

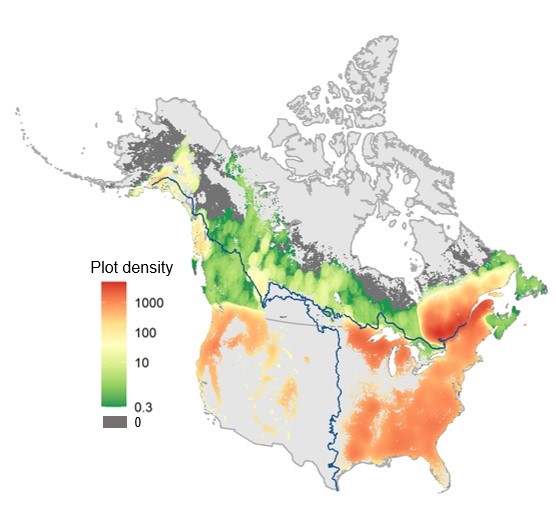
**Extended Data Fig. 1.** **Present forest type distribution in percent area in the West and Boreal regions.**



**Extended Data Fig. 2.** **Present forest type distribution in percent area in the East region.**



**Extended Data Fig. 3. a, Variable importance based on the Gini impurity for the ratio of forest migration velocity to tree species migration velocity. b, the distribution of tree species evenness.** It is the average of past (1970-1999) and present (2000-2019). **c, the distribution of climate change.** It is an aggregated indicator of temporal changes in the top nine bioclimate variables in terms of variable importance (variables in red in a), normalized between 0 and 1. The predictor variable names correspond to Extended Data Table 1.



**Extended Data Fig. 4.** **Forest inventory plot density for the present dataset (2000–2019).** Plot density represents the number of sample plots per 0.1×0.1° grid (~100 km2). Thick line indicates the border between West, East, and Boreal categories.



**Extended Data Fig. 5.** **Performance of two candidate machine learning models to map forest types**. Kappa statistic and accuracy of random forests and support vector machine imputation models. Mean values from 20 repetitions and 95% CI are shown for each time period and region. Random forests outperformed support vector machine in all cases, and thus random forests were used to map forest types in this paper.



**Extended Data Fig. 6. Variable importance and correlogram of all predictor variables used in this study. a,** Variable importance based on classification accuracy of the random forests model. **b,** Correlation matrix of predictor variables for the present (2000-2019) dataset. See Extended Data Table 1 for detailed definition and description of each variable.



**Extended Data Fig. 7. Average silhouette width with different number of clusters and number of dimensions obtained from autoencoder neural network. (a**, **b)** West, (**c**, **d**) East, and (**e**, **f**) Boreal regions. Left column (**a**, **c**, **e**) is 2000-2019 dataset, and right column (**b**, **d**, **f**) is 1970-1999 dataset. Since silhouette width does not improve above number of dimensions = 15, we chose 15 as the number of dimensions for all models. Due to the data size, we used 90% of the East 2000-2019 dataset to conduct K-means cluster analysis and calculate silhouette width.



**Extended Data Fig. 8. Confusion matrix of the random forests model trained using present (2000-2019) data for the West (a), East (b), and Boreal (c) region.** The values are percent mean number of cases based on 20 repetitions.



**Extended Data Fig. 9. Confusion matrix of the random forests model trained using past (1970-1999) data for the West (a), East (b), and Boreal (c) region.** The values are percent mean number of cases based on 20 repetitions.

**Extended Data Table 1. List of predictor variables used to map forest types.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Definition (unit)** | **1970-1999** | | | **2000-2019** | | |
| **Data source** | **Reference year** | **Resolution** | **Data source** | **Reference year** | **Resolution** |
| **Climate covariates** | | | | | | | |
| C1 | Annual mean temperature (0.1 °C) | WorldClim v.2.1 (70) | 1970-2000 | 1 km2 | CHELSA v.1.2 (71) | 1979-2013 | 1 km2 |
| C2 | Mean diurnal range (°C) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C3 | Isothermality (unitless\*100) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C4 | Temperature seasonality (standard deviation\*100) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C5 | Temperature annual range (0.1 °C) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C6 | Mean temperature of wettest quarter (0.1 °C) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C7 | Mean temperature of driest quarter (0.1 °C) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C8 | Mean temperature of warmest quarter (0.1 °C) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C9 | Mean temperature of coldest quarter (0.1 °C) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C10 | Annual precipitation (mm) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C11 | Precipitation seasonality (coefficient of variation) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C12 | Precipitation of wettest quarter (mm) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C13 | Precipitation of driest quarter (mm) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C14 | Precipitation of warmest quarter (mm) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C15 | Precipitation of coldest quarter (mm) | WorldClim v.2.1 | 1970-2000 | 1 km2 | CHELSA v.1.2 | 1979-2013 | 1 km2 |
| C16 | Potential evapotranspiration (mm year-1) | CGIAR-CSI v.2 (72) | 1970-2000 | 1 km2 | CGIAR-CSI v.2 | 1970-2000 | 1 km2 |
| C17 | Indexed annual aridity (unitless index\*10-4) | CGIAR-CSI v.2 | 1970-2000 | 1 km2 | CGIAR-CSI v.2 | 1970-2000 | 1 km2 |
| **Topographic covariates** | | | | | | | |
| T1 | Elevation (m) | EarthEnv (73) | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T2 | Roughness | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T3 | Terrain ruggedness index | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T4 | Topographic position index | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T5 | Aspect cosine | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T6 | Aspect sine | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T7 | Slope | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T8 | Profile curvature | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T9 | Tangential curvature | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T10 | First order partial derivative (E-W slope) | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T11 | First order partial derivative (N-S slope) | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T12 | Second order partial derivative (E-W slope) | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| T13 | Second order partial derivative (N-S slope) | EarthEnv | 2010 | 1 km2 | EarthEnv | 2010 | 1 km2 |
| **Soil covariates** | | | | | | | |
| S1 | Bulk density (g cm-3) | WISE30sec v1.0 (74) | na | 1 km2 | WISE30sec v1.0 | na | 1 km2 |
| S2 | Percent clay (mass %) | WISE30sec v1.0 | na | 1 km2 | WISE30sec v1.0 | na | 1 km2 |
| S3 | Organic carbon content (g kg-1) | WISE30sec v1.0 | na | 1 km2 | WISE30sec v1.0 | na | 1 km2 |
| S4 | pH measured in water | WISE30sec v1.0 | na | 1 km2 | WISE30sec v1.0 | na | 1 km2 |
| S5 | Electrical conductivity (dS m-1) | WISE30sec v1.0 | na | 1 km2 | WISE30sec v1.0 | na | 1 km2 |
| S6 | C/N ratio | WISE30sec v1.0 | na | 1 km2 | WISE30sec v1.0 | na | 1 km2 |
| S7 | Total nitrogen (g kg-1) | WISE30sec v1.0 | na | 1 km2 | WISE30sec v1.0 | na | 1 km2 |
| **Anthropogenic impact** | | | | | | | |
| H | Human footprint | (75) | 1993 | 1 km2 | (75) | 2009 | 1 km2 |