Methods: Model Settings

All model code can be found on Dryad (doi: 10.5061/dryad.3p121).

**Boosted Regression Trees:** To fit the model, we used the “Bernoulli” family with an individual tree complexity of 5, a learning rate of 0.01, and a bag fraction of 0.5. To predict, we used ‘best.trees’ for the number of trees.

- R packages: ‘dismo’ (1) for model fitting; ‘gbm’ (2) for predicting.

**Maximum Entropy:** Our predictor input was a RasterBrick of climate data.

- R packages: ‘dismo’ (1) package for model fitting; also requires ‘rJava’ (3).

**Generalized Linear Modeling, logistic:** We used the binomial family with the logit link function.

- R packages: ‘stats’ (4) for model fitting.

**k-Nearest Neighbor:** We set the number of neighbors to k=3.

- R packages: ‘FNN’ (5) for model fitting.

**Random Forest:** We ran this model as regression.

- R packages: ‘randomForest’ (6) for fitting.

**Plug and Play Gaussian:** Code was provided by JMD. We used the “regularized” method.

**Range Bagging:** Code was provided by JMD. We set this model to use 256 votes and bag 1 dimension of ranges, with proportion of points used set to 0.8.

**Ecological Niche Factor Analysis:** We converted the pixel utilization weights to 0s and 1s, to be consistent with the other models. To evaluate and map model predictions, we first transformed the ENFA prediction object to a raster and standardized using an ecdf transformation. Then we subtracted that result from 1 for the final raster to evaluate and map.

- R packages: ‘adehabitatHS’ (7) for model fitting and prediction; ‘sp’ (8,9) for preparing presence data for model input.

**Additional R package notes:** ‘dismo’ (1) for evaluation, prediction, and pseudo-absence buffers; ‘maptools’ (10) for world map outline; ‘raster’ (11) for prediction; ‘rgdal’ (12) for setting CRS of climate layers and creating pseudo-absence buffers; ‘rgeos’ (13) for creating pseudo-absence buffers; ‘sp’ (8,9) for sampling pseudo-absence points.

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Methods: Climate Variables

Table S1. Fifty-five climatic variables used in model fitting. The empirical cumulative distribution function (ecdf) transformation was used when log transformation failed to reduce skewness and outliers in the data. ecdf creates a uniform distribution, and was computed on values in a raster and applied to that raster to return a rescaled version. After transformations listed in table, all variables (excluding ecdf variables) were rescaled by subtracting mean and dividing by standard deviation. Units for 'tmin' and 'tmax' are °C. Units for 'prec' are millimeters. For units of bioclimatic variables, see http://worldclim.org/bioclim.

| Variables  | Information                              | Mean (2.5-min, 5 min) | Standard Deviation (2.5-min, 5 min) | Transformations |
|------------|------------------------------------------|-----------------------|-------------------------------------|-----------------|
| Bio1       | Annual Mean Temperature                   | 81.61, 81.42          | 147.96, 148.18                      |                 |
| Bio2       | Mean Diurnal Range                        | 111.37, 110.89        | 31.22, 31.34                        |                 |
| Bio3       | Isothermality                             | 38.19, 38.19          | 20.62, 20.67                        |                 |
| Bio4       | Temperature Seasonality                   | 8302.76, 8282.27      | 5200.44, 5200.29                    |                 |
| Bio5       | Max Temp. of Warmest Month               | 258.15, 257.45        | 103.15, 103.30                      |                 |
| Bio6       | Min Temp. of Coldest Month               | -90.45, -90.04        | 199.56, 199.8                       |                 |
| Bio7       | Temperature Annual Range                 | 348.60, 347.49        | 137.81, 138.08                      |                 |
| Bio8       | Mean Temp. of Wettest Quarter            | 152.70, 152.32        | 105.67, 105.75                      |                 |
| Bio9       | Mean Temp. of Driest Quarter             | 23.67, 23.70          | 204.73, 204.95                      |                 |
| Bio10      | Mean Temp. of Warmest Quarter            | 186.05, 185.64        | 96.46, 96.61                        |                 |
| Bio11      | Mean Temp. of Coldest Quarter            | -25.36, -25.22        | 203.79, 203.99                      |                 |
| Bio12      | Annual Precipitation                     | 705.24, 709.23        | 680.97, 686.58                      | ecdf            |
| Bio13      | Precipitation of Wettest Month           | 116.86, 117.31        | 111.41, 112.19                      | ecdf            |
| Bio14      | Precipitation of Driest Month            | 20.86, 21.10          | 31.36, 31.71                        | ecdf            |
| Bio15      | Precipitation Seasonality                | 60.48, 60.32          | 33.93, 33.87                        |                 |
| Bio16      | Precipitation of Wettest Quarter         | 309.36, 310.63        | 296.15, 298.32                      | ecdf            |
| Bio17      | Precipitation of Driest Quarter          | 73.36, 74.11          | 104.23, 105.38                      | ecdf            |
| Bio18 | Precipitation of Warmest Quarter | 209.53, 210.19 | 187.72, 188.69 | log |
|------|----------------------------------|----------------|----------------|-----|
| Bio19| Precipitation of Coldest Quarter | 128.13, 129.35 | 206.7, 207.64 | log |
| tmin1| Average Jan. min temperature     | -72.86, -72.49 | 214.19, 214.37 |     |
| tmin2| Average Feb. min temperature     | -63.01, -62.78 | 211.70, 211.93 |     |
| tmin3| Average Mar. min temperature     | -30.53, -30.55 | 194.48, 194.86 |     |
| tmin4| Average Apr. min temperature     | 19.02, 18.82   | 158.36, 158.85 |     |
| tmin5| Average May min temperature      | 67.98, 67.83   | 116.83, 117.17 |     |
| tmin6| Average June min temperature     | 103.99, 103.90 | 91.2, 91.57   |     |
| tmin7| Average July min temperature     | 121.78, 121.72 | 82.91, 83.00  |     |
| tmin8| Average Aug. min temperature     | 114.65, 114.65 | 85.40, 85.51  |     |
| tmin9| Average Sept. min temperature    | 85.97, 86.01   | 101.52, 101.70|     |
| tmin10| Average Oct. min temperature    | 40.09, 40.15   | 134.52, 134.80|     |
| tmin11| Average Nov. min temperature    | -17.11, -16.89 | 177.67, 177.88|     |
| tmin12| Average Dec. min temperature    | -55.96, -55.63 | 201.46, 201.62|     |
| tmax1| Average Jan. max temperature    | 33.66, 33.63   | 230.24, 230.19|     |
| tmax2| Average Feb. max temperature    | 48.69, 48.47   | 225.26, 225.34|     |
| tmax3| Average Mar. max temperature    | 87.02, 86.51   | 203.75, 204.05|     |
| tmax4| Average Apr. max temperature    | 137.41, 136.73 | 170.40, 170.78|     |
| tmax5| Average May max temperature     | 183.65, 182.95 | 135.53, 135.82|     |
| tmax6| Average June max temperature    | 219.89, 219.22 | 109.13, 109.32|     |
| tmax7| Average July max temperature    | 236.73, 236.13 | 96.27, 96.40  |     |
| tmax8| Average Aug. max temperature    | 228.14, 227.59 | 100.86, 101.00|     |
| tmax9| Average Sept. max temperature   | 195.49, 294.99 | 123.22, 123.36|     |
| tmax10| Average Oct. max temperature   | 145.41, 145.02 | 159.48, 159.57|     |
|   |   |   |   |   |
|---|---|---|---|---|
| tmax11 | Average Nov. max temperature | 86.16, 85.99 | 198.91, 198.91 |
| tmax12 | Average Dec. max temperature | 47.63, 47.58 | 220.08, 220.02 |
| prec1 | Average Jan. precipitation | 54.29, 54.70 | 78.05, 78.55 | log |
| prec2 | Average Feb. precipitation | 50.13, 50.45 | 71.94, 72.31 | log |
| prec3 | Average Mar. precipitation | 54.57, 54.86 | 75.19, 75.52 | log |
| prec4 | Average Apr. precipitation | 52.75, 52.99 | 67.67, 67.91 | log |
| prec5 | Average May precipitation | 56.36, 56.65 | 70.06, 70.43 | log |
| prec6 | Average June precipitation | 62.95, 63.26 | 78.32, 79.00 | log |
| prec7 | Average July precipitation | 73.04, 73.29 | 89.43, 90.00 | log |
| prec8 | Average Aug. precipitation | 72.54, 72.80 | 83.54, 84.09 | log |
| prec9 | Average Sept. precipitation | 63.89, 64.25 | 71.47, 72.01 | log |
| prec10 | Average Oct. precipitation | 57.43, 57.85 | 65.51, 66.13 | log |
| prec11 | Average Nov. precipitation | 53.32, 53.73 | 65.16, 65.71 | log |
| prec12 | Average Dec. precipitation | 53.96, 54.38 | 73.24, 73.74 | log |
Figure S1. False negative rates, with 95% confidence intervals, for (a) five-part chronological analysis, averaged over time steps, (b) ten-fold cross-validation, averaged across folds, and (c) random split, averaged across balanced presence-background test sets.
Figure S2. AUC values from the random split. Error bars represent 95% confidence intervals, from evaluating models on ten different sets of background data, each in conjunction with the test set of presence points.
Fig. S3. Boyce index values from the five-part chronological analysis.

Figure S4. Comparison map for BRT vs. MaxEnt. Green represents areas predicted to be more suitable by BRT than by MaxEnt. Orange represents areas predicted to be more suitable by MaxEnt than by BRT. Raster values for map calculated as BRT prediction value minus MaxEnt prediction value.
**Figure S5.** Comparison map for RF vs. RB. Green represents areas predicted to be more suitable by RF than by RB. Orange represents areas predicted to be more suitable by RB than by RF. Raster values for map calculated as RF prediction value minus RB prediction value. BRT vs. RB comparison map is nearly identical.