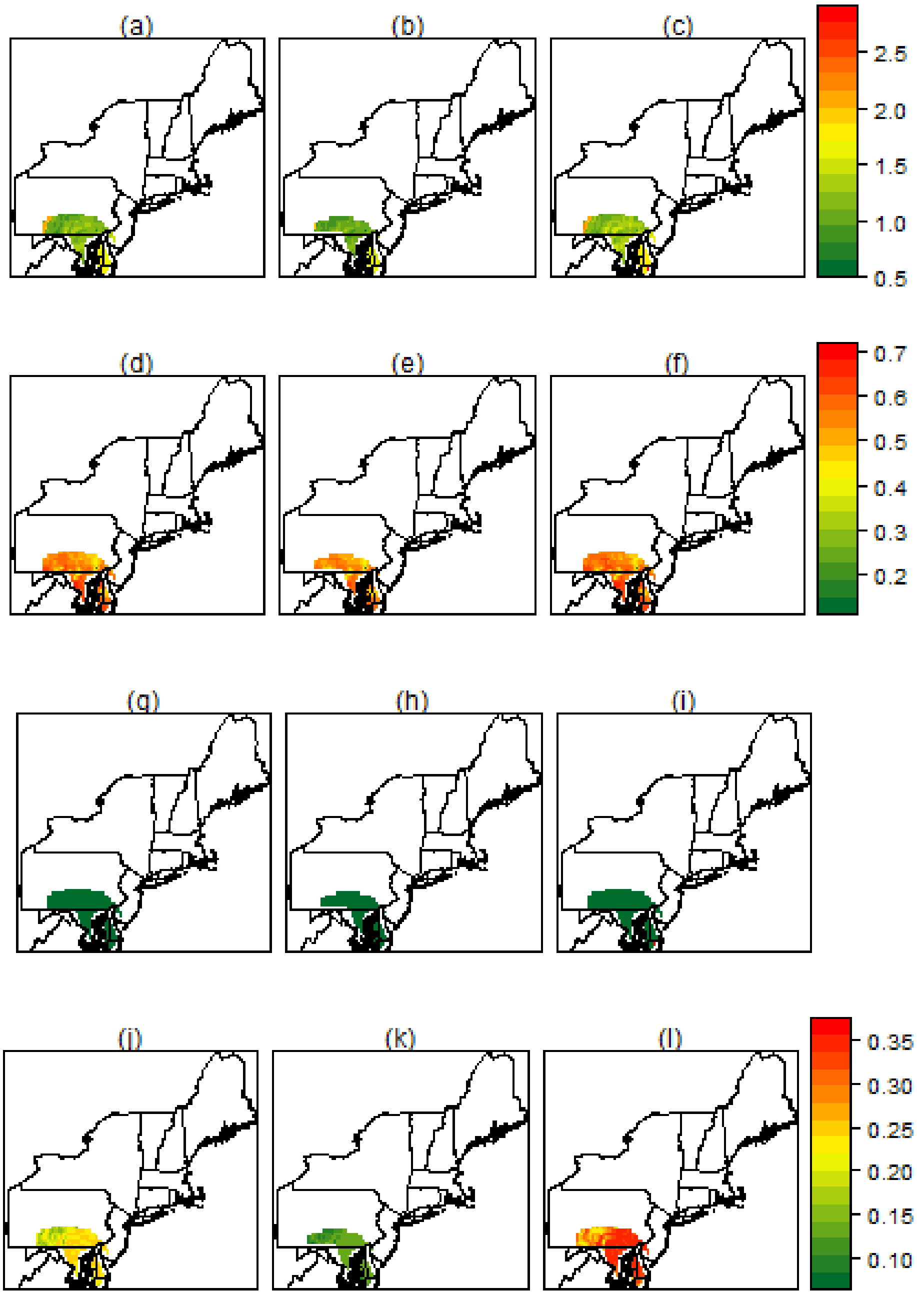

Figure AVIII. 1.44.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

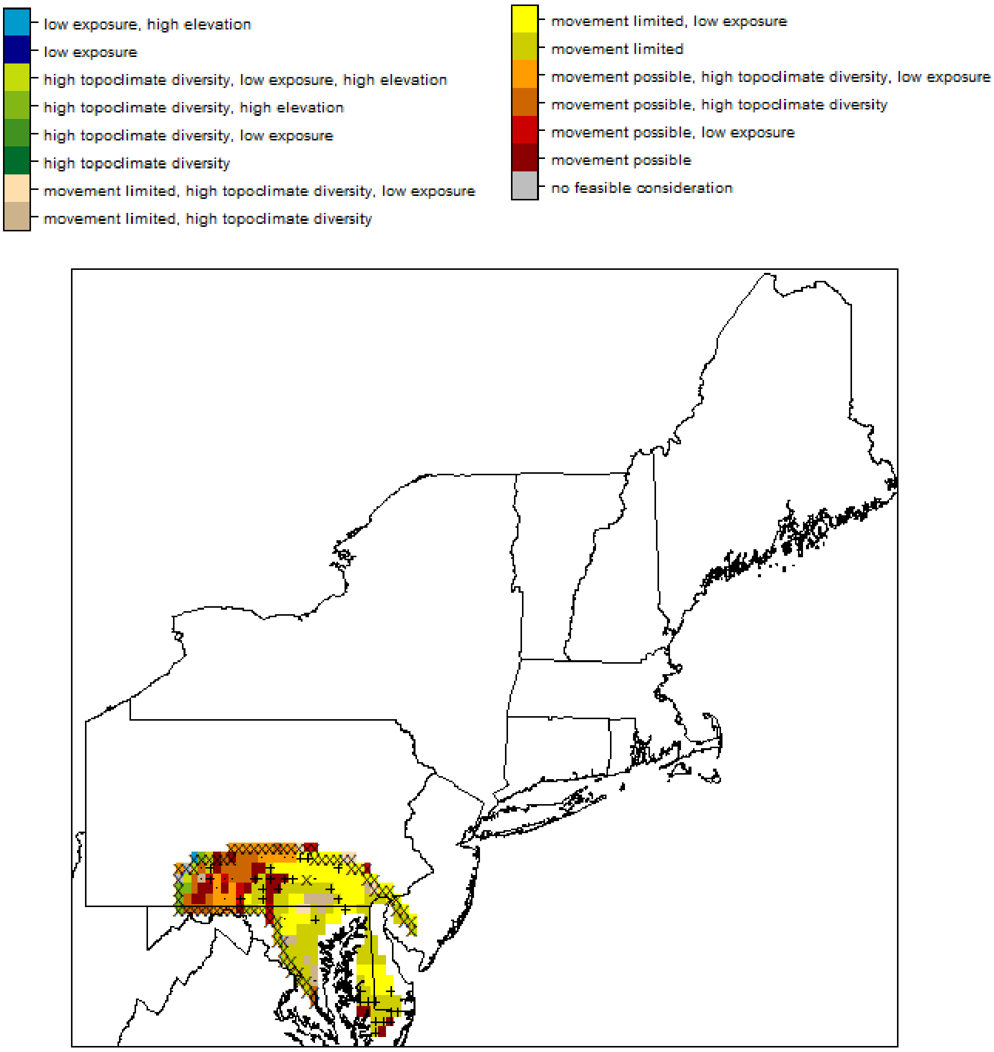

Figure AVIII. 1.44.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

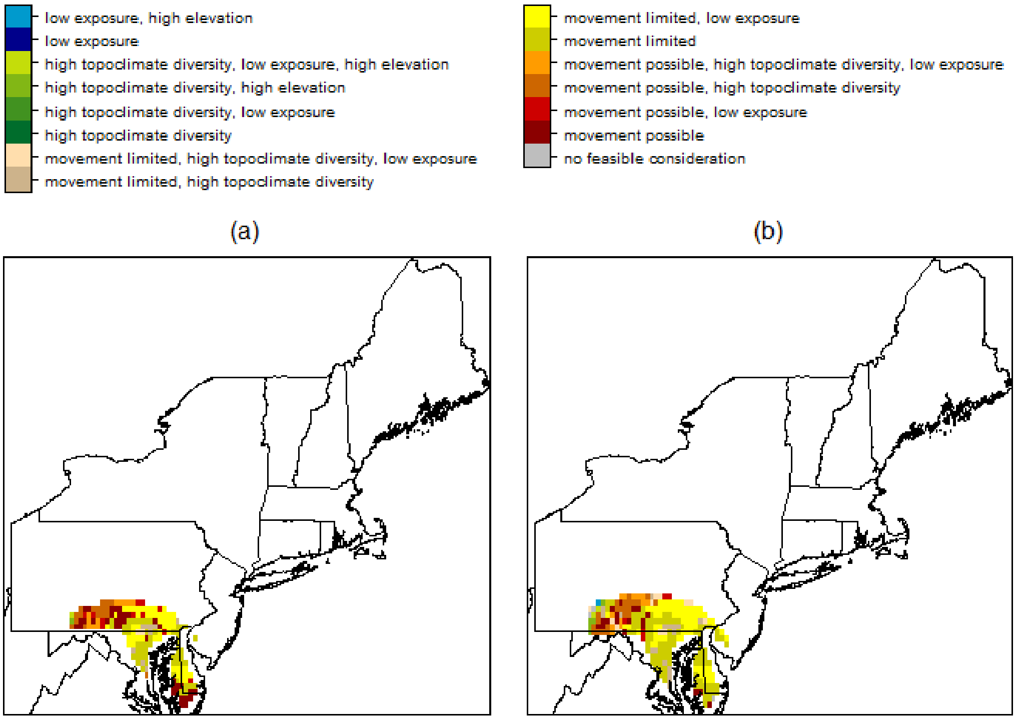

Figure AVIII. 1.44.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.45 Black-billed cuckoo (*Coccyzus erythropthalmus*)

Table AVIII. 1.45.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	27.50
low	0.38	0.50	0.66	0.00	1.00	3.00
high	0.57	0.50	0.68	0.02	1.00	100.00

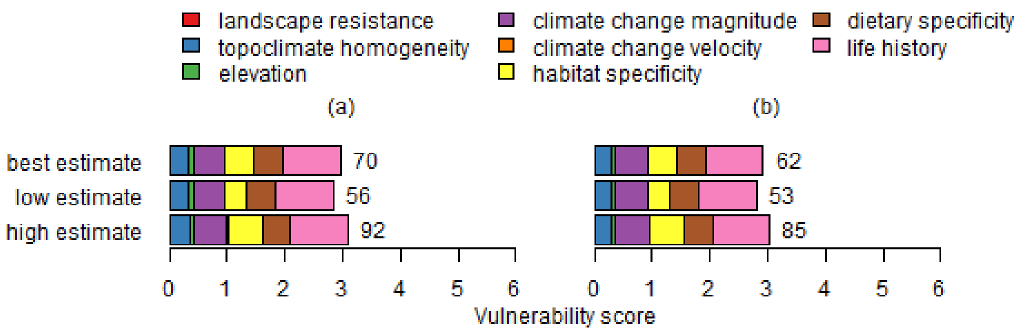

Figure AVIII. 1.45.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

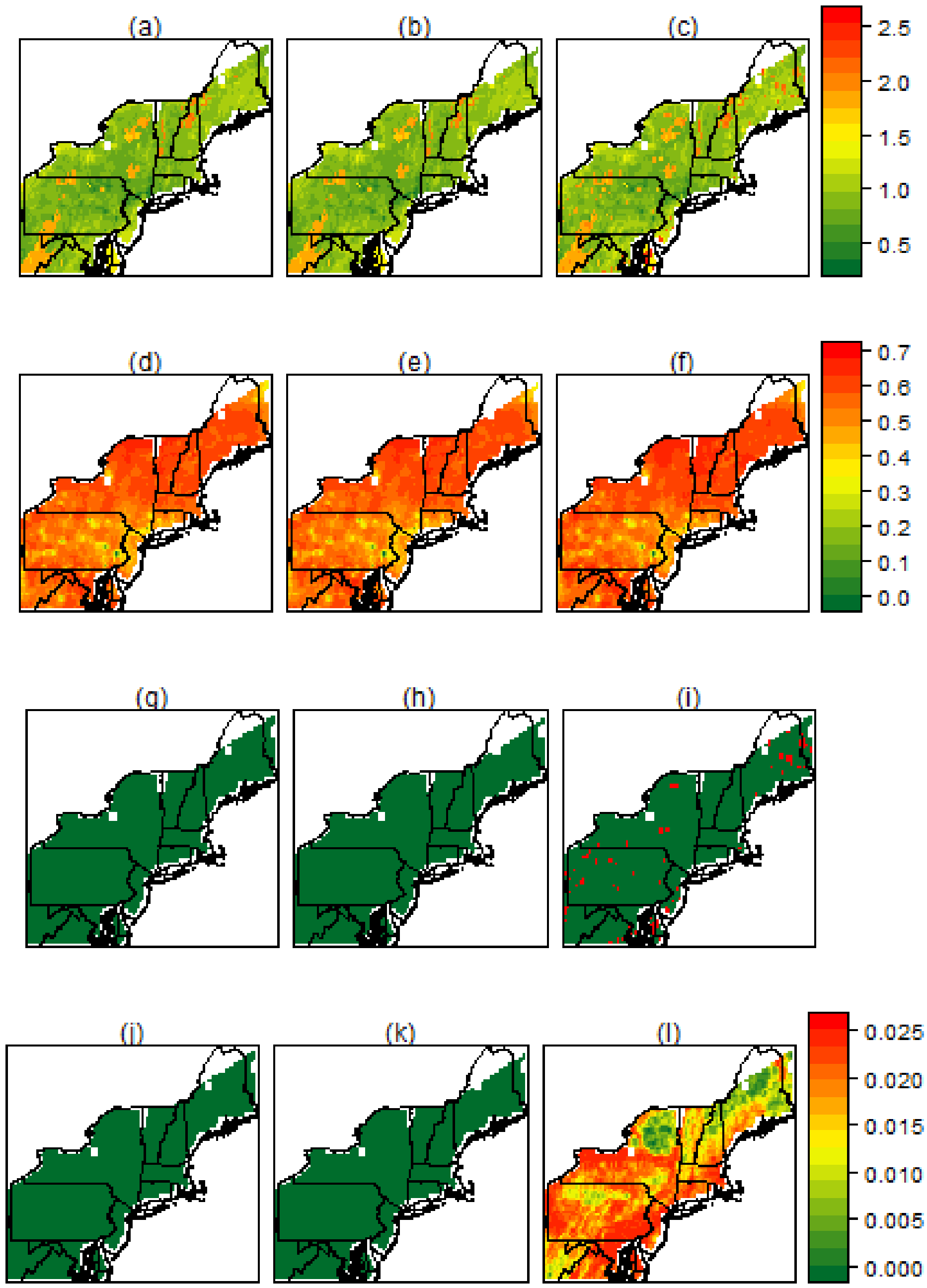

Figure AVIII. 1.45.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

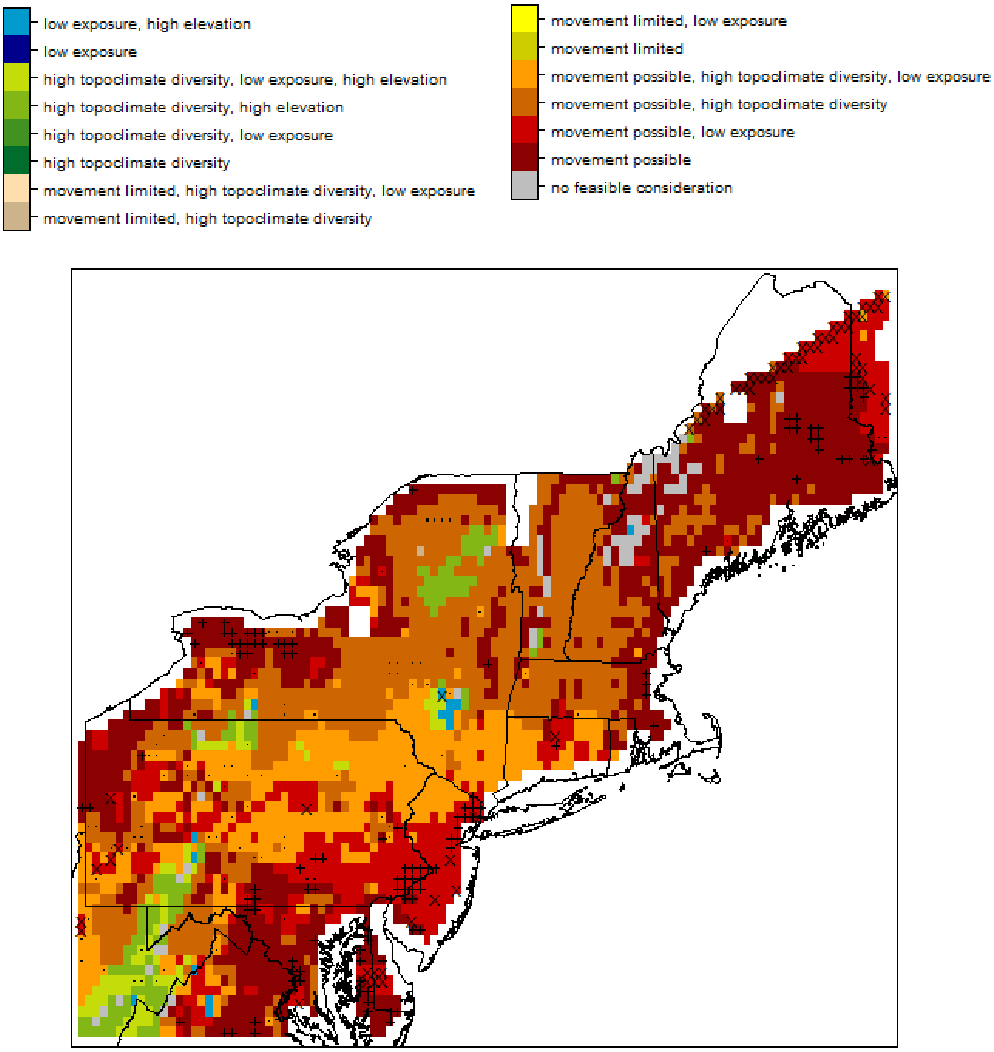

Figure AVIII. 1.45.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

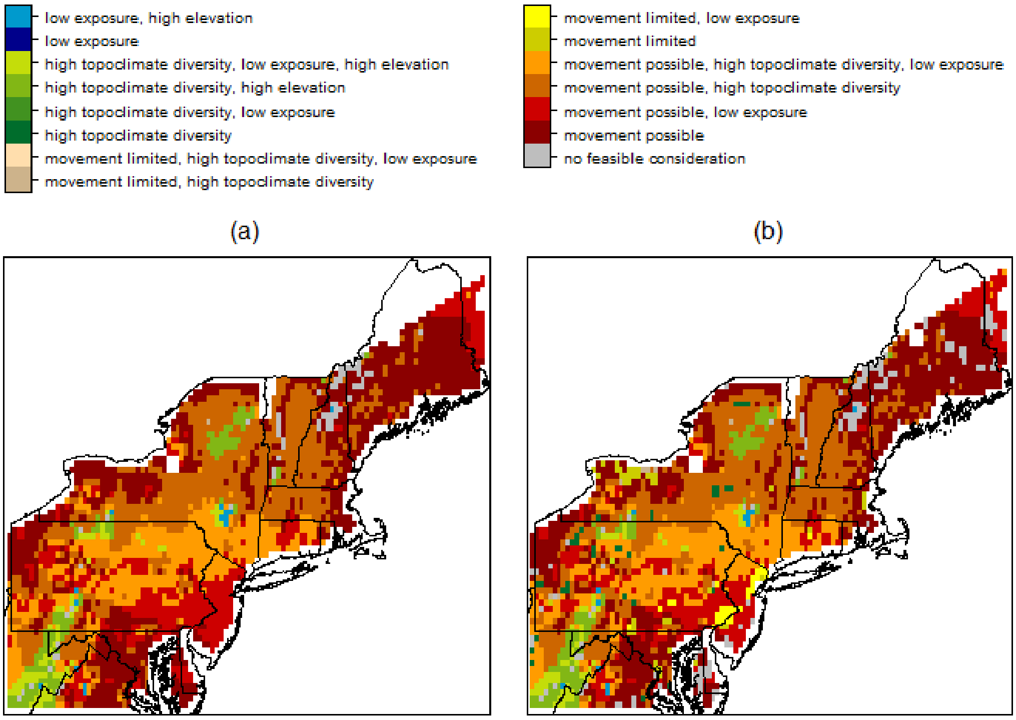

Figure AVIII. 1.45.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.46 Henslow's sparrow (*Ammodramus henslowii*)

Table AVIII. 1.46.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.40	0.67	0.20	1.00	12.80
low	0.46	0.35	0.63	0.17	1.00	3.12
high	0.56	0.43	0.72	0.26	1.00	127.50

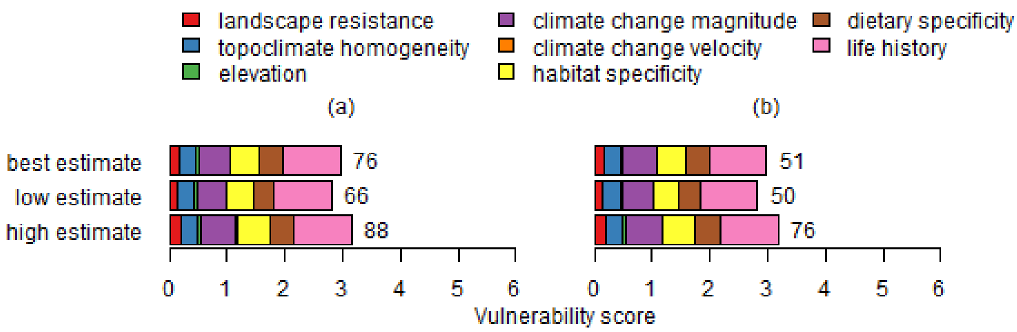

Figure AVIII. 1.46.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

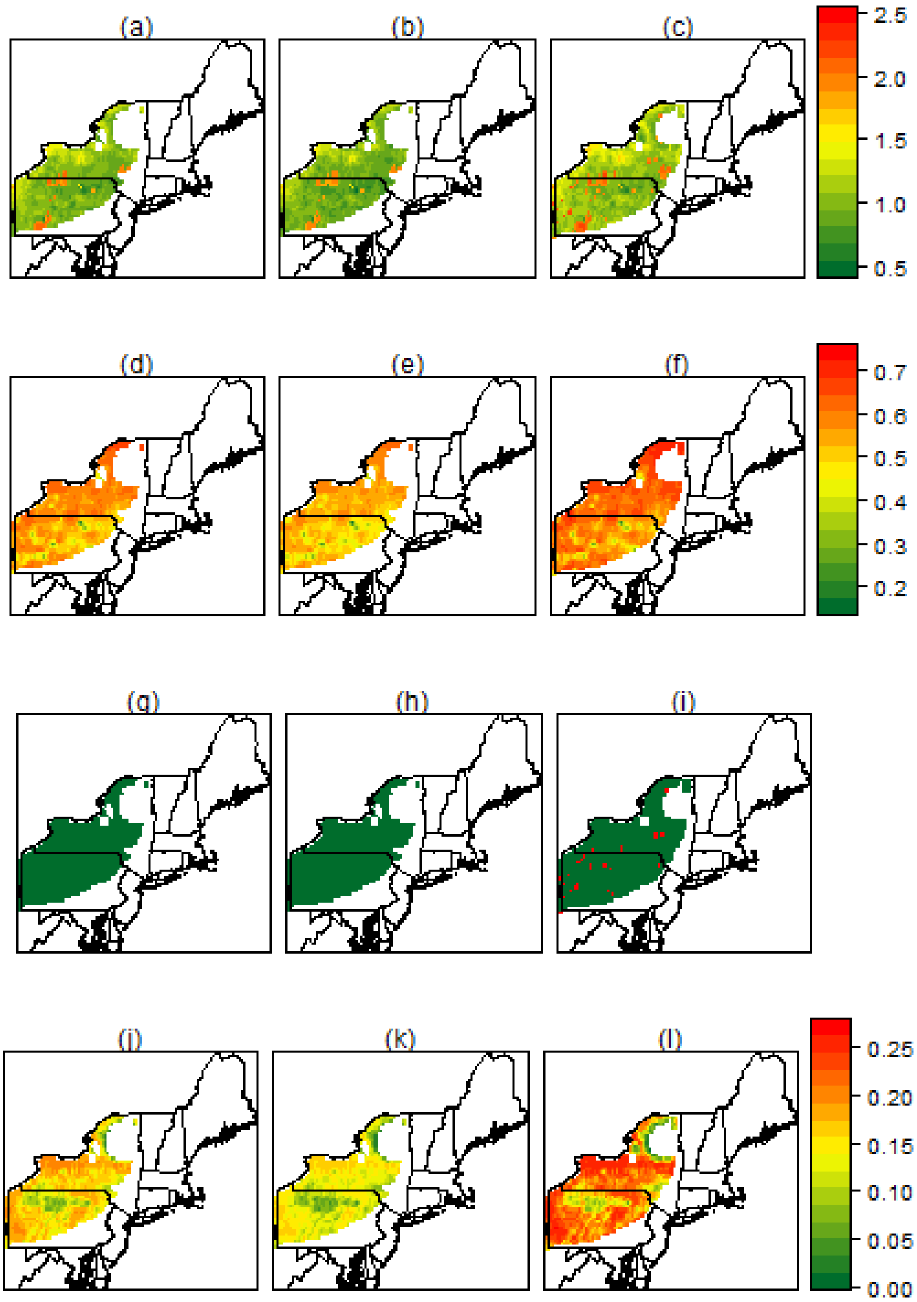

Figure AVIII. 1.46.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

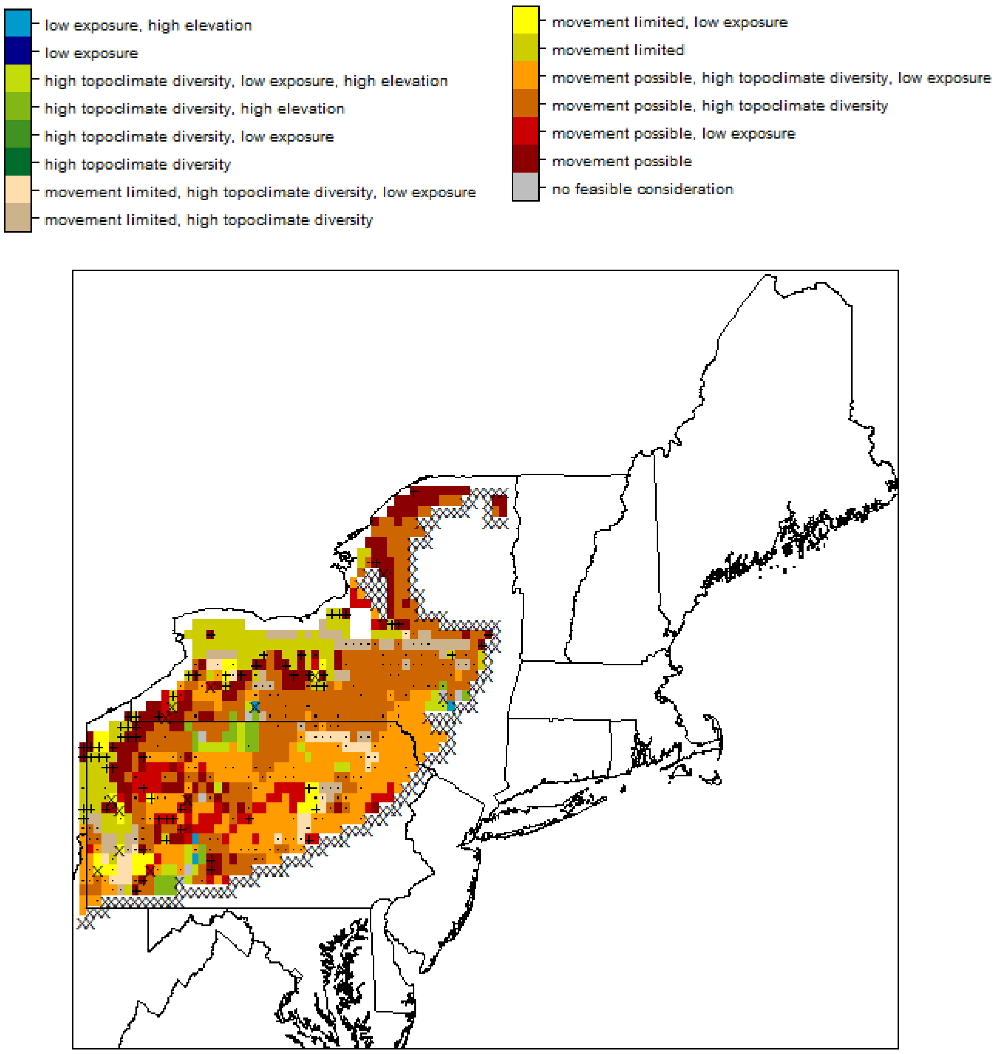

Figure AVIII. 1.46.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

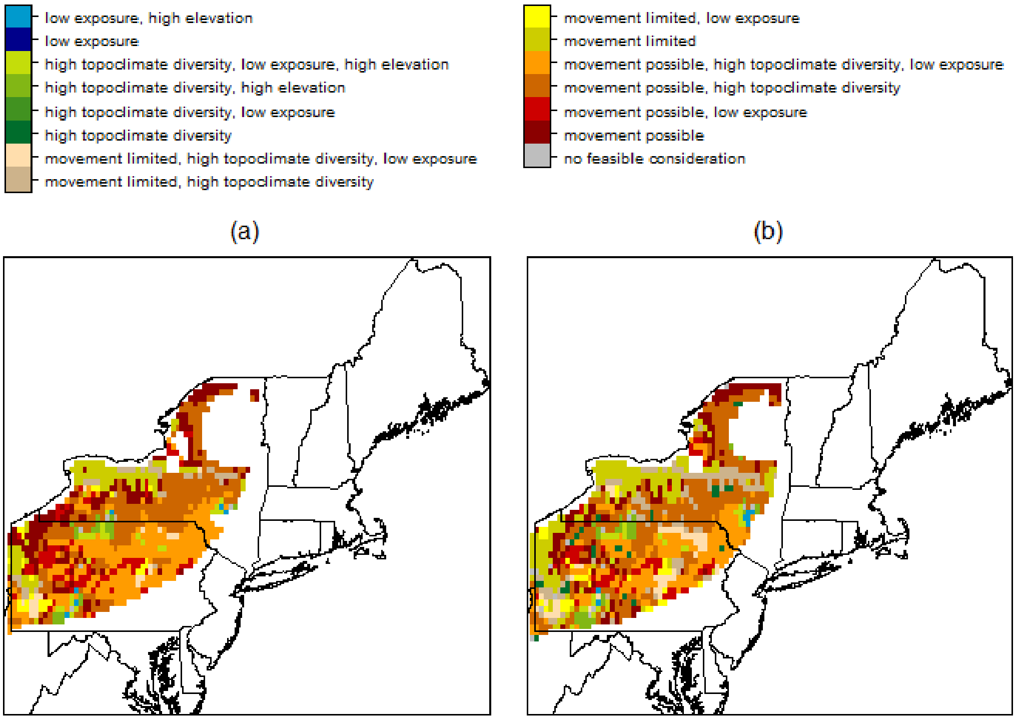

Figure AVIII. 1.46.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.47 Grasshopper sparrow (*Ammodramus savannarum*)

Table AVIII. 1.47.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.33	0.69	0.17	1.00	8.80
low	0.46	0.28	0.65	0.05	1.00	3.12
high	0.53	0.36	0.74	0.31	1.00	58.75

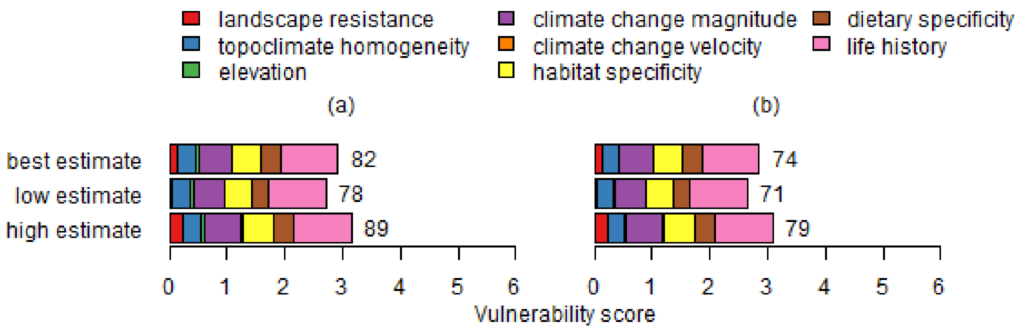

Figure AVIII. 1.47.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

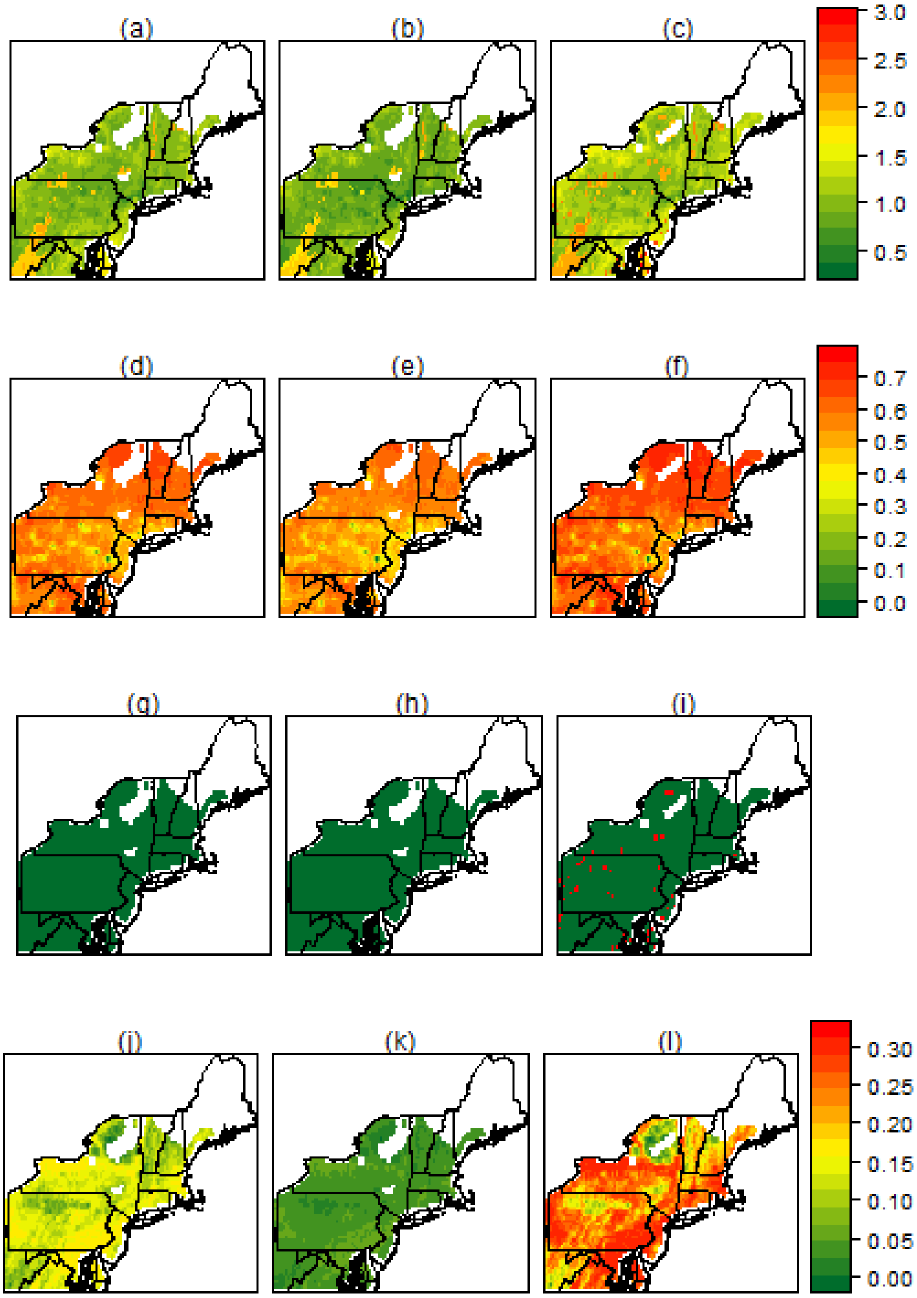

Figure AVIII. 1.47.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

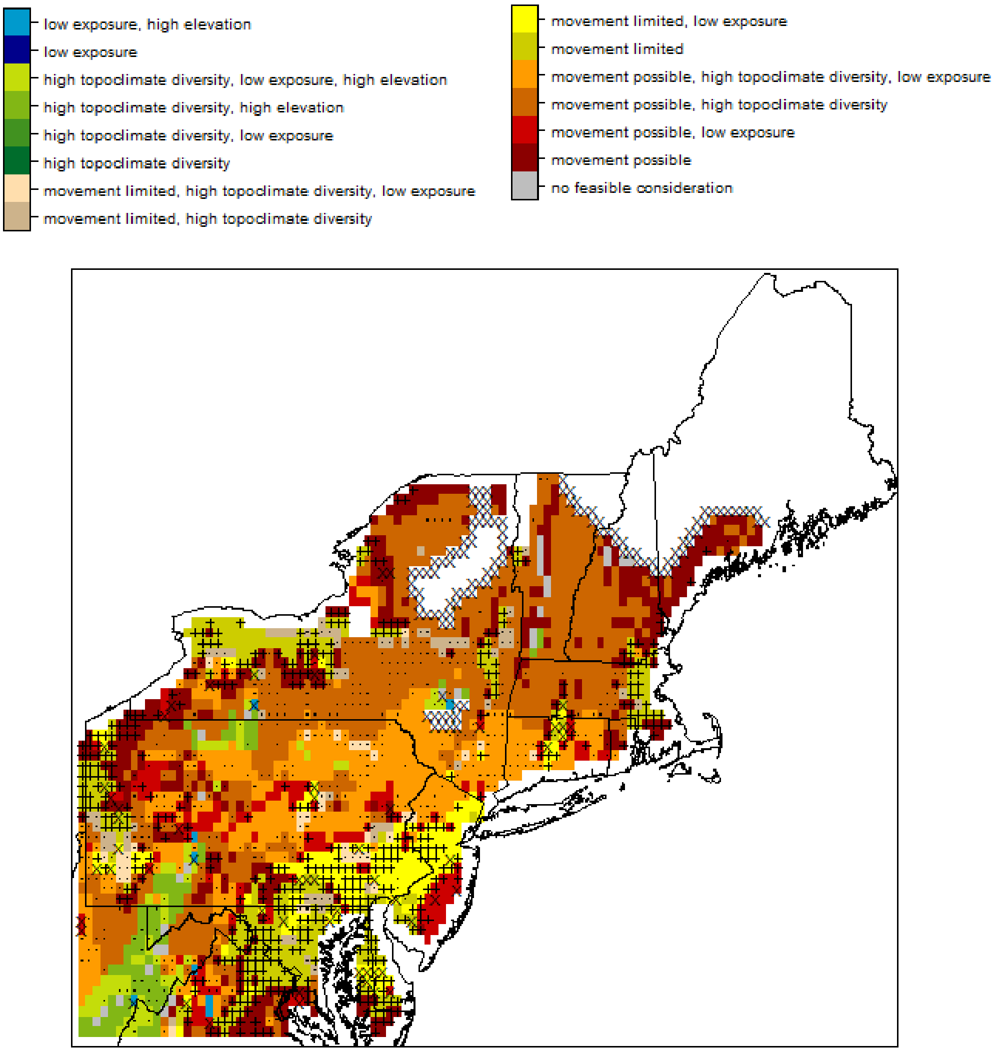

Figure AVIII. 1.47.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

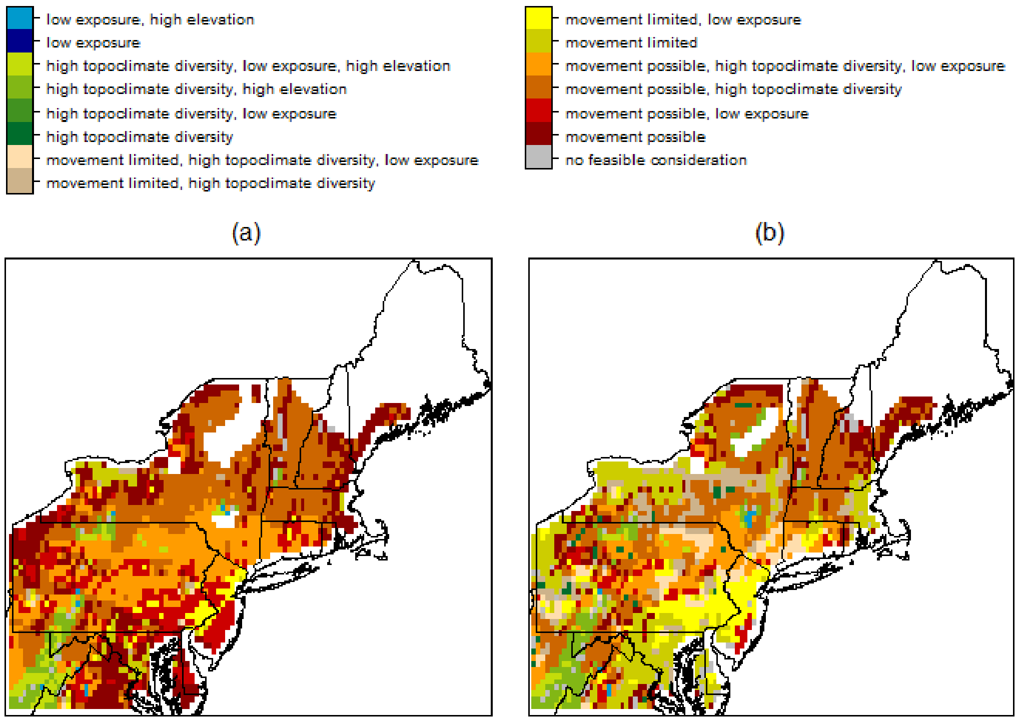

Figure AVIII. 1.47.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.48 Vesper sparrow (*Pooecetes gramineus*)

Table AVIII. 1.48.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.38	0.66	0.19	1.00	6.00
low	0.44	0.31	0.63	0.07	1.00	0.88
high	0.52	0.41	0.71	0.32	1.00	77.50

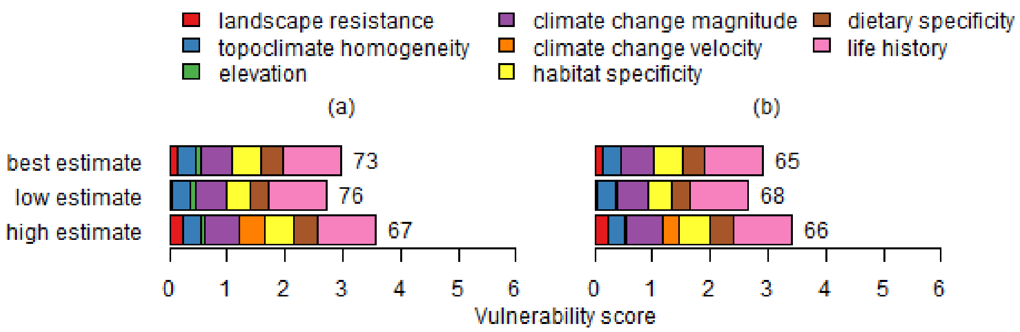

Figure AVIII. 1.48.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

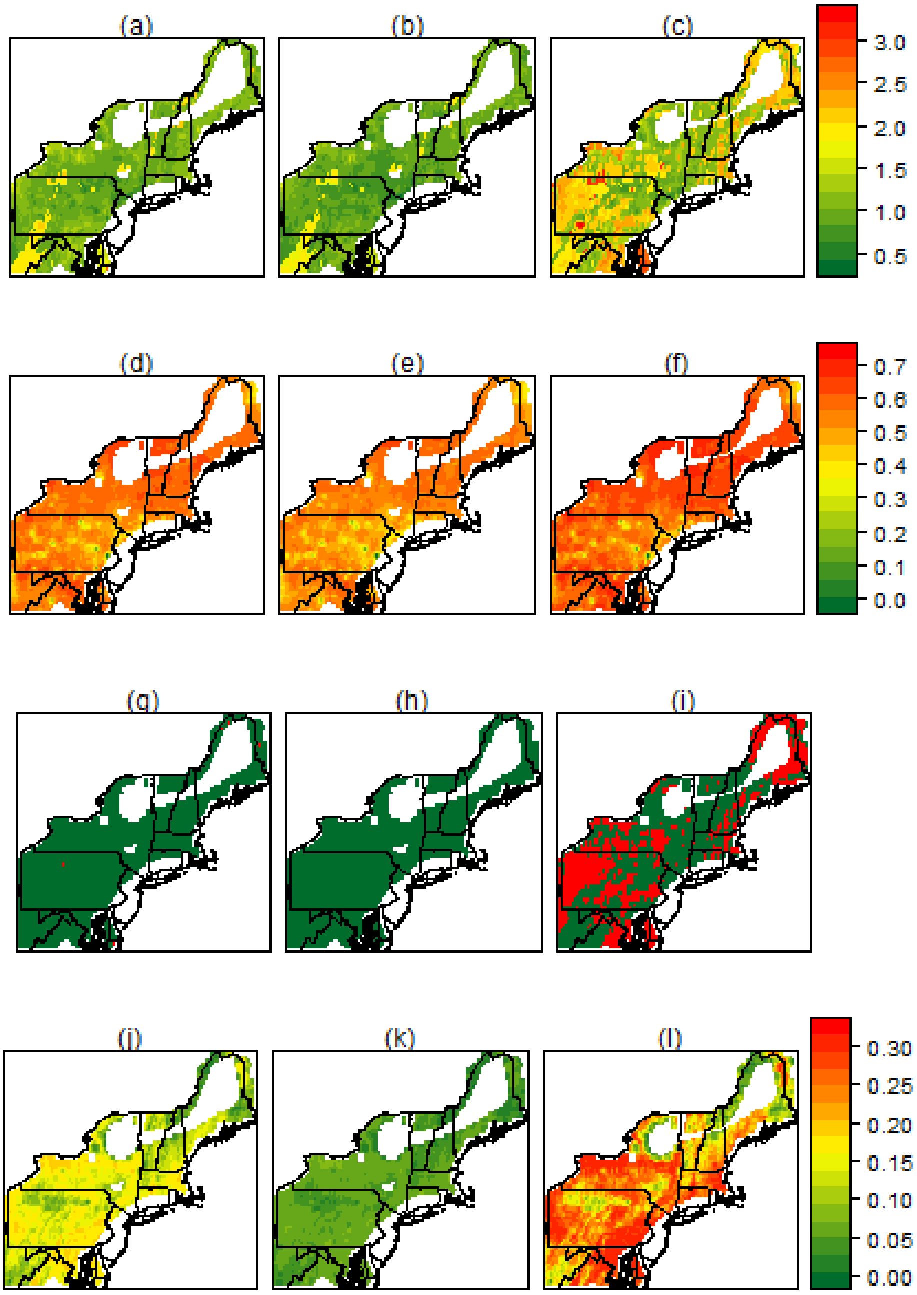

Figure AVIII. 1.48.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

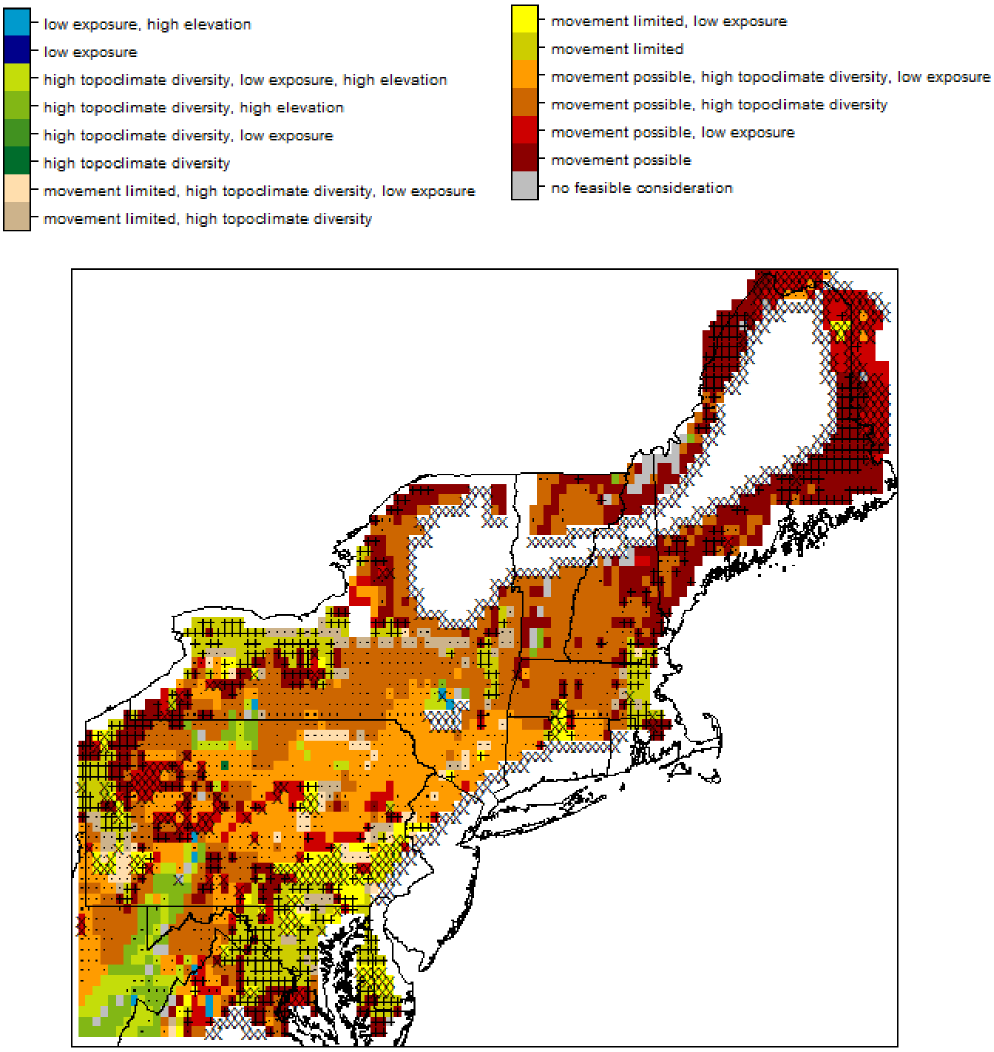

Figure AVIII. 1.48.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

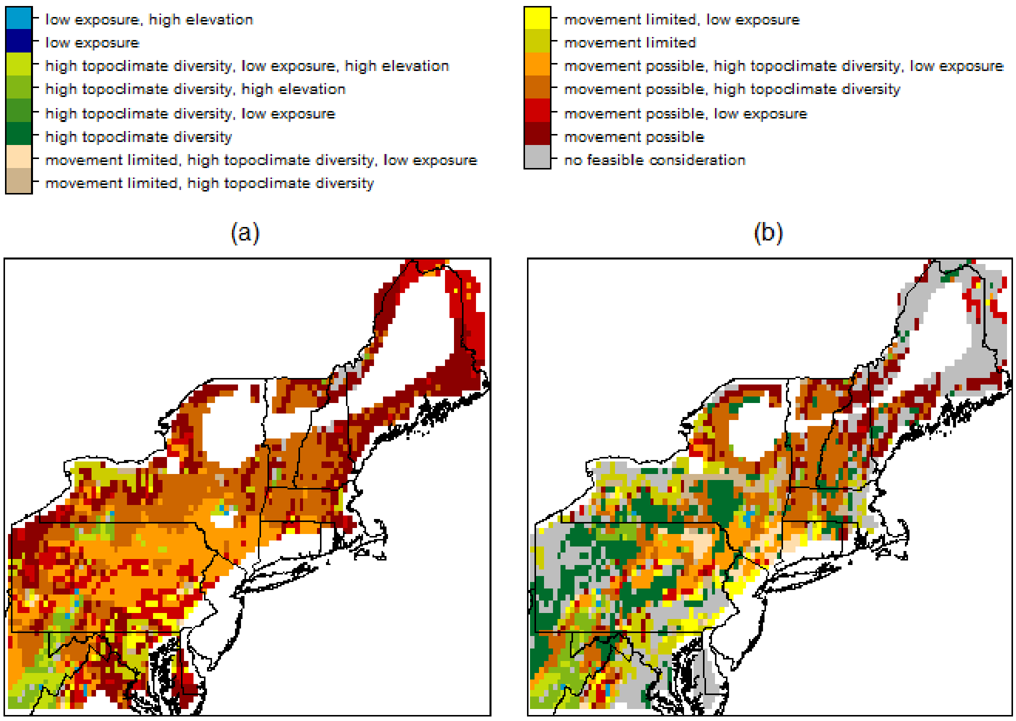

Figure AVIII. 1.48.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.49 Bobolink (*Dolichonyx oryzivorus*)

Table AVIII. 1.49.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.21	0.71	0.14	1.00	7.17
low	0.37	0.18	0.64	0.04	1.00	1.70
high	0.51	0.27	0.81	0.27	1.00	57.00

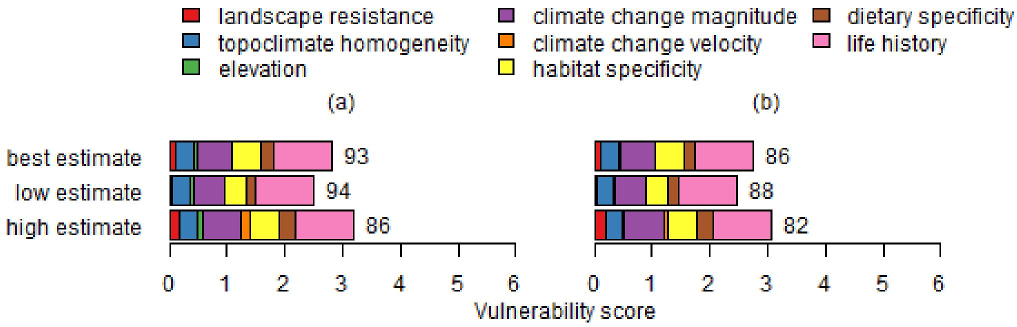

Figure AVIII. 1.49.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

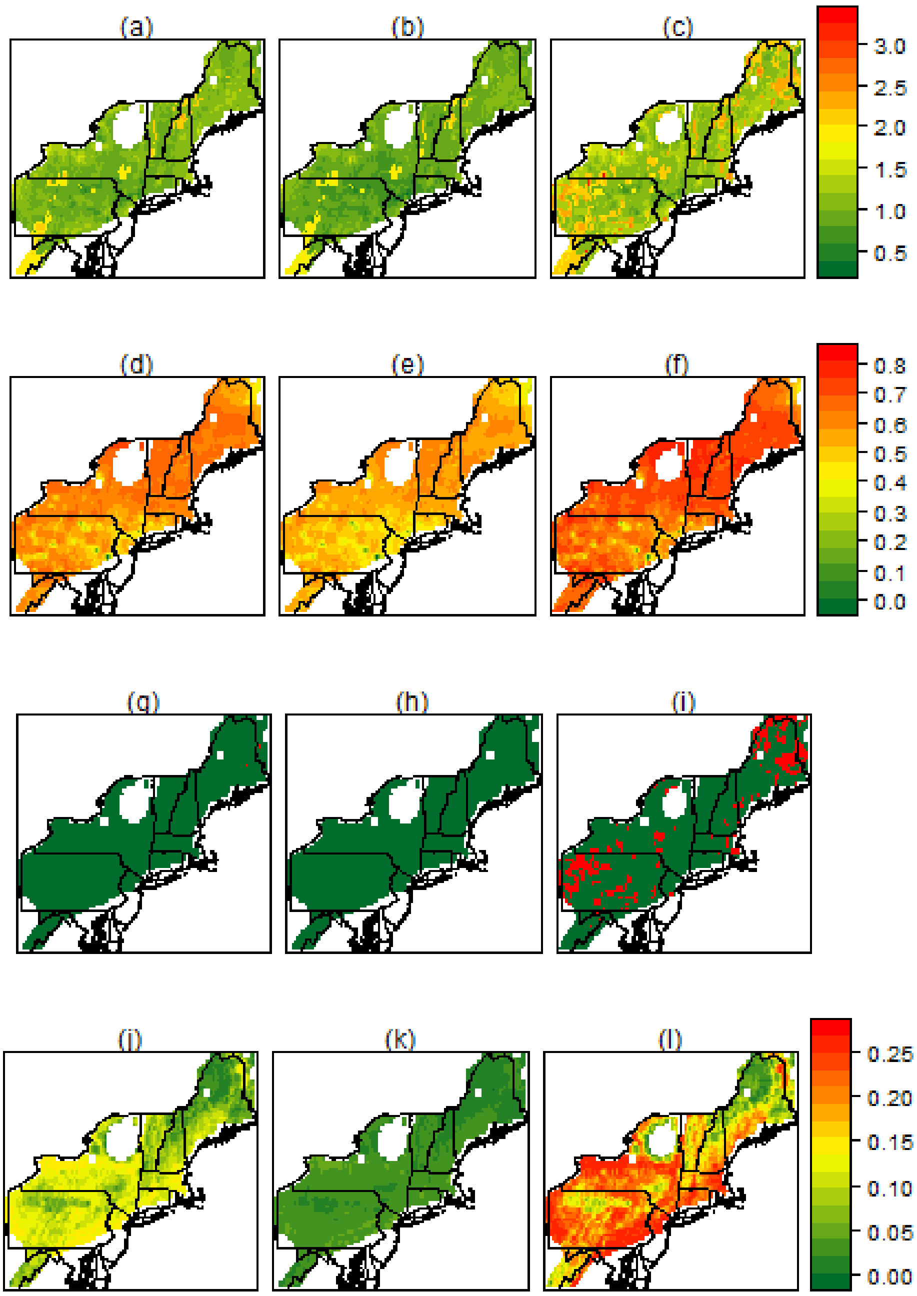

Figure AVIII. 1.49.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

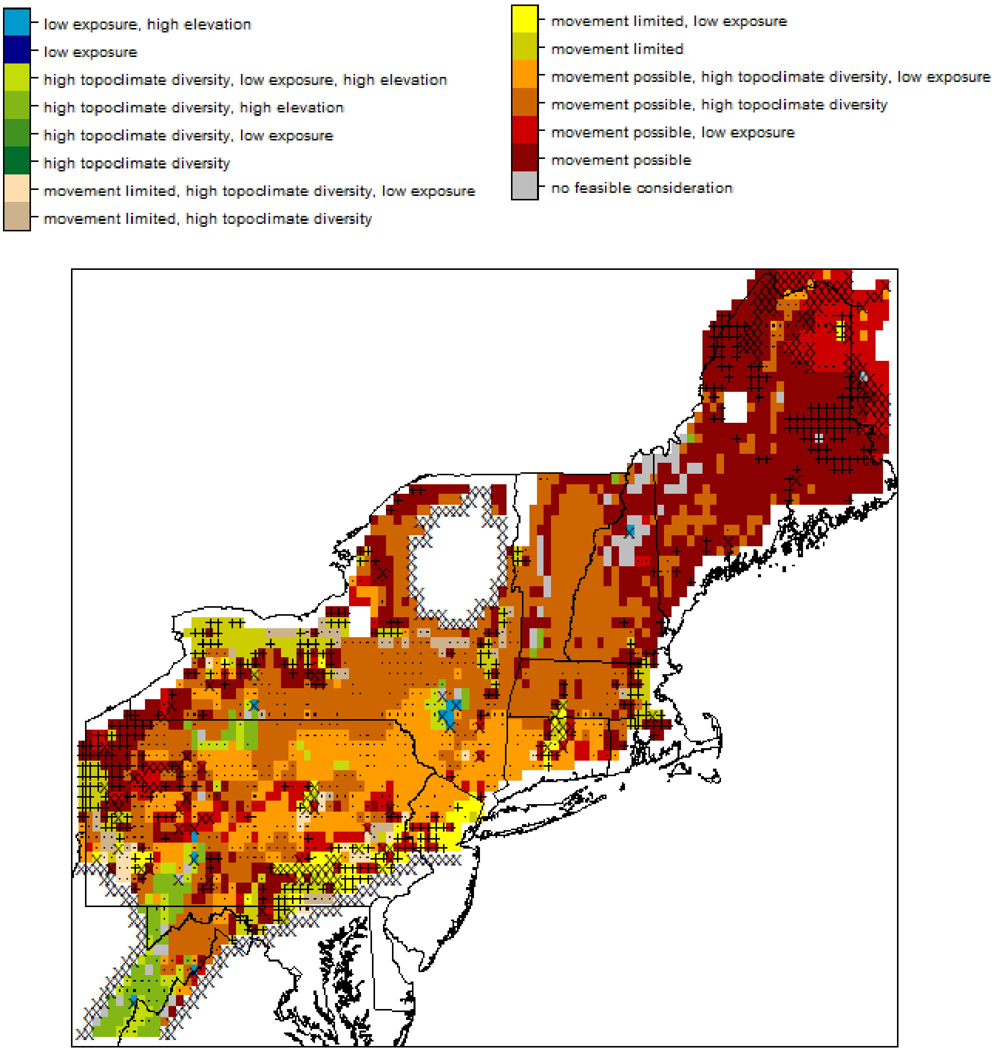

Figure AVIII. 1.49.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

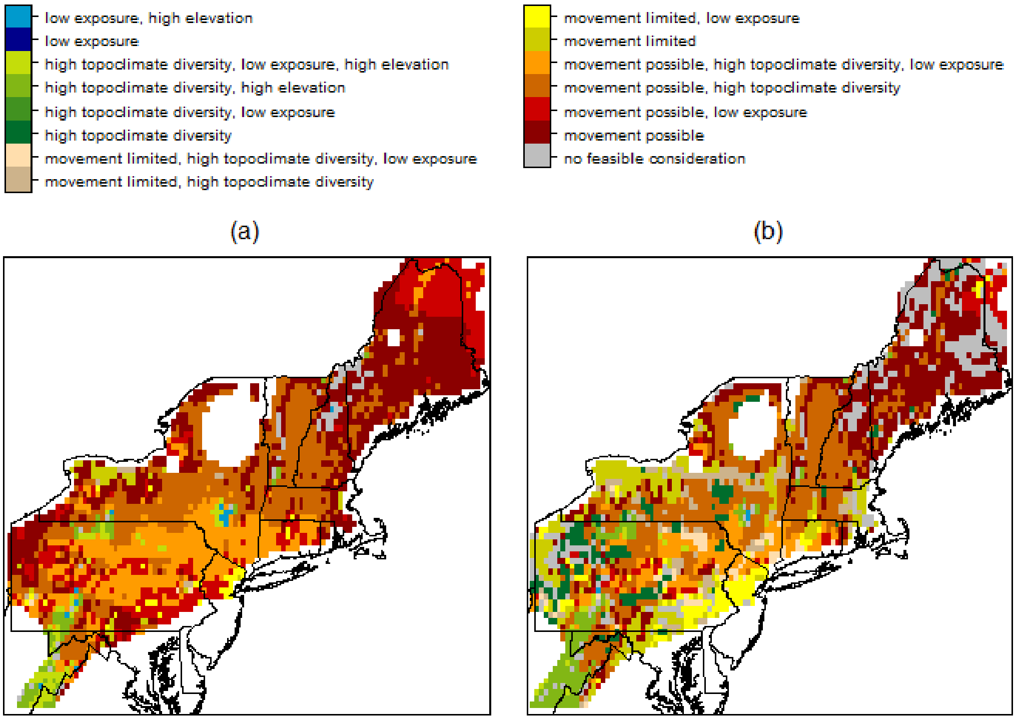

Figure AVIII. 1.49.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.50 Rusty blackbird (*Euphagus carolinus*)

Table AVIII. 1.50.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.25	1.00	0.00	1.00	7.50
low	0.25	0.17	0.90	0.00	1.00	0.00
high	0.35	0.32	1.00	0.10	1.00	300.00

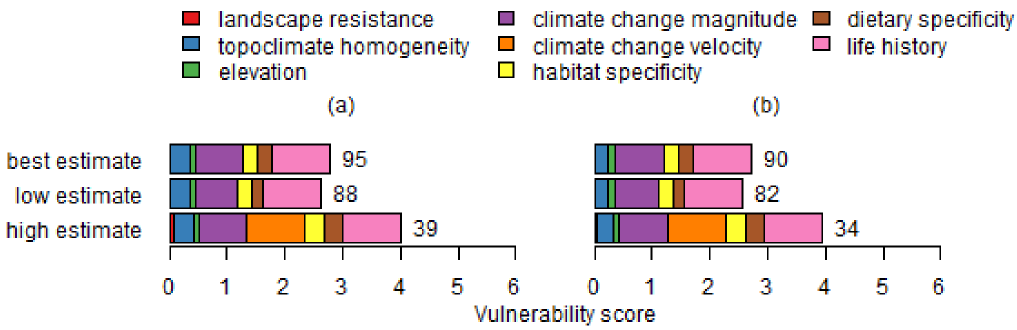

Figure AVIII. 1.50.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

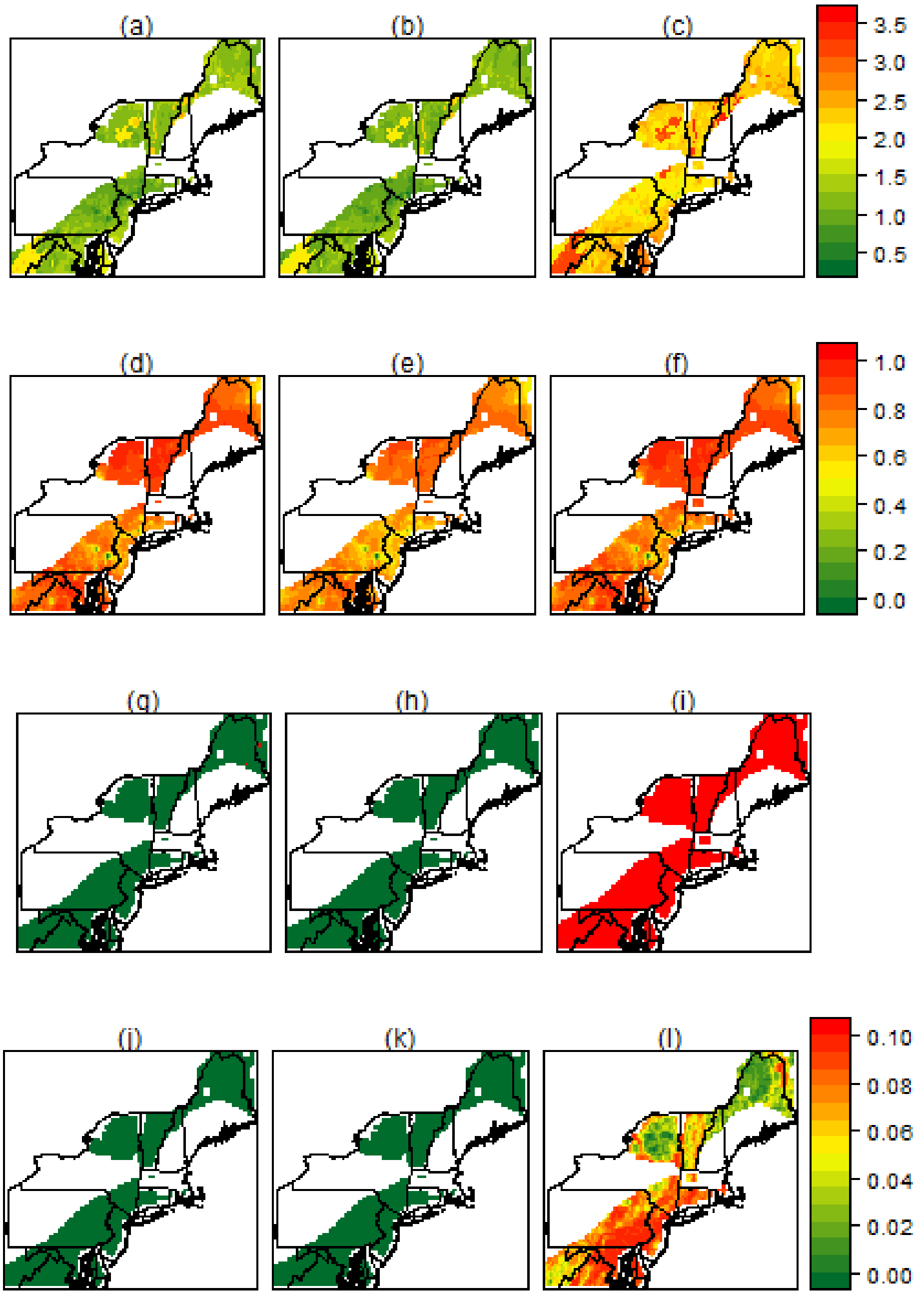

Figure AVIII. 1.50.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

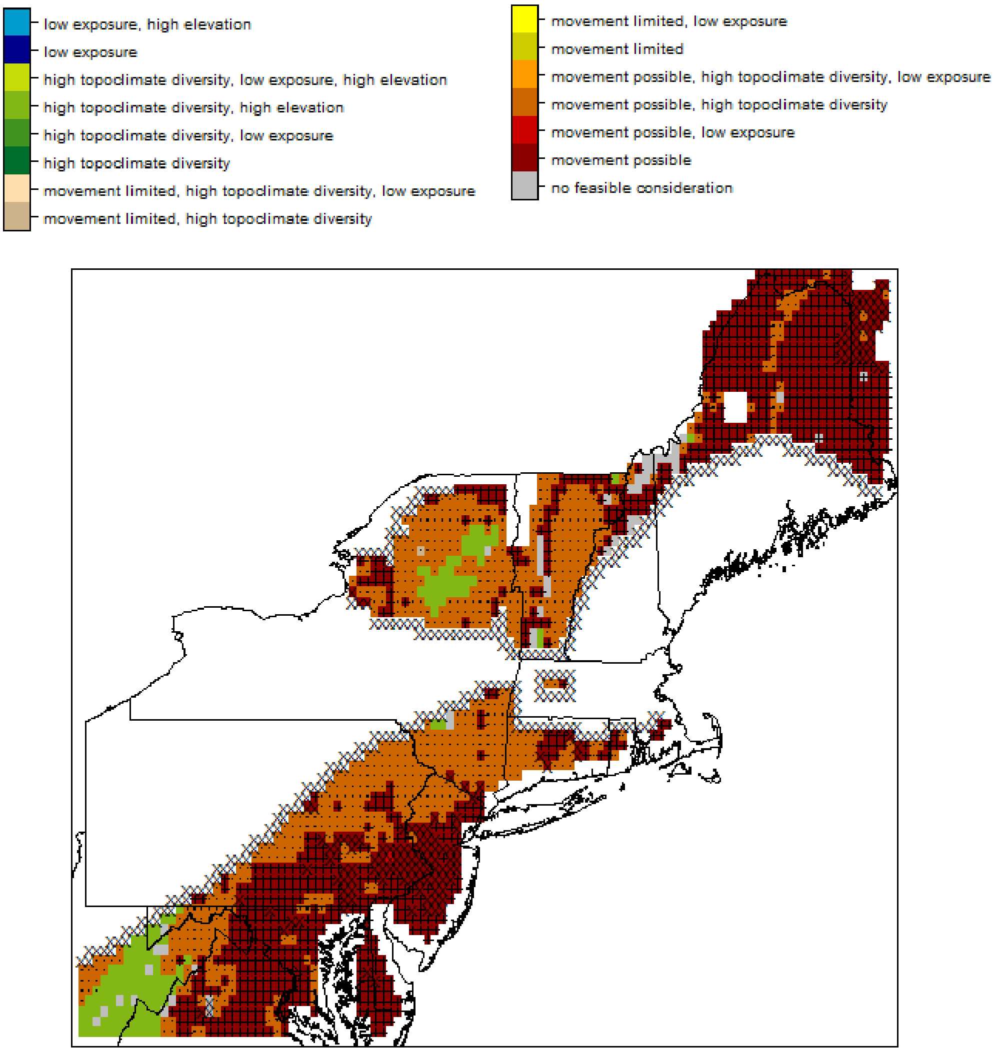

Figure AVIII. 1.50.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

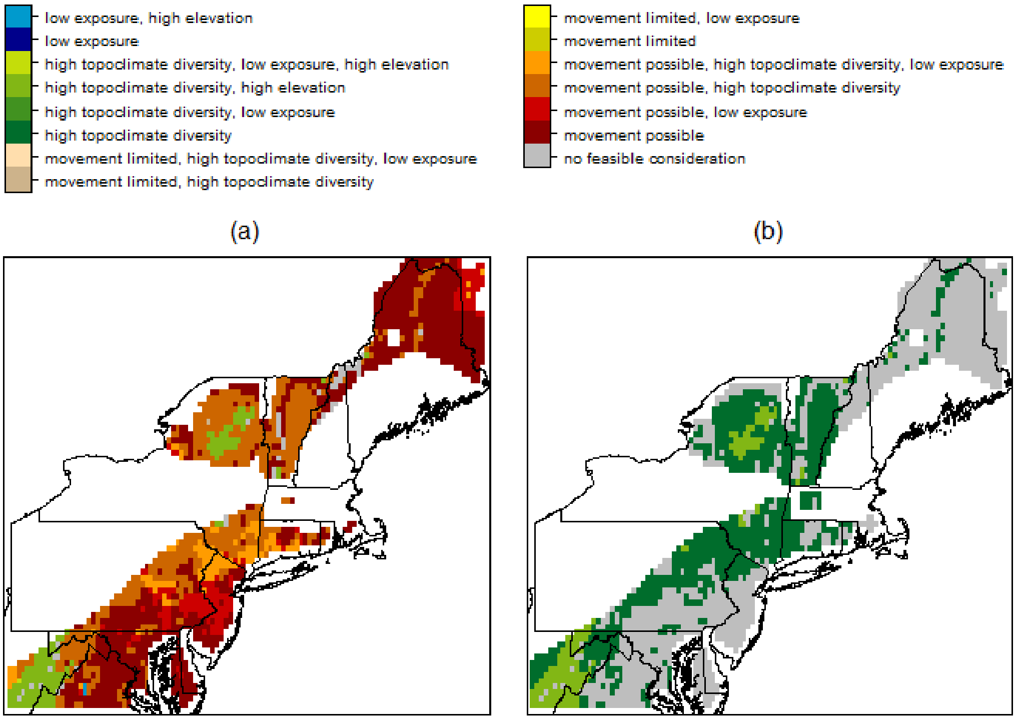

Figure AVIII. 1.50.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.51 Eastern meadowlark (*Sturnella magna*)

Table AVIII. 1.51.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.25	0.69	0.12	1.00	7.80
low	0.38	0.21	0.63	0.07	1.00	1.88
high	0.52	0.32	0.77	0.22	1.00	63.75

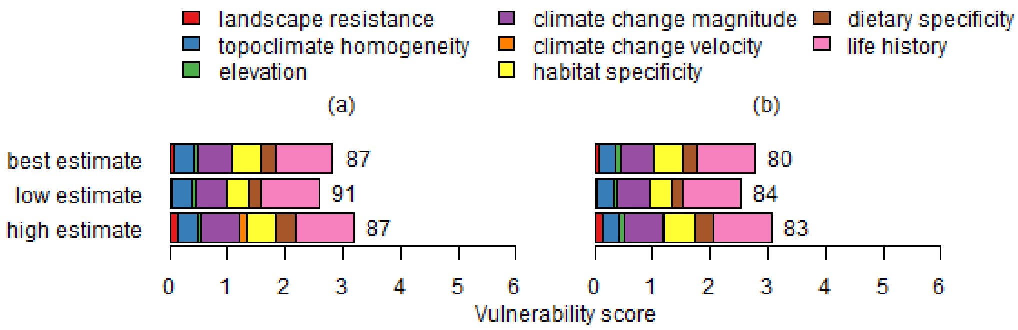

Figure AVIII. 1.51.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

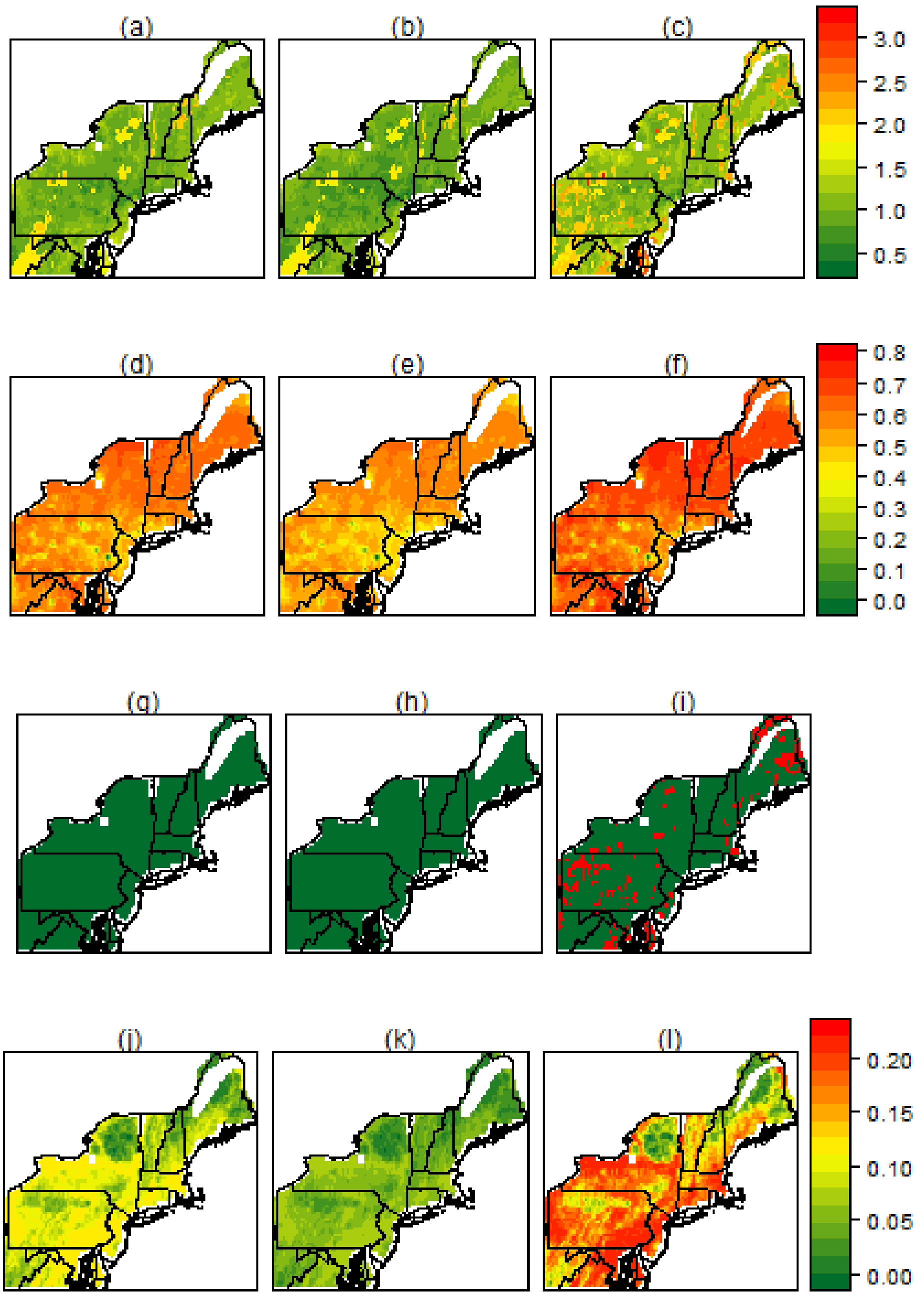

Figure AVIII. 1.51.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

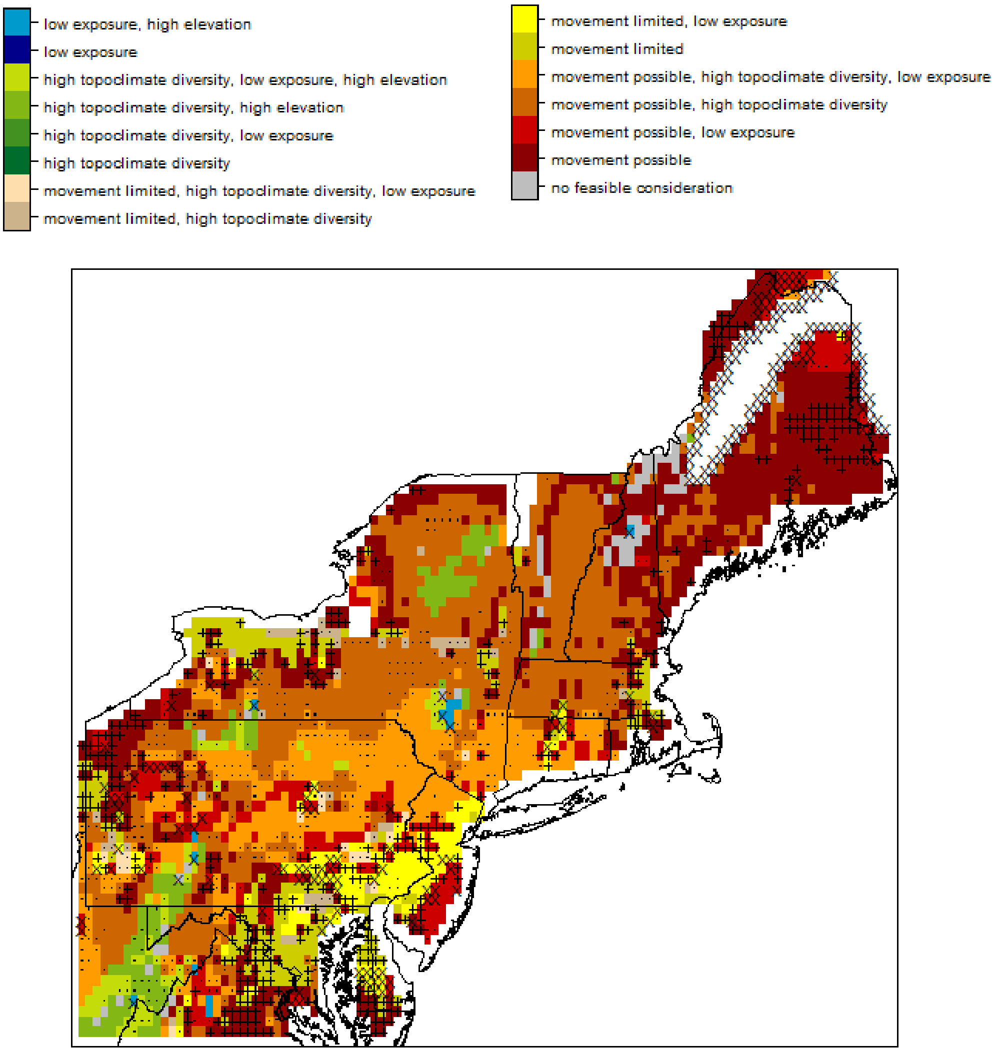

Figure AVIII. 1.51.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

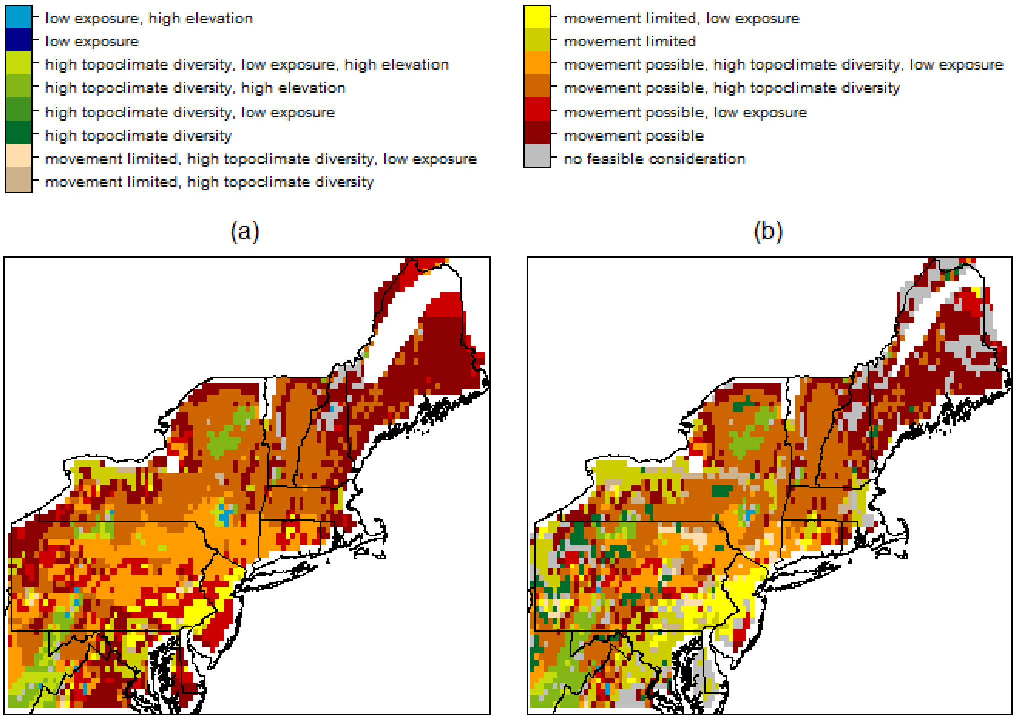

Figure AVIII. 1.51.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.52 Loggerhead shrike (*Lanius ludovicianus*)

Table AVIII. 1.52.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.50	1.00	15.00
low	0.29	0.50	0.62	0.43	1.00	1.00
high	0.71	0.50	0.70	0.67	1.00	100.00

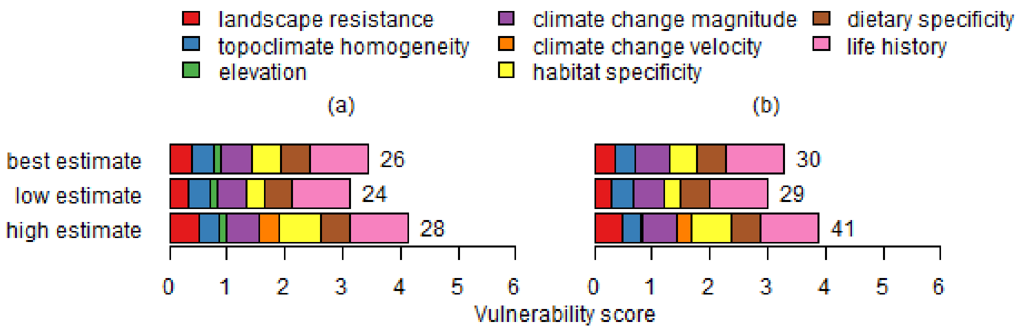

Figure AVIII. 1.52.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

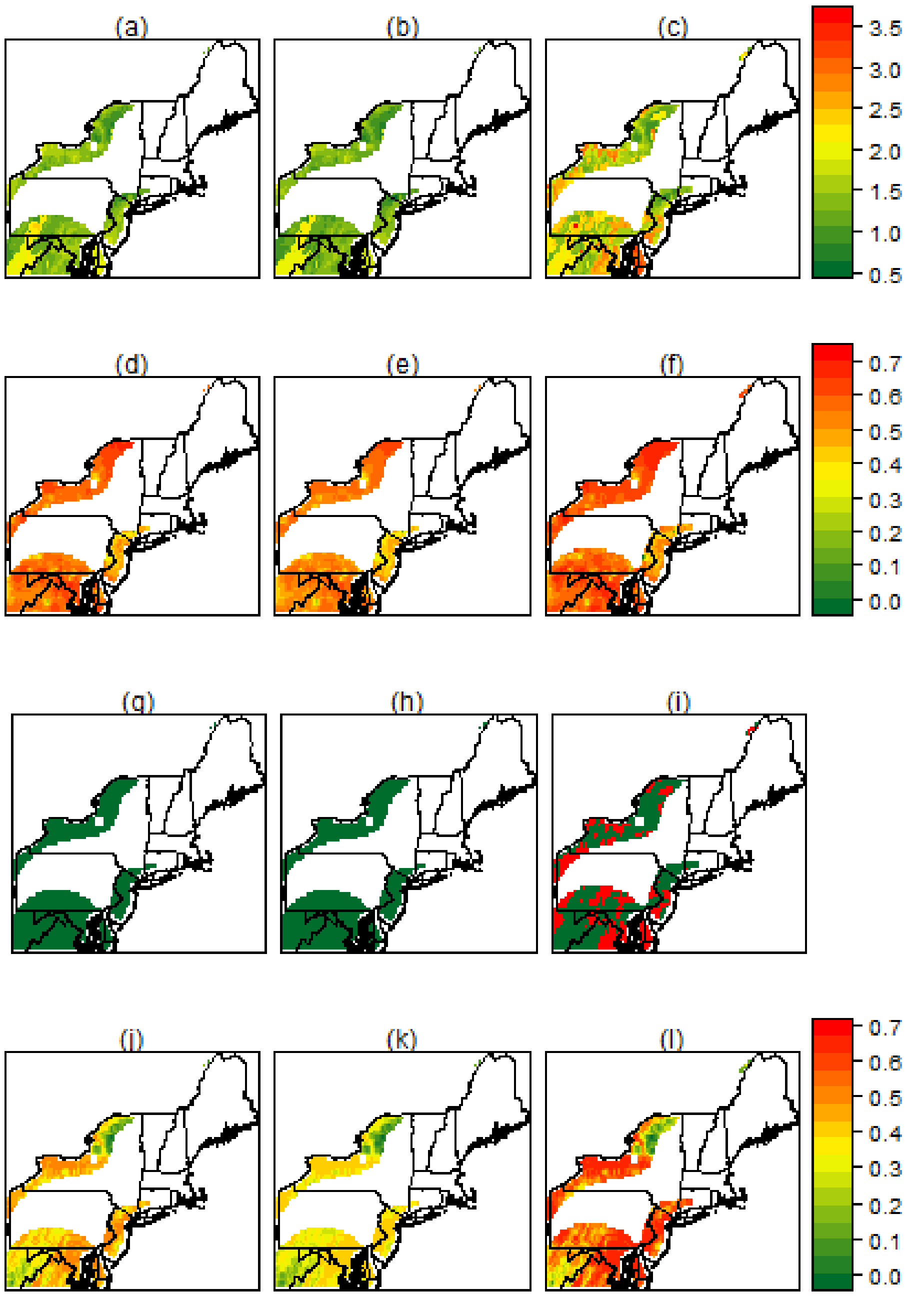

Figure AVIII. 1.52.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

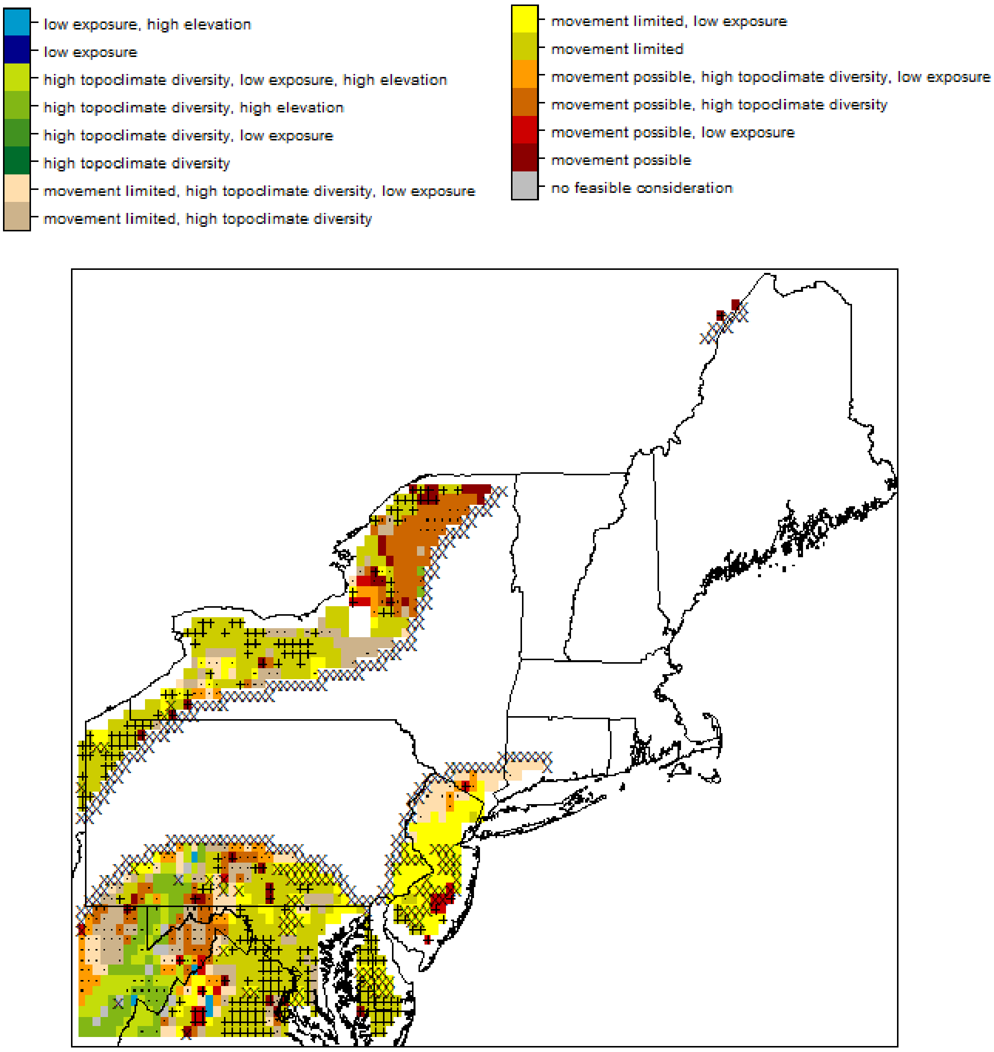

Figure AVIII. 1.52.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

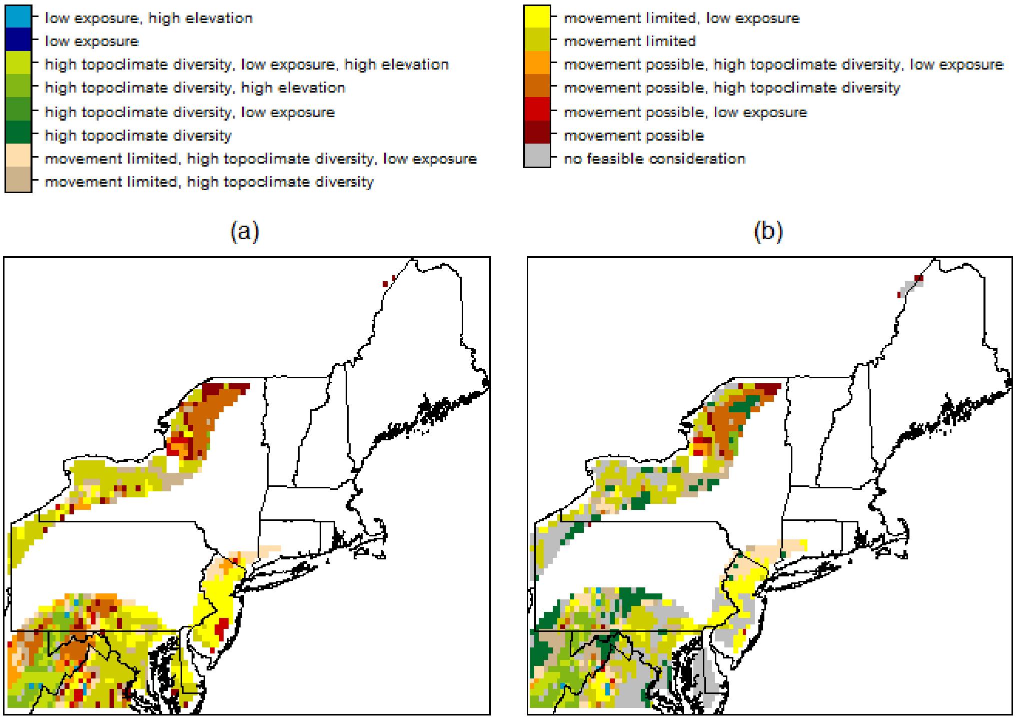

Figure AVIII. 1.52.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.53 Brown thrasher (*Toxostoma rufum*)

Table AVIII. 1.53.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.33	0.50	0.66	0.00	1.00	7.33
low	0.13	0.40	0.66	0.00	1.00	0.33
high	0.50	0.50	0.66	0.05	1.00	73.33

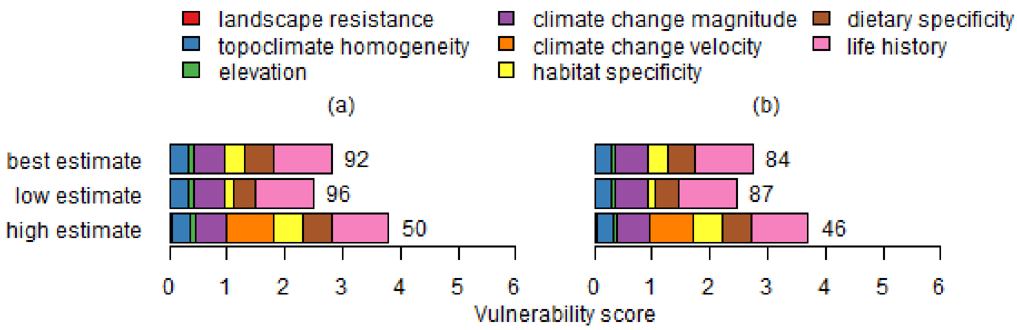

Figure AVIII. 1.53.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

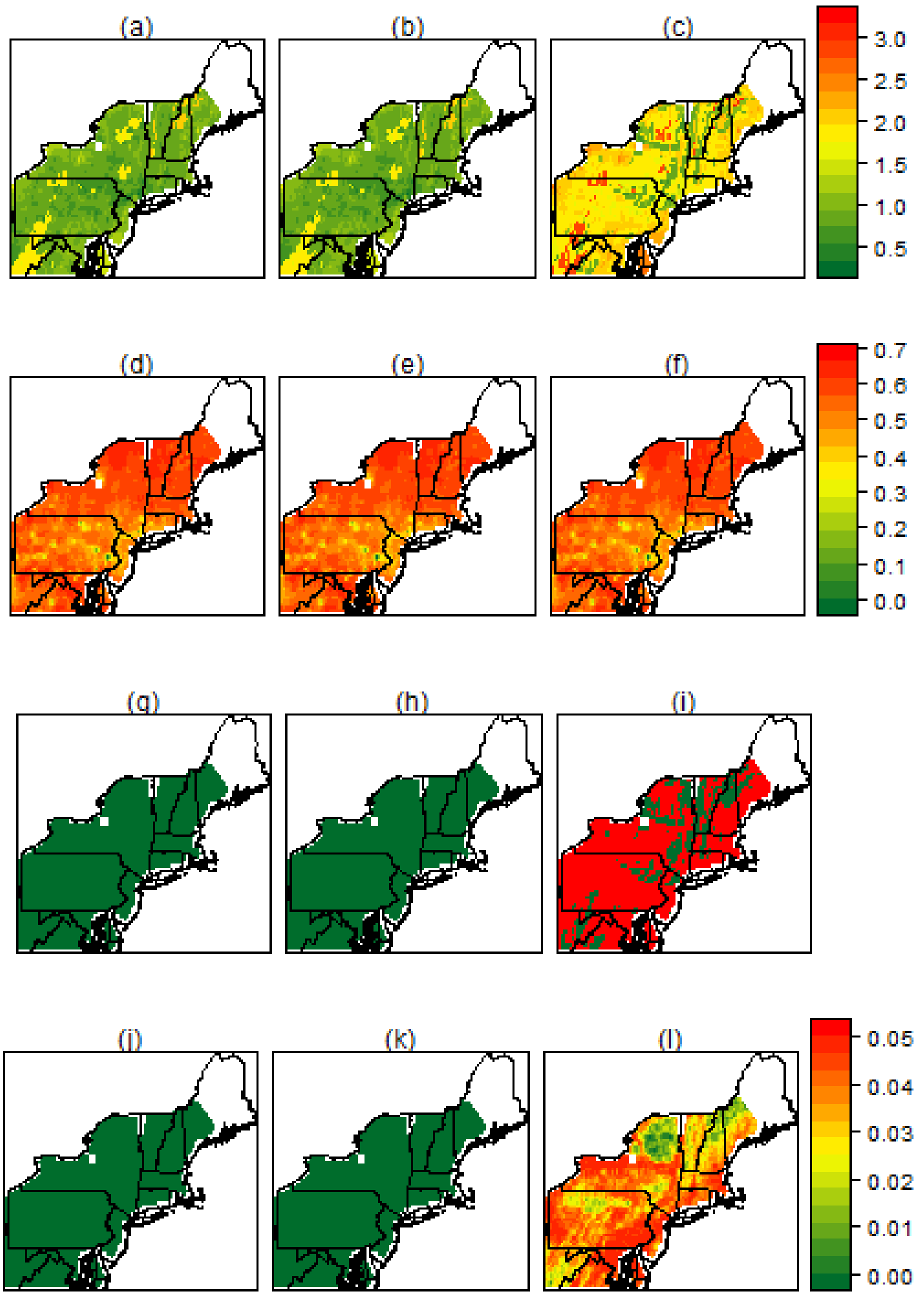

Figure AVIII. 1.53.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

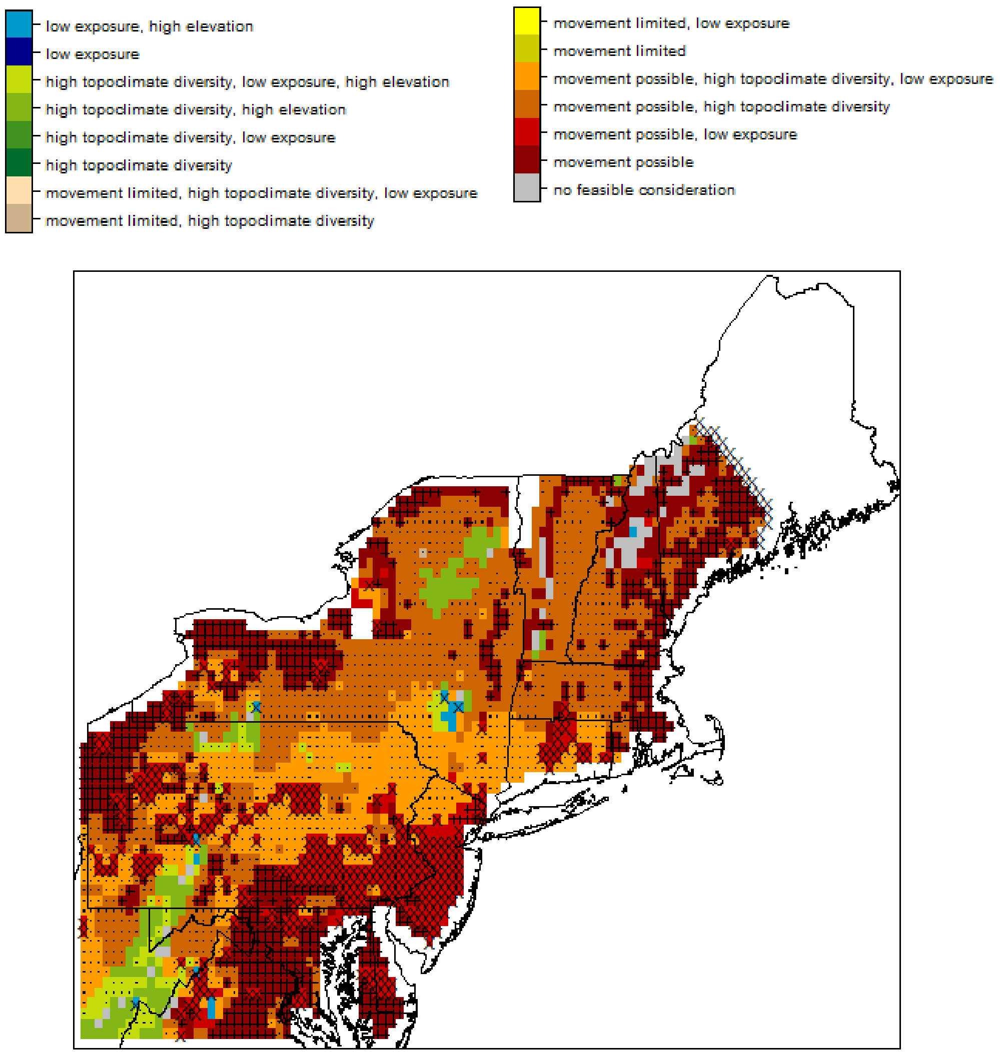

Figure AVIII. 1.53.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

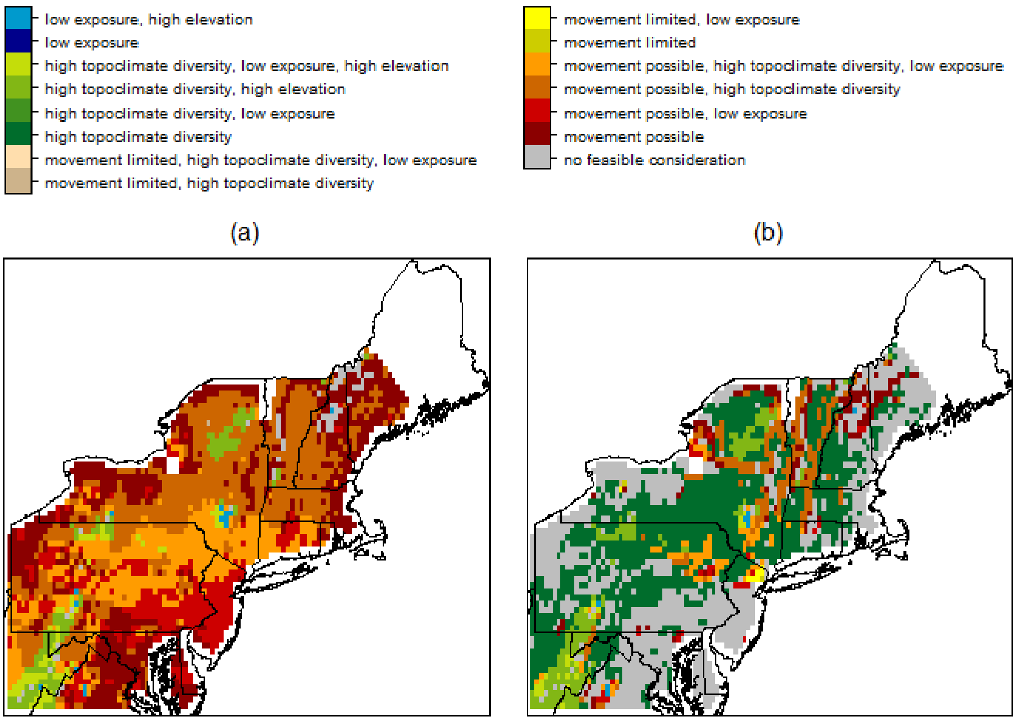

Figure AVIII. 1.53.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.54 Black-throated blue warbler (*Dendroica caerulescens*)

Table AVIII. 1.54.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	10.00
low	0.40	0.50	0.66	0.00	1.00	0.00
high	0.50	0.50	0.80	0.10	1.00	300.00

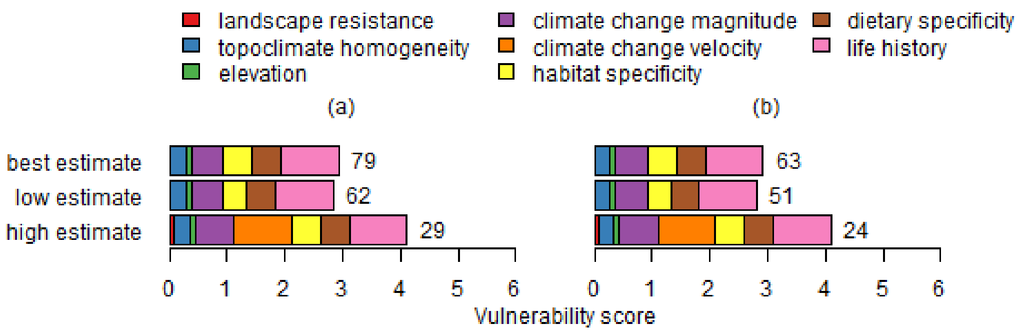

Figure AVIII. 1.54.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

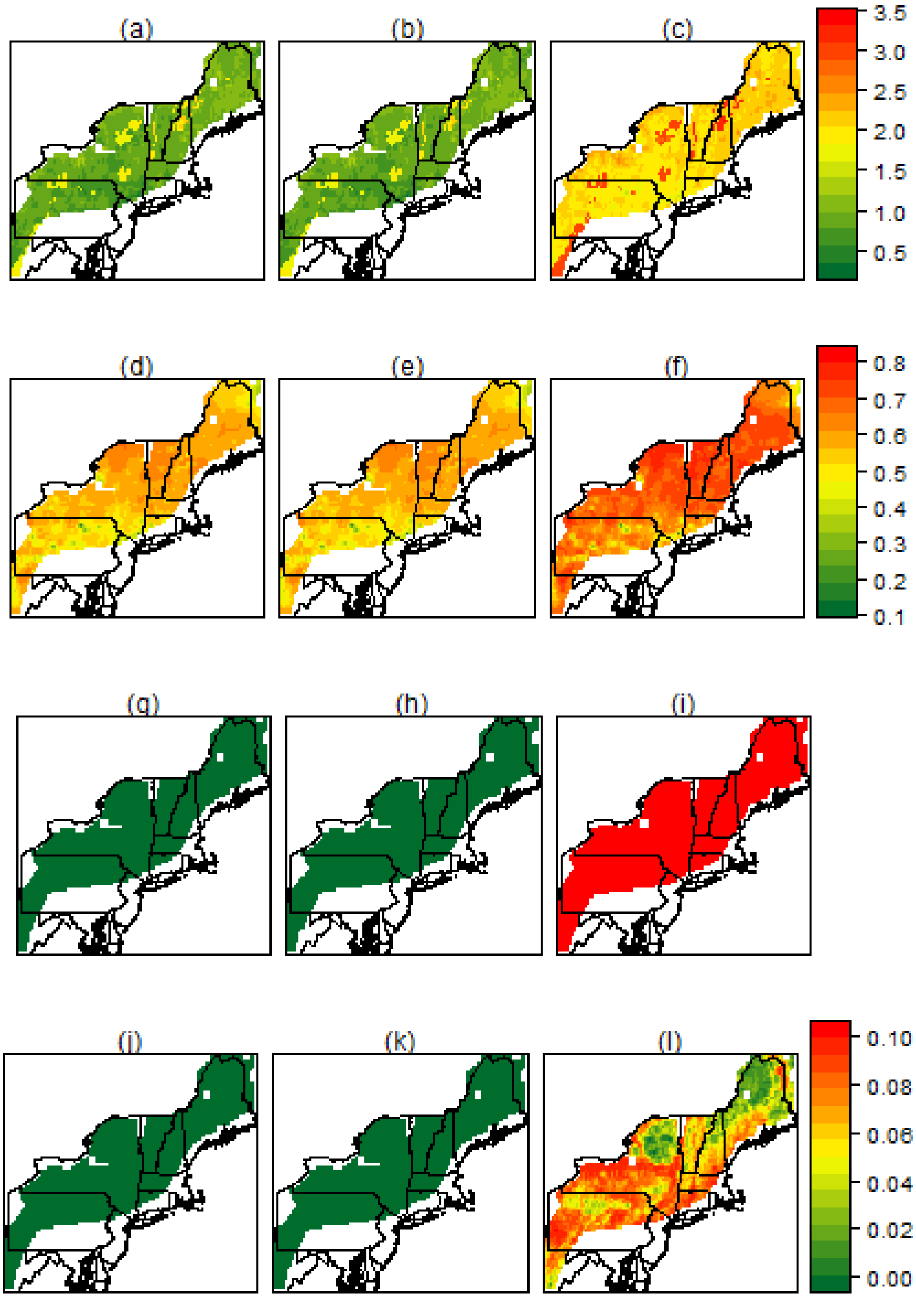

Figure AVIII. 1.54.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

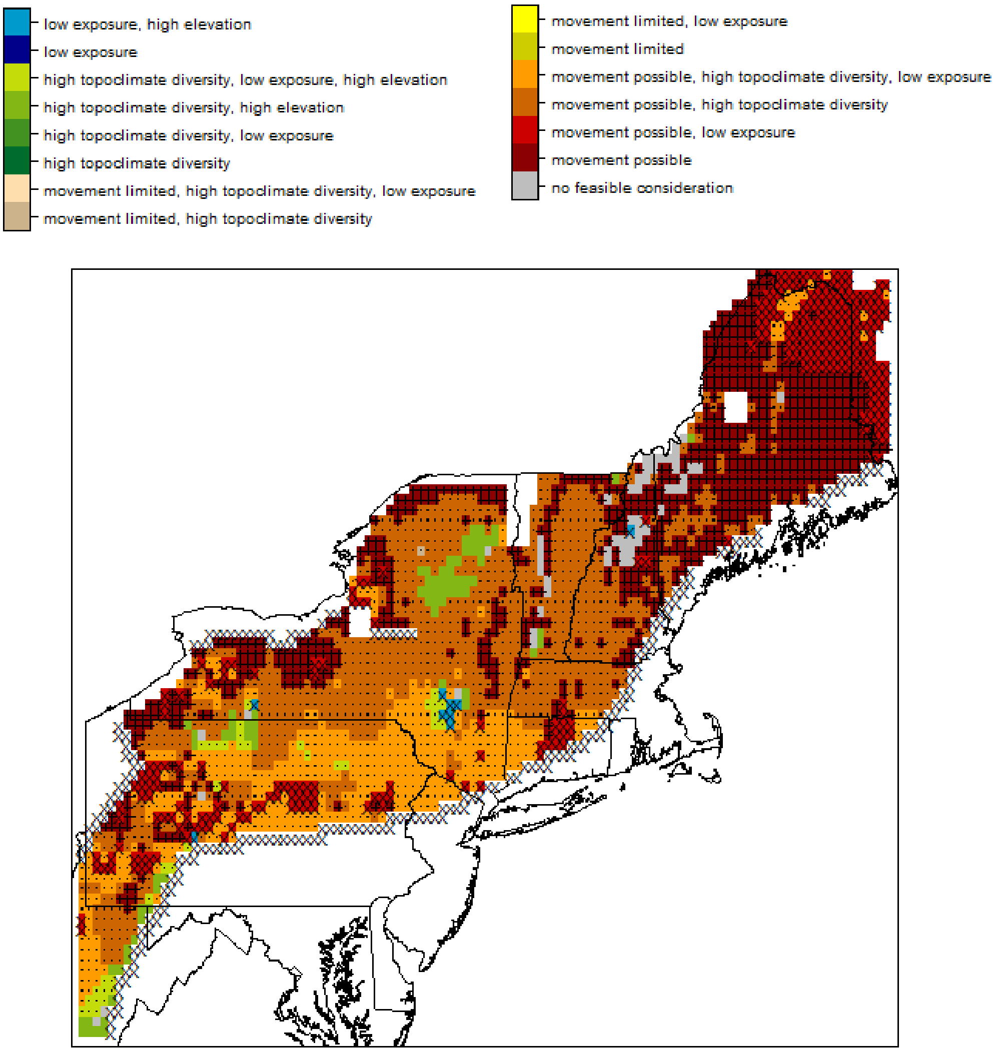

Figure AVIII. 1.54.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

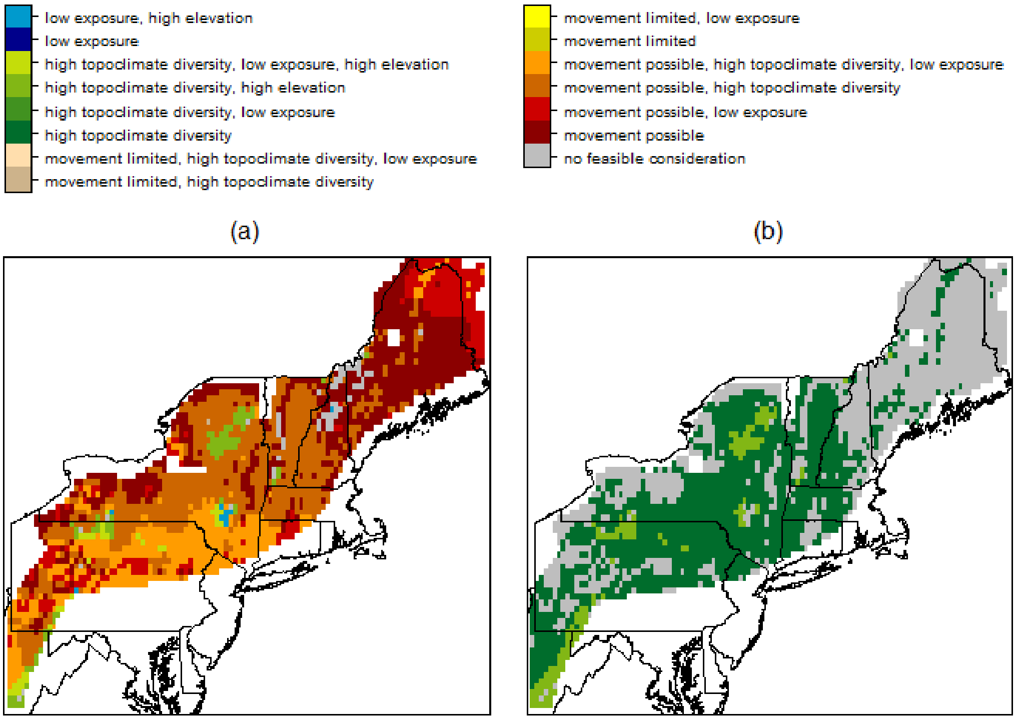

Figure AVIII. 1.54.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.55 Bay-breasted warbler (*Dendroica castanea*)

Table AVIII. 1.55.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	1.00	0.00	1.00	10.00
low	0.44	0.50	0.86	0.00	1.00	0.00
high	0.61	0.65	1.00	0.10	1.00	300.00

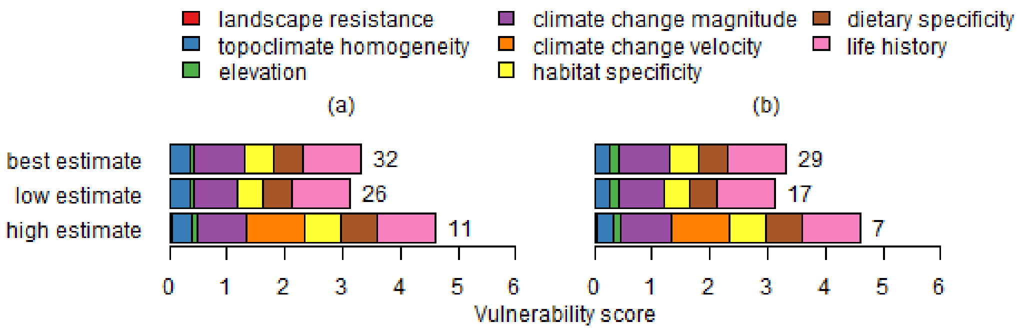

Figure AVIII. 1.55.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

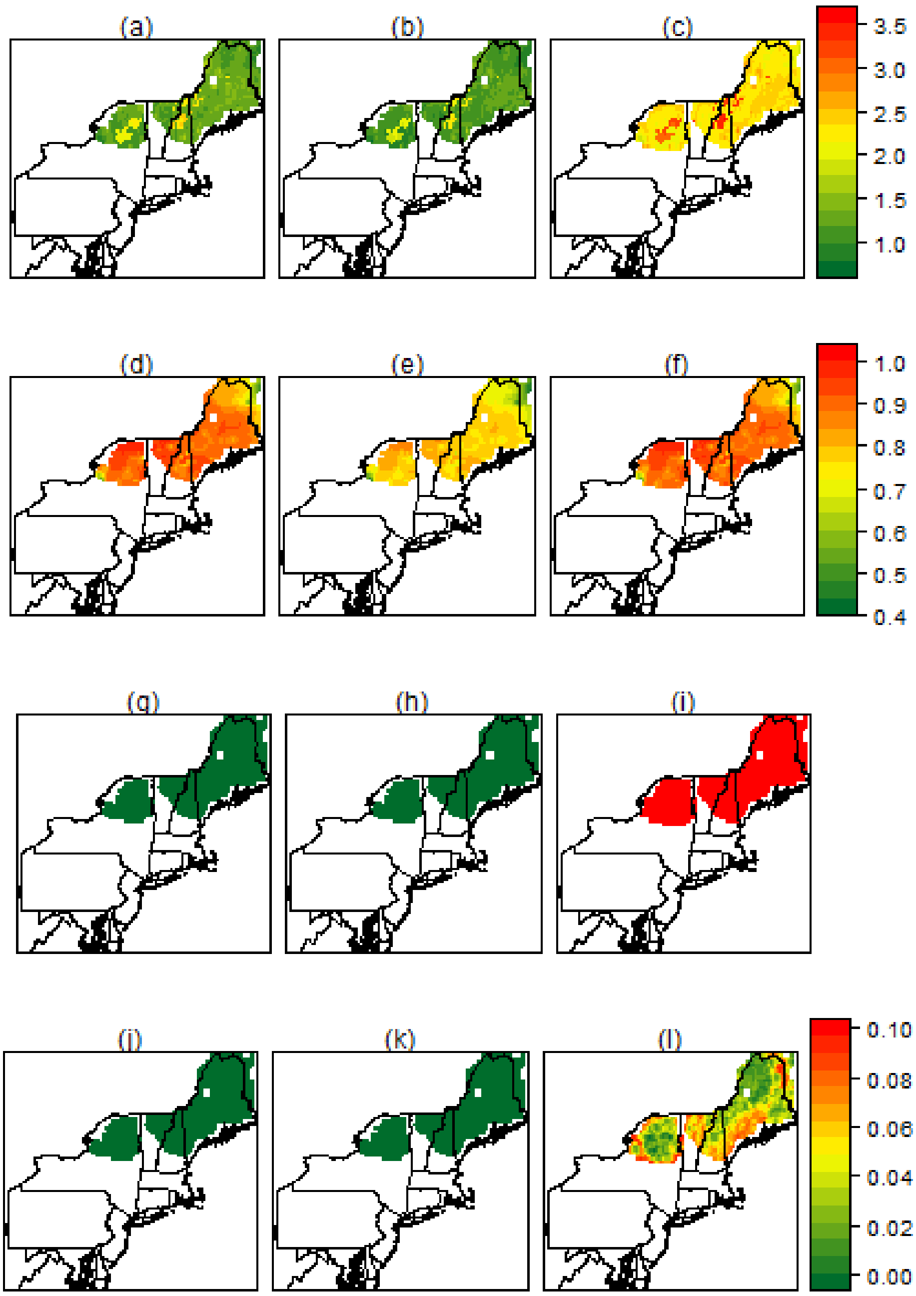

Figure AVIII. 1.55.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

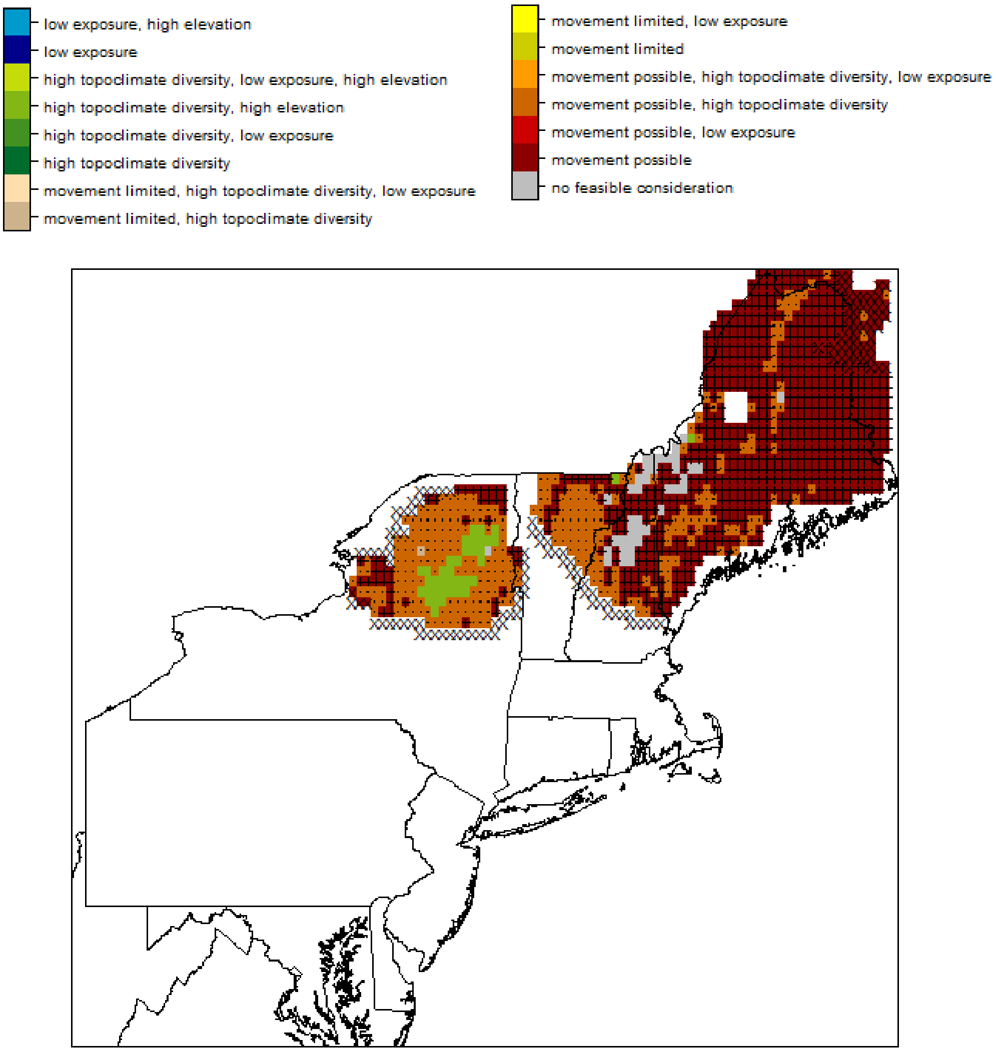

Figure AVIII. 1.55.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

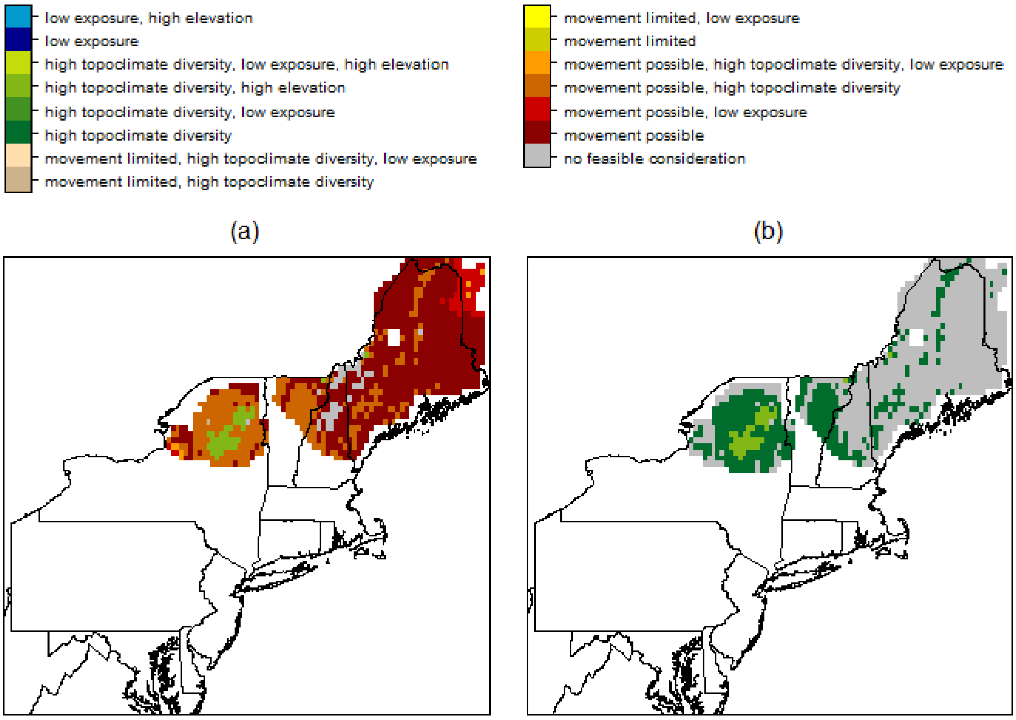

Figure AVIII. 1.55.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.56 Cerulean warbler (*Dendroica cerulea*)

Table AVIII. 1.56.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.75	0.25	1.00	7.50
low	0.42	0.47	0.62	0.20	1.00	0.50
high	0.50	0.50	0.85	0.30	1.00	175.00

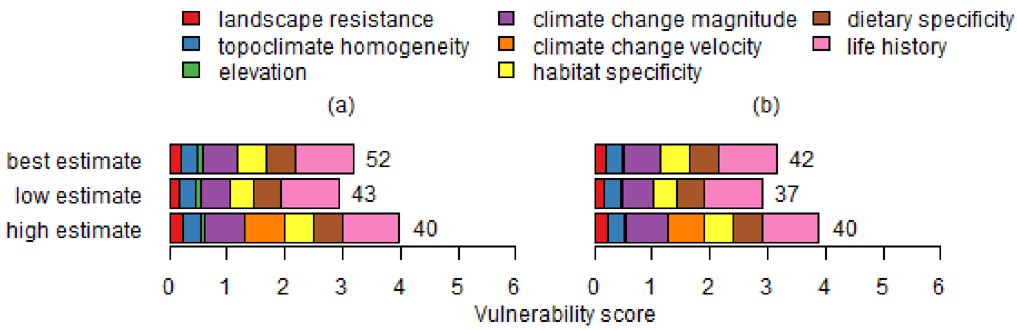

Figure AVIII. 1.56.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

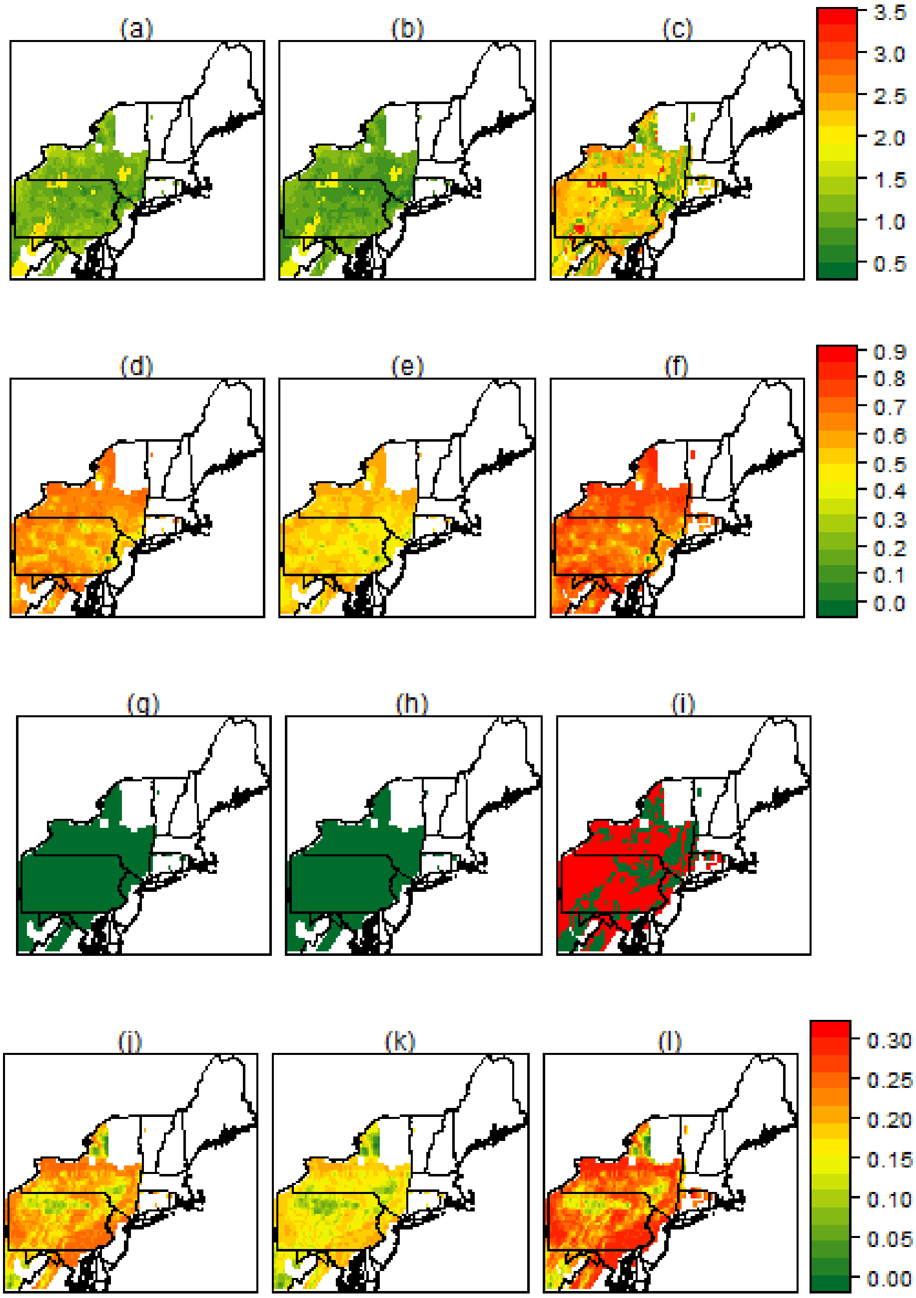

Figure AVIII. 1.56.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

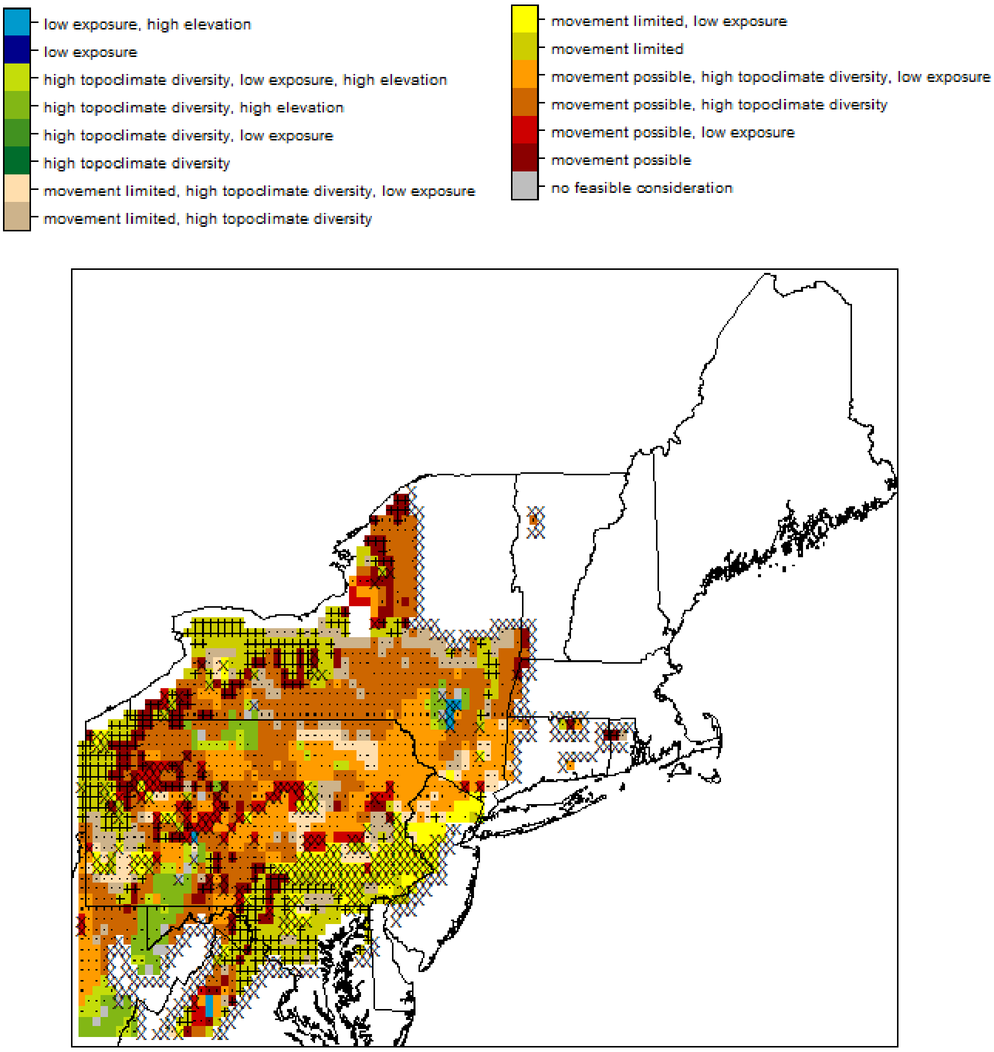

Figure AVIII. 1.56.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

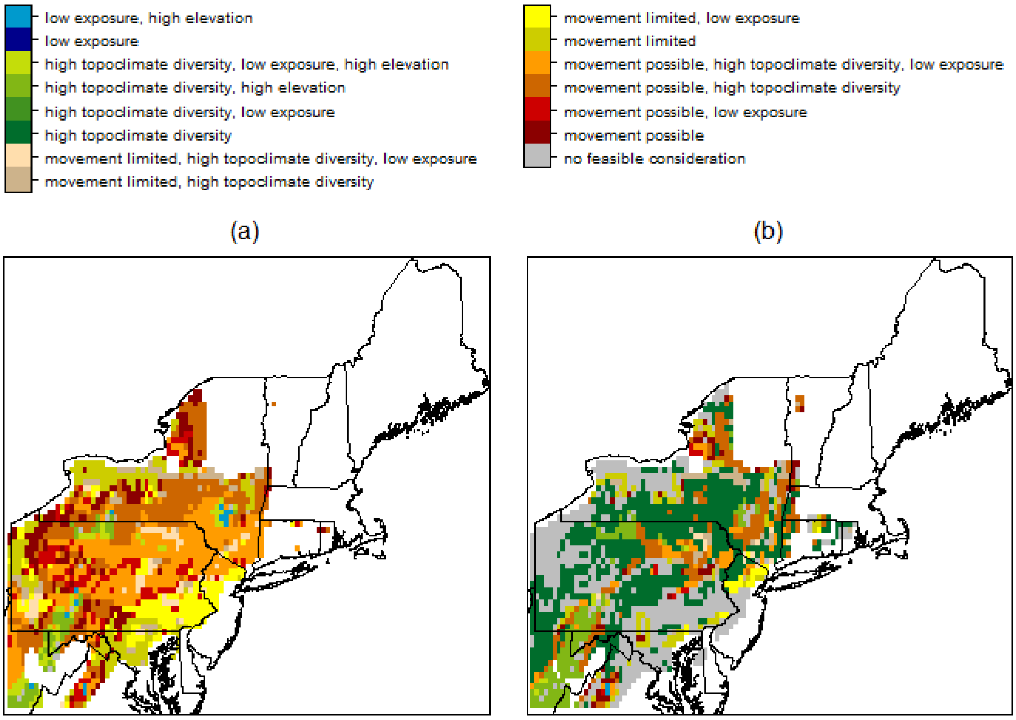

Figure AVIII. 1.56.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.57 Prairie warbler (*Dendroica discolor*)

Table AVIII. 1.57.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	4.00
low	0.40	0.50	0.55	0.00	1.00	0.00
high	0.50	0.50	0.71	0.10	1.00	300.00

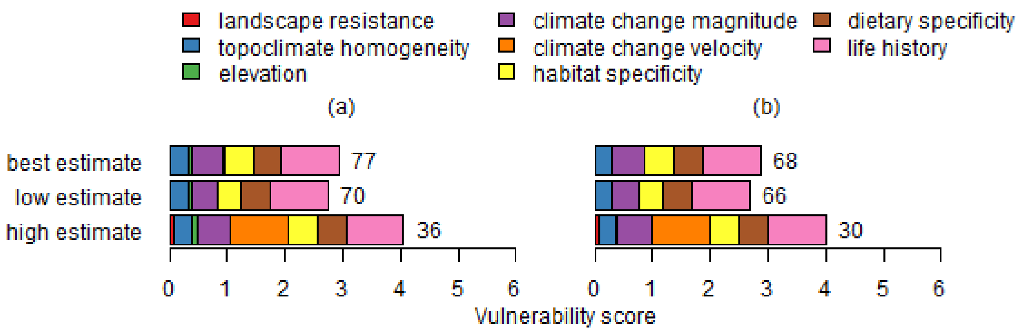

Figure AVIII. 1.57.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

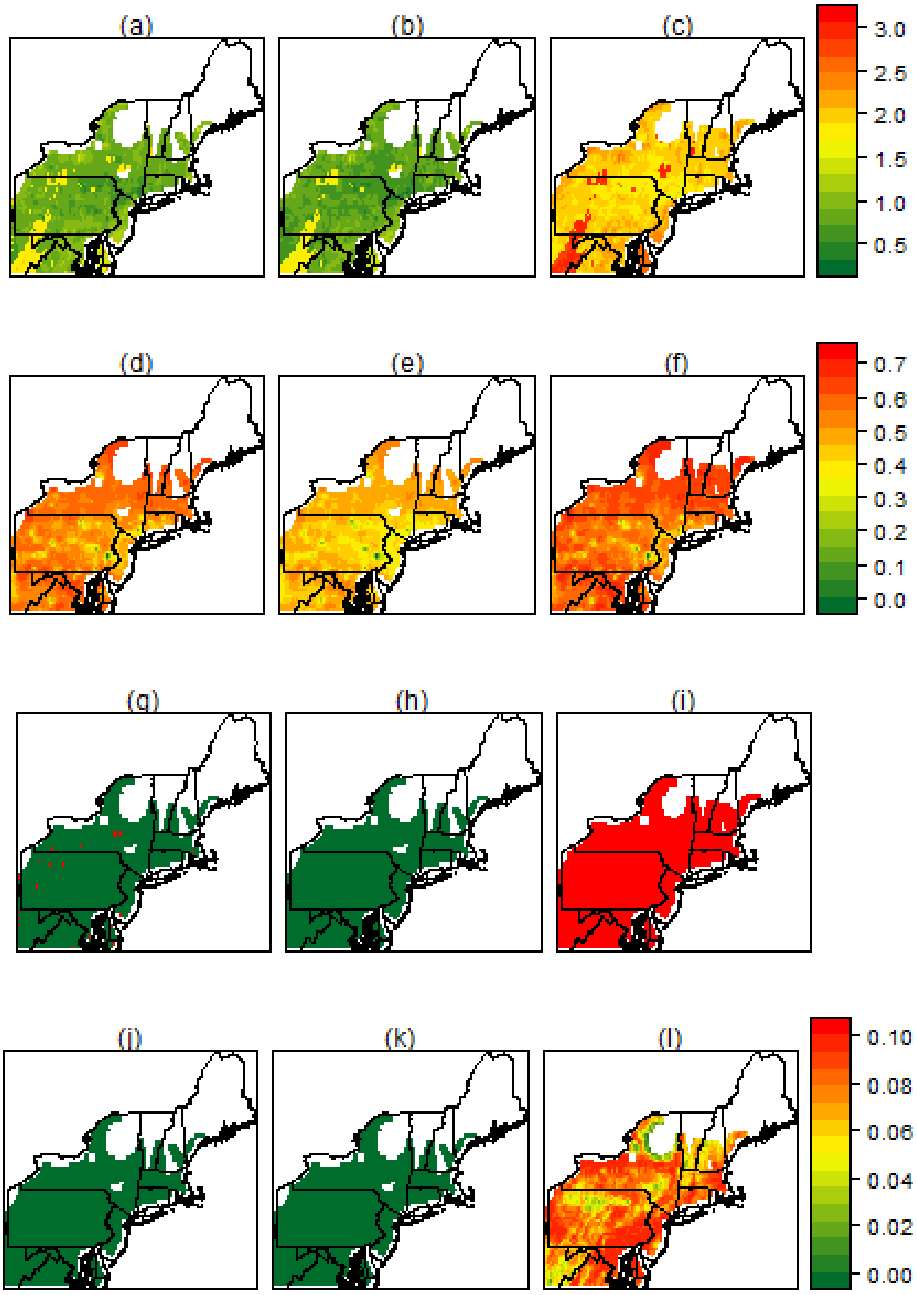

Figure AVIII. 1.57.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

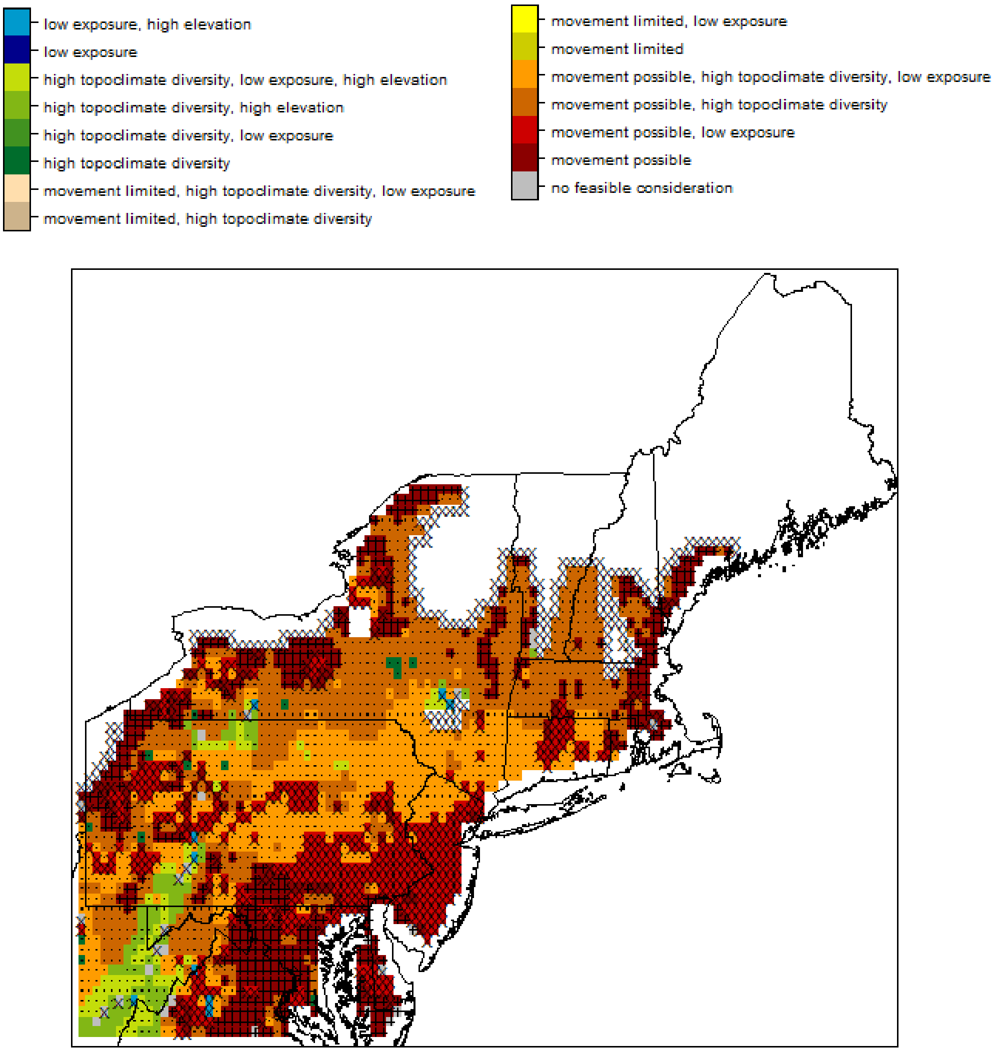

Figure AVIII. 1.57.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

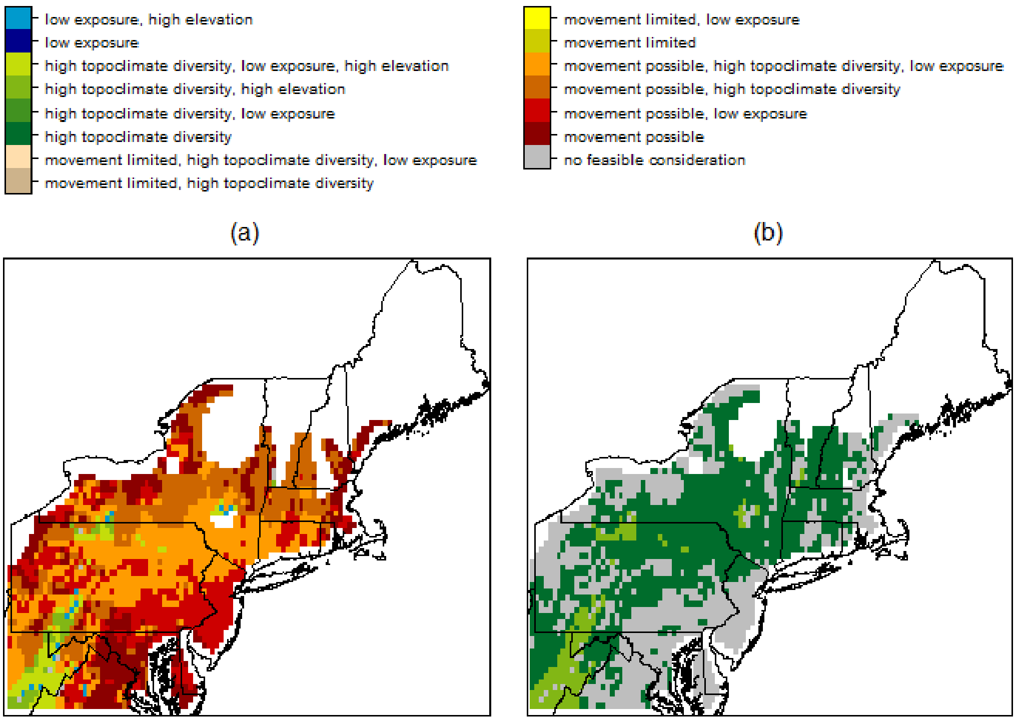

Figure AVIII. 1.57.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.58 Cape May warbler (*Dendroica tigrina*)

Table AVIII. 1.58.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	1.00	0.00	1.00	8.00
low	0.44	0.50	0.86	0.00	1.00	0.00
high	0.61	0.70	1.00	0.10	1.00	300.00

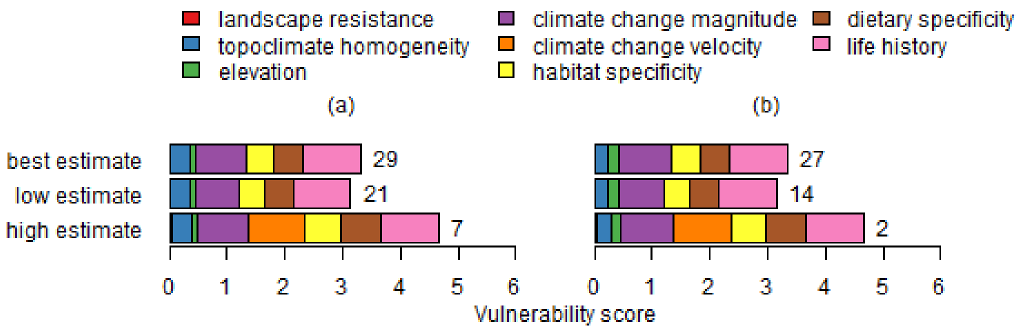

Figure AVIII. 1.58.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

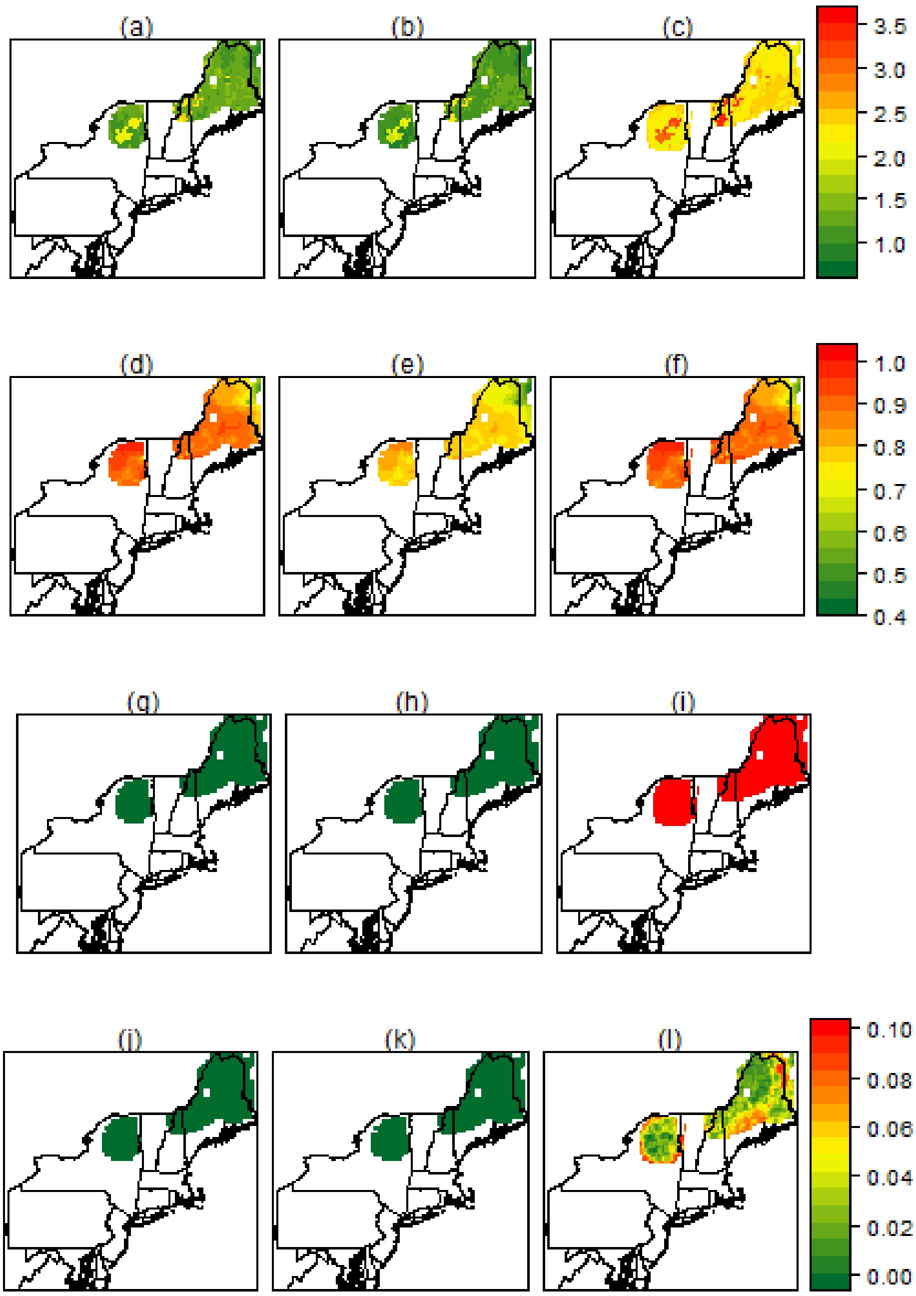

Figure AVIII. 1.58.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

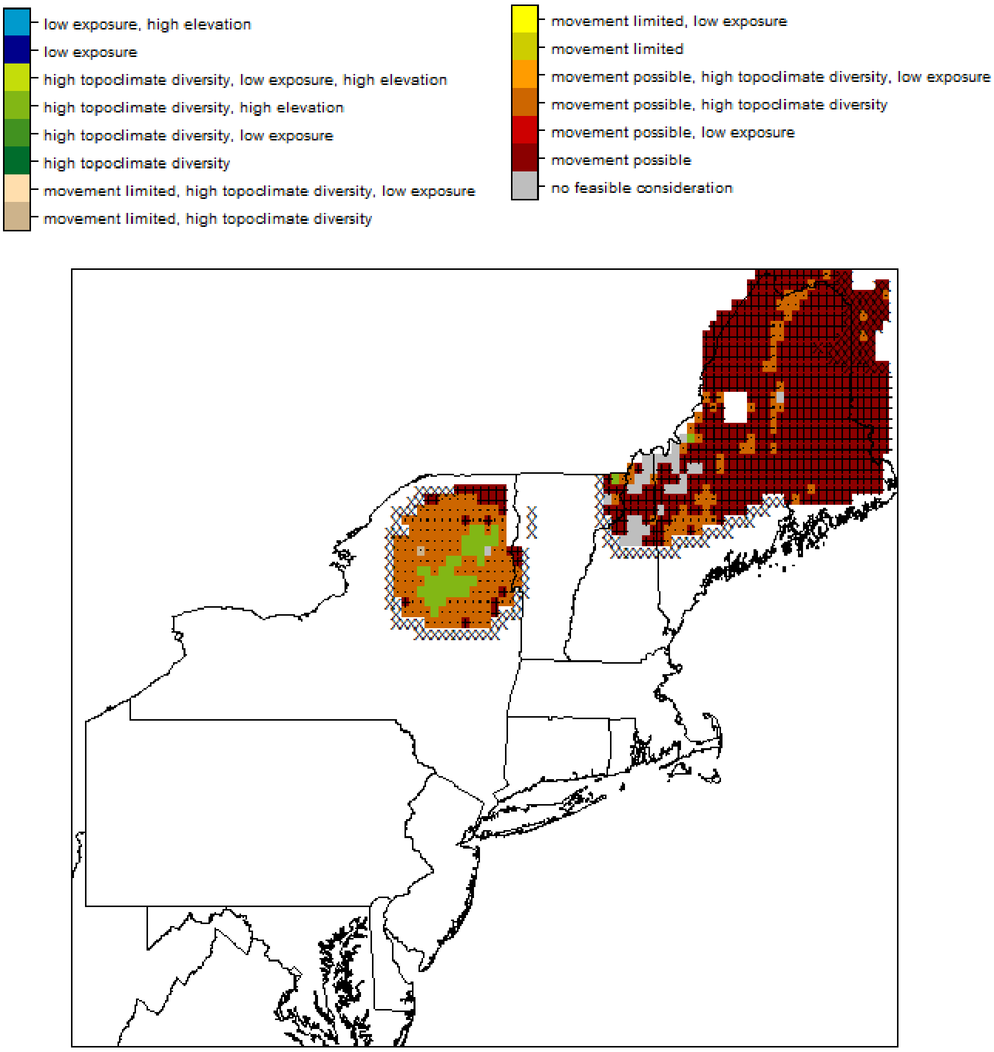

Figure AVIII. 1.58.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

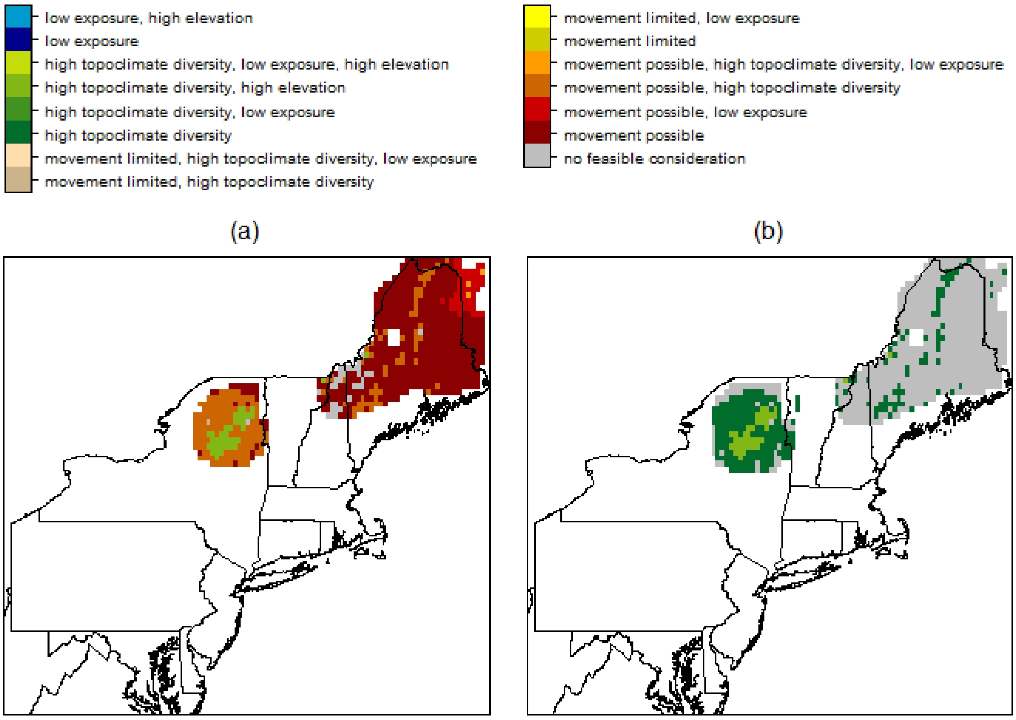

Figure AVIII. 1.58.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.59 Worm-eating warbler (*Helmitheros vermivorum*)

Table AVIII. 1.59.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	10.00
low	0.45	0.50	0.58	0.00	1.00	0.00
high	0.50	0.50	0.74	0.10	1.00	300.00

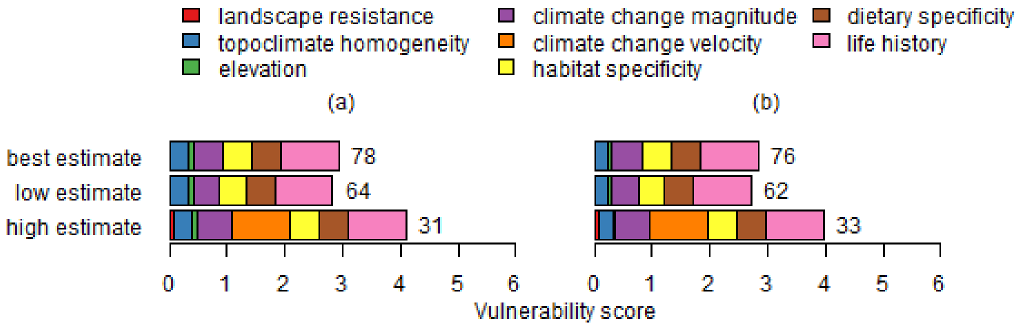

Figure AVIII. 1.59.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

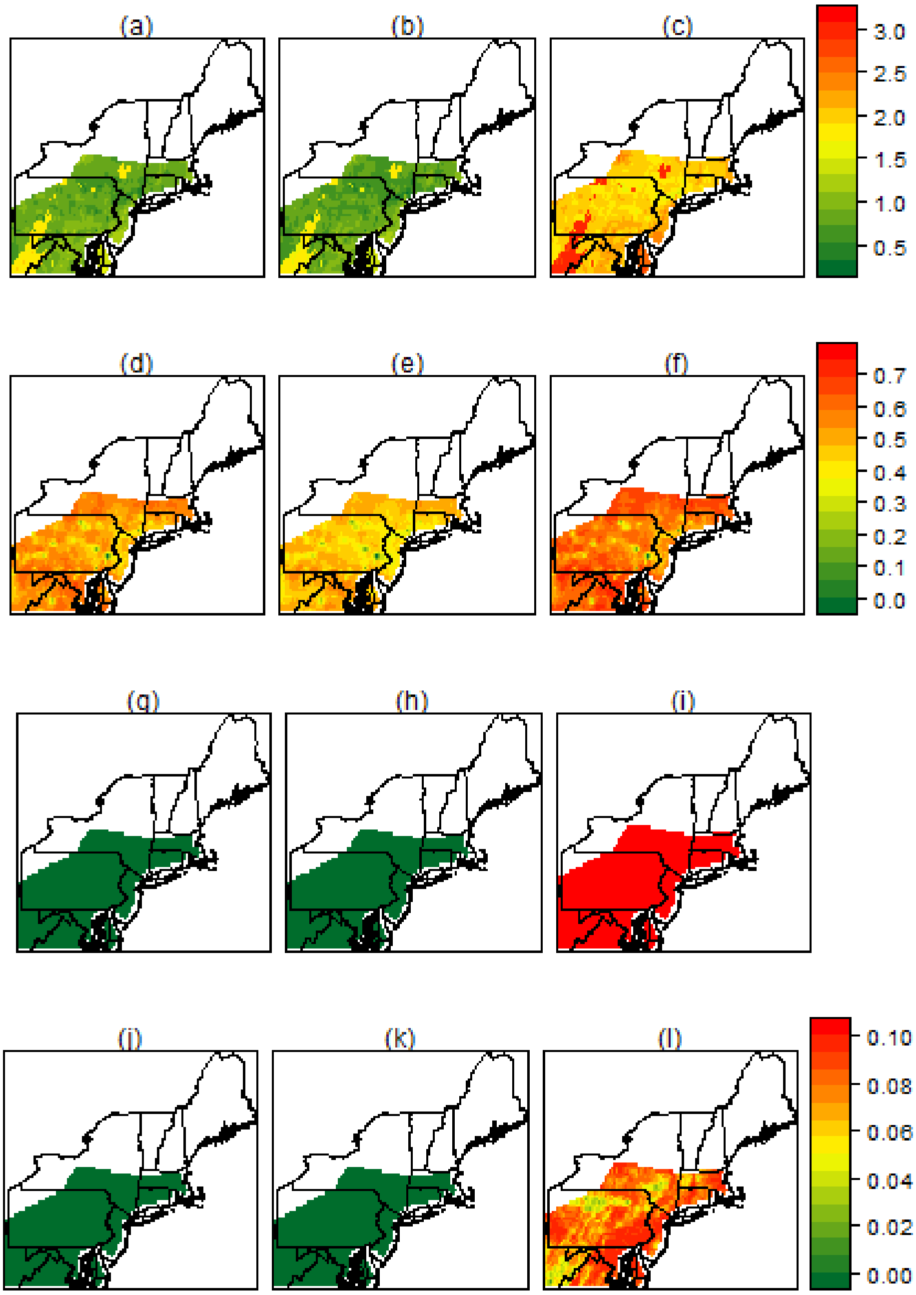

Figure AVIII. 1.59.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

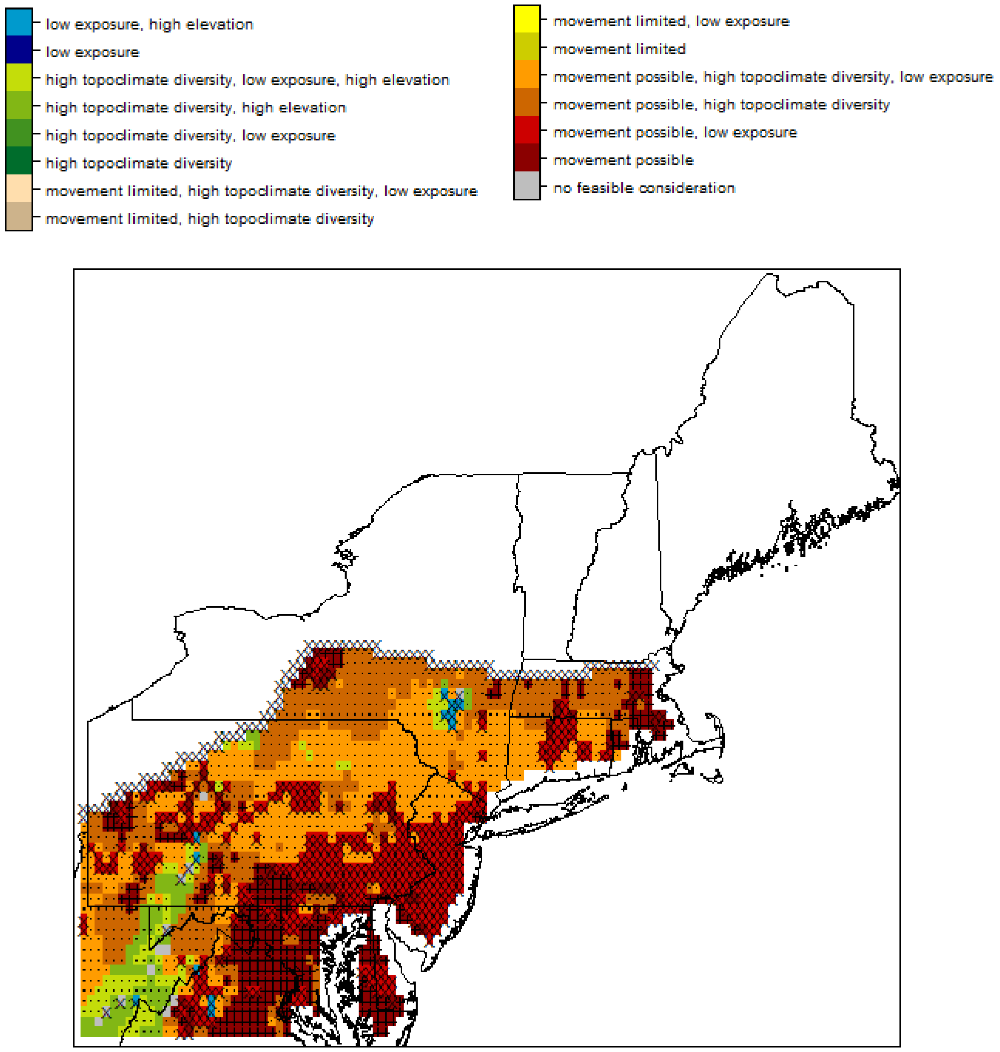

Figure AVIII. 1.59.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

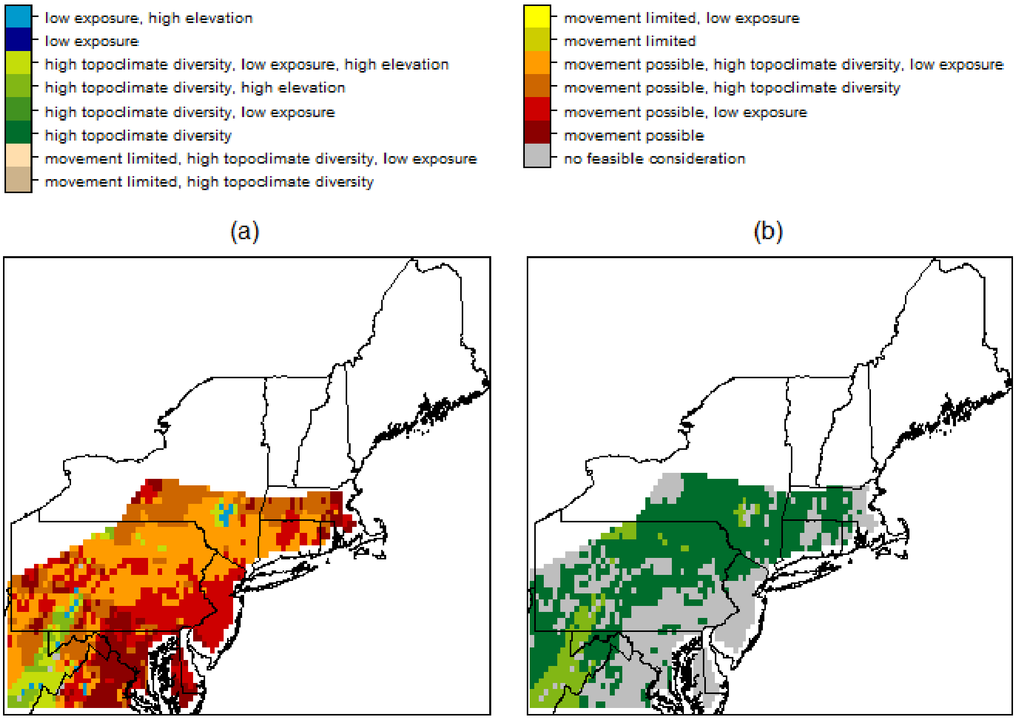

Figure AVIII. 1.59.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.60 Yellow-breasted chat (*Icteria virens*)

Table AVIII. 1.60.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.50	0.66	0.00	1.00	10.00
low	0.00	0.35	0.55	0.00	1.00	0.00
high	0.50	0.50	0.71	0.10	1.00	300.00

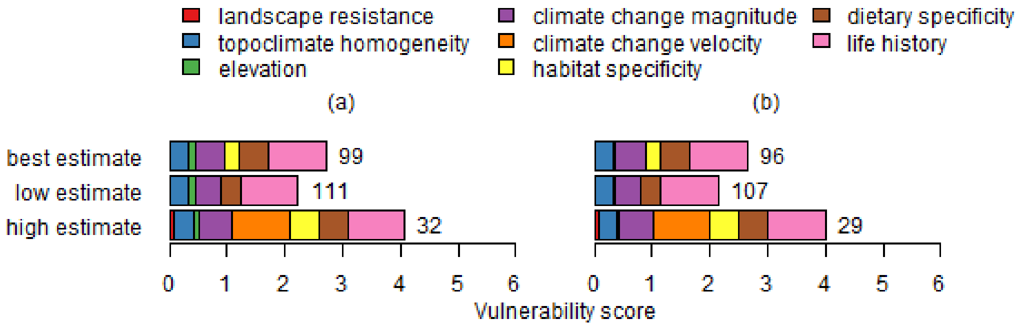

Figure AVIII. 1.60.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

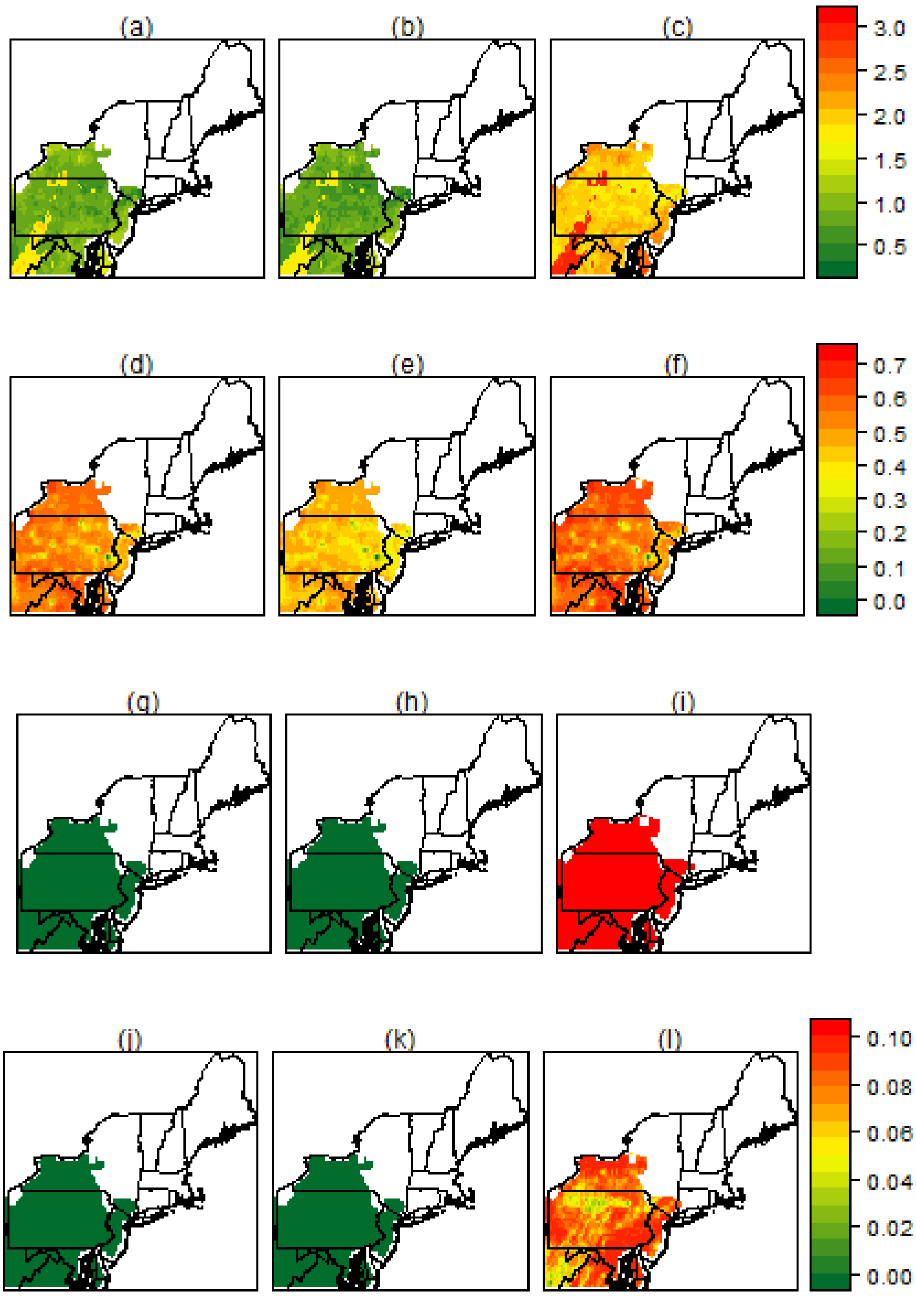

Figure AVIII. 1.60.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

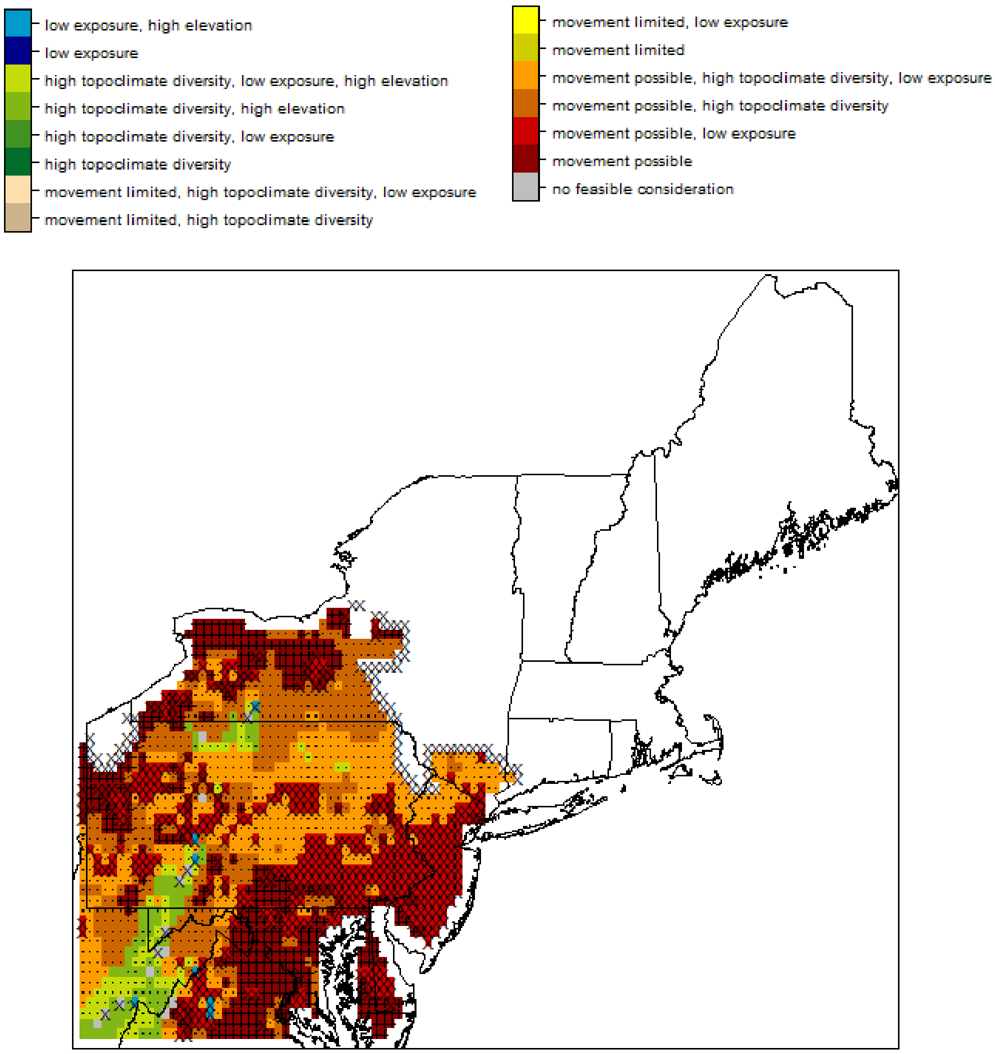

Figure AVIII. 1.60.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

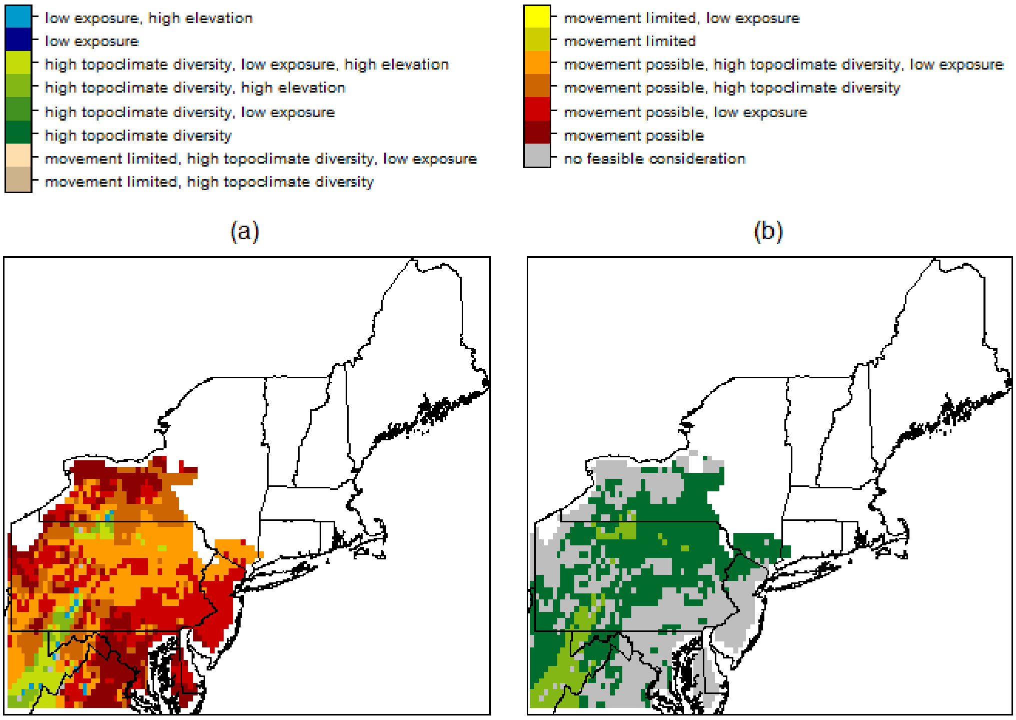

Figure AVIII. 1.60.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.61 Kentucky warbler (*Oporornis formosus*)

Table AVIII. 1.61.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	10.00
low	0.35	0.50	0.62	0.00	1.00	0.00
high	0.50	0.50	0.70	0.10	1.00	300.00

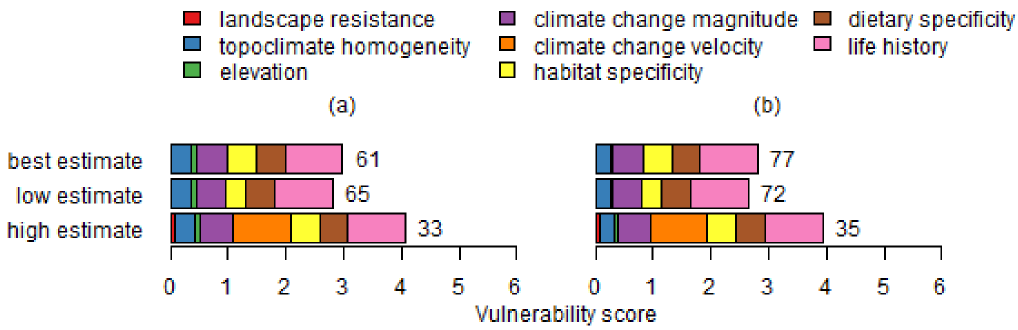

Figure AVIII. 1.61.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

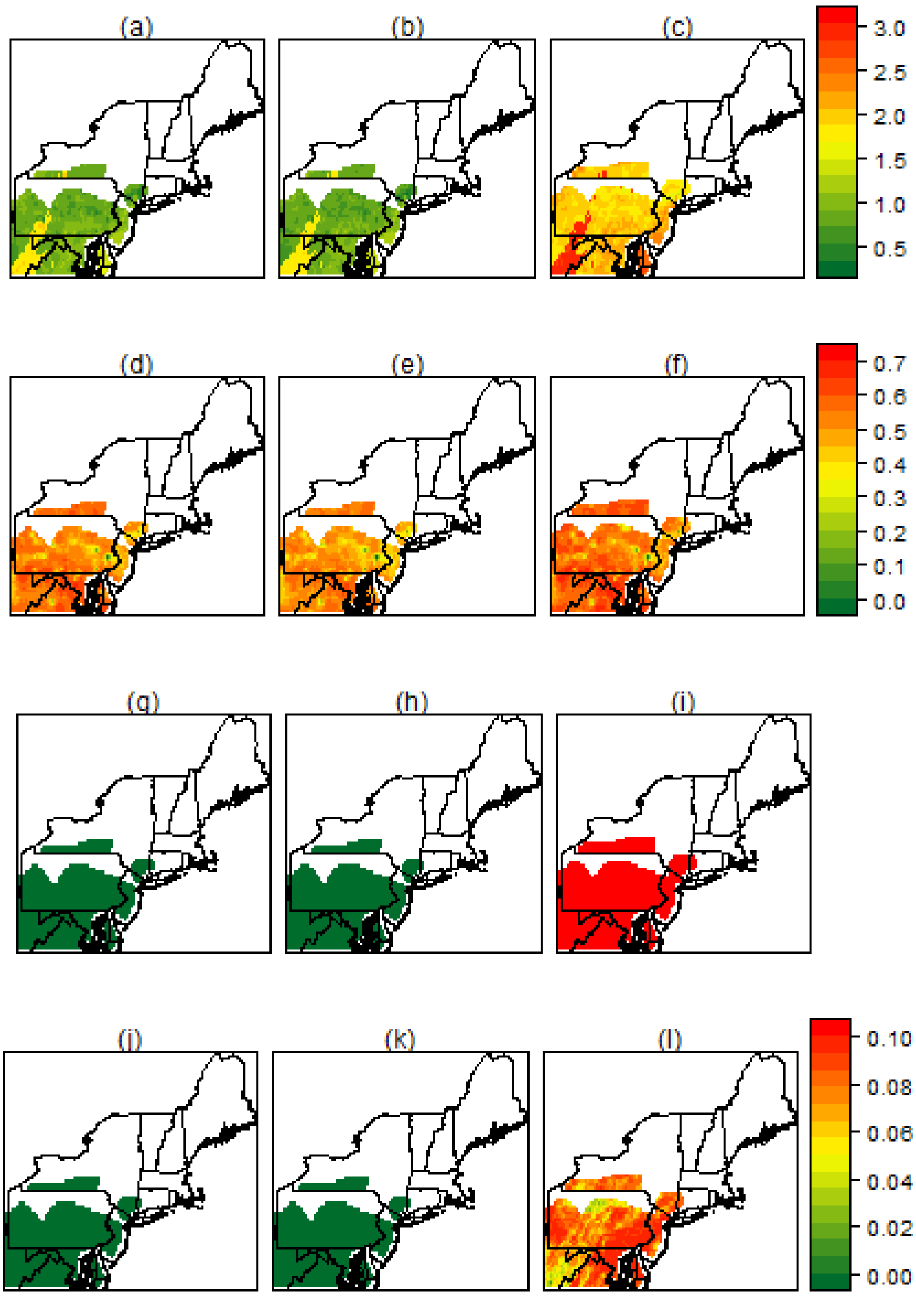

Figure AVIII. 1.61.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

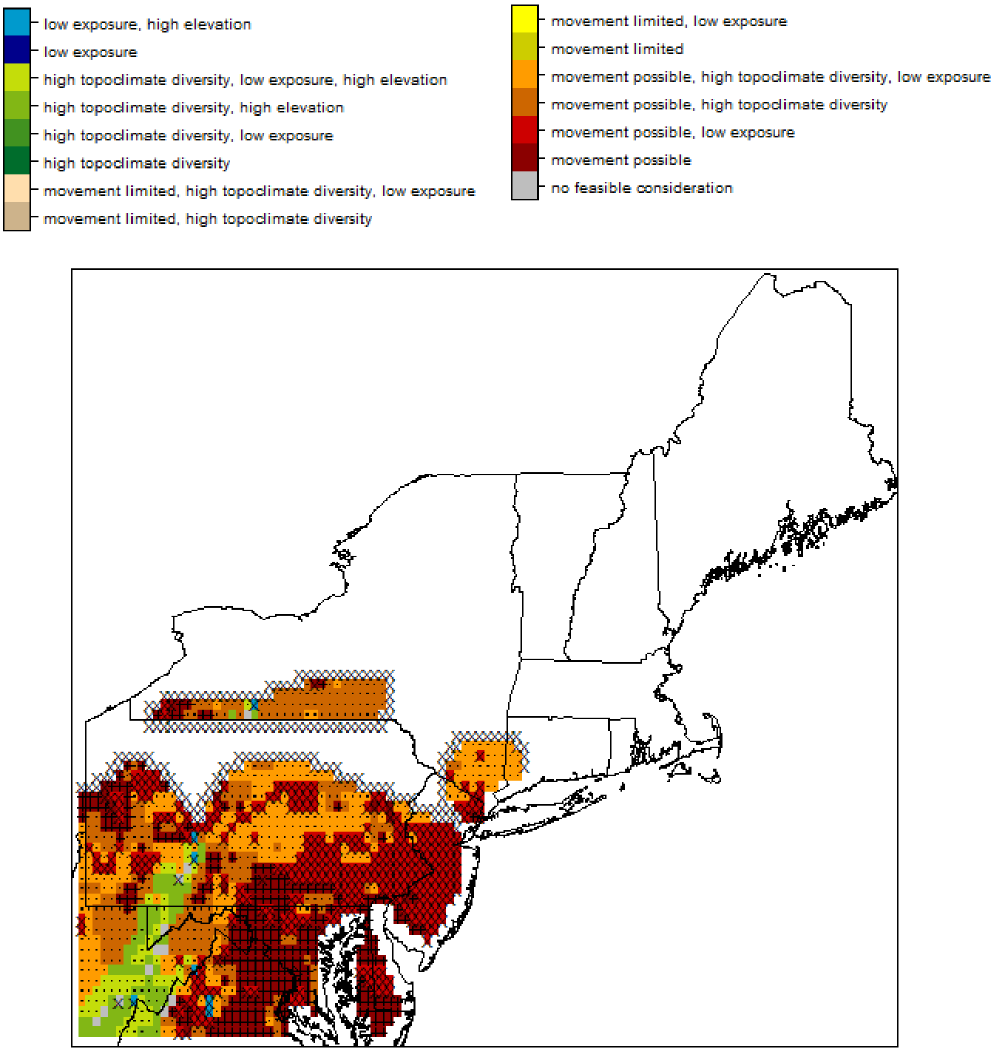

Figure AVIII. 1.61.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

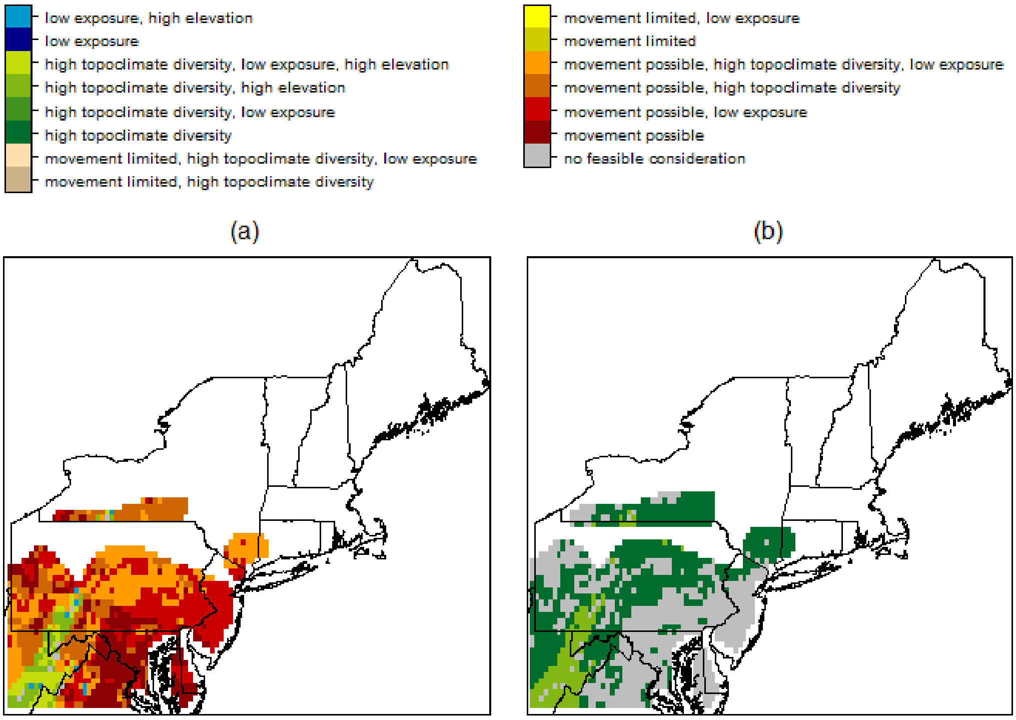

Figure AVIII. 1.61.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.62 Prothonotary warbler (*Protonotaria citrea*)

Table AVIII. 1.62.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	3.00
low	0.40	0.50	0.55	0.00	1.00	0.00
high	0.50	0.50	0.71	0.10	1.00	100.00

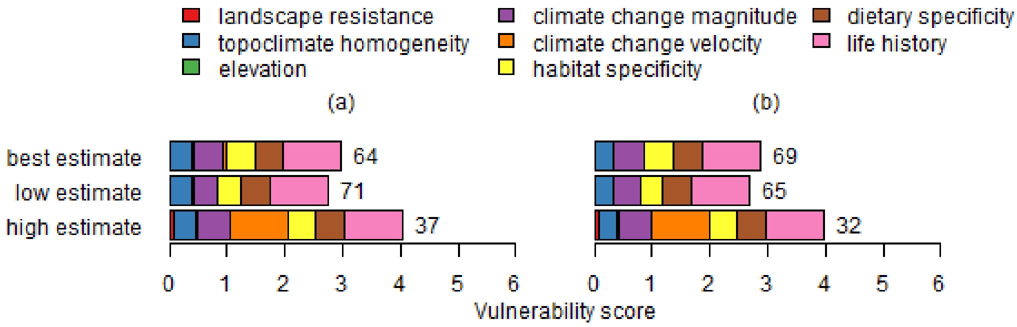

Figure AVIII. 1.62.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

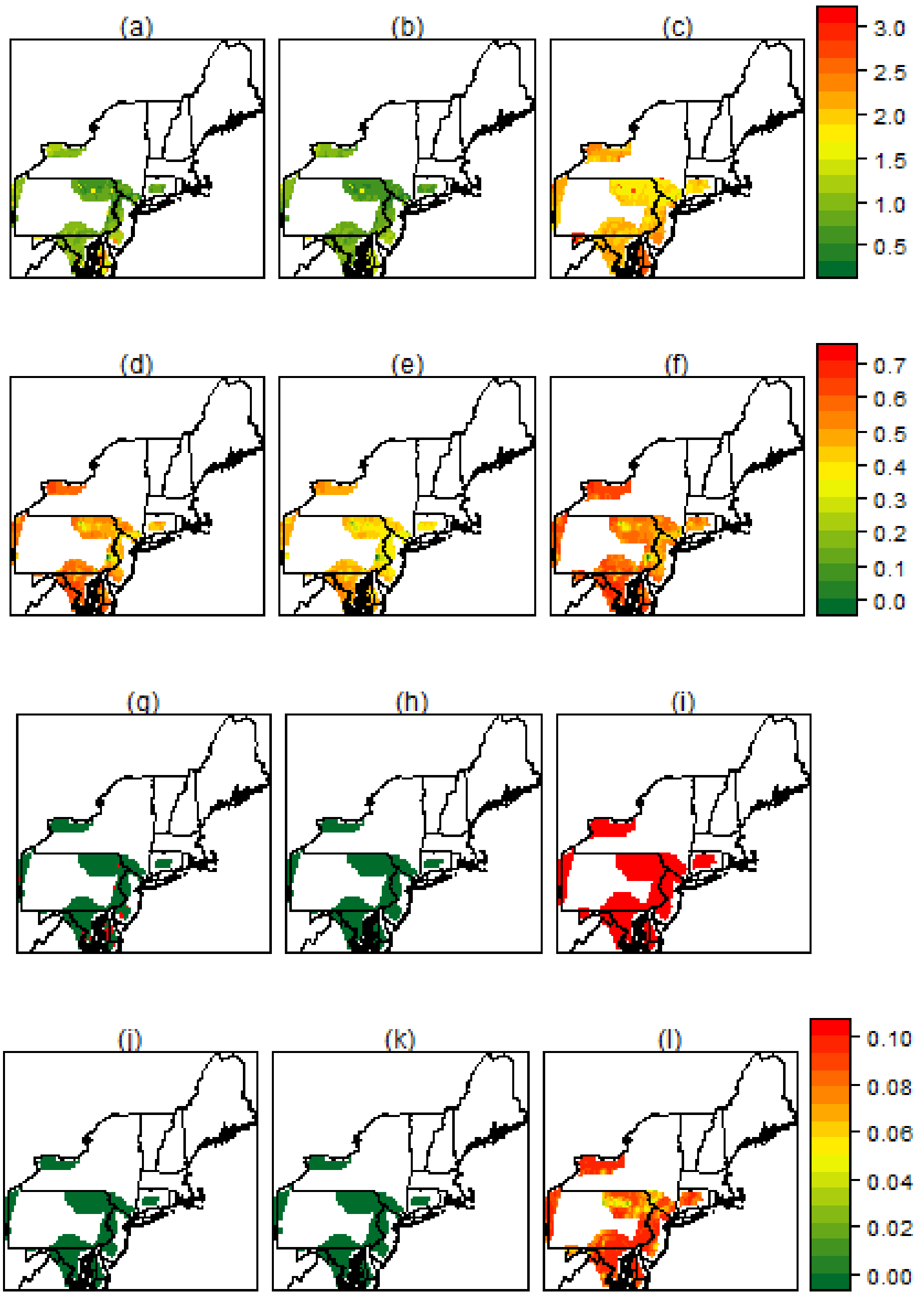

Figure AVIII. 1.62.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

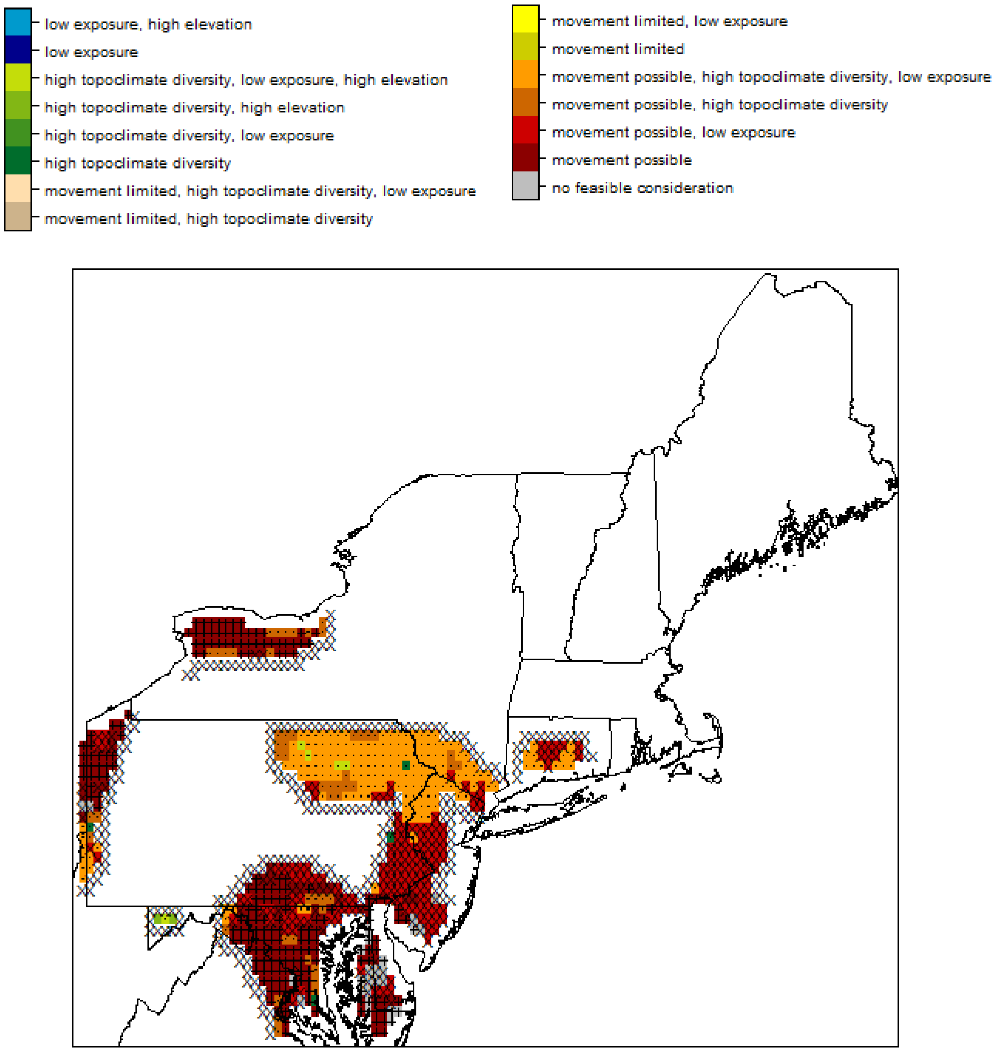

Figure AVIII. 1.62.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

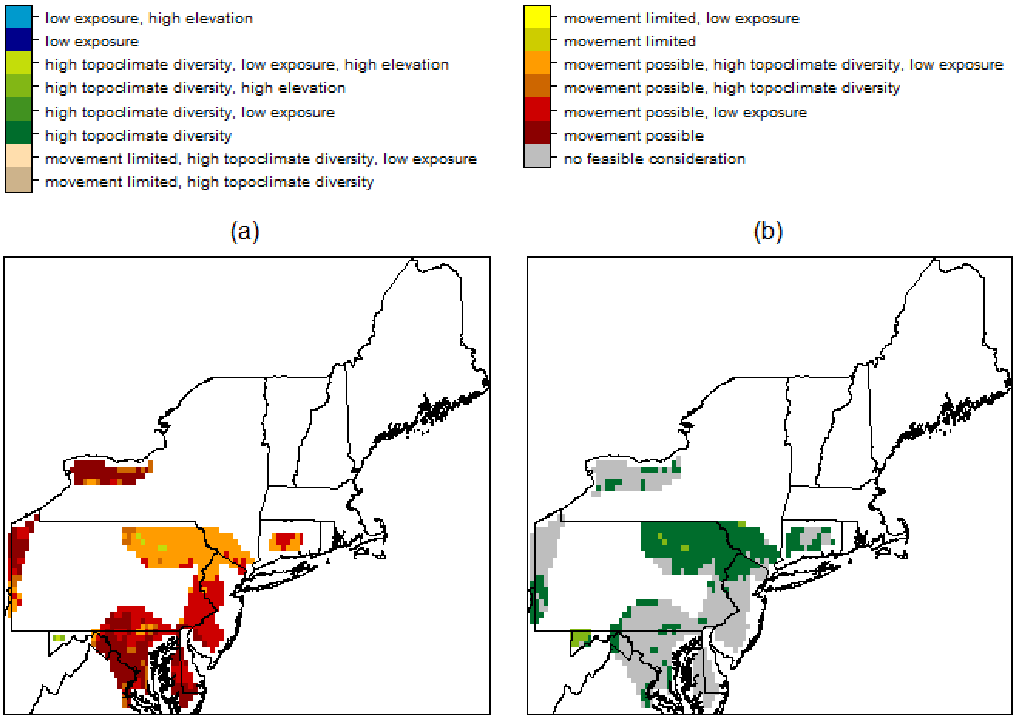

Figure AVIII. 1.62.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.63 Louisiana waterthrush (*Seiurus motacilla*)

Table AVIII. 1.63.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	4.00
low	0.45	0.50	0.59	0.00	1.00	0.00
high	0.50	0.50	0.70	0.10	1.00	300.00

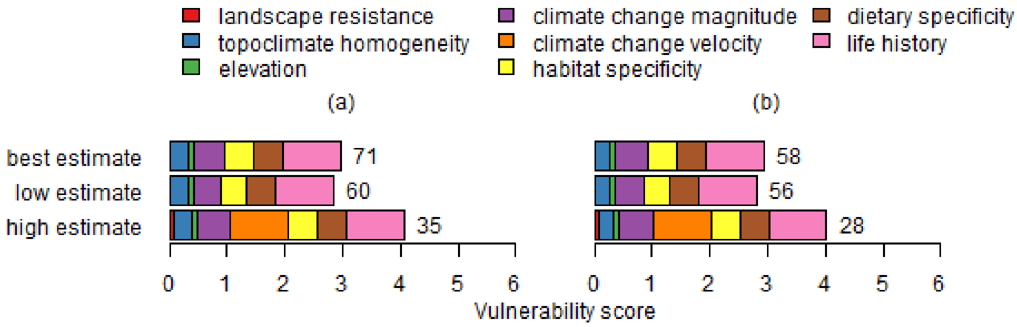

Figure AVIII. 1.63.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

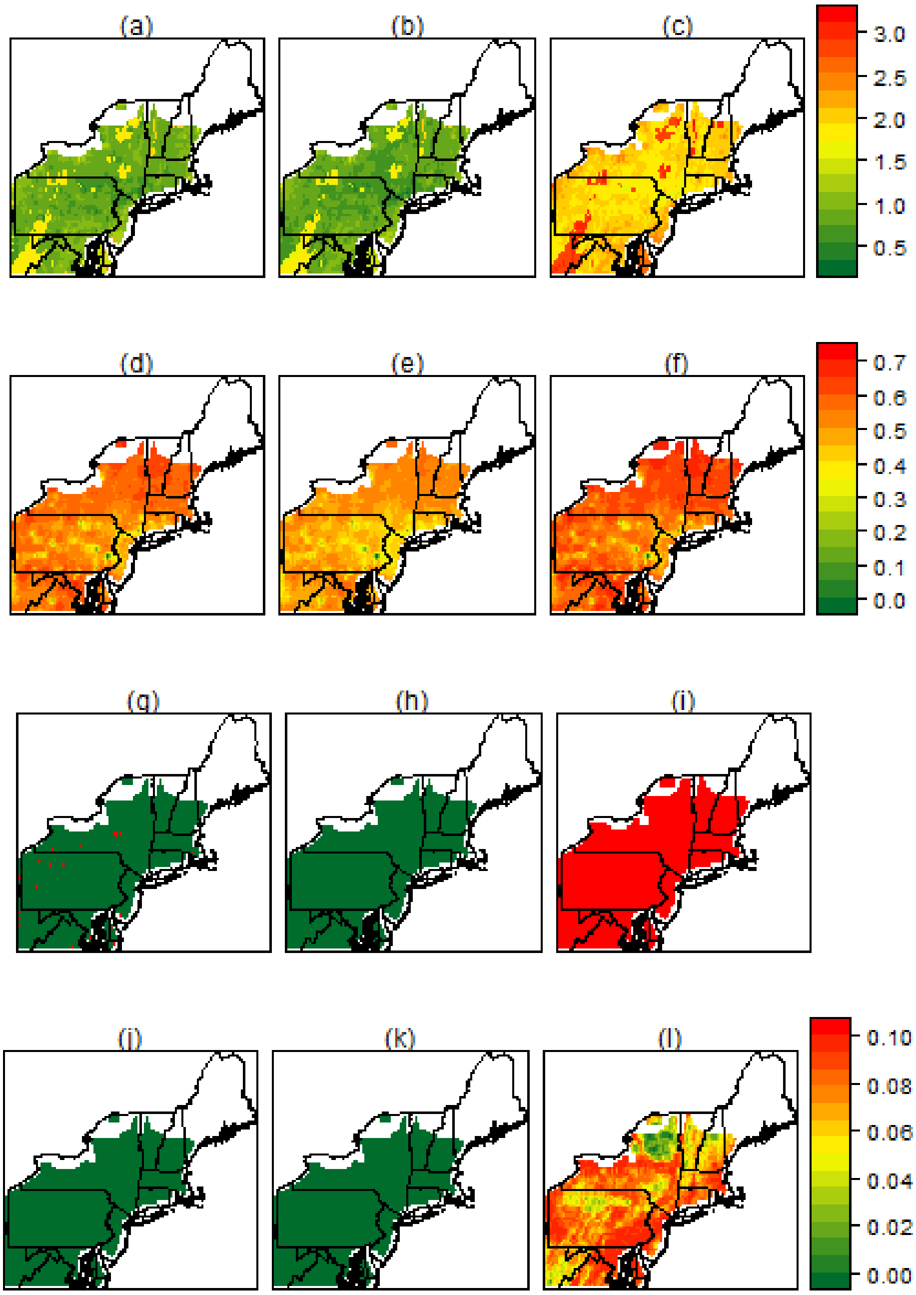

Figure AVIII. 1.63.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

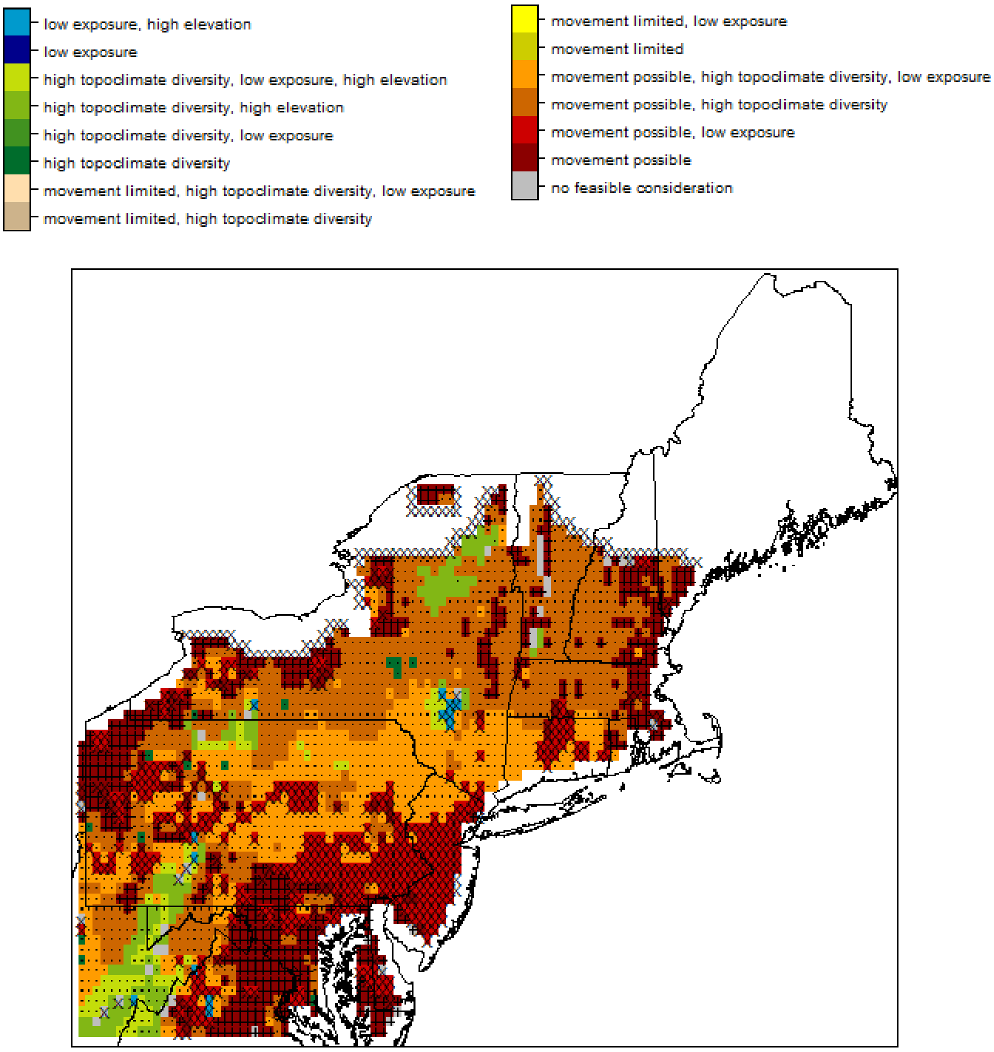

Figure AVIII. 1.63.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

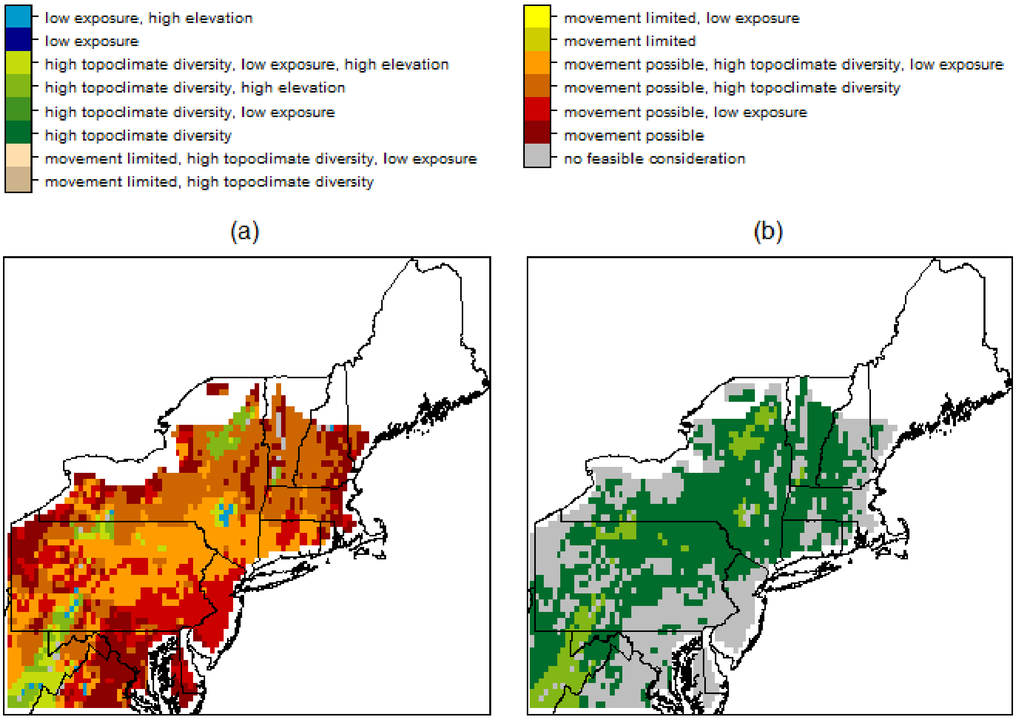

Figure AVIII. 1.63.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.64 Golden-winged warbler (*Vermivora chrysoptera*)

Table AVIII. 1.64.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.80	0.21	1.00	5.80
low	0.47	0.49	0.73	0.12	1.00	1.50
high	0.50	0.50	0.86	0.28	1.00	92.00

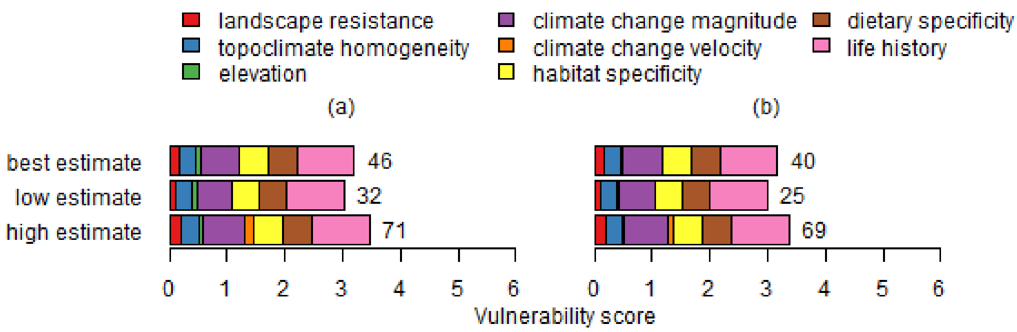

Figure AVIII. 1.64.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

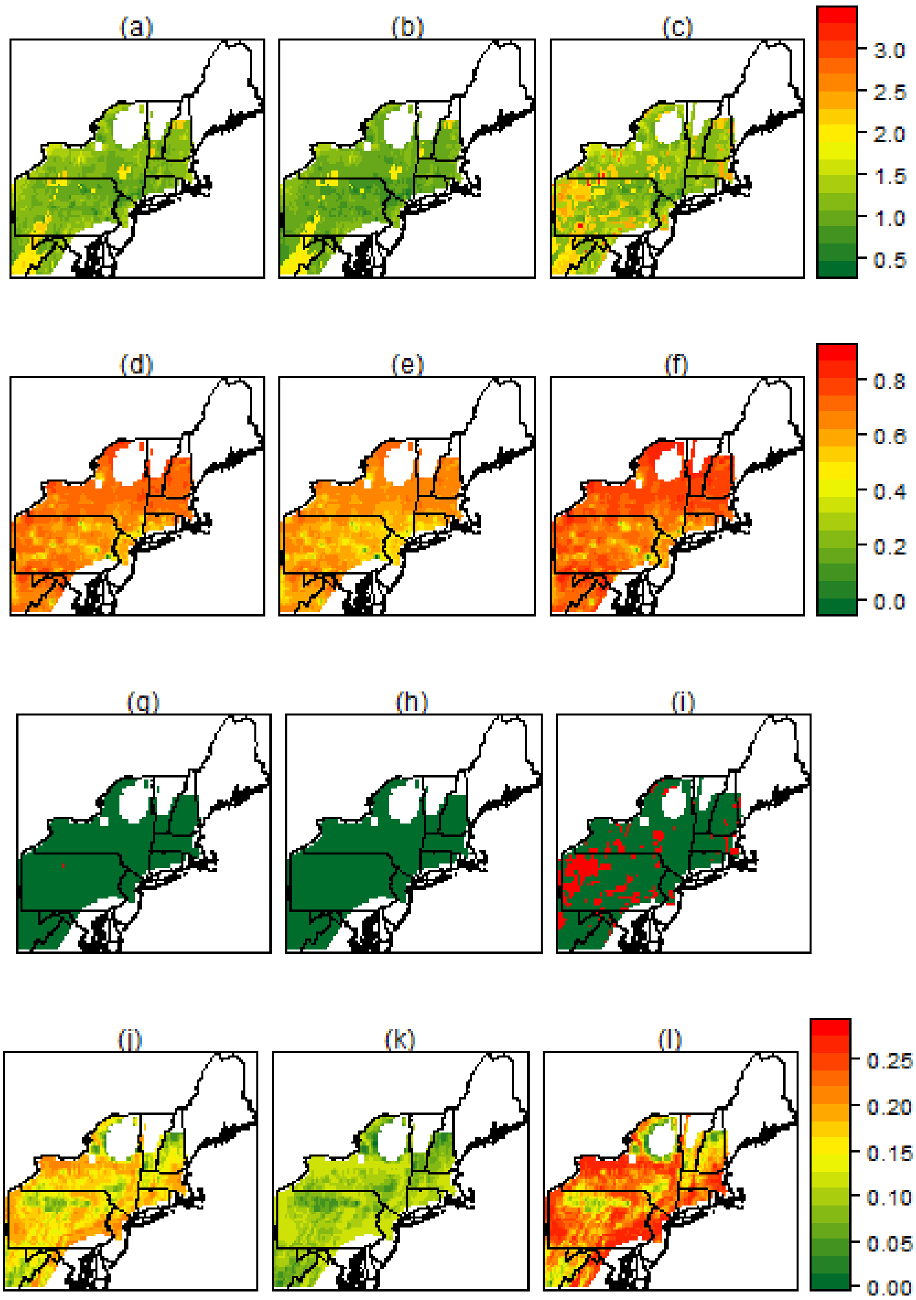

Figure AVIII. 1.64.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

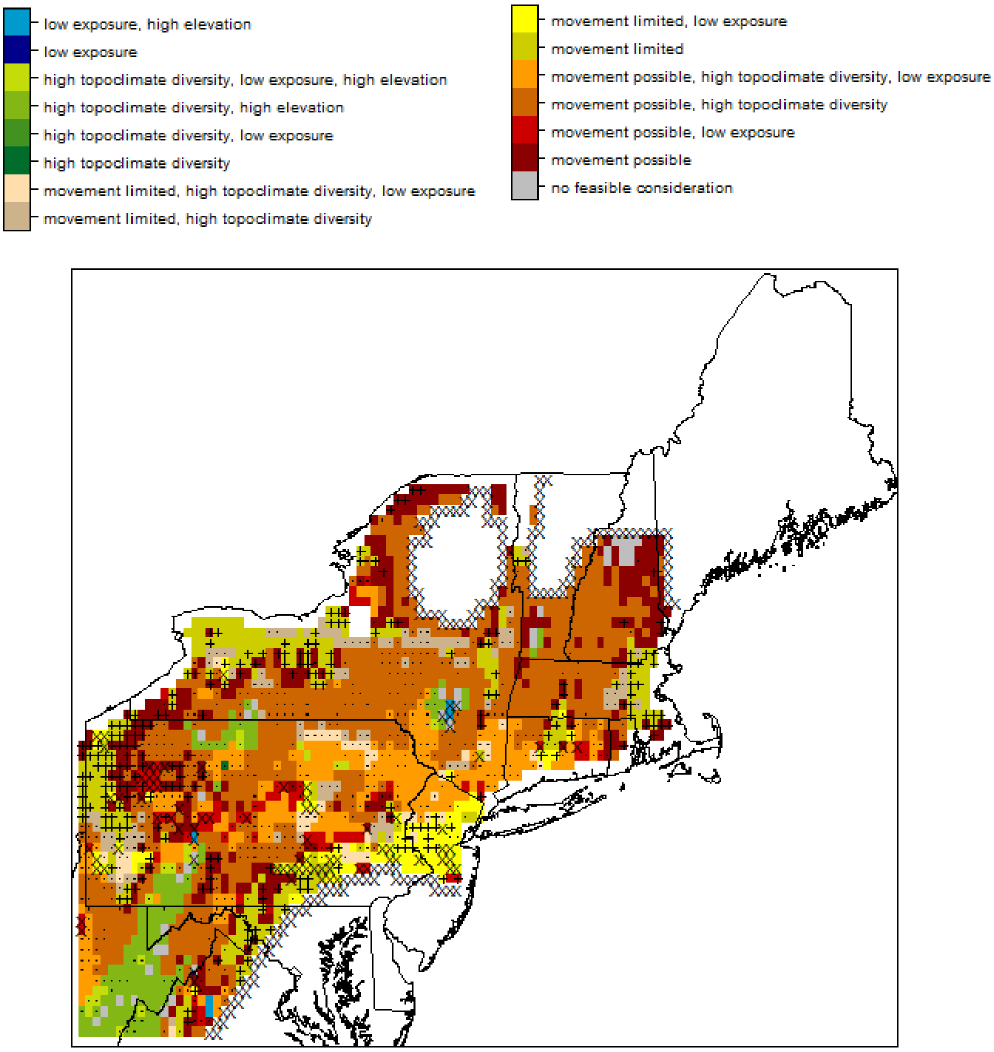

Figure AVIII. 1.64.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

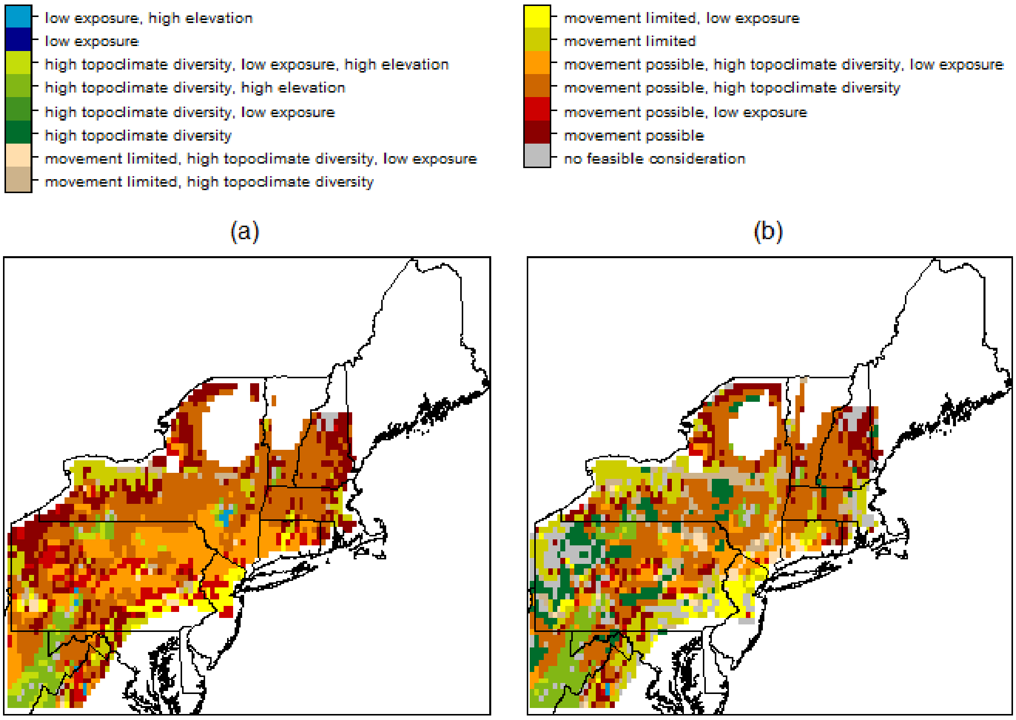

Figure AVIII. 1.64.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.65 Tennessee warbler (*Vermivora peregrina*)

Table AVIII. 1.65.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	1.00	0.00	1.00	10.00
low	0.35	0.50	0.86	0.00	1.00	0.00
high	0.50	0.70	1.00	0.10	1.00	300.00

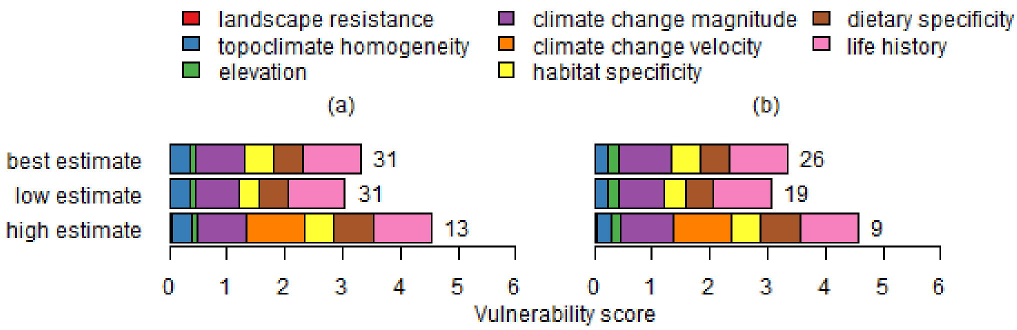

Figure AVIII. 1.65.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

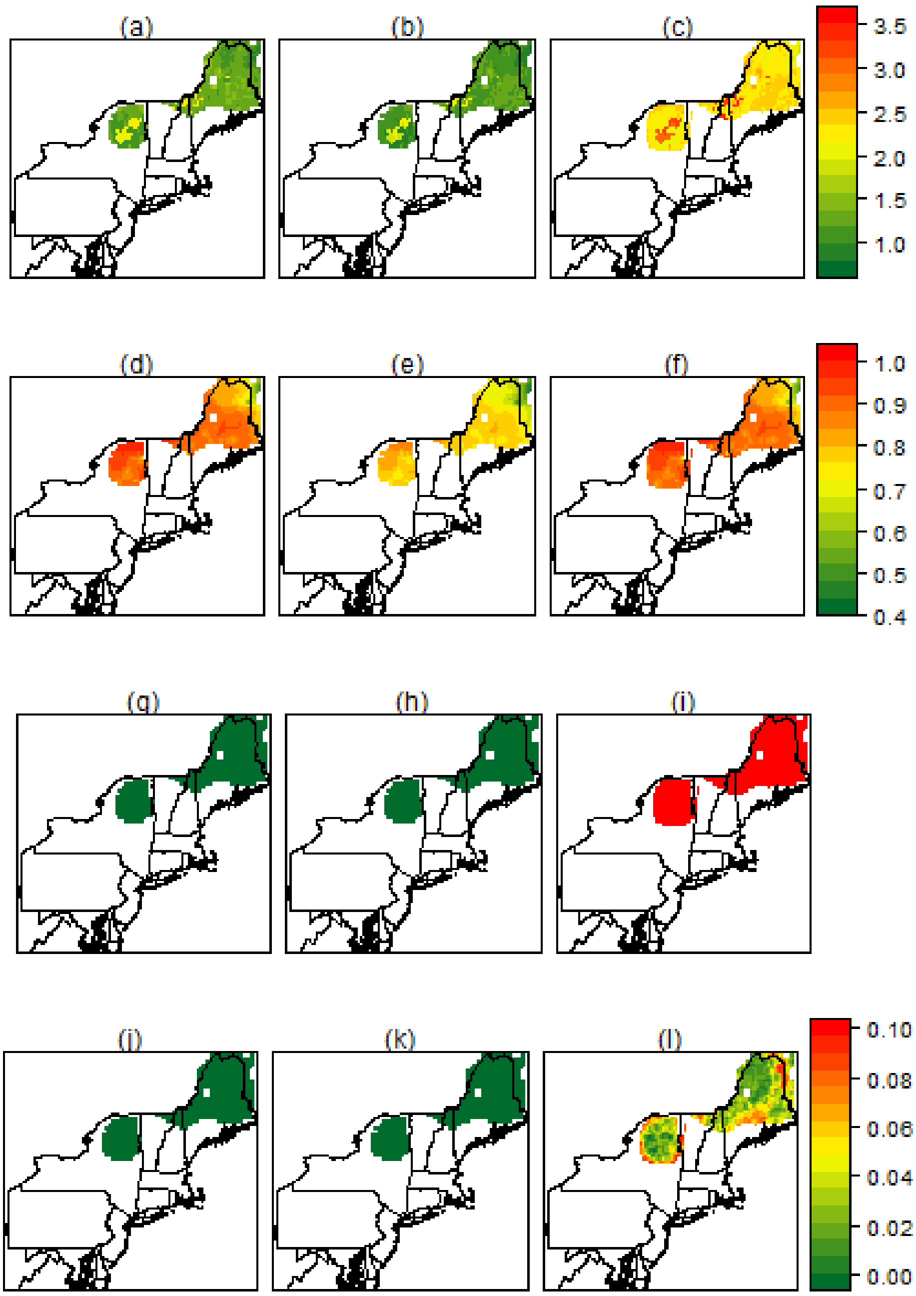

Figure AVIII. 1.65.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

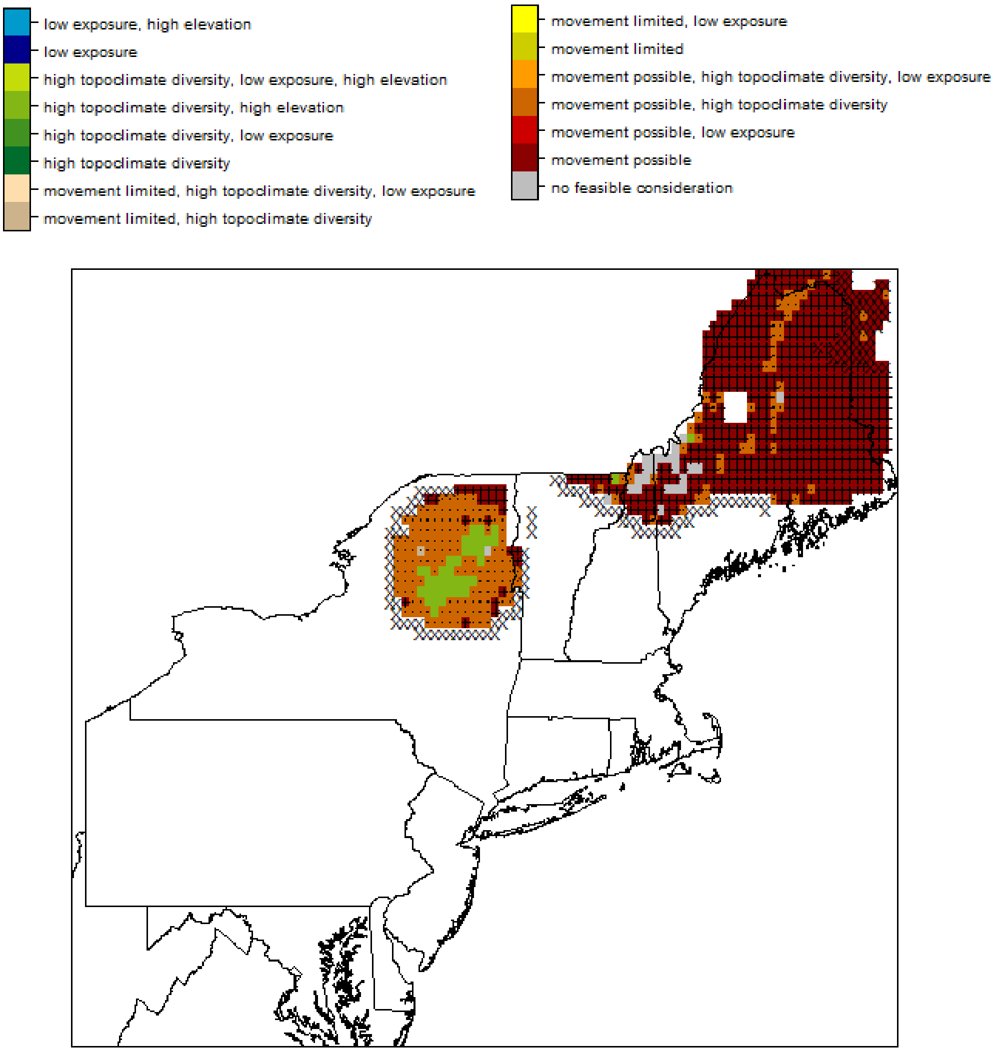

Figure AVIII. 1.65.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

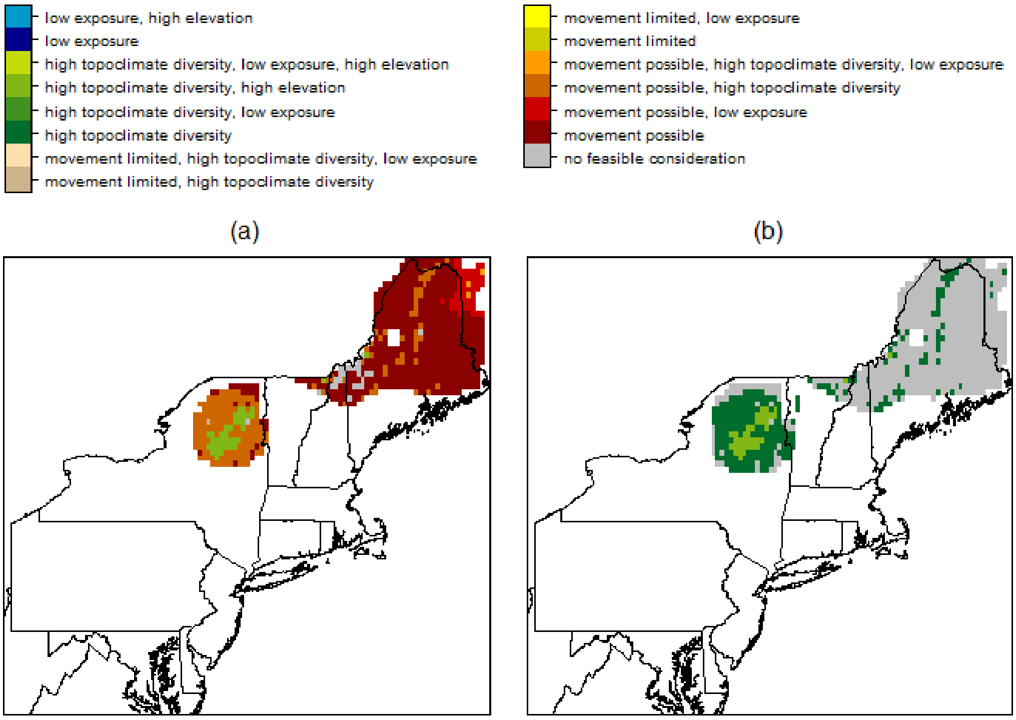

Figure AVIII. 1.65.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.66 Blue-winged warbler (*Vermivora pinus*)

Table AVIII. 1.66.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.38	0.50	0.58	0.00	1.00	10.00
low	0.15	0.50	0.46	0.00	1.00	2.50
high	0.50	0.50	0.68	0.05	1.00	175.00

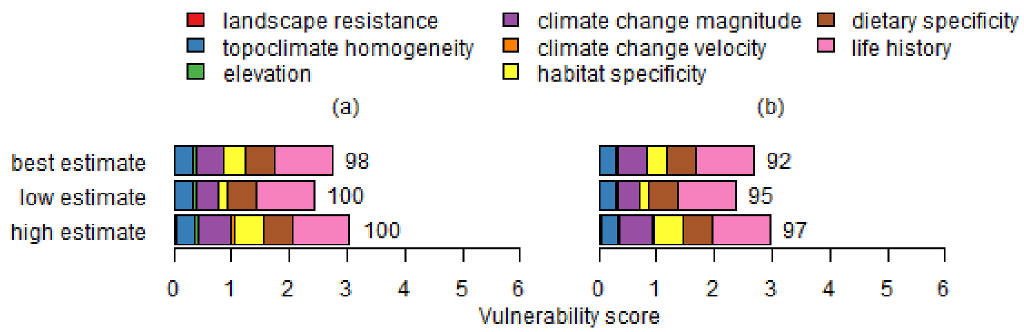

Figure AVIII. 1.66.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

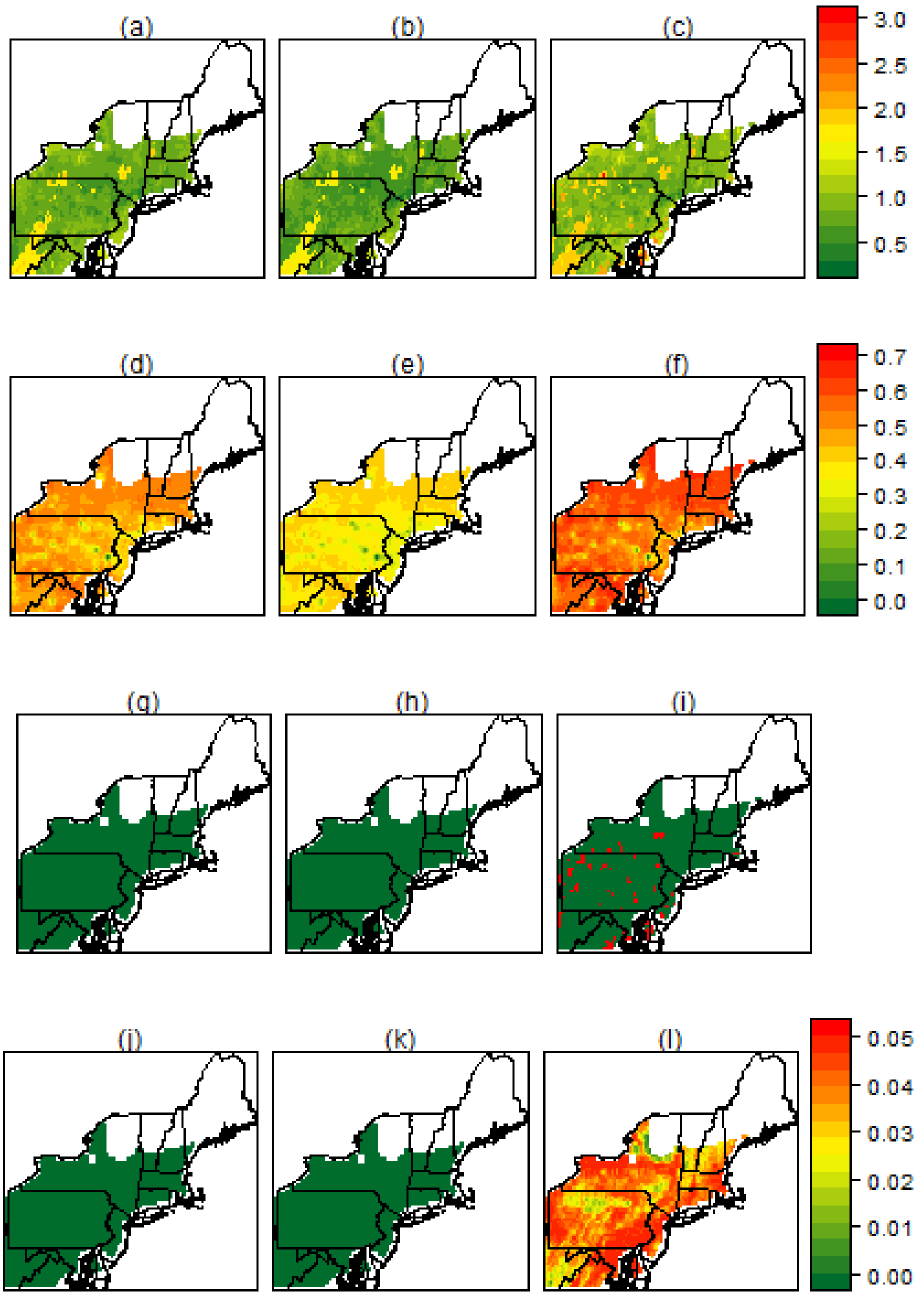

Figure AVIII. 1.66.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

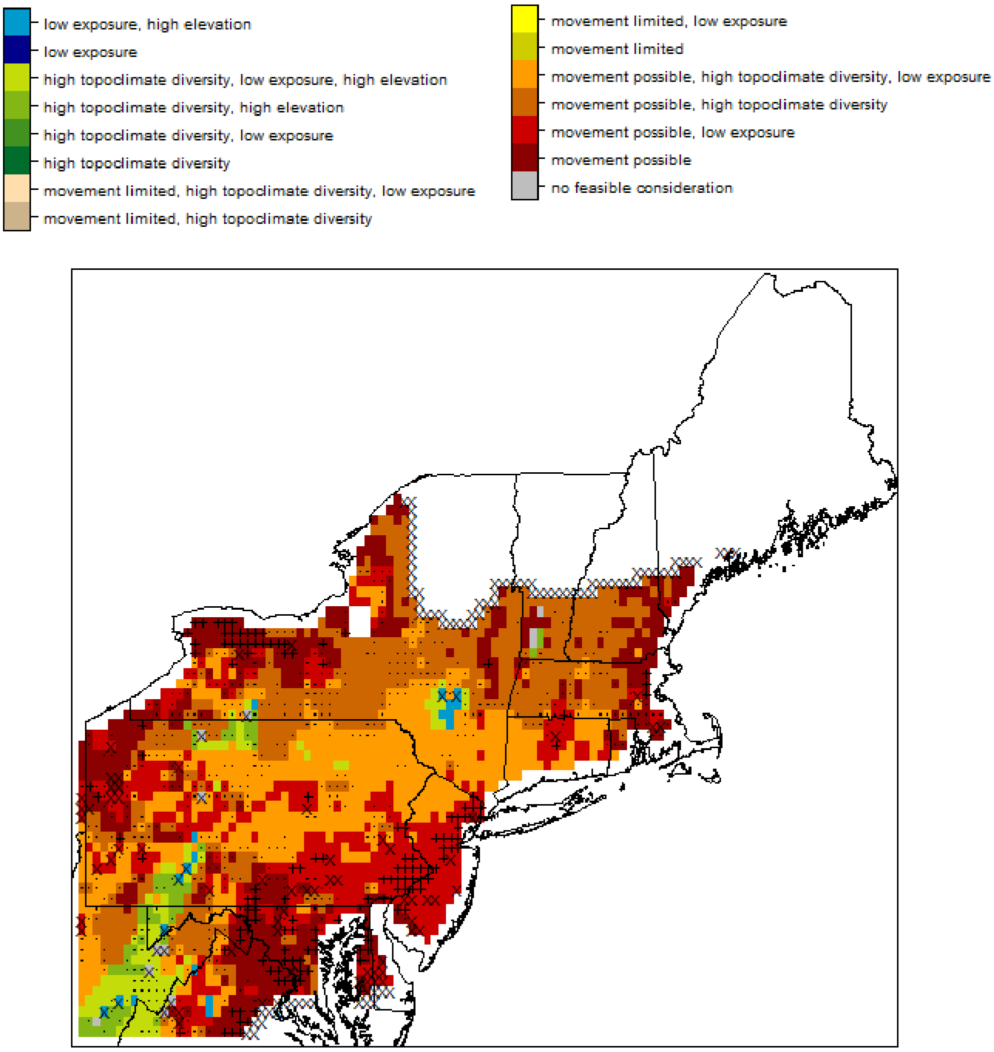

Figure AVIII. 1.66.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

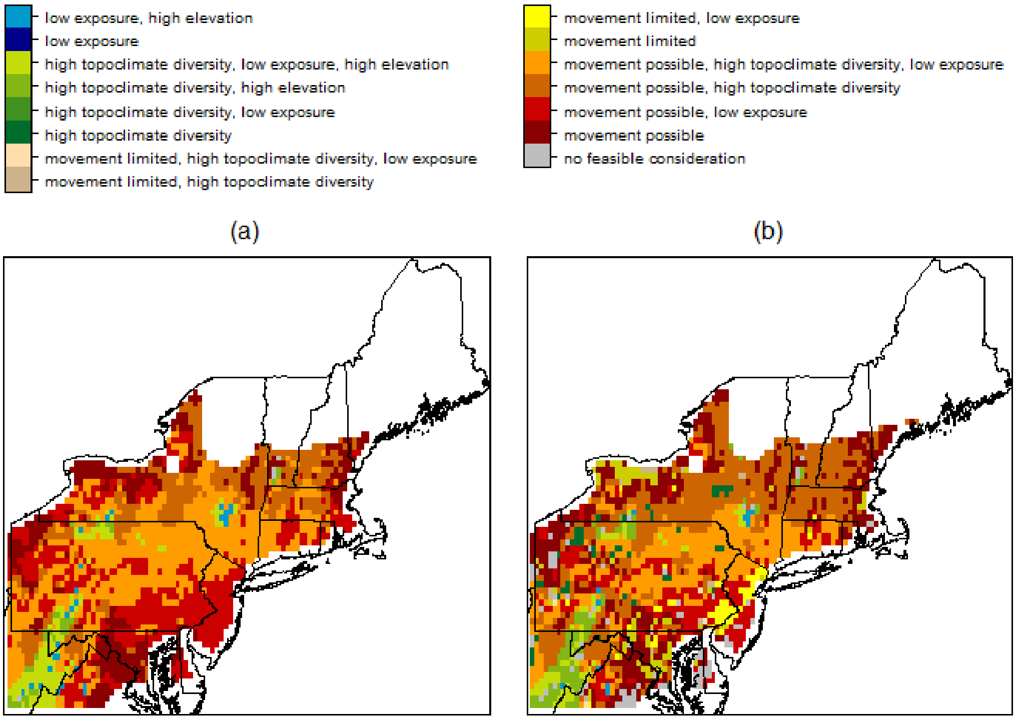

Figure AVIII. 1.66.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.67 Canada warbler (*Wilsonia canadensis*)

Table AVIII. 1.67.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	10.00
low	0.38	0.50	0.59	0.00	1.00	0.50
high	0.50	0.50	0.80	0.05	1.00	175.00

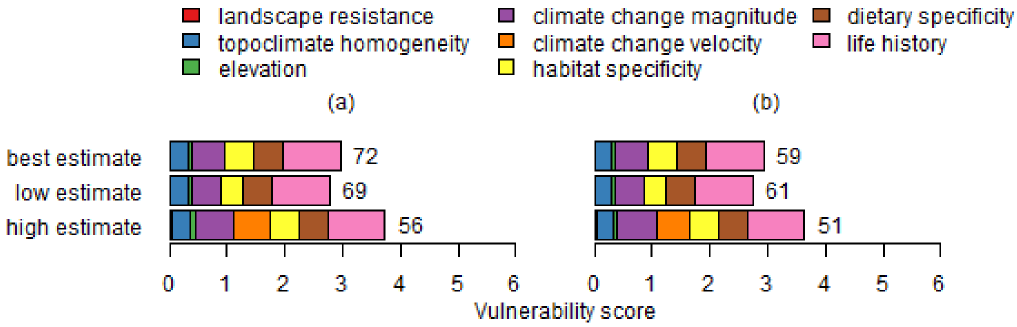

Figure AVIII. 1.67.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

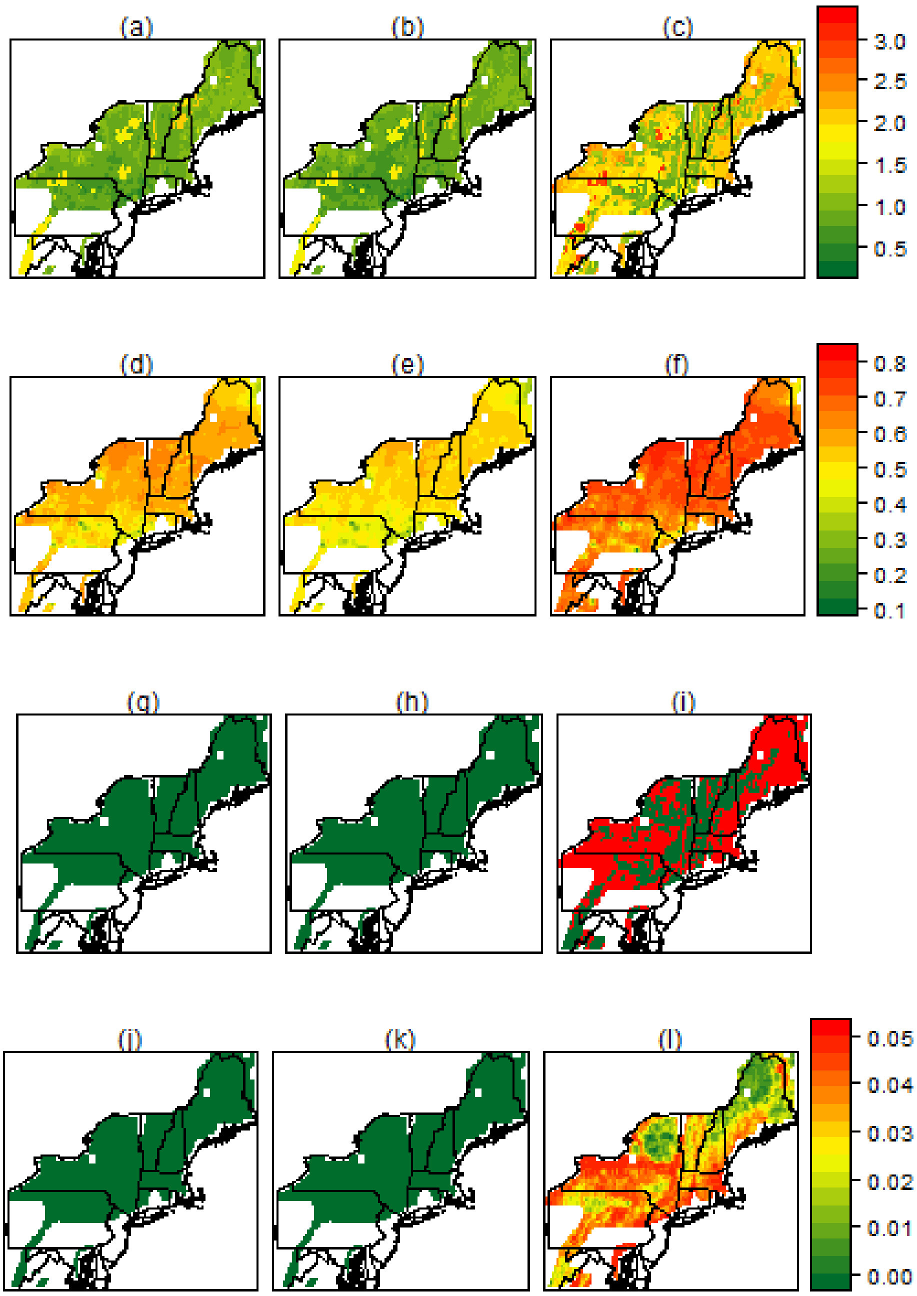

Figure AVIII. 1.67.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

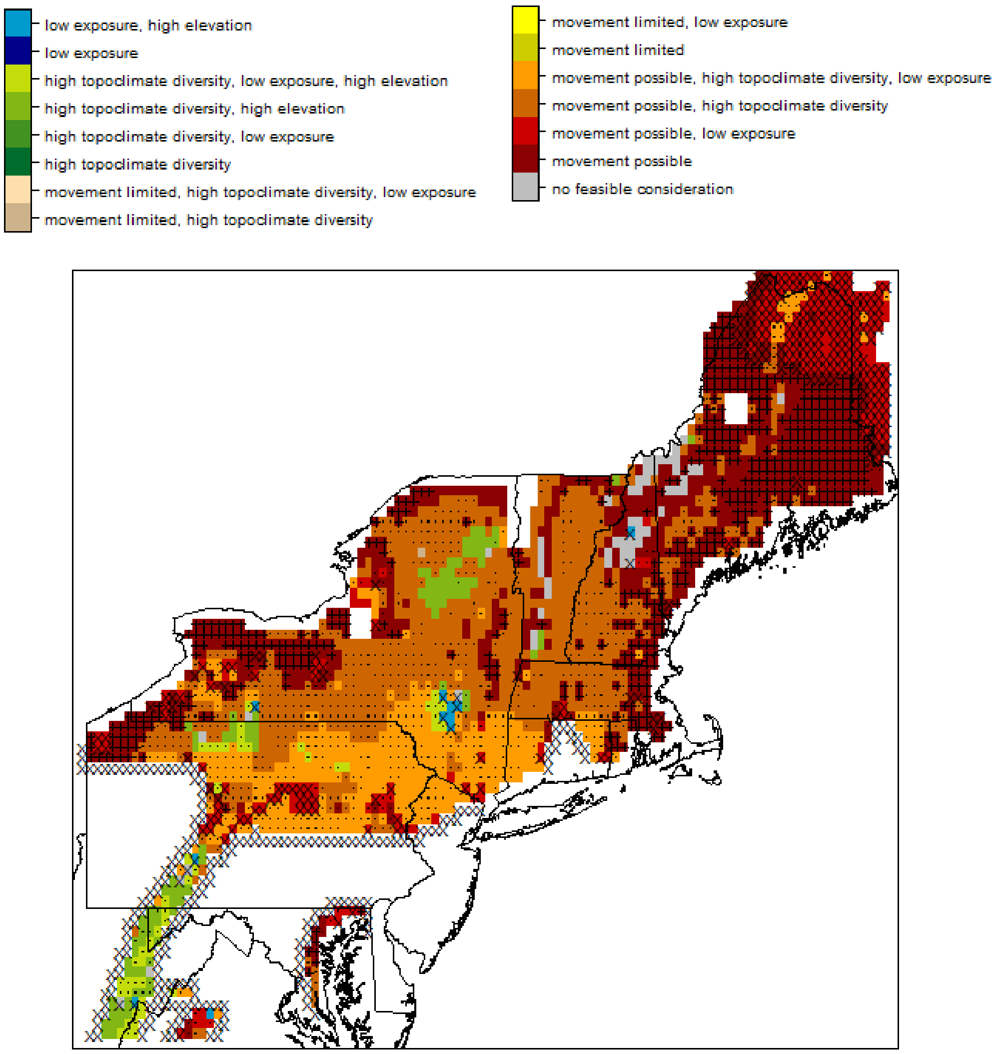

Figure AVIII. 1.67.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

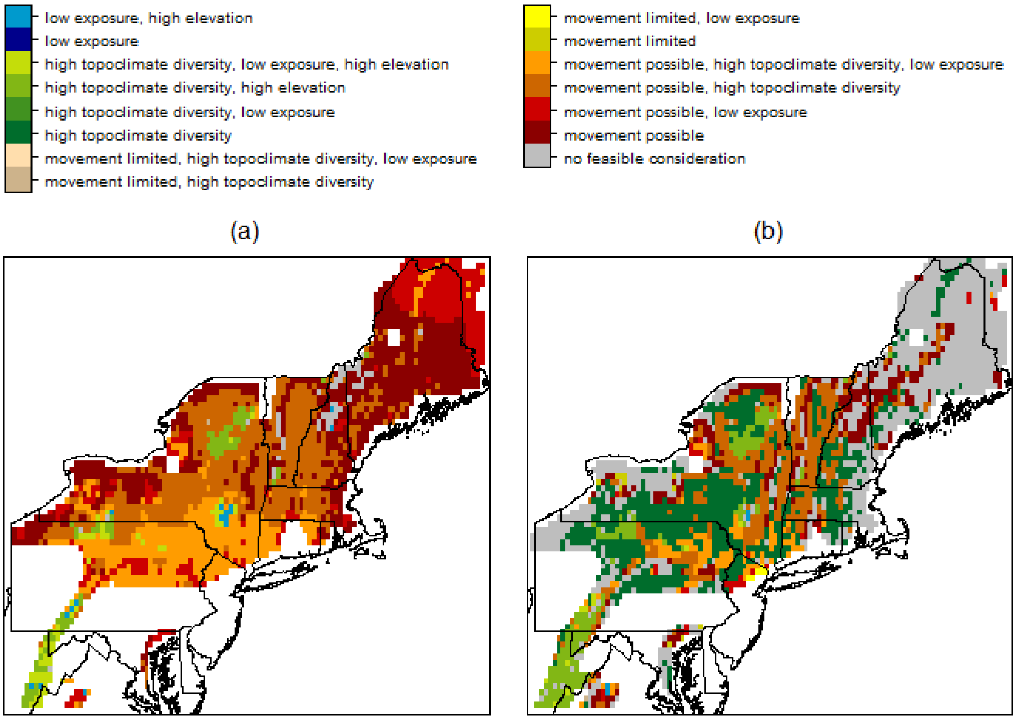

Figure AVIII. 1.67.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.68 Sedge wren (*Cistothorus platensis*)

Table AVIII. 1.68.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Dispersal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.77	0.12	1.00	17.40
low	0.46	0.46	0.69	0.05	1.00	2.50
high	0.56	0.50	0.85	0.24	1.00	172.00

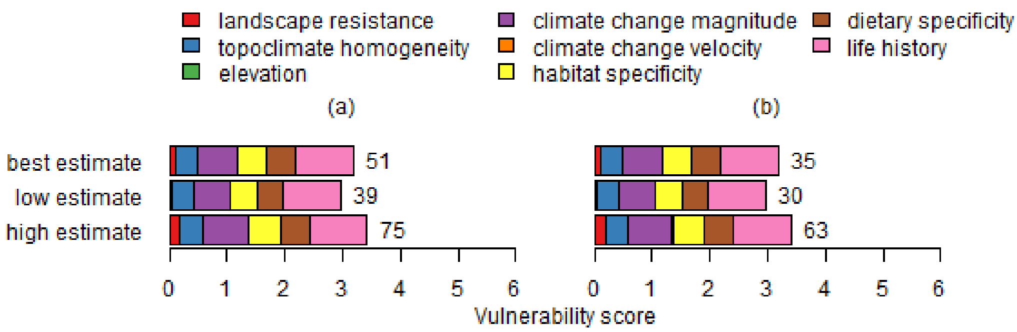

Figure AVIII. 1.68.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

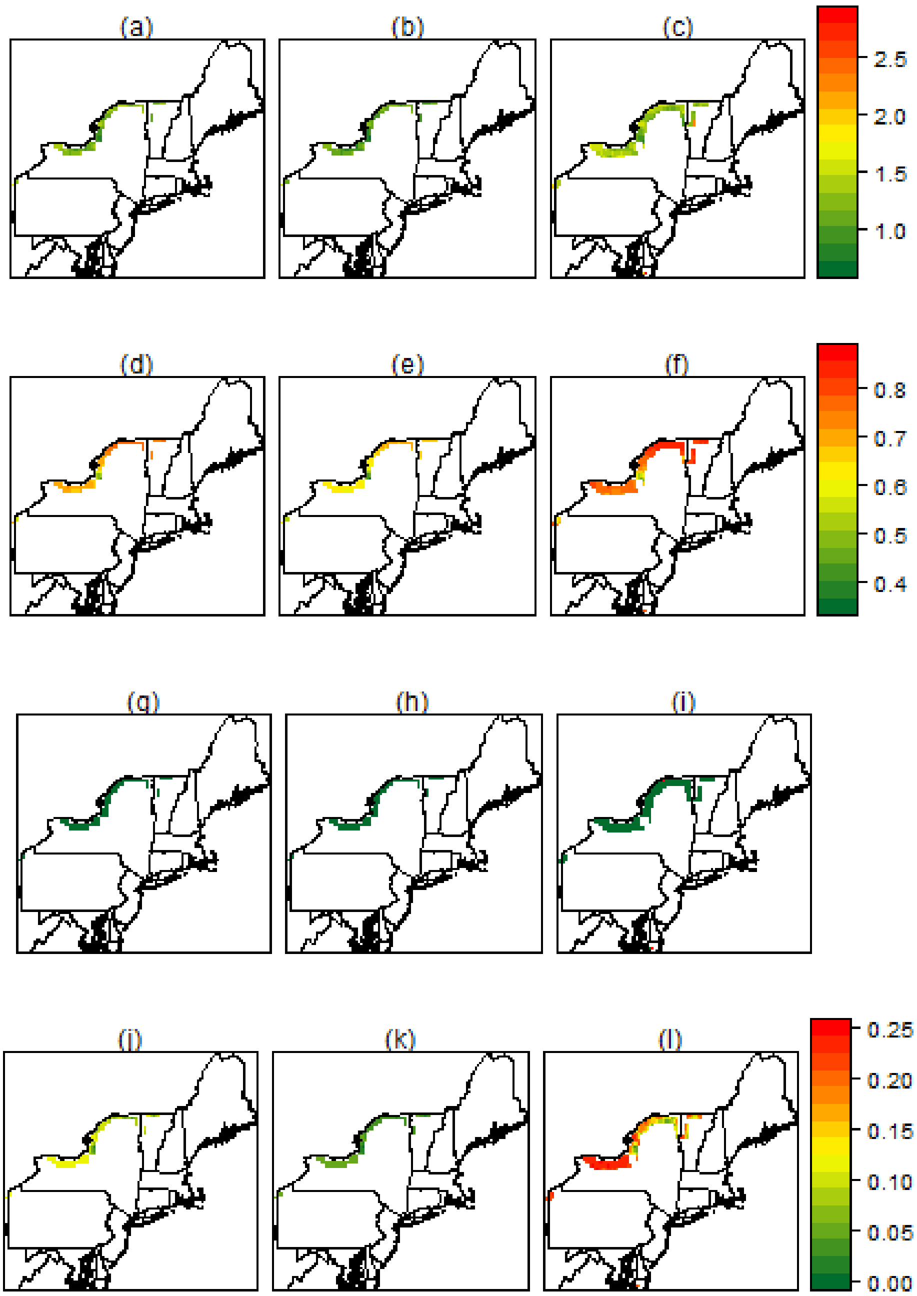

Figure AVIII. 1.68.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

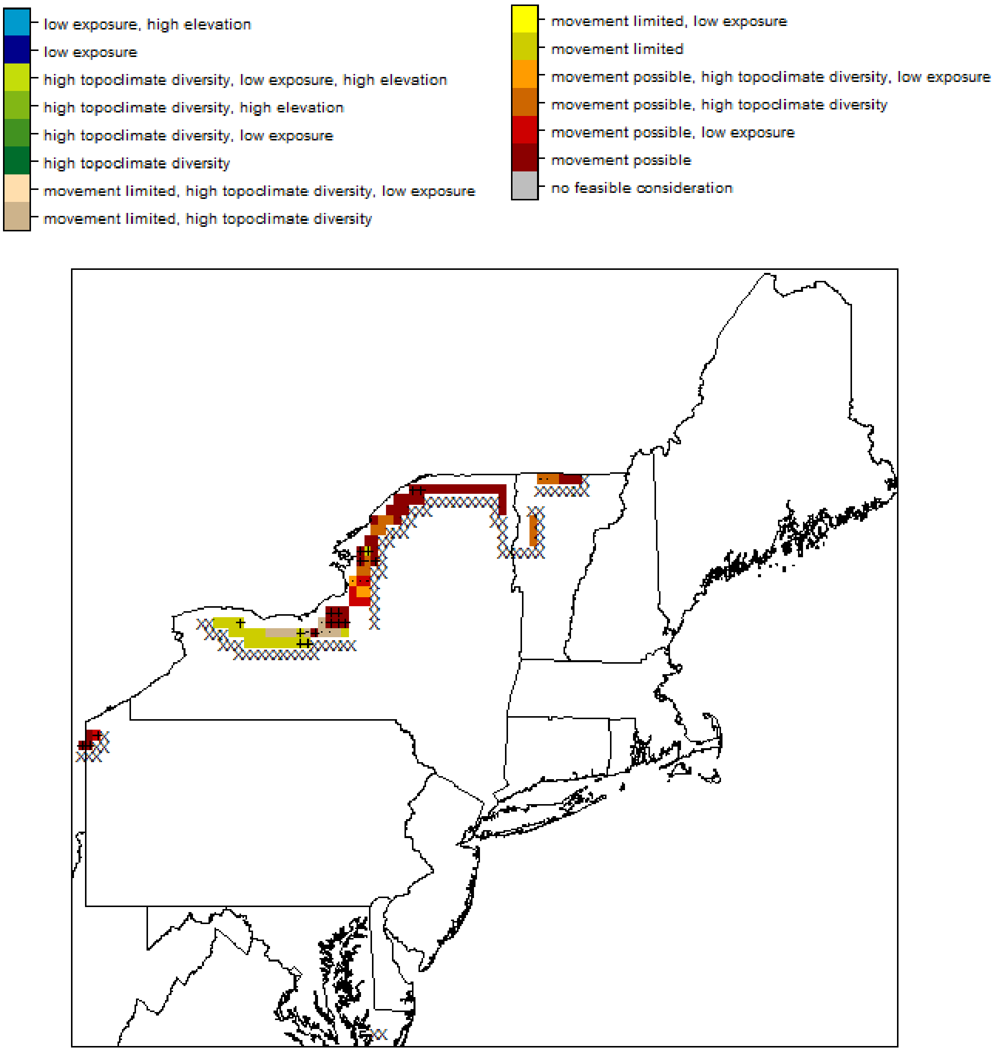

Figure AVIII. 1.68.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

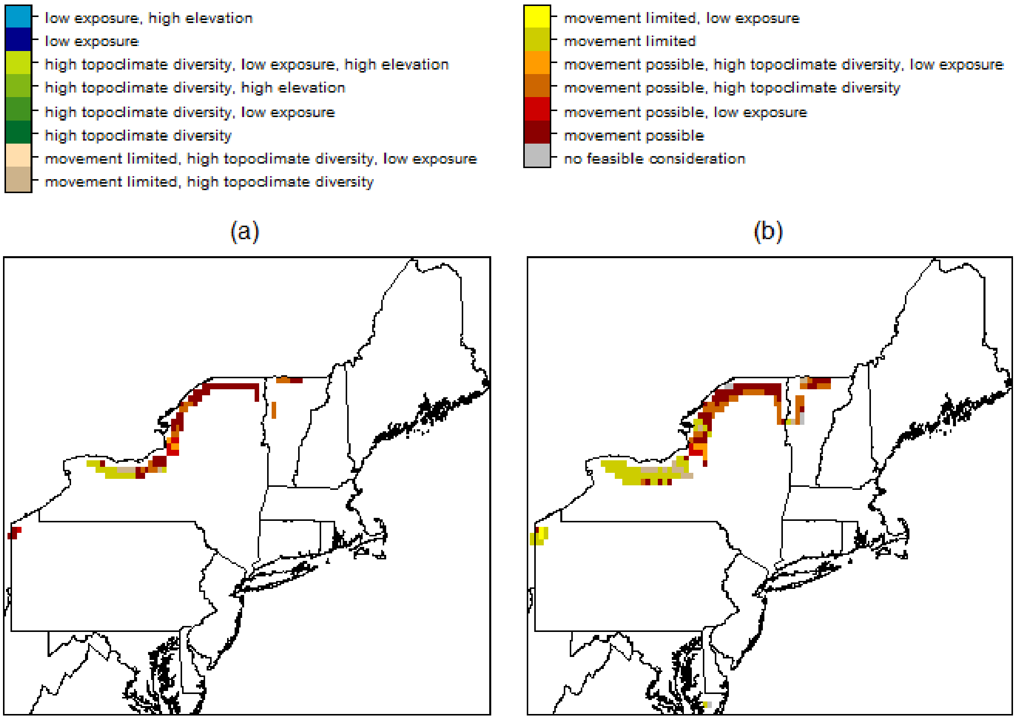

Figure AVIII. 1.68.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.69 Bicknell's thrush (*Catharus bicknelli*)

Table AVIII. 1.69.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.60	0.30	0.97	0.15	1.00	15.00
low	0.52	0.25	0.87	0.10	1.00	0.75
high	0.63	0.30	1.00	0.22	1.00	140.00

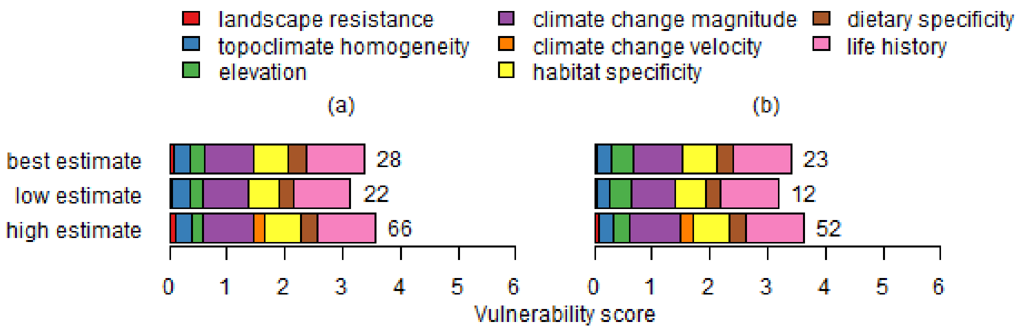

Figure AVIII. 1.69.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

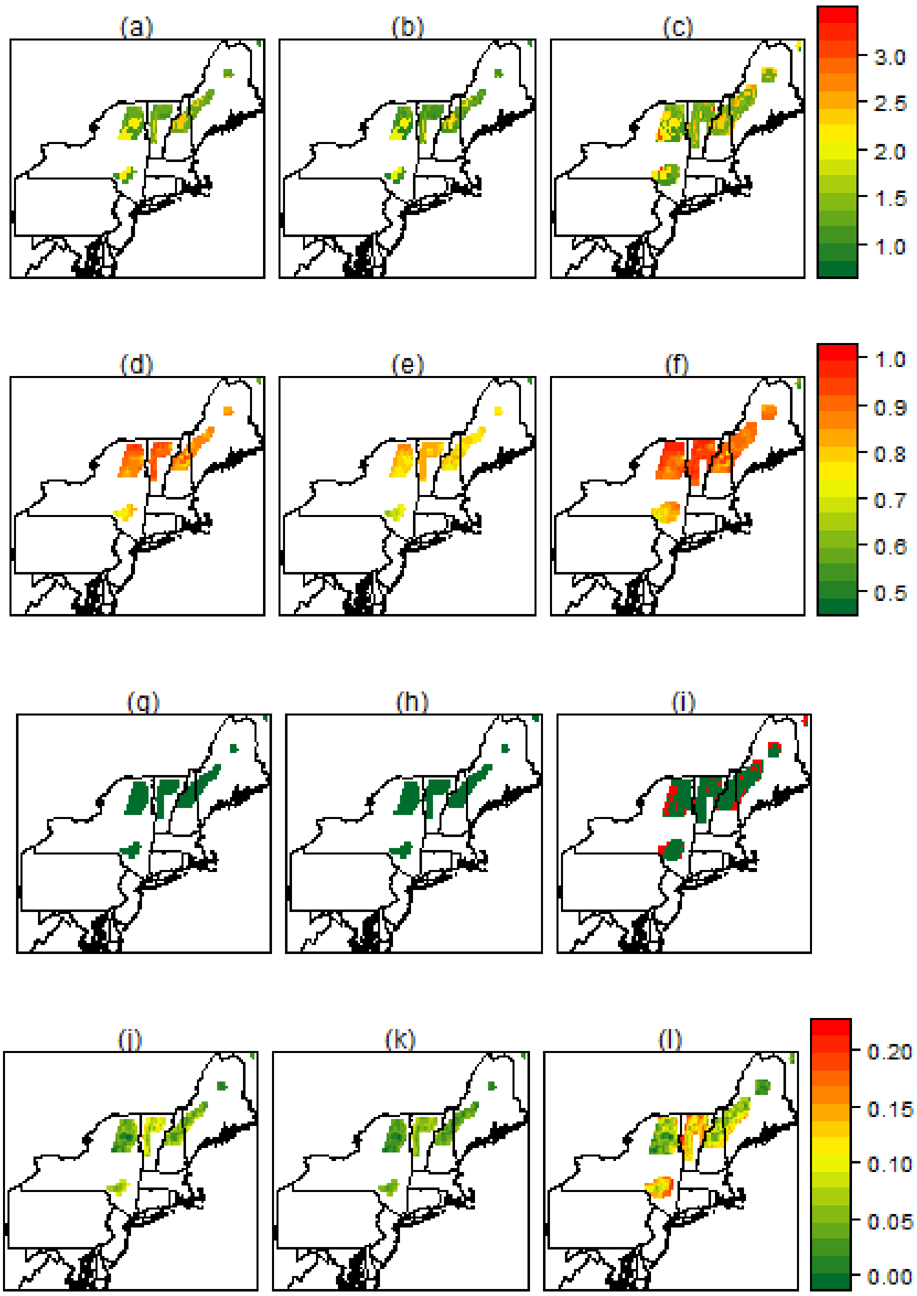

Figure AVIII. 1.69.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

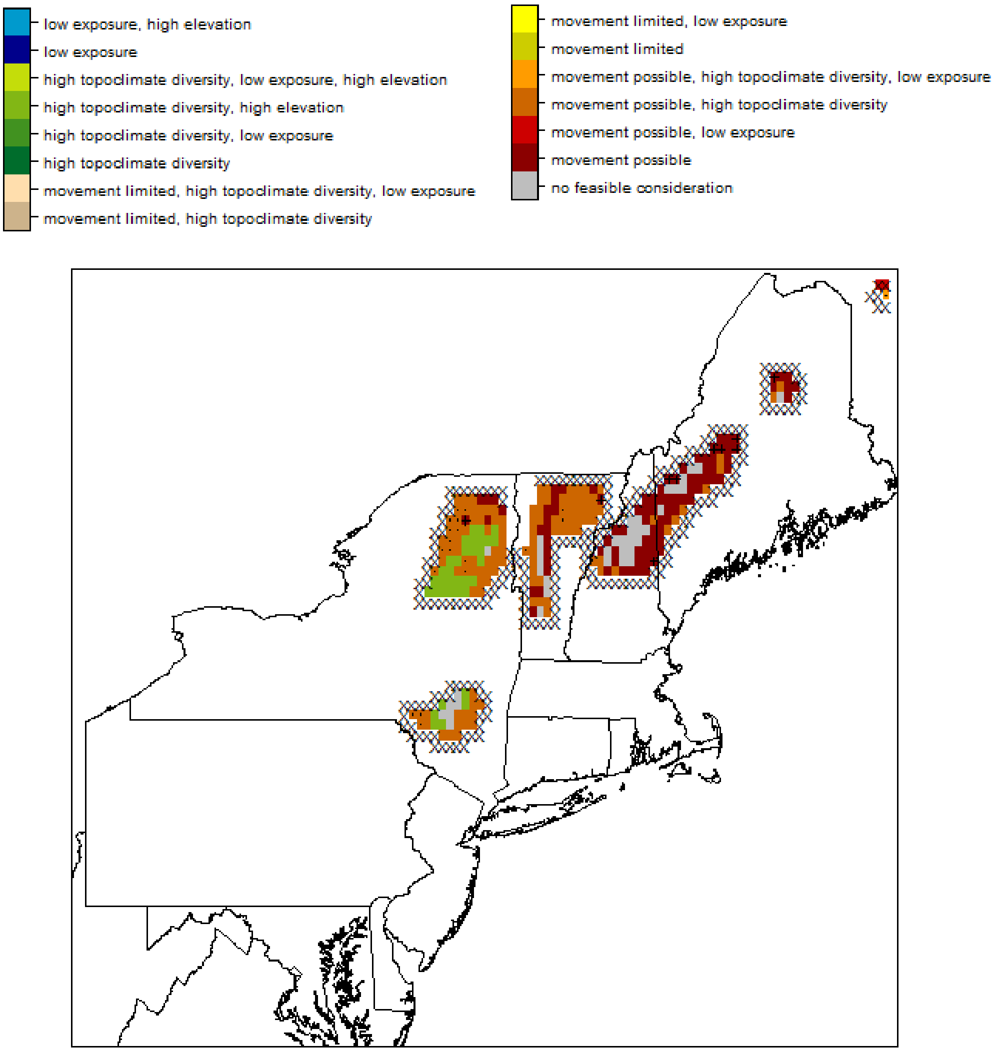

Figure AVIII. 1.69.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

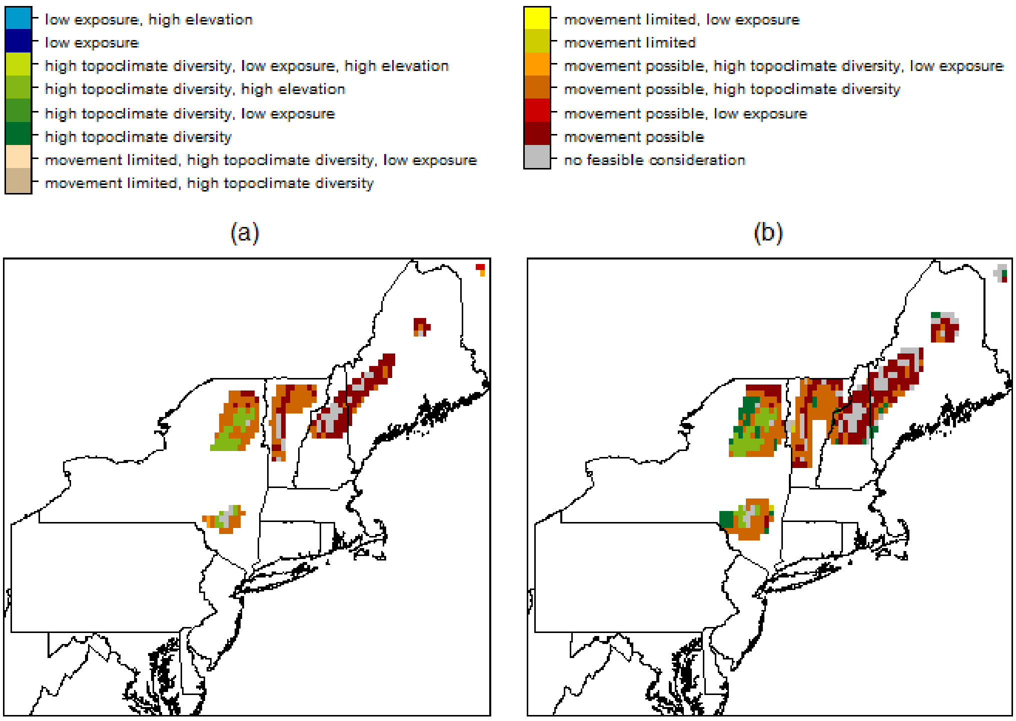

Figure AVIII. 1.69.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.70 Wood thrush (*Hylocichla mustelina*)

Table AVIII. 1.70.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.40	0.73	0.15	1.00	2.40
low	0.40	0.33	0.66	0.06	1.00	0.60
high	0.50	0.40	0.81	0.23	1.00	34.15

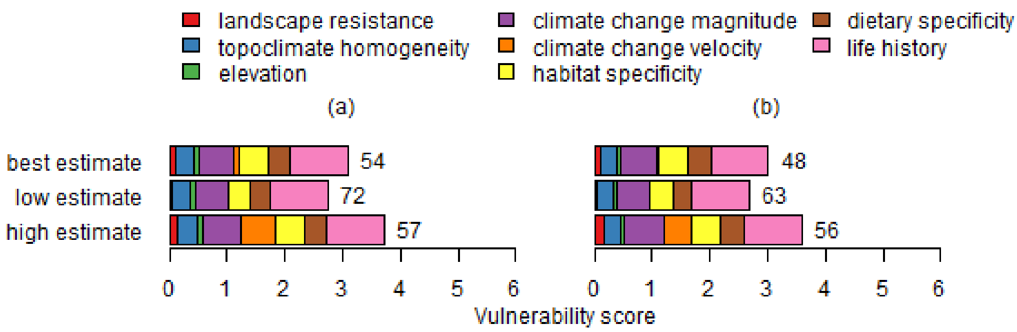

Figure AVIII. 1.70.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

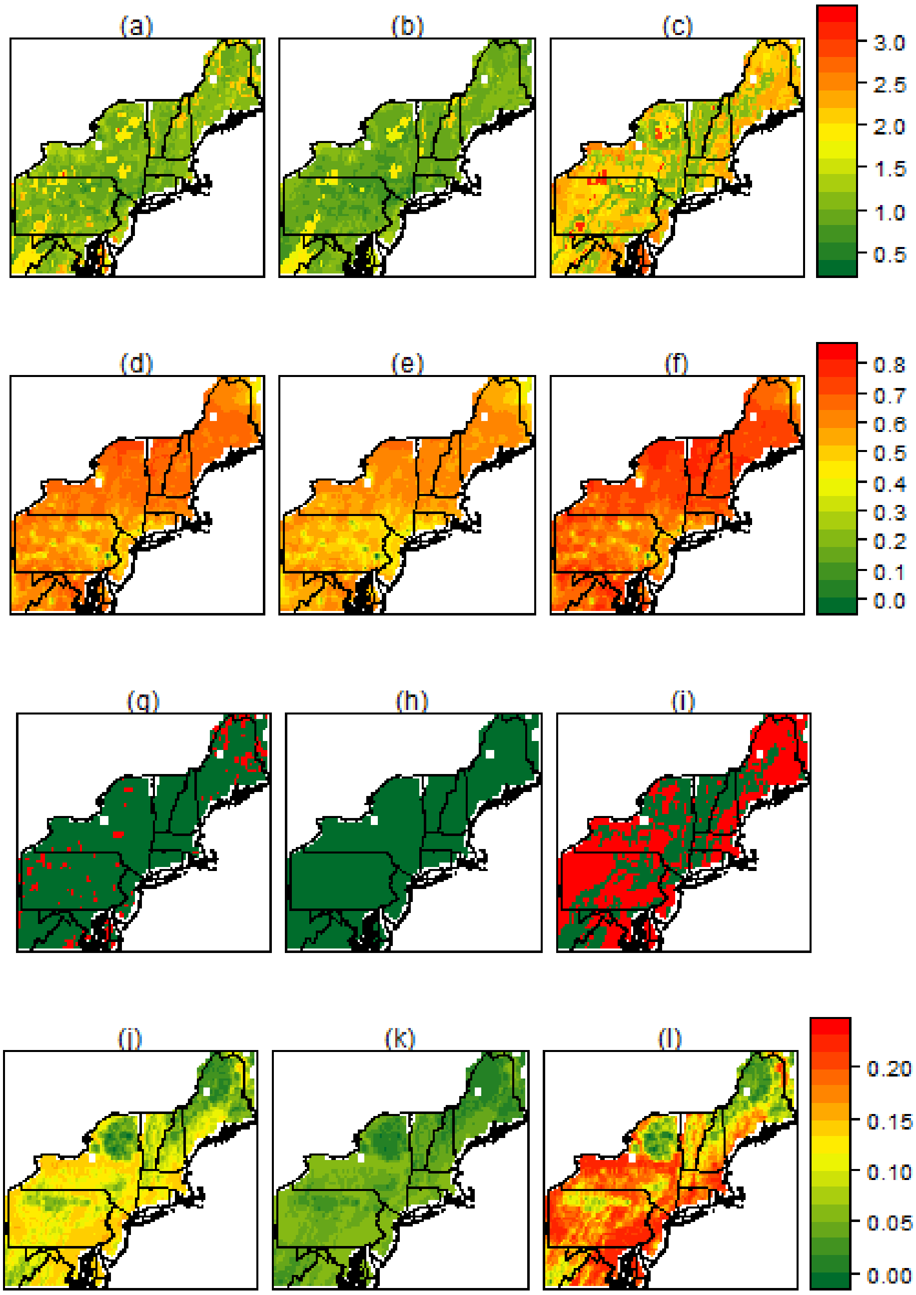

Figure AVIII. 1.70.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

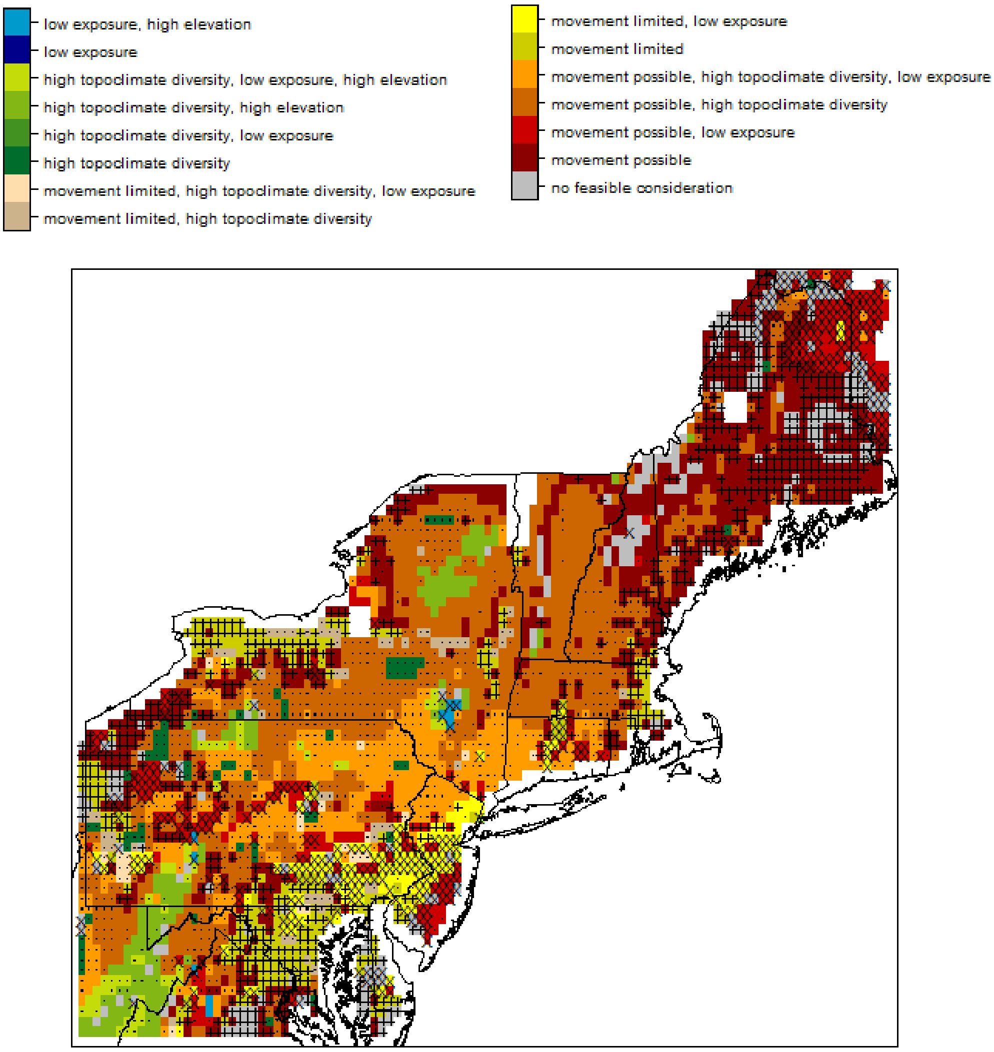

Figure AVIII. 1.70.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

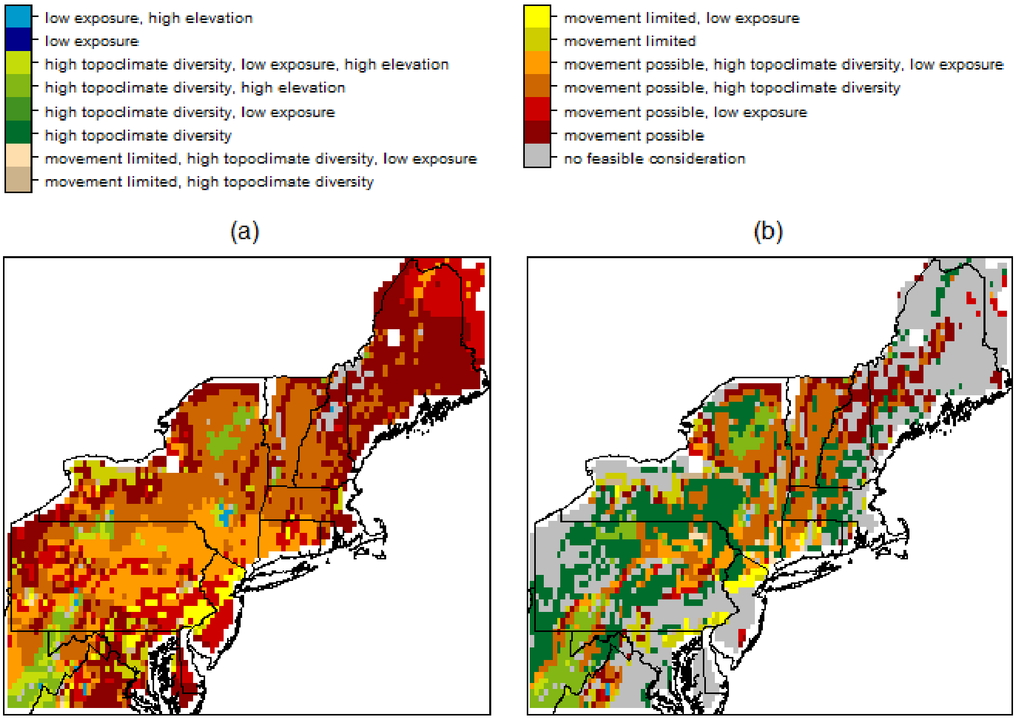

Figure AVIII. 1.70.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.71 Olive-sided flycatcher (*Contopus cooperi*)

Table AVIII. 1.71.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	1.00	0.00	1.00	10.00
low	0.45	0.50	0.86	0.00	1.00	0.00
high	0.50	0.60	1.00	0.10	1.00	300.00

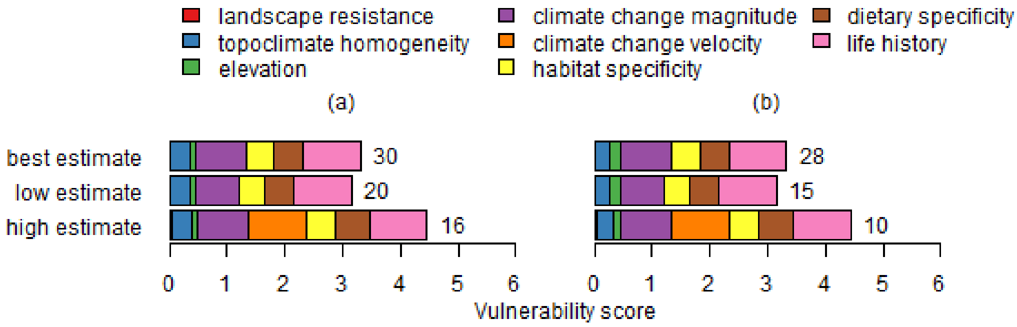

Figure AVIII. 1.71.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

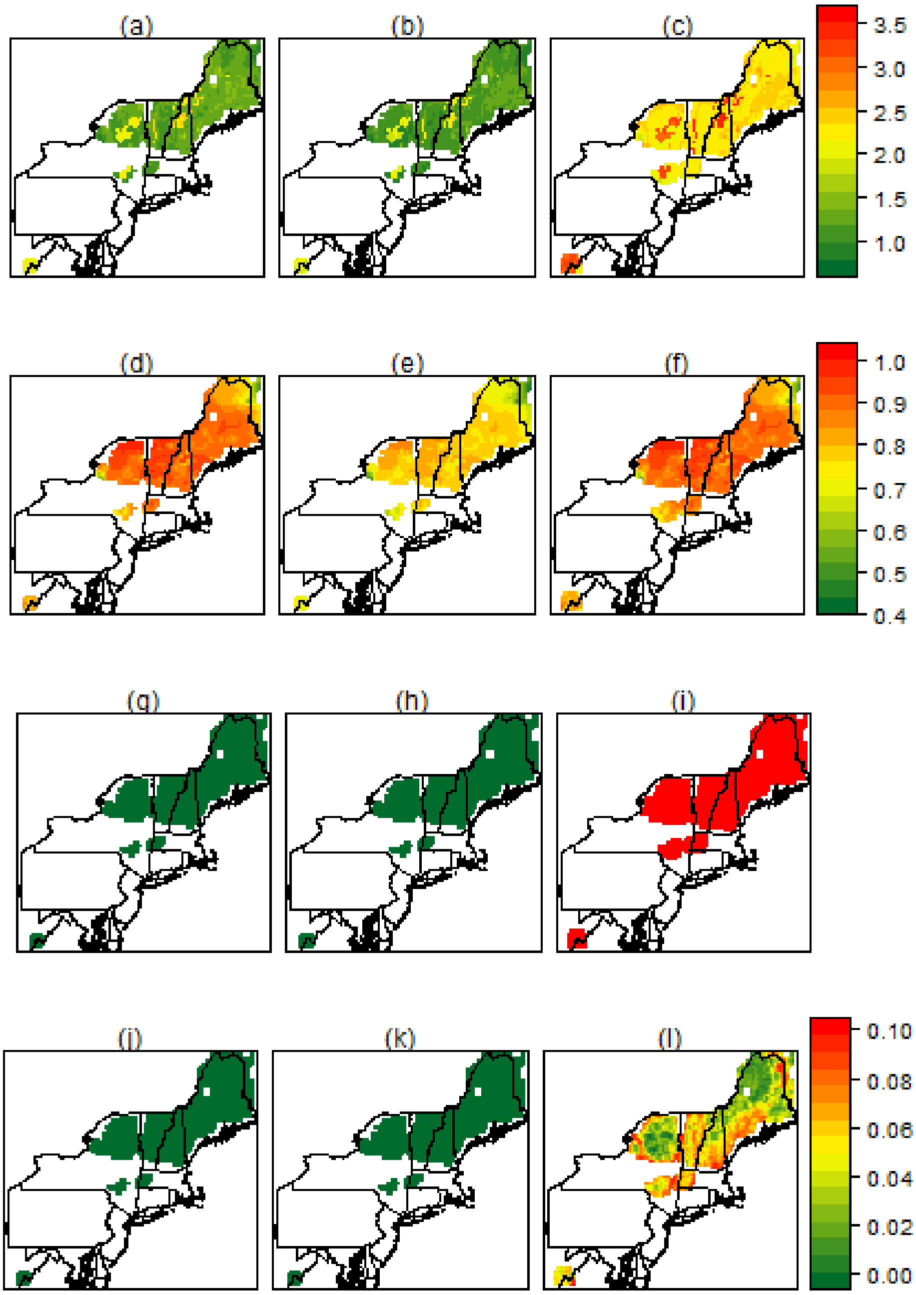

Figure AVIII. 1.71.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

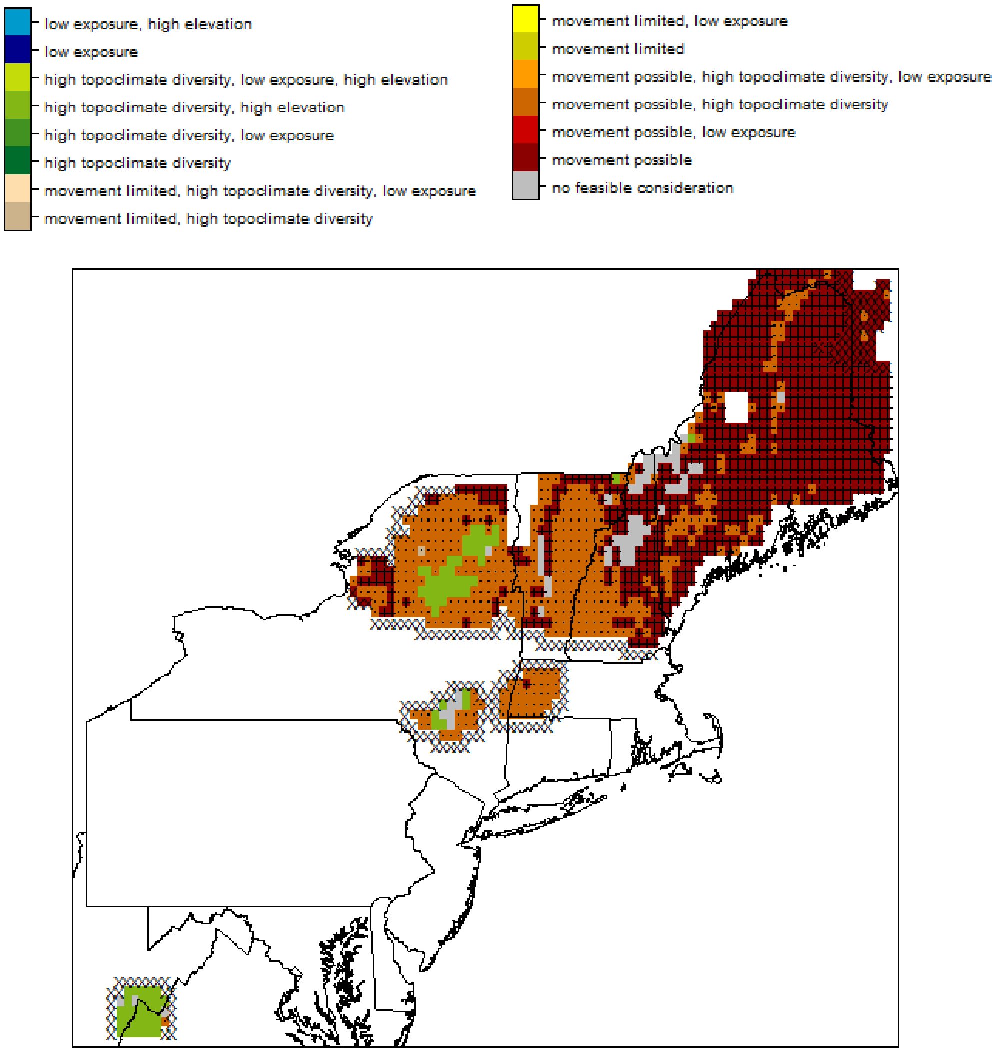

Figure AVIII. 1.71.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

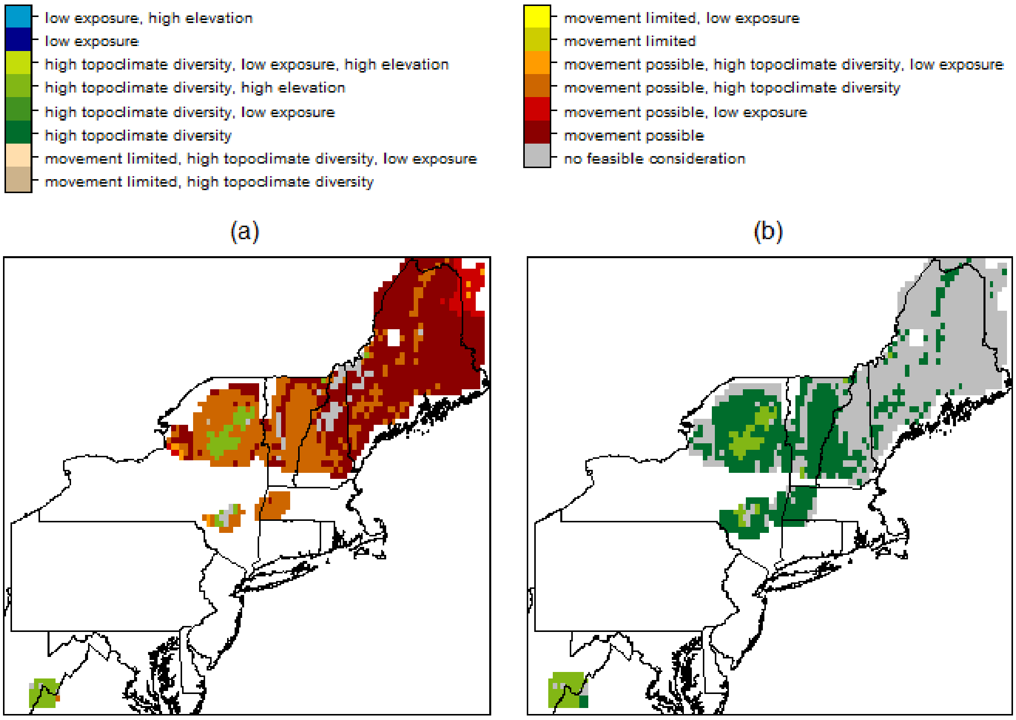

Figure AVIII. 1.71.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

1.72 Willow flycatcher (*Empidonax traillii*)

Table AVIII. 1.72.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.42	0.50	0.66	0.00	1.00	9.00
low	0.24	0.48	0.66	0.00	1.00	0.83
high	0.52	0.50	0.67	0.03	1.00	134.17

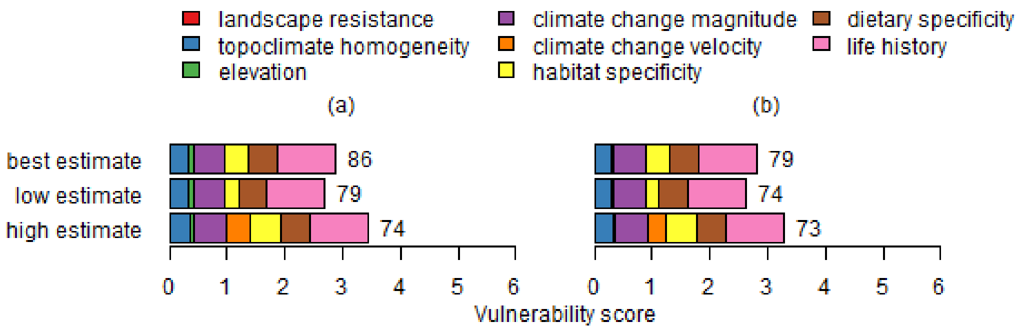

Figure AVIII. 1.72.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

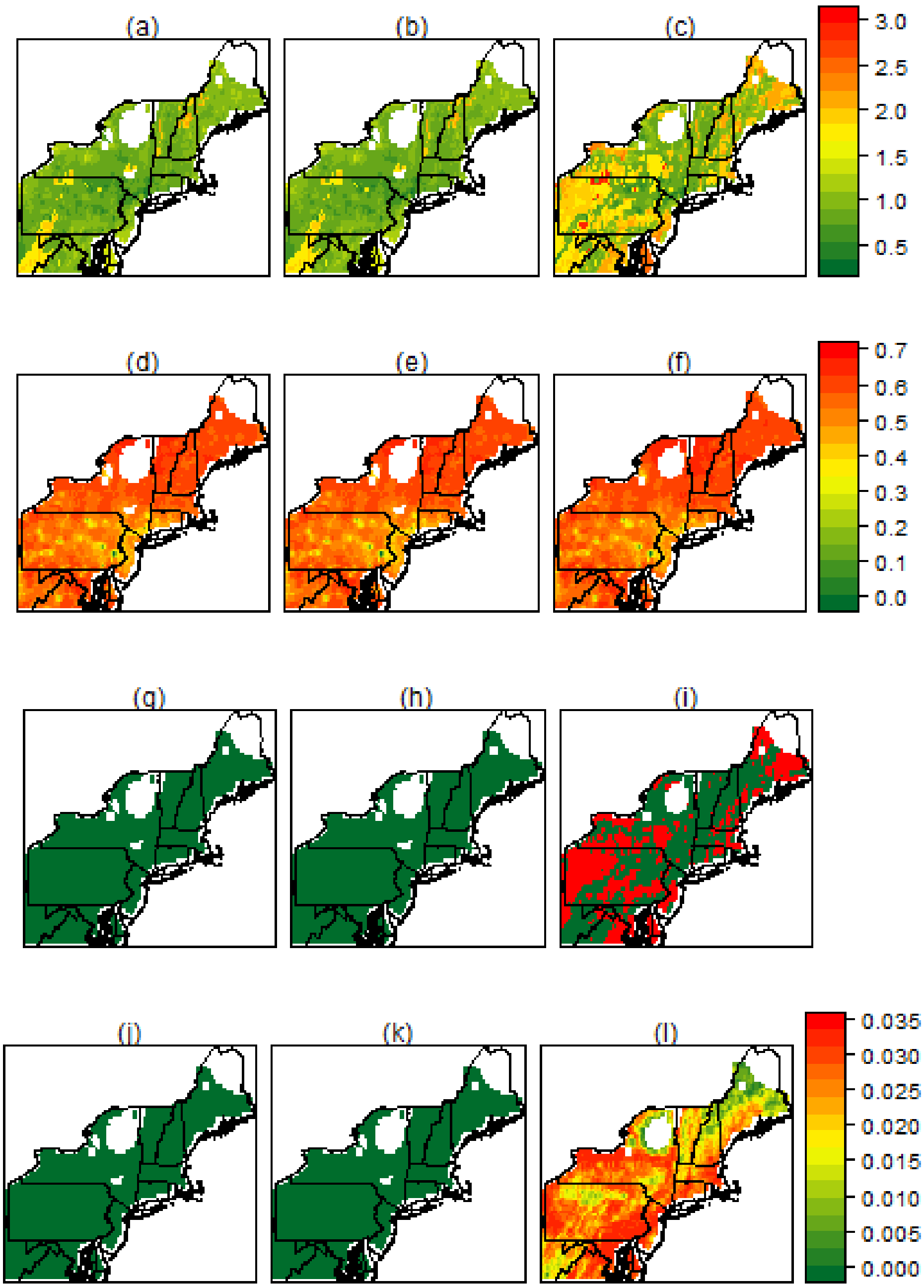

Figure AVIII. 1.72.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

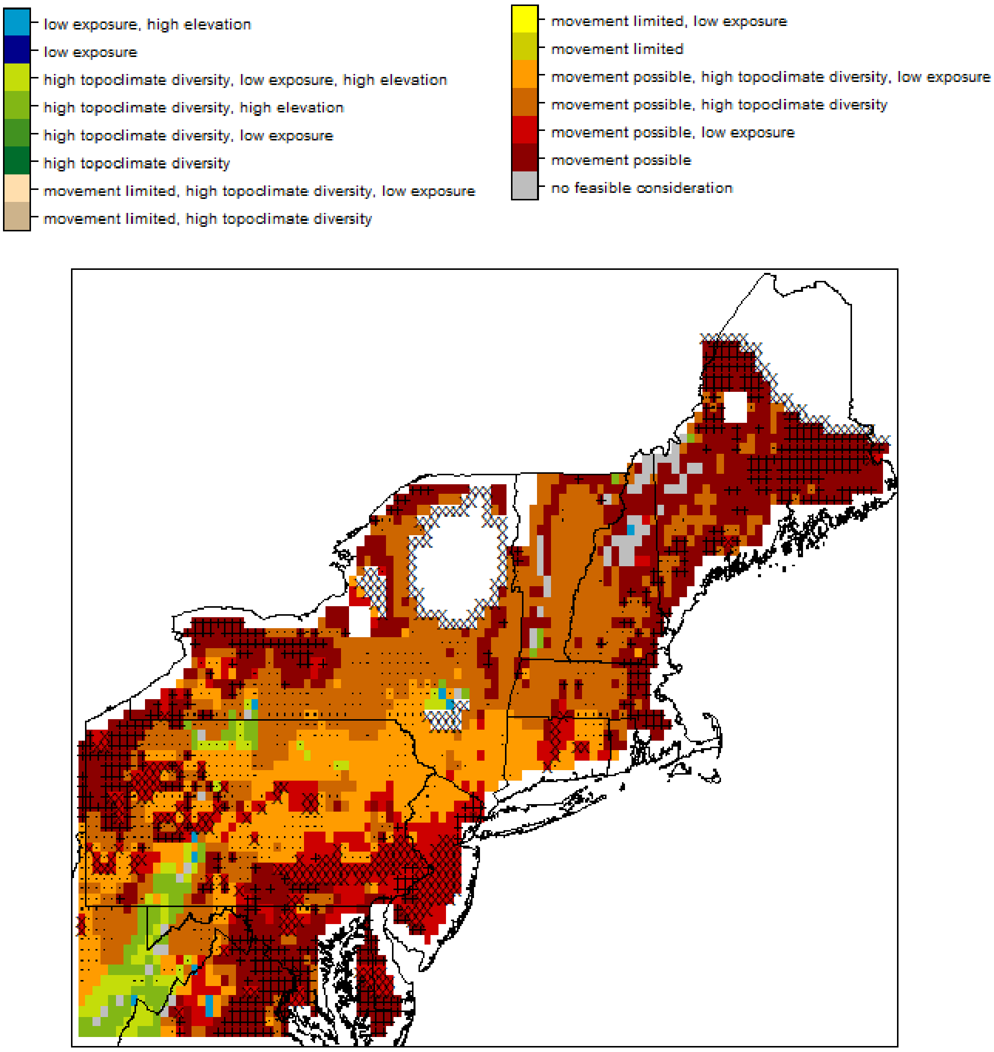

Figure AVIII. 1.72.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

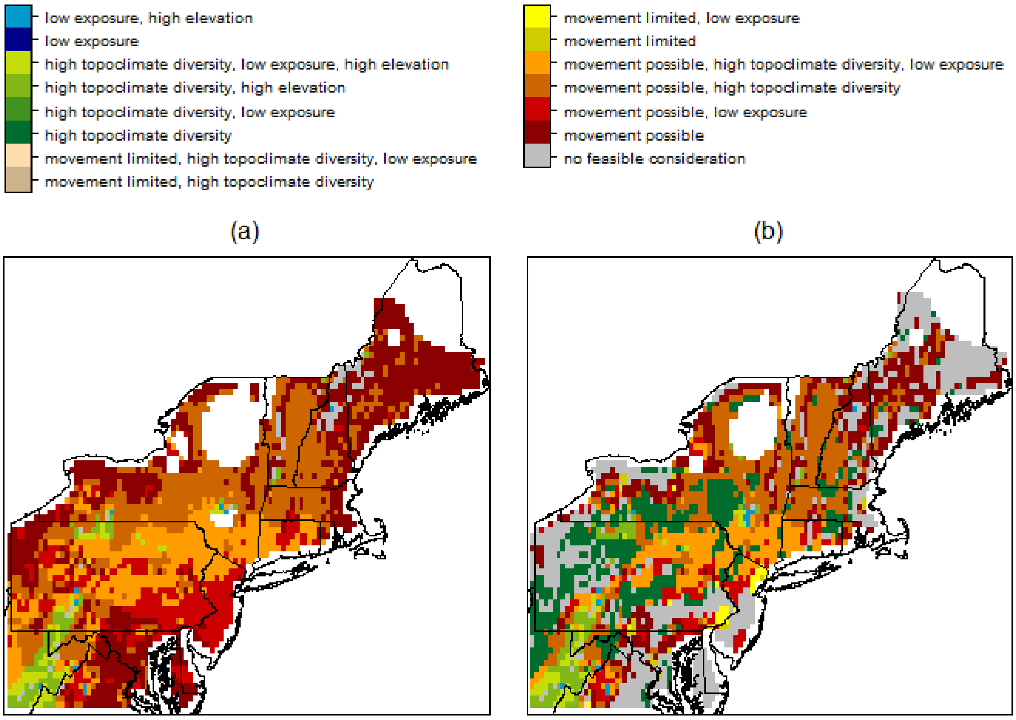

Figure AVIII. 1.72.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2 Herpetofauna

2.1 Northern cricket frog (*Acris crepitans*)

Table AVIII. 2.1.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.80	0.75	0.96	0.85
low	0.45	0.50	0.75	0.72	0.97	0.35
high	0.50	0.50	0.89	0.78	0.96	1.75

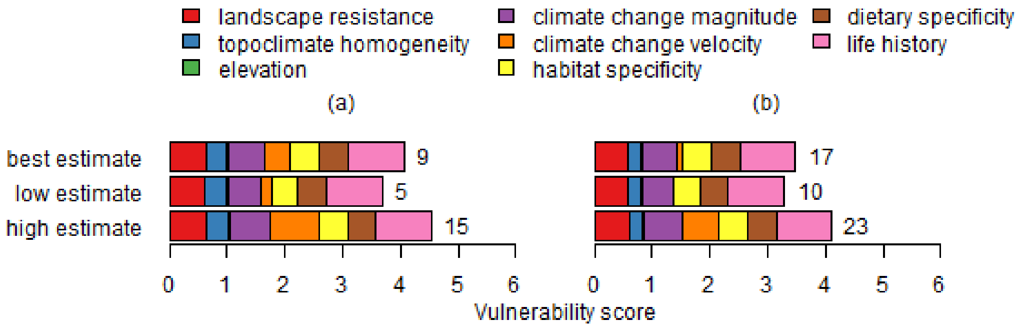

Figure AVIII. 2.1.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

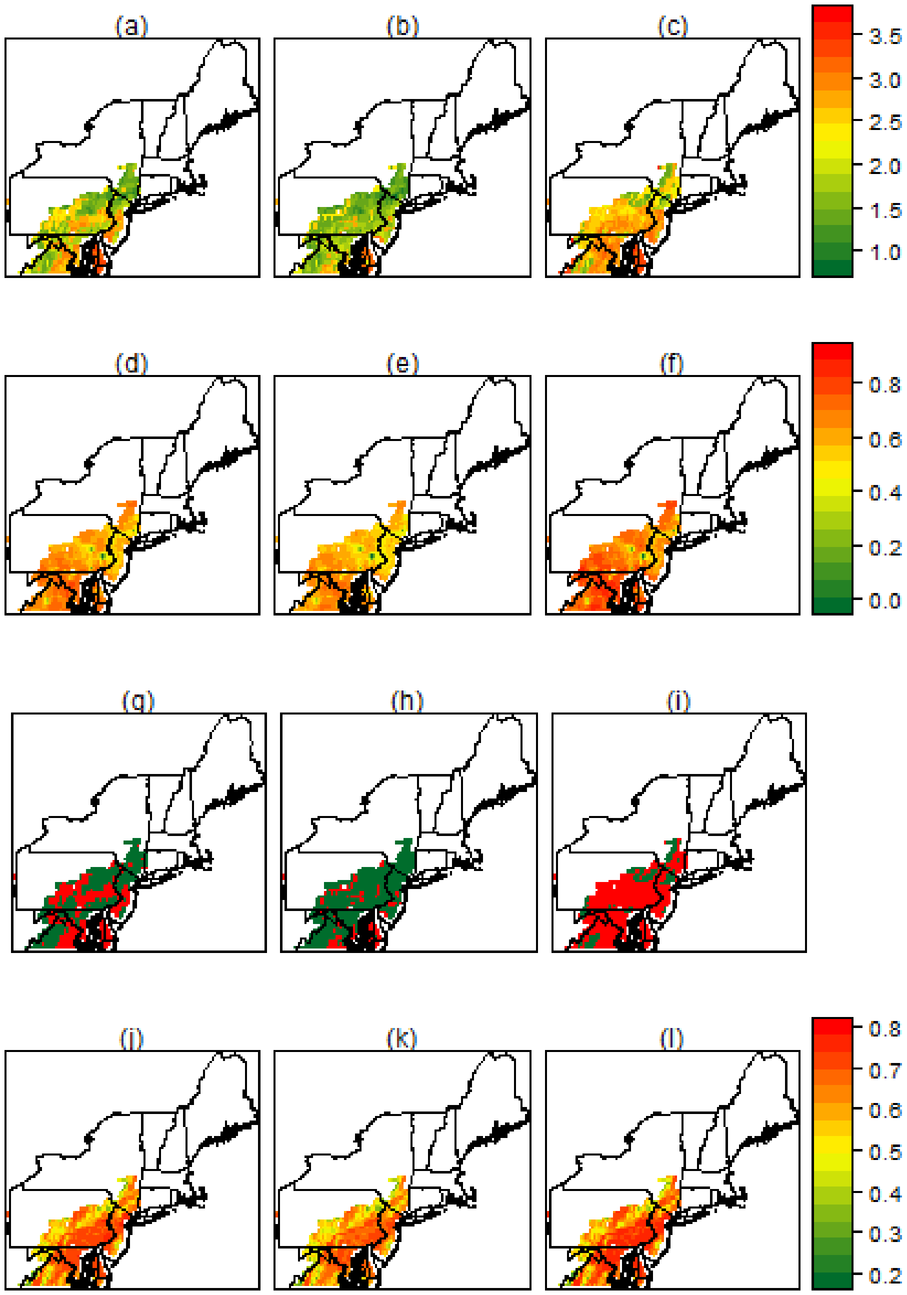

Figure AVIII. 2.1.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

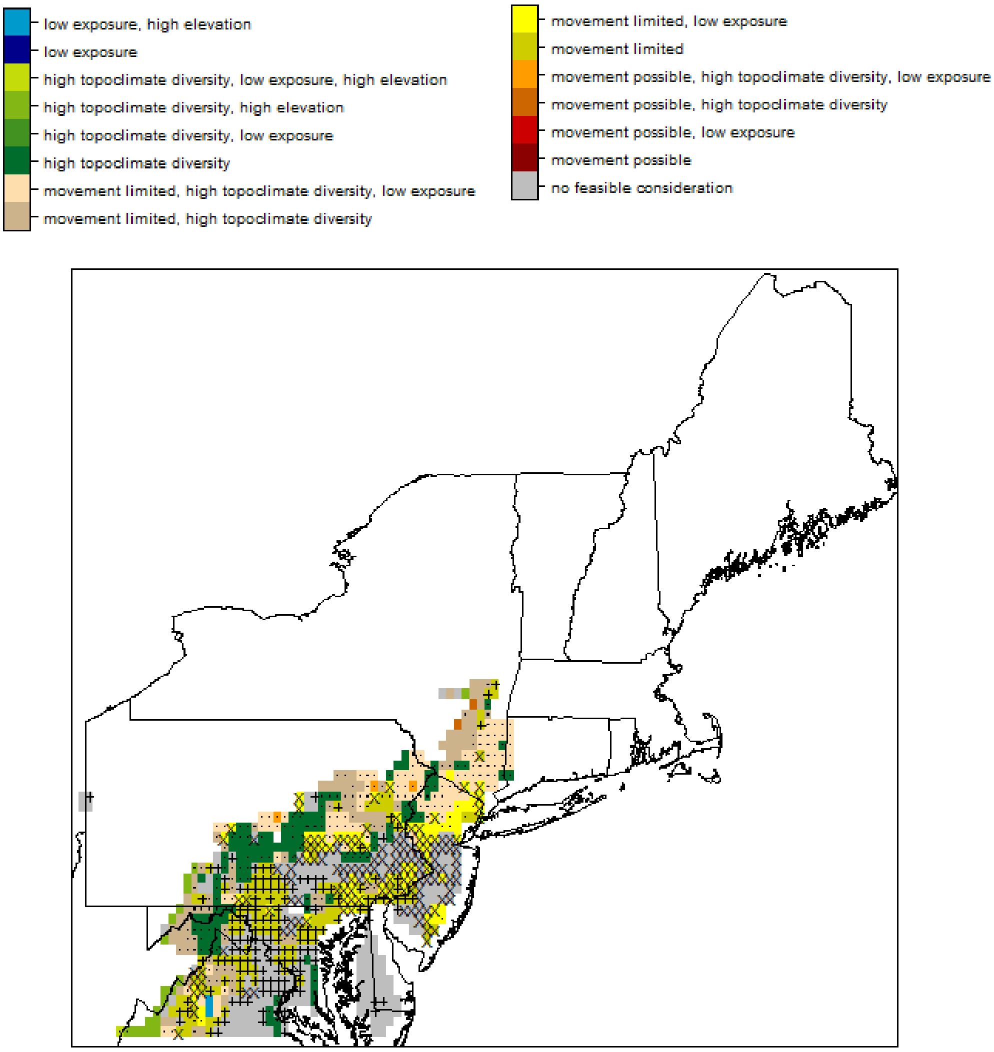

Figure AVIII. 2.1.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

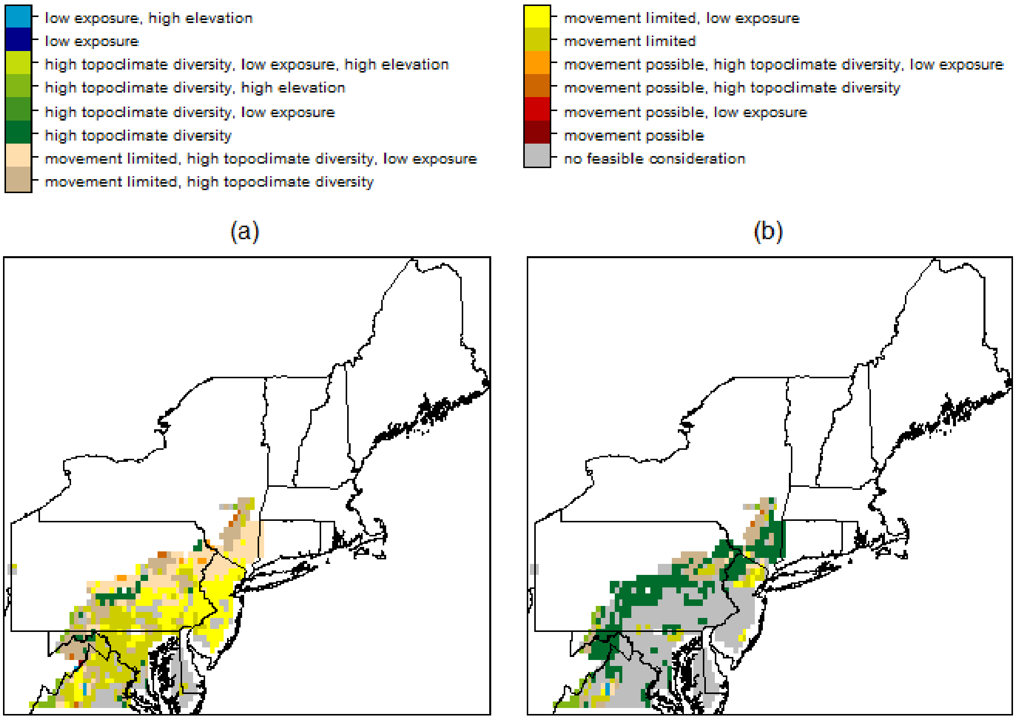

Figure AVIII. 2.1.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.2 Eastern spadefoot (*Scaphiopus holbrookii*)

Table AVIII. 2.2.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.65	0.40	0.65	0.40	0.78	0.36
low	0.42	0.40	0.53	0.34	0.93	0.02
high	0.71	0.43	0.88	0.65	0.59	1.04

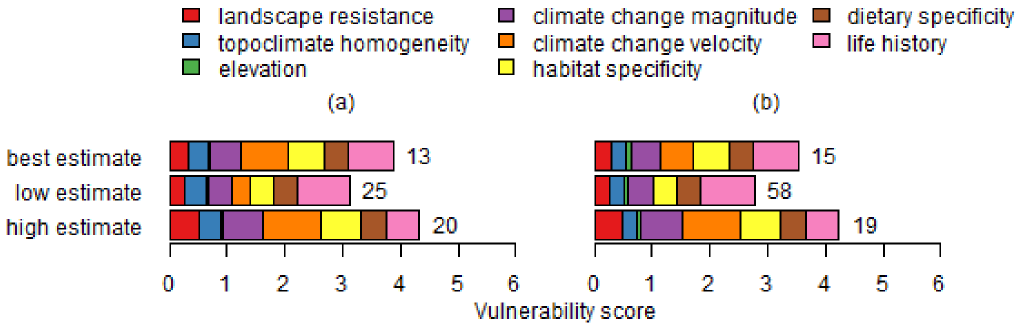

Figure AVIII. 2.2.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

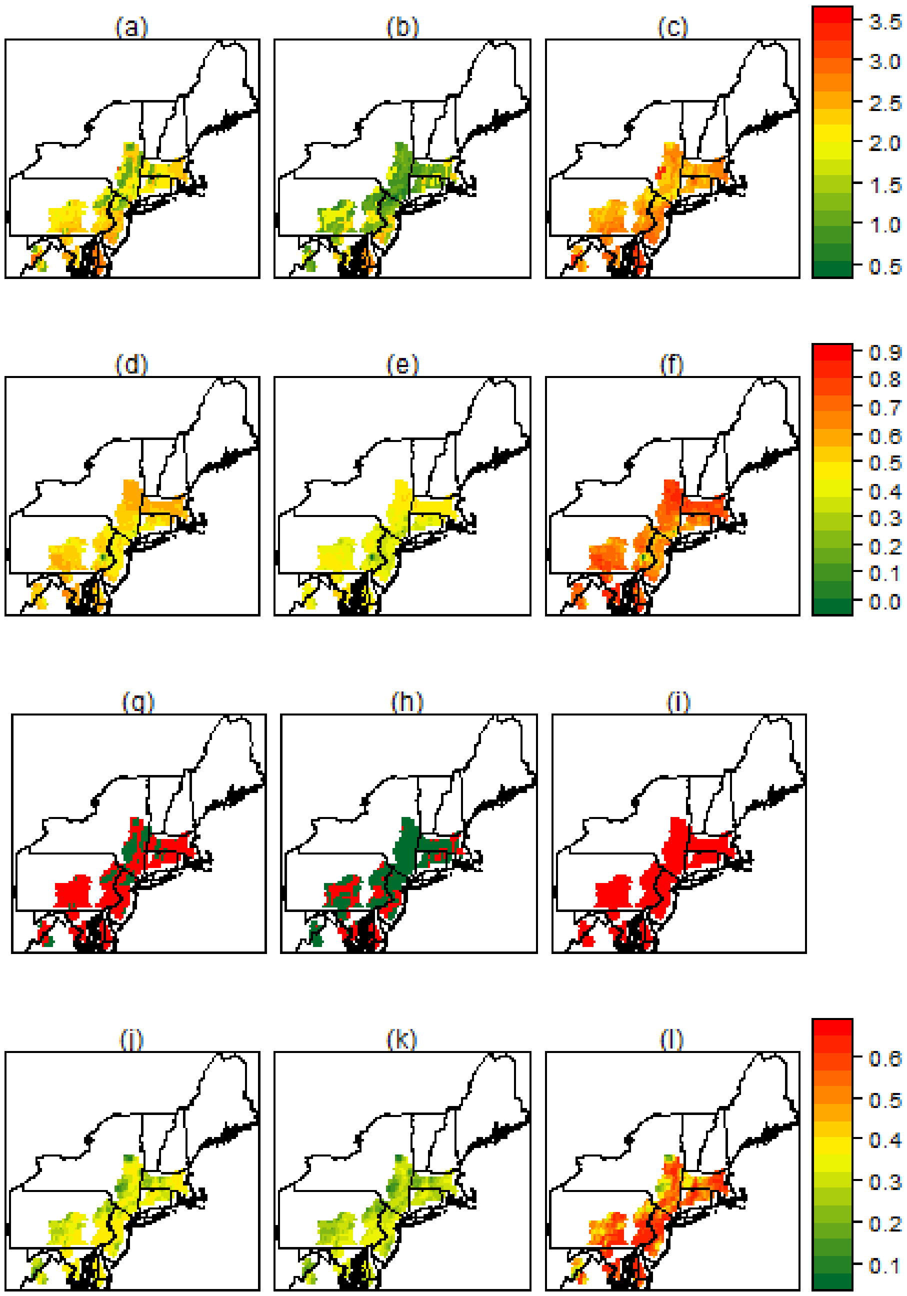

Figure AVIII. 2.2.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

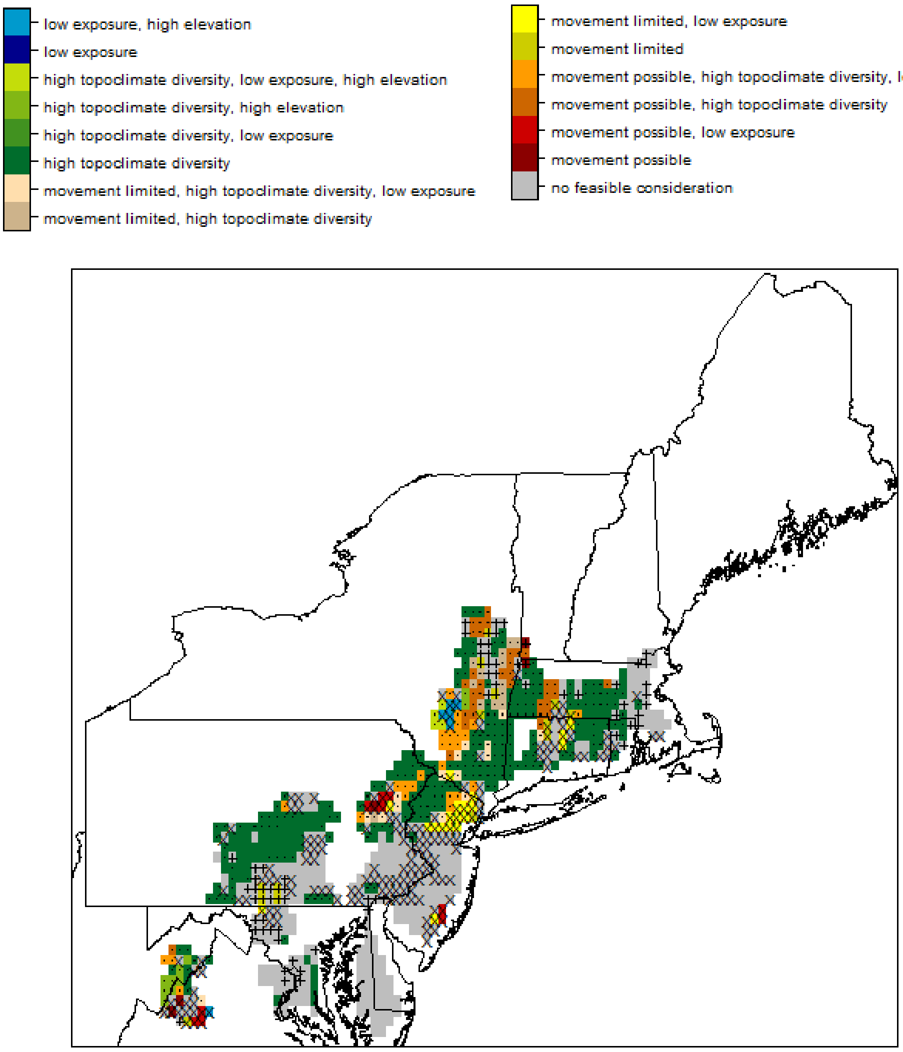

Figure AVIII. 2.2.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

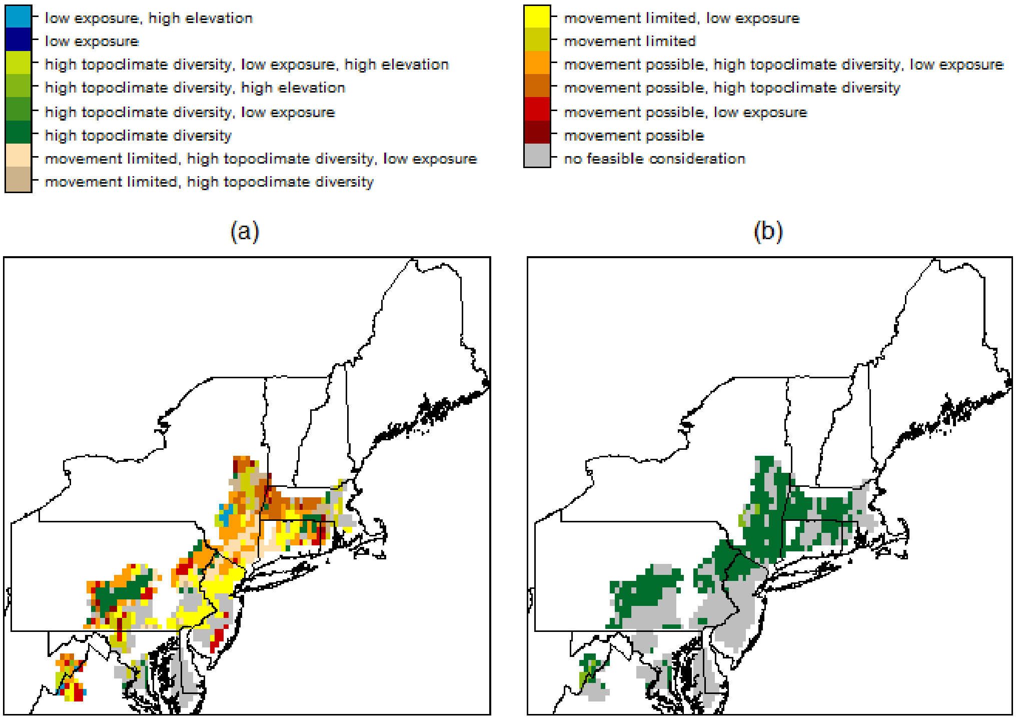

Figure AVIII. 2.2.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.3 Southern leopard frog (*Lithobates sphenocephalus*)

Table AVIII. 2.3.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.25	0.83	0.50	0.91	3.00
low	0.34	0.25	0.55	0.33	0.97	0.50
high	0.53	0.32	0.81	0.67	0.76	10.00

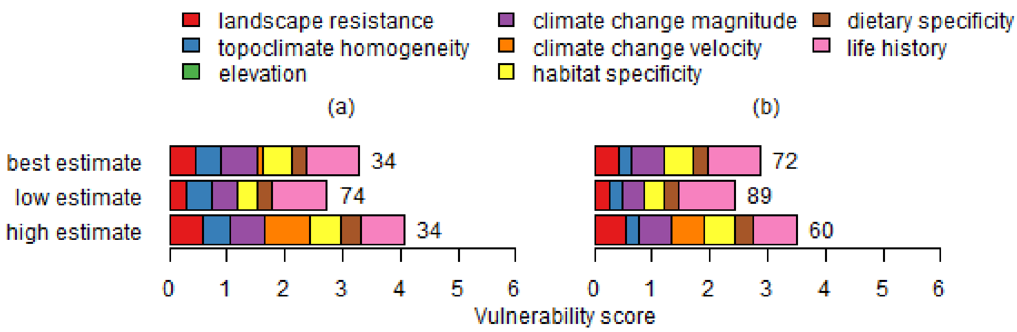

Figure AVIII. 2.3.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

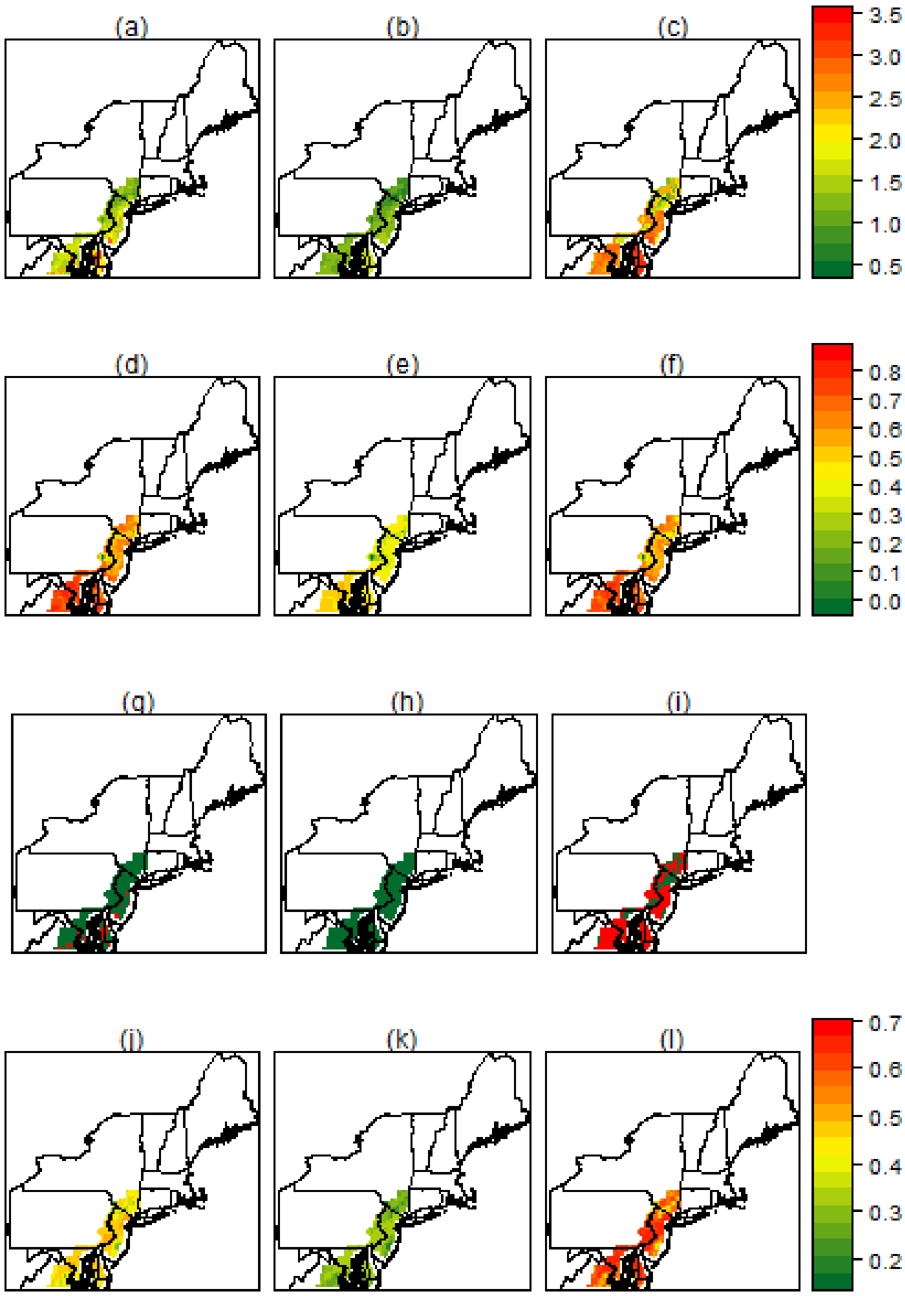

Figure AVIII. 2.3.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

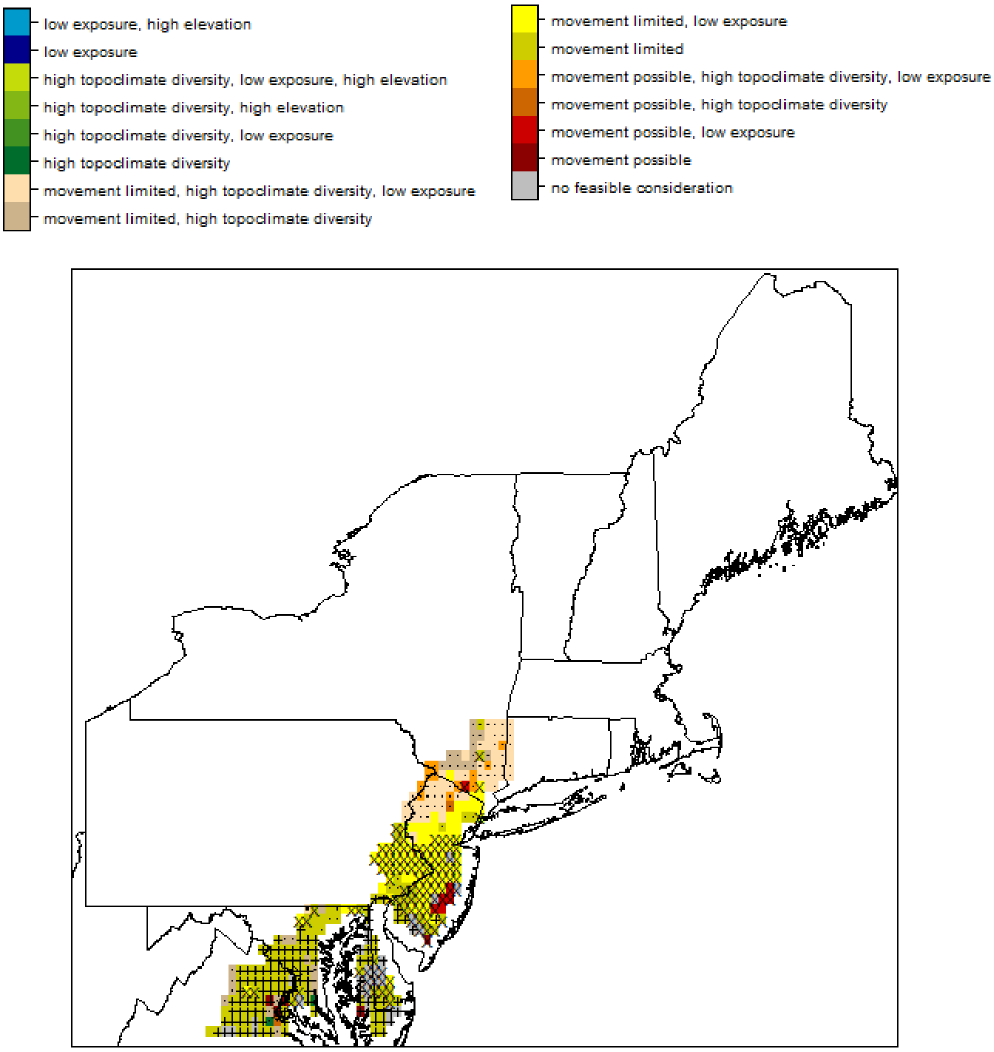

Figure AVIII. 2.3.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

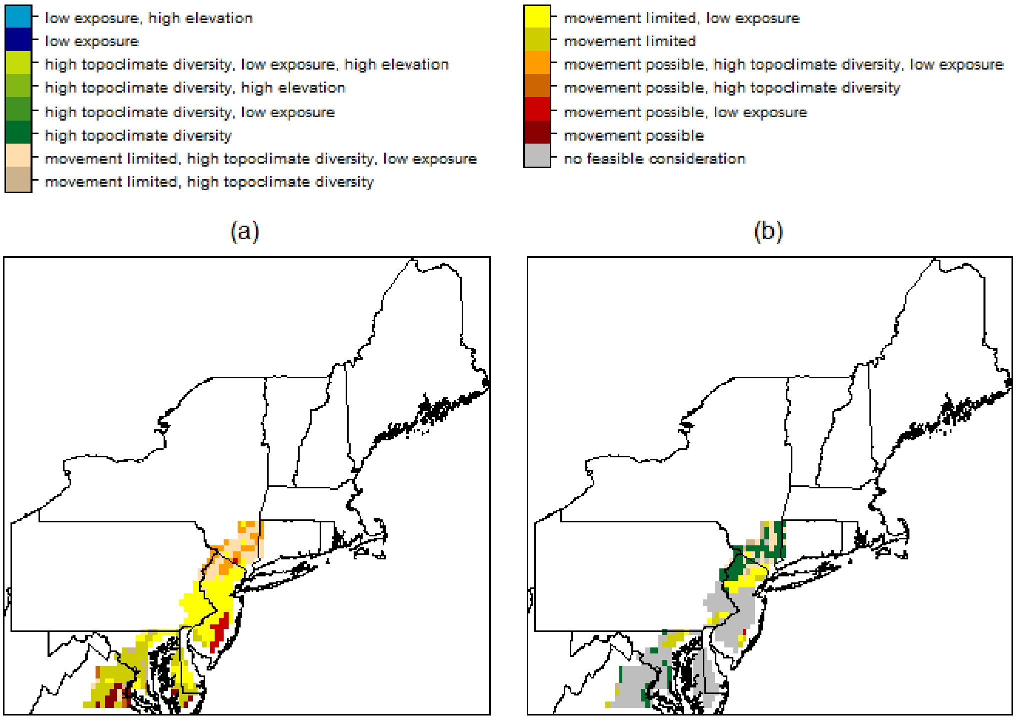

Figure AVIII. 2.3.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.4 Jefferson salamander (*Ambystoma jeffersonianum*)

Table AVIII. 2.4.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.38	0.25	0.83	0.50	0.98	0.68
low	0.15	0.25	0.83	0.50	0.98	0.55
high	0.50	0.25	0.88	0.57	0.98	1.00

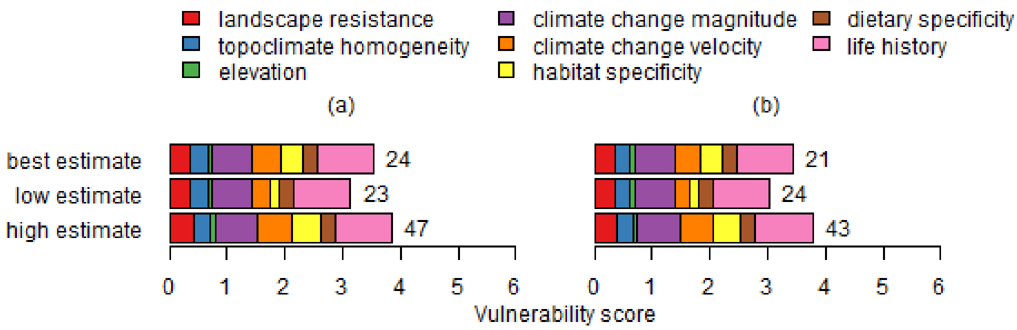

Figure AVIII. 2.4.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

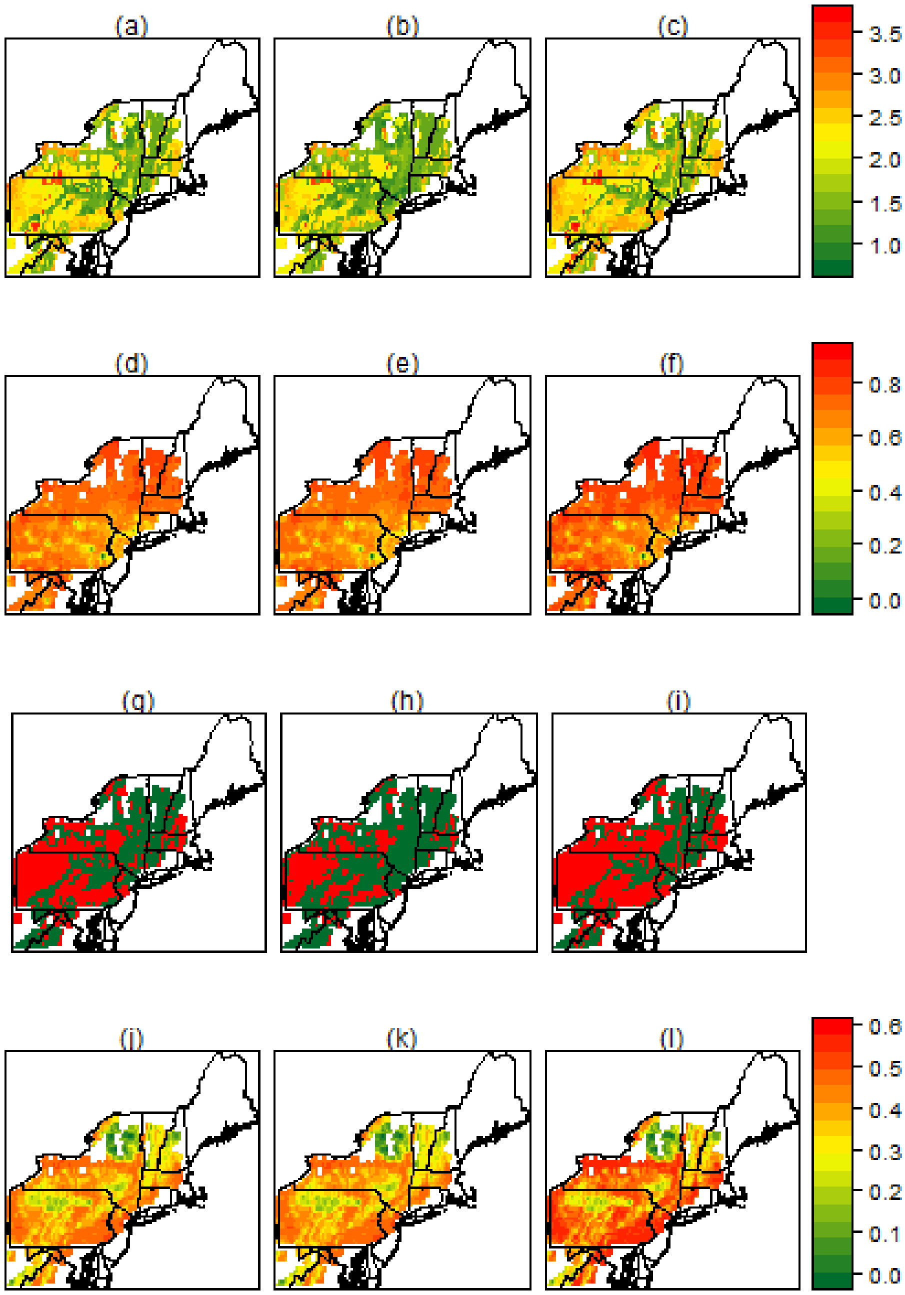

Figure AVIII. 2.4.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

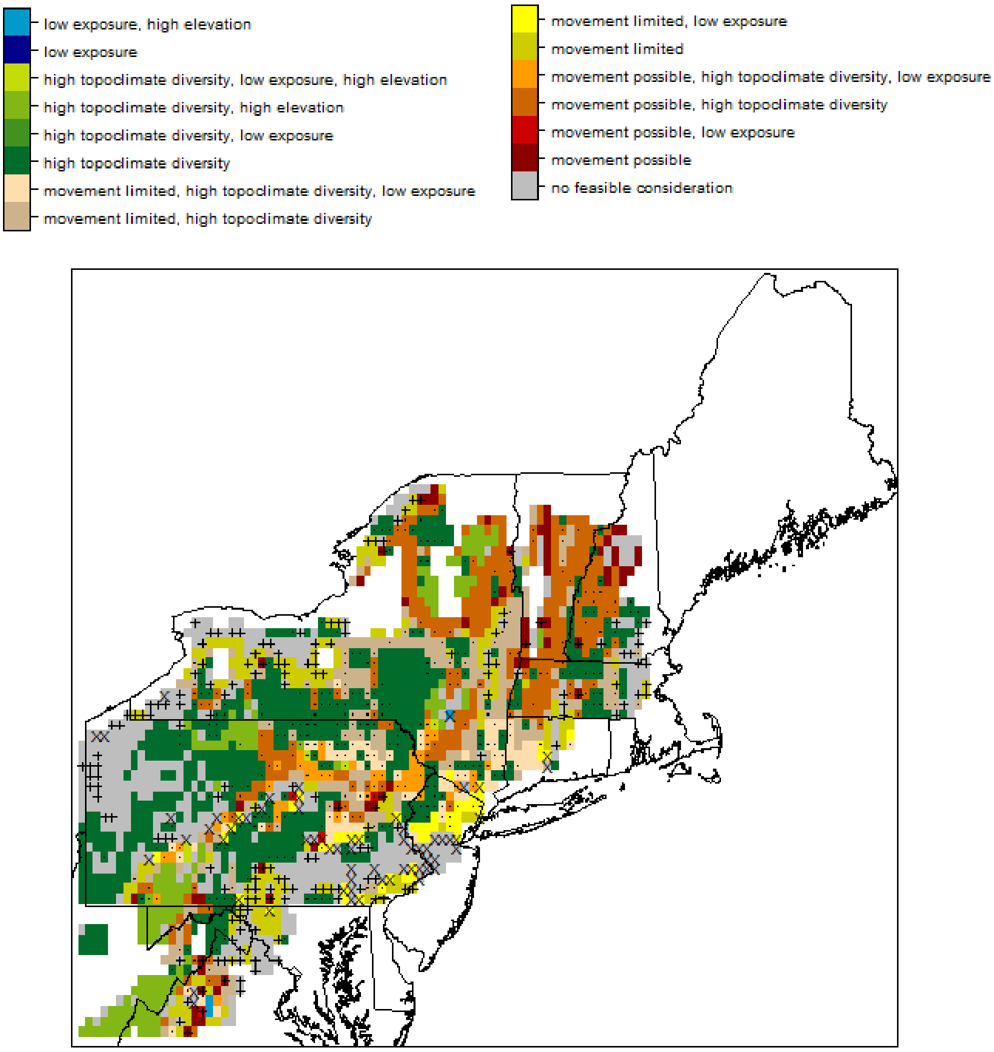

Figure AVIII. 2.4.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

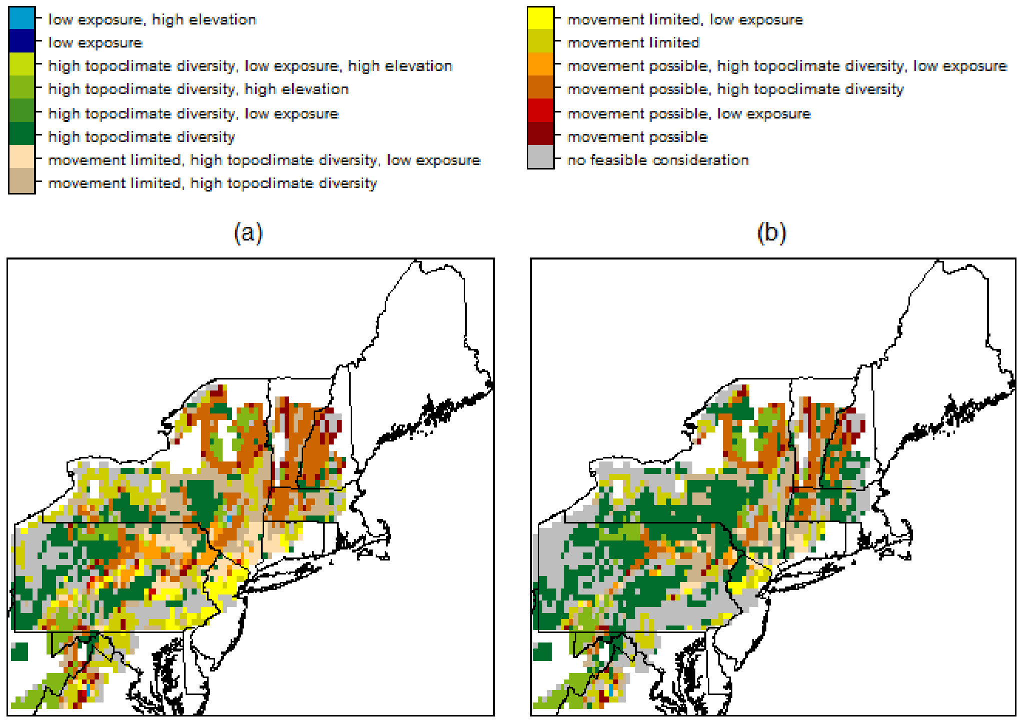

Figure AVIII. 2.4.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.5 Blue-spotted salamander (*Ambystoma laterale*)

Table AVIII. 2.5.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.00	1.00	1.00	0.97	0.35
low	0.00	0.00	1.00	1.00	0.98	0.10
high	0.50	0.00	1.00	1.00	0.97	0.40

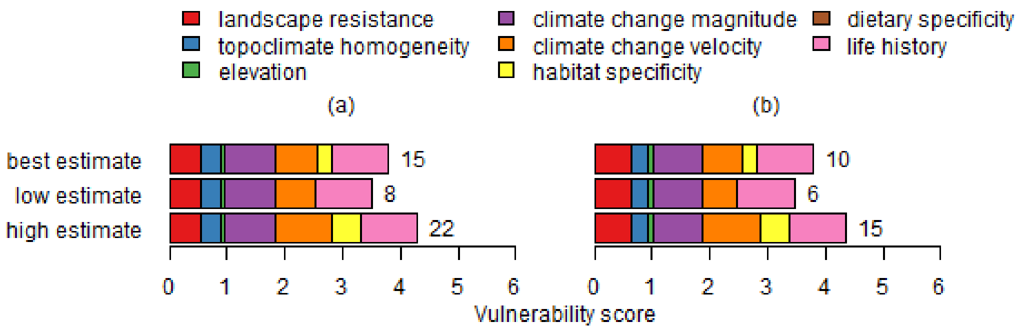

Figure AVIII. 2.5.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

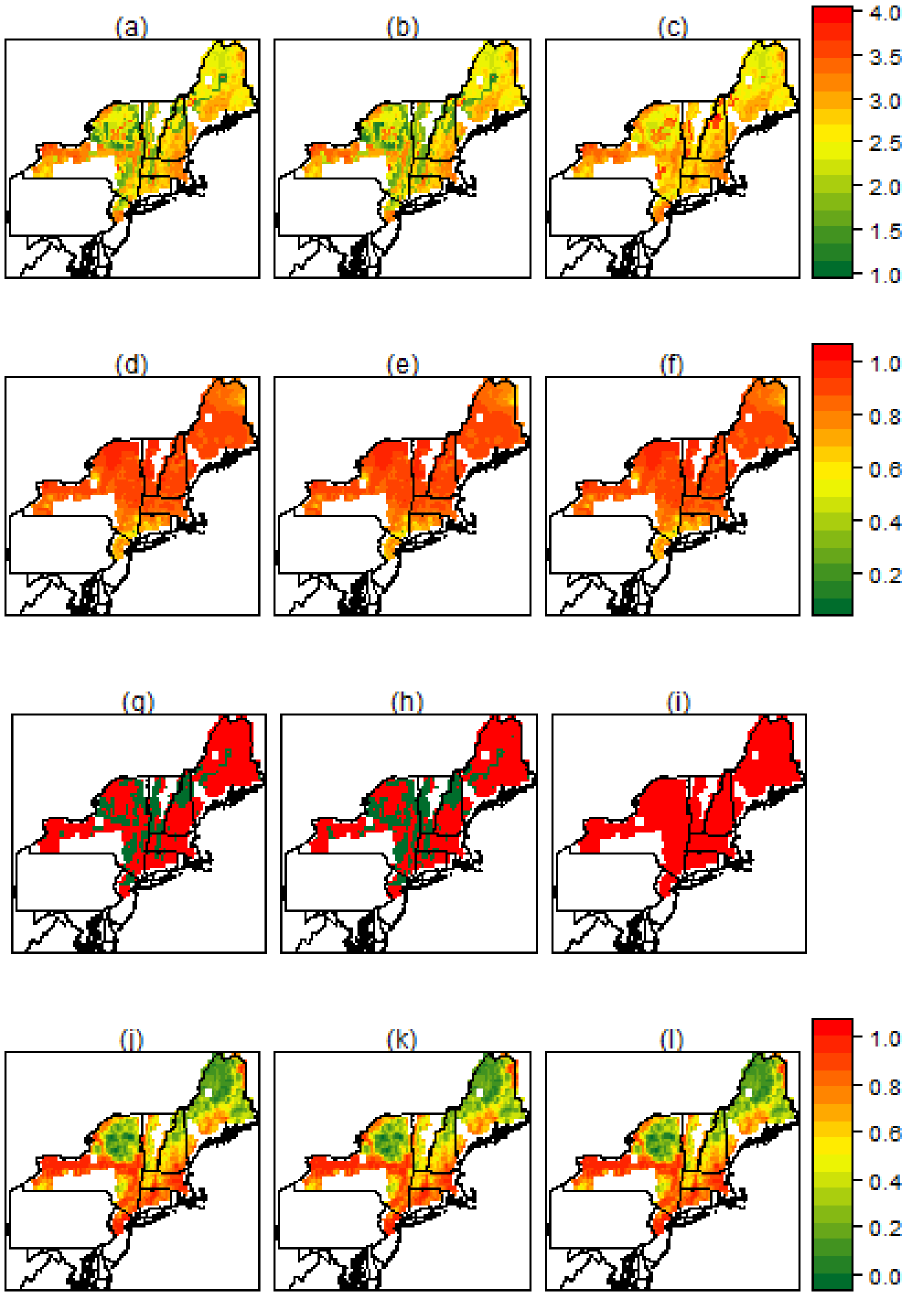

Figure AVIII. 2.5.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

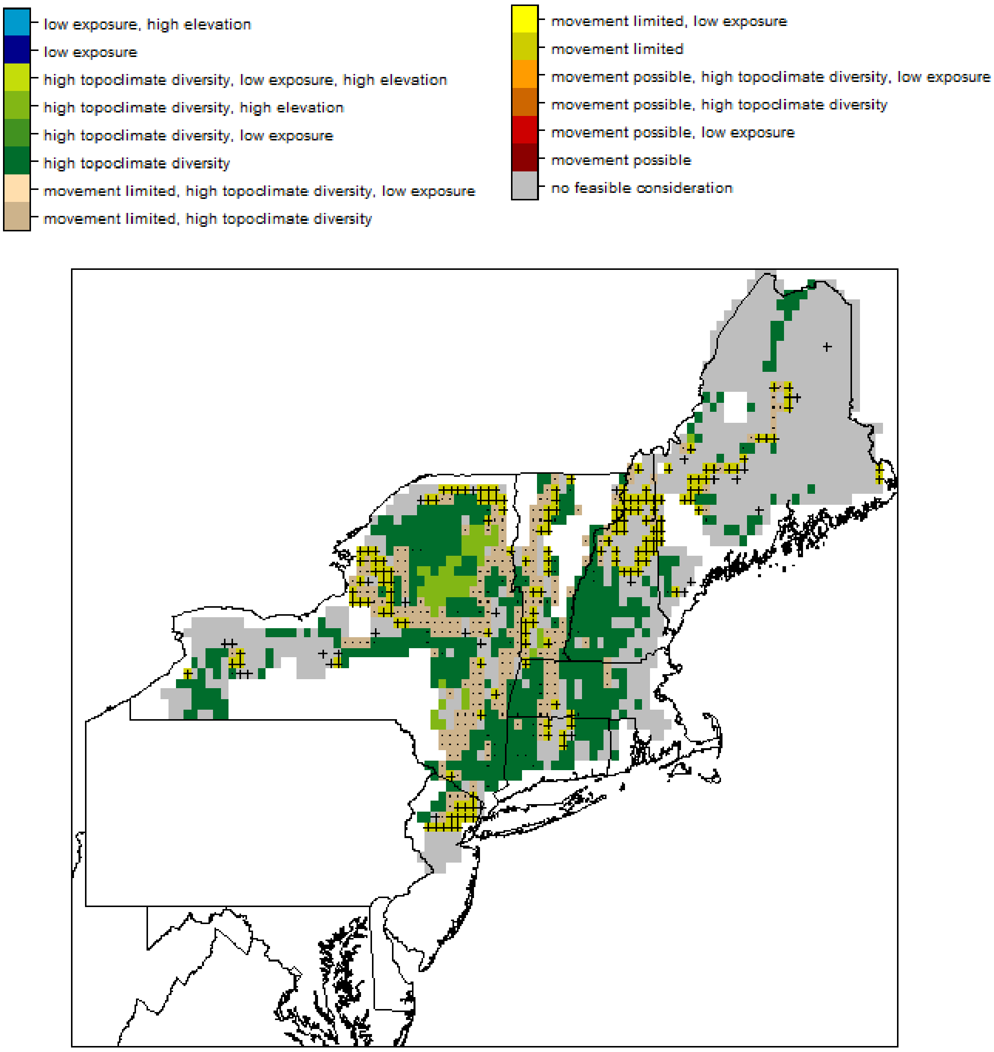

Figure AVIII. 2.5.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

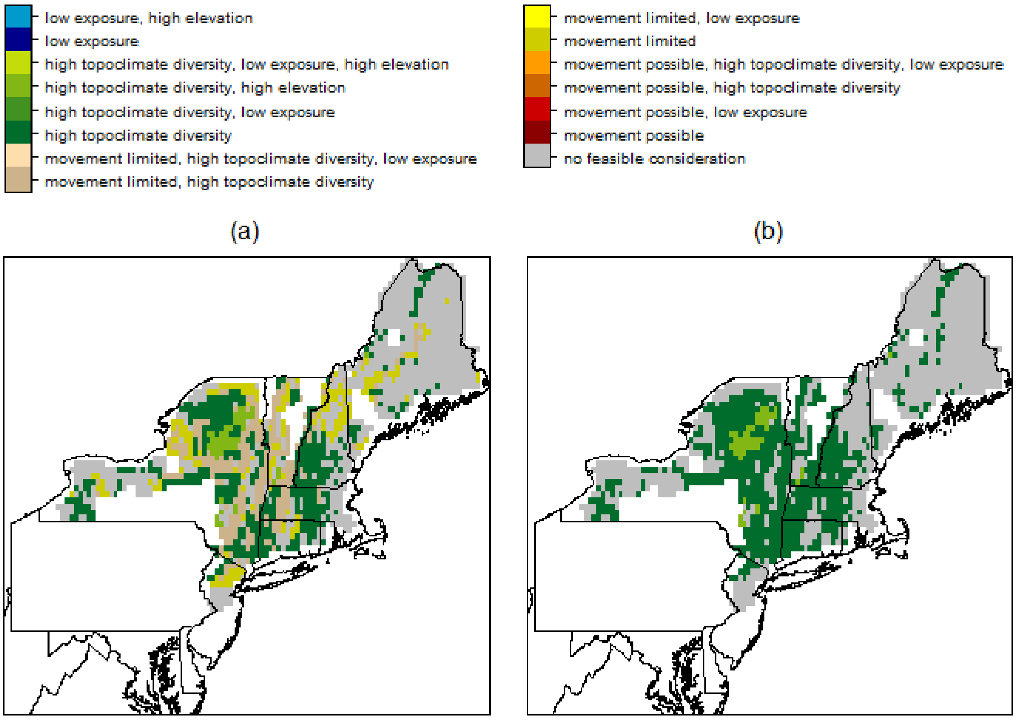

Figure AVIII. 2.5.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.6 Marbled salamander (*Ambystoma opacum*)

Table AVIII. 2.6.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.25	0.83	0.65	0.99	0.45
low	0.43	0.25	0.58	0.50	1.00	0.01
high	0.57	0.29	0.90	0.74	0.98	1.37

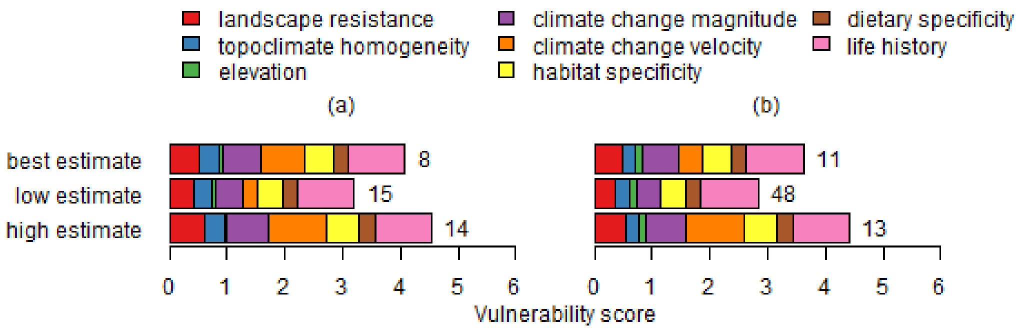

Figure AVIII. 2.6.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

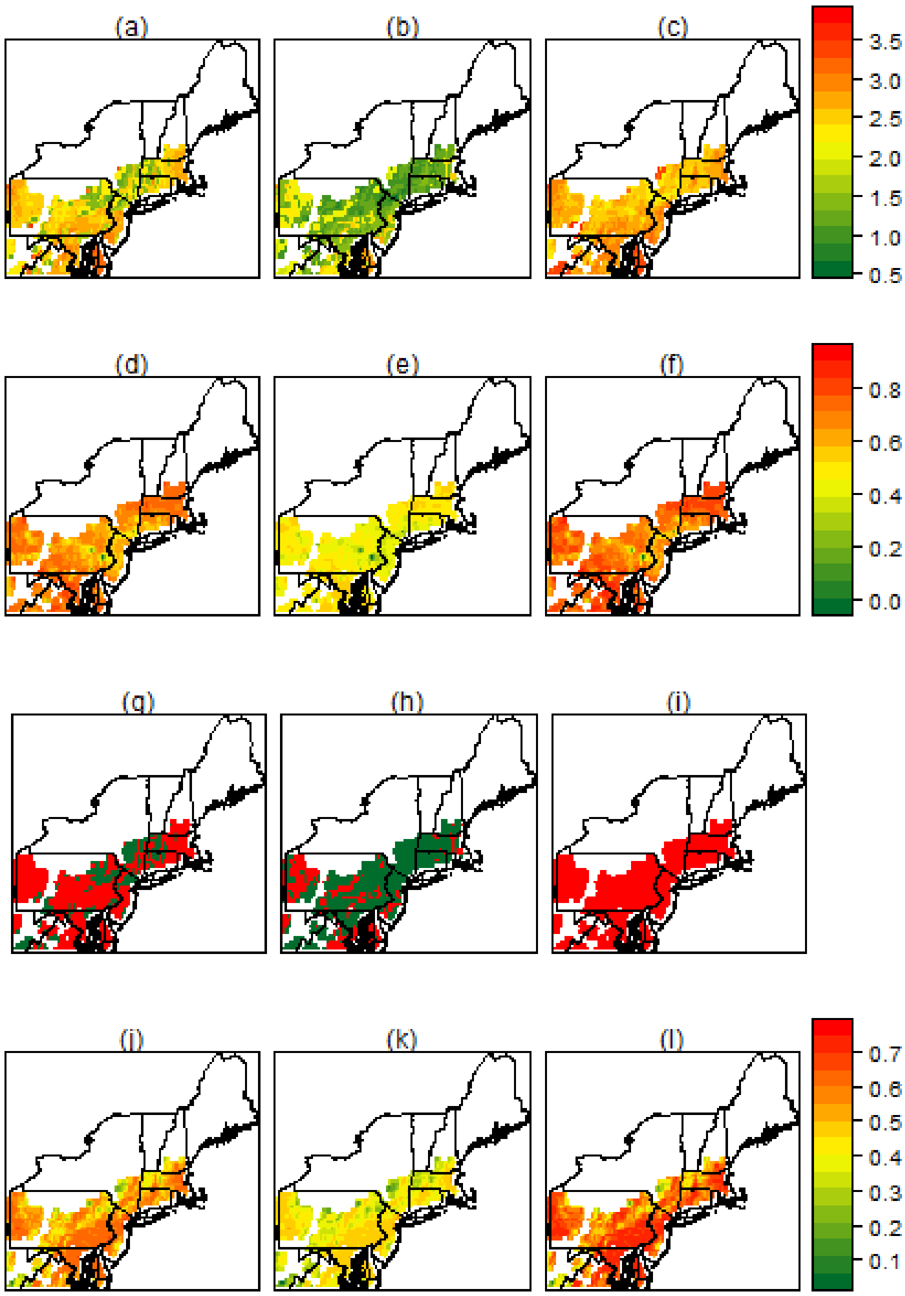

Figure AVIII. 2.6.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

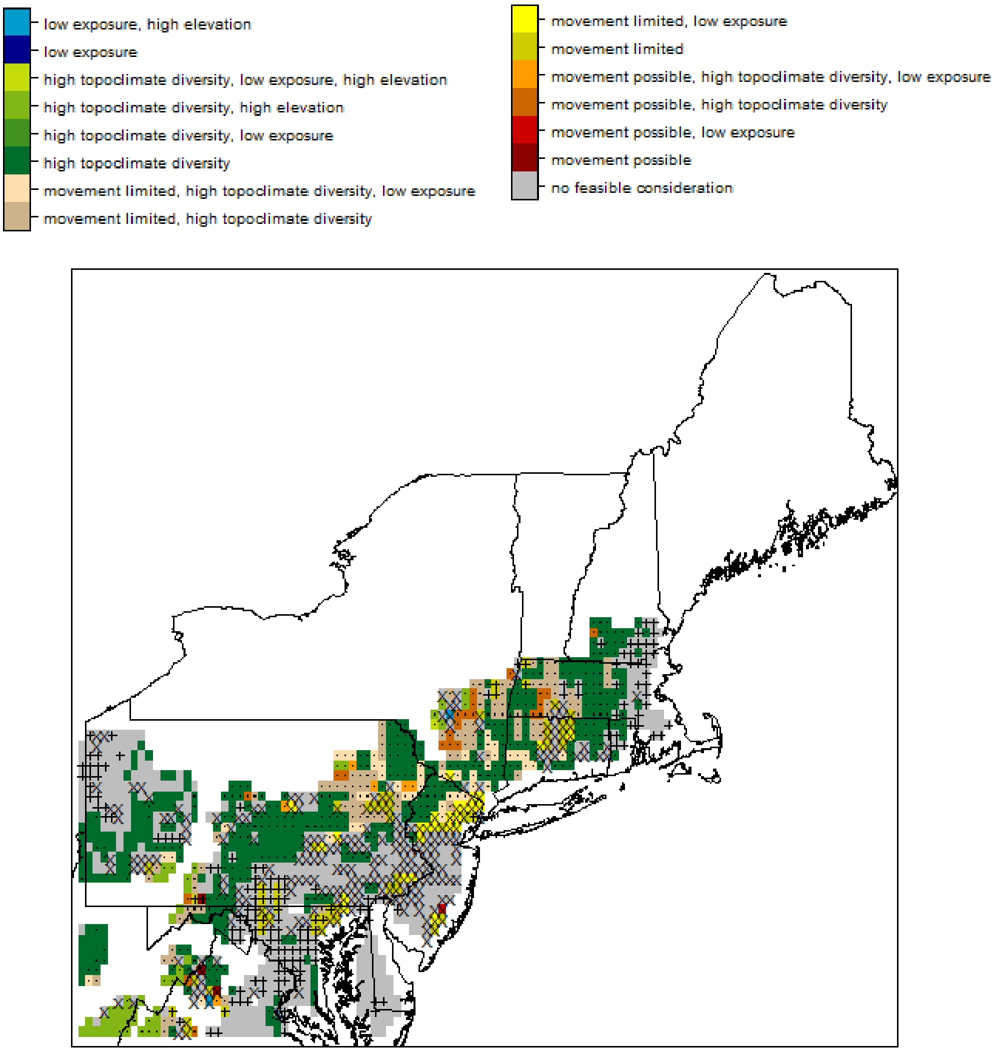

Figure AVIII. 2.6.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

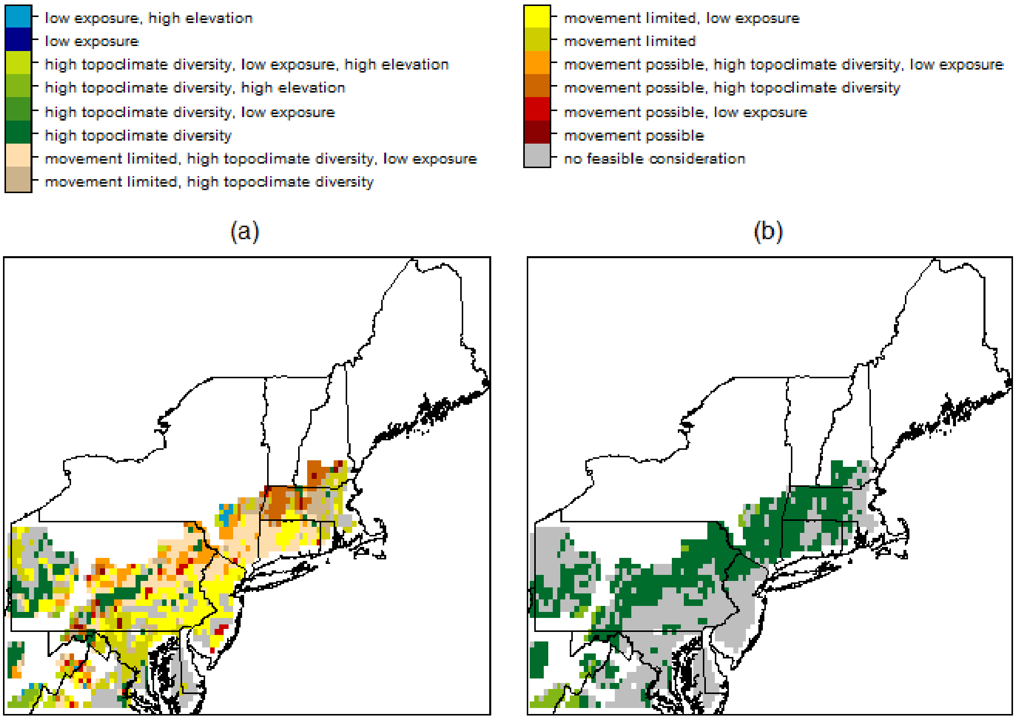

Figure AVIII. 2.6.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.7 Tiger salamander (*Ambystoma tigrinum*)

Table AVIII. 2.7.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.57	0.21	0.81	0.69	0.98	0.90
low	0.48	0.20	0.63	0.56	1.00	0.22
high	0.65	0.23	0.88	0.77	0.97	2.46

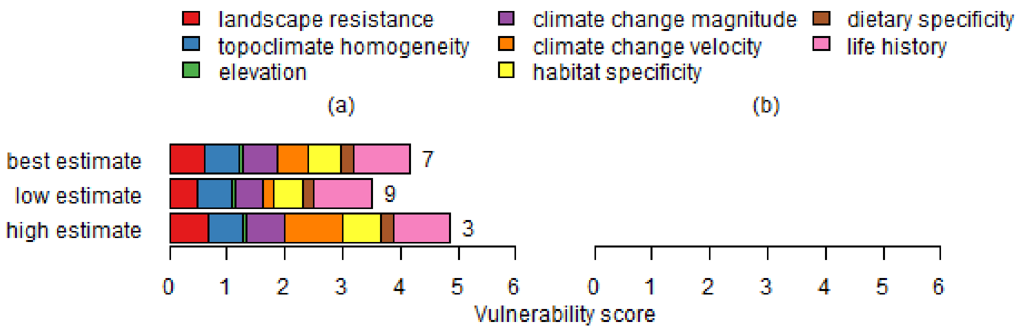

Figure AVIII. 2.7.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

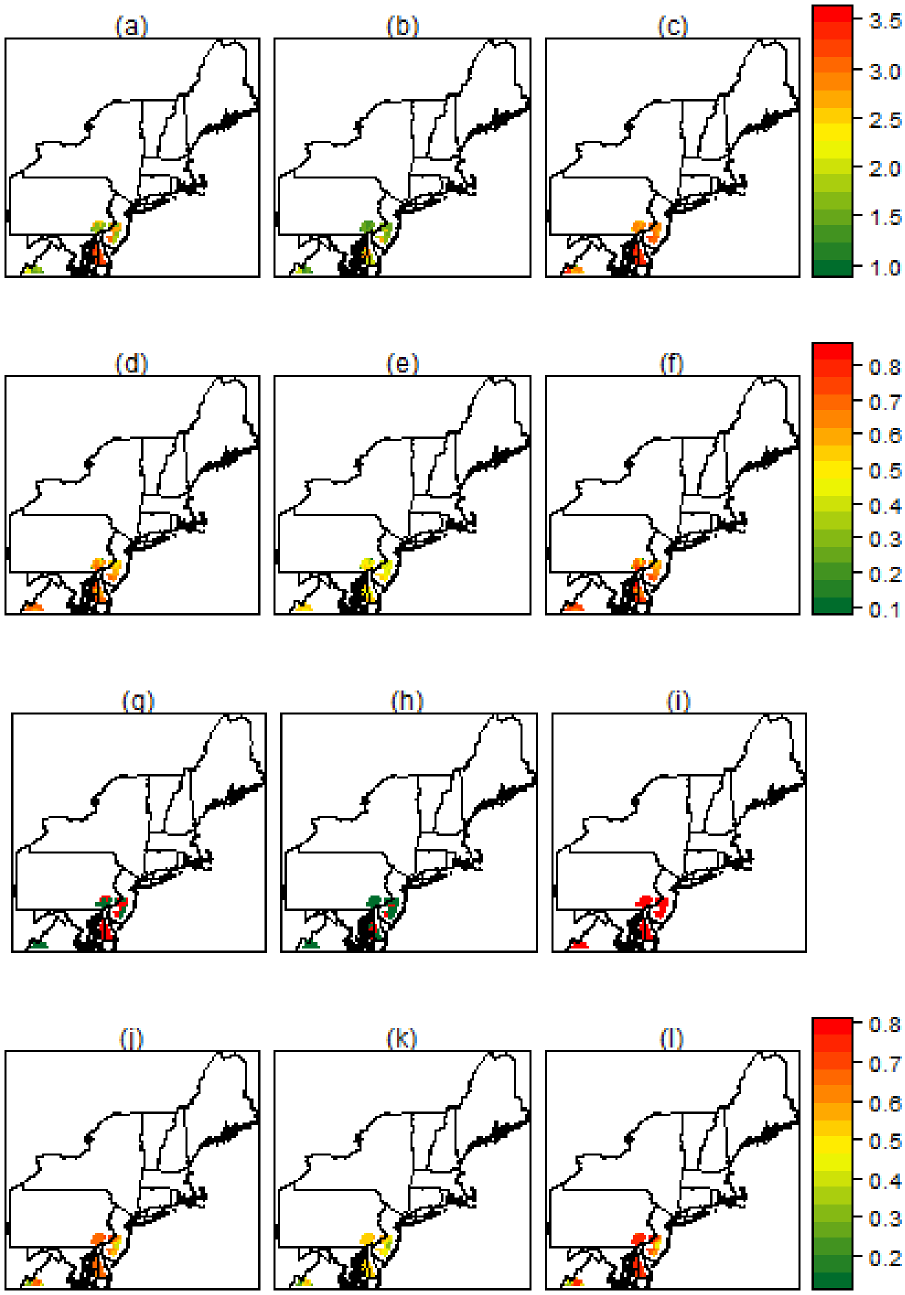

Figure AVIII. 2.7.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

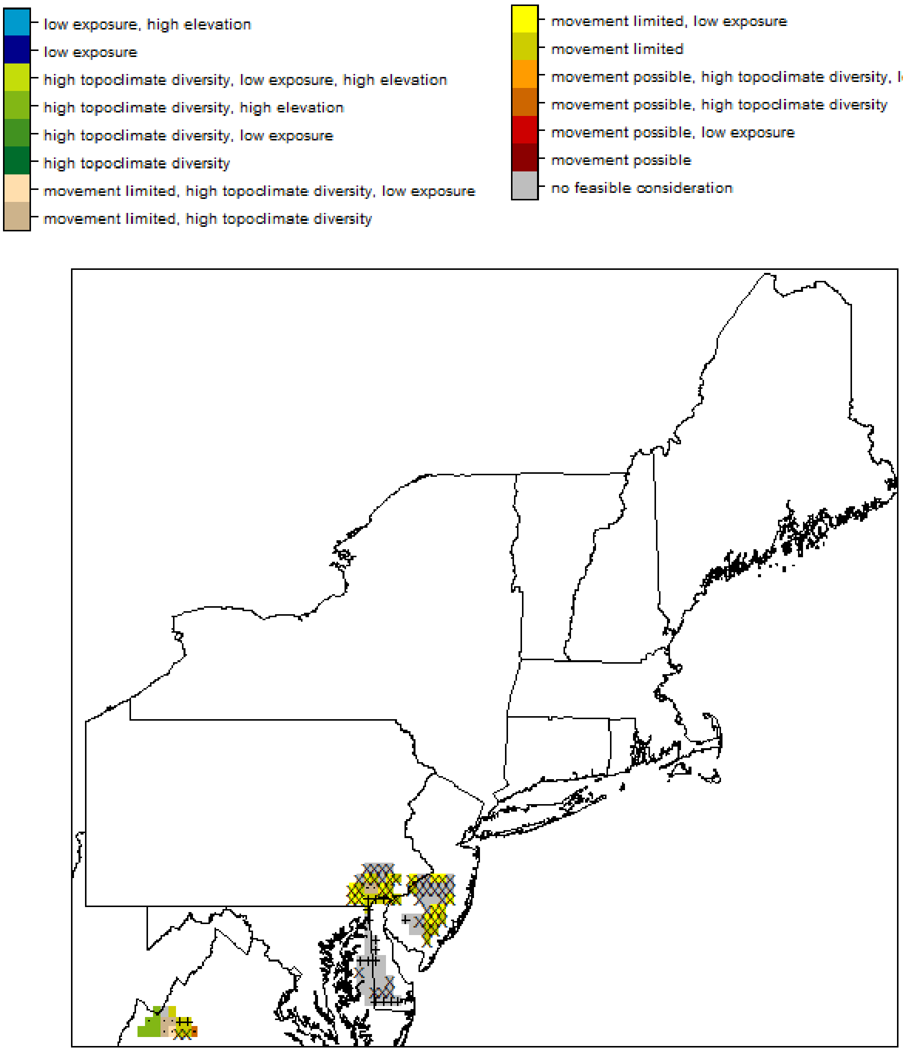

Figure AVIII. 2.7.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

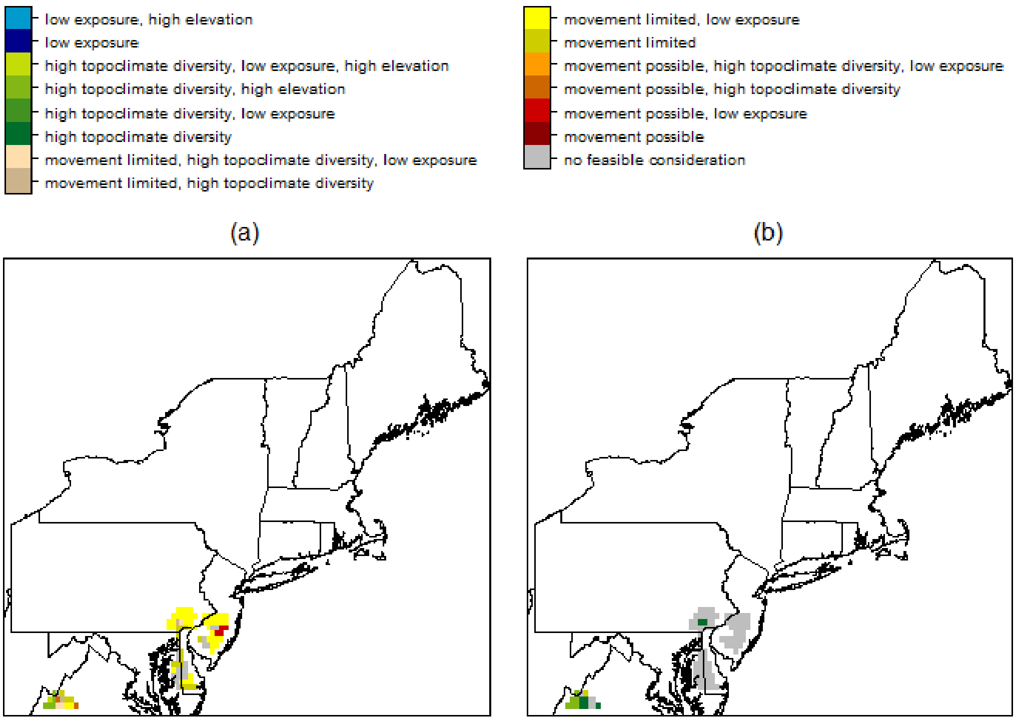

Figure AVIII. 2.7.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.8 Longtail salamander (*Eurycea longicauda*)

Table AVIII. 2.8.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.17	0.55	0.50	1.00	0.51
low	0.40	0.17	0.55	0.43	1.00	0.37
high	0.50	0.17	0.55	0.53	1.00	0.83

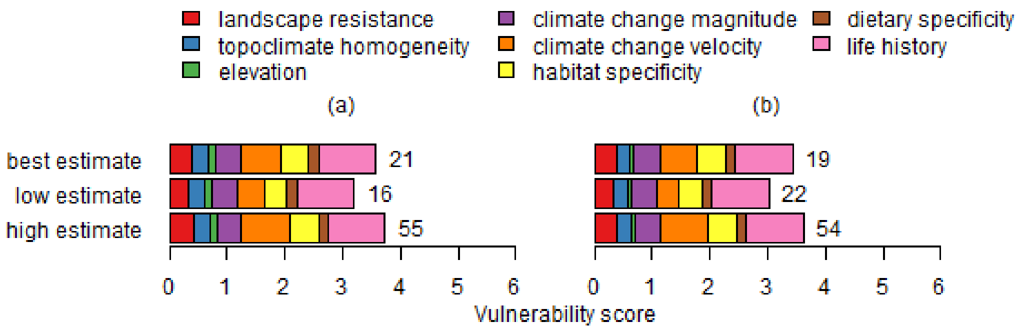

Figure AVIII. 2.8.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

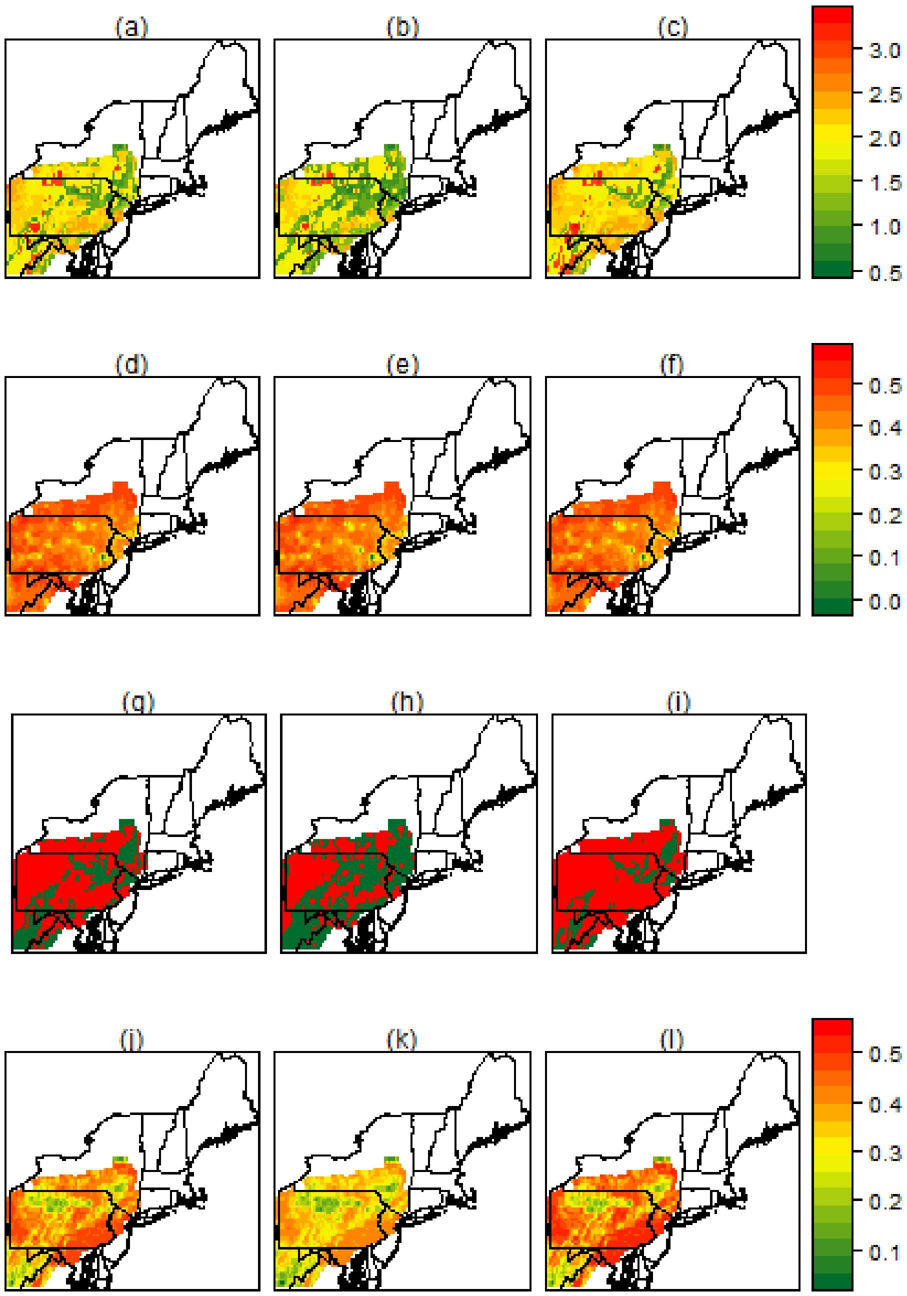

Figure AVIII. 2.8.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

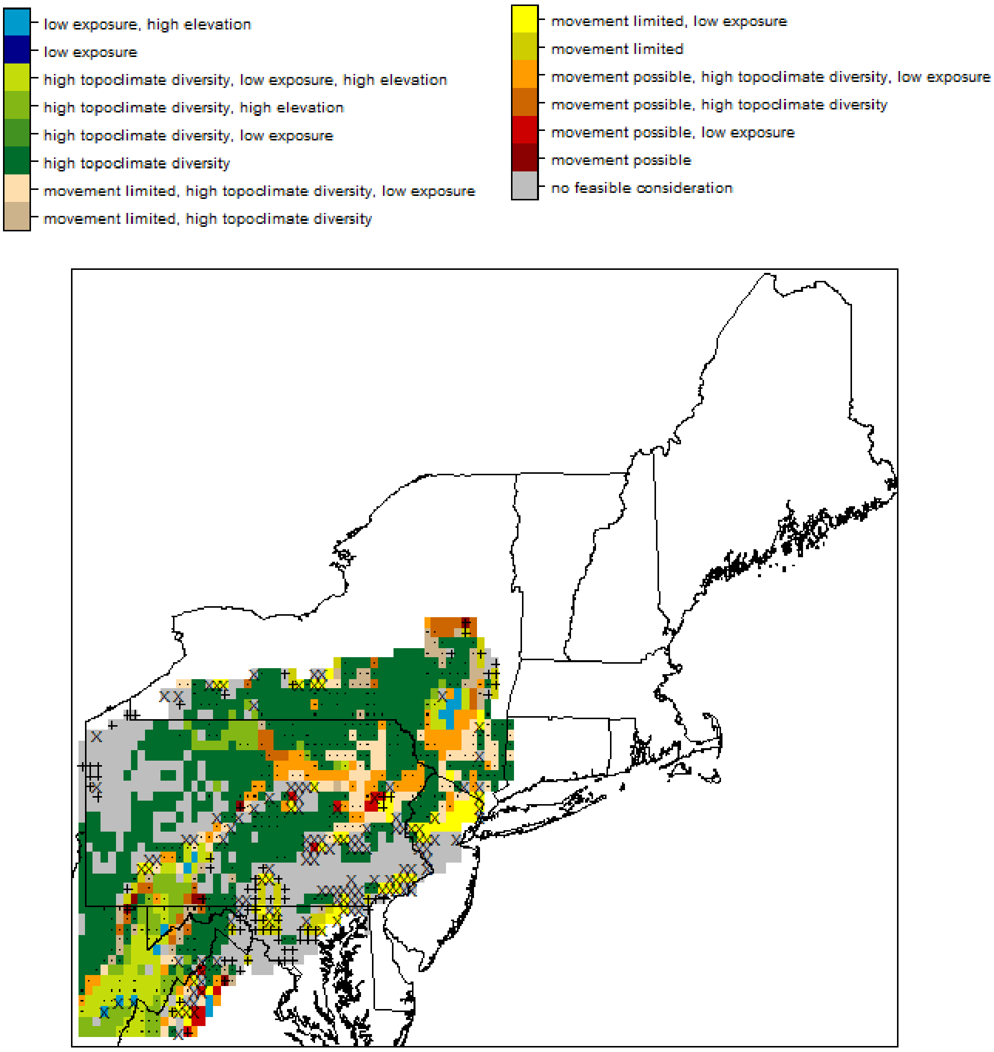

Figure AVIII. 2.8.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

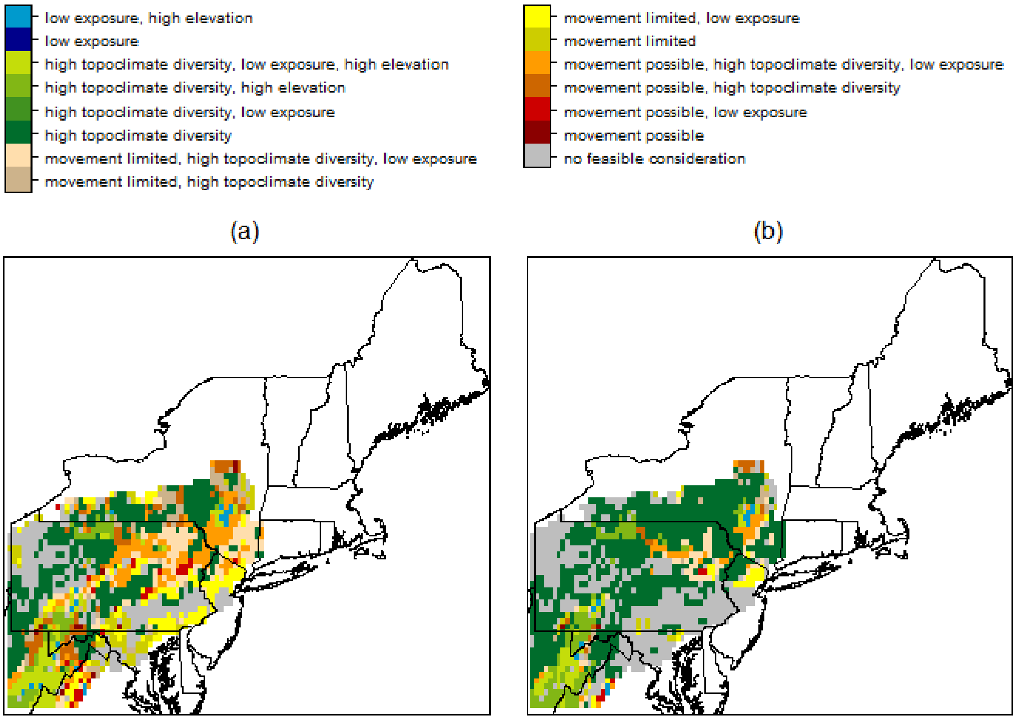

Figure AVIII. 2.8.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.9 Four-toed salamander (*Hemidactylium scutatum*)

Table AVIII. 2.9.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.33	0.83	0.75	1.00	0.12
low	0.47	0.33	0.77	0.64	1.00	0.08
high	0.57	0.33	0.89	0.89	0.99	0.60

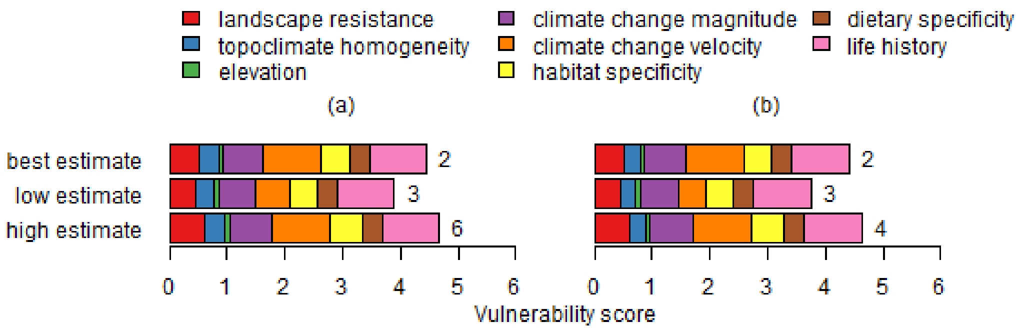

Figure AVIII. 2.9.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

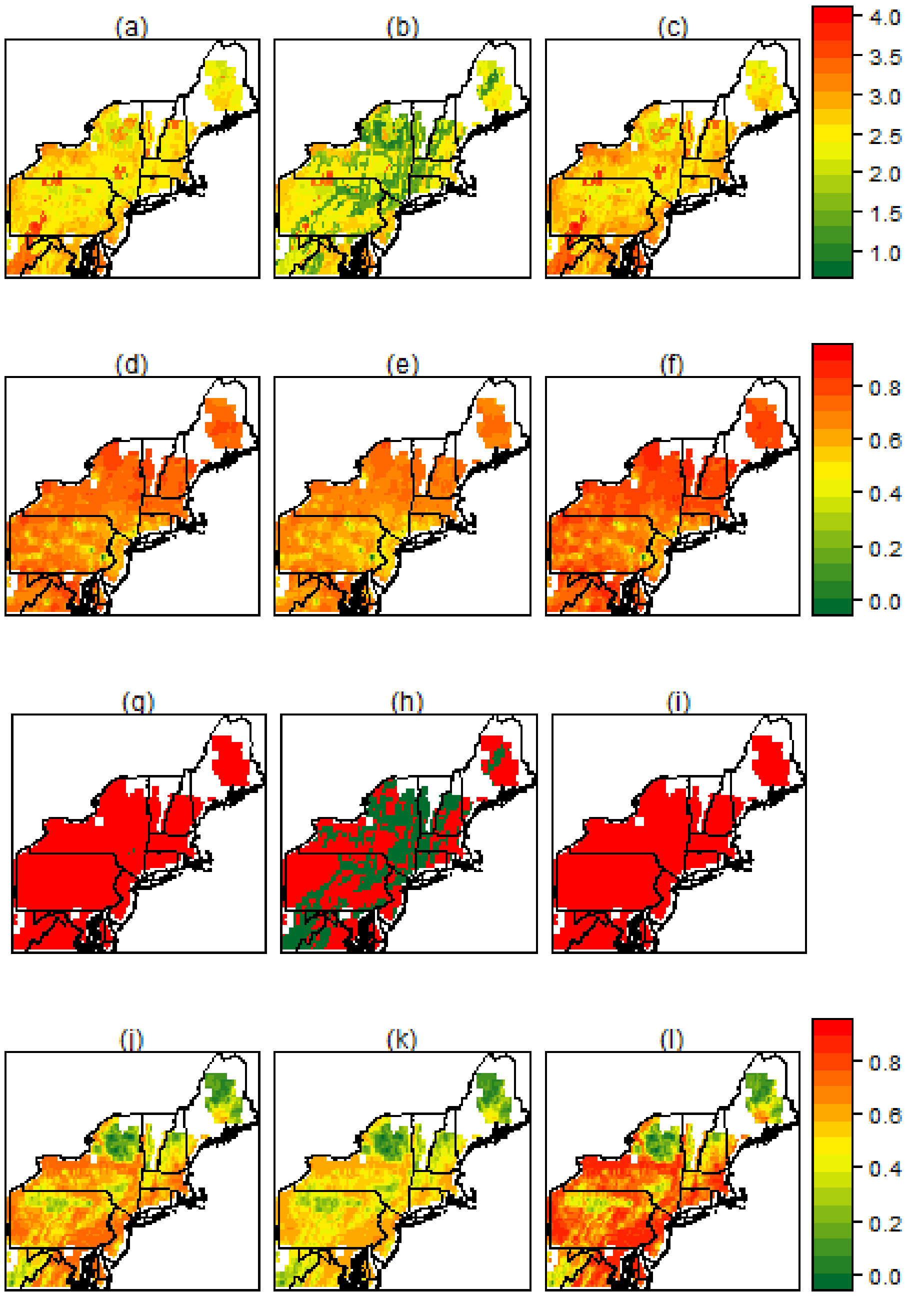

Figure AVIII. 2.9.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

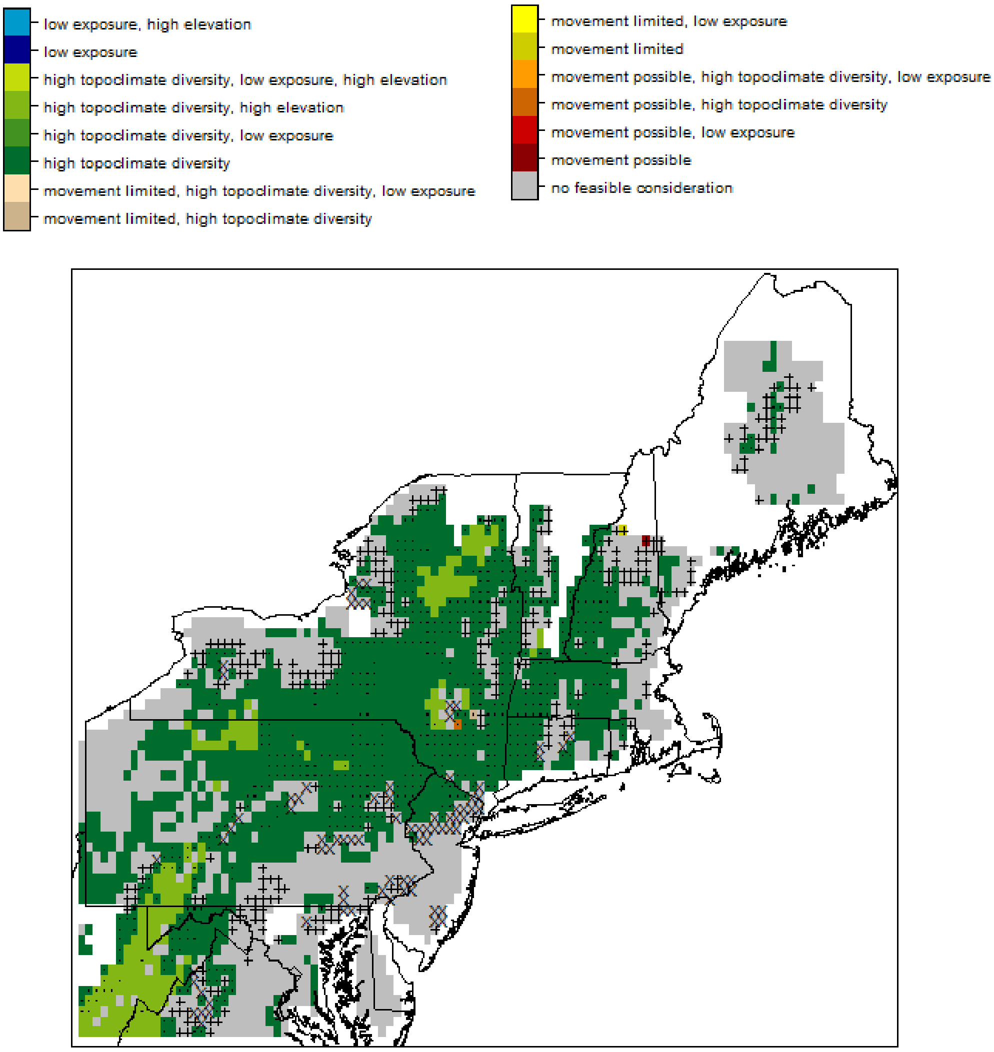

Figure AVIII. 2.9.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

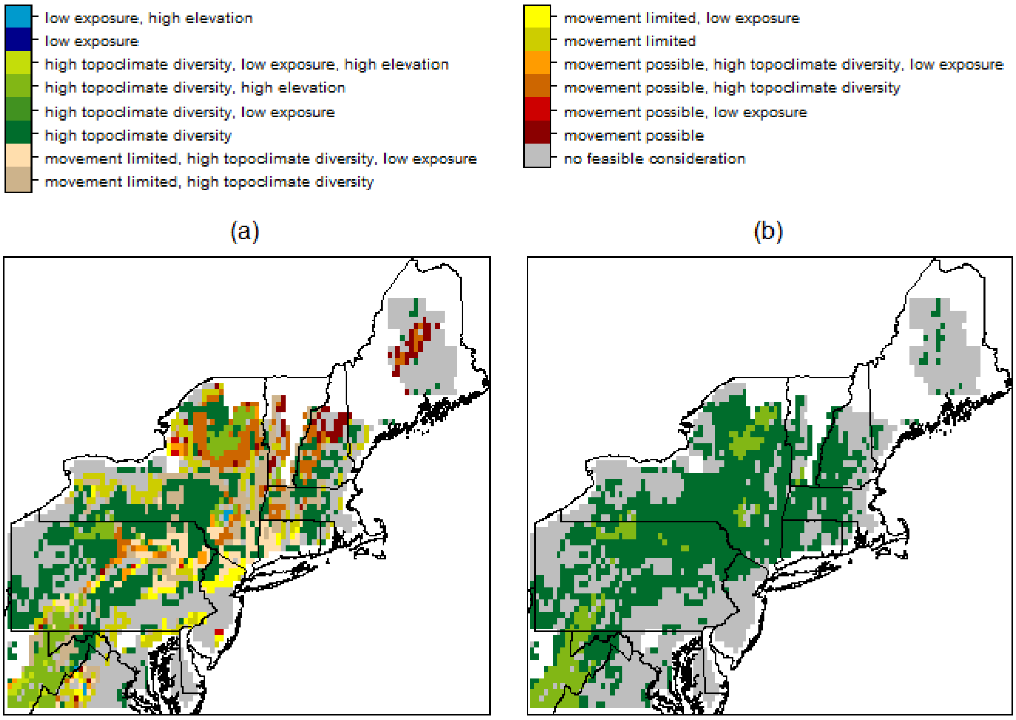

Figure AVIII. 2.9.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.10 Northern red salamander (*Pseudotriton ruber*)

Table AVIII. 2.10.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.25	0.66	0.75	0.99	0.06
low	0.15	0.25	0.59	0.62	0.99	0.02
high	0.30	0.25	0.73	0.81	0.99	0.50

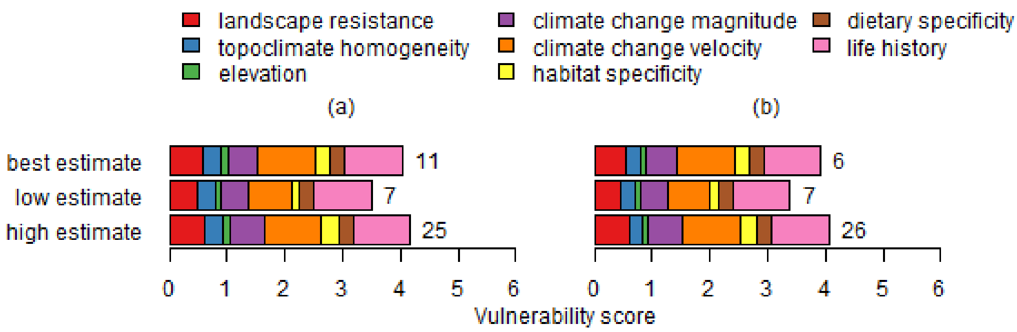

Figure AVIII. 2.10.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

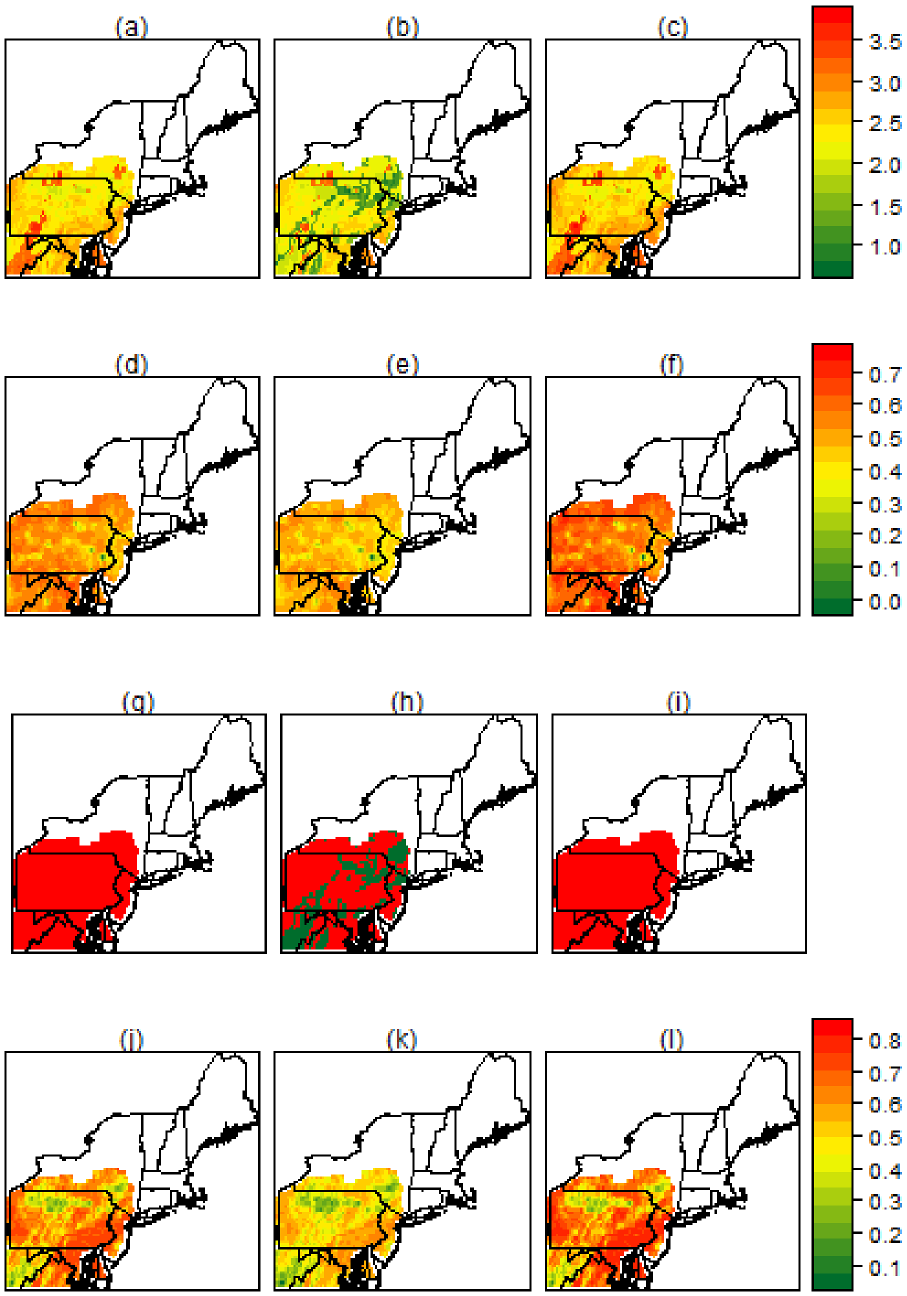

Figure AVIII. 2.10.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

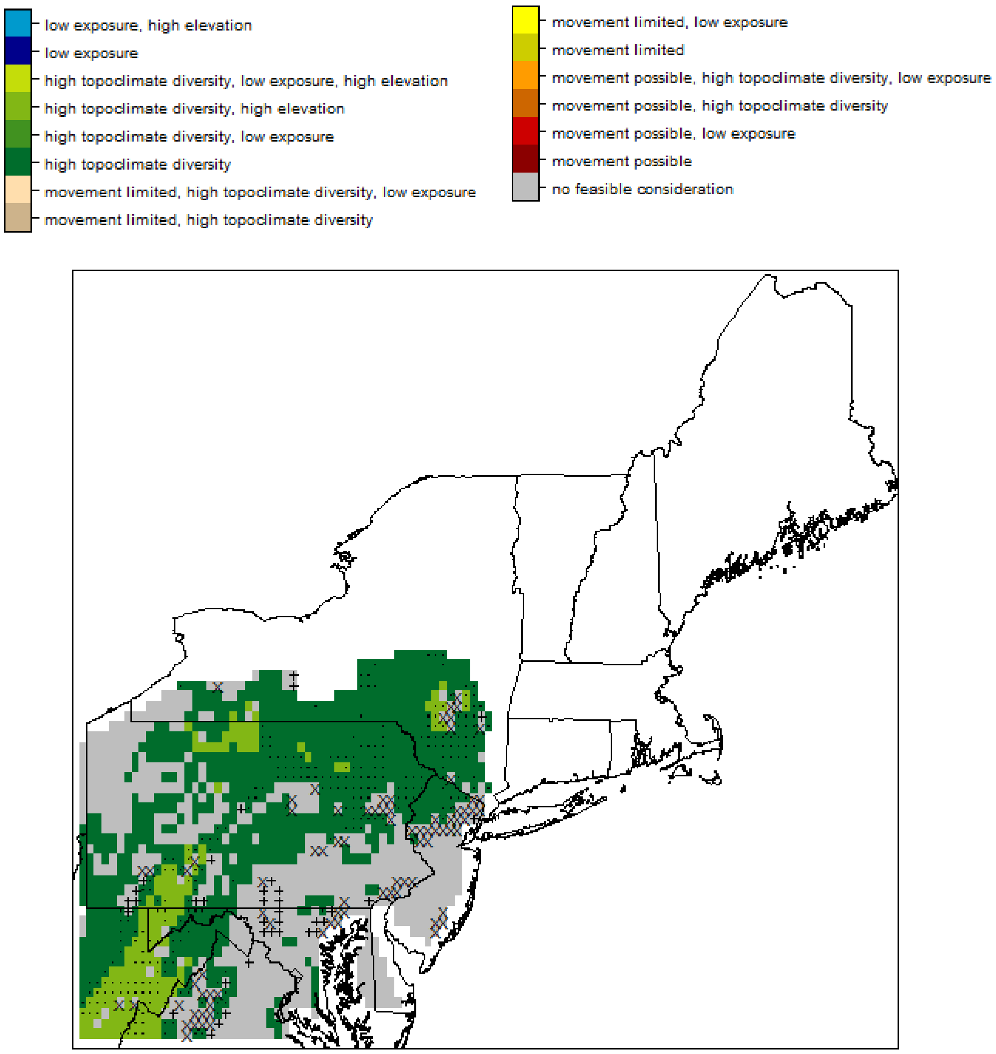

Figure AVIII. 2.10.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

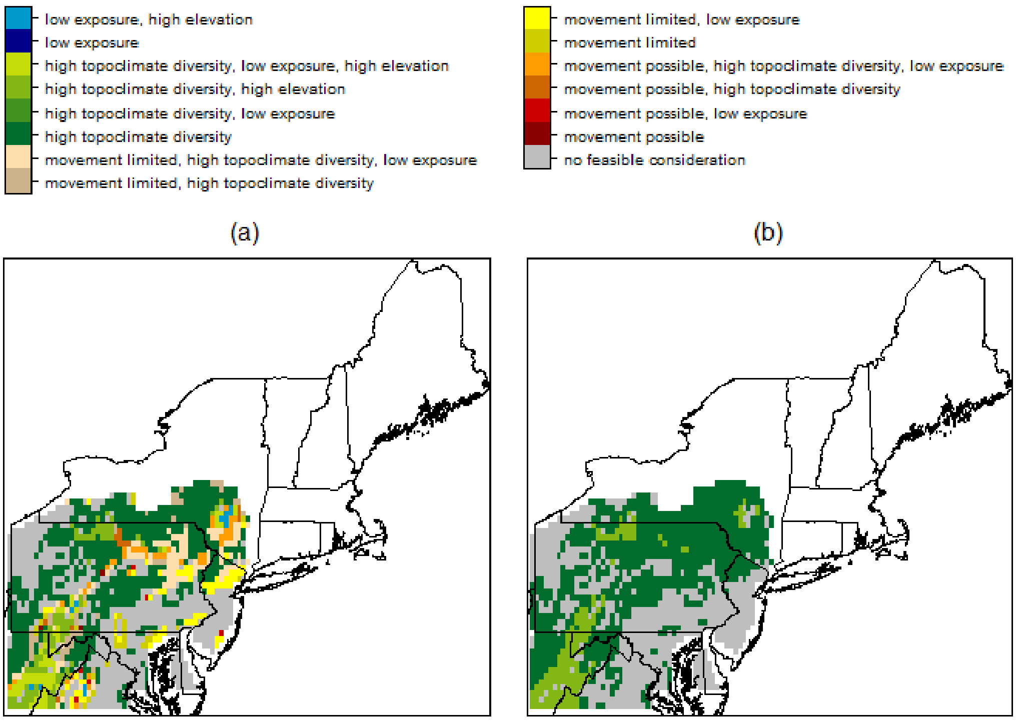

Figure AVIII. 2.10.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.11 Snapping turtle (*Chelydra serpentina*)

Table AVIII. 2.11.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.06	0.11	0.59	0.42	1.00	1.40
low	0.06	0.10	0.58	0.36	1.00	0.30
high	0.15	0.12	0.64	0.50	0.99	4.78

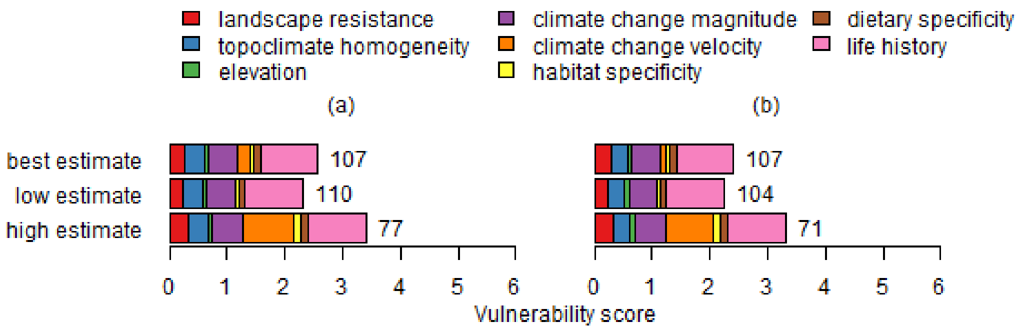

Figure AVIII. 2.11.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

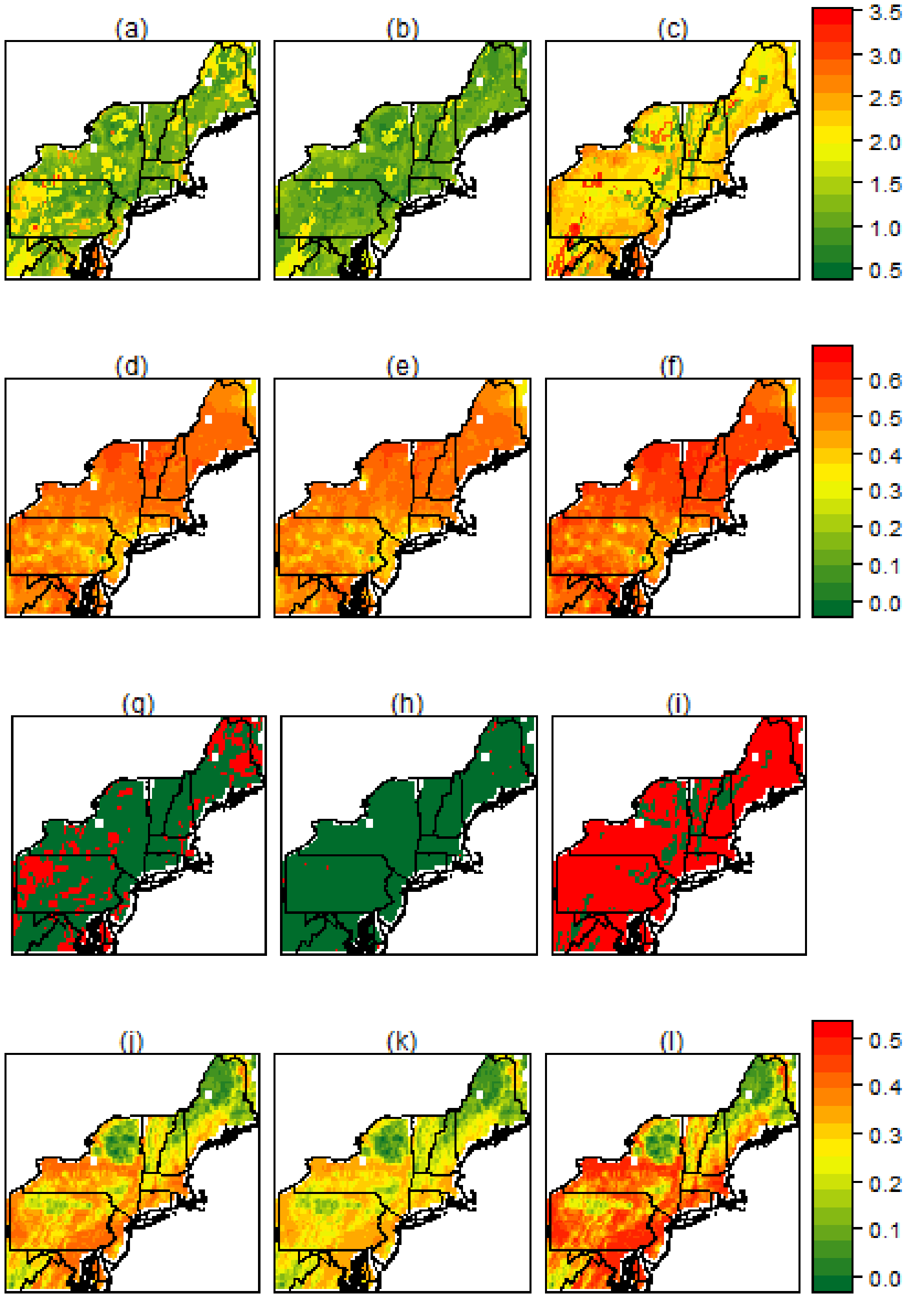

Figure AVIII. 2.11.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

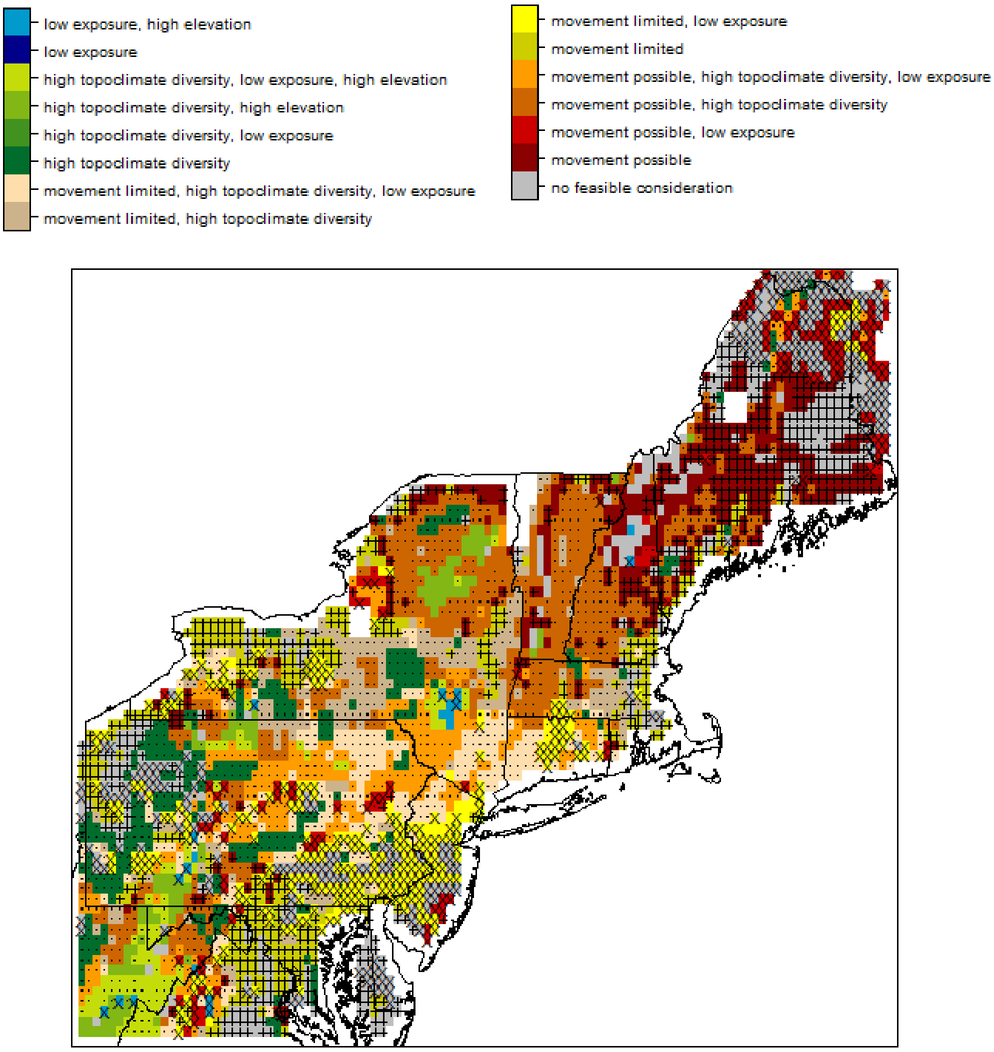

Figure AVIII. 2.11.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

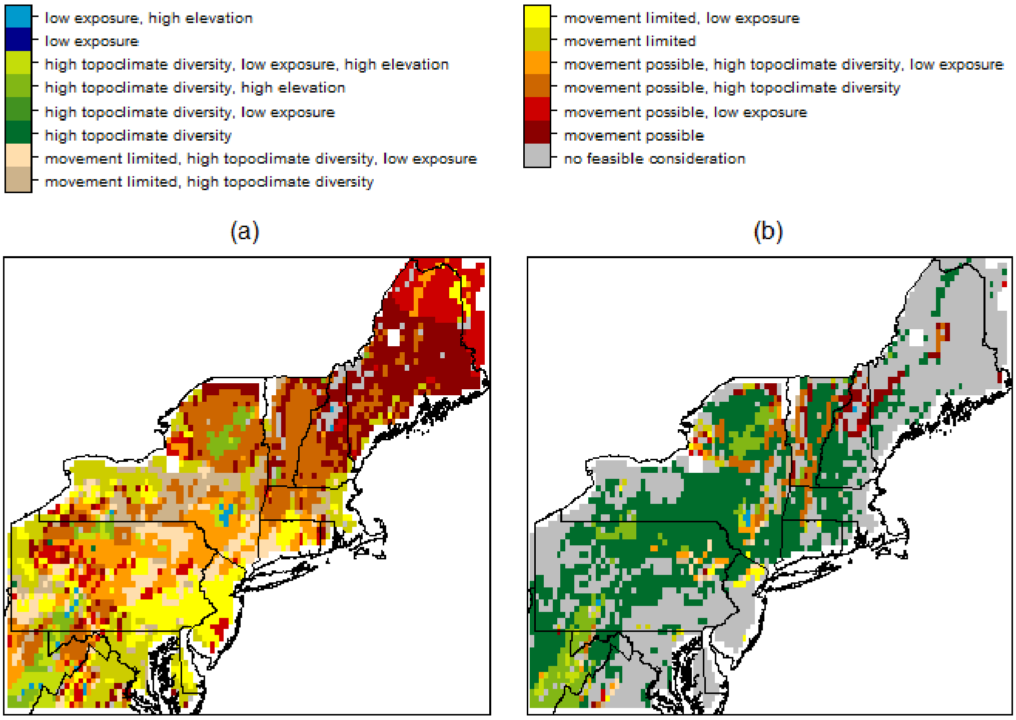

Figure AVIII. 2.11.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.12 Spotted turtle (*Clemmys guttata*)

Table AVIII. 2.12.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.47	0.28	0.70	0.64	1.00	0.68
low	0.29	0.24	0.59	0.54	1.00	0.32
high	0.53	0.31	0.80	0.72	1.00	2.99

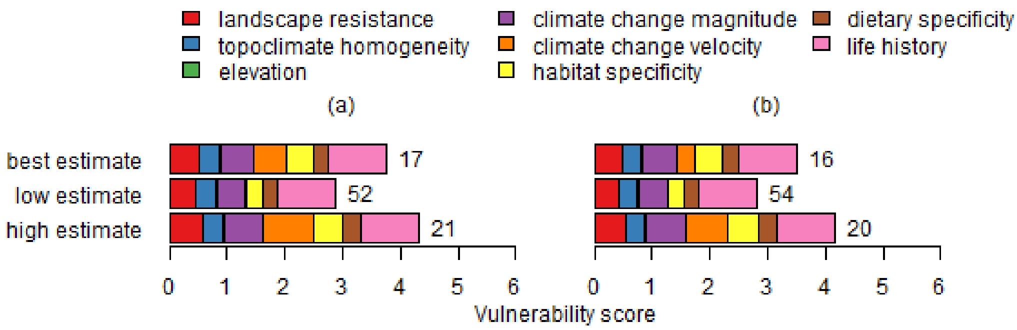

Figure AVIII. 2.12.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

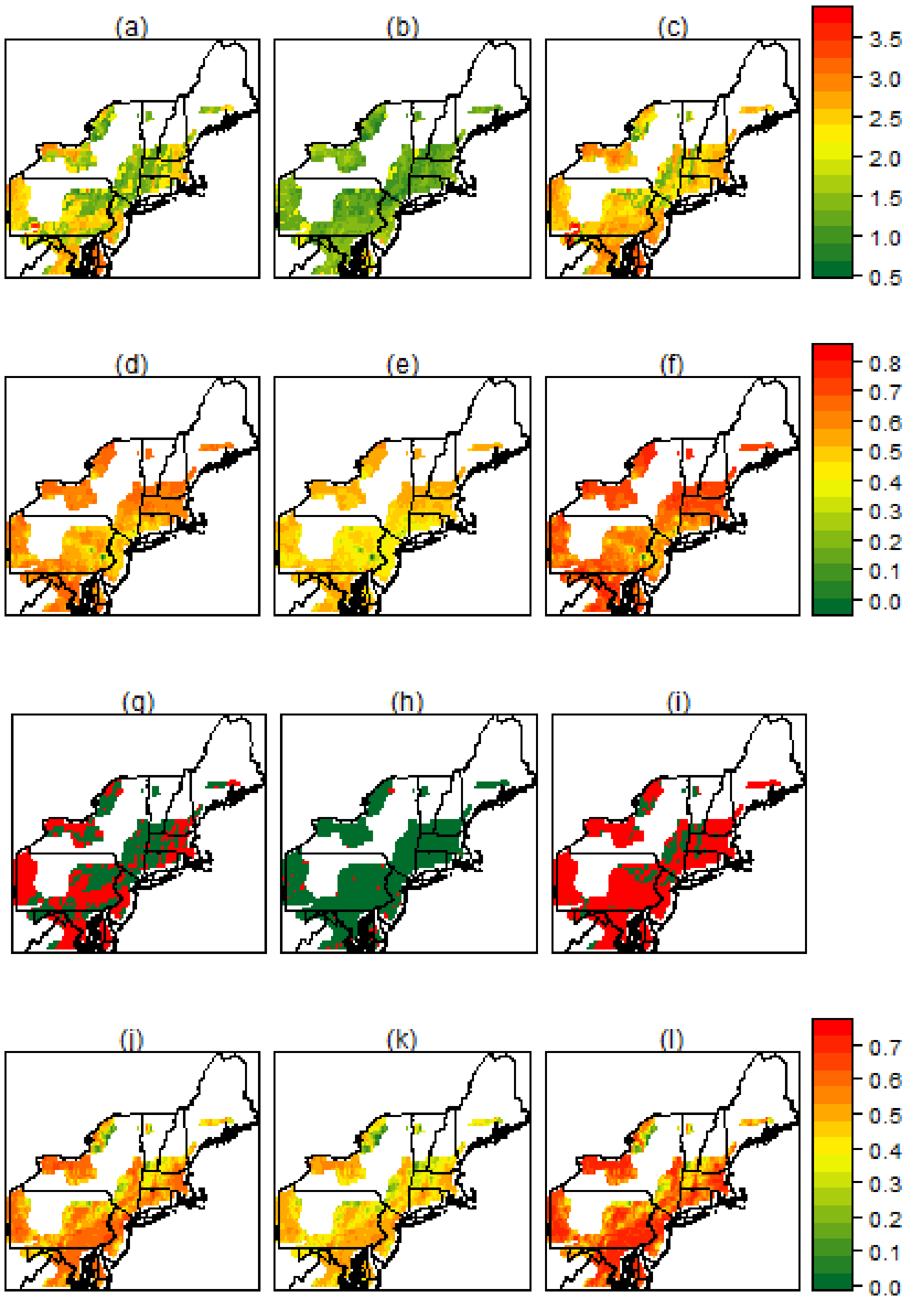

Figure AVIII. 2.12.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

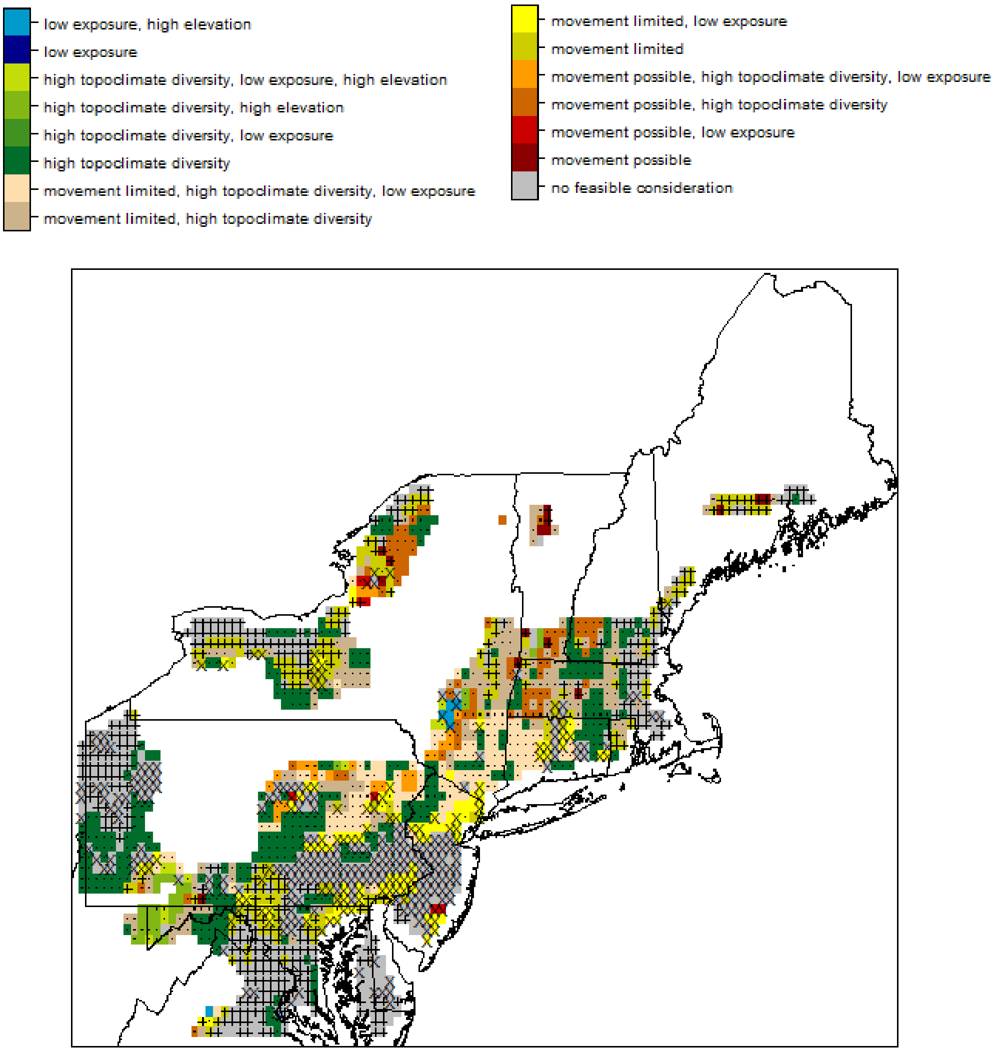

Figure AVIII. 2.12.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

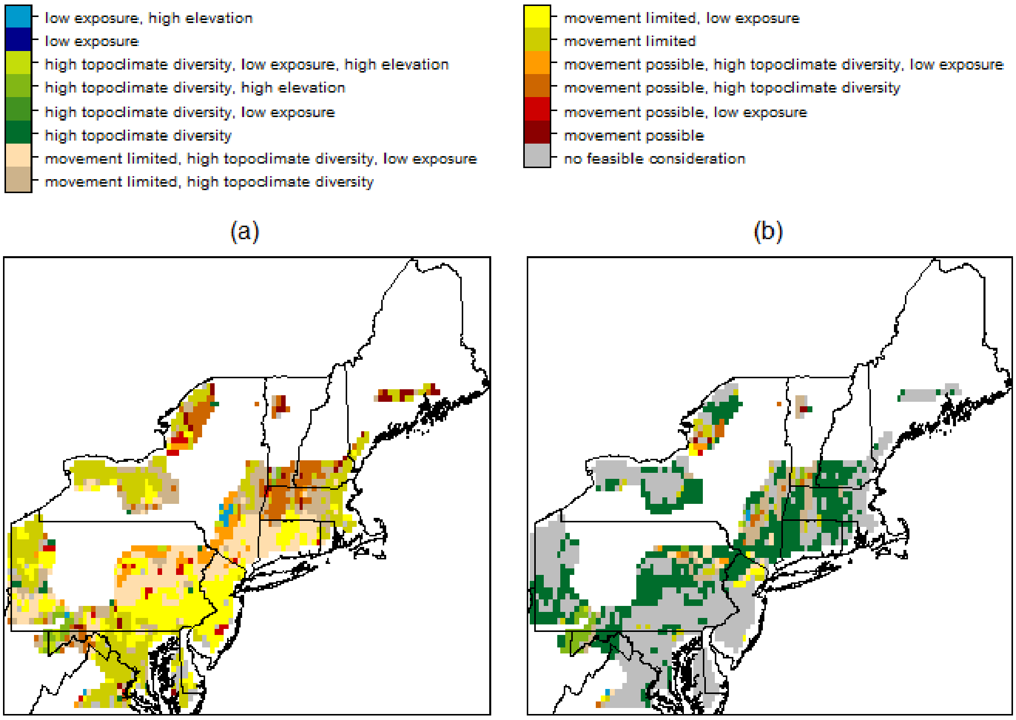

Figure AVIII. 2.12.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.13 Wood turtle (*Glyptemys insculpta*)

Table AVIII. 2.13.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.36	0.14	0.76	0.46	1.00	1.52
low	0.27	0.13	0.72	0.40	1.00	0.62
high	0.50	0.17	0.81	0.56	1.00	5.17

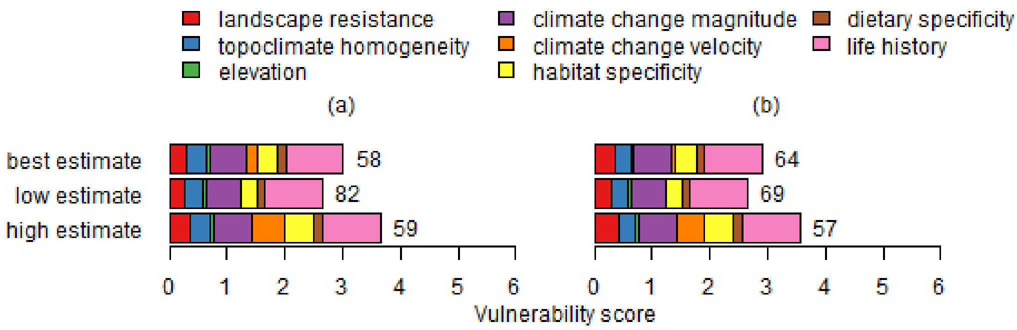

Figure AVIII. 2.13.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

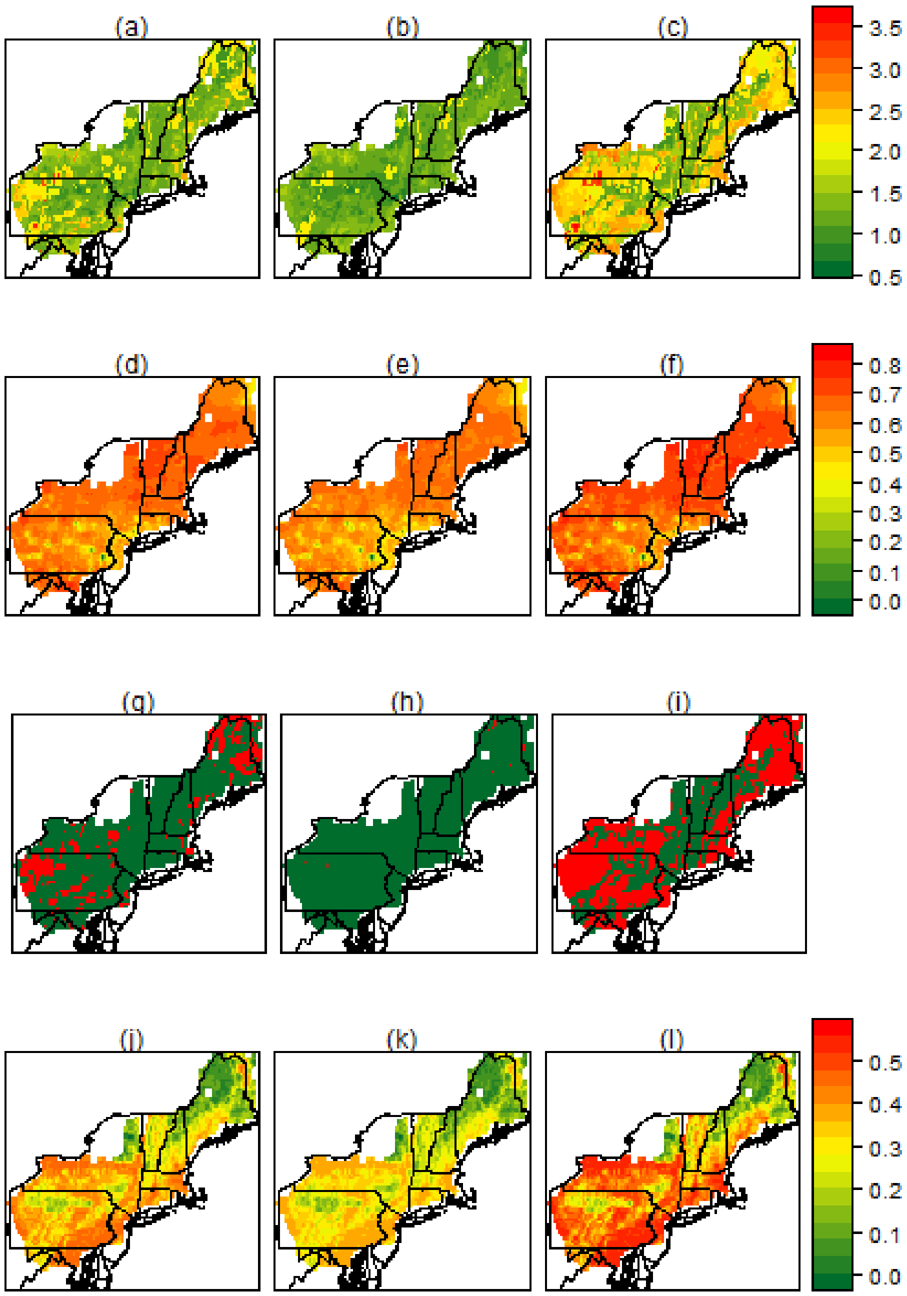

Figure AVIII. 2.13.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

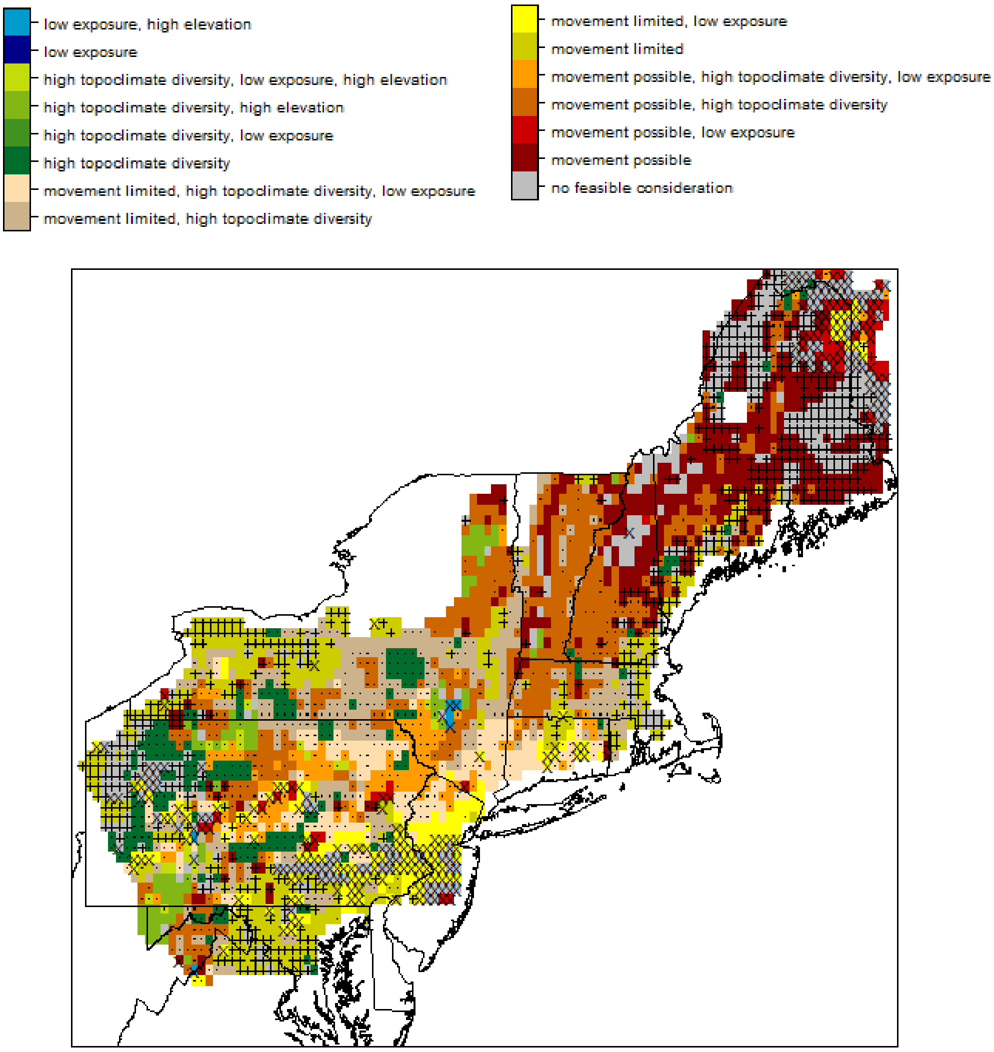

Figure AVIII. 2.13.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

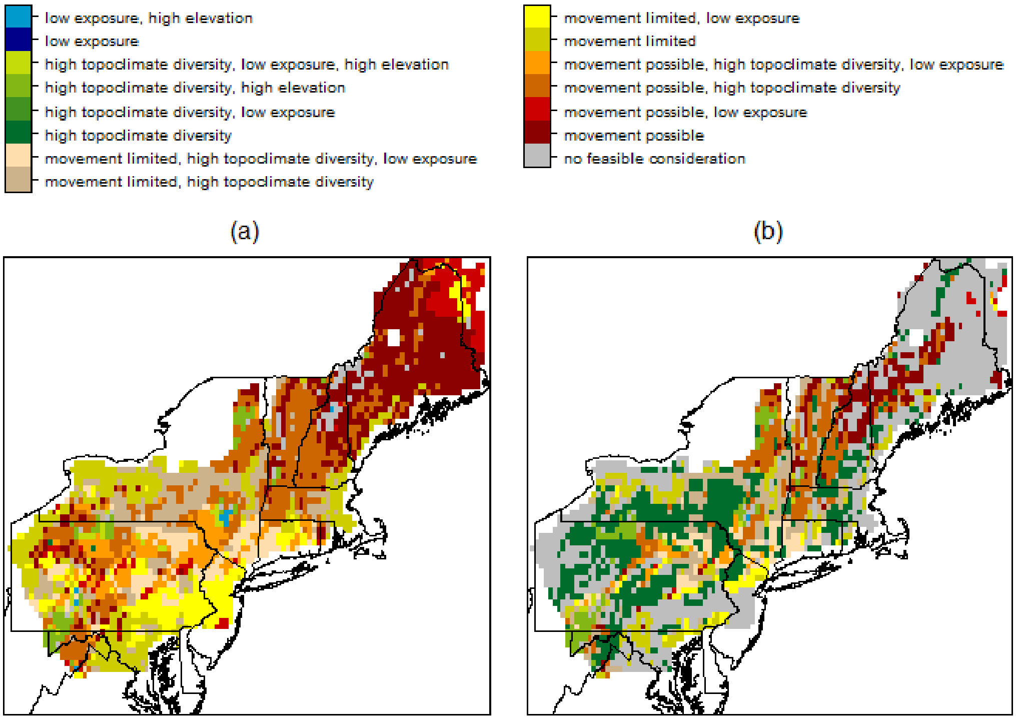

Figure AVIII. 2.13.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.14 Bog turtle (*Glyptemys muhlenbergii*)

Table AVIII. 2.14.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.83	0.33	0.83	0.83	1.00	0.69
low	0.58	0.32	0.77	0.74	1.00	0.38
high	0.80	0.36	0.88	0.86	1.00	3.25

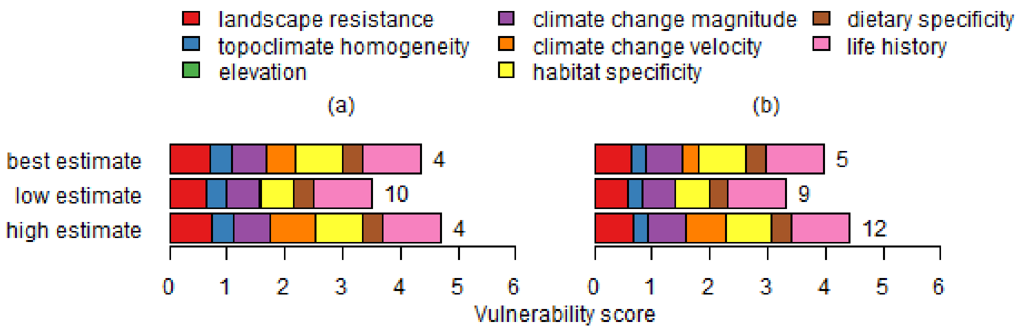

Figure AVIII. 2.14.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

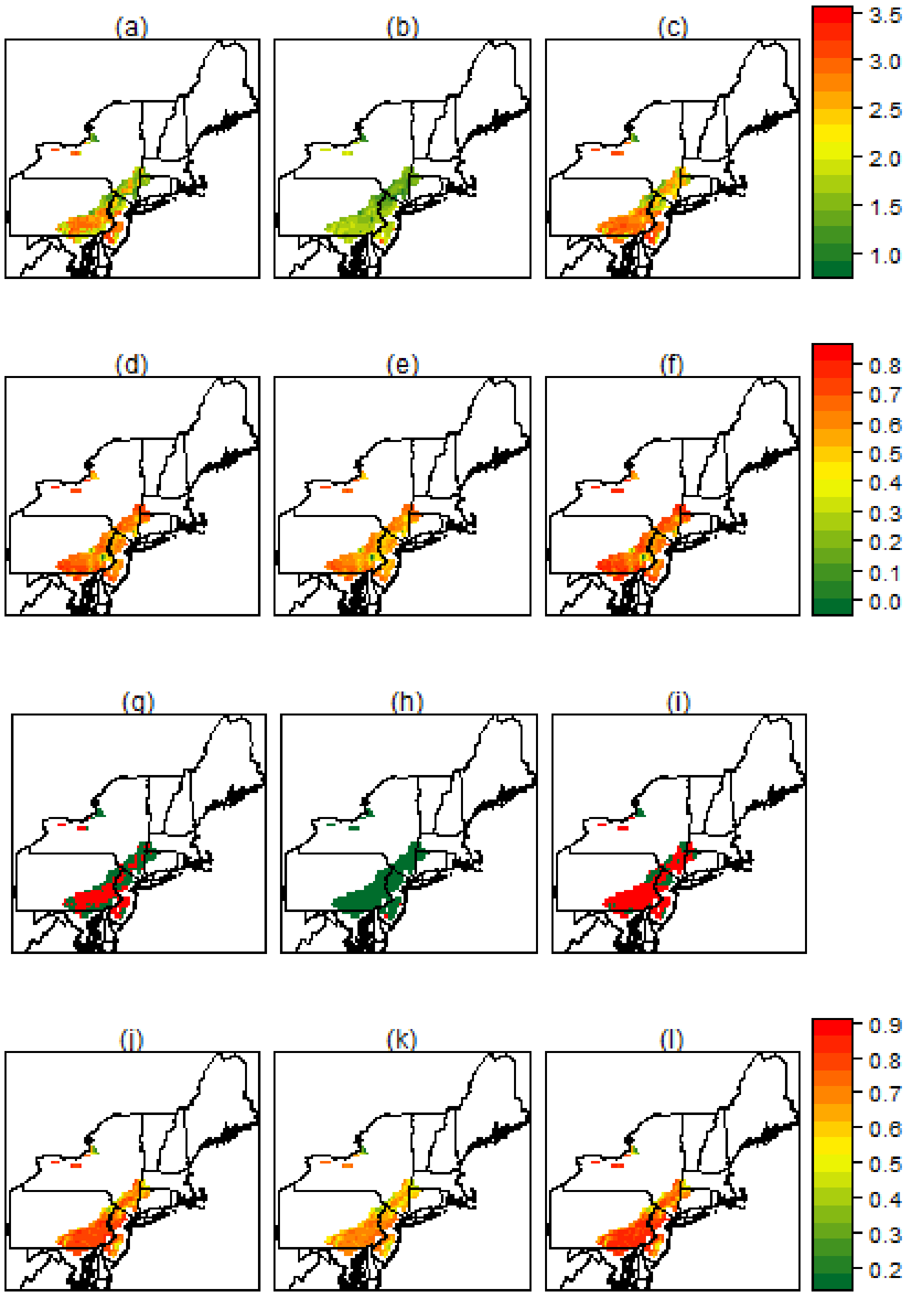

Figure AVIII. 2.14.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

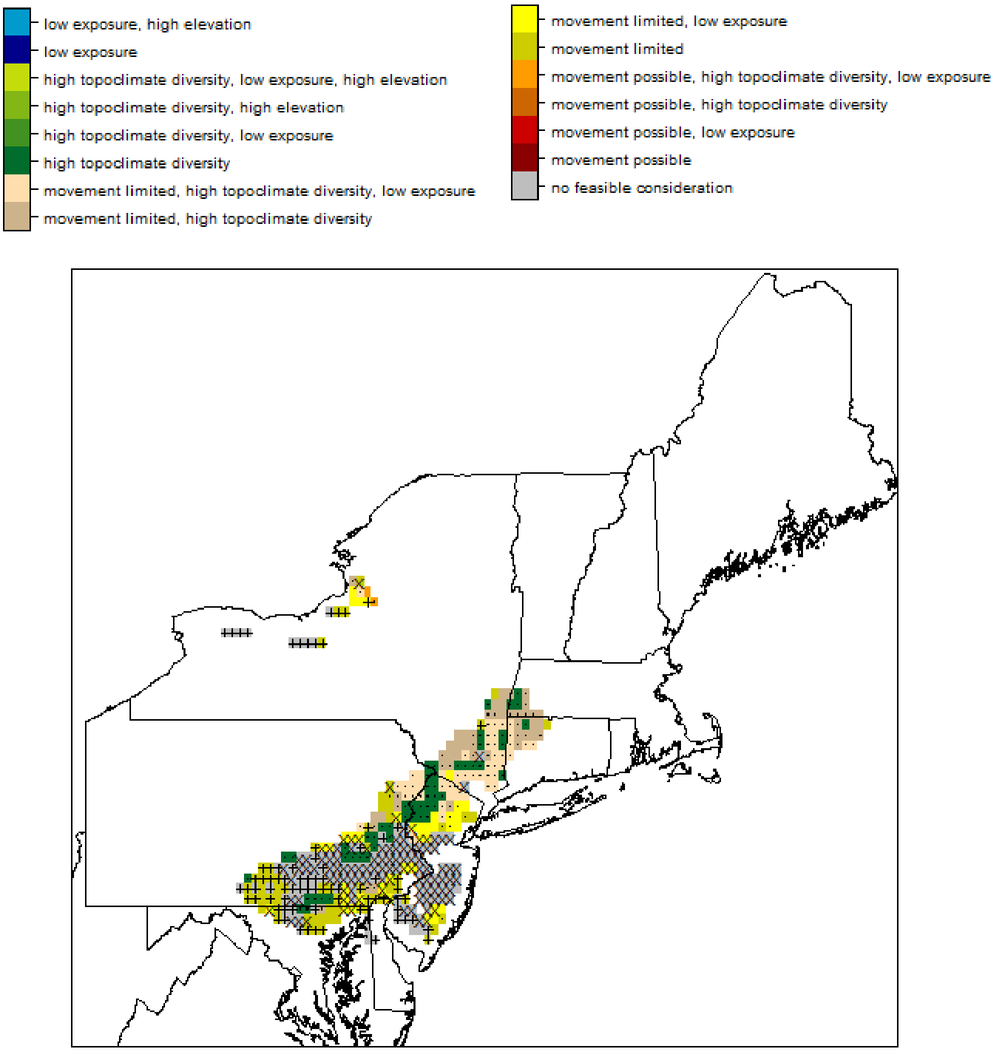

Figure AVIII. 2.14.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

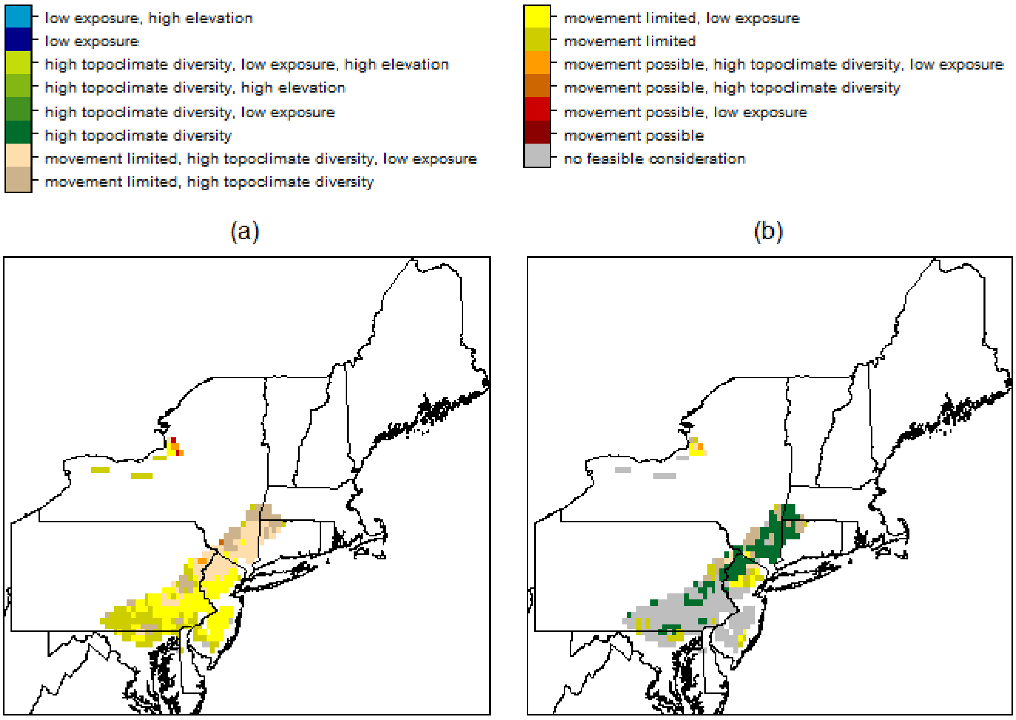

Figure AVIII. 2.14.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.15 Eastern box turtle (*Terrapene carolina*)

Table AVIII. 2.15.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Dispersal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.06	0.06	0.62	0.53	1.00	2.20
low	0.00	0.06	0.60	0.49	1.00	0.39
high	0.28	0.07	0.69	0.67	1.00	5.38

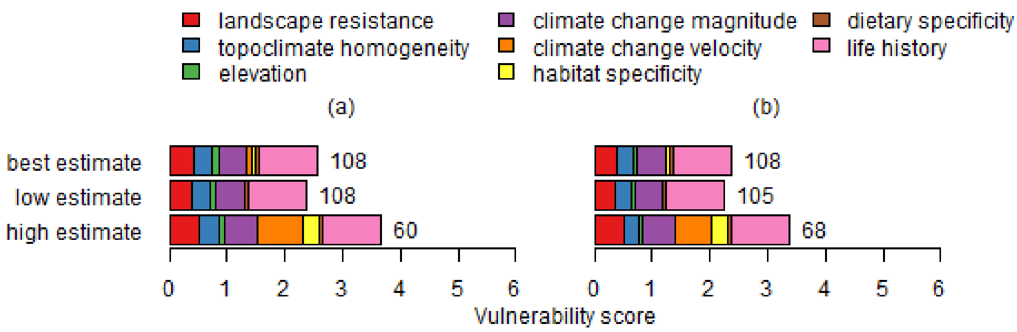

Figure AVIII. 2.15.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

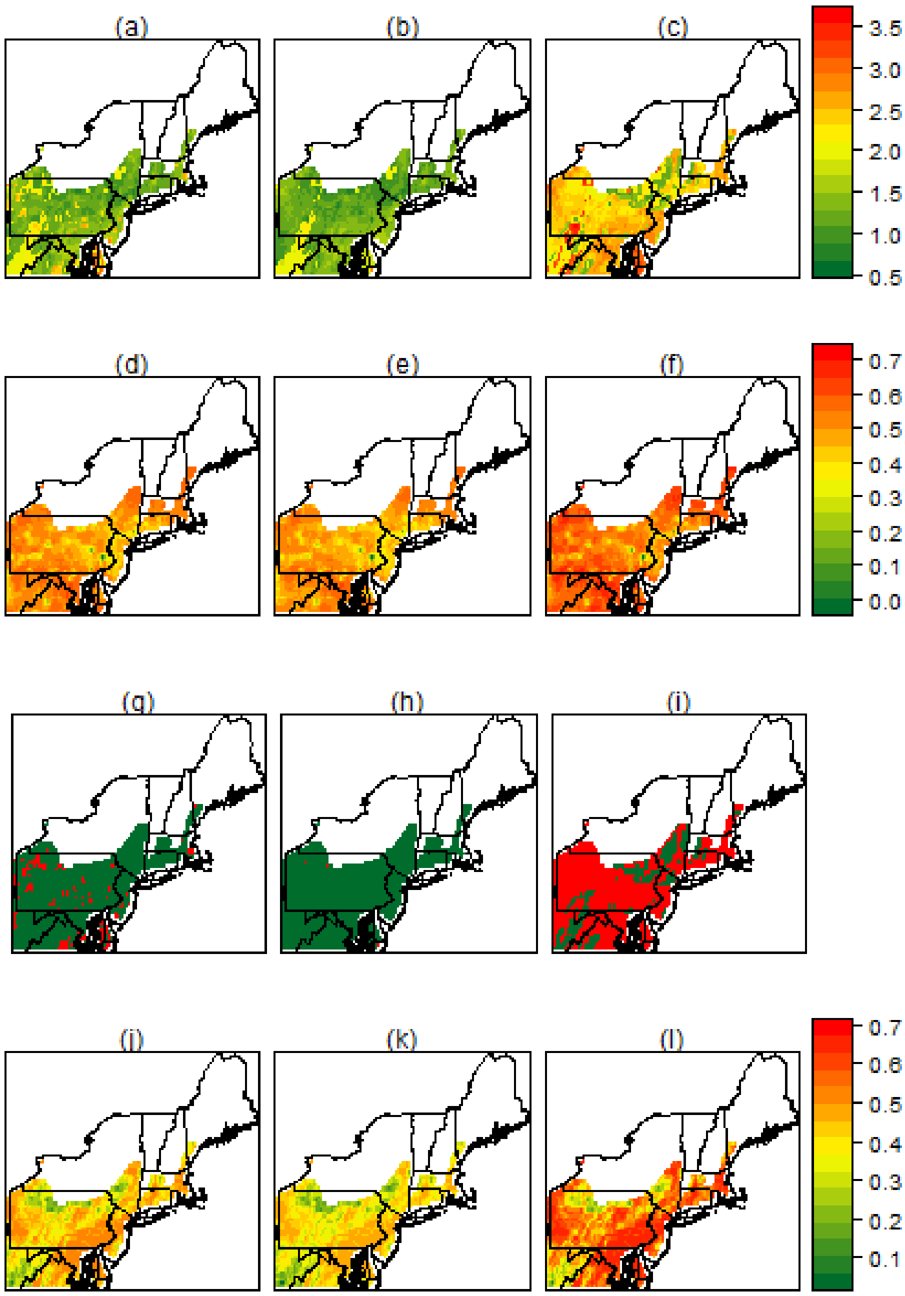

Figure AVIII. 2.15.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

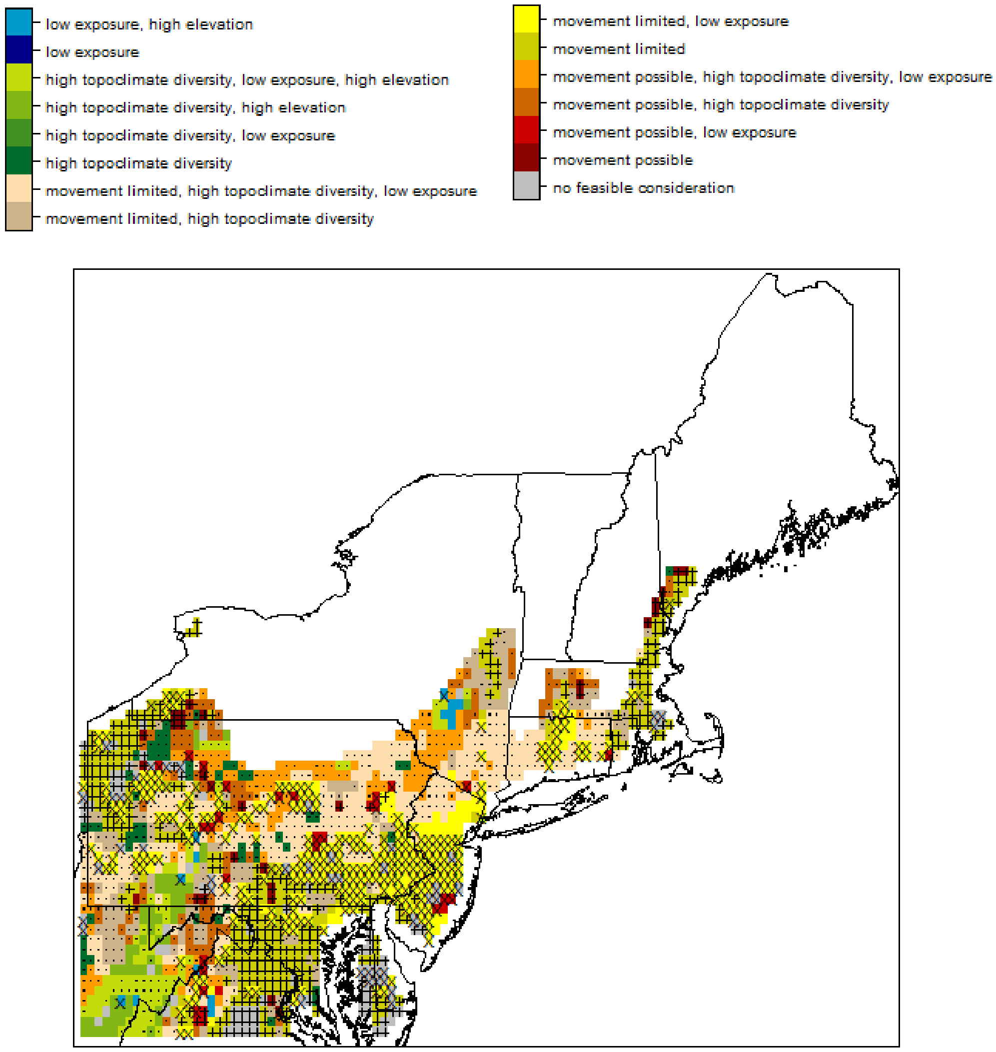

Figure AVIII. 2.15.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

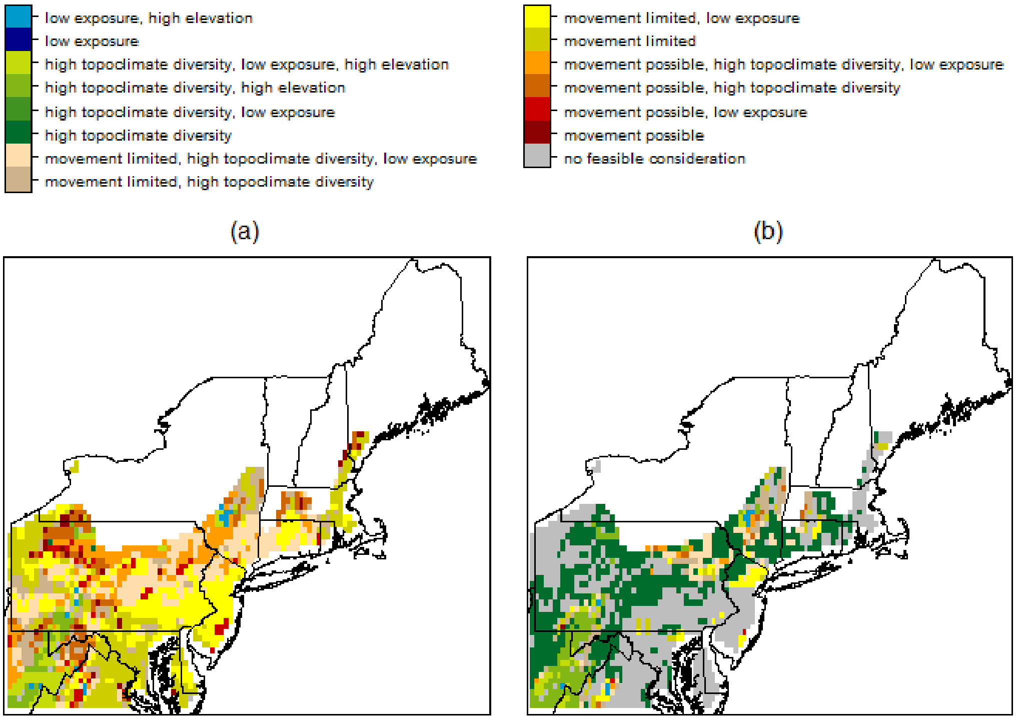

Figure AVIII. 2.15.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.16 Eastern mud turtle (*Kinosternon subrubrum*)

Table AVIII. 2.16.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.33	0.33	1.00	0.67	1.00	1.37
low	0.30	0.28	0.85	0.60	1.00	0.33
high	0.38	0.33	0.97	0.70	1.00	4.67

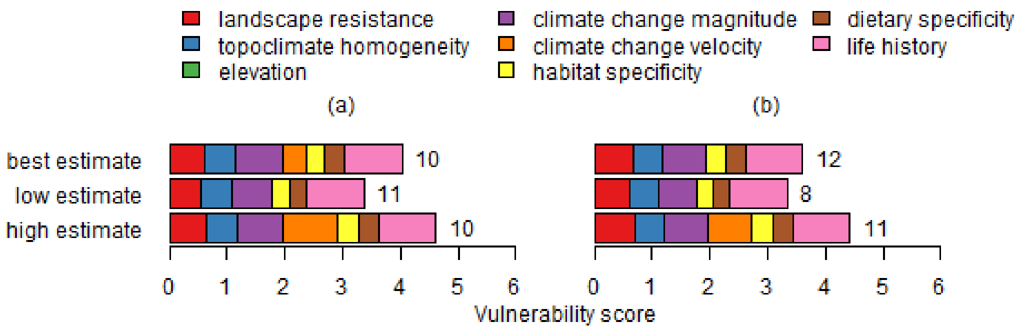

Figure AVIII. 2.16.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

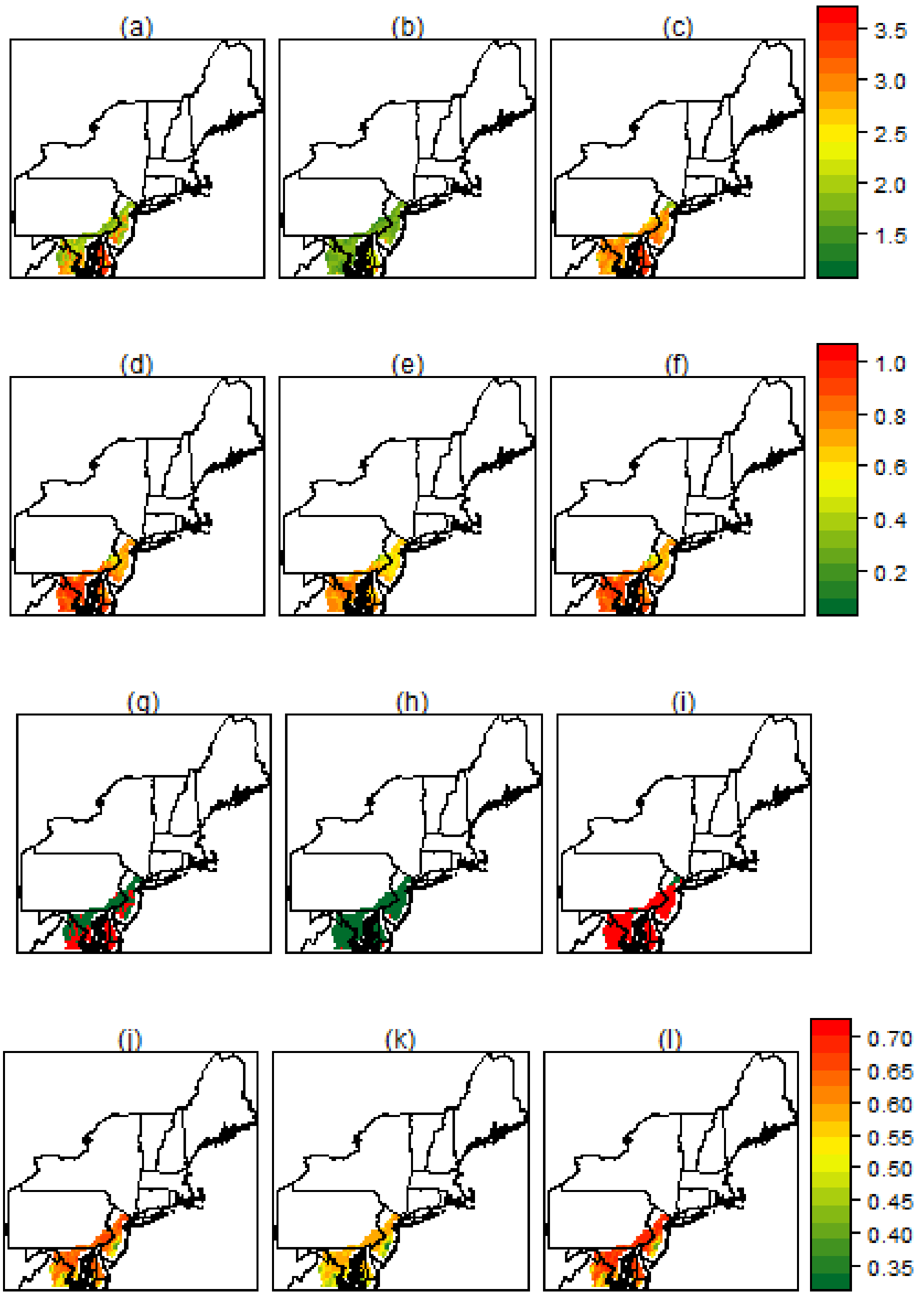

Figure AVIII. 2.16.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

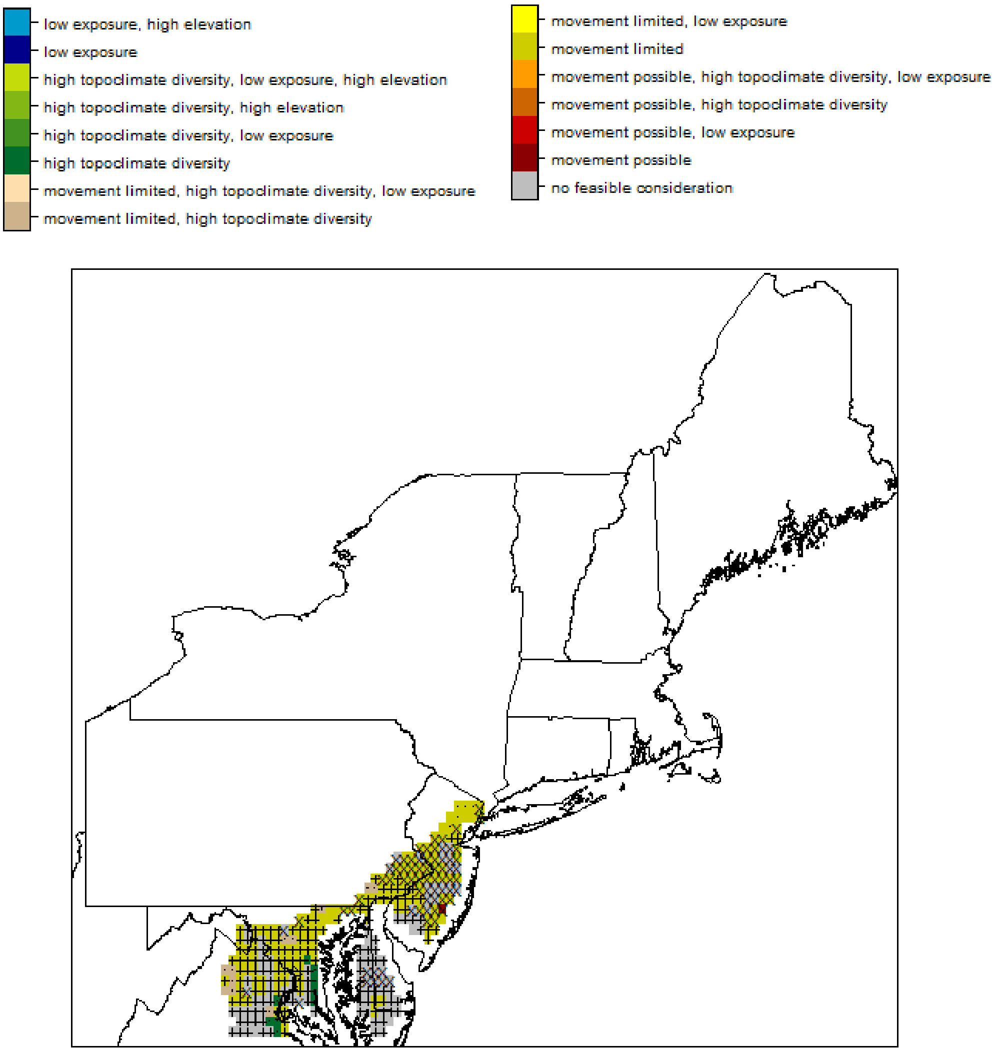

Figure AVIII. 2.16.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

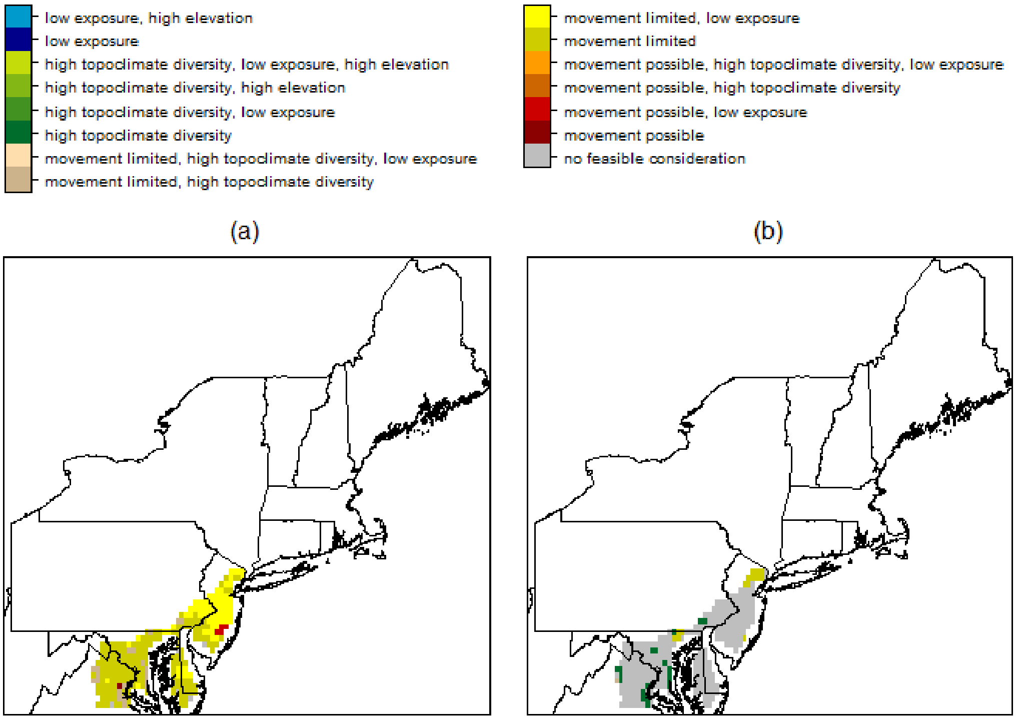

Figure AVIII. 2.16.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.17 Fence lizard (*Sceloporus undulatus*)

Table AVIII. 2.17.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.00	0.33	0.00	1.00	0.25
low	0.00	0.00	0.33	0.00	1.00	0.10
high	0.50	0.00	0.33	0.00	1.00	0.50

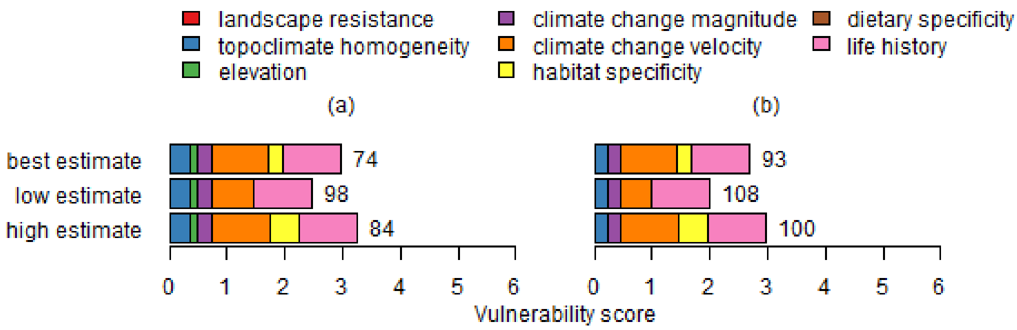

Figure AVIII. 2.17.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

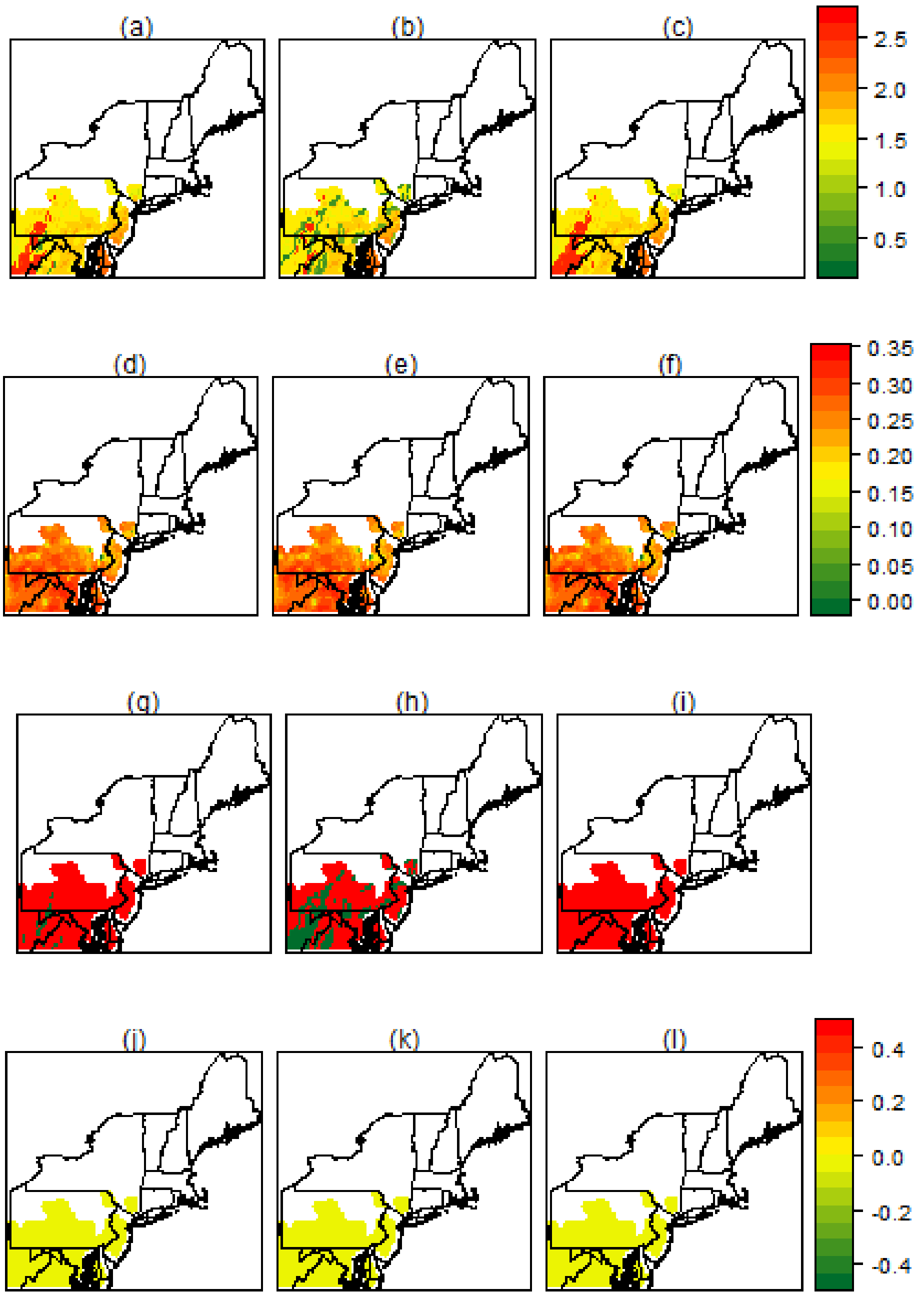

Figure AVIII. 2.17.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

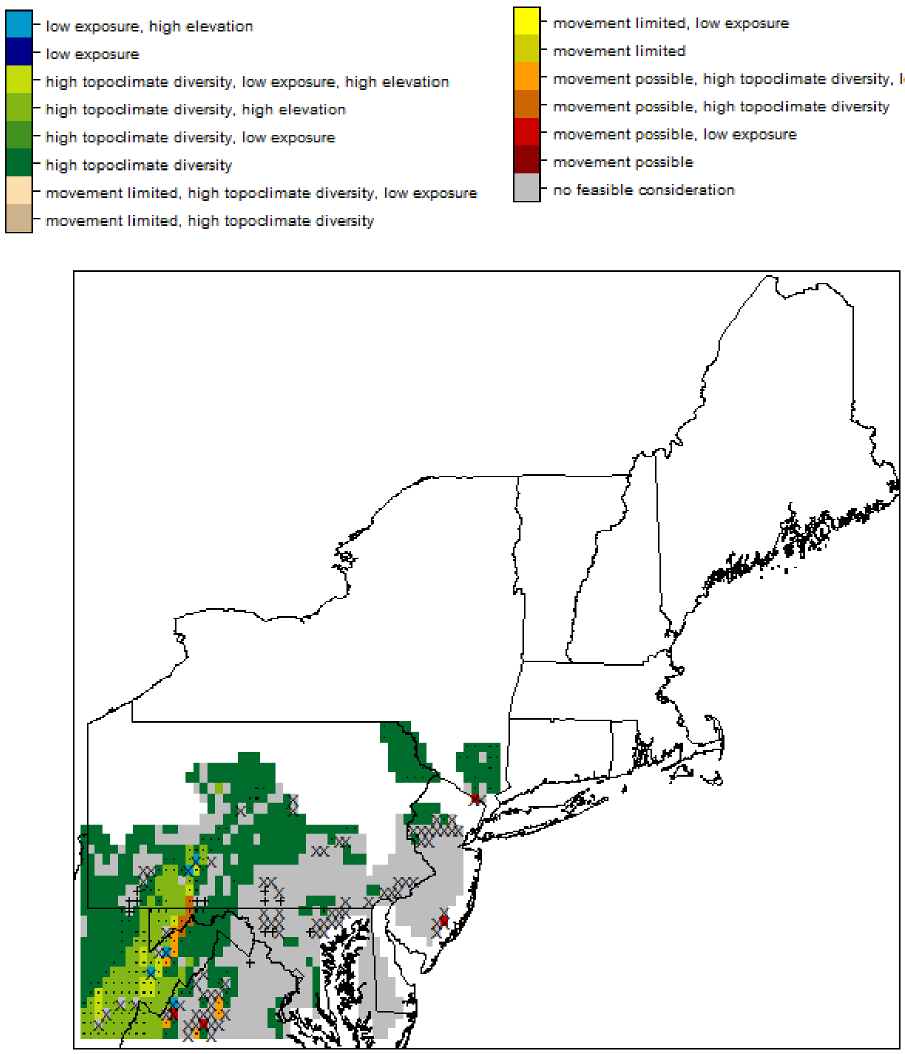

Figure AVIII. 2.17.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

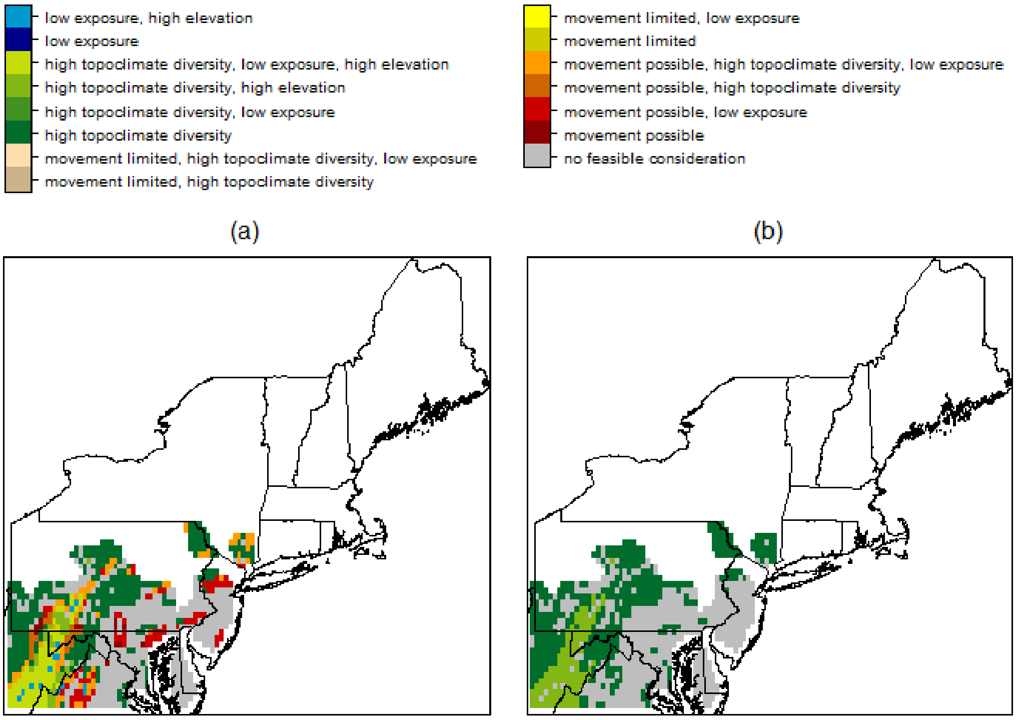

Figure AVIII. 2.17.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.18 Coal skink (*Plestiodon anthracinus*)

Table AVIII. 2.18.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.38	0.38	0.66	0.50	1.00	0.63
low	0.29	0.38	0.65	0.49	1.00	0.50
high	0.55	0.38	0.78	0.57	1.00	0.80

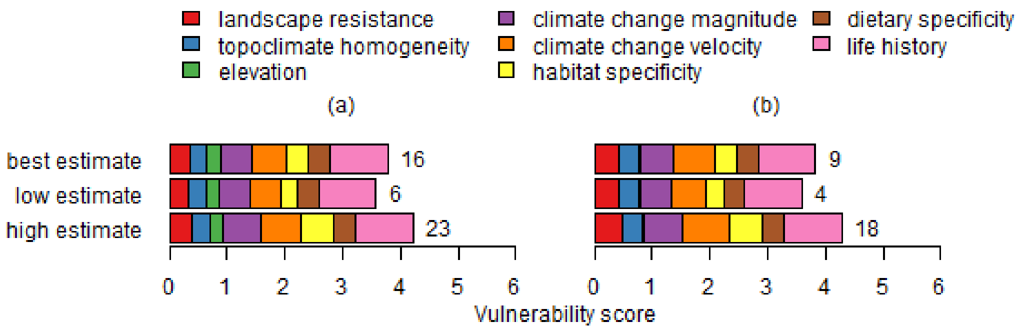

Figure AVIII. 2.18.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

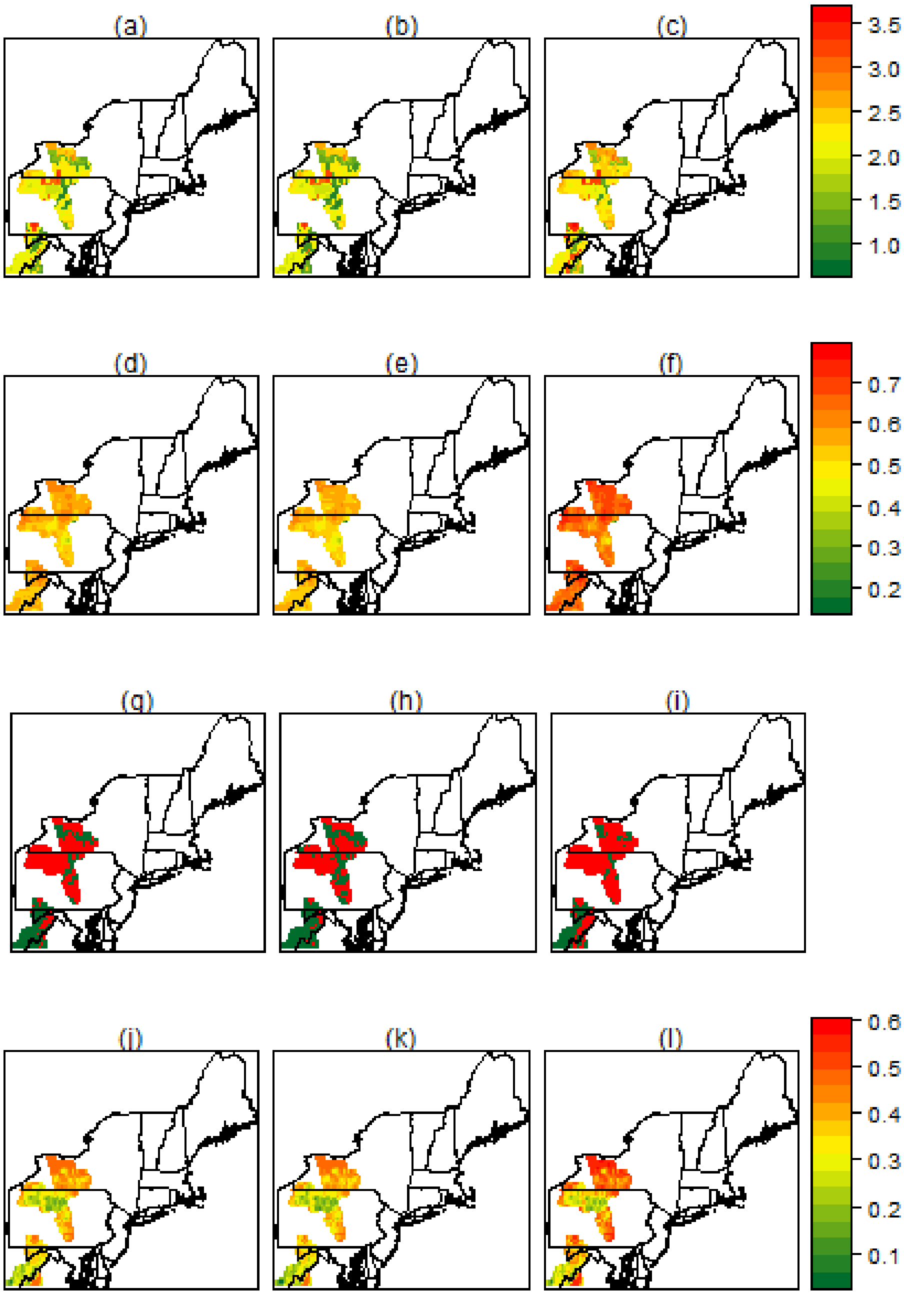

Figure AVIII. 2.18.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

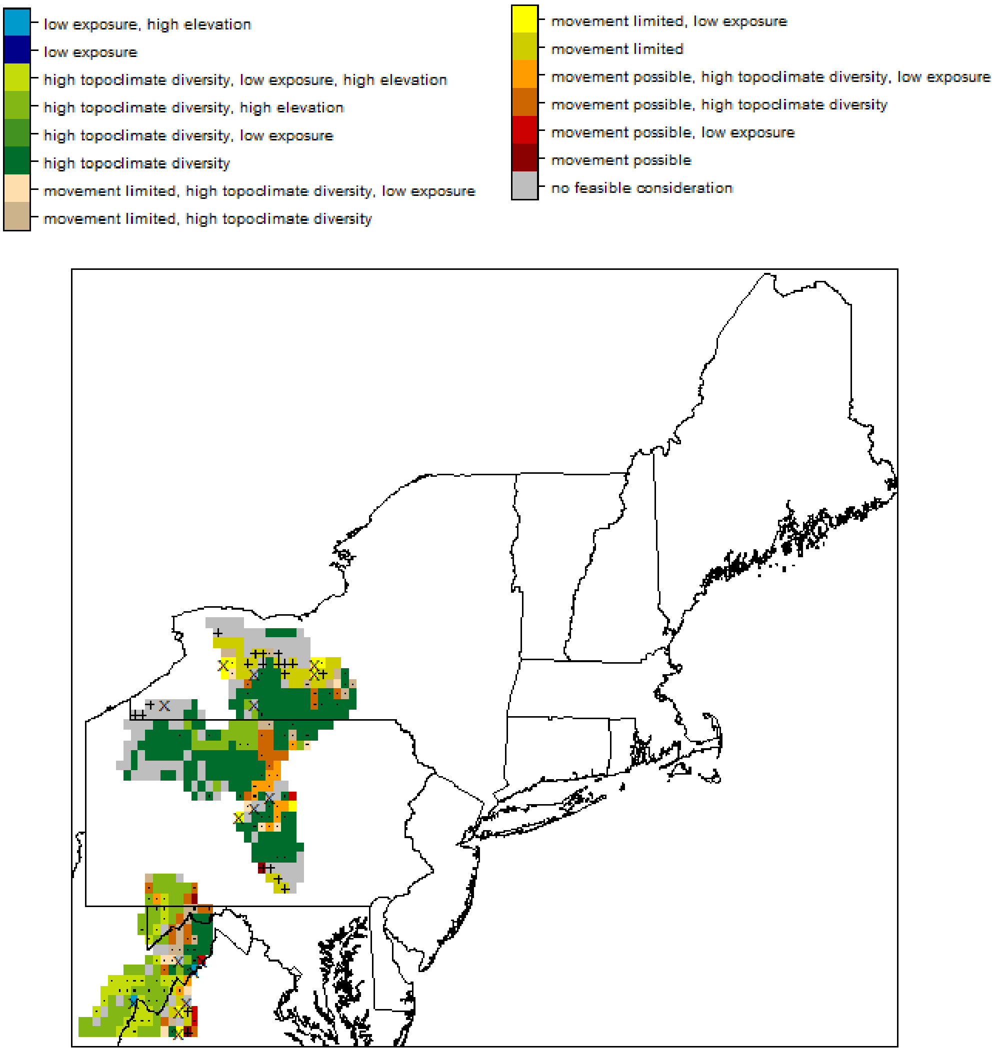

Figure AVIII. 2.18.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

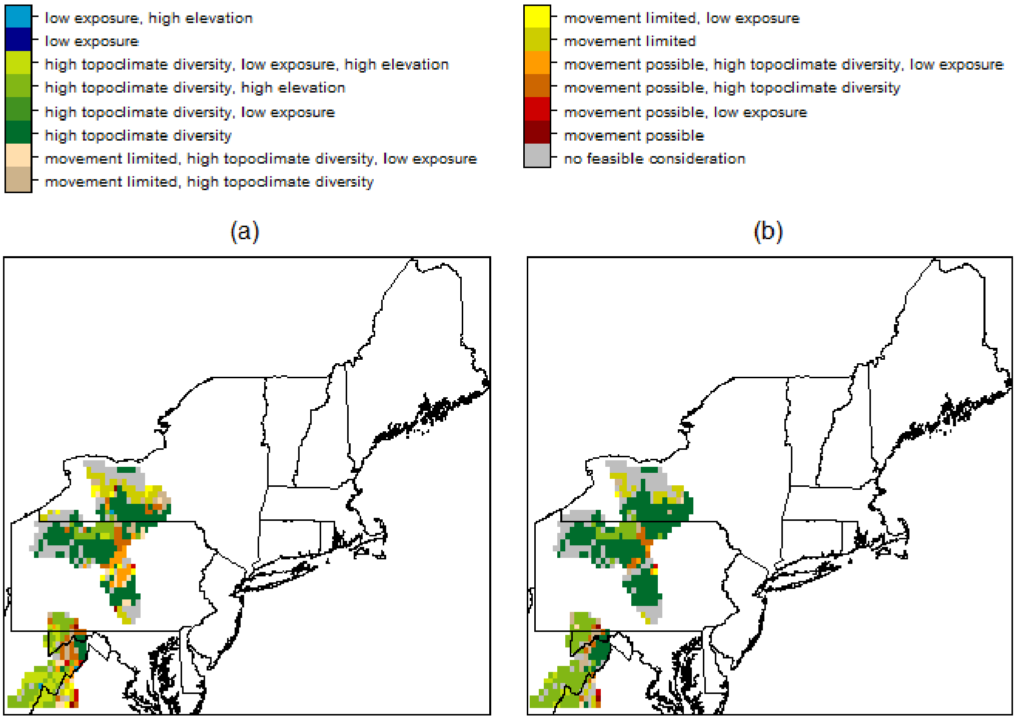

Figure AVIII. 2.18.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.19 Common five-lined skink (*Plestiodon fasciatus*)

Table AVIII. 2.19.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.17	0.33	0.61	0.33	1.00	0.62
low	0.17	0.33	0.55	0.33	1.00	0.55
high	0.22	0.33	0.66	0.37	1.00	0.75

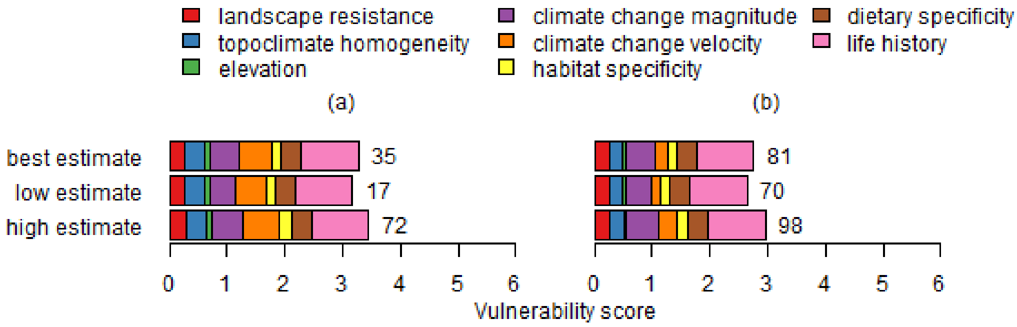

Figure AVIII. 2.19.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

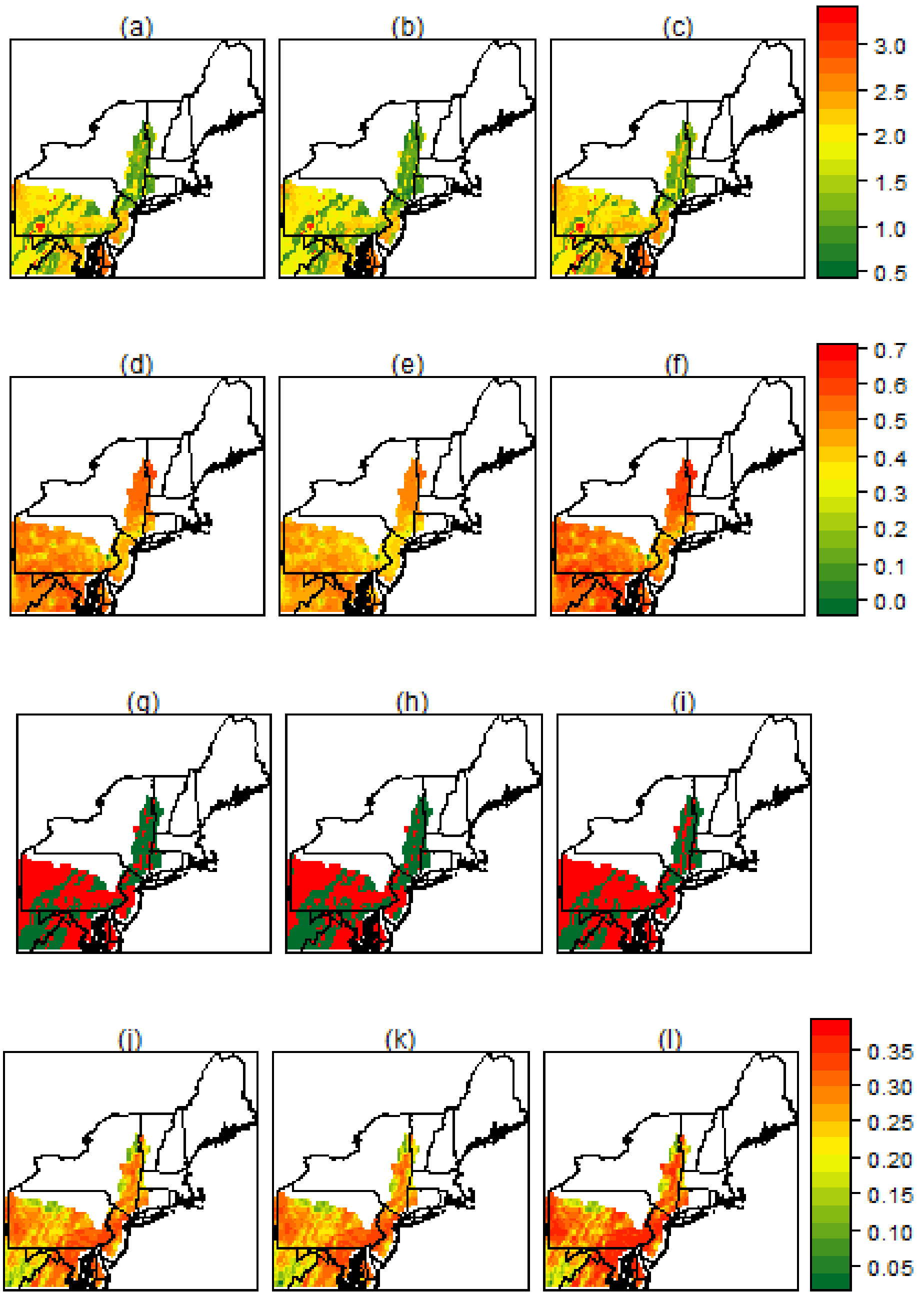

Figure AVIII. 2.19.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

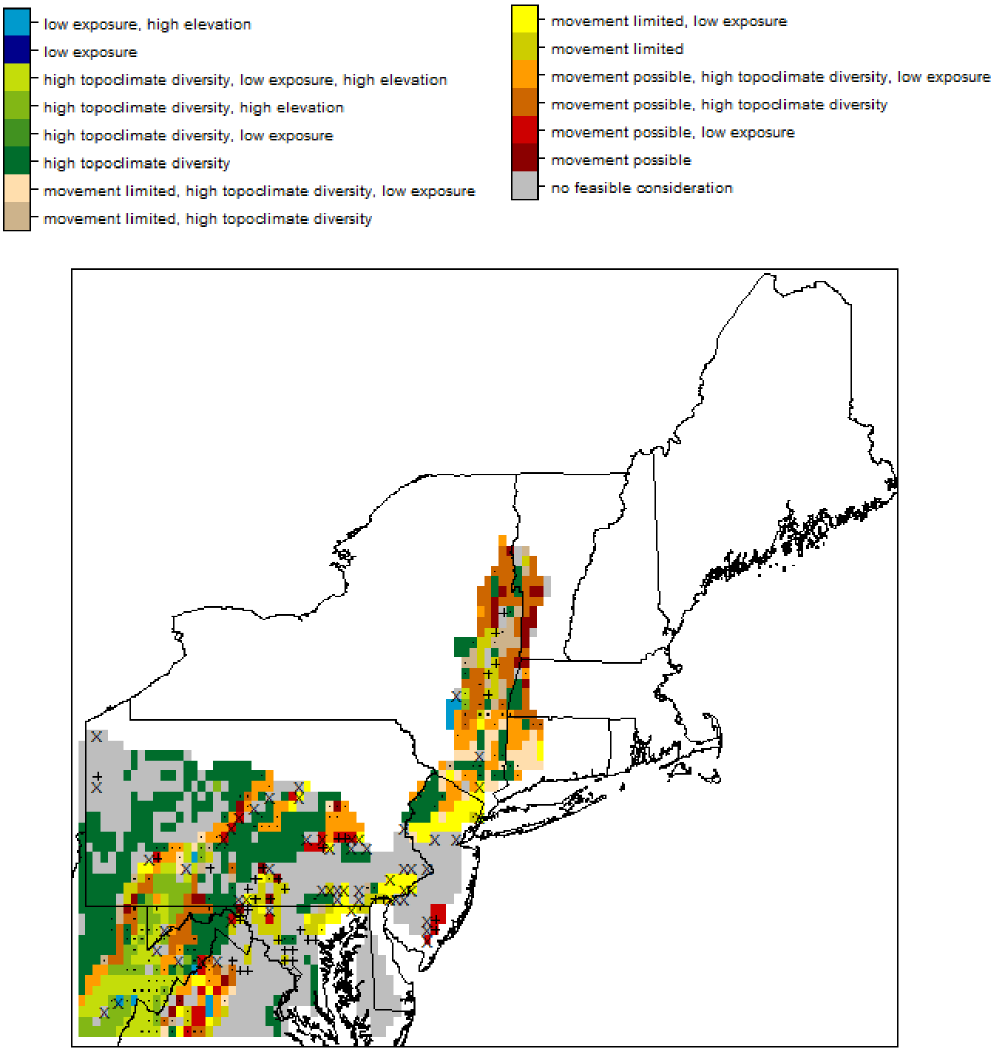

Figure AVIII. 2.19.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

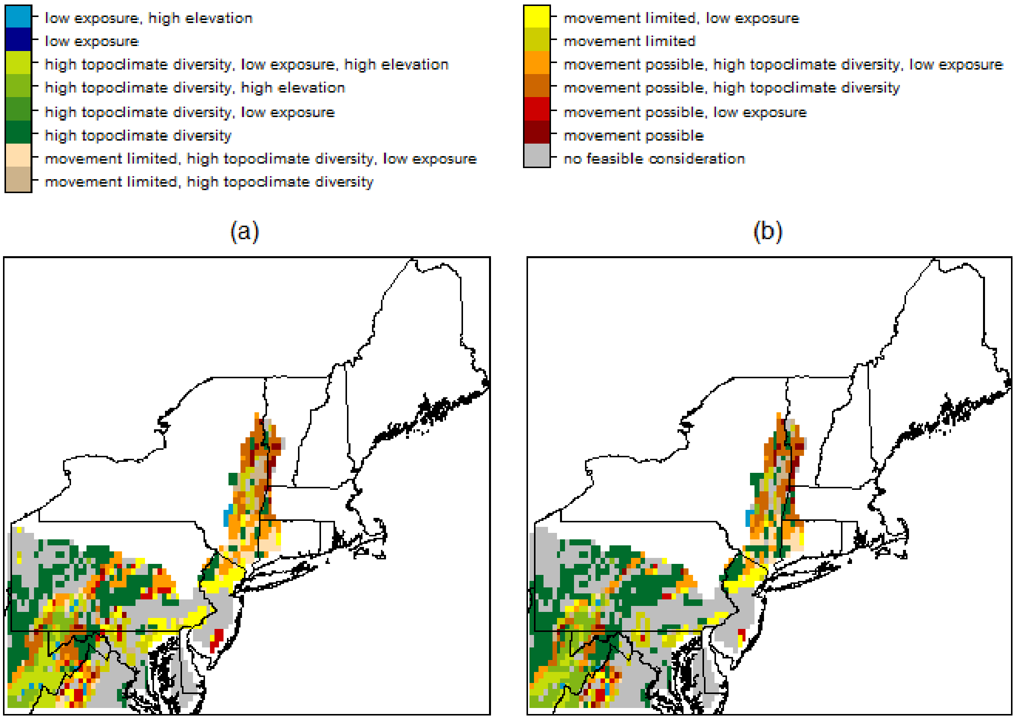

Figure AVIII. 2.19.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.20 Worm snake (*Carphophis amoenus*)

Table AVIII. 2.20.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.62	0.50	0.66	0.75	1.00	0.02
low	0.47	0.50	0.62	0.54	1.00	0.00
high	0.81	0.55	0.70	0.86	1.00	0.12

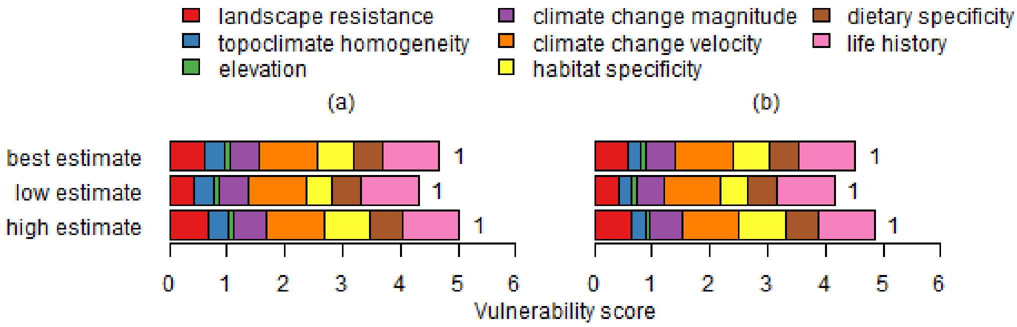

Figure AVIII. 2.20.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

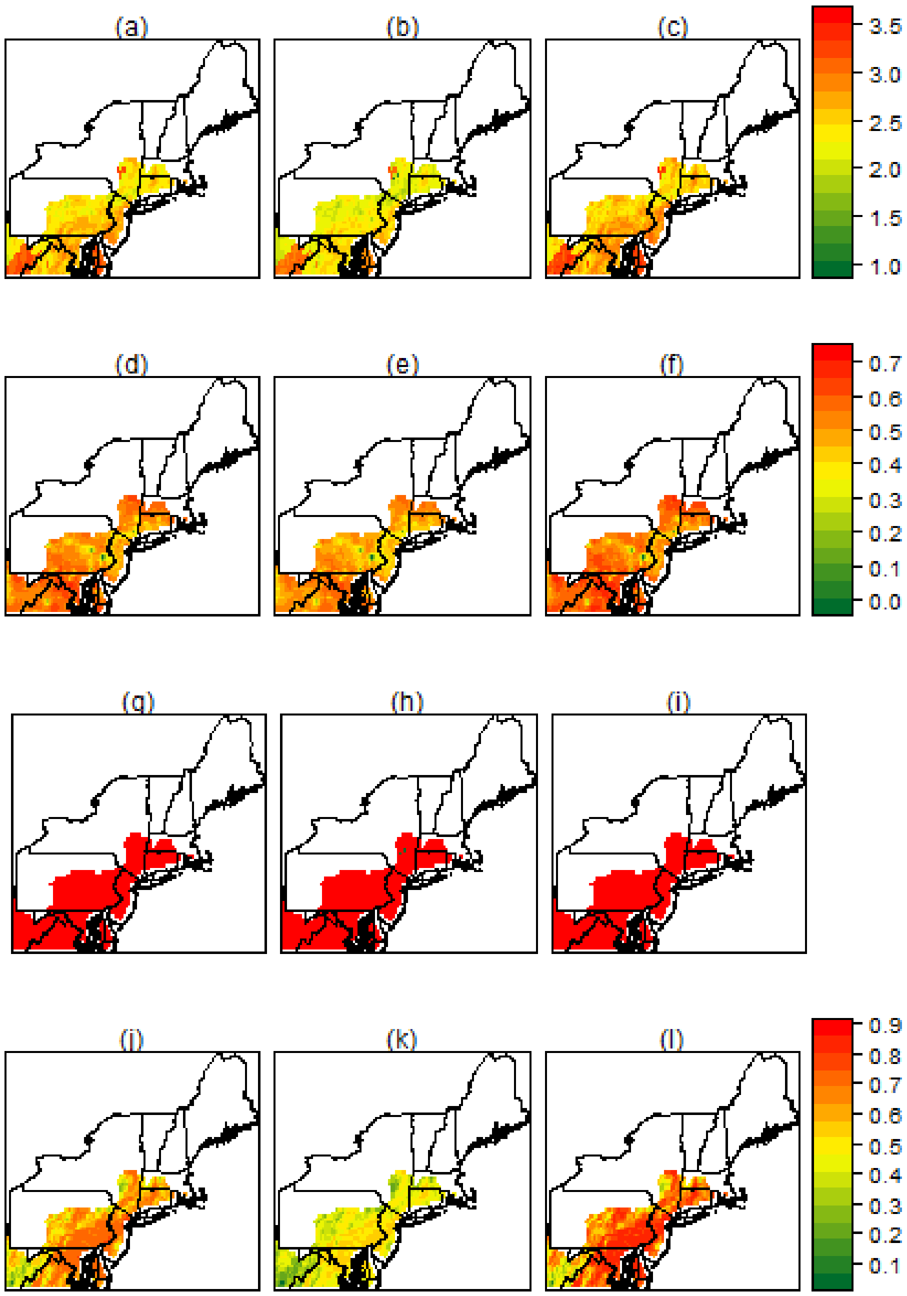

Figure AVIII. 2.20.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

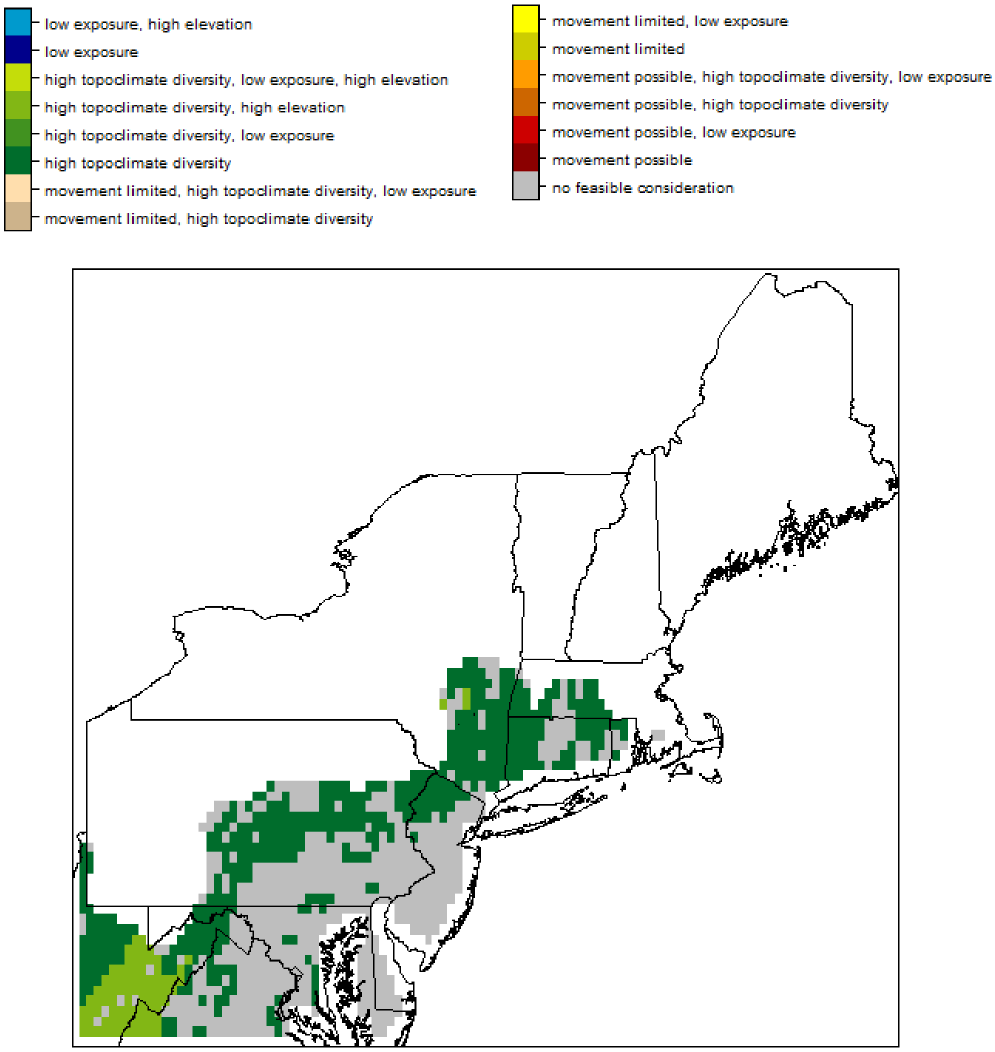

Figure AVIII. 2.20.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

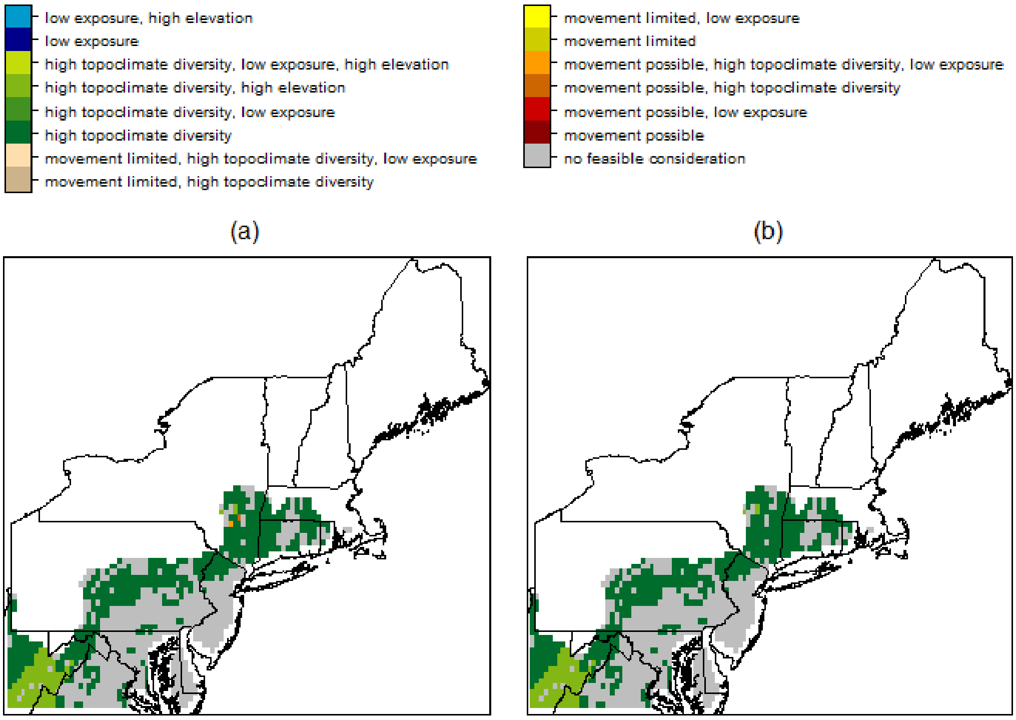

Figure AVIII. 2.20.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.21 Northern black racer (*Coluber constrictor*)

Table AVIII. 2.21.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.38	0.00	0.49	0.25	1.00	0.28
low	0.19	0.00	0.43	0.16	1.00	0.14
high	0.56	0.05	0.54	0.32	1.00	0.52

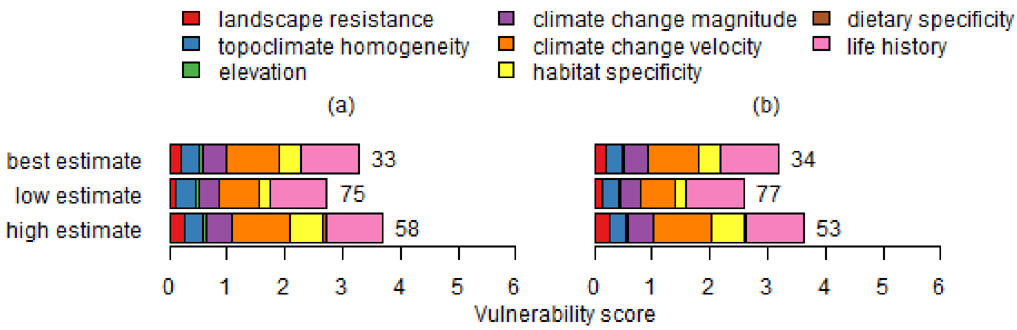

Figure AVIII. 2.21.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

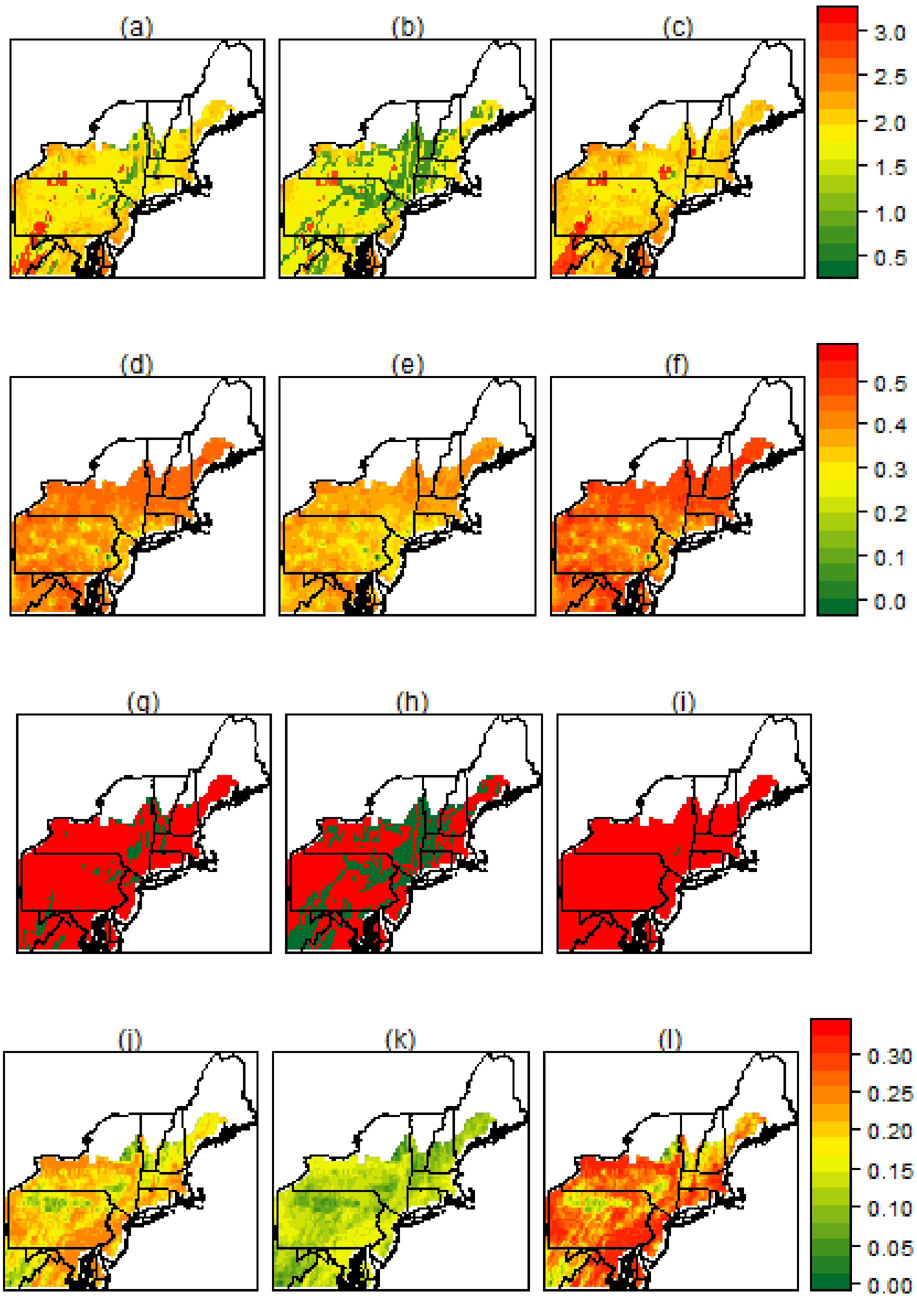

Figure AVIII. 2.21.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

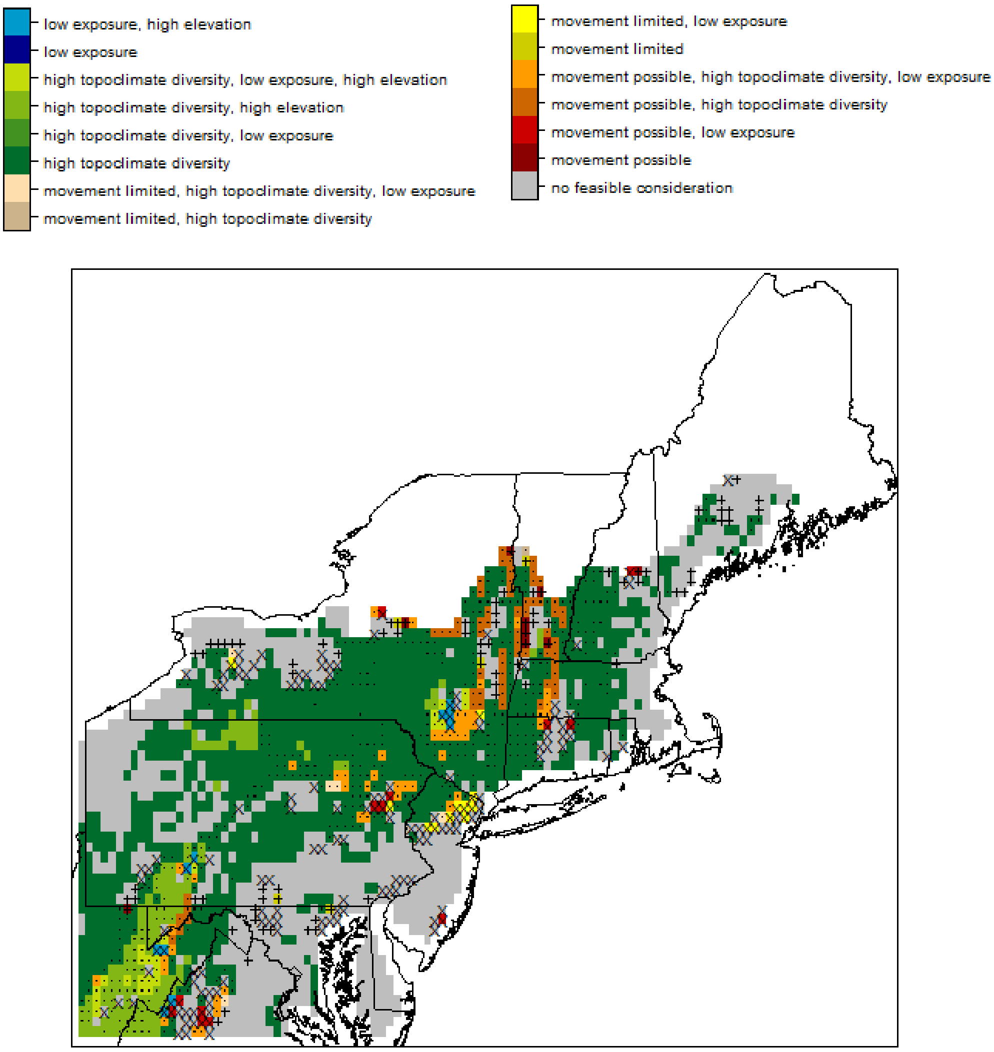

Figure AVIII. 2.21.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

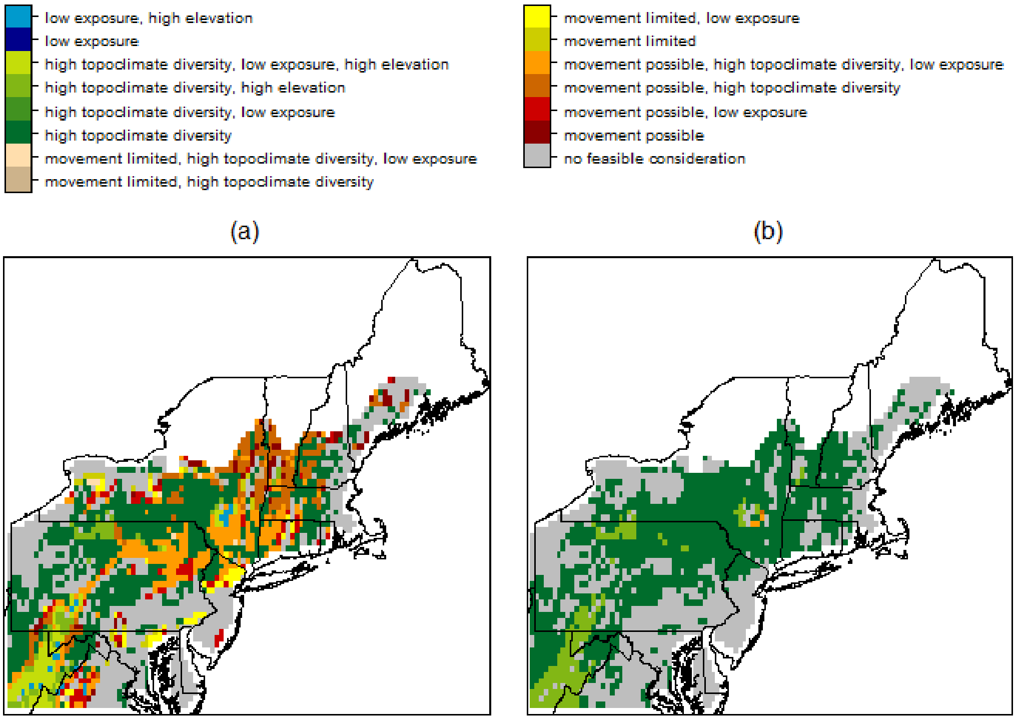

Figure AVIII. 2.21.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.22 Eastern hognose snake (*Heterodon platirhinos*)

Table AVIII. 2.22.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.75	0.94	0.50	0.50	1.00	0.80
low	0.57	0.85	0.50	0.47	1.00	0.38
high	0.72	1.00	0.75	0.56	1.00	1.97

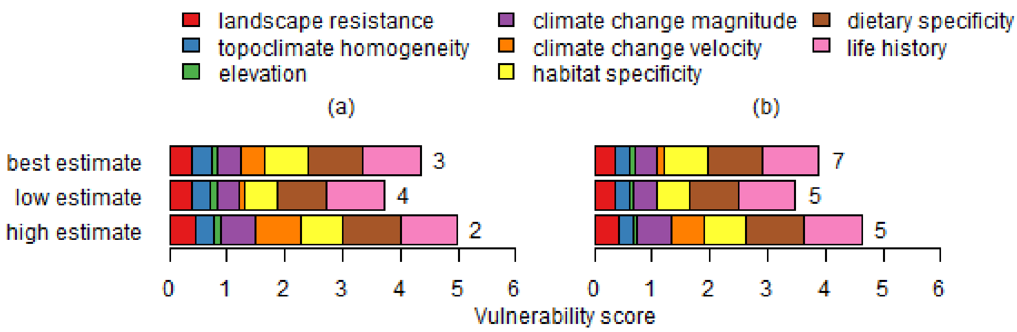

Figure AVIII. 2.22.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

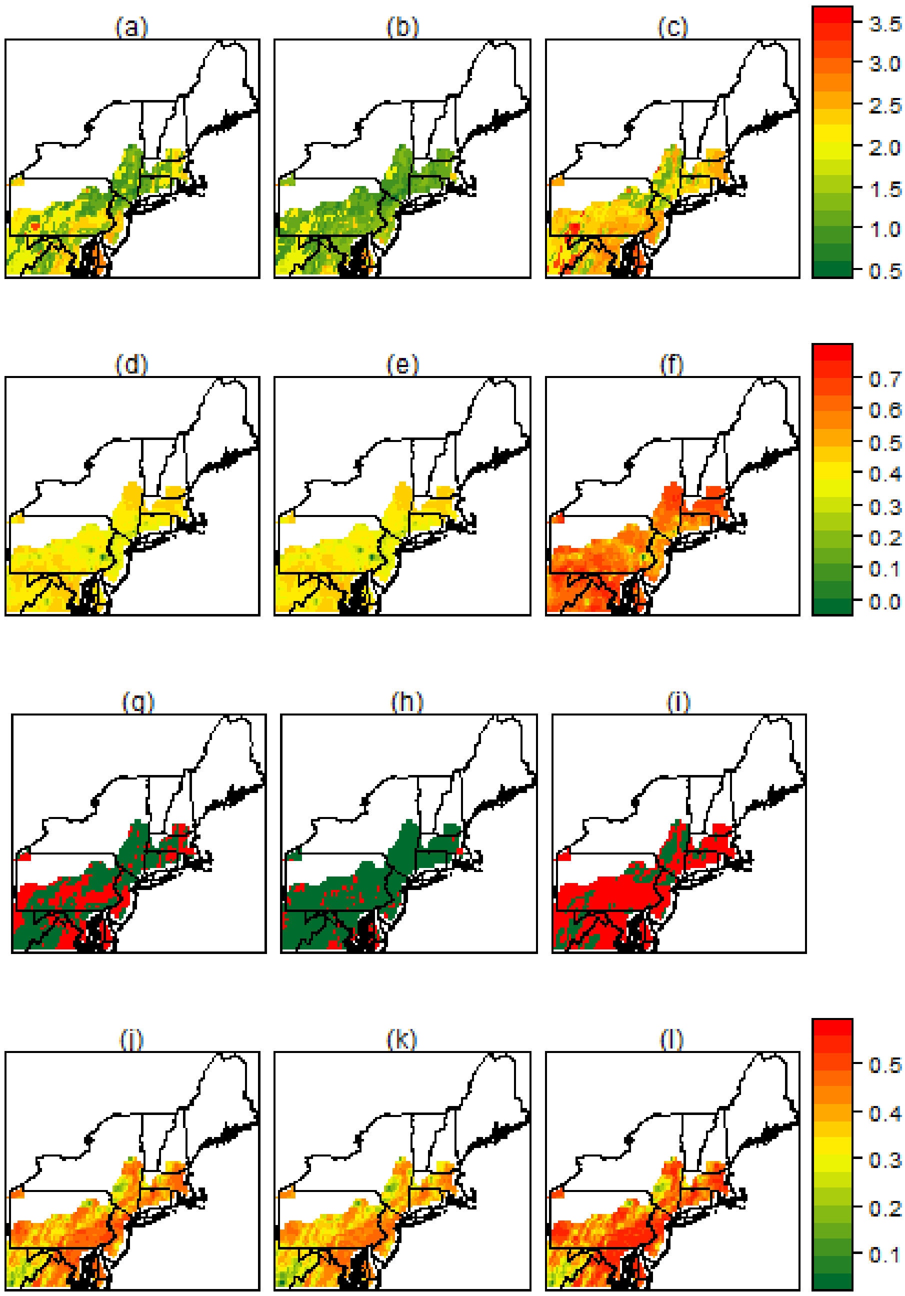

Figure AVIII. 2.22.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

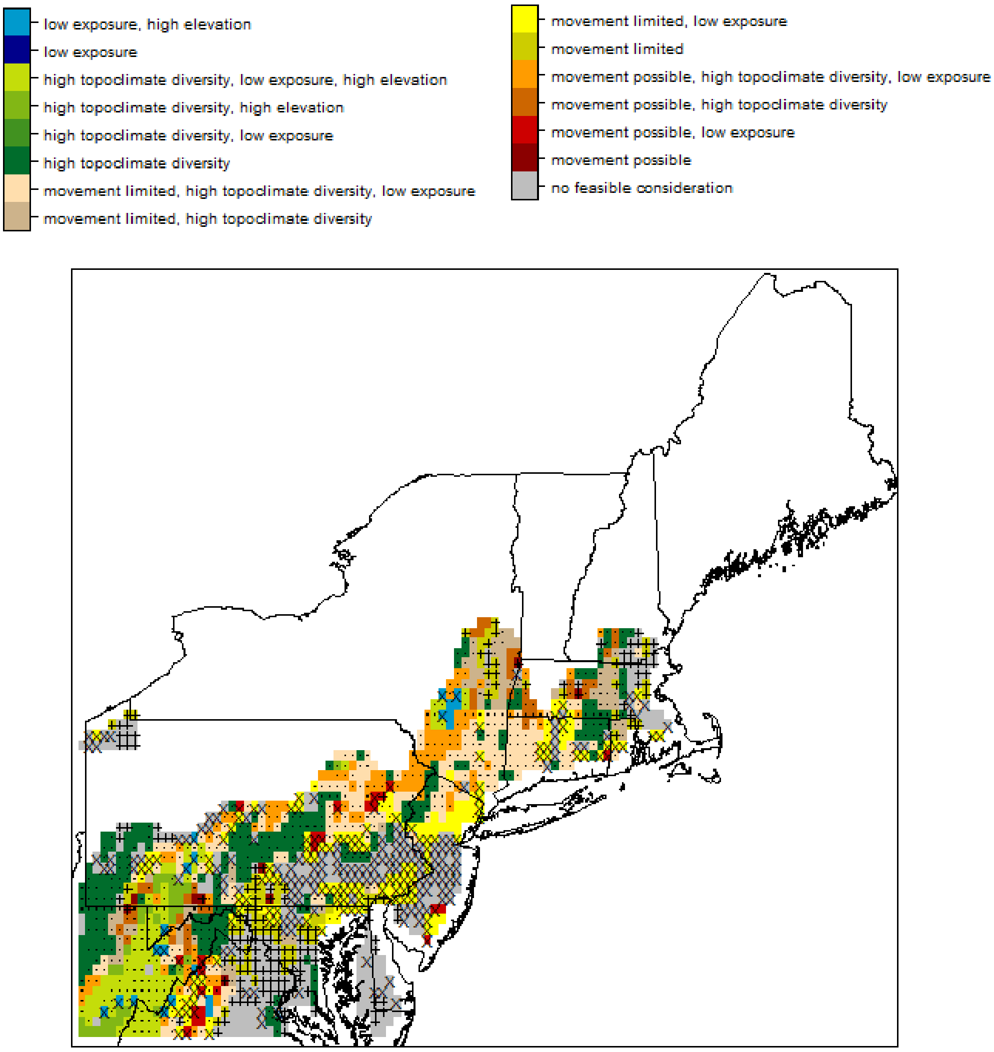

Figure AVIII. 2.22.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

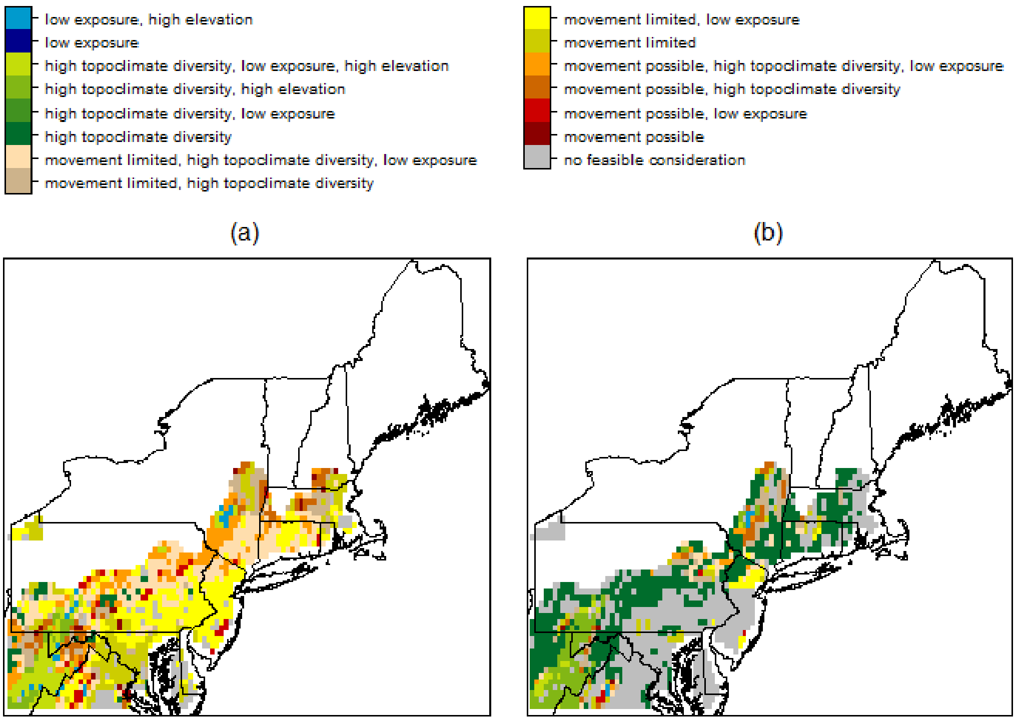

Figure AVIII. 2.22.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.23 Smooth greensnake (*Liochlorophis vernalis*)

Table AVIII. 2.23.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.50	0.33	0.45	1.00	0.25
low	0.15	0.50	0.33	0.38	1.00	0.10
high	0.35	0.50	0.36	0.58	1.00	0.50

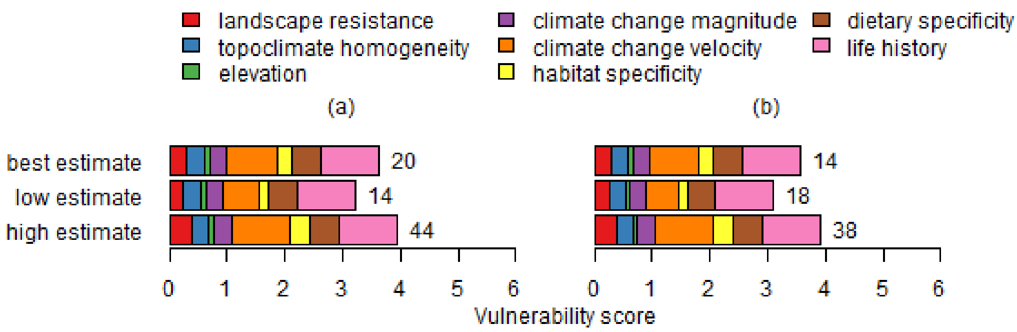

Figure AVIII. 2.23.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

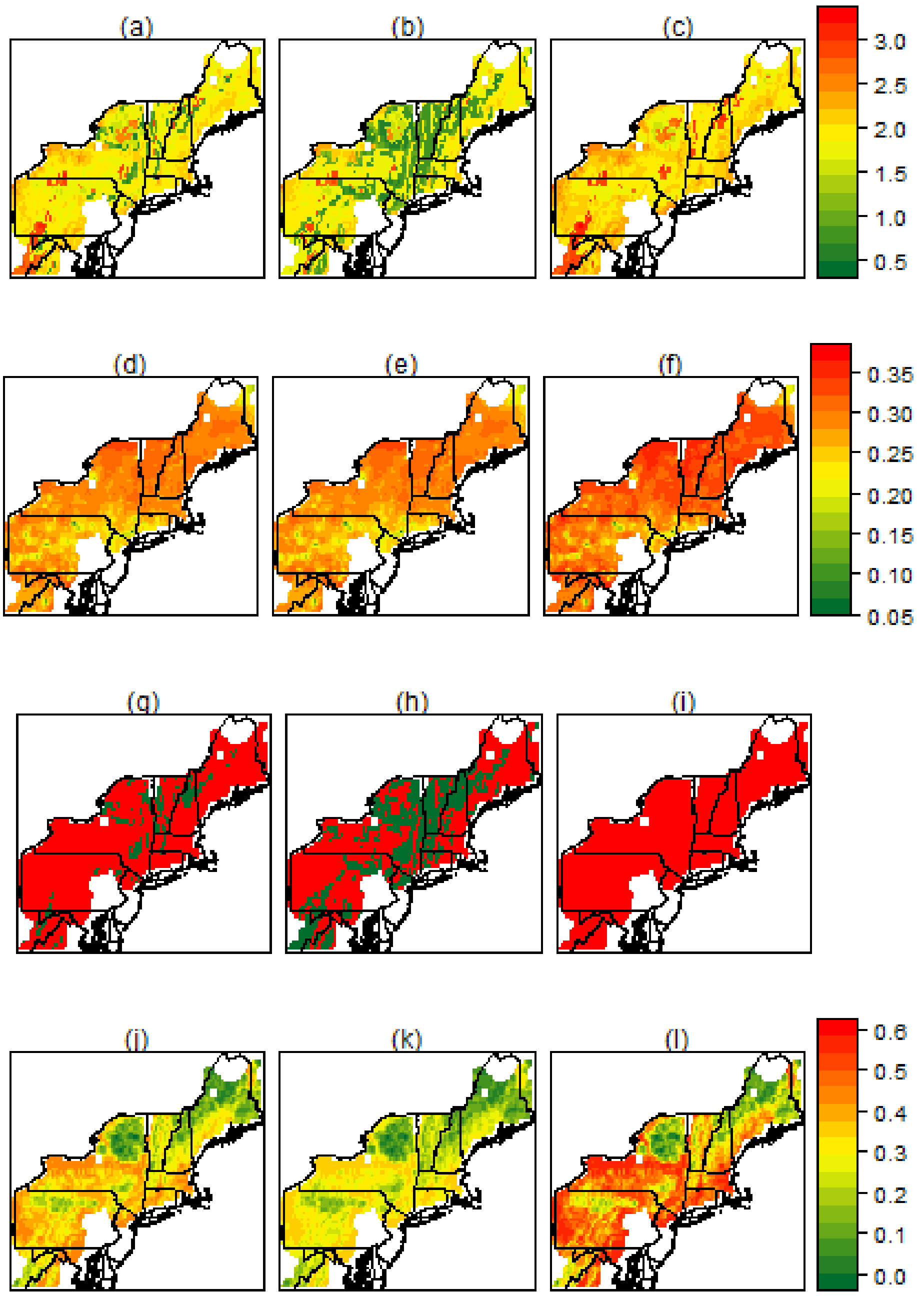

Figure AVIII. 2.23.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

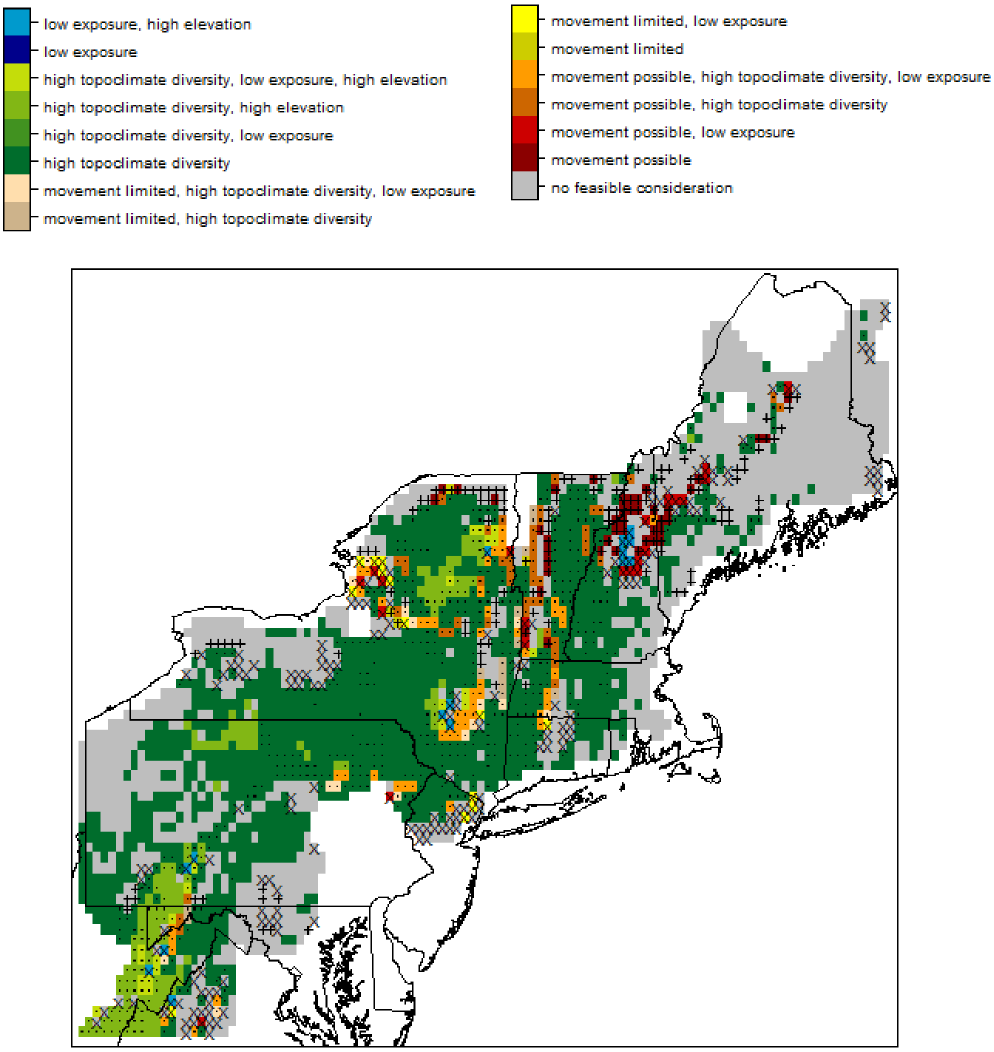

Figure AVIII. 2.23.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

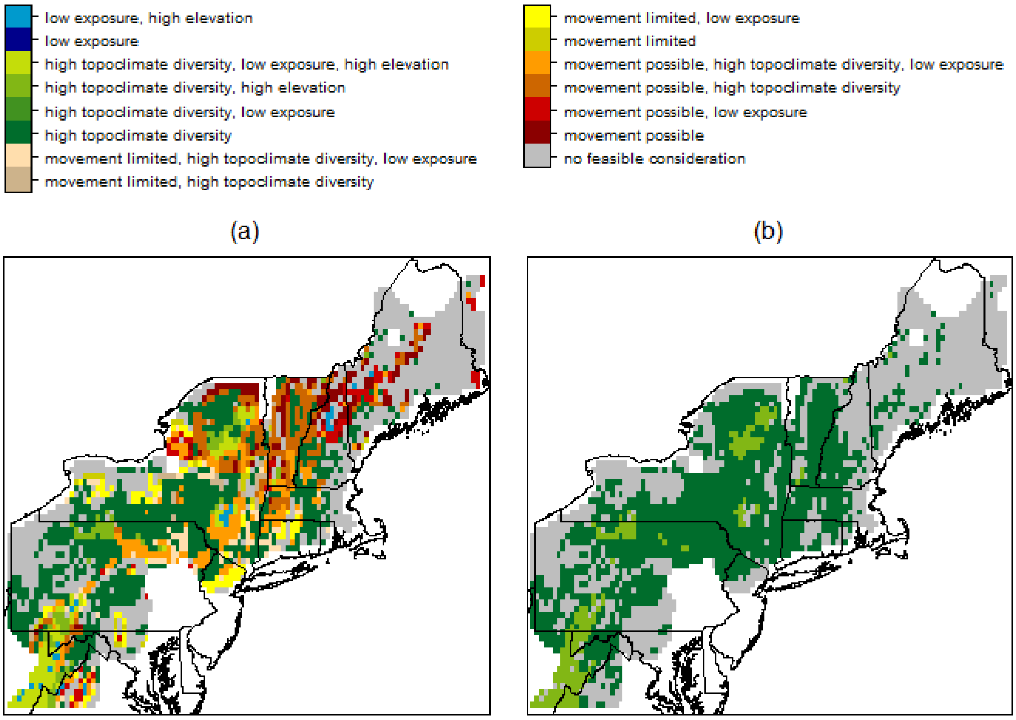

Figure AVIII. 2.23.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.24 Black ratsnake (*Pantherophis obsoletus*)

Table AVIII. 2.24.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.25	0.50	0.33	0.00	1.00	0.35
low	0.00	0.50	0.33	0.00	1.00	0.25
high	0.50	0.50	0.33	0.00	1.00	0.50

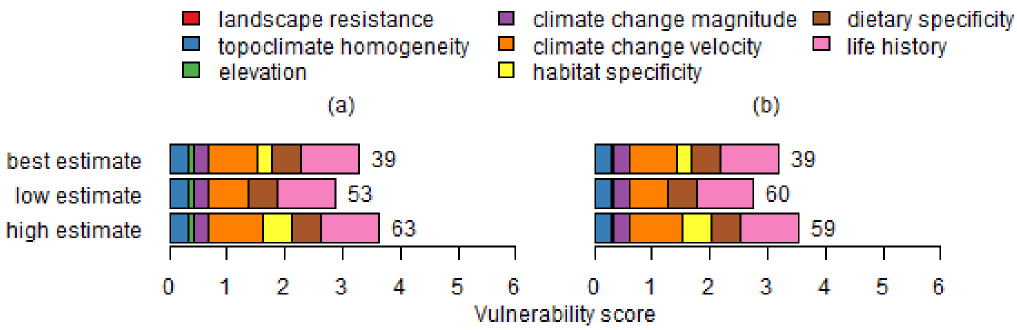

Figure AVIII. 2.24.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

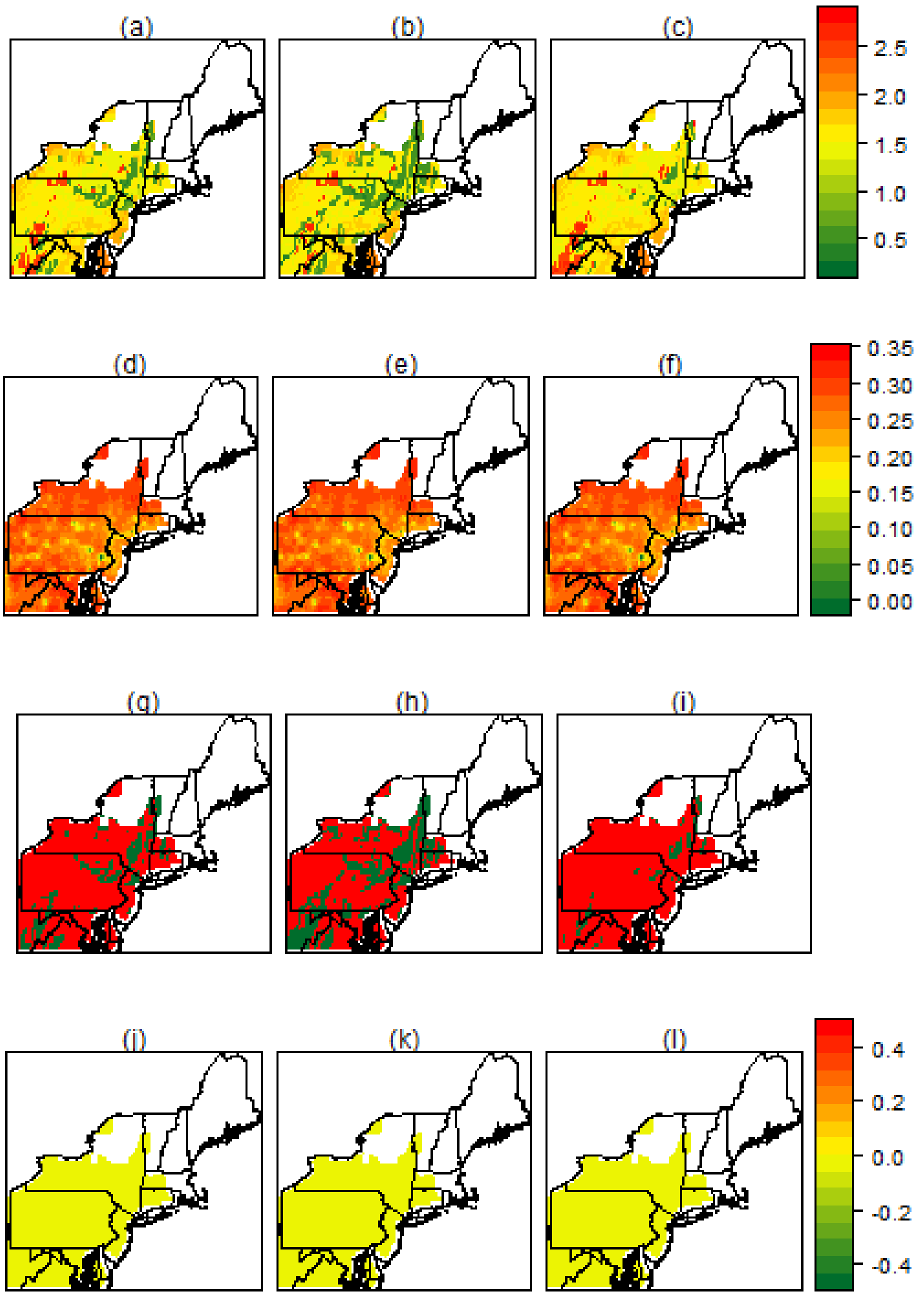

Figure AVIII. 2.24.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

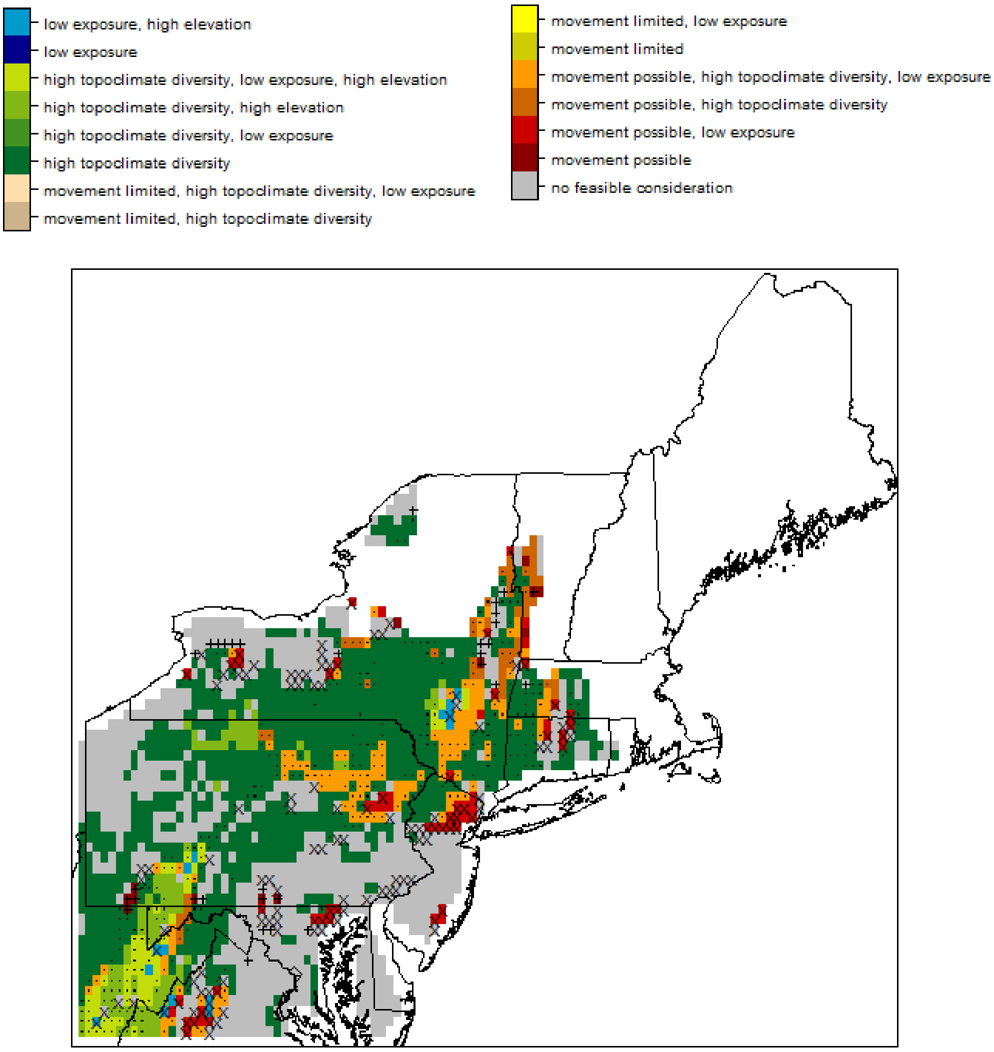

Figure AVIII. 2.24.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

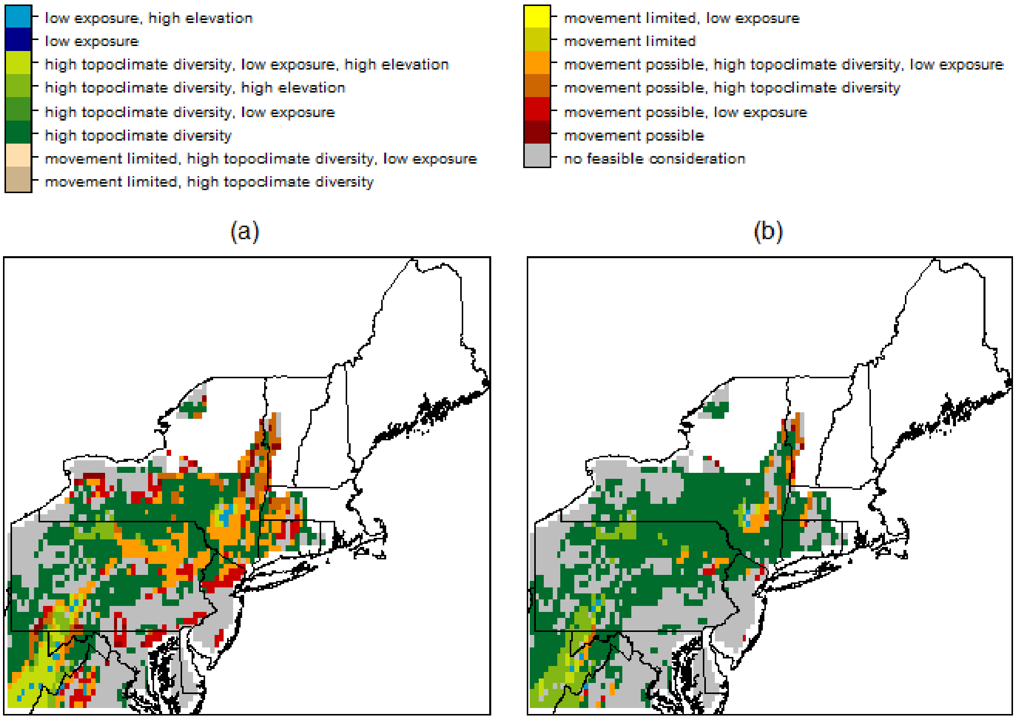

Figure AVIII. 2.24.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.25 Short-headed gartersnake (*Thamnophis brachystoma*)

Table AVIII. 2.25.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.12	0.25	0.33	0.50	1.00	0.90
low	0.00	0.25	0.33	0.50	1.00	0.35
high	0.25	0.25	0.58	0.52	1.00	1.75

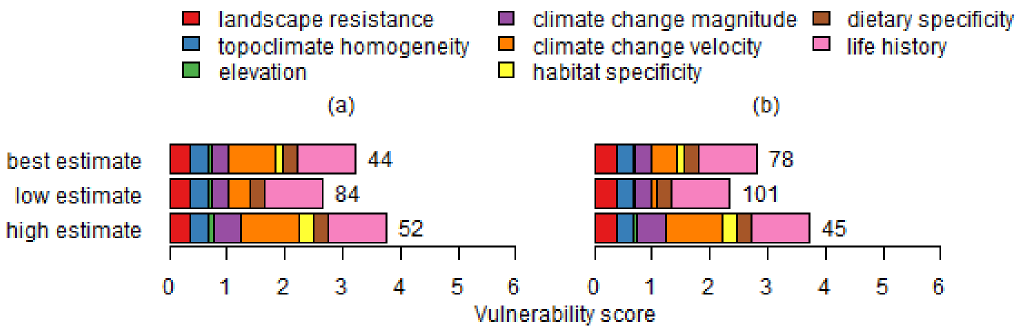

Figure AVIII. 2.25.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

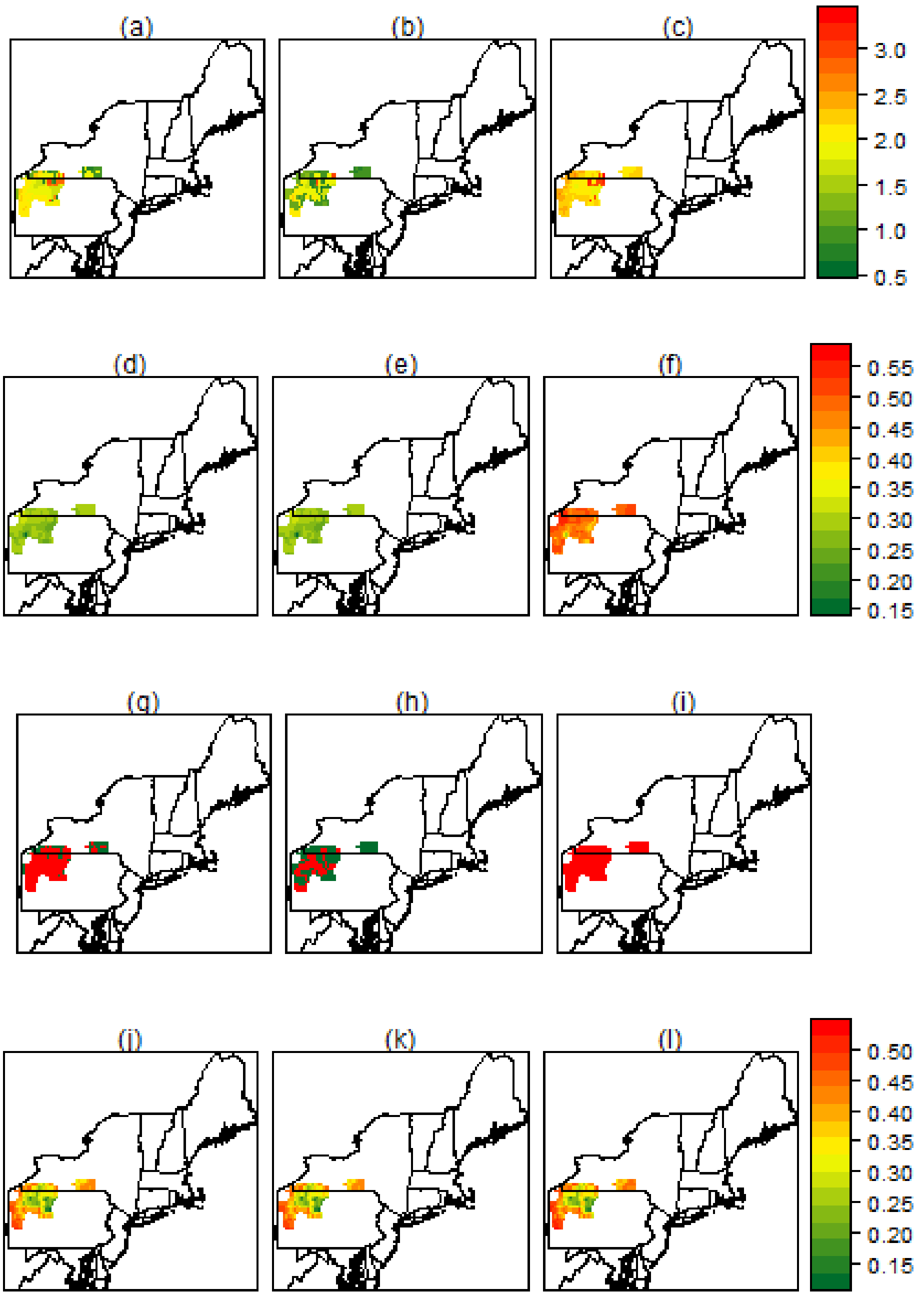

Figure AVIII. 2.25.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

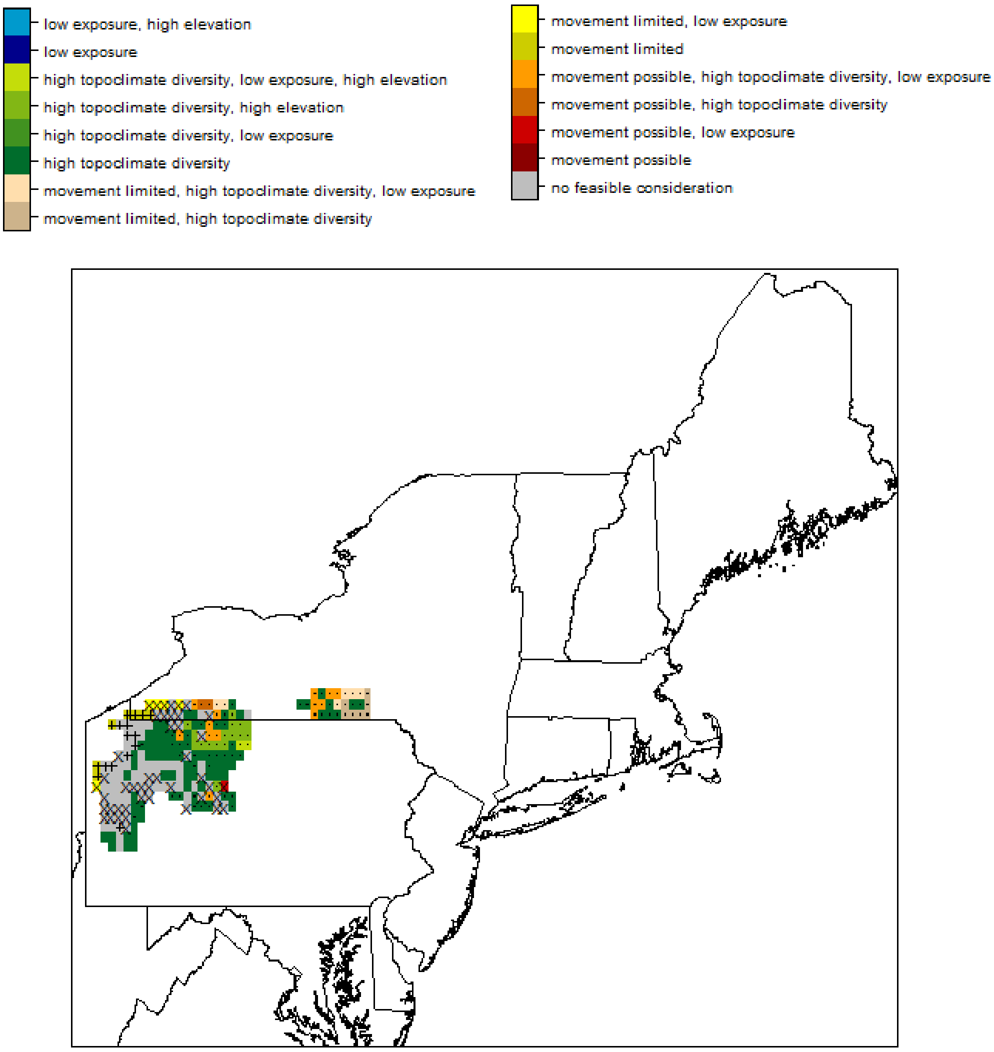

Figure AVIII. 2.25.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

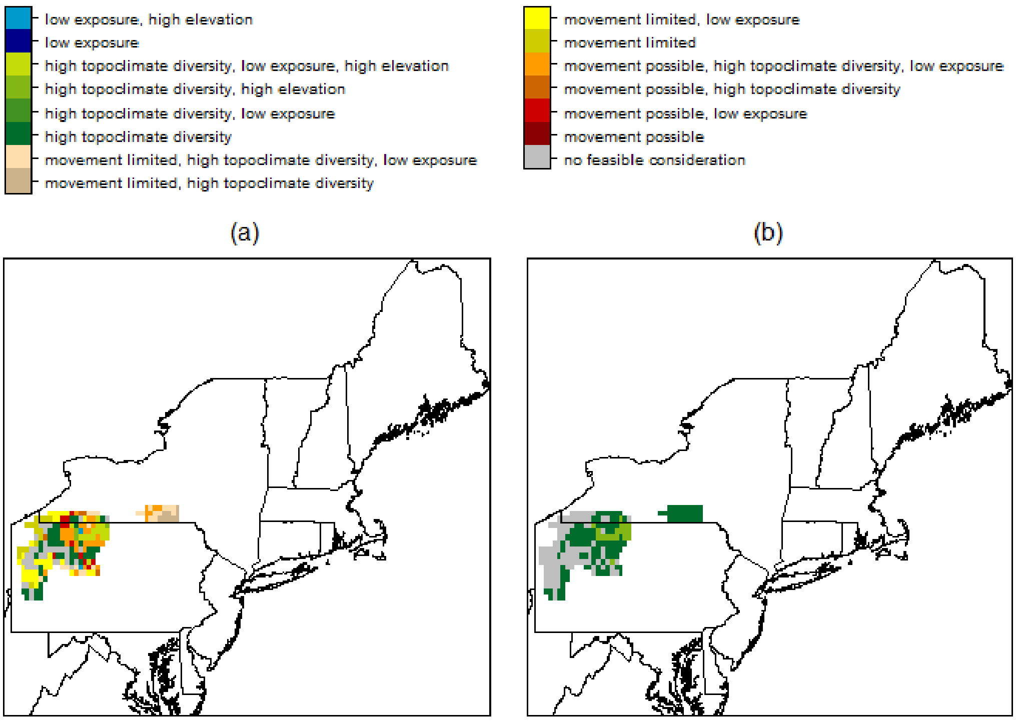

Figure AVIII. 2.25.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.26 Eastern ribbonsnake (*Thamnophis sauritus*)

Table AVIII. 2.26.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.38	0.50	0.49	0.50	1.00	0.26
low	0.19	0.50	0.43	0.41	1.00	0.14
high	0.56	0.57	0.54	0.57	1.00	0.57

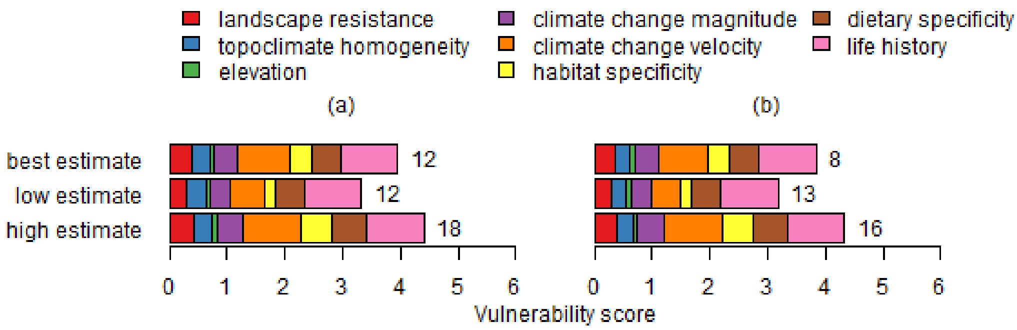

Figure AVIII. 2.26.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

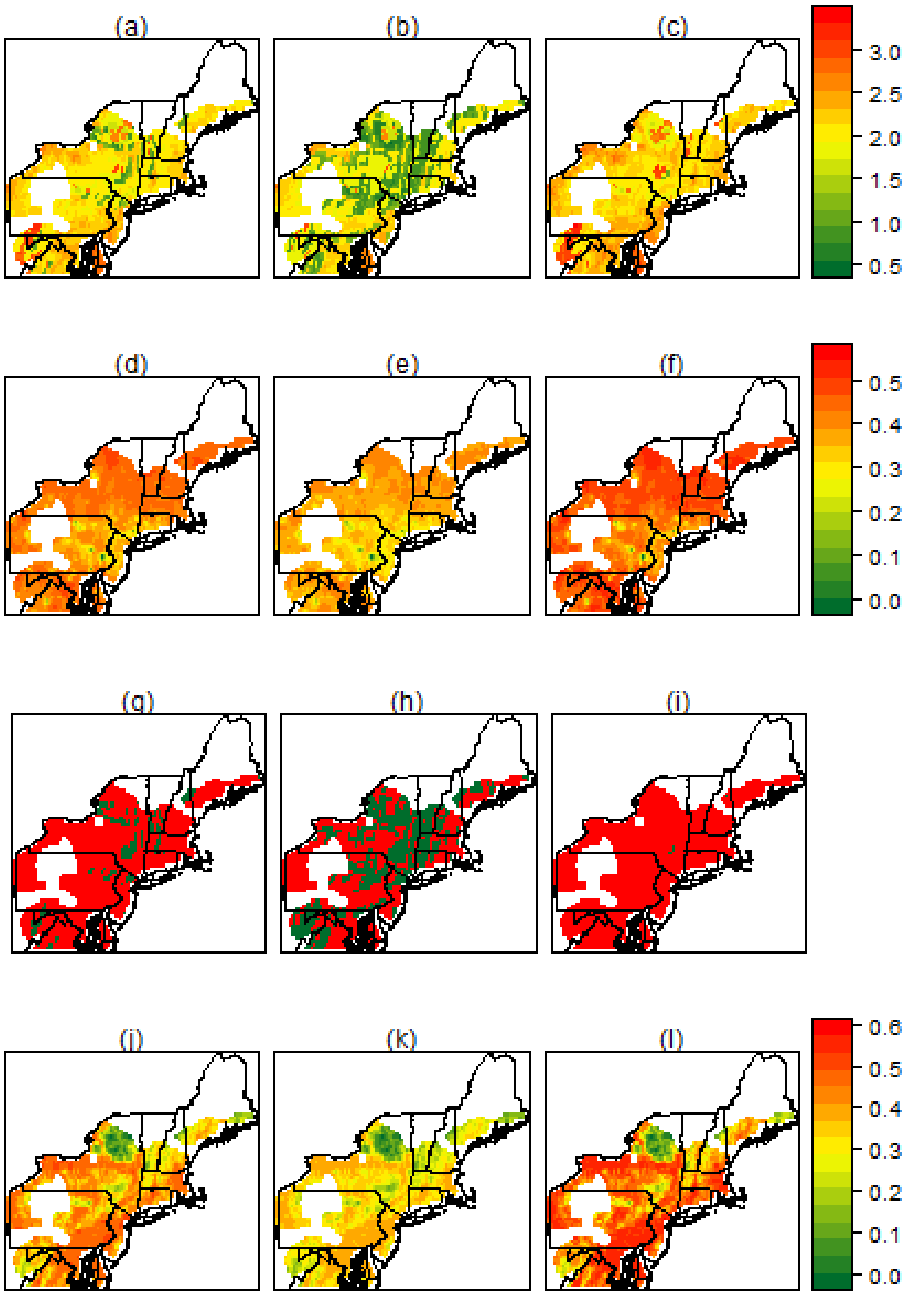

Figure AVIII. 2.26.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

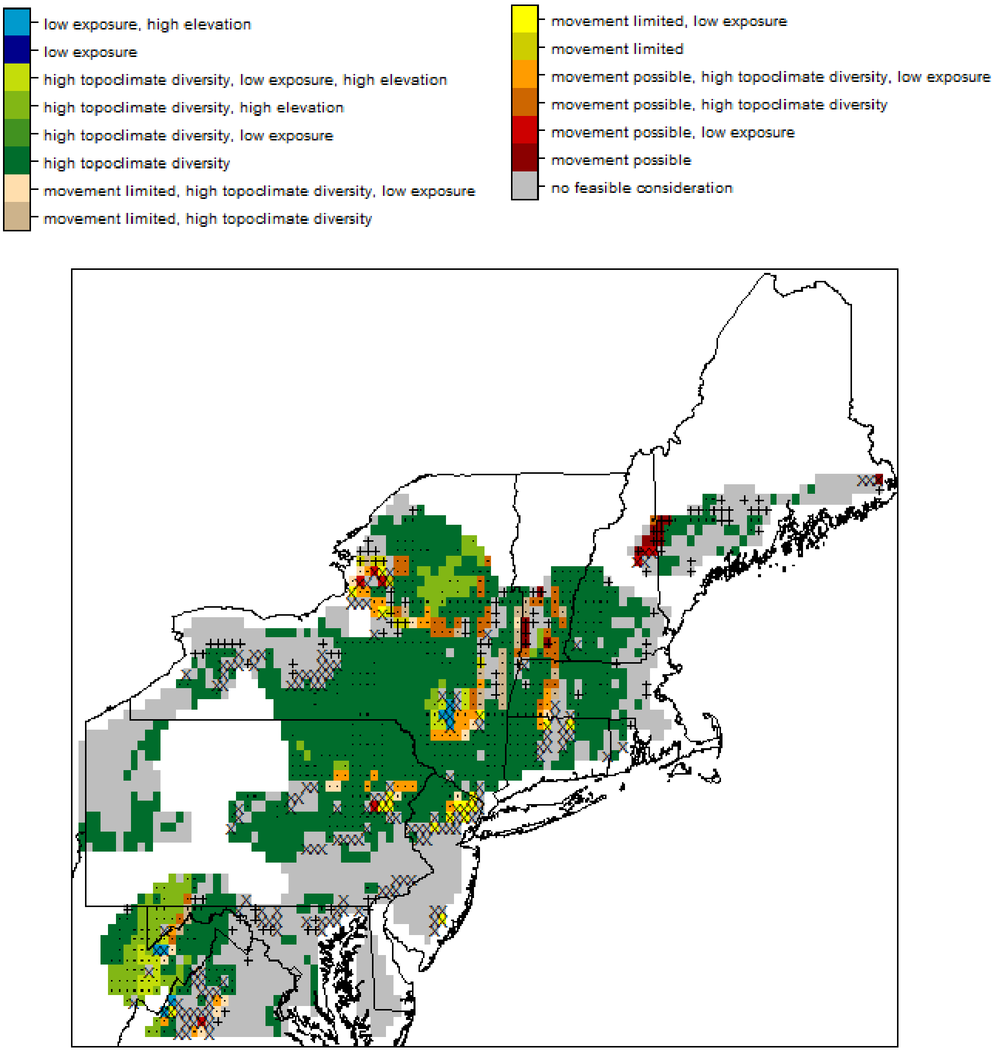

Figure AVIII. 2.26.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

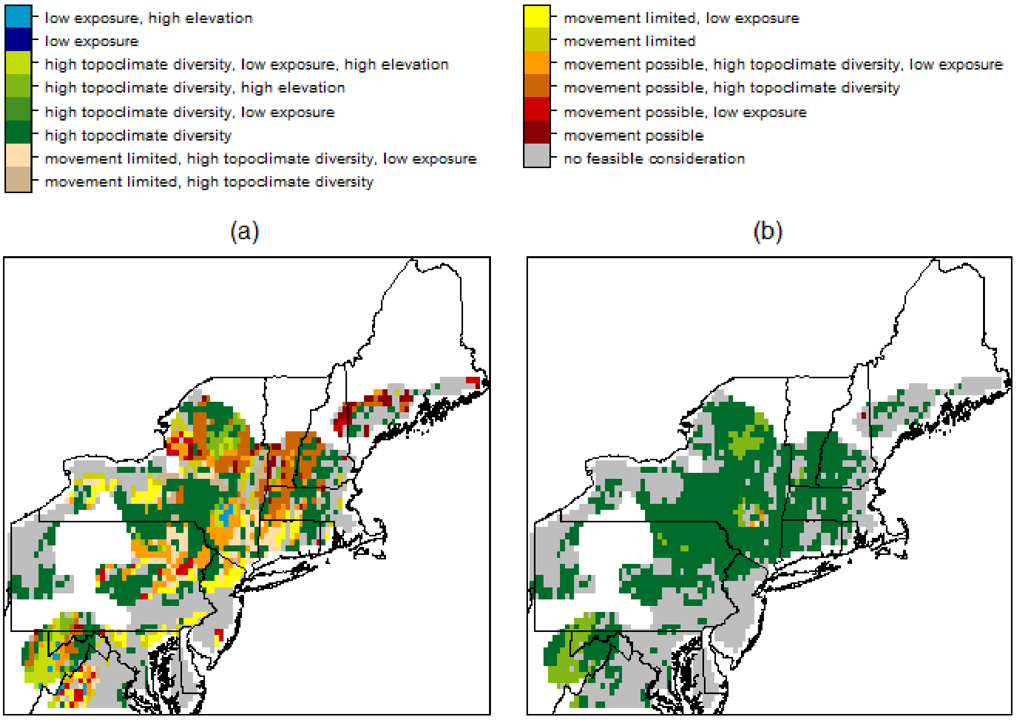

Figure AVIII. 2.26.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.27 Northern copperhead (*Agkistrodon contortrix mokasen*)

Table AVIII. 2.27.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.17	0.55	0.83	1.00	5.50
low	0.38	0.17	0.52	0.77	1.00	2.75
high	0.50	0.27	0.86	0.83	1.00	10.75

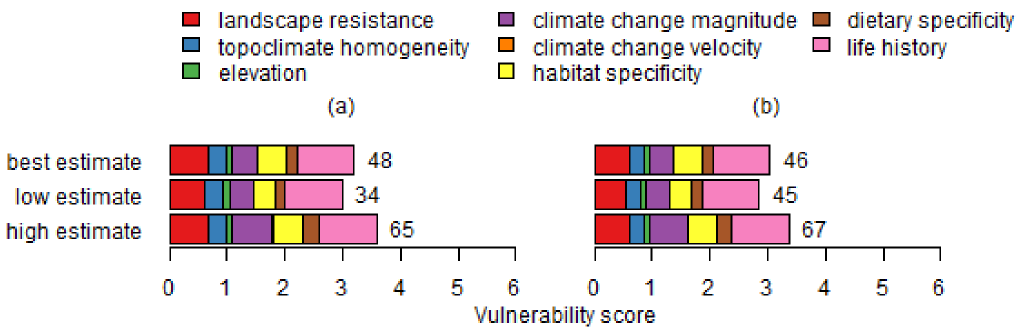

Figure AVIII. 2.27.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

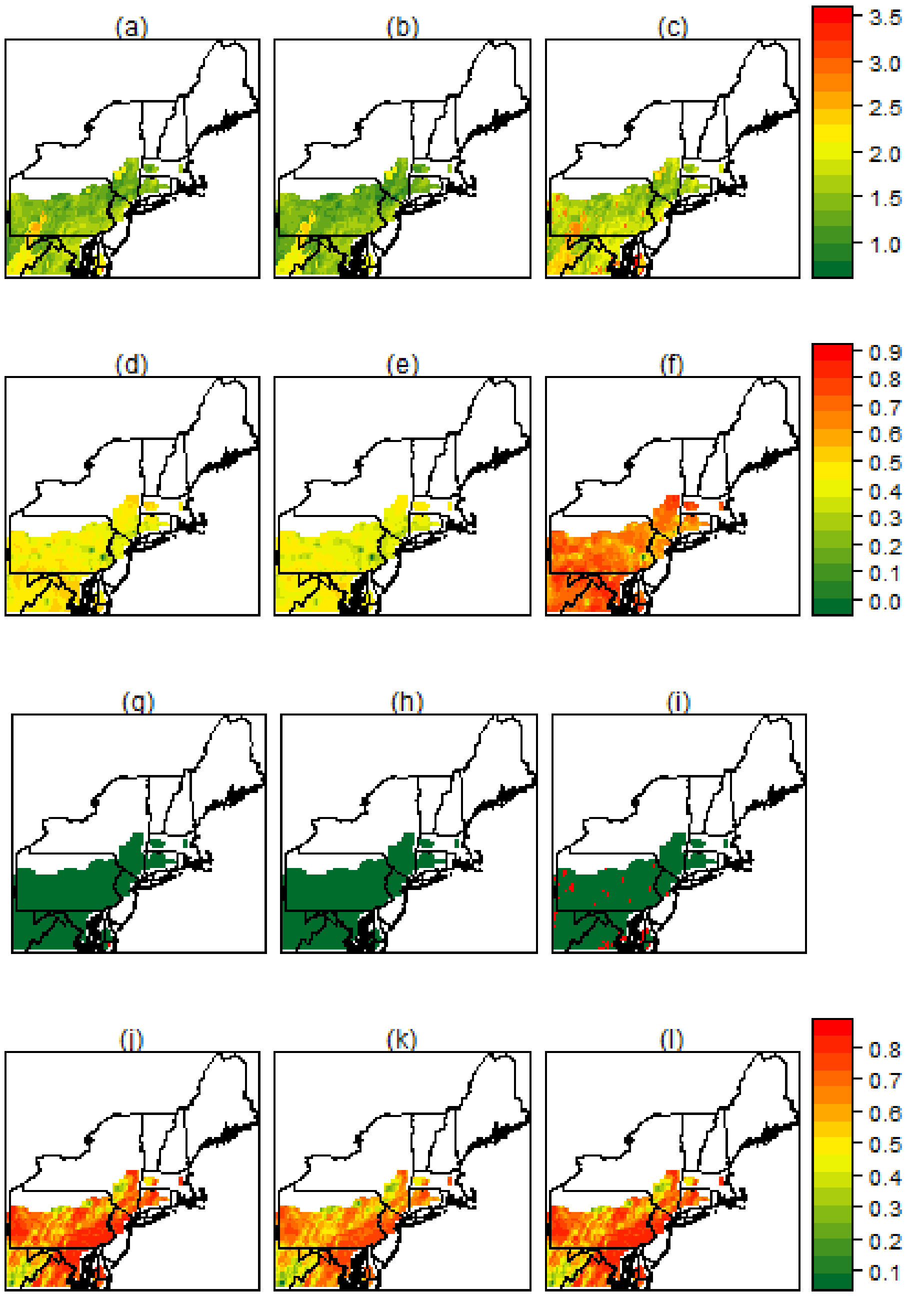

Figure AVIII. 2.27.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

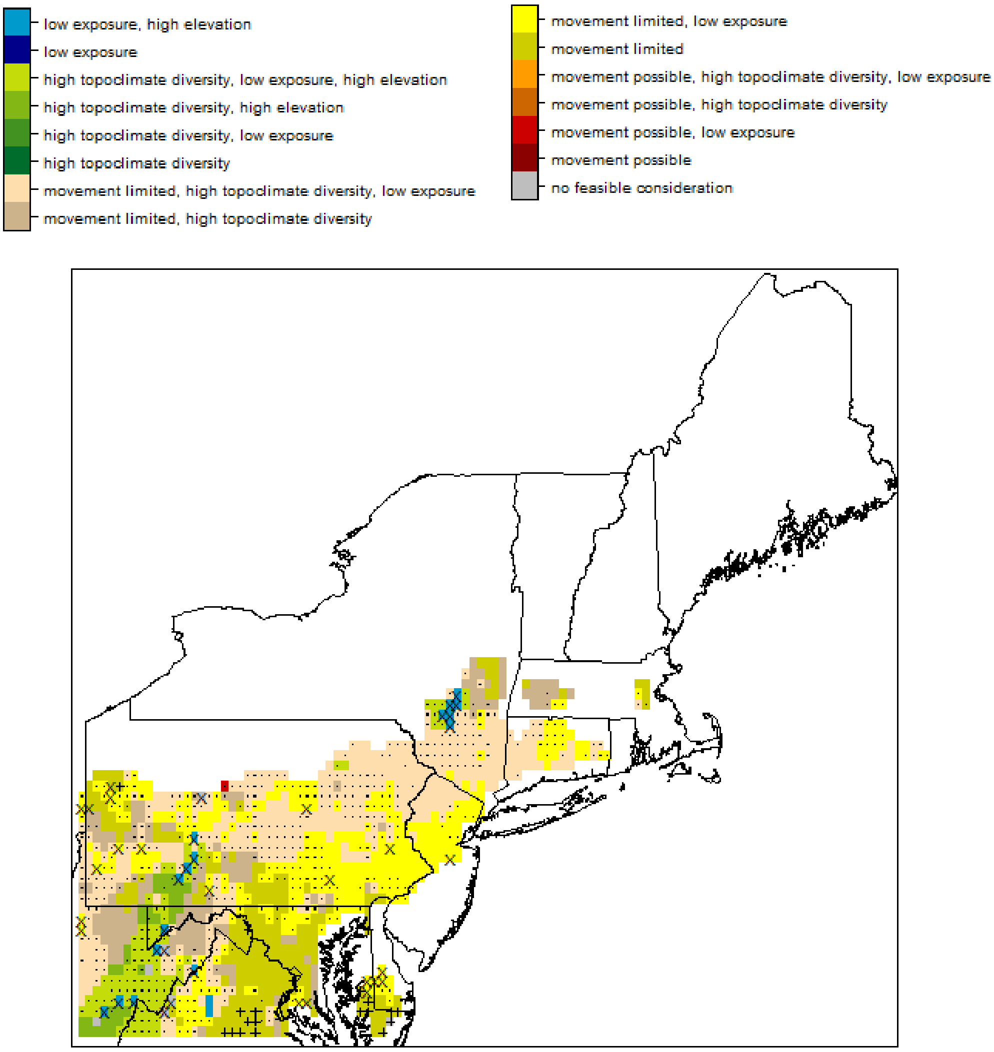

Figure AVIII. 2.27.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

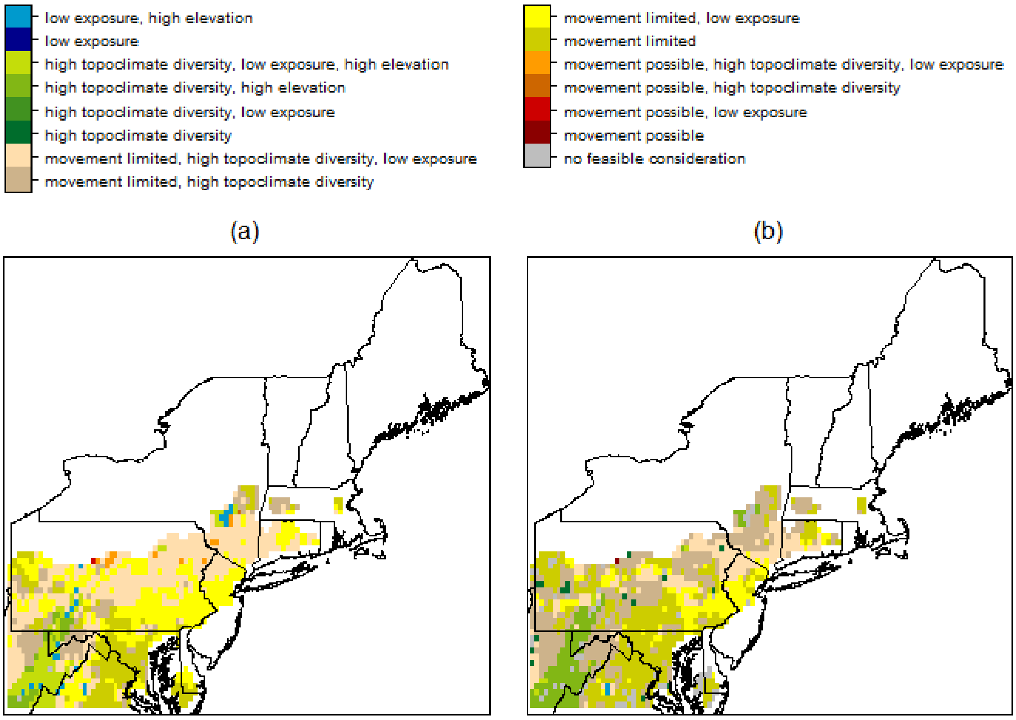

Figure AVIII. 2.27.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.28 Timber rattlesnake (*Crotalus horridus*)

Table AVIII. 2.28.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.64	0.36	0.38	0.64	1.00	2.07
low	0.55	0.34	0.36	0.60	1.00	0.95
high	0.67	0.37	0.59	0.66	1.00	4.16

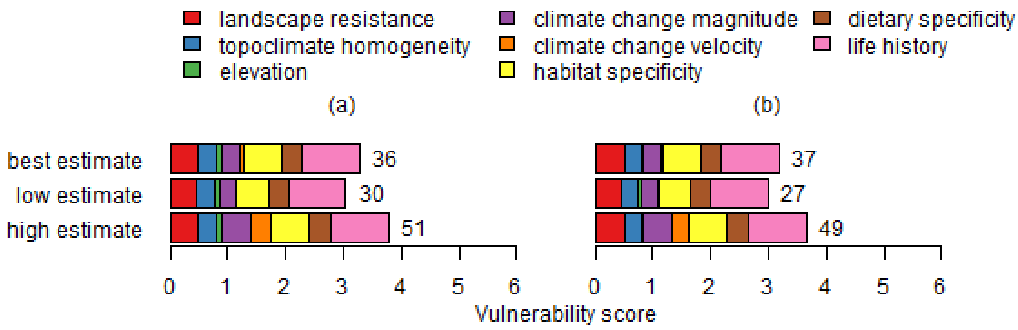

Figure AVIII. 2.28.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

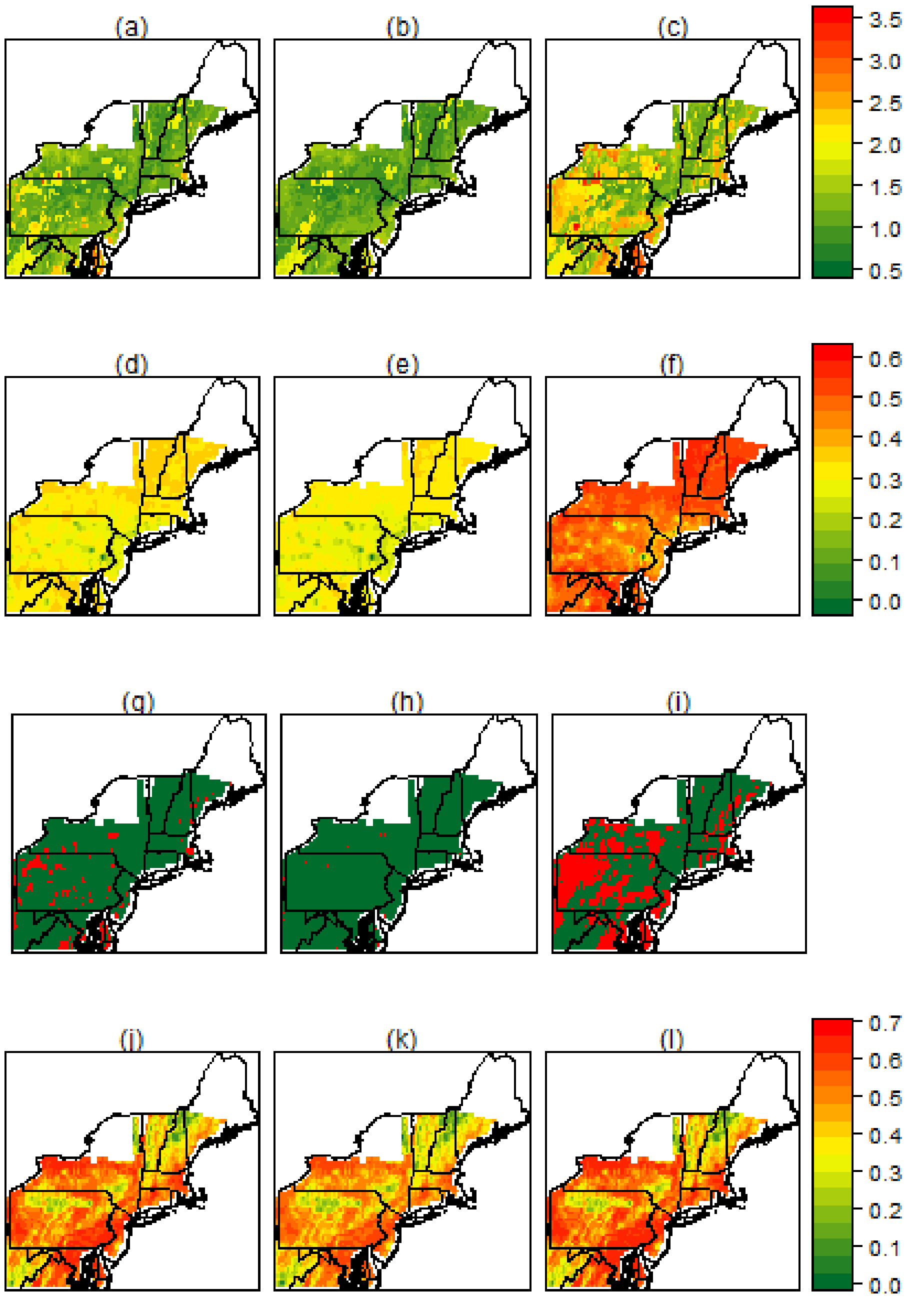

Figure AVIII. 2.28.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

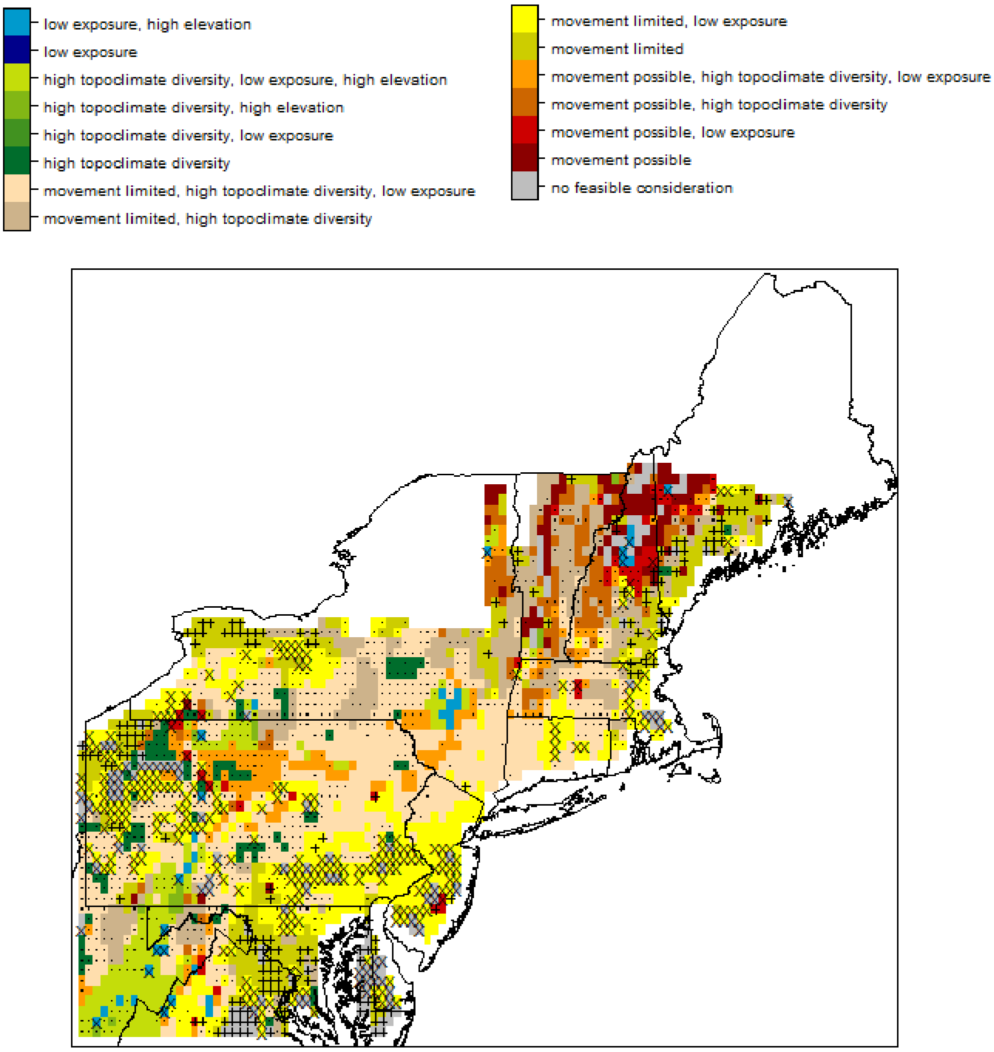

Figure AVIII. 2.28.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

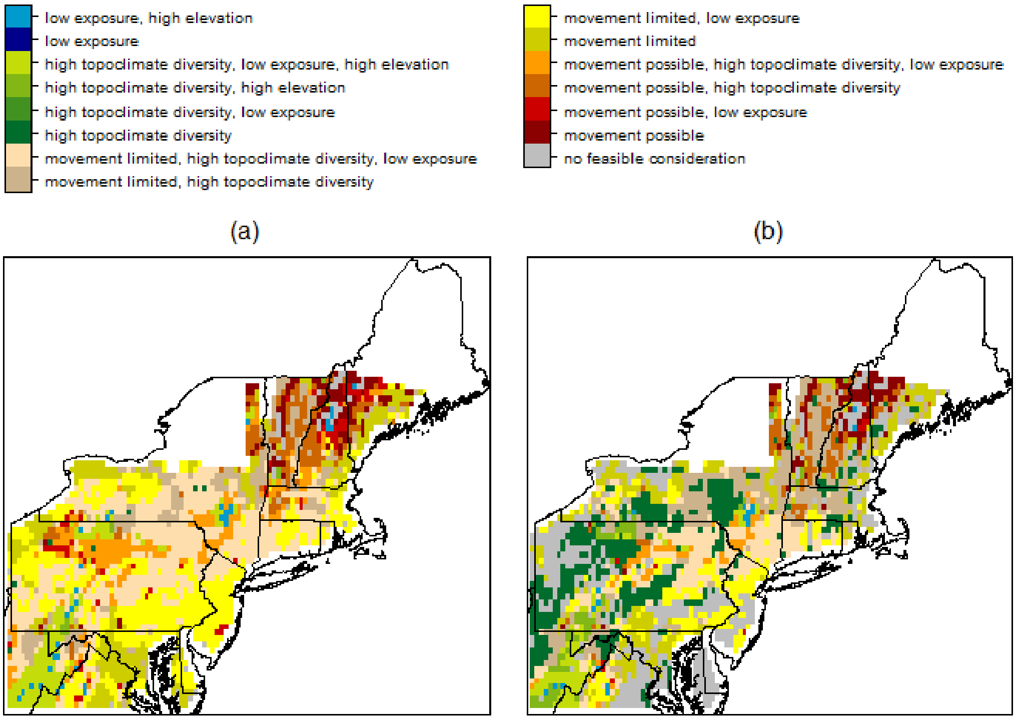

Figure AVIII. 2.28.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

2.29 Eastern massasauga (*Sistrurus catenatus*)

Table AVIII. 2.29.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.25	0.60	0.60	1.00	1.20
low	0.46	0.20	0.47	0.57	1.00	0.68
high	0.56	0.33	0.67	0.64	1.00	2.38

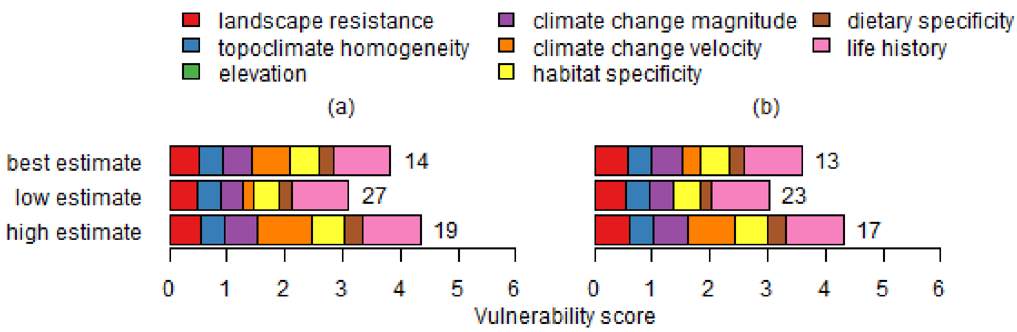

Figure AVIII. 2.29.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

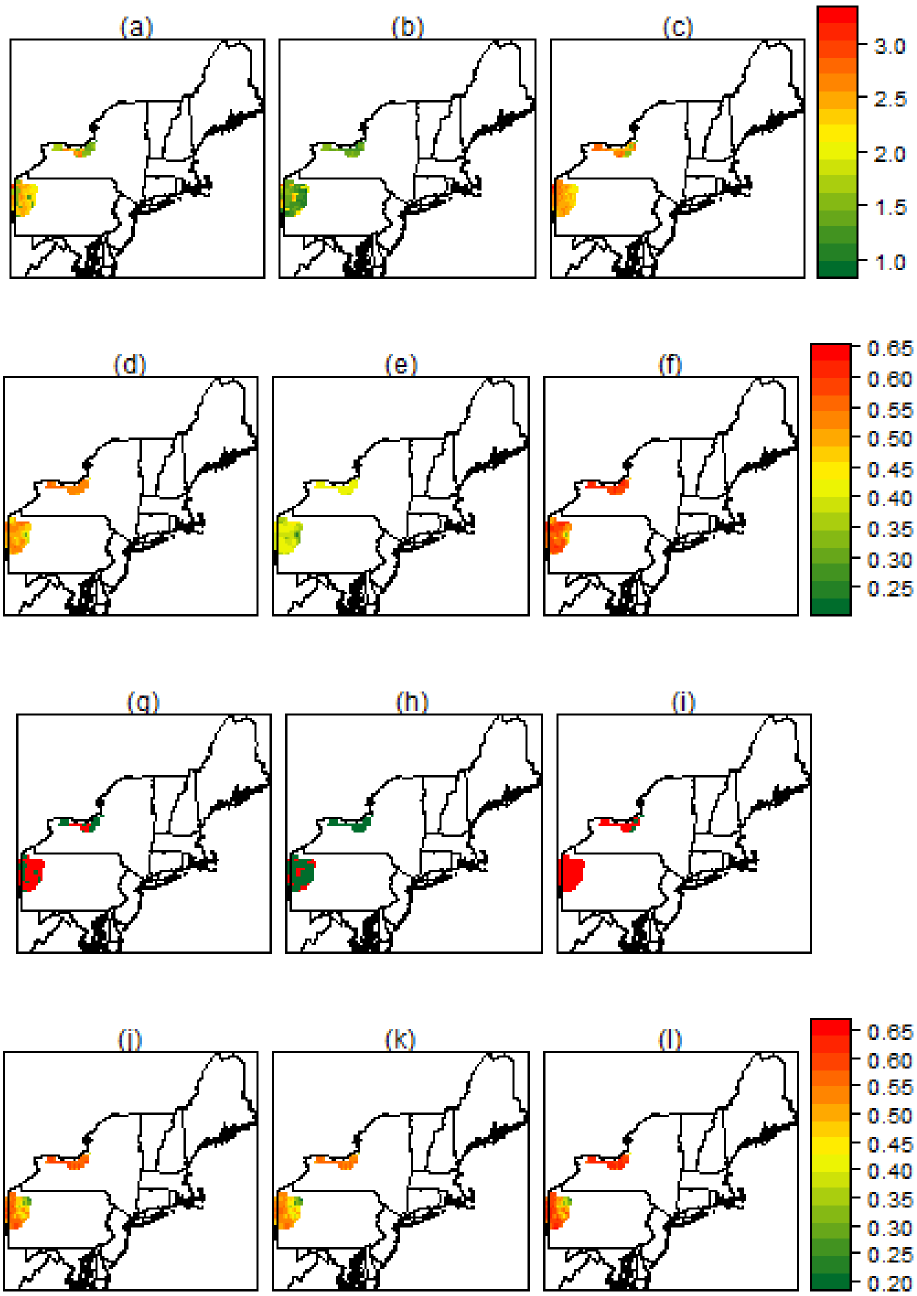

Figure AVIII. 2.29.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

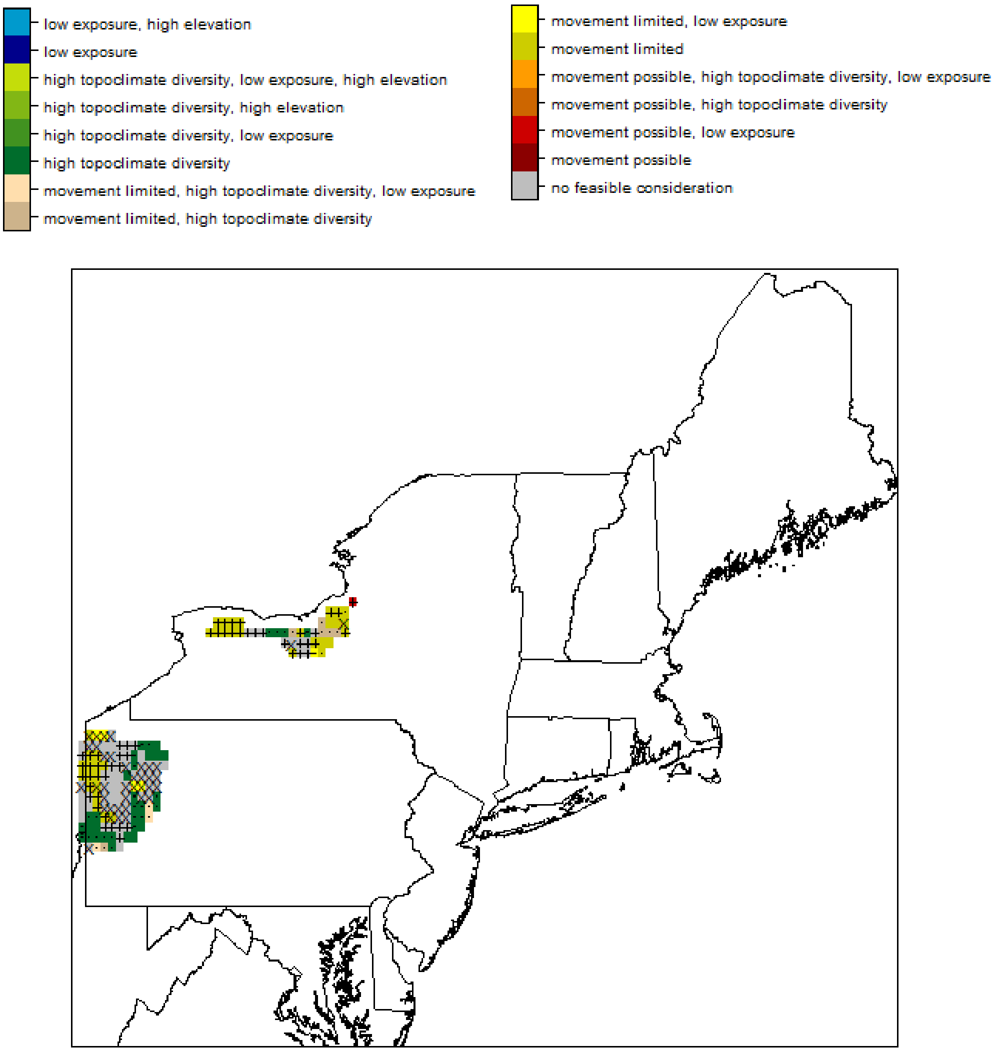

Figure AVIII. 2.29.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

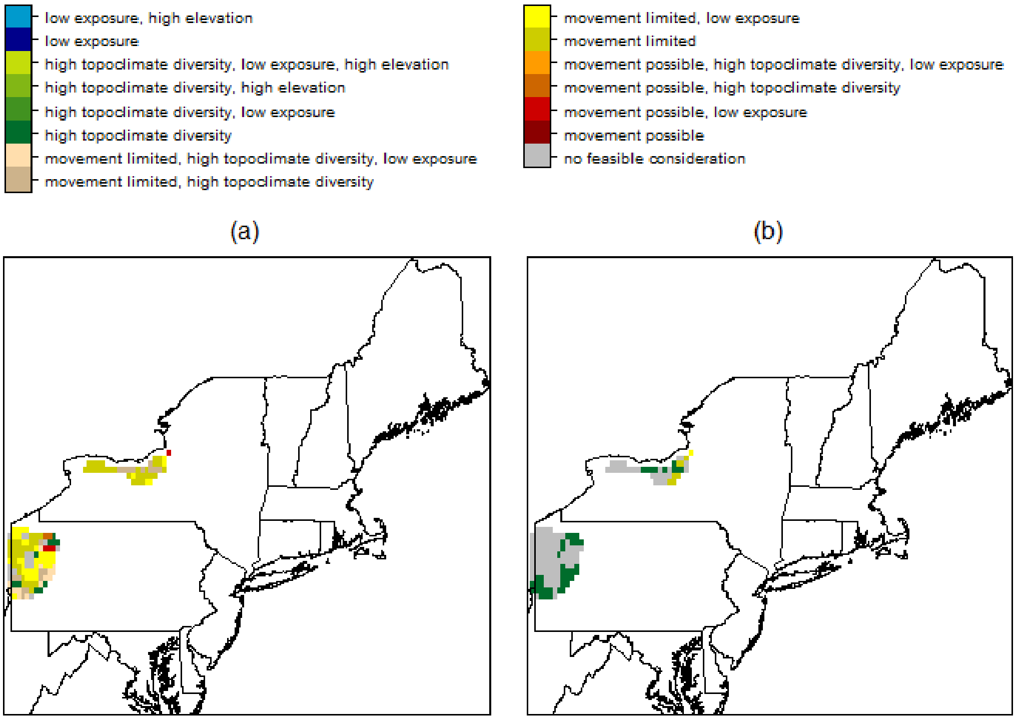

Figure AVIII. 2.29.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3 Mammals

3.1 Allegheny woodrat (*Neotoma magister*)

Table AVIII. 3.1.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.40	0.33	0.50	1.00	0.50
low	0.44	0.25	0.33	0.38	1.00	0.10
high	0.56	0.67	0.46	0.62	1.00	2.00

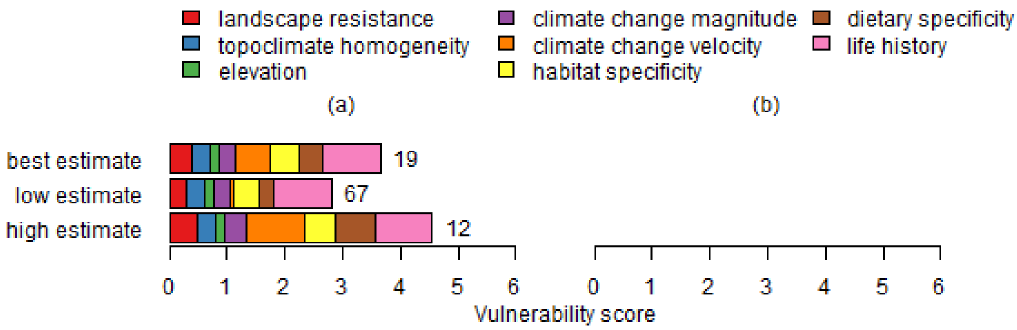

Figure AVIII. 3.1.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

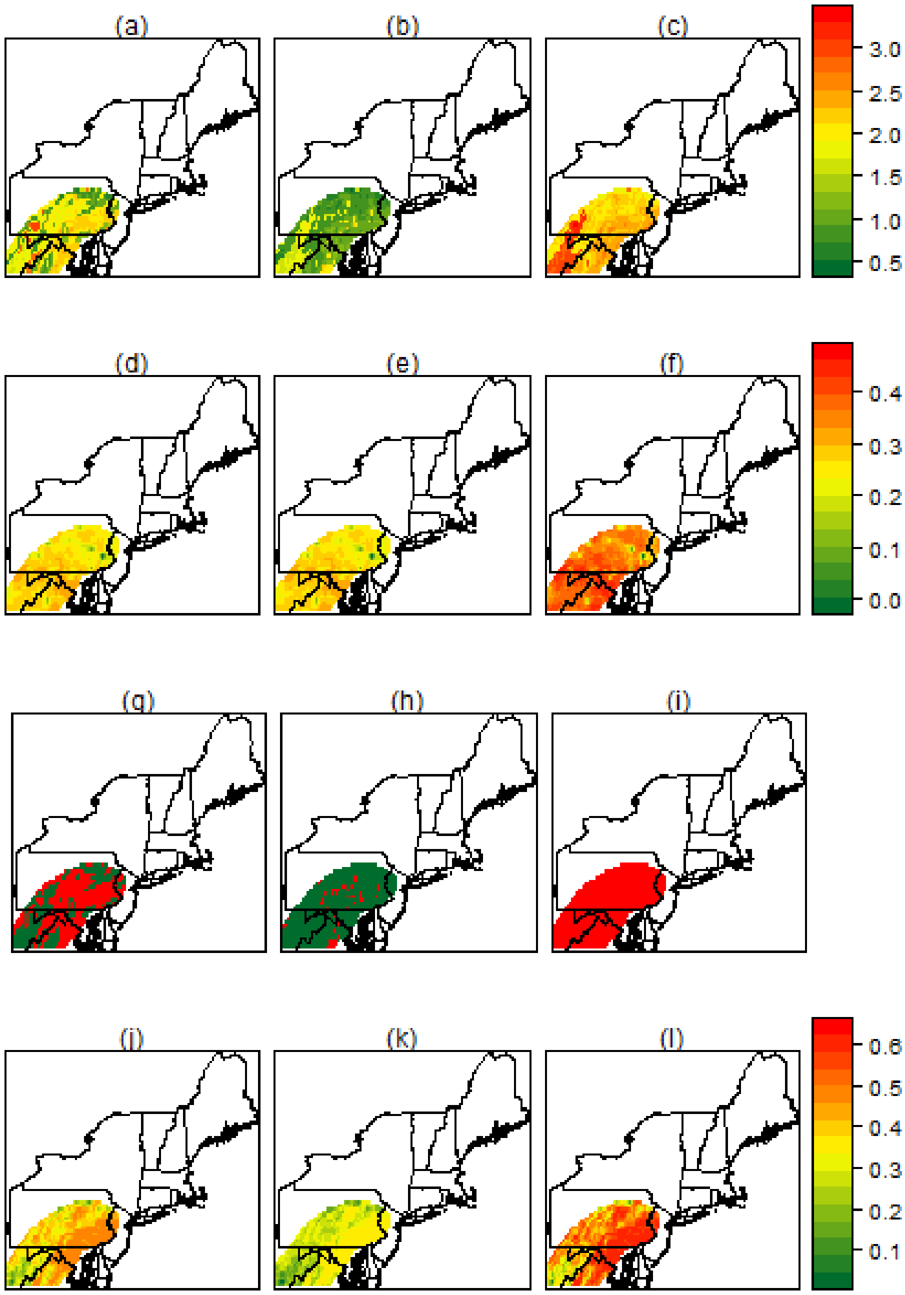

Figure AVIII. 3.1.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

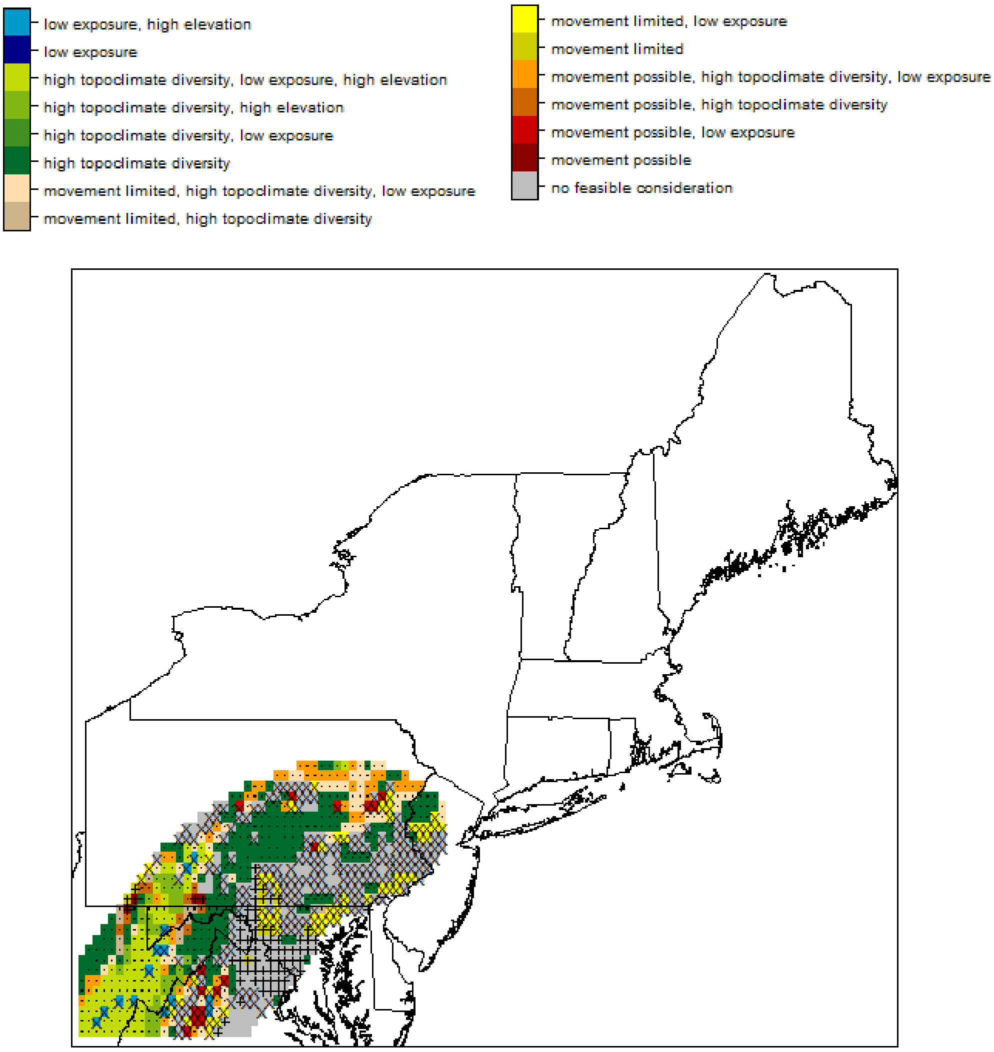

Figure AVIII. 3.1.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

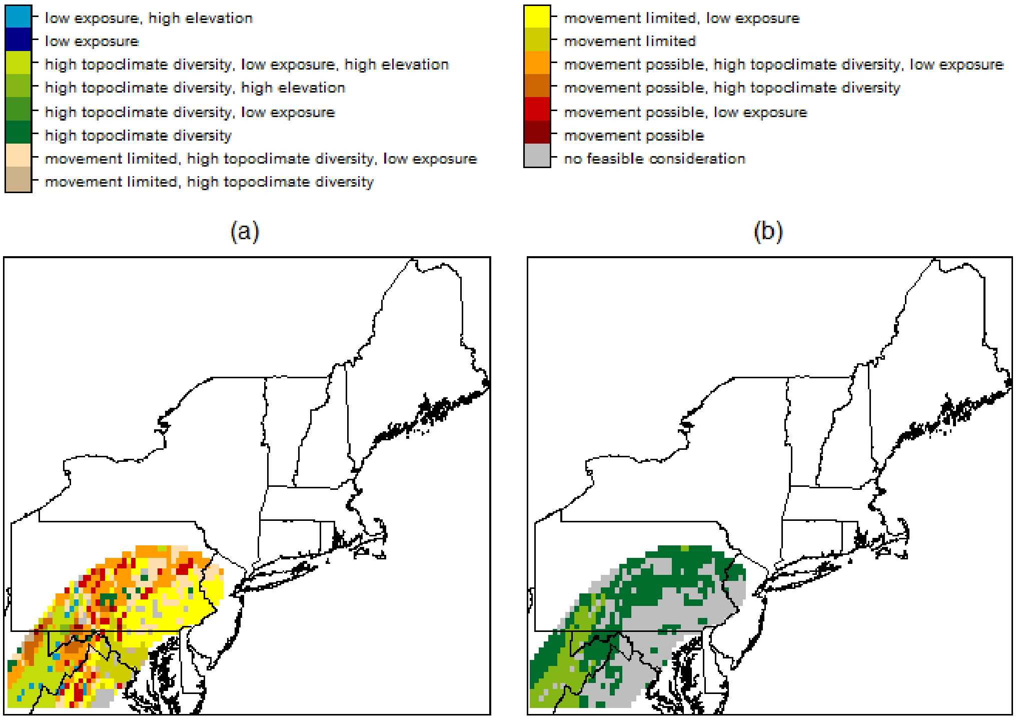

Figure AVIII. 3.1.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.2 New England cottontail (*Sylvilagus transitionalis*)

Table AVIII. 3.2.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.78	0.75	0.99	1.75
low	0.45	0.50	0.60	0.32	1.00	1.05
high	0.53	0.55	0.92	0.69	0.99	11.00

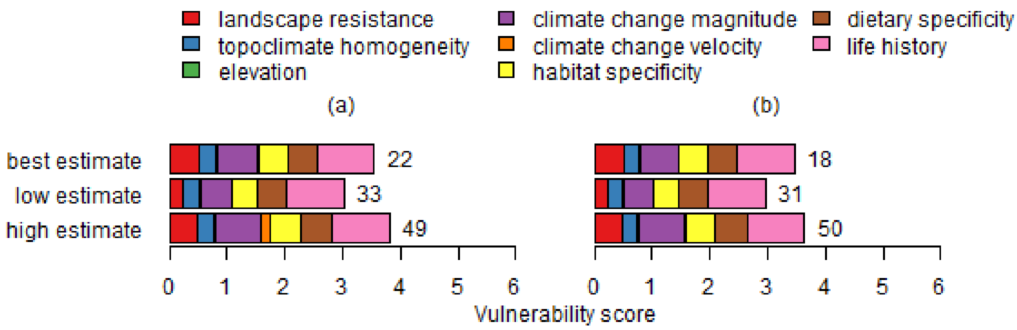

Figure AVIII. 3.2.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

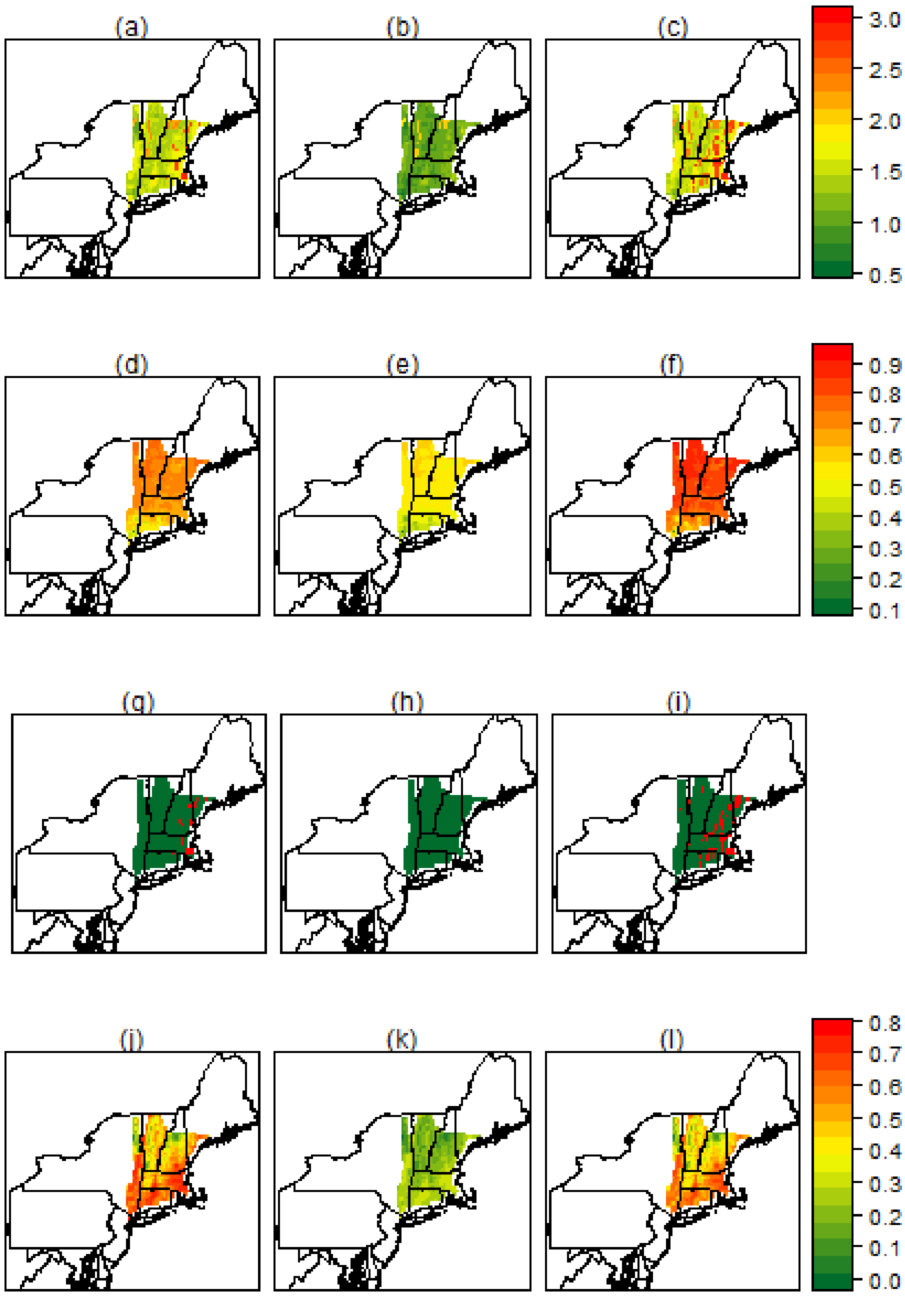

Figure AVIII. 3.2.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

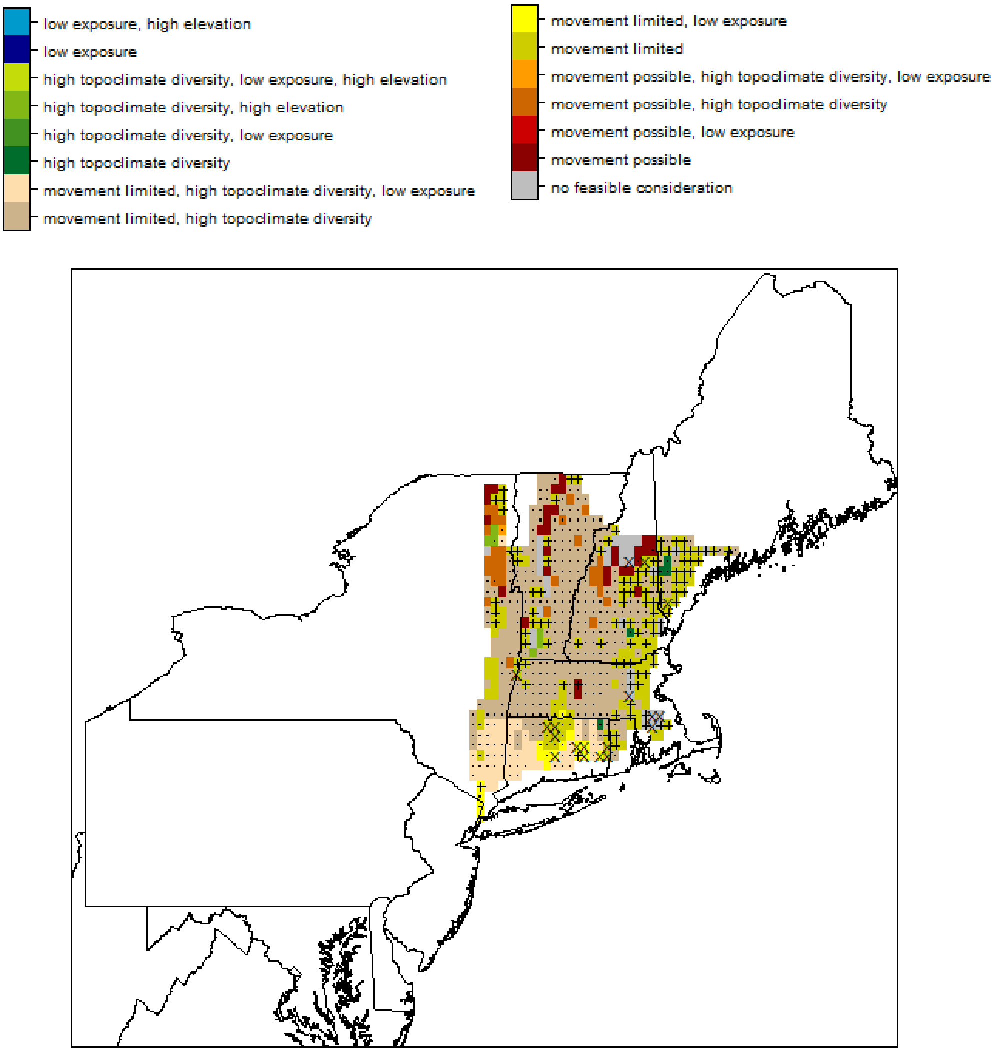

Figure AVIII. 3.2.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

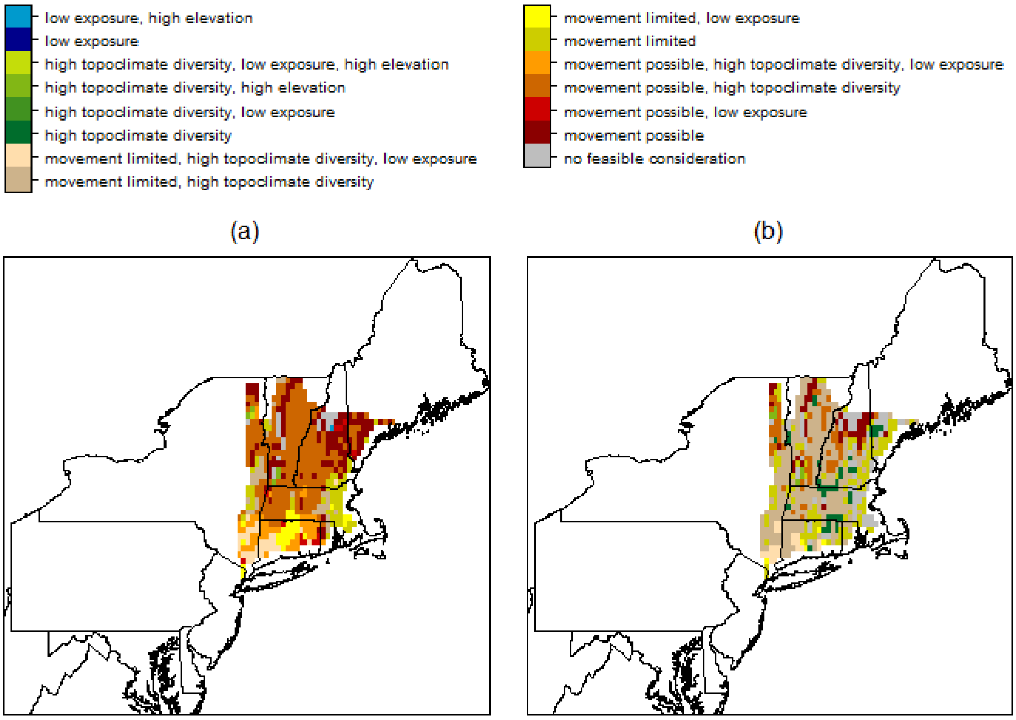

Figure AVIII. 3.2.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.3 Least shrew (*Cryptotis parva*)

Table AVIII. 3.3.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.00	0.66	1.00	1.00	0.20
low	0.50	0.00	0.62	0.90	1.00	0.02
high	0.55	0.10	0.70	1.00	1.00	0.40

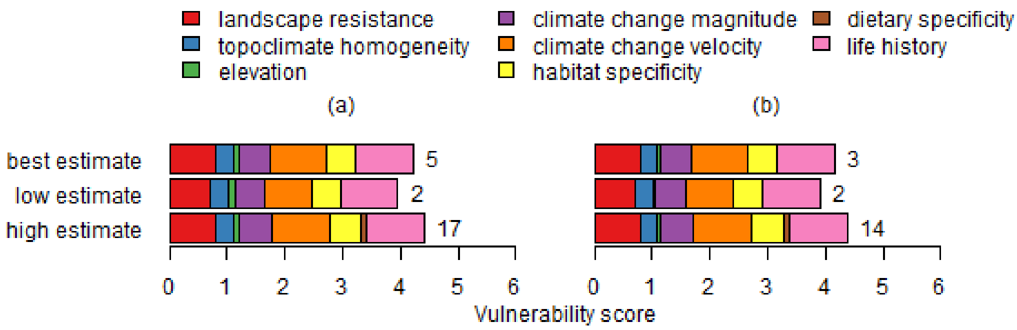

Figure AVIII. 3.3.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

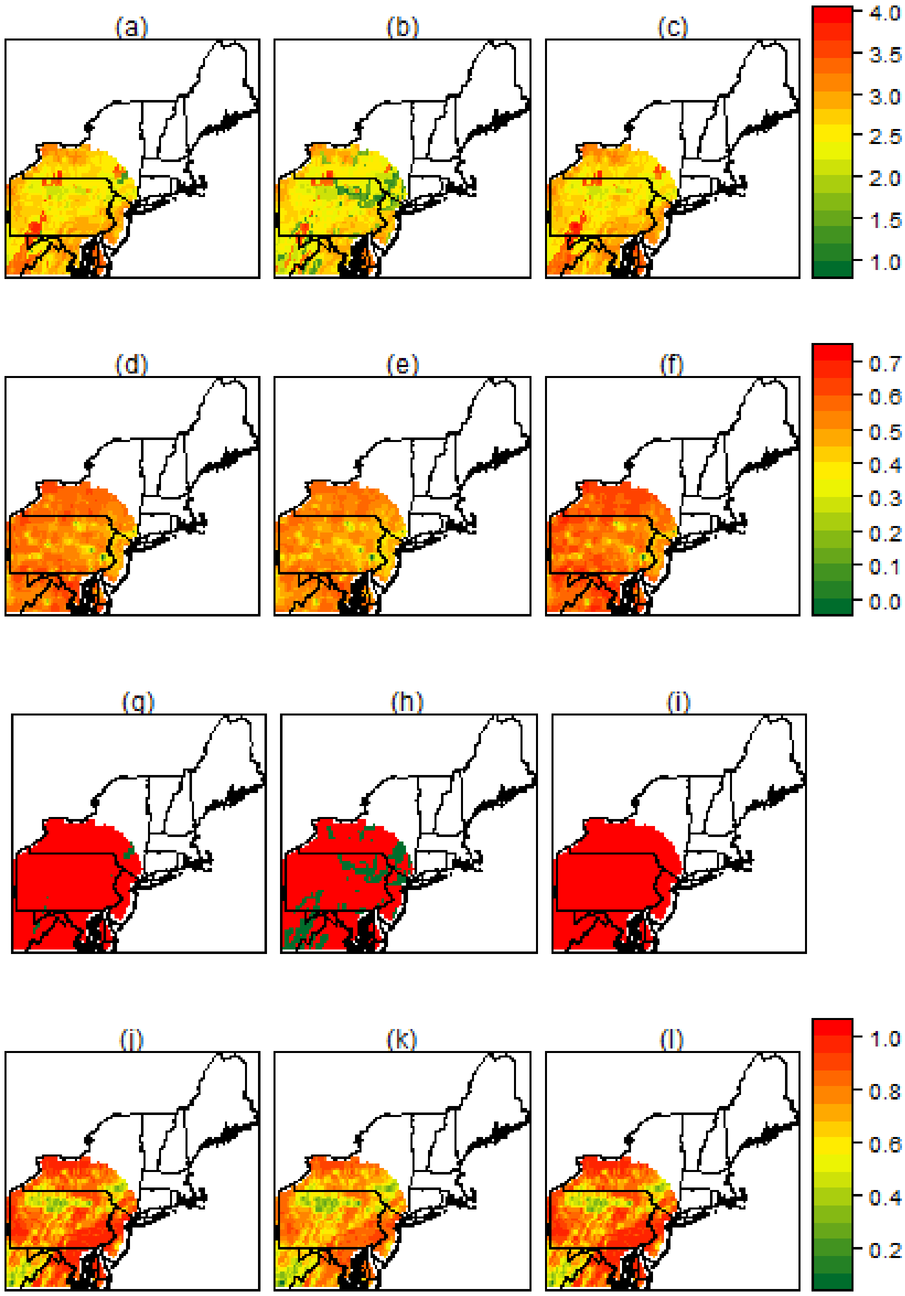

Figure AVIII. 3.3.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

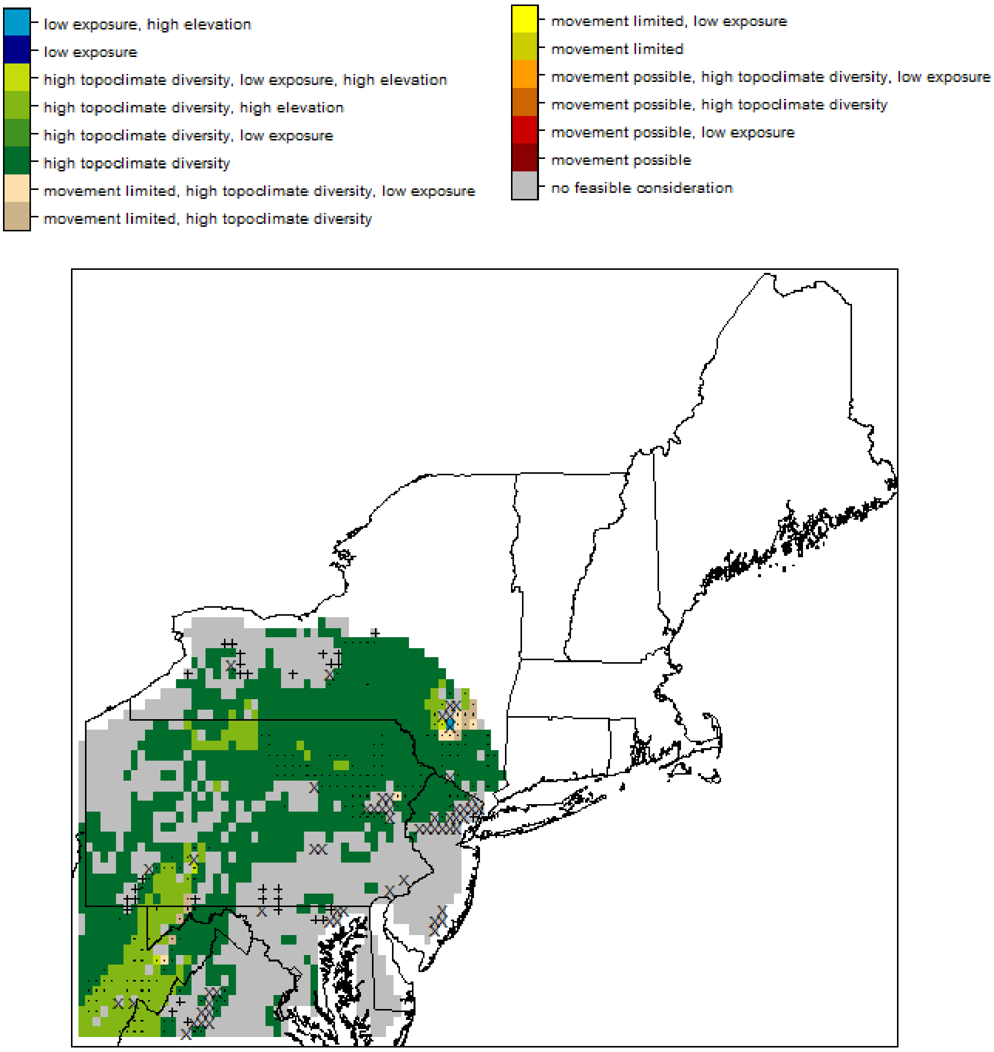

Figure AVIII. 3.3.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

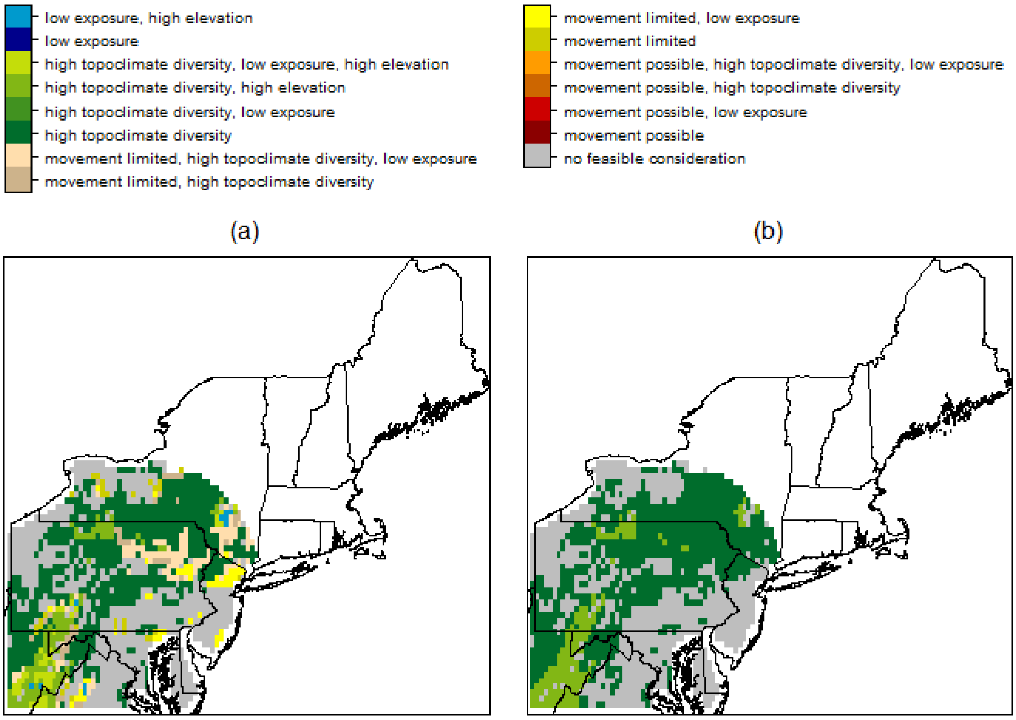

Figure AVIII. 3.3.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.4 Silver-haired bat (*Lasionycteris noctivagans*)

Table AVIII. 3.4.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.12	0.50	0.66	0.12	1.00	3.25
low	0.00	0.50	0.59	0.00	1.00	0.00
high	0.32	0.50	0.73	0.25	1.00	65.00

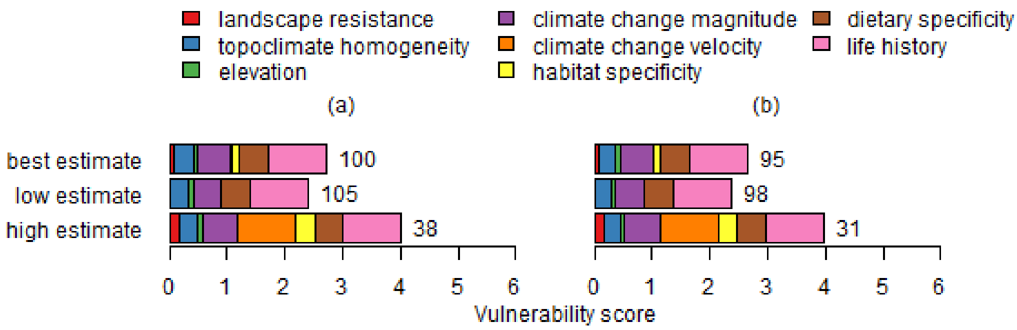

Figure AVIII. 3.4.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

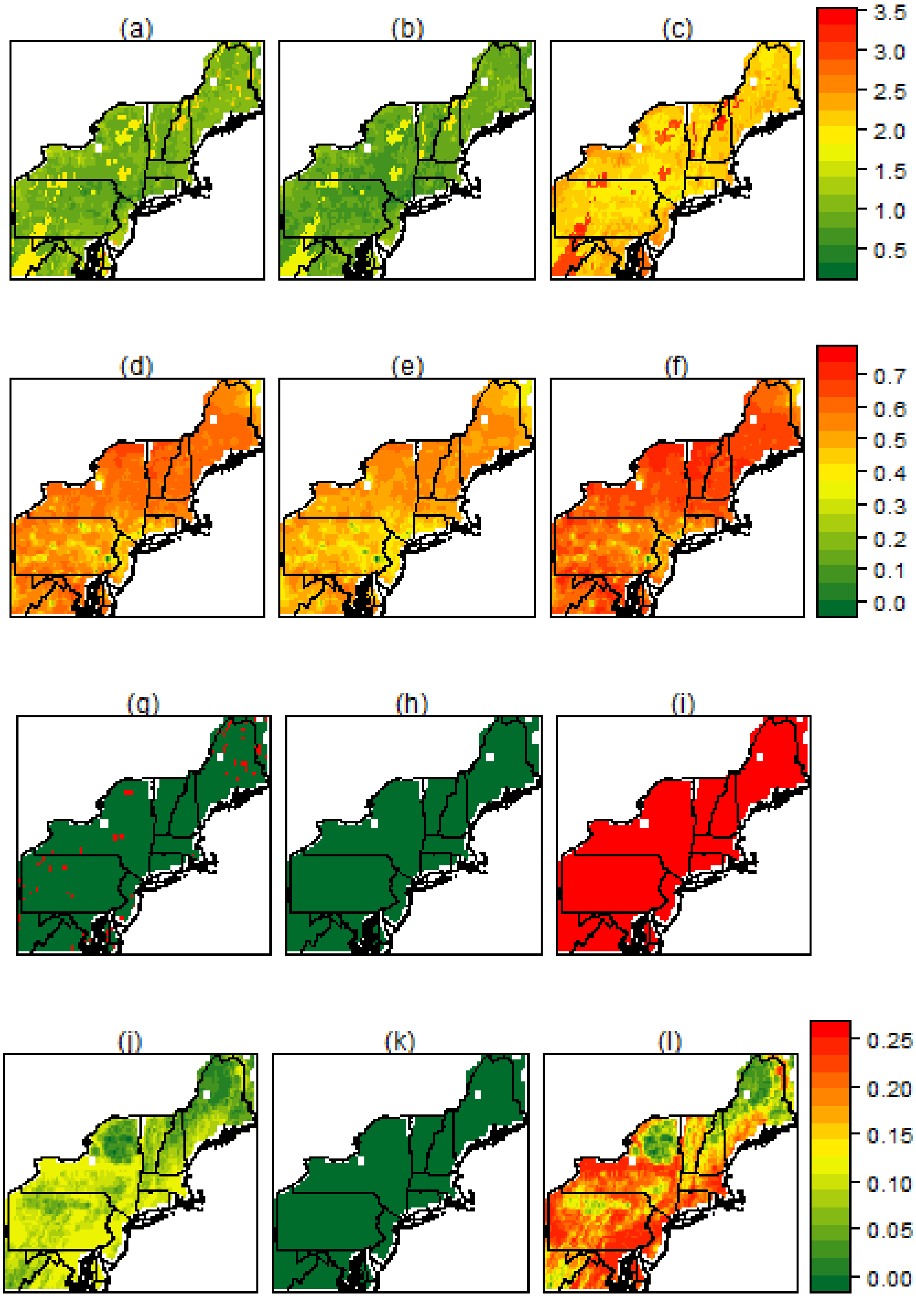

Figure AVIII. 3.4.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

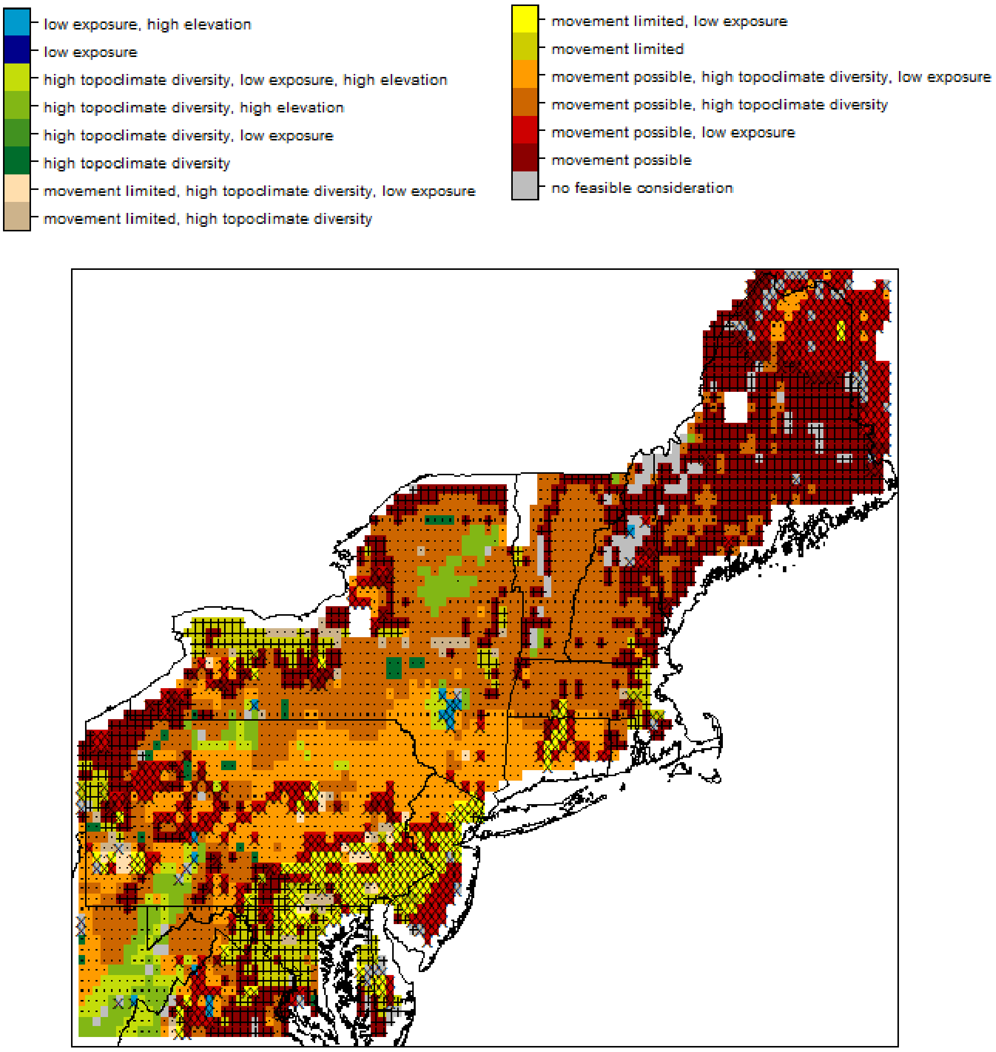

Figure AVIII. 3.4.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

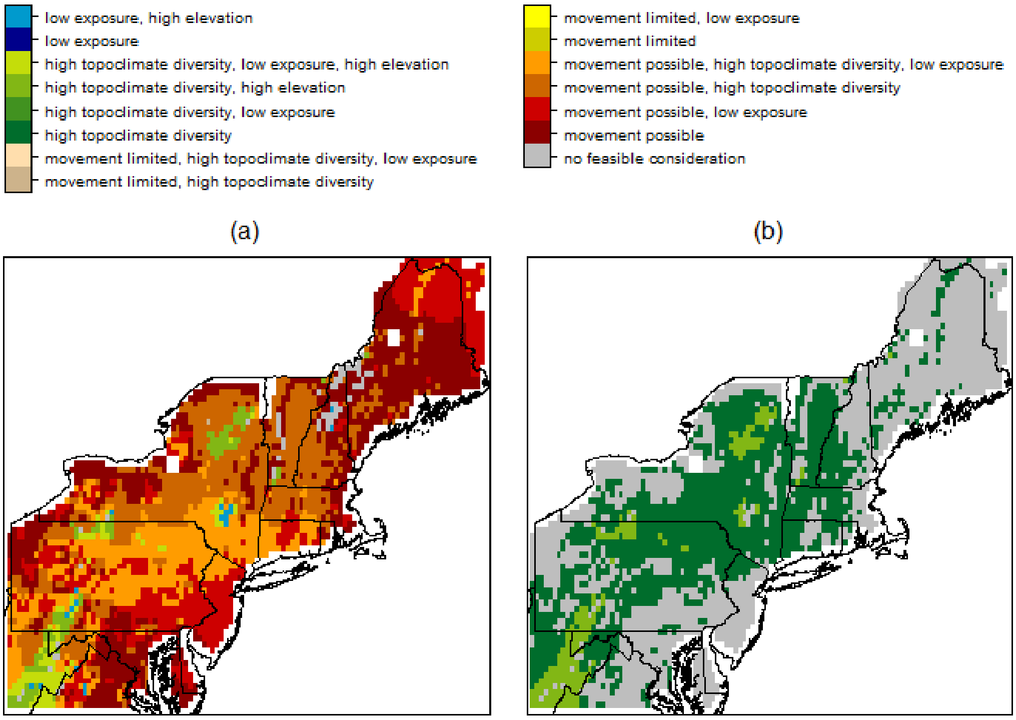

Figure AVIII. 3.4.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.5 Eastern red bat (*Lasiurus borealis*)

Table AVIII. 3.5.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.00	0.50	0.66	0.12	1.00	3.25
low	0.00	0.50	0.59	0.00	1.00	0.00
high	0.05	0.50	0.73	0.25	1.00	65.00

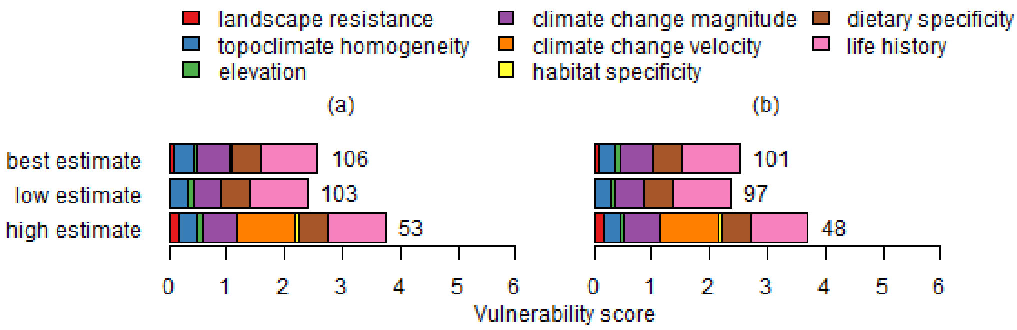

Figure AVIII. 3.5.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

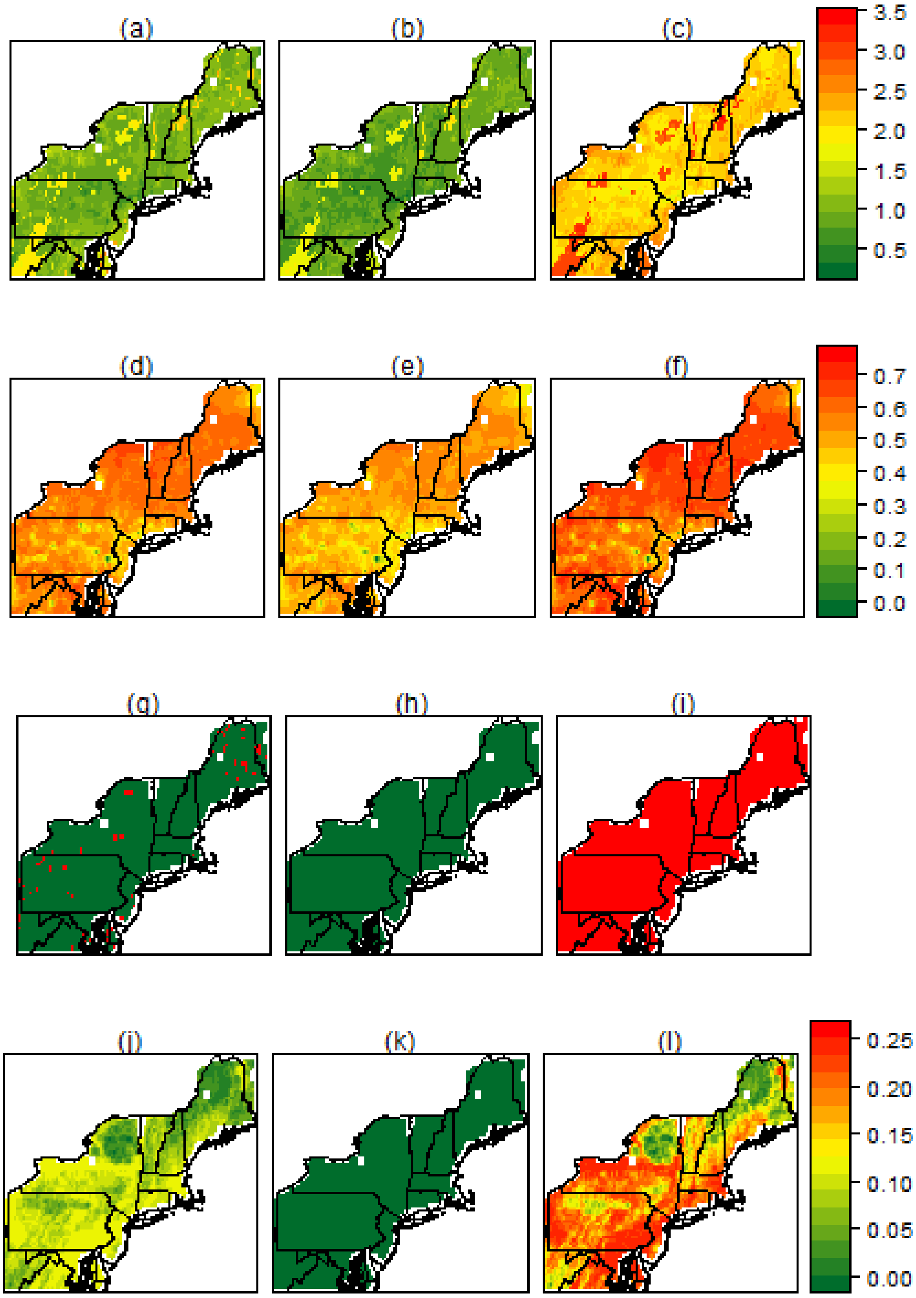

Figure AVIII. 3.5.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

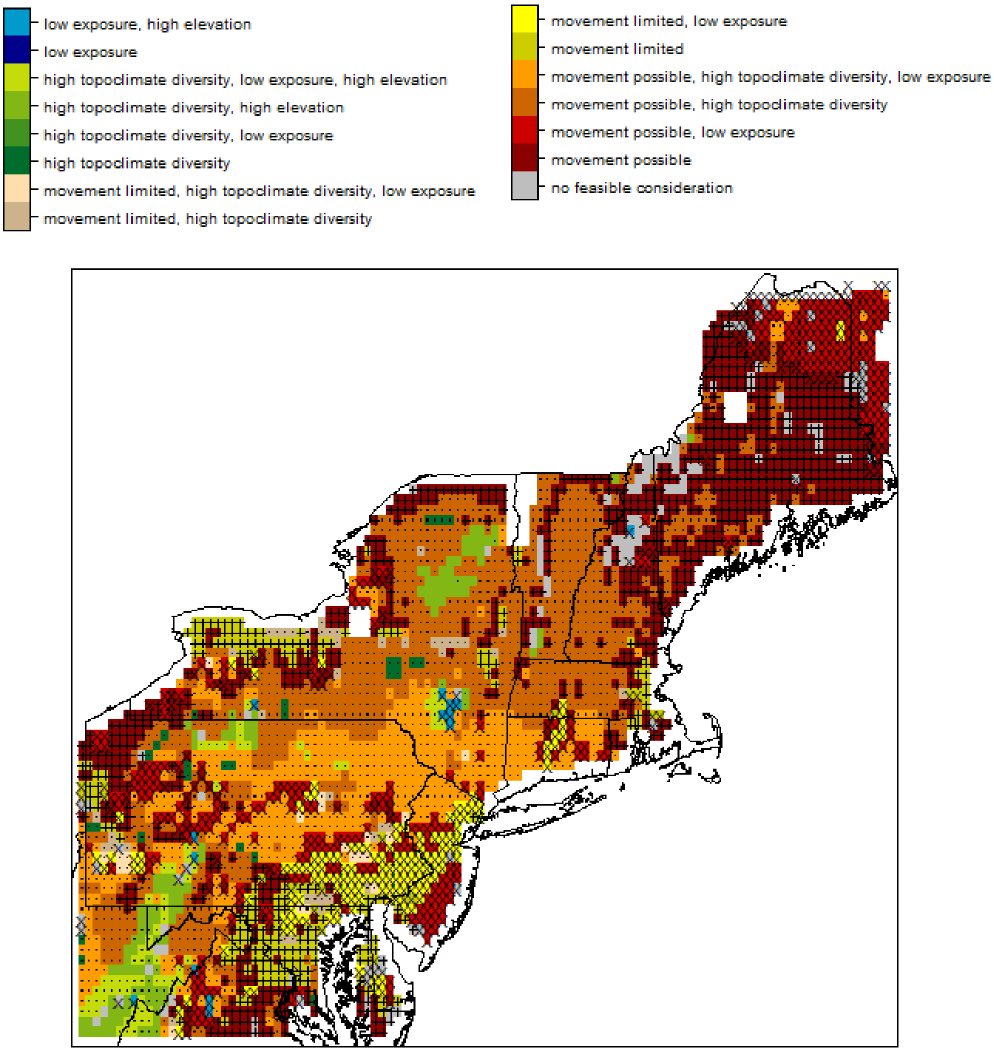

Figure AVIII. 3.5.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

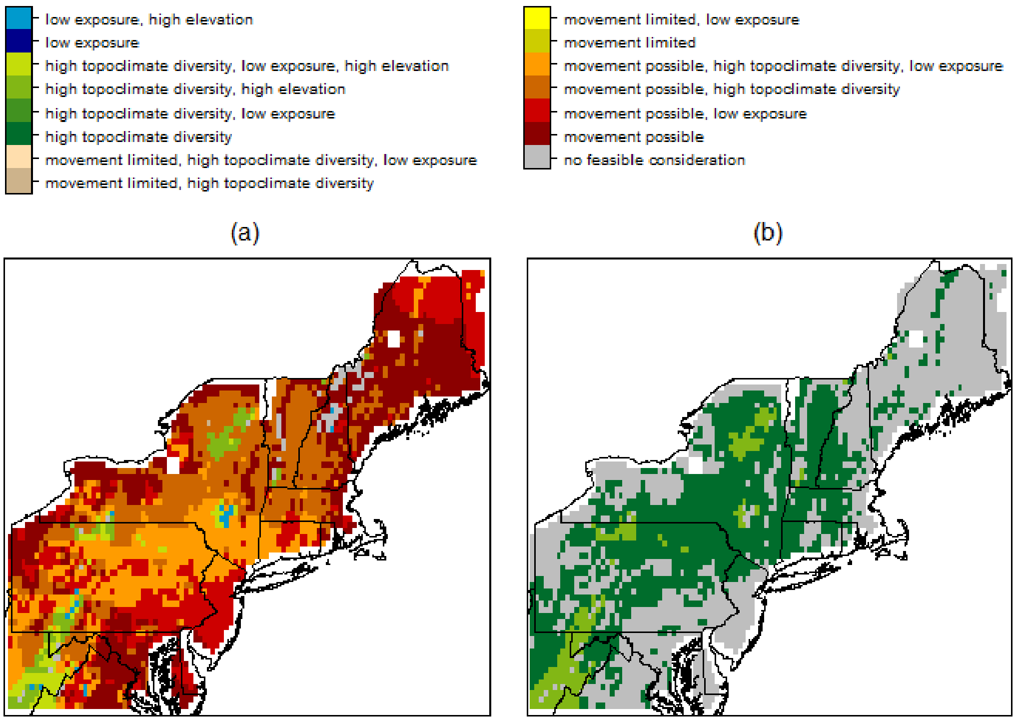

Figure AVIII. 3.5.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.6 Hoary bat (*Lasiurus cinereus*)

Table AVIII. 3.6.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.00	0.50	0.66	0.12	1.00	3.25
low	0.00	0.50	0.59	0.00	1.00	0.00
high	0.05	0.50	0.73	0.25	1.00	65.00

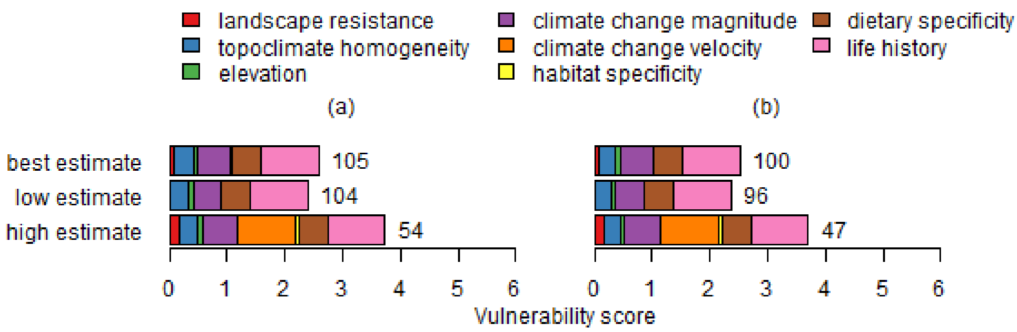

Figure AVIII. 3.6.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

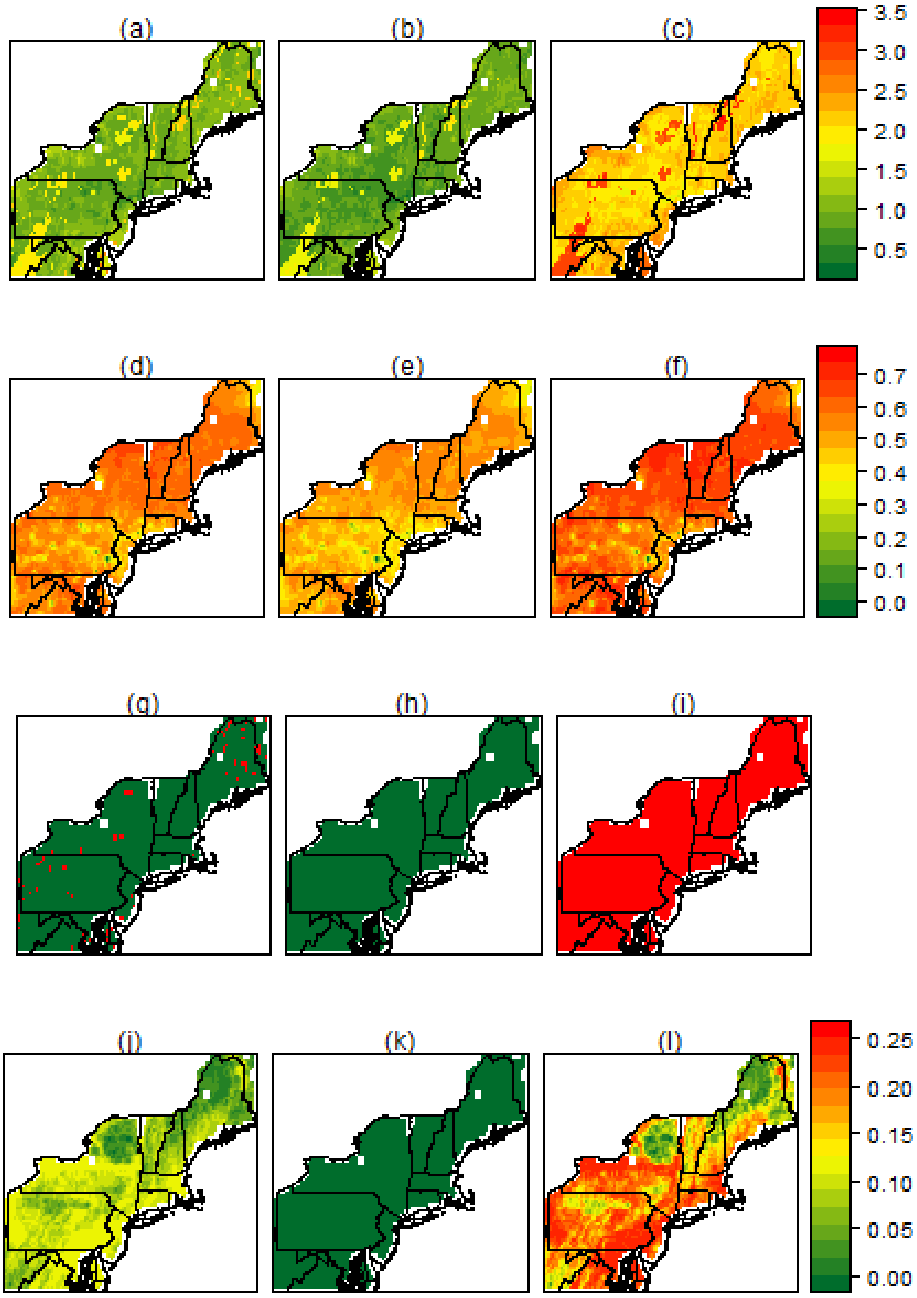

Figure AVIII. 3.6.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

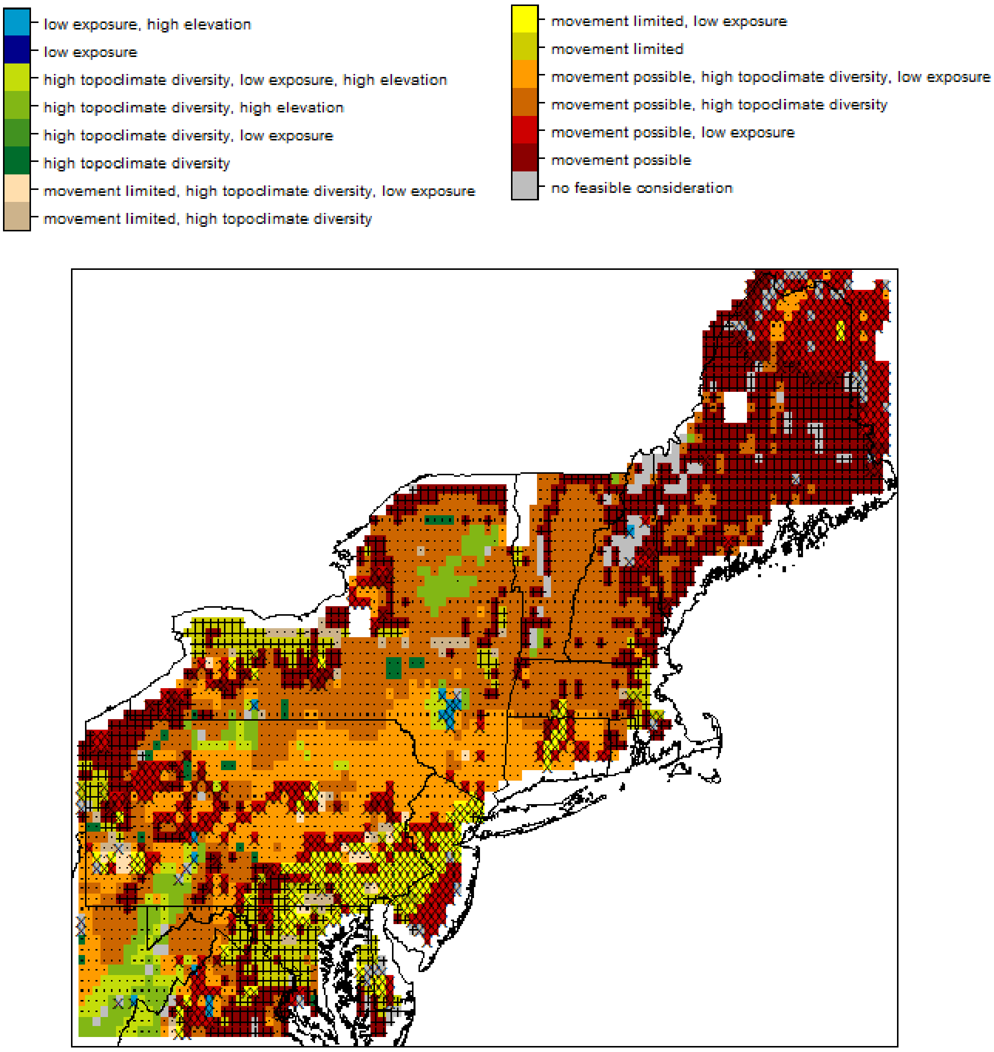

Figure AVIII. 3.6.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

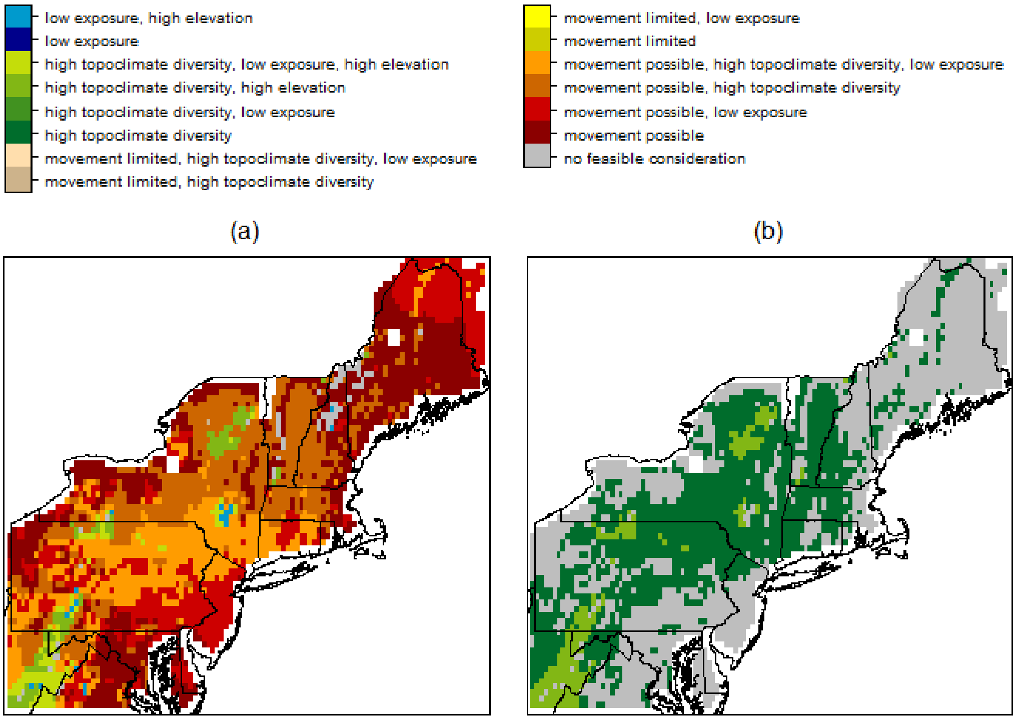

Figure AVIII. 3.6.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.7 Small-footed bat (*Myotis leibii*)

Table AVIII. 3.7.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.66	0.00	1.00	3.25
low	0.50	0.50	0.52	0.00	1.00	0.00
high	0.50	0.50	0.81	0.00	1.00	65.00

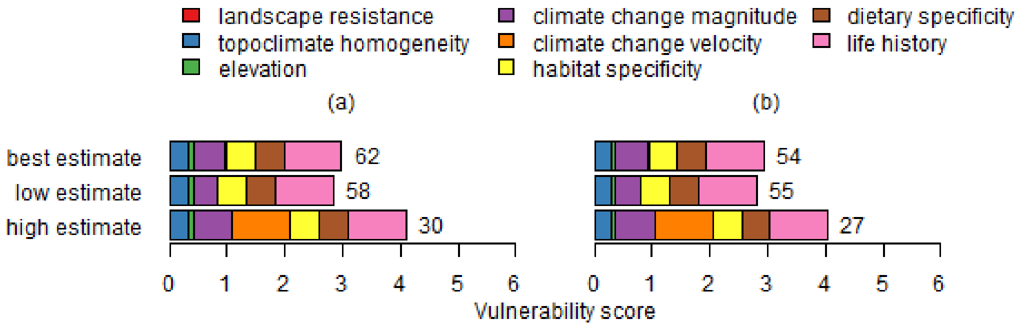

Figure AVIII. 3.7.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

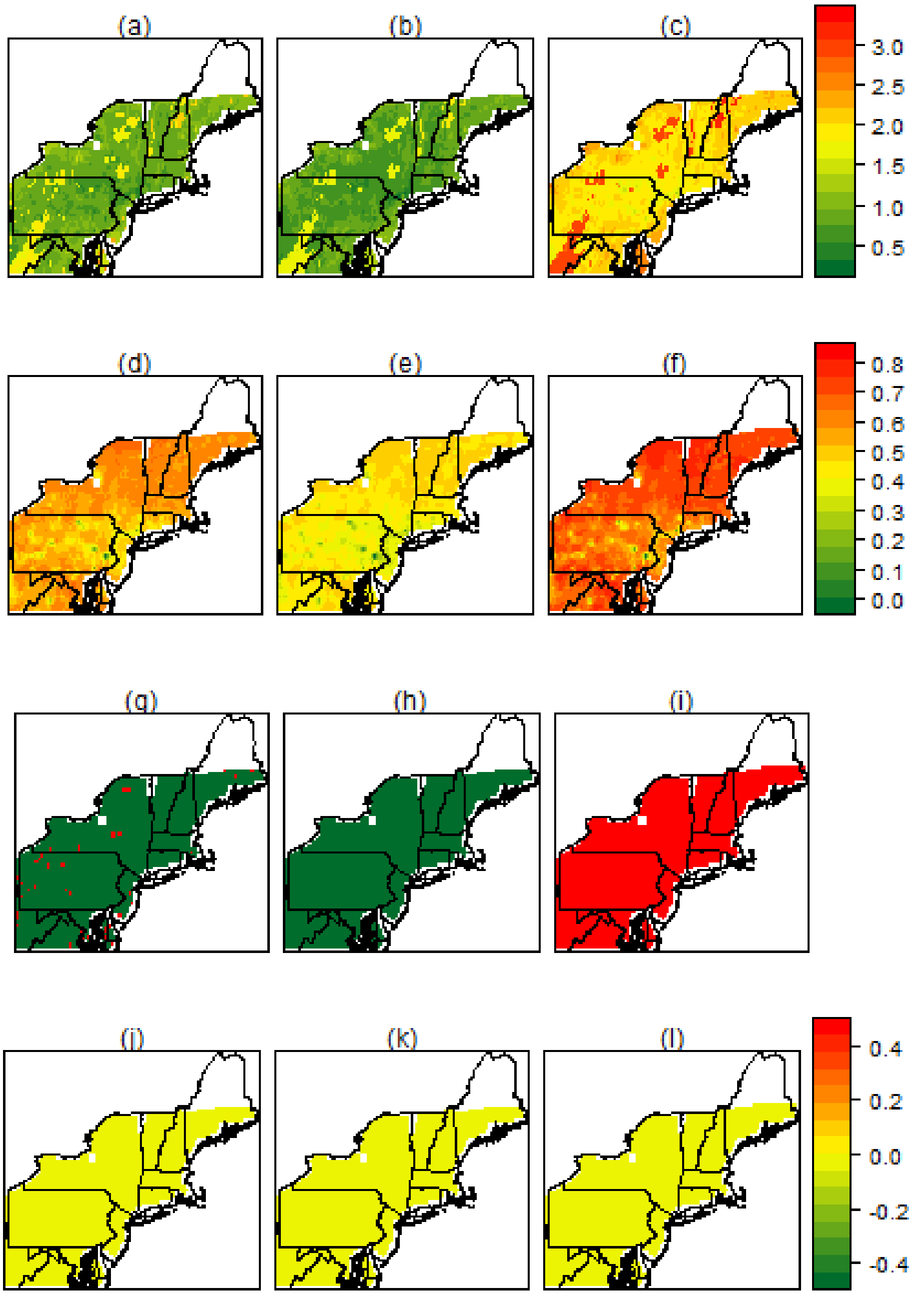

Figure AVIII. 3.7.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

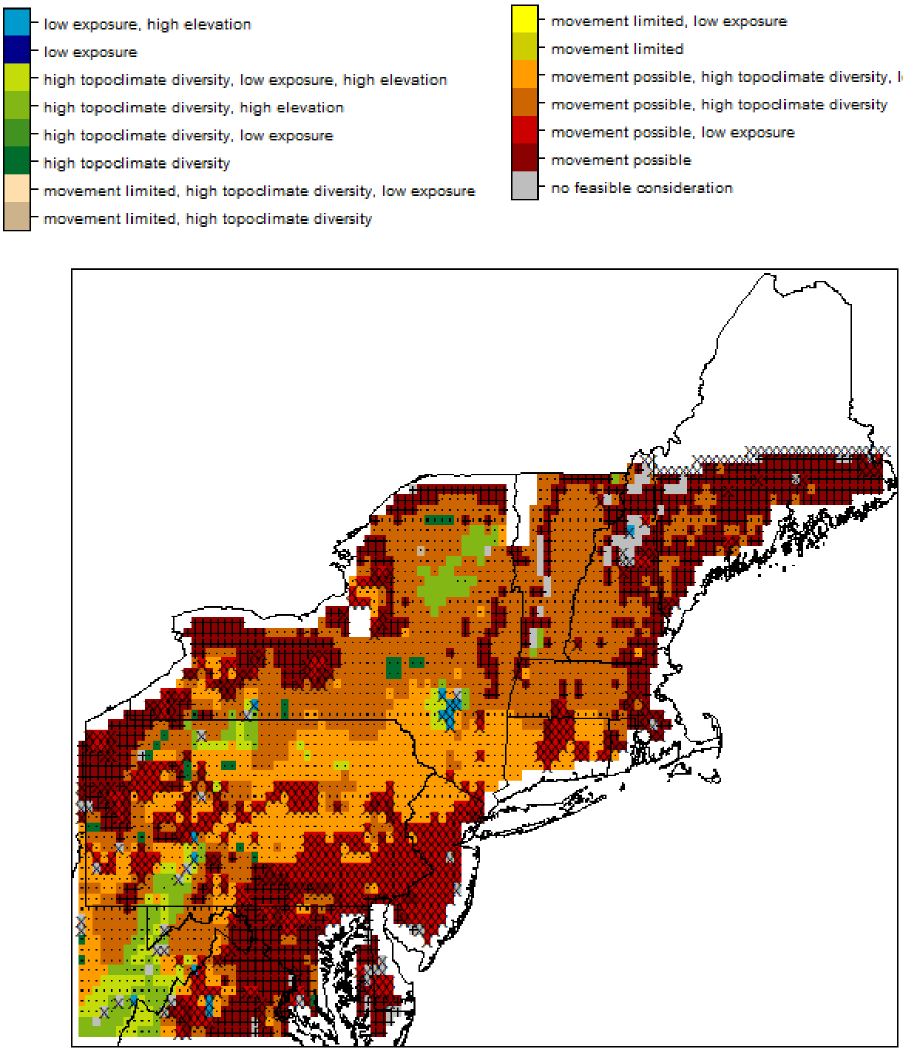

Figure AVIII. 3.7.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

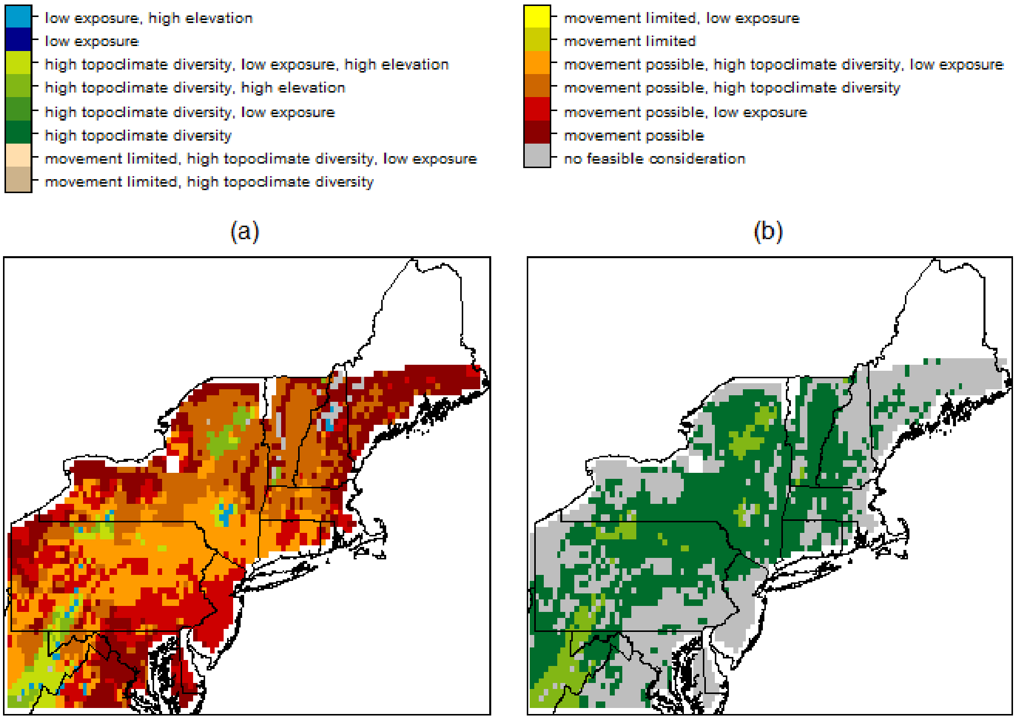

Figure AVIII. 3.7.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.8 Indiana bat (*Myotis sodalis*)

Table AVIII. 3.8.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.50	0.78	0.33	1.00	3.25
low	0.50	0.50	0.48	0.30	1.00	0.00
high	0.77	0.50	0.88	0.37	1.00	65.00

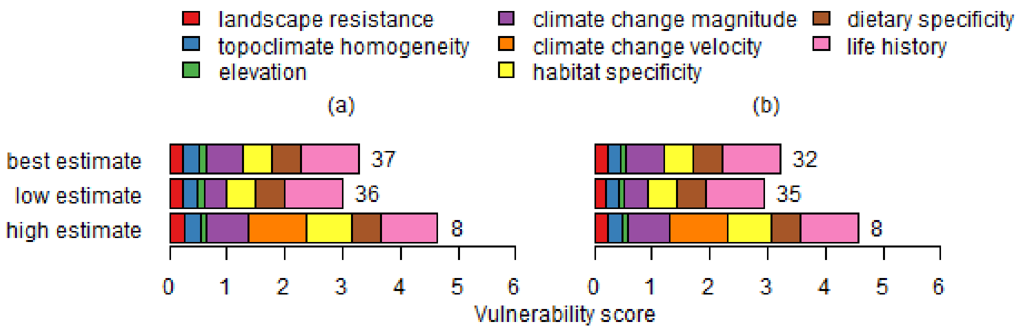

Figure AVIII. 3.8.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

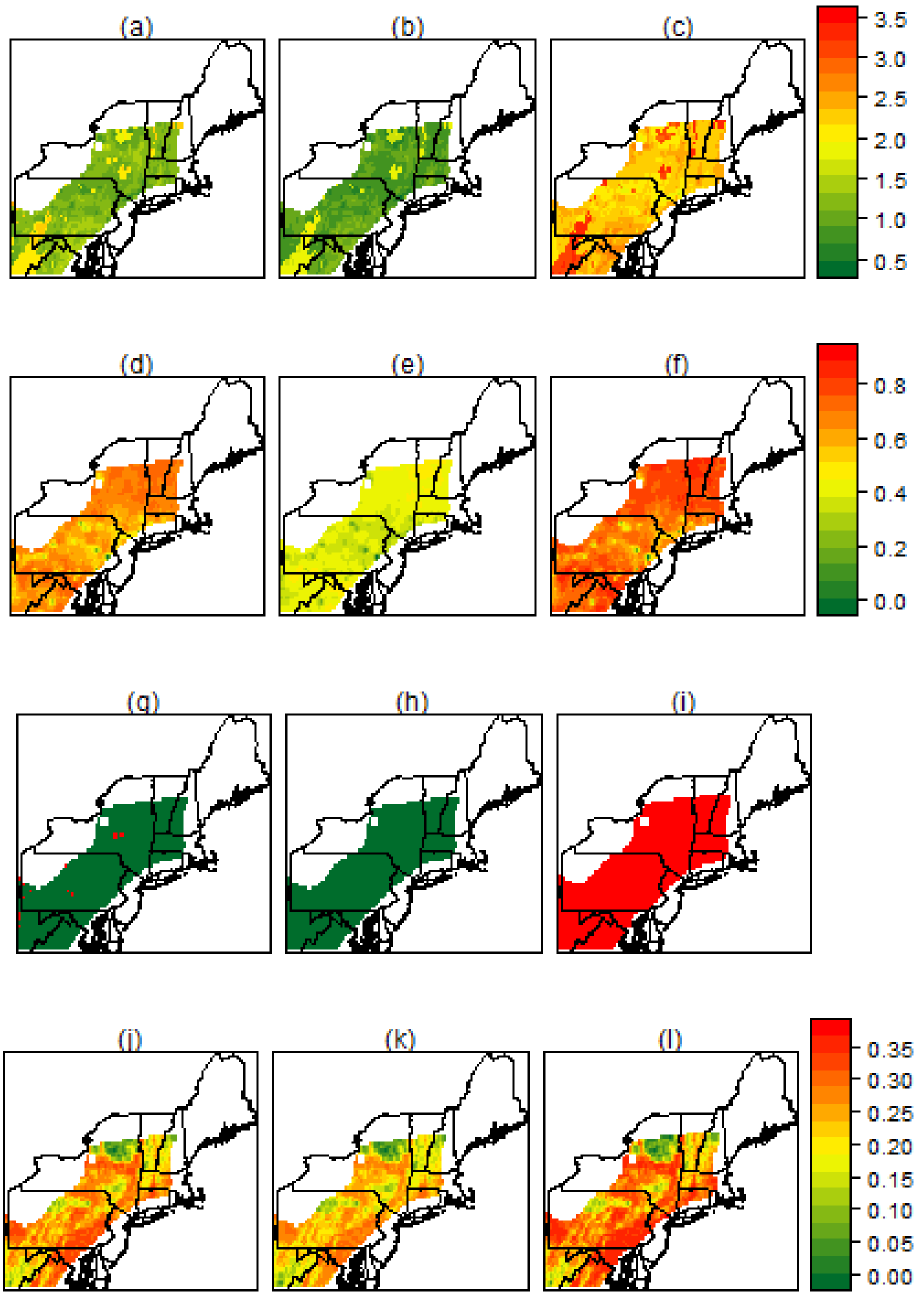

Figure AVIII. 3.8.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

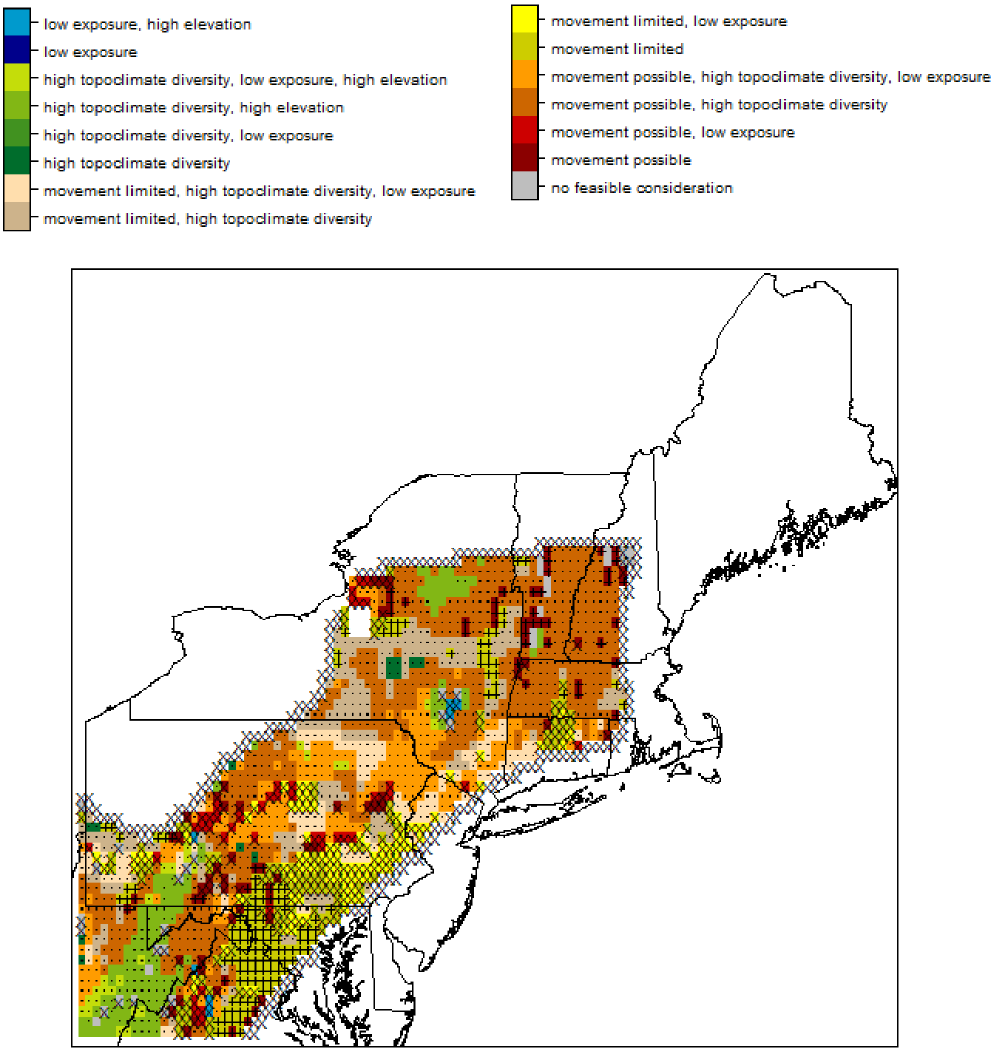

Figure AVIII. 3.8.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

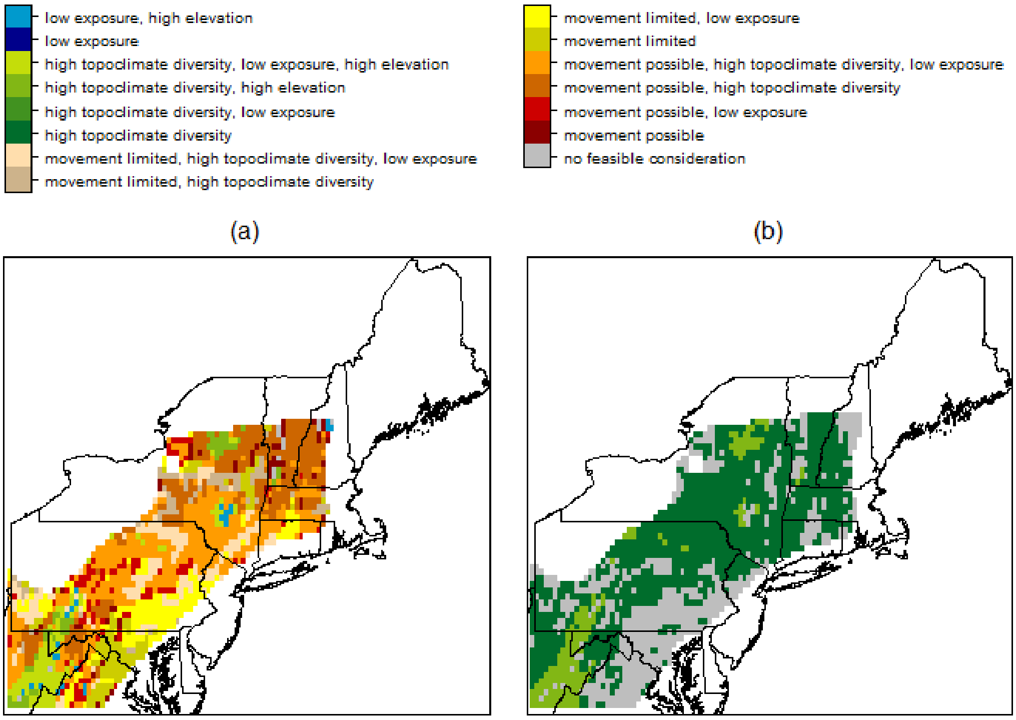

Figure AVIII. 3.8.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.9 Canada lynx (*Lynx canadensis*)

Table AVIII. 3.9.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	1.00	0.83	0.25	1.00	77.50
low	0.50	0.17	0.83	0.08	1.00	26.00
high	0.55	0.94	0.90	0.49	1.00	757.50

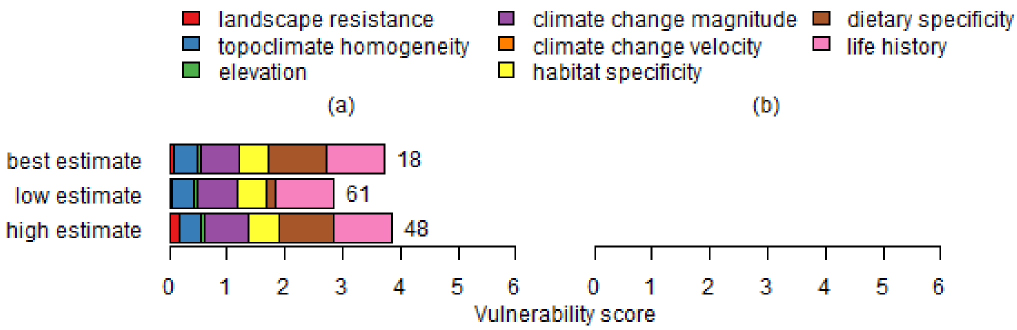

Figure AVIII. 3.9.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

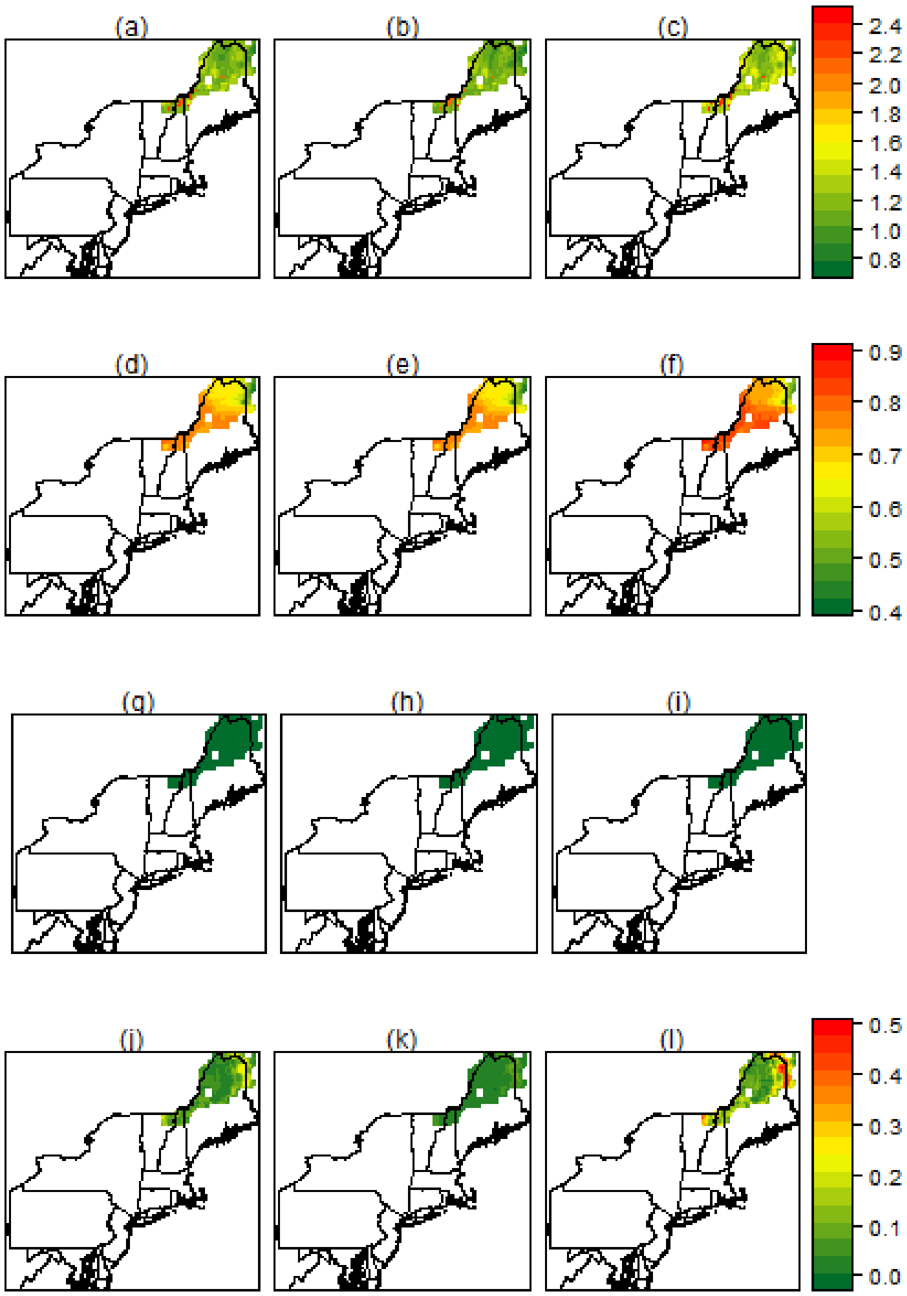

Figure AVIII. 3.9.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

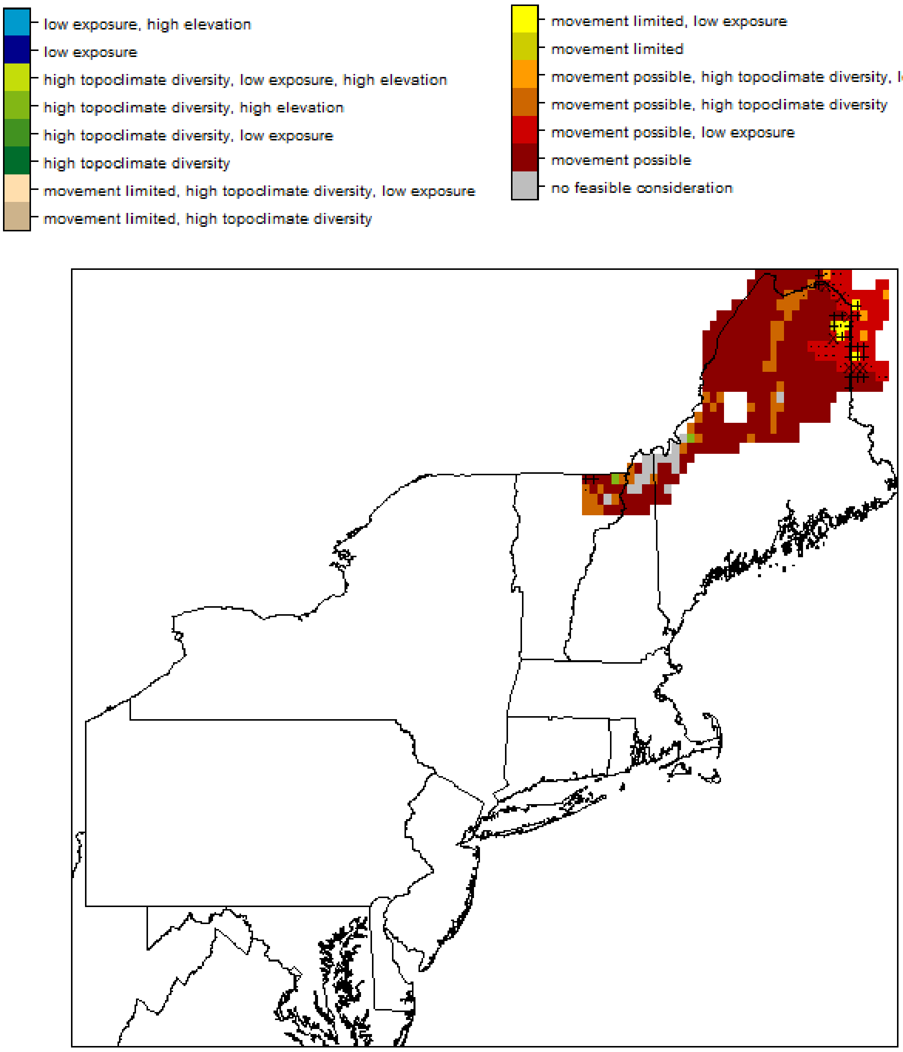

Figure AVIII. 3.9.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

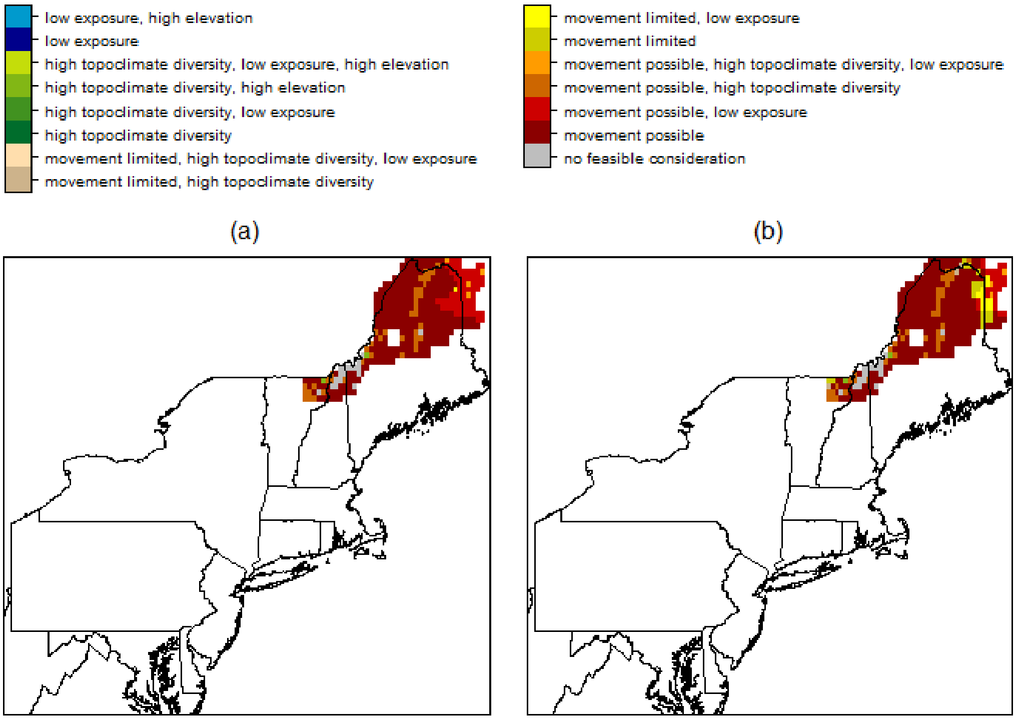

Figure AVIII. 3.9.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.10 River otter (*Lontra canadensis*)

Table AVIII. 3.10.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Dispersal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	1.00	0.50	0.66	0.00	1.00	4.00
low	0.33	0.50	0.66	0.00	1.00	2.00
high	0.89	0.50	0.69	0.62	1.00	10.00

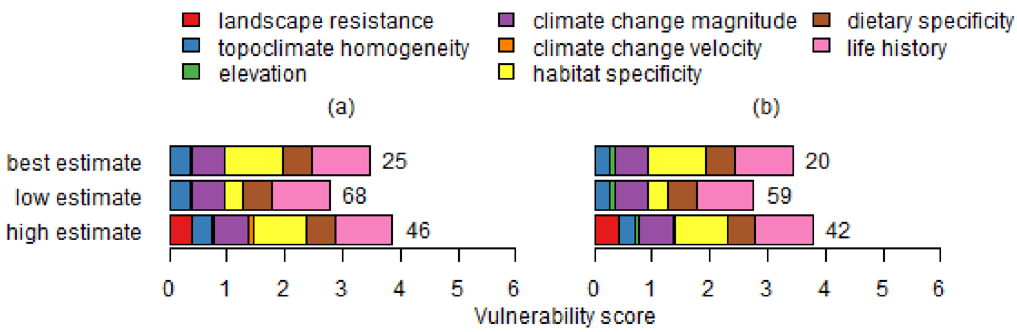

Figure AVIII. 3.10.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

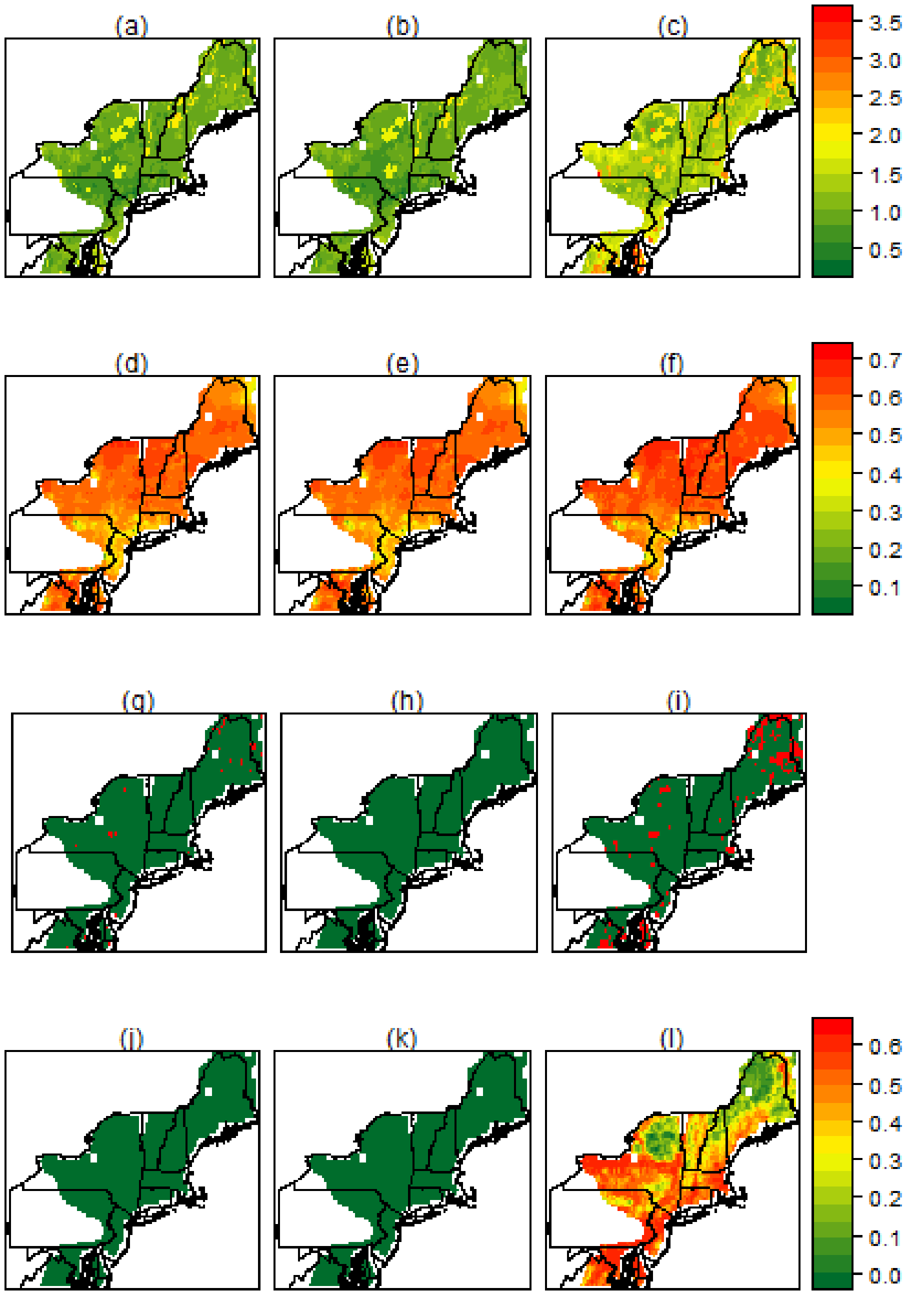

Figure AVIII. 3.10.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

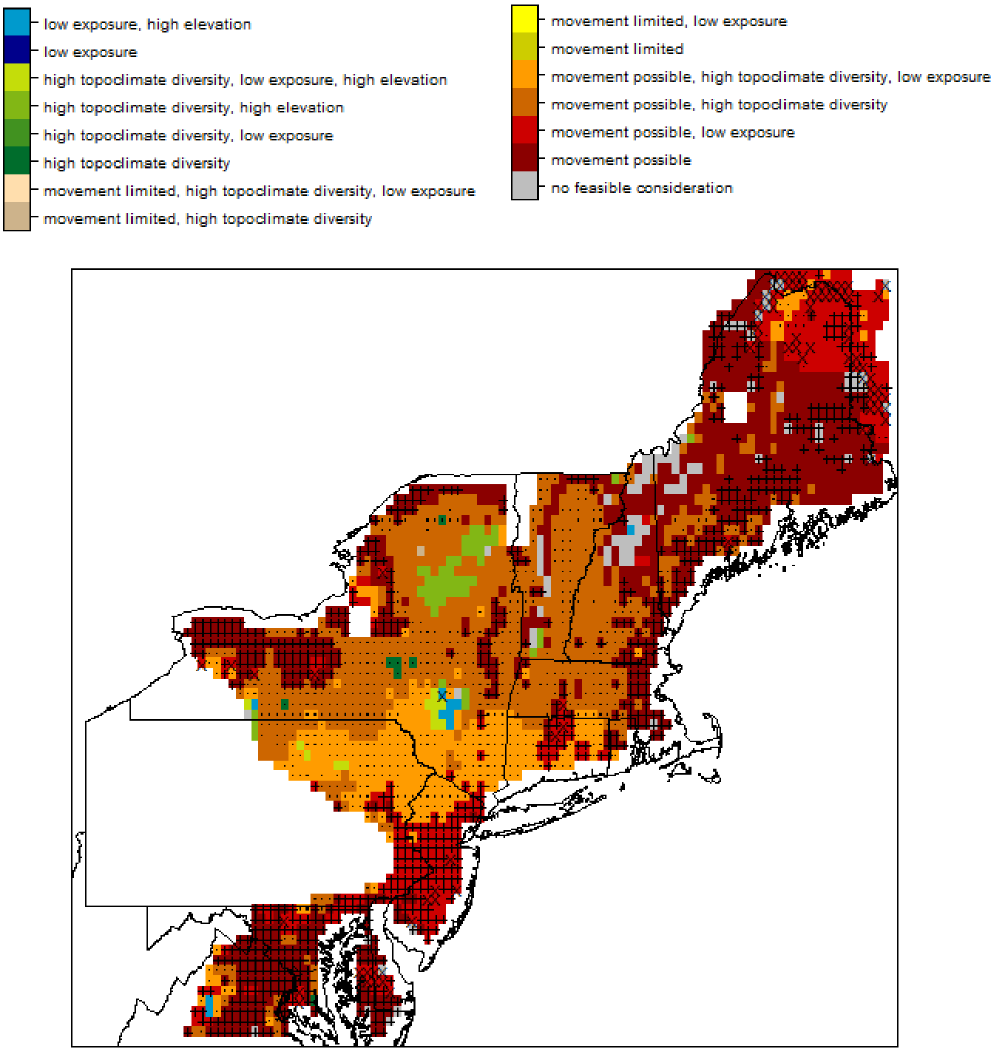

Figure AVIII. 3.10.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

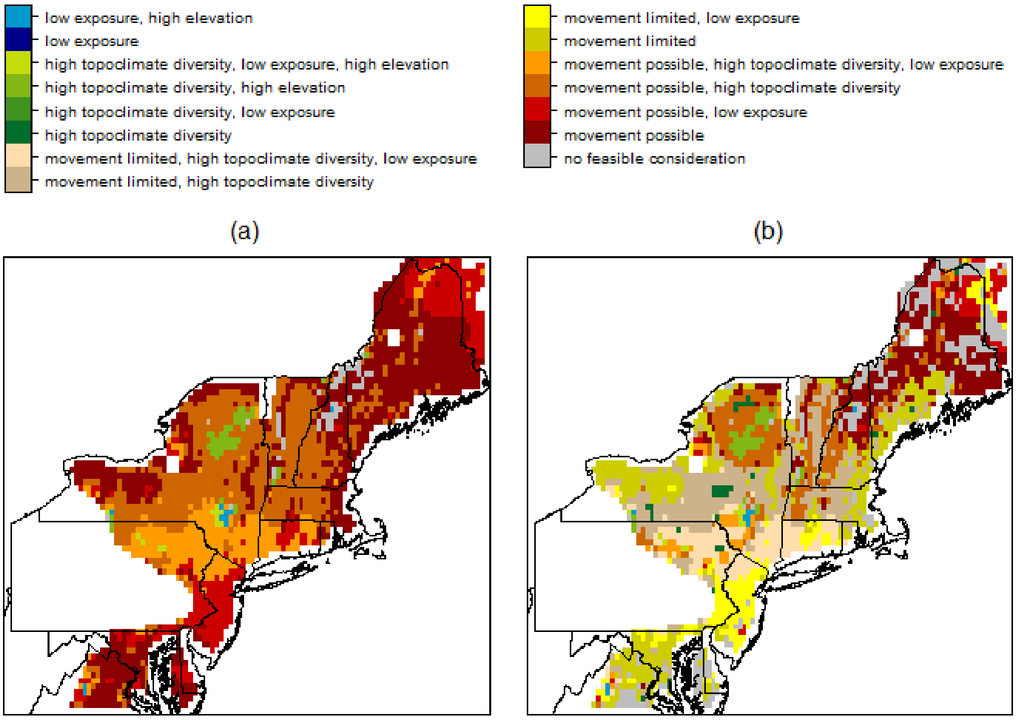

Figure AVIII. 3.10.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.11 American marten (*Martes americana*)

Table AVIII. 3.11.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.00	1.00	0.50	1.00	15.00
low	0.45	0.00	0.93	0.40	1.00	10.00
high	0.50	0.00	1.00	0.50	1.00	40.00

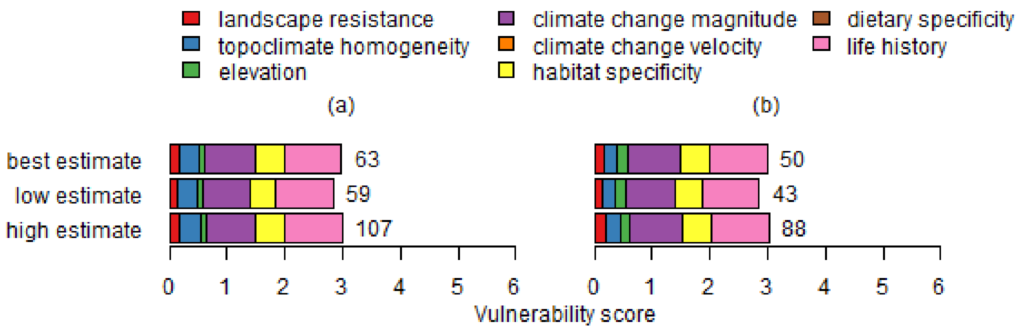

Figure AVIII. 3.11.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

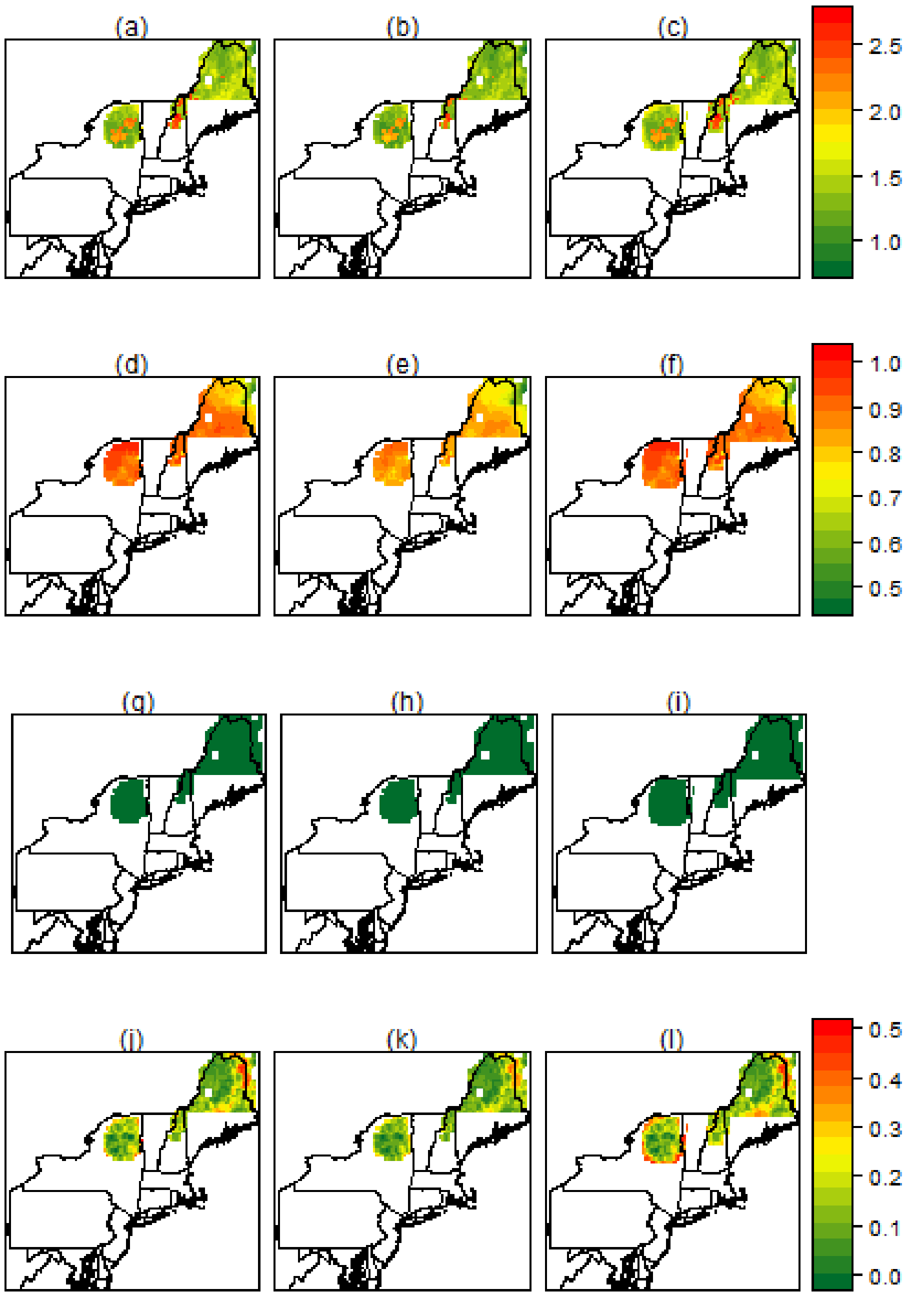

Figure AVIII. 3.11.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

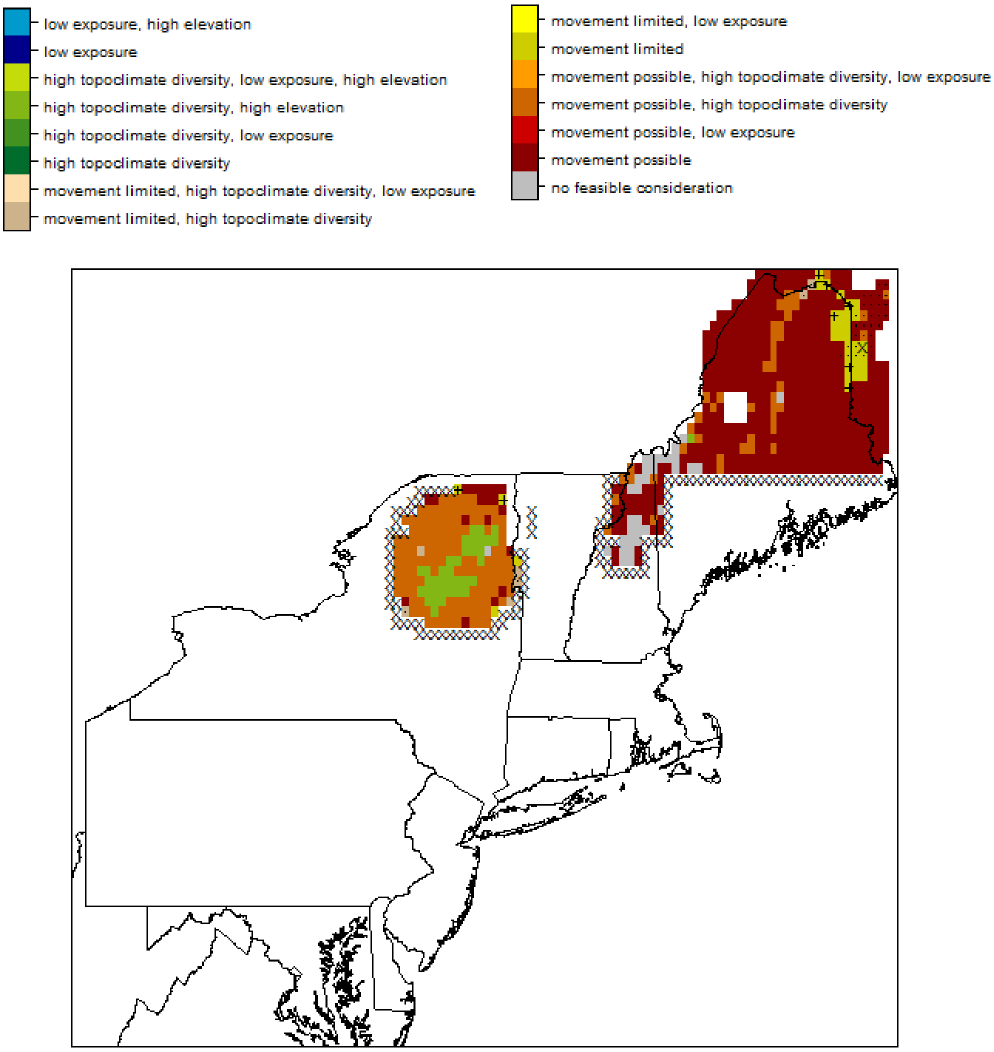

Figure AVIII. 3.11.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

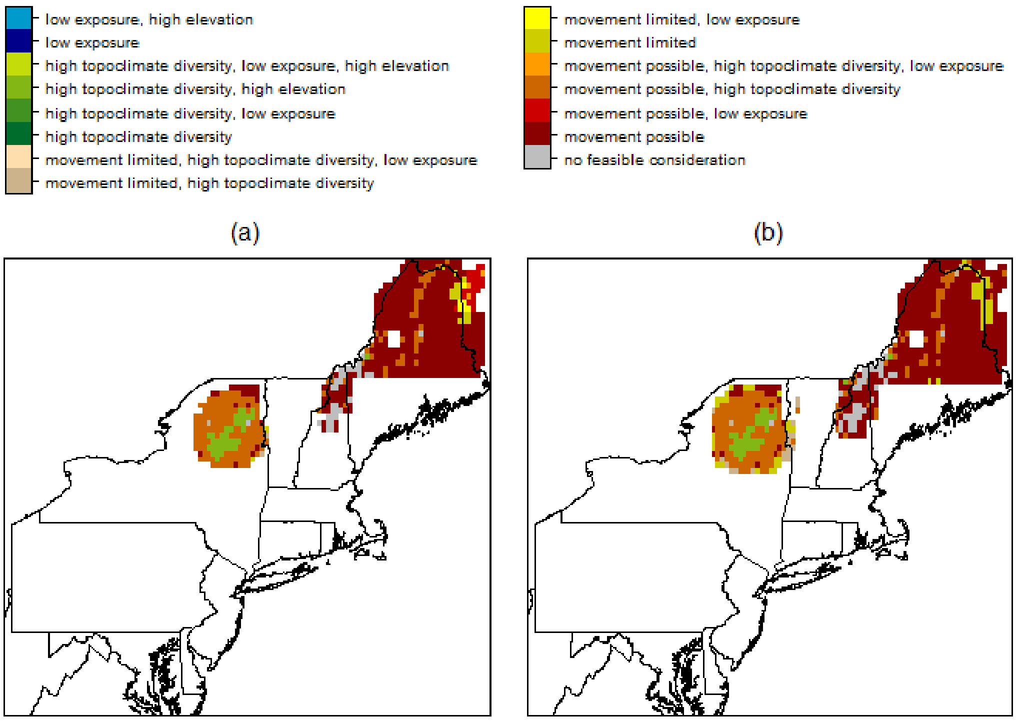

Figure AVIII. 3.11.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

3.12 Least weasel (*Mustela nivalis*)

Table AVIII. 3.12.1. Estimates of trait values provided by experts for the species. The values presented are averaged across experts if more than one expert provided information for the species. The first five traits are scaled between zero and one, where zero suggests that the trait will make the species least vulnerable and one suggests that the trait will make the species most vulnerable to climate change.

	Habitat Specificity (0-1)	Dietary Specificity (0-1)	Physiological Tolerance (0-1)	Sensitivity to Disperal Barriers (0-1)	Life History (0-1)	Dispersal Distance (km)
best	0.50	0.00	0.66	0.00	1.00	0.50
low	0.50	0.00	0.66	0.00	1.00	0.10
high	0.60	1.00	0.69	0.10	1.00	3.00

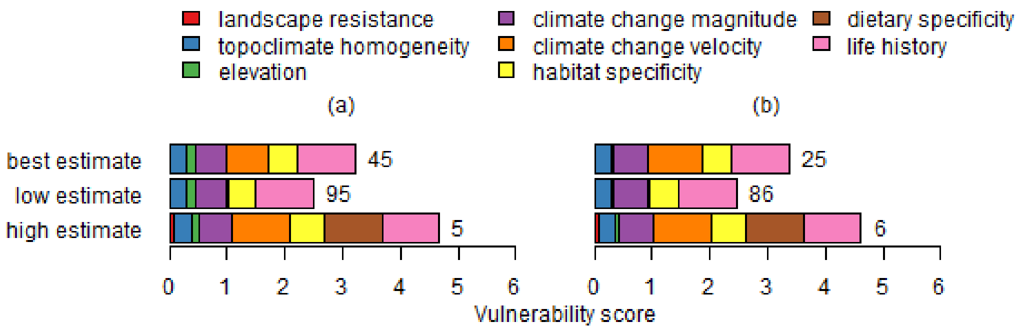

Figure AVIII. 3.12.1. The relative vulnerability score (and component scores) for the species in (a) the northeastern United States and (b) New York State (if the species occurs in New York State). Each component has a maximum value of one (most vulnerable). The best, low, and high estimates are estimates based on experts' best, low, and high estimate of species traits. The number to the right of each bar is the relative vulnerability rank for the species relative to the other 113 species evaluated (where one is the most vulnerable species).

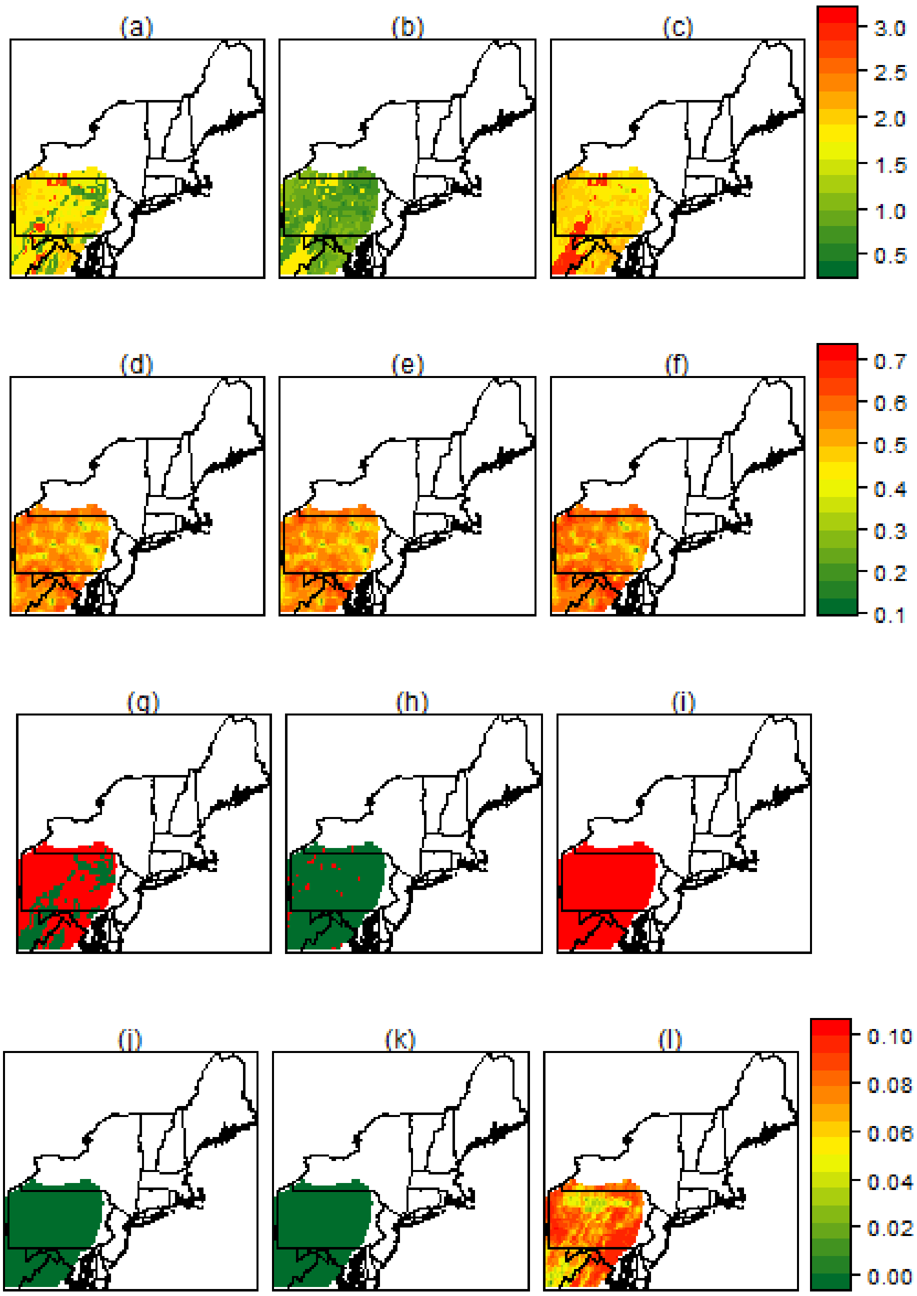

Figure AVIII. 3.12.2. (a, b, c) Species-specific landscape vulnerability and the components of vulnerability that rely on species-trait data, including: (d, e, f) climate change magnitude weighted by the species physiological tolerance, (g, h, i) climate change velocity reclassified into areas where the species is unlikely to be able to keep pace with climate change (red cells), and (j, k, l) local landscape resistance weighted by the species sensitivity to dispersal barriers. The three columns are based on data from experts' (a, d, g, j) best, (b, e, h, k) low, and (c, f, i, l) high estimates of species traits. In all plots red indicates the highest and green the lowest vulnerability.

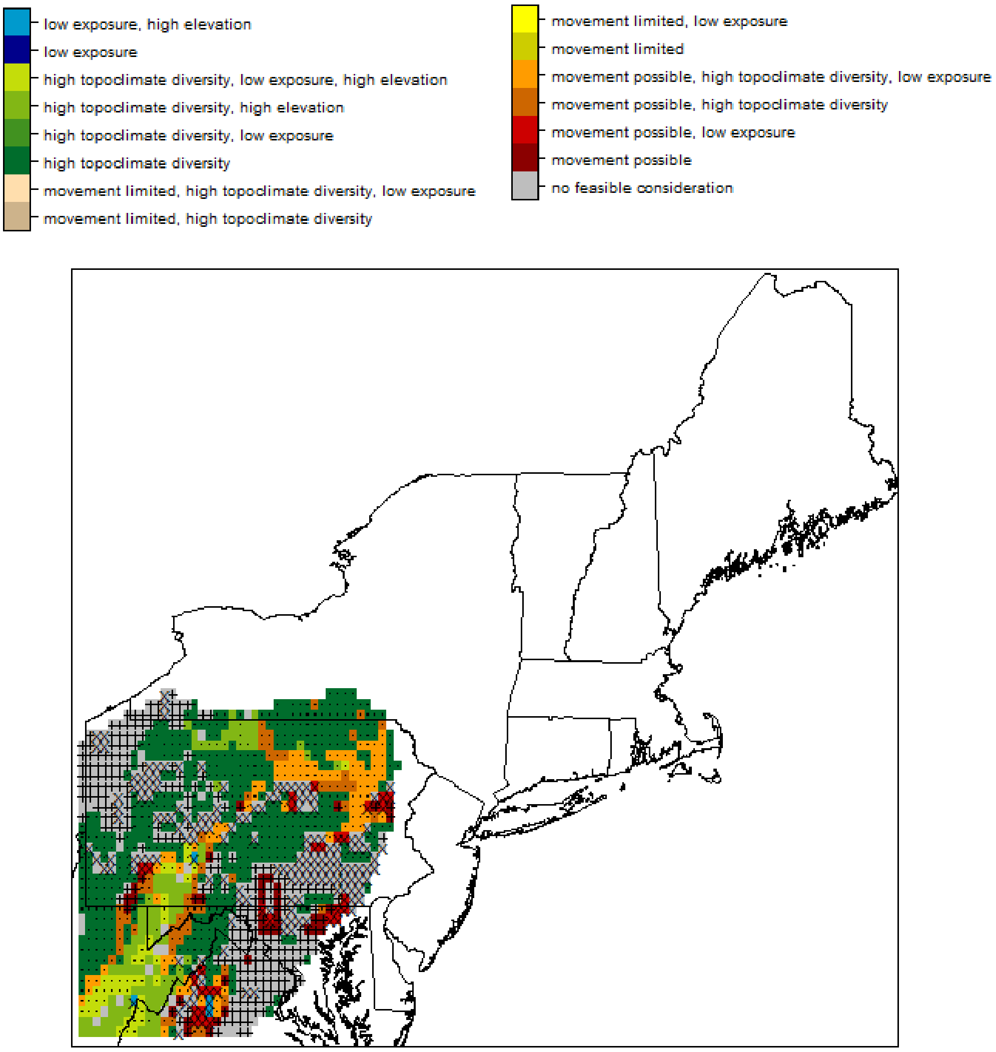

Figure AVIII. 3.12.3. Climate-smart management considerations for the species given experts' best estimate of species traits. See Tables 2.2 and 2.3 for definitions of the management considerations. Stippling in each landscape cell represents three levels of uncertainty caused by differences among maps produced using experts' best, low, and high estimates of species traits: (.) uncertainty in exposure or one of the two other considerations in the cell, (+) uncertainty in the management consideration, and (X) uncertainty in both the exposure and the management consideration.

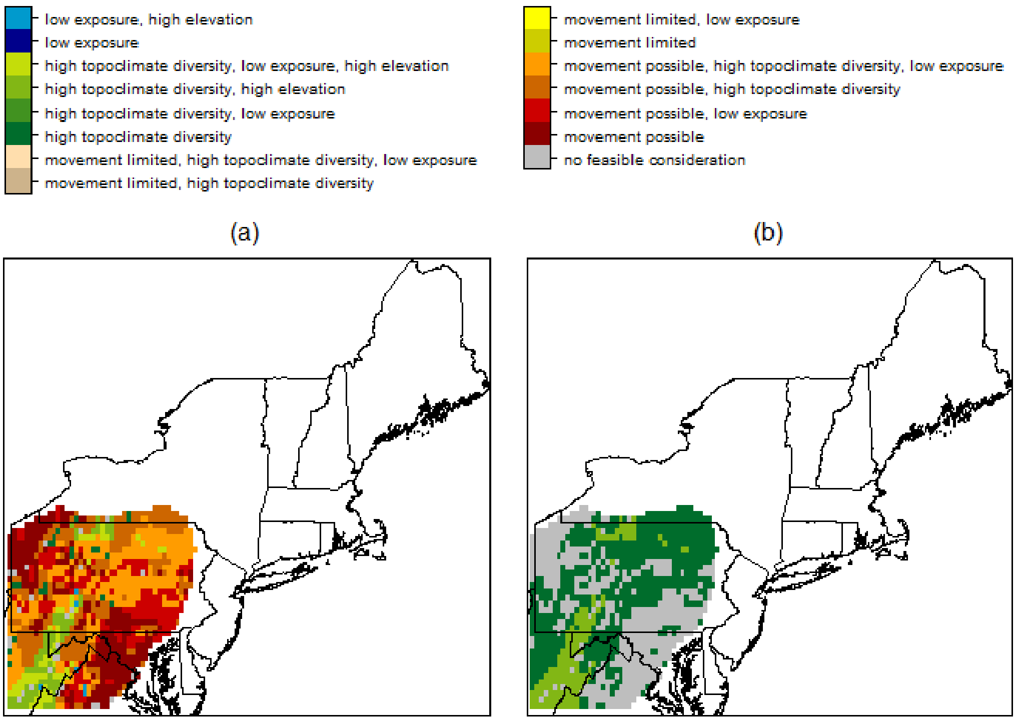

Figure AVIII. 3.12.4. Climate-smart management considerations for the species given experts' (a) low and (b) high estimates of species traits. See Tables 2.2 and 2.3 for definitions of the climate-smart management considerations.

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