Text S1. Description of Model Iteration (Round One):

Maxent modeling. – We used 13 refugia occurrences in our initial Maxent model iteration (round one, 2019). Due to our small sample size, we limited model complexity by using only the variables *slope*, *topographical position index* (TPI), and *aspect* (See main text and Table 1) and specified only the linear (L) feature class in the Maxent. All other Maxent settings remained at their default values. We evaluated the relative performance of the model using the area under the curve (AUC) of the receiver operating characteristic (Hanley & McNeil, 1982) and examination of observed versus predicted test omission rates (See main text for description). Due to our small sample size, we used a bootstrapping approach. The training data was selected by randomly sampling the occurrence records with replacement (with the number of samples equaling the total number of occurrence records) and testing the model on the occurrence records not selected. We repeated the bootstrapping procedure for 100 replicate runs and reported the results for an averaged model ± one standard deviation of the replicate runs. Finally, we generated a Clog-log transformed raster from the averaged model representing the predicted probability of suitable refugia habitat across Illinois.

We examined how each predictor variable affected the probability of suitable refugia habitat using the final averaged model's marginal response. The plot data was output by the Maxent software and then imported into R (R Core Team 2021) to create graphs using the package 'ggplot2' (Wickham et al., 2016). We also examined the relative importance of each variable in predicting suitable refugia habitat using jackknife tests and variable percent contributions, both output by Maxent.

The bootstrap-averaged top model received a mean AUC performance value of 0.92 (SD = 0.54), and the omission rate of training samples closely resembled the predicted omission rate (i.e., followed a straight line, Fig. S2), both suggesting good model fit. We provide the results for jackknife tests of variable importance (Fig. S2), the omission rate and predicted area as a function of the cumulative threshold (Fig. S2), and marginal response plots (Fig. S3) below.

Survey procedures. – To bolster sample sizes and to field-validate the model, we conducted model-guided surveys throughout southern Jersey County, IL (Fig. S1). We selected southern Jersey County because we knew *C. horridus* were present throughout the region, but specific refugia locations were unknown, thus warranting further investigation. To maximize our chances of finding refugia, we constrained our survey efforts to areas with a probability ≥ 50% (as determined by a Maxent-derived C-loglog probability raster) and searched during the species' spring egress period when snakes were likely to be surface active at refugia. We randomly selected 24 sites from across the region (Fig. S1) using the "random points" tool in ArcGIS Pro 3.0, with the constraining extent set to areas with a Probability ≥ 50% and the minimum distance between points (sites) set to 0.5 km to increase our coverage of the region.

We designed our initial survey procedures to fit within a detection and occupancy survey framework, whereby we split each site into eighteen 50 x 10 m transects (three rows of six; Fig.

S1) positioned along the top, middle, and bottom of suspected outcrops and shallow slopes as determined via bands of high probability habitat. Teams of three surveyors (six volunteers) surveyed each site at least once during the spring egress period, beginning at one end of the site and navigating through the pre-determined transects using GPS devices (which also tracked the time spent in each transect). To reduce search bias, each surveyor switched rows (see map inset in Fig. S1) every two transects, thus searching the top, middle, and bottom of the potential outcrops twice per site (each with varying habitat and topographic characteristics, such as the abundance of outcrop/crevices).

Overall, between 6–25 April, surveyors spent 135.34 person-hours across 10 days searching for *C. horridus* (three sites per day with some repeat site visits). Twenty-three of the 24 sites (96%) comprised bluff or interior forest outcrops with associated talus slopes and boulder fields, while one set consisted of highly sloped shallow soils with minimal surface outcrops. Surveyors found two additional refugia. We identified the first refugia by three snakes (2 adults and 1 juvenile) coiled near a large crevice and the second by a large male egressing from a hole at the soil-rock interface.

Description of Model Iteration (Round Two):

Maxent modeling. – In 2022 (model round two), we created a revised Maxent model using 34 refugia locations (21 new refugia). Alongside the two refugia discovered from the first model iteration, we included eight refugia located by IDNR staff and in-state naturalists during surveys in southern Illinois in 2020. We also included 11 refugia determined via opportunistic information from landowners and in-state naturalists who had located refugia in the past 20 years. The modeling procedures (e.g., predictor variables used, MaxEnt settings, and model evaluation) for our second model iteration were identical to the third (final) iteration explained in the main text.

With 100% of the cumulative AIC_c model weight, the best-fit Maxent model included the quadratic and hinge feature classes with an L1-regularization multiplier of 1. The bootstrap-averaged top model received a mean AUC performance value of 0.94 (SD = 0.23), and the omission rate of training samples closely resembled the predicted omission rate (i.e., followed a straight line, Fig. S6), suggesting excellent model fit. We provide the results for jackknife tests of variable importance (Fig. S6A), the omission rate and predicted area as a function of the cumulative threshold (Fig. S6B), and marginal response plots (Fig. S7) below.

Survey procedures. – In April 2023, we conducted model-guided surveys in northern Pope County, southern IL, to bolster sample sizes and field-validate the second model iteration. We selected Pope County because, like Jersey County, we knew *C. horridus* were present throughout the region, but specific refugia locations (besides one location) were unknown, thus warranting further investigation. Surveying in Pope County also allowed us to validate model predictions in other regions of Illinois (Pope County is ~230 km southeast of Jersey County). Adapting from previous survey efforts in Jersey County, we conducted surveys only on warmer days (daytime temps > 20 °C) during the spring egress period and made repeat visits to habitats deemed highly suitable (P ≥ 75%) by our HSM to maximize detection chances. Additionally, we did not constrain ourselves to the detection-occupancy survey (transect) procedures adopted during the Jersey County surveys because they limited survey time in an already restricted search window (i.e., between snake egress and dispersal to summer habitat). Thus, surveys in Pope County consisted of searching all high-probability habitats throughout the region, hiking the same route each day between 1000–1800 hrs (see survey route; Fig. S4).

Between 10–20 April, one surveyor searched for 30.22 hr over 5 days (mean = 6.04 hours/day). All high-probability habitats consisted of south-facing outcrops and ridgelines on upper slopes and ridges, which resembled habitat at known refugia locations throughout Illinois. Searches were conducted around outcrops, associated talus slopes, and boulder fields alongside nearby logs and brush piles. We found two new *C. horridus* refugia during the surveys ~1.5 km apart, revealed as *C. horridus* emerged from holes at the soil-rock interface. Two adult snakes (unknown sex) were located at the first refugia ~10 m apart; one coiled under a rock slab and one emerging from a hole under a large outcrop. We located the second refugia as a large male *C. horridus* emerged from a hole under a rock slab and returned to the refugia shortly after the surveyor approached.

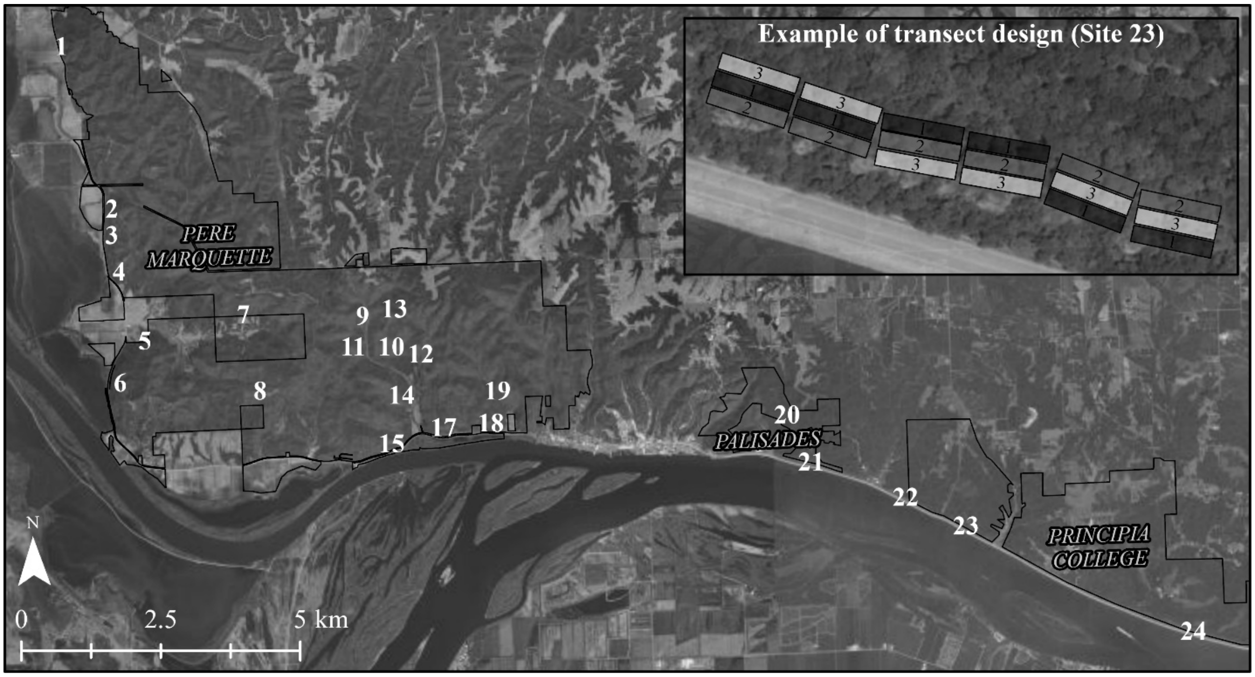

Fig. S1. Sites (n = 24) surveyed for *Crotalus horridus* and refugia during our first model iteration (round one) in spring 2019 at Pere Marquette State Park, Palisades Nature Preserve, and Principia College, in southern Jersey County, Il. White numbers represent each site's location, and black polygons denote property boundaries. The map inset shows an example transect design carried out by three surveyors at each site, with numbers in each transect denoting the surveyor ID (1, 2, or 3).

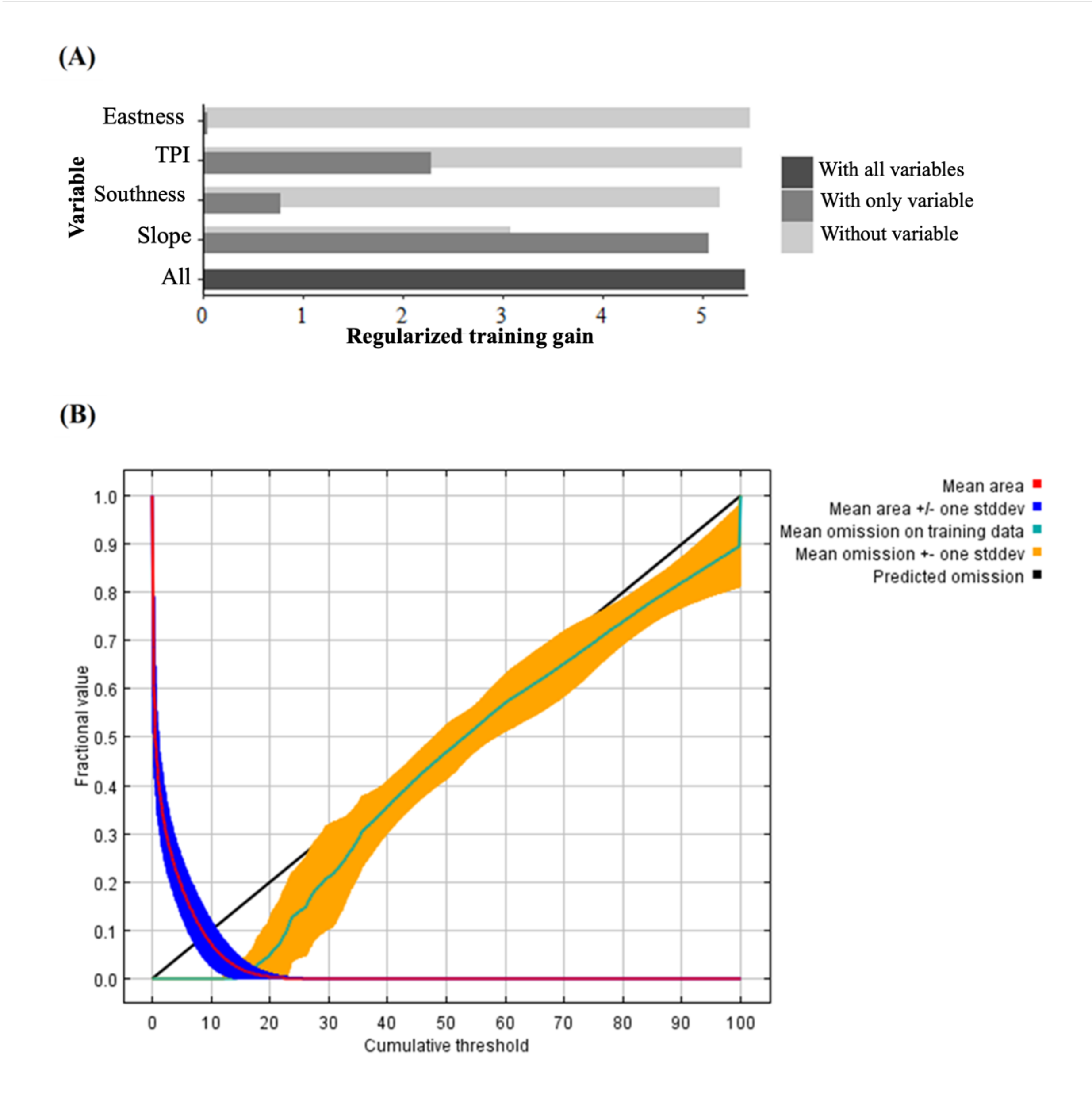

Fig. S2. Model performance metrics for the first Maxent model iteration (Round One) in 2019 averaged over 100 bootstrapped replicate runs: (A) Jackknife plots of variable importance, and (B) the omission rate and predicted area as a function of the cumulative threshold.

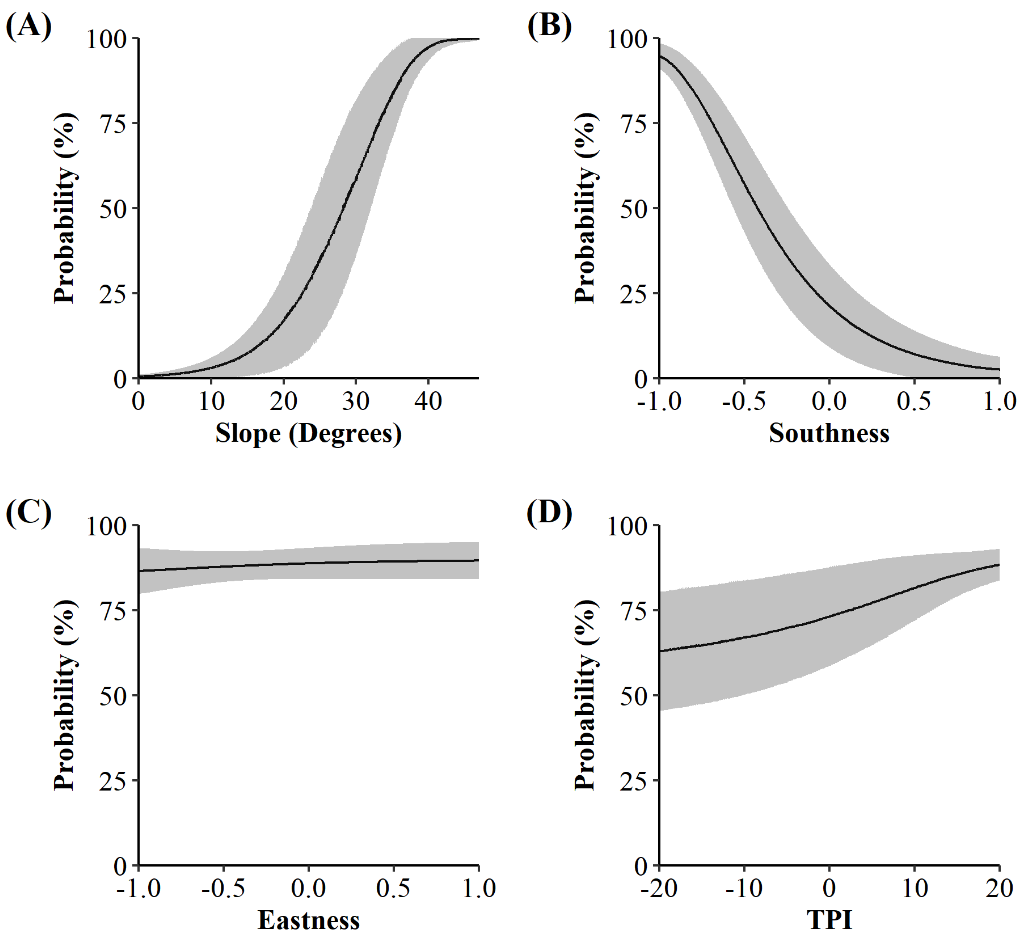

Fig. S3. Marginal response plots for the first Maxent model iteration (round one) in 2019, depicting the predicted probability of suitable refugia habitat for each predictor variable while holding all other predictor variables at their mean values. Each plot shows the mean response of 100 bootstrapped replicate runs (black lines) ± one standard deviation (grey ribbons).

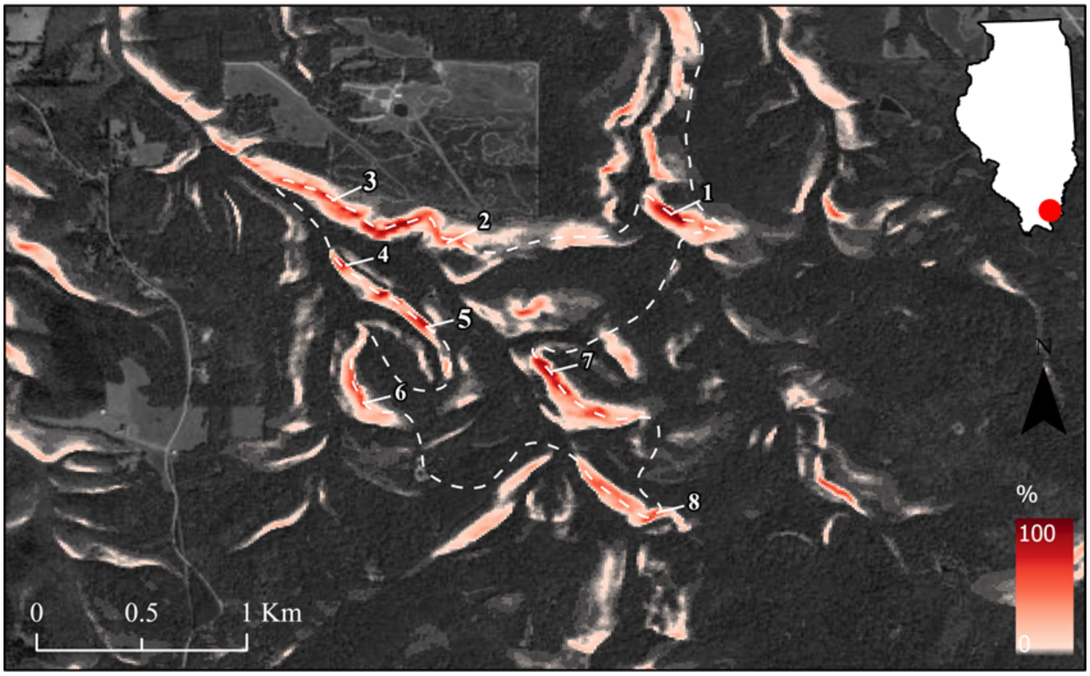

Fig. S4. Model-guided survey route (white dashed line) during our second model iteration (round two) in spring 2023 at northern Pope County, Il. We have overlain the probability raster (Clog-log output; Probability values of 0% made transparent) used during our surveys to aid in map interpretation. We searched for *C. horridus* and refugia along the survey route (white-dashed line) in all habitats with probability > 75%. Number labels correspond to the locations of photos in Fig. S6, taken during the survey period. The approximate location of the map (red dot) is displayed on an inset map of Illinois (top right).

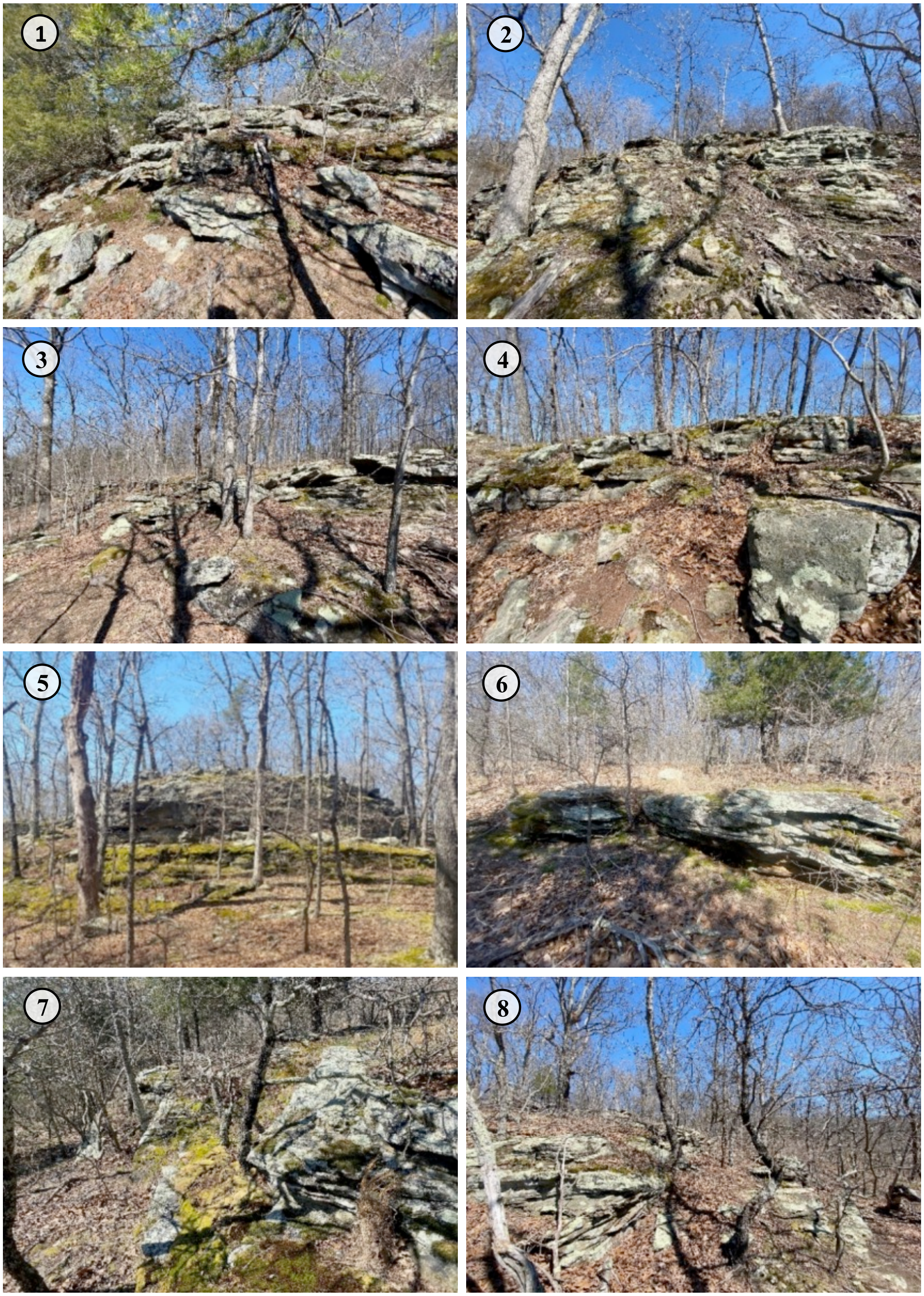

Fig. S5. Photos of surveyed habitat in Pope County identified as "highly suitable" (P > 75%) by our second Maxent model iteration. Each photo number corresponds to labeled locations detailed in Fig. S4. We found two new refugia during our model-guided surveys.

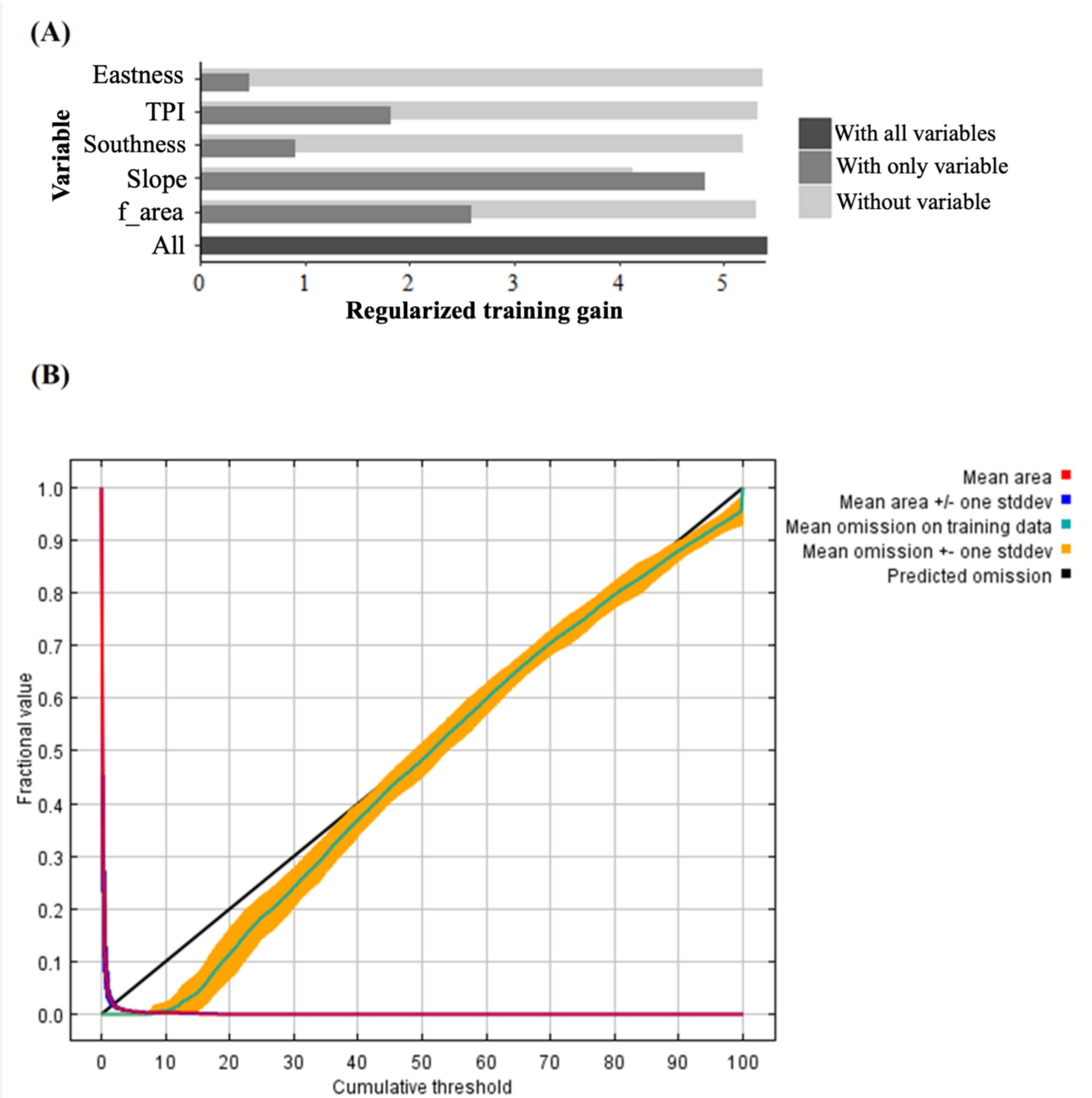

Fig. S6. Model performance metrics for the second Maxent model iteration (Round two) in 2023, averaged over 100 bootstrapped replicate runs: A) Jackknife plot of variable importance; and B) the omission rate and predicted area as a function of the cumulative threshold.

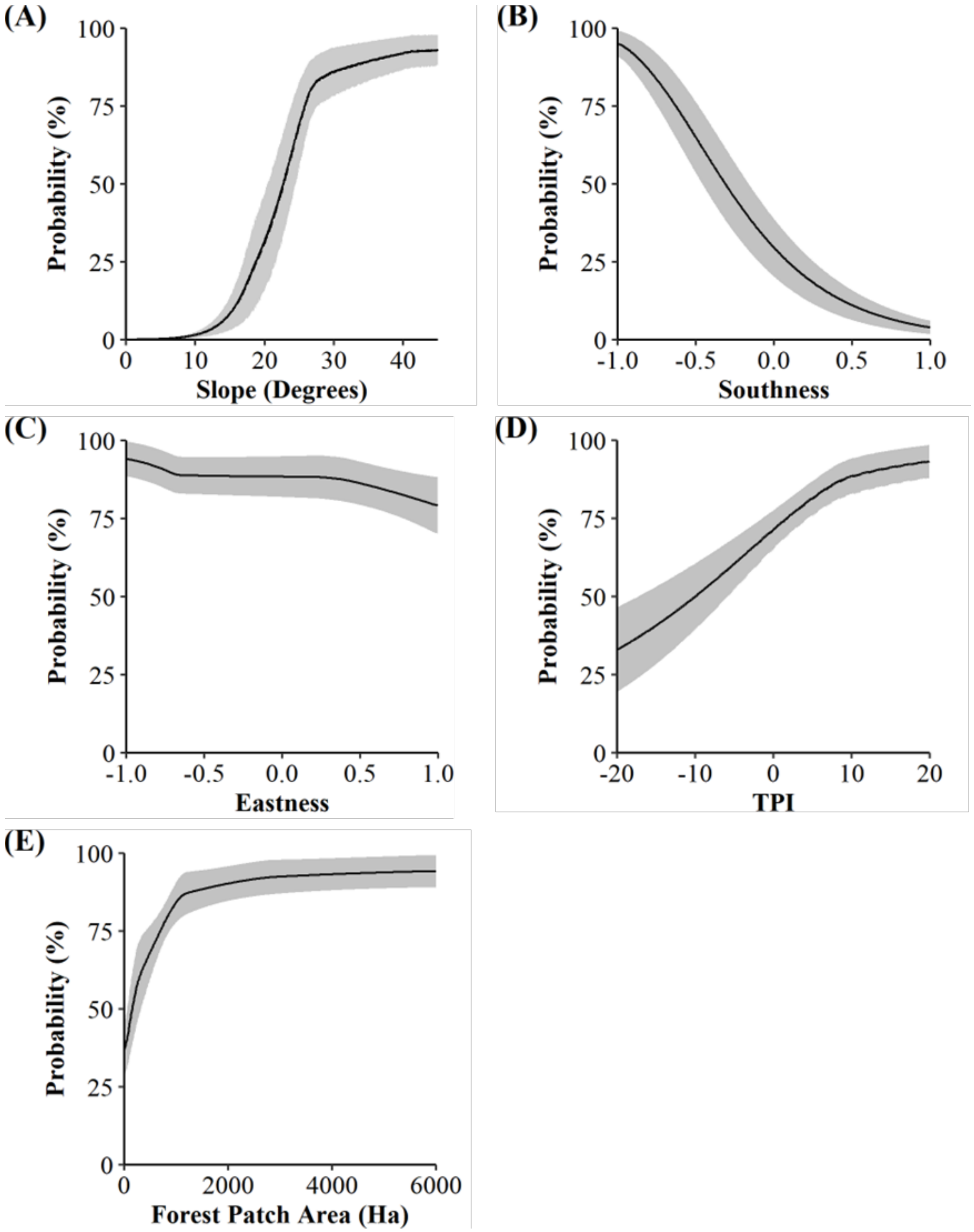

Fig. S7. Marginal response plots for the second Maxent model iteration (round two) in 2023, depicting the predicted probability of suitable refugia habitat for each predictor variable while holding all other predictor variables at their mean values. Each plot shows the mean response of 100 bootstrapped replicate runs (black lines) ± one standard deviation (grey ribbons).