**Methods**

**Study area, data sources and preparation**

We acquired interpolated daily minimum and maximum temperature data covering the study area for the years 1980 - 2016 from the Daily Surface Weather And Climatological Summaries (DAYMET) project (THORNTON et al., 2017). The DAYMET data are distributed as raster tiles in a Lambert Conformal Conic projection with 1km x 1km grid cells. For MPB tree mortality, we retrieved raster data containing the estimated number of trees killed due to MPB in both ponderosa and lodgepole pines for the years 1997 - 2010 (“Data Basin,” 2018; Meddens and Hicke, 2014). Polygon spatial data for national forest boundaries was obtained from the United States Forest Service (“USDA Forest Service FSGeodata Clearinghouse - FSGeodata Clearinghouse,” 2018). To determine host species range, we used polygon data derived from Little (“Data Basin,” 2018; Little, 1971).

To define the study area, we created a mask consisting of the intersection of the polygon pine range data for P. ponderosa and *P. contorta* with the polygons of national forests. The mortality data for *P. contorta* and P. ponderosa were combined into a raster whose cells were the sum of cells of the two trees’ data. Raster cells falling under this mask were used for analysis. To reconcile the weather and tree raster data for analysis, we used the projection and resolution of the tree data by locating the nearest corresponding raster cells in the weather data. For each cell in the tree data, we defined the corresponding cell in the weather data as that cell whose center was nearest the center of the tree data.

**MPB Overwinter Survival Model**

To estimate the potential MPB overwinter survival rates, we implemented a spatially-explicit version of the physiological process-based model of MPB cold tolerance created by Régnière and Bentz (Régnière and Bentz, 2007) in Java version 1.8 (Nelson, 2018). To verify the correctness of our model implementation, we compared survival estimates using temperature data from the weather stations to those found in Table 1 of (Régnière and Bentz, 2007). We ran the model with the daily weather data to create rasters of estimated MPB overwinter survival for winters ending 1981 – 2016.

**Analyses**

We calculated aggregate statistics for estimated MPB survival and tree mortality by calculating the mean values for each of all raster cells falling under the study site masks for each year. The pine data includes trees that were killed in the year prior to the observed red stage. To assess the relationship between estimated MPB survival and pine mortality, we compared the aggregate mean survival for winters ending 1996 – 2009 to pines killed in summer 1996 – 2009. For the lag time analysis we calculated mean survival for periods of 2 to 16 years for periods ending in the springs of 1996 – 2009 and compared these to the pines killed in the subsequent summer seasons. Due to the possibility of temporal autocorrelations in the data, we used linear regressions with autocorrelated error terms to examine the strength of the relationship between mean predicted MPB survival and mean pine kill for lag periods of 1 to 16 years.

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