Appendix 3: Postfire Conifer Regeneration Prediction Tools

Hugh D. Safford

Two tools have recently been developed to aid in the identification of areas in yellow pine, dry mixed-conifer, and moist mixed-conifer forest that are unlikely to support sufficient conifer regeneration to meet management goals. Both tools are focused on predicting seedling densities 5 years after fire, because the National Forest Management Act and Forest Service regulations (e.g., USDA FS (1992) require that productive forest be restocked within 5 years after a major stand-altering event, such as major tree harvest or a stand-replacing fire. Five years is also a forestry rule-of-thumb threshold beyond which burned areas require major extra investment in site preparation to plant, and planting in such locations is therefore rarely undertaken. We recommend that the tools be used sequentially. First, the Postfire Spatial Conifer Regeneration Prediction Tool (POSCRTPT) (Shive et al. 2018) is used to identify locations where probability of conifer seedling presence 5 years after fire is low enough to warrant concern. Next, the Welch et al. (2016) field assessment tool is used to field check locations identified by the spatial prediction and determine whether seedling densities 5 years after fire are likely to meet seedling stocking guidelines or not. Using these tools, sites where seedling regeneration is likely to be adequate or inadequate can be quickly identified and sites for reforestation efforts can be prioritized.

Conifer Regeneration Prediction at the Landscape Scale Using Spatial Data

Shive et al. (2018) used an extensive Forest Service postfire inventory dataset from California to develop POSCRPT for forecasting postfire forest regeneration. POSCRPT predicts spatial variation in seed availability by using a kernel-based estimator of annual seed production based on live basal area (either as measured postfire, or from prefire basal area adjusted by burn severity). After scaling by 30-year mean annual precipitation, POSCRPT generates a map of predicted seedling densities that can be binned into higher accuracy seedling-presence probability classes (the probability of observing at least one living seedling in a 60-m^2 (646-ft^2) area 5 years after fire).

[1] **Hugh D. Safford** is the regional ecologist, Pacific Southwest Region, 1323 Club Drive, Vallejo, CA 94592;

POSCRPT is a distinct improvement over current Forest Service practice in the Pacific Southwest Region, which bases reforestation considerations on basal area mortality maps produced through the Monitoring Trends in Burn Severity (MTBS) program. Areas with >50 percent basal area mortality as mapped by MTBS are declared “deforested” and reforestation need is assessed using this baseline. However, basal area mortality maps are not predictions of postfire seedling recruitment and do not include considerations of climate, burn patch size, or distance to nearest living seed tree (among other things), all of which are major drivers of tree regeneration. POSCRPT incorporates these factors and directly models conifer regeneration. It is also worth noting that Welch et al. (2016) showed that natural seedling recruitment in areas with basal area mortality <75 percent was nearly always sufficient to meet stocking guidelines, which means that even under current practice the area of land considered for reforestation could be reduced substantially.

There is very high spatial variation in seedling density in the postfire environment (see Shive et al. 2018: table 3). For example, plots falling in the seedling probability class 0.6 to 0.8 showed a median density of 333 seedlings/ha (134 seedlings/ac), a mean density of 3,665 seedlings/ha (1,478 seedling/ac), and a range from 0 to 380,166 seedlings/ha (153,311 seedlings/ac). Current Pacific Southwest Region stocking guidelines for mixed-conifer forest (dry or moist) recommend targeting a median of at least 200 seedlings/ac, but this value is based on production forestry assumptions and ignores forest-density sustainability issues under warming climates and increasing fire risk (Welch et al. 2016). We suggest that the users of the spatial regeneration tool focus on areas with <0.6 probability of seedling presence after fire, as these are the areas where median densities (stocking rate) are predicted to fall well below stocking guidelines.

Employment of the spatial prediction tool requires some background in using Python coding and *R* statistical analysis. Applications of the tool are currently being carried out by the Pacific Southwest Region Ecology Program, and first implementations of the tool were made in the fall of 2018. An example is provided in the mixed-conifer forest case study for the Rough Fire (chapter 4). Recent updates to the tool include the ability to incorporate postfire weather and masting, but fine-scale dynamics, such as competition and microclimates, cannot be modeled.

Conifer Regeneration Prediction in the Field

Welch et al. (2016) used the same dataset as Shive et al. (2018) to develop a set of statistical models of conifer regeneration density in yellow pine and mixed-conifer forests (dry and moist) 5 years after fire. The models were used to build a simple-to-use graphical tool that permits identification in the field of locations that are likely to be above or below a predetermined stocking threshold (fig. A3.1), based on a series of easily measured variables (slope, aspect, live basal area in the stand, distance to nearest living seed tree). Independently assessed classification accuracy of the method was about 75 percent, which is very high for a field tool.

Welch et al. (2016) published a suggested field protocol for using the tool. The text is reproduced below.

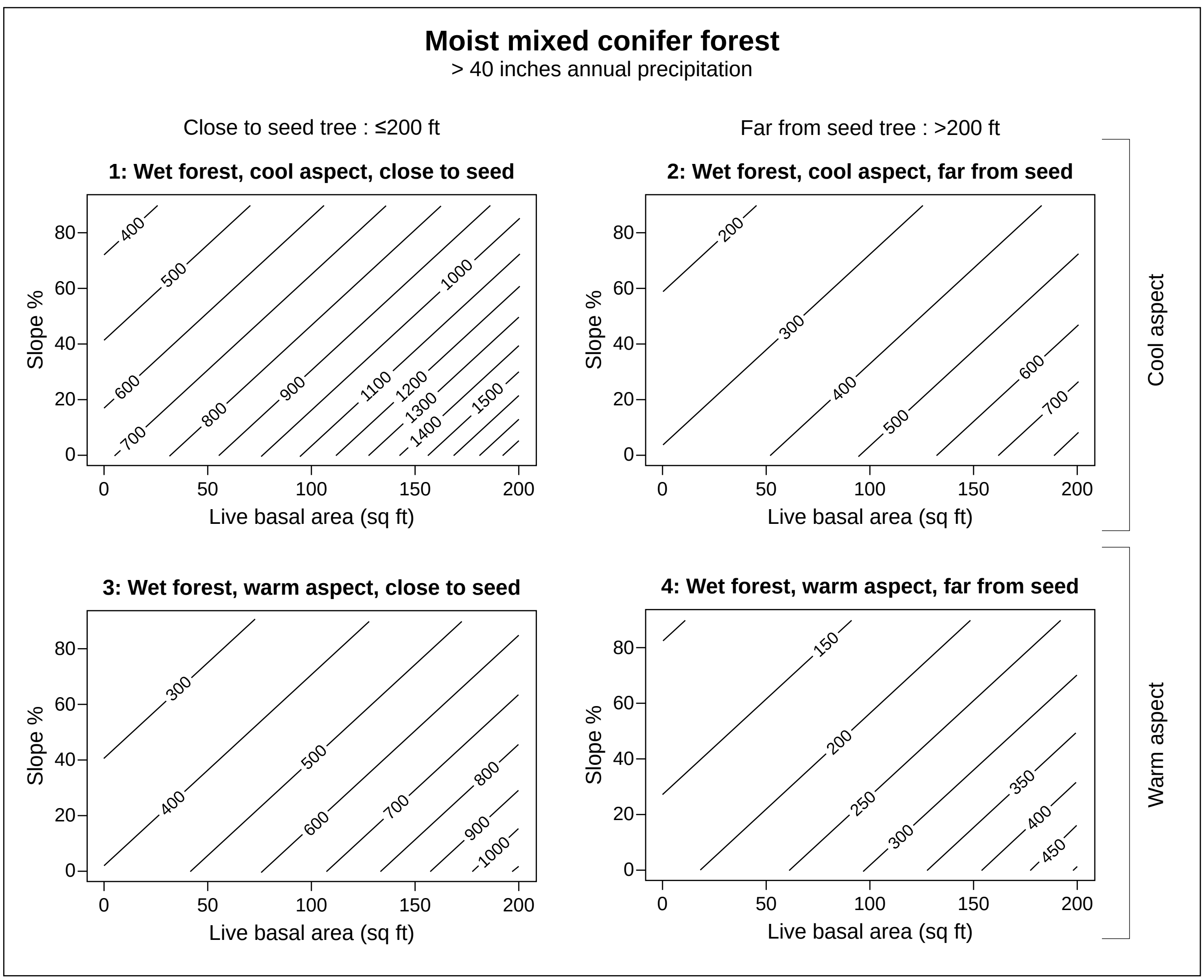

Figure A3.1—Seedling density isolines from the Welch et al. (2016) predictive method, in U.S. units to facilitate Forest Service field use.

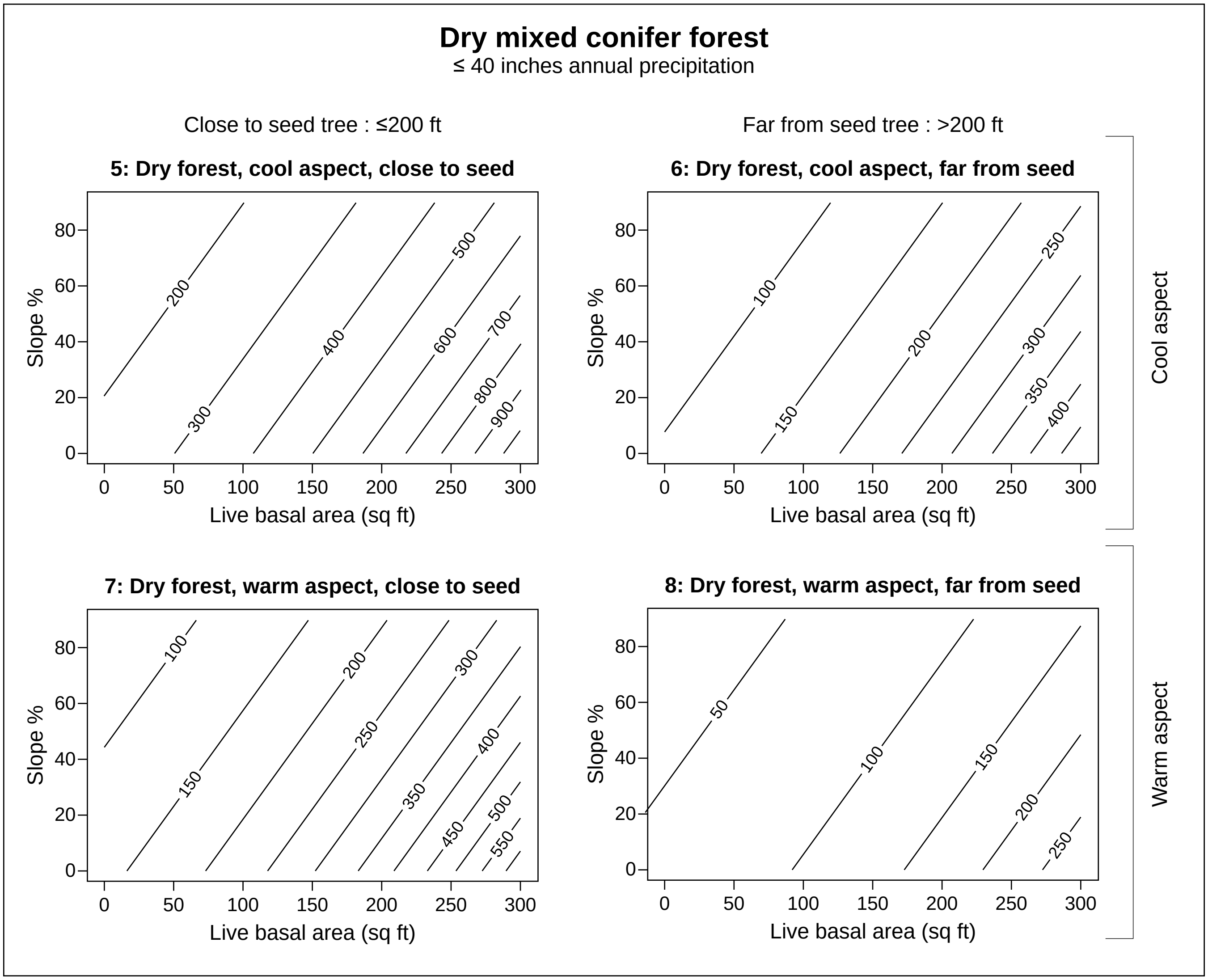

Figure A3.1 (continued)—Seedling density isolines from the Welch et al. (2016) predictive method, in English units to facilitate Forest Service field use.

Suggested Protocol for Field Assessment of Predicted Seedling Densities 5 to 6 Years After Fire

Typically, a preliminary assessment of postfire reforestation need will be made based on remotely sensed imagery (of fire severity, for example) or aerial photography or field reconnaissance, using variables such as fire severity, aspect, and distance to remnant forest edge. Polygons are then drawn on maps with preliminary hypotheses of probable reforestation need. Ideally, this preliminary estimate is made using the POSCRPT spatial prediction tool described in Shive et al. (2018) and already in use on Pacific Southwest Region fires. Figure A3.1 provides information to be used in subsequent field verification of the preliminary polygons for dry and moist mixed-conifer forests (dry mixed-conifer forests includes yellow pine dominated forests) that have burned at high severity (≥75 percent loss of prefire basal area). Field sampling protocols will vary according to need, ease of access, and size of the areas to be assessed, but in general, we recommend that a protocol be adopted that visits at least 1 percent of the area in question. Each 60-m^2 (646-ft^2) plot is equivalent to 0.6 percent of a hectare and 1.5 percent of an acre, so we recommend sampling a minimum of two plots per hectare or one plot per acre.

Follow these steps:

1. Develop a paper or electronic datasheet for the data to be collected.
2. Determine whether the area to be visited is within dry or moist mixed-conifer forest. Use local knowledge of precipitation and vegetation patterns, or climate datasets like PRISM, or maps of potential natural vegetation (local maps or the LANDFIRE biophysical setting data, for example). Remember that north slopes in areas with <1000 mm precipitation may support moist mixed-conifer forests (dominated by shade-tolerant conifers like firs and Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco]), and some south and west slopes or thin soils in areas with >1000 mm (39.4 inches) precipitation may support dry mixed-conifer forests (dominated by pines and oaks).
3. Visit a set of previously selected Global Positioning System (GPS) locations, which were ideally selected through a stratified random process laid over a spatial grid in a Geographic Information System (GIS). GIS data can be used to assign the appropriate forest type, aspect class, and distance from forest edge to the plot locations before they are visited; however, all of these determinations are important to verify in the field as all of these variables have major influence on predicted seedling densities. In the case of the distance to forest edge value, there are often living trees within high-severity patches, and the distance to nearest seed tree is therefore typically less than the distance to the forest edge.
4. Perform the following at each site in the field:
    a. Verify the forest type
    b. Determine the aspect class (warm: south and west; cool: north and east)
    c. Use a rangefinder to measure the distance to the nearest living seed tree
    d. Measure the slope inclination with a clinometer (percentage of slope)
    e. Use a basal area gauge or prism to estimate the live basal area in the surrounding stand
5. Determine whether there are any seedlings within a circular area of 60 m^2 (646 ft^2) around the GPS point; 60 m^2 has a radius of 4.37 m (14.3 ft), which corresponds to 5.7 paces for a standard human (a pace = 76.2 cm or 30 inches).

6. Using forest type, distance class to nearest living seed tree, and aspect class, choose the appropriate subgraphic in figure A3.1.
7. Using percentage of slope (y-axis) and live basal area (x-axis), locate the appropriate x, y coordinate for the plot being visited.
   a. If there is at least one seedling in the sample plot, enter the predicted seedling density (the value at the x, y coordinate). This is a prediction of the seedling density that one would sample at this site 5 to 7 years after fire given the site variables.
   b. If there are no seedlings in the plot, enter the following in the predicted seedling density field:
      i. The predicted density from figure A3.1, if the plot is <30 m (98 ft) from the nearest living seed tree.
      ii. Half of the predicted density from figure A3.1, if the plot is 30 to 60 m (98 ft) from the nearest living seed tree.
      iii. Enter "0" if the plot is >60 m from the nearest living seed tree.

After collecting the field data, enter the data into a spreadsheet or database and calculate predicted median seedling densities. Compare the median seedling density against your desired stocking rate to determine if the area is a candidate for reforestation. This comparison can also serve to prioritize areas.

References

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