National Algorithms for Determining Stocking Class, Stand Size Class, and Forest Type for Forest Inventory and Analysis Plots

Stanford L. Arner
Sharon Woudenberg
Shirley Waters
John Vissage
Colin MacLean
Mike Thompson
Mark Hansen

February 13, 2001

Abstract. Procedures to assign stocking values to individual trees, and forest type, stand size, and stocking class to all Forest Inventory and Analysis plots nationwide are presented. The stocking values are assigned using species specific functions of diameter developed from normal yield tables and stocking charts. These algorithms will be included as part of the set of standardized procedures being developed by Forest Inventory and Analysis that will result in consistent estimates without regard to political boundaries.

Background

Forest Inventory and Analysis (FIA) area and volume estimates are often summed across FIA unit boundaries using such plot classifications as forest type, stand size class, and stocking class. Much concern has been expressed that the methods used to determine these classifications be consistent among FIA units so that the estimates can be summed for large area analyses such as the periodic Resource Planning Act (RPA) assessments and for numerous other regional and national studies. Concern about the lack of complete consistency of FIA area classifications between states has been raised both internally within FIA and externally by user groups, particularly the American Forestry Council. In 1991, the FIA Project Leaders appointed an “ad hoc” committee to address this issue. Specifically, our mission was to develop procedures to determine stocking and related area classifications (forest type and stand size) that were acceptable to the scientific community and could be recommended for use by FIA projects nationwide.

Prior to this all FIA units based most tree-related area classifications on stocking proportions; that is, they assigned a value to each tally tree that represents the tree's contribution to stocking. The classification of a sample stand was based on various procedures that summed and compared these assigned stocking values across various classes of trees tallied in the stand. For example a stand could not be classified as a softwood forest type unless the stocking of all softwood species exceeded the total stocking of all hardwood species. The committee decided to continue with this approach of assigning a portion of the stand stocking to each tally tree and then base classification on these stocking values.

Prior to the work of this committee, the various FIA projects had used somewhat different procedures to assign stocking and determine forest type and stand size. The methods for some of the units are described in published reports (Hansen and Hahn 1992, May 1991); for other units written descriptions are limited and the methods exist only as computer code (usually Fortran). The committee's first task was to identify a method of assigning the stocking contribution to individual tally trees that was acceptable to all FIA projects, nationwide. Following this, common methods to assign forest type, stand size, and stocking class based on these stocking values would be developed.

What is Stocking

Stocking is an expression of stand density that may be expressed in absolute terms, such as basal area per acre, volume per acre, number of trees per acre, or in relative terms, as a percent of some previously defined standard. Absolute stocking is meaningful in the presence of other information, such as stand size, forest type, etc. Relative stocking, on the other hand, implies a standard that accounts for the effects of stage of development and species composition, and therefore would be a useful tool for interpreting the findings of extensive inventories, where a wide variety of stands are sampled.

Past FIA Stocking Procedures

Crown Closure – early estimates of stocking were based on crown closure assessments from aerial photo interpretations. This procedure usually sorted stands into four crude categories – well-stocked, moderately stocked, poorly stocked, and nonstocked. Because individual tree species and size classes could not be consistently identified, the usefulness of this classification as a tool for area classification was limited.

Basal Area Standard – in this procedure, tally trees are counted to determine the predominant species and age group. The basal area standard is the basal area expected in a normal stand of similar species, site index, and age group, as indicated by a normal yield table. The stocking contribution of a tally tree is the basal area per acre that the tree represents, expressed as a percent of the basal area standard of the stand. This method performs poorly in mixed and multi-aged stands. The selection of the predominant species and the determination of the average stand age may strongly affect the basal area standard. Thus, two stands, each with the same basal area and stand age and with similar species composition, but one with 51 percent conifer and 49 percent hardwood, and the other with 51 percent hardwood and 49 percent conifer, may be assigned very different stocking values. By the same token, stands with very different distribution of tree ages may get similar stocking assignments, not because their densities are really similar, but because their average age is the same. Field experience in trying to apply the basal area standard convinced most of us that the method would not satisfy our purposes.

Basal Area – some members of our committee felt that basal area could be used to determine forest type, stand size class, and other tree-based site classifications that require assessing the relative density of various stand components. This led to a discussion of objectives. Our conclusion was that FIA classifications should be based on site occupancy, the degree of site utilization by various stand components. Where light is the limiting factor, site occupancy is closely related to crown density. Where moisture is the limiting factor, site occupancy may be more closely related to the surface area of the tree's root system. In either case, the relationship of site occupancy to cross-sectional bole area may vary substantially by species, by stage of development, and by social position. Thus, 100 ft^2 of red alder may fully occupy a site with a capacity for growing 150 ft^2 of similar-sized Douglas-fir. In our view, basal area might well be the variable most closely related to current timber volume. But it is inadequate as a descriptor of stand composition in a multi-resource inventory, and, in the absence of additional information, is inadequate as a measure of present site utilization. An additional problem with basal area as a measure of stocking is its inadequacy for rating of small-diameter stands. Saplings have very little basal area and seedlings have none. Basal area is of little use in describing regeneration stands.

Relative Density for FIA Plots

Because FIA inventories are extensive, covering a wide range of conditions, the committee decided that a relative measure of stand density would be most appropriate. Curtis (1970, 1971) has compared the usual measures of relative density. All use either normal stands or open-grown trees as a point of reference. All are developed for use with even-aged, uniformly stocked stands of a single species or forest type, and all give comparable results. How can such standards be applied to uneven-aged, mixed species stands with variable spacing? One way is to rate the density contribution of each tree individually, taking into account that tree's individual characteristics. Using this approach, the density standard applied to the plot as a whole is a weighted average density that reflects the species, stage of development, and social position of trees present. A variant of this approach was adopted for the Timber Resources Review (TRR) in the 1950's (USDA Forest Service, 1958), where the stocking percent assigned to individual trees varies by tree diameter and forest type. This TRR approach is the basis for the stocking values previously used by several of the FIA units. At about the same time, Larson (1956) proposed that stocking in the East be based on the relationship between diameter at breast height (dbh) and the crown area of free-growing trees of each major species group. The stocking procedures in use in the Pacific Northwest Research Station for inventories of Washington, Oregon, and California, were a refinement of the TRR approach that attempts to account for the effects of species, stage of development, and social position on the area occupied by individual trees. The procedure is described in detail in MacLean (1979).

Although stage of development is frequently defined by site and age, stands with the same quadratic mean diameter (D) have been found "…more alike in every way than stands of the same site and age…" (McArdle et al., 1961). Thus, two stands of the same average diameter, one a young stand on a good site and the other an old stand on a poor site, are usually more similar than stands of the same site and age but differing average diameters. Reineke (1933) has shown that the space occupied by average trees growing in normal stands increases exponentially with increasing quadratic mean diameter at a rate that is approximately proportional to $D^{1.6}$. Chisman and Schumacher (1940) expressed the area occupied by an individual tree, or tree area in terms of a quadratic function of the tree's diameter, and expressed the density of a normal stand of unit area as a tree area ratio, the sum of individual tree areas. Curtis (1970, 1971) used Reineke's (1933) power function equation form to express tree area and tree area ratio. His exponent of 1.55 for Douglas-fir stands is very close to the 1.6 value of Reineke.

Evidence from yield tables suggests that the relationship between tree area and diameter varies among species. For example a comparison of "Normal yield tables for red alder" (Worthington and others, 1960) with "The yield of Douglas fir in the Pacific Northwest" (McArdle and others, 1961) indicates that the space occupied by a 5-inch red alder is about 50% more than that occupied by a similar sized conifer.

Considerations Used in Selecting the Recommended Stocking Curves

The following is a summary of the committee's considerations that led to the final recommended algorithm to assign stocking values to individual trees tallied on all forested FIA plots. We began with the common understanding that a measure of relative density was most appropriate. We found that normal yield tables and stocking guides are widely, although not universally, available for the wide variety of species encountered by FIA. These normal yield tables and stocking guides are based on natural stands and assume no particular management regime. The committee decided that the stocking values for our plots should be based on these normal yield tables and stocking guides because FIA plots represent a random sample of stands without regard to management or other factors. Stocking functions specific to a species or to a forest type were used to access the contribution of individual trees to stocking., The stocking functions relate the area occupied by an individual tree to the area occupied by a tree of the same size growing in a fully-stocked stand of like trees. Standards were determined using the "normal" value or "A-line" (Gingrich, 1967) of the stocking guides. The equation form that we selected was a power function approximating the 3/2 power, the so-called thee halves power function described by Reineke (1933) and others (Curtis 1970). Our reasons for this were two-fold: (1) The 3/2 thinning rule is widely accepted and well described in the literature; and (2) it is a model that extrapolates well, an important consideration when many of the existing yield tables and stocking guides cover less than the full range of diameters found on FIA plots.

We also considered the quadratic tree area ratio used by Gingrich (1967) and Stout and Nyland (1986). We compared the two equations using 2944 plots of the most recent inventory of Pennsylvania. The results are presented in Table 1. When trees 5" and larger are used, the absolute difference in stocking between the power function and the quadratic function was no more than 4.7 on 98% of the plots. When trees at least 1" in diameter are used, a much higher proportion of the plots had much greater differences. Investigation revealed that most of the large differences were caused by one species group. For trees under 7 inches, the quadratic equation expressing tree area for this group is a decreasing instead of increasing function of diameter.

Table 2 contains a list of equations that we developed to assign stocking values to trees. The column named species contains the predominant species or forest type used to develop the stocking guide or yield tables; b0 and b1 are the coefficients of the power function. The coefficients were estimated using the relationship between trees per acre and average stand diameter of the A-line of the stocking charts, or the level of average maximum competition as described by Curtis (1970,1971):

$$S = (100/TPA) = b0 \cdot D^{b1}$$

where D = average stand diameter

TPA = trees per acre at average maximum density for a stand with average diameter D,

and 100 = the reference level or density of a stand of average maximum competition.

The equation for red maple, and cherry-ash-poplar are calculated by transforming the quadratic tree area ratio functions in Stout and Nyland (1986) to the power functions used here. The hemlock and basswood equations were determined from data in a report by Bragg (1992). He made adjustments to the trees per acre values of Tubbs (1977) to better fit the northern hardwoods equation of the Northeast Decision Model (Marquis 1991).

The Northeast Decision Model uses the red maple equation for hardwoods and the jack pine equation for softwoods for species not used to develop any of the available stocking guides. With help from other members of the FIA staffs while considering the description in Silvics of North America (1990), we assigned a stocking equation to each species in our database, Table 3.

All members of the committee thought that the density equations would overestimate the contribution of understory trees to a certain extent. PNW has developed discounting factors to adjust the density contribution of each tree according to stand position. In the northeast Hillebrand et al. (1991) have investigated the use of relative diameter as a weighting factor. Somewhat arbitrarily we decided to apply the crown position adjustment factors found in Table 4 to trees larger than 1” dbh. Using these weights could result in slight underestimation of total stocking on the plot. However their use will concentrate the classification procedures to the main canopy, which we believe will outweigh this deficiency.

There is a wide range in the size of trees considered in the development of the yield tables. Some use all trees 1” and larger (Roach 1977). Others use only trees in the main canopy (Leak et al. 1987). Few consider stands with average diameter under 3 inches. All ignore seedlings. For these reasons we felt that the density equations would not work well in regeneration stands. Also, the density of the stand when it reaches some minimum size suitable for commercial thinning is of more interest than that of current seedlings and saplings. We therefore decided to apply a “future-stand” value to seedlings and saplings when the total stocking of 5”+ trees was less than a specified limit, and to assign a stocking value based on the “future” diameter. We arbitrarily chose 5 inches as the “future” diameter.

Because FIA will no longer rotate subplots into a uniform condition, a subplot as well as the plot may straddle two or more ecotypes. When this occurs FIA field crews differentiate the plot by condition and map the condition boundaries using the procedures outlined in Hahn et al. (1995). The conditions that are mapped are land use (forest, nonforest), forest type, stand size, and stand origin (natural, planted).

A plot may also have limitations on its ability to support trees such as rock outcrops or small ponds. Low moisture is especially important in certain areas of the West. To account for these limitations a stockability proration can be applied expressing the ability to support trees as a proportion of the potential of the "normal" stands from which the stocking guides were developed. These proration values are determined by the individual units.

Certain woodland species are measured at the root collar. These root collar diameters are used in our equations. On plots with multiple subplots we did not want a very high stocking of one subplot to completely compensate for very low stocking on other subplots. To account for this "clumpiness" we put a limit on the total stocking contribution of a subplot and adjust the stocking values on subplots that are above the limit.

We also thought that the forest type classification algorithm should retain as much emphasis as possible on trees larger than 5" dbh when they are present. We did not want a high stocking total for seedlings and saplings to result in a reduction to the stocking values of the larger trees due to the "clumpiness" adjustment. We therefore put further limits on the stocking of seedlings and saplings by allowing a sapling total stocking only up to the remainder of the difference between the subplot maximum and the total for 5"+ trees, and seedling total stocking up to the remainder after accounting for 5"+ and sapling stocking.

With these considerations in mind, the procedure to assign stocking values to individual trees is outlined below.

Algorithm to Determine Stocking Values on Forested FIA Plots

Plots with multiple subplots

Let L_i = number of subplots in original design for plot i ,

L_{ik} = number of subplots of plot i in condition k

dbh_{iklj} = diameter at breast height of tree j, subplot l, condition k of plot i

= .1 for seedlings

tpa_{iklj} = trees per acre expansion factor of tree j on subplot l , condition k of plot i, reflecting the plot size disregarding condition; i.e., condition does not enter into the computation of the expansion factor

J_{ikl} = number of trees in condition k of subplot l , plot i

p_{ikl} = proportion of subplot l of plot i that is condition k

q_{ik} = stockability proportion for condition k of plot i

I = 100, the index reflecting maximum stocking for a plot

I_l = $100/L_i$, subplot index reflecting maximum stocking for subplot *l* of plot *i*

s_{iklj} = stocking value for tree *j* in condition *k* of subplot *l*, plot *i*.

Stocking values are assigned to live trees only. It is assumed that the proportion of each subplot in condition *k*, p_{ikl} , has been determined prior to the start of the algorithm. See Scott and Bechtold (1995) for the method FIA uses to calculate p_{ikl} for the fully mapped plot design as implemented by FIA (Hahn et al. 1995).

1. Assign an initial stocking value to each tree.
   A. Determine the stocking equation number; Table 3 contains the stocking code for each species code.
   B. Assign values to the coefficients b0 and b1 based on the stocking equation number determined in step A; Table 2 lists the coefficients for each equation.
   C. Assign an initial stocking value,

$$s_{iklj} = (b0 \cdot dbh_{iklj}^{b1}) \cdot tpa_{iklj}/q_{ik}.$$

The diameter used for seedlings is .1 inch. Although not a reasonable value in most cases, .1 yields a non-zero value that has little effect on the classification algorithms in the presence of larger trees.

2. Adjust the initial values to reflect competitive position in relation to other trees on the subplot. For saplings, poletimber, and sawtimber trees, competitive position is based on crown class. However, FIA does not collect crown class on seedlings, and some units have not collected crown class on saplings in the past. In the absence of crown class we attempt to account for social position for these smaller trees through a ratio relating diameter of the tree to a maximum diameter on the subplot.
   A. Determine a crown competition factor CF_{iklj}.
      i. For trees with a recorded crown class, CF_{iklj} is assigned as in Table 4.
      ii. For 5”+ trees without crown class, set CF_{iklj} to a default value of 1.
      iii. For seedlings and saplings without a crown class,
         a. Sum the stocking of large (dbh>5”) trees for each subplot in each condition,

$$G_{ikl} = \sum_{j=1}^{J_{ikl}} s_{iklj} \cdot \delta_{iklj}$$

where δ_{iklj} = 1 if $dbh_{iklj} \geq 5$
= 0, otherwise.

         b. Calculate CF as a diameter ratio,

$$CF_{iklj} = dbh_{iklj}/D_{max}$$

where D_{max} = 5 if $G_{ikl} \geq .1 \cdot p_{ikl} \cdot I_l$

or D_{max} = maximum diameter of seedlings and saplings for condition *k* of subplot *l*, plot *i* if $G_{ikl} < .1 \cdot p_{ikl} \cdot I_l$.

The 10% of subplot total stocking for 5"+ trees is used as the cutoff in assigning D_{max} with the reasoning that if the subplot total is greater than 10%, most of the time seedlings and saplings will have a lesser competitive position, while if the total stocking is less than 10%, most of the time the competitive position of the seedlings and saplings will not be affected by the larger trees.

B. Multiply the initial stocking value by the crown competition factor

$$s_{iklj} = s_{iklj} \cdot CF_{iklj}$$

3. Decide whether "future-stand" or standard values are to be used for seedlings and saplings.

a. First calculate several condition and subplot values to be used for the tests:

$$p_{ik.} = \sum_{l=1}^{L_i} p_{ikl} / n_{L_i}$$

= proportion of whole plot *i* in condition *k*

$$F_{ikl} = .2 \cdot p_{ikl} \cdot I_l$$

= 20% of the subplot index adjusted for the proportion of subplot *l* in condition *k*

$$F_{ik.} = .2 \cdot p_{ik.} \cdot I$$

= 20 % of whole plot index adjusted for proportion of plot *i* in condition *k*

$$G_{ik.} = \sum_{l=1}^{L_i} G_{ikl}$$

= condition total stocking of trees at least 5" dbh

$$U_{ikl} = (120/L_i) \cdot p_{ikl}$$

= maximum total stocking allowed for condition *k* of subplot *l*, plot *i*.

The 120 maximum value used in determining U_{ikl} allows for an overstocked condition when compared with the index of 100.

b. Compare the total stocking of 5"+ trees for the condition with the 20% condition index. The "future-stand" procedure is used if $G_{ik.} < F_{ik.}$. If there are enough subplots we feel that we should also try to account for distribution of stocking among the subplots when testing whether the "future-stand" procedure is to be used. Extensive testing indicated that the 20% condition total test, without consideration of subplot distribution, seemed to work best for the 4-subplot Forest Health Monitoring (FHM) plot layout (Scott 1993, Bechtold et al. 1992) that is currently being used by all FIA units, while consideration of subplot distribution seemed to improve the results of the 10-point variable radius plot that has been used by most of the FIA units prior to adoption of the FHM plot design. Therefore, with more than 4 subplots, the "future-stand" procedure is used if either $G_{ik.} < F_{ik.}$ or the condition total stocking on a subplot is less than the 20% subplot index, i.e., $G_{ikl} < F_{ikl}$ on more than half of the subplots in the condition.

4. If "future-stand" procedure is used:
   a. Reassign the stocking values of seedlings and saplings using 5" as the diameter in the equation displayed in step 1-C.
   b. Adjust the recalculated values by multiplying by the competition factor, CF_{iklj}, determined in step 2.

5. Future-stand and standard stocking values are further adjusted to account for clumpiness (unequal distribution among subplots) and to assure that seedlings and saplings do not reduce the stocking values of larger trees.
   a. Calculate a subplot total stocking for both saplings, A_{ikl} and seedlings, E_{ikl}:

$$A_{ikl} = \sum_{j=1}^{J_{ikl}} s_{iklj} \cdot \delta'_{iklj}$$

$$E_{ikl} = \sum_{j=1}^{J_{ikl}} s_{iklj} \cdot \delta''_{iklj}$$

where $\delta'_{iklj} =$ if $1 \le dbh_{iklj} < 5$

$= 0$, otherwise,

and $\delta''_{iklj} = 1$ if $0 \le dbh_{iklj} < 1$

$= 0$, otherwise.

   b. Determine an upper limit for both seedlings, UE_{ikl}, and saplings, UA_{ikl}:

$$UA_{ikl} = \max(U_{ikl} - G_{ikl}, 0)$$

$$UE_{ikl} = \max(UA_{ikl} - O_{ikl}, 0)$$

where max(a,b) is a function returning the larger of the values a and b.

c. Calculate a proration ratio for 5”+ trees ($PR5_{ikl}$), saplings (PRA_{ikl}), and seedlings (PRE_{ikl});

$$PR5_{ikl} = \min(U_{ikl}/G_{ikl}, 1)$$

$$PRA_{ikl} = \min(UA_{ikl}/A_{ikl}, 1)$$

$$PRE_{ikl} = \min(UE_{ikl}/E_{ikl}, 1)$$

where min(a,b) is a function returning the smaller of a and b.

d. Multiply the stocking values by the appropriate adjustment,

$$s_{iklj} = s_{iklj} \cdot PR_{ikl} + z_{iklj}$$

where $PR_{ikl} = PR5_{ikl}$ if $dbh_{iklj} \geq 5$

$= PRA_{ikl}$ if $1 \leq dbh_{iklj} < 5$

$= PRE_{ikl}$ if $0 < dbh_{iklj} < 1$

and $z_{iklj} = .0001$ if $PR_{ikl} = 0$ and $dbh_{iklj} < 5$

$= 0.0$ if $PR_{ikl} > 0$ or $dbh_{iklj} \geq 5$.

The small value, z_{iklj}, is added to saplings and seedlings to obtain a small positive value when the remainder adjustment results in zero. This is done so that the mere presence of any species can be recognized by the forest type algorithm.

6. Finally adjust the values for the proportion of the whole plot in the condition,

$$s_{iklj} = s_{iklj}/p_{ik} .$$

This final adjustment recovers the index value of 100 for each condition. As an example, for a condition stocked at average maximum density but occupying 25% of the plot, the total stocking determined using steps 1 through 5 would be 25. Dividing by .25 yields a total stocking for the condition of 100.

Single fixed radius plots with multiple regeneration subplots

The Northeast FIA unit has used plots having a single fixed radius plot and multiple regeneration subplots. The procedure presented for multiple subplots needs to be modified slightly since we cannot account for unequal distribution of 5”+ trees among several subplots.

Let LR_{ik} = the number of regeneration subplots in condition *k* of plot *i*
and $L_{ik} = LR_{ik} + 1$.

The subplot index *i* is set to 1 for the single subplot with poletimber and sawtimber trees, with the subplot index for the regeneration subplots ranging from 2 to L_{ik}.

1. For subplot *i* = 1 only, perform steps 1 through 4 of the multiple subplot procedure. Thus U_{ik1} of step 3 is the maximum total stocking for condition *k*.

2. For the regeneration subplots, *l*=2 through L_{ik}, execute steps 5a and 5b of the multiple subplot procedure. In step 5b

$$UA_{ikl} = \max((U_{ik1} - G_{ik1})/LR_{ik}, 0)$$

= the upper limit of stocking allowed for seedlings and saplings for regeneration subplot *l*.

3. Determine the proration ratios as in step 5c. For 5"+ trees, *l* = 1 and

$$PR5_{ik1} = \min(U_{ik1}/G_{ik1}, 1)$$

For seedlings and saplings, *l*=2 through L_{ik},

$$PRA_{ikl} = \min(UA_{ikl}/A_{ikl}, 1)$$

and

$$PRE_{ikl} = \min(UE_{ikl}/E_{ikl}, 1).$$

4. Execute steps 5d and 6.

These procedures can be used for most of our old plots, including the 10-point variable radius plots, as well as the current national fully mapped design (Hahn et al. 1995) using the 4-subplot FHM layout (Scott 1993, Bechtold et al. 1992). However, for the variable radius subplots it is assumed that the plot occupies only one condition.

Determination of Stocking Class, Stand Size Class, and Forest Type

For each condition delineated on the plot with recorded boundaries, the stocking values are used to determine stocking class, stand size class, and forest type. When a plot is split so that a condition is represented by a small section of the plot, or the condition has a low tree count, the classification algorithms could return results that are not representative of the condition. Alternative procedures are compromises among time or cost, accuracy of classification, and consistency.

We believe that the best classifications would be obtained with supplementary measurements in the condition. This would also be the most expensive and raises questions about the amount of additional measurement needed, the measurement procedure, and about a consistent but unbiased method of determining the location of the supplementary measurements.

We also feel that the field crews can do a good job of classification using observation not restricted to the plot. The major concern with using field crew classification without additional measurement is consistency over time and among field crews. With these considerations, FIA will use field crew classifications, with or without supplemental measurements, when a condition occupies less than 25% of the plot.

Stocking class for each condition

For determination of stocking class, first sum the stocking values of all live trees in the condition. The class is assigned by comparing this total stocking with the following class boundaries:

Stocking-class	Class boundaries
Nonstocked	0 - < 10
Poorly stocked	10 - < 35
Moderately stocked	35 - < 60
Fully stocked	60 - ≤ 100
Overstocked	> 100

Stand size class

Assign each tree to one of the following size classes based on dbh.

Size class	Class boundaries	
Seedling-sapling	dbh <5”	
Poletimber	5” ≤ dbh < 9”	for hardwoods
	5” ≤ dbh < 11”	for softwoods
Sawtimber	9” ≤ dbh	for hardwoods
	11” ≤ dbh	for hardwoods

Sum the stocking values for each size class and for all classes combined.
Assign the stand size class associated with the first condition that is met in the following table:

Condition	Stand size class
Total stocking <10	Nonstocked
Seedling-sapling stocking > 50% of total stocking	Seedling-sapling
Poletimber stocking > Sawtimber stocking	Poletimber
Poletimber stocking ≤ Sawtimber stocking	Sawtimber

Forest type

An algorithm was developed that can be used to determine forest type by all FIA units. The forest types determined by the algorithm are, for the most part, the same as those previously reported by each FIA unit and are based on types presented by Eyre (1980).

1. Using the species code, determine an initial type group for each tree. Table 3 lists the initial type group for each species.
2. Sum the stocking values of individual trees comprising each initial type group to obtain a stocking total for each initial type.
3. For each combined type group listed in Table 5, sum the stocking of the initial type groups included in the combined type group.
4. The accumulated stocking of the combined types are then used in the decision tree depicted in Figure 1 to determine forest type. At each node, either the total stocking of an individual combined group is compared to a constant, or the total stocking of several combined groups are compared. When several groups are compared the algorithm proceeds down the branch with the predominant combined group, or the group with the highest stocking of those being compared, to the next decision node. The combined group names in the decision tree are those listed in Table 5. The groups compared at each node are preceded by the same letter in Table 5. With this approach logical combinations of species take precedence over a single species. If the true firs account for most of the stocking, the algorithm would yield one of the forest types in the true fir subgroup, even though the individual species with the largest value is not a true fir. In the case of ties, the first group listed is chosen.

5. Assign a national (RPA) forest type group based on the forest type determined. Table 6 lists the forest type group assignment for each forest type.

Thus, after accumulating stocking into combined type groups, and determining that the condition is at least 10% stocked, the hierarchical process begins by comparing softwoods and hardwoods. If softwoods predominate, the true firs and spruce, doug fir-larch-western white pine, sitka spruce-hemlock, other western pines, redwoods, eastern pines, eastern spruce-fir, pinyon-juniper, and exotic softwoods are compared. If true firs-spruce predominate then spruce-subalpine fir, western hemlock, true firs, Alaska yellow-cedar, and western white pine are compared. If spruce-subalpine fir predominate then Engelmann spruce-subalpine fir is compared with blue spruce. In several instances, plurality only is not enough to determine type; additional conditions are required. In this discussion the terms predominance and plurality are used interchangeably when choosing among two or more species groups. The group with plurality, or the predominant group, is that which has the most stocking of those being compared.

If Engelmann spruce-subalpine fir predominates blue spruce, then if the stocking of both subalpine fir and Engelmann spruce is between 5 and 50 percent of total stocking, the forest type is Engelmann spruce-subalpine fir. Otherwise the type is either Engelmann spruce or subalpine fir depending on which species predominates.

The stepwise progression would proceed along other paths in a similar fashion. At each step the path proceeds to the next lower level of the group with the plurality of stocking.

Special situations where this algorithm is not strictly adhered to are noted below. If the process has led to the red-white-jack pine group and white pine-hemlock is at least 50% of total stocking while individual contributions of white pine and hemlock are at least 5% but less than 50% of total stocking, then the forest type is white pine-hemlock. Likewise, if the algorithm has reached the upland spruce-fir combined group, balsam fir-red spruce is at least 50% of total stocking, and balsam fir and red spruce are each between 5 and 50 percent, the forest type is spruce-fir.

The pine-hardwood mixed types occur if softwood stocking is less than half of the total, but the amount in the oak-pine group is at least 25% of total stocking. Oak-pine is the combined group (Table 5) composed of those pines and Eastern red-cedar that make up one of the mixed pine-hardwood types. Type is then based on plurality among the types within the oak-pine subgroup. Predominance of Eastern redcedar, shortleaf pine, eastern white pine, longleaf pine, Virginia pine, loblolly pine, and slash pine yield individual species types, while predominance of jack pine, red pine, sand pine, table mountain pine, pitch pine, or pond pine yield a type called other pine-hardwood.

If hardwoods predominate and oak-pine is less than 25% of total stocking, several of the major hardwood groups have certain species added before determining the predominate group. Some of these species are included specifically in one or more forest types, but can occur over a wide range of conditions. Other associates are not mentioned specifically in a forest type. The addition of these associates to a particular group depends on physiographic class. In some cases non-zero stocking is also required before addition to prevent the situation where the algorithm reaches a major hardwood type in which the stocking is comprised of associates only.

In particular note that Southern red oak is added to Post-blackjack oak and Chestnut oak only if these types already have a non-zero stocking. Although we wanted Southern red oak included in these types, we did not want these types determined by Southern red oak only. Similarly, Eyre (1980) lists black ash as the defining species in Black ash-American elm-red maple. We did not want to reach this forest type without some black ash.

One exception to the addition of associates to the major groups depending on physiographic class occurs. With a lowland physiographic class, if both the elm-ash-cottonwood and oak-gum-cypress groups have zero stocking, then black cherry, beech, red maple, white ash, and green ash are added to one of the upland groups. This will prevent having types not being determined when all of the stocking is due to these species.

With these additions, the major hardwood groups are compared for plurality of stocking. These include maple-beech-birch, oak-hickory, oak-gum-cypress, elm-ash-cottonwood, aspen-birch, alder-maple, western oaks, tan oak-laurel, other western hardwoods, tropical hardwoods, and exotic hardwoods.

In several of these major hardwood groups, single species types are assigned only if certain conditions are met. In oak-hickory, if white oak, bur oak, chestnut oak, northern red oak, scarlet oak, yellow poplar, black walnut, red maple, or black locust is at least 50% of total stocking, the type assigned is that of the appropriate species. Otherwise type is assigned to one of the combination groups based on plurality. However, if the stocking of the type determined is less than 25% of the oak-hickory stocking, the mixed upland hardwood type is assigned.

In the oak-gum-cypress group the first test determines whether Atlantic white cedar is at least half of total stocking. If not, the type is assigned based on plurality of the subgroups within oak-gum-cypress.

If elm-ash-cottonwood is the predominant hardwood group, the cottonwood, willow, or red maple/lowland type is assigned if the stocking of one of these is at least half of the total. Otherwise plurality among the subgroups determines type.

Within the maple-beech-birch hardwood group, type is decided by plurality unless the stocking of black cherry or red maple is at least 50% of the total. For the other hardwood groups, type is based on plurality of species groups at the lowest level of the decision tree. This level is reached in each case by one or more successive tests on plurality of stocking of groups at the same level.

The final special situation occurs in California. In certain counties a California mixed conifer type is assigned if the forest type is Douglas fir. A California mixed confer type is also assigned if the forest type determined is sugar pine or incense cedar, or if the type determined is ponderosa pine, or Jeffrey pine and the stocking of ponderosa pine is less than 80% of the total, or the type determined is white fir or red fir and the stocking of true firs is less than 80% of the total.

Future modifications

So that there is consistency in procedures and estimates among all FIA units, FIA is reviewing all aspects of their program. One of the outcomes will be a standardized species list that could be slightly different than that presented in this report. Modification of the tree species list can affect stocking and attributes such as forest type, stand size, and stocking class that are determined using the stocking values. It will be necessary to assign a stocking equation, initial type, and other attributes to additional species. Also, it may be necessary to modify the algorithms to account for deletions from the species list.

Improved stocking guides can be incorporated into the procedures by changing the coefficients or adding to the list of equations, which will also require changes to the stocking equation assignment for the affected species.

Literature Cited

Barnes, G.H. 1962. Yield of even-aged stands of western hemlock. Tech. Bull. 1273. Washington, DC: U.S. Department of Agriculture. Forest Service. 52p.

Bechtold, W.A., Labau, V.J., McLain, W., and Rogers, P. 1992. Site classification, growth, and regeneration. In Forest health monitoring field methods guide (national guide), Conkling, B.L., and G.E. Byers (eds.). U.S. Environmental Protection Agency, Office of Research and Development, internal rep. Research Triangle Park, NC. 434p.

Benzie, J.W. 1977. Manager's handbook for jack pine in the North Central States. Gen. Tech. Rep. NC-32. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station. 18p.

Benzie, J.W. 1977. Manager's handbook for red pine in the North Central States. Gen. Tech. Rep. NC-33. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station. 22p.

Bickford, C.A., F.S. Baker, and F.B. Wilson. 1957. Stocking, normality, and measurement of stand density. J. For. 55(2):99-104.

Bragg, W.C. Northeast decision model relative density algorithm. Unpublished.

Burns, R.M. and B.H. Honkala, tech. Cords. 1990. Silvics of North America: 1. Conifers. Agriculture Handbook 654. U. S. Department of Agriculture. Forest Service, Washington, DC. Vol. 1, 675p.

Burns, R.M. and B.H. Honkala, tech. Cords. 1990. Silvics of North America: 2. Hardwoods. Agriculture Handbook 654. U. S. Department of Agriculture. Forest Service, Washington, DC. Vol. 1, 675p.

Chisman, H.H. and F.X. Schumacher. 1940. On the tree-area ratio and certain of its applications. J. For. 38:311-317.

Cochran, P.H. 1985. Site index, height growth, normal yields and stocking levels for larch in Oregon and Washington. Res. Pap. PNW-424. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 24p.

Curtis, R.O. 1970. Stand density measures: an interpretation. For. Sci. 16:403-414.

Curtis, R.O. 1971. A tree area power function and related stand density measures for Douglas-fir. For. Sci. 17:146-159.

Dahms, W.G. 1964. Gross and net yield tables for lodgepole pine. Res. Pap. PNW-8 Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 14p.

Eyre, F.H., ed. 1980. Forest cover types of the United States and Canada. Soc. Am. For., Bethesda, MD. 148p.

Gingrich, S.F. 1967. Measuring and evaluating stocking and stand density in upland hardwood forests in the Central States. Forest Science. Vol. 13, No. 1:38-53.

Hahn, J.T., MacLean, C.D., Arner, S.L., Bechtold, W.A. 1995. Procedures to handle inventory cluster plots that straddle two or more conditions. Forest Science Monograph. 31:12-25.

Hansen,M.H. and J.T. Hahn. 1992. Determining stocking, forest type and stand-size class from Forest Inventory data. Northern Journal of Applied Forestry, Vol. 9, No. 3, p. 82-89.

Haig, I.T. 1932. Second growth yield, stand, and volume tables for western white pine type. Tech. Bull. 323. Washington DC: U.S. Department if Agriculture, Forest Service. 65p.

Hillebrand, J.J., R.L. Earnst, S.L. Stout, and S. Fairweather. 1992. Using relative diameter to improve density measures in Allegheny hardwood stands. Forest Ecology Management. 55:225-232.

Johnston, W.F. 1977. Manager's handbook for Northern white cedar in North Central States. Gen. Tech. Rep. NC-35. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station.

Larson, R.W. 1956. Standards and procedures for classification of stocking. Unpublished office report. On file at the Southern Forest Experiment Station. U.S. Department of Agriculture, Forest Service. Ashville, NC.

Leak, W.B., D.S. Solomon, and P.S. Debald. 1987. Silvicultural guide for northern hardwood types in the Northeast(revised). Res. Pap. NE-603. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 36p.

McArdle, R.E., W.H. Meyer, and D. Bruce. 1961. The yield of Douglas-fir in the Pacific Northwest. USDA Tech. Bull. 201. (revised). U.S. Department of Agriculture, Forest Service, Washington, DC. 74p.

MacLean, C.D. Emperical data on redwoods using FIA plots in Northern California. Unpublished.

Maclean, C.D. 1979. Relative density: The secret to stocking assessment in regional analysis – a Forest Survey viewpoint. Gen. Tech. Rep. PNW-78. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.

MacLean, C.D., Bolsinger, C.L. 1973. Estimating productivity on sites with a low stocking capacity. Res. Pap. PNW-152. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experimental Station. 18p.

Marquis, D.A. 1991. The Northeast decision Model; a multi-resource silvicultural decision model for forests of the Northeastern United States. In: Systems Analysis in Forestry, Symposium, Charlston, SC, 5-7 March, 1991. 419-431.

May, D.M. 1991. Stocking, forest type, and stand size class- the Southern Forest Inventory and Analysis unit's calculation of three important stand descriptors. Gen. Tech. Rep. SO-77. New Orleans, LA: U. S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 7p.

Meyer, W.H. 1961. Yield of even-aged stands of ponderosa pine. Tech. Bull. 630(revised). Washington, DC: U.S. Department of Agriculture, Forest Service. 59p.

Meyers, C.C. and R. Buchman. 1984. Manager's handbook for elm-ash-cottonwood in the North Central States. Gen. Tech. Rep. NC-98. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station. 11p.

Osbourne, J.G., and R. K. Winters. 1935. Growth and yield of second growth red gum in fully stocked stands on alluvial lands in the south. USFS SOFES occasional paper 54. 34p.

Perala, D.A. 1997. Manager's handbook for aspen in the North Central States. Gen. Tech. Rep. NC-36. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station. 30p.

Philbrook, J.S., J.P. Barrett, and W.B. Leak. 1973. A stocking guide for Eastern White Pine. Res. Note NE-168. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station. 3p.

Plonski, W.L. 1960. Normal yield tables for black spruce, jack pine, tolerant hardwoods, white pine, and red pine. Ontario Department of Lands and Forests Sivicultural Series. Bull. No. 2. 39p.

Reineke, L.H. 1933 Perfecting a stand-density index for even-aged forests. J. Agric. Res. 46:627-638.

Roach, B.A. and S.F. Gingrich. 1962. Timber management guide for upland central hardwoods. U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station and North Central Region. 33p.

Roach, B.A. 1977. A stocking guide for Allegheny hardwoods and its use in controlling intermediate cuttings. Res. Pap. NE-373. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station. 30p.

Scott, C.T. 1993. Optimal design of a plot cluster for monitoring. In:Rennolls, K.; Gertner, G.. eds. The optimal design of forest experiments and forest surveys. London: University of Greenwich, School of Mathematics, Statistics and Computing: 233-242.

Scott, C.T. and W.A. Bechtold. 1995. Techniques and computations for mapping plot clusters that straddle stand boundaries. Forest Science Monograph. 31: 46-61.

Safford, L.O. 1983. Silvicultural guide for paper birch in the Northeast (revised). Res. Pap. NE535. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station. 29p.

Schlesinger, R.C. and D.T. Funk. 1977. Manager's guide for black walnut. Gen Tech. Rep. NC-38. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station.

Schumacher, F.X., and T.S. Coile. 1960. Growth and yield of natural stands of the southern pines. T.S. Coile, Inc., Durham, NC 115p.

Solomon, D.S., R.A. Hosmer, and H.T. Hayslett, Jr. 1987. Fiber Handbook: A growth model for spruce-fir and northern hardwood forest types. Res. Pap. NE-602. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station. 19p.

Stout, S.L. and R.D. Nyland. 1986. Role of species composition in relative density measurement in Allegheny hardwoods. Can. J. For. Res. Vol. 16:574-579.

Tubbs, C.H. 1977. Manager's handbook for northern hardwoods in the North Central States. Gen. Tech. Rep. NC-39. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station.

USDA Forest Service. 1929. (re. 1976) Volume, yield, and stand tables for second-growth southern pines. USDA Misc. Pub. 50. 202p.

USDA Forest Service. 1958. Timber resources for America's Future. USDA For. Serv. Res. Rep. No. 14. Washington, DC. 713p.

Worthington, N.P., F.A. Johnson, G.R. Staebler, and W.J. Lloyd. 1960. Normal yield tables for red alder. Res. Paper 36. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.

Table 1. Percentiles of the distribution of differences in plot density between the power and quadratic functions

	Tree size	
Percentile	1"+	5"+
99%	9.4	4.7
95%	3.4	3.1
50%	-1.3	0.3
5%	-23.3	-2.5
1%	-74.8	-4.7

Table 2: Stocking equation coefficients and references

Species	Equation number	Coefficients b0	Coefficients b1	References
Spruce-fir	1	.00869	1.48	Solomon, Hosmer, Hayslett(1987)
Western larch	2	.00454	1.73	Cochran(1985)
Black spruce	3	.01691	1.05	Plonski(1960)
Jack pine	4	.00946	1.59	Benzie(1977a)
Lodgepole pine	5	.00422	1.70	Dahms(1964)
Shortleaf pine	6	.00509	1.81	USDA Misc. Publ. 50(1976)
Slash pine	7	.00458	1.91	Schumacher and Coile(1960) USDA Misc. Publ. 50(1976)
Western white pine	8	.00335	1.73	Haig(1932)
Longleaf pine	9	.01367	1.44	Schumacher and Coile(1960) USDA Misc. Publ. 50(1976)
Ponderosa pine	10	.00250	2.00	Meyer(1961)
Red pine	11	.00609	1.67	Benzie(1977b)
Pond pine	12	.00914	1.67	Schumacher and Coile(1960)
Eastern white pine	13	.00900	1.51	Philbrook, Barrett, Leak(1973)
Loblolly pine	14	.00680	1.72	Schumacher and Coile(1960) USDA Misc. Publ. 50(1976)
Douglas fir	15	.00769	1.54	McArdle, Meyer, Bruce (1961)
Northern white cedar	16	.00433	1.80	Johnston(1977)
Eastern hemlock	17	.00313	2.11	Bragg(1992), Tubbs(1977)
Western hemlock	18	.00427	1.67	Barnes(1962)
Redwood	19	.00333	1.68	MacLean(unpublished)
Red maple	25	.01105	1.53	Stout and Nyland(1986)
Red alder	26	.01671	1.41	Worthington, et al.(1960)
Maple,beech,birch	27	.00694	1.86	Bragg(1992) Stout and Nyland(1986) Leak, Solomon, Debald(1987) Roach(1977)
Paper birch	28	.00635	1.89	Safford(1983)
Oaks and hickory	29	.01119	1.63	Roach and Gingrich(1962)
Black walnut	30	.01546	1.50	Schlesinger and Funk(1977)
Sweetgum	31	.00429	1.87	Osbourne and Winters(1935)
Aspen	32	.01429	1.46	Perala(1977)
Cherry,ash,yellow poplar	33	.02197	1.13	Stout and Nyland(1986)
Basswood	35	.00442	2.02	Bragg(1992), Tubbs(1977)
Elm,ash,cottonwood	36	.00688	1.86	Meyers and Buckman(1984)

Table 3. Initial types with species assignment and stocking equation assignment to species.

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
1	11	Pacific silver fir	18	Western hemlock
2	14	Santa lucia fir	18	Western hemlock
	15	White fir	15	Douglas fir
3	17	Grand fir	18	Western hemlock
4	18	Corkbark fir	1	Spruce-fir
	19	Subalpine fir	1	Spruce-fir
5	20	California red fir	18	Western hemlock
	21	Shasta red fir	18	Western hemlock
6	120	Bishop pine	10	Ponderosa pine
7	22	Noble fir	18	Western hemlock
8	41	Port-Orford-cedar	18	Western hemlock
9	42	Alaska-yellow-cedar	18	Western hemlock
10	81	Incense-cedar	18	Western hemlock
11	242	Western redcedar	18	Western hemlock
12	50	Cypress	10	Ponderosa pine
	51	Arizona cypress	10	Ponderosa pine
	52	Baker cypress	10	Ponderosa pine
	53	Tecate cypress	10	Ponderosa pine
	54	Monterey cypress	10	Ponderosa pine
	55	Sargent cypress	10	Ponderosa pine
13	73	Western larch	2	Western larch
14	93	Engelmann spruce	1	Spruce-fir
15	96	Blue spruce	1	Spruce-fir
16	90	Spruce sp.	1	Spruce-fir
	94	White spruce	1	Spruce-fir
	99	Lutz spruce	1	Spruce-fir
17	95	Black spruce	3	Black spruce
18	98	Sitka spruce	18	Western hemlock
19	101	Whitebark pine	10	Ponderosa pine
20	102	Bristlecone pine	10	Ponderosa pine
	104	Foxtail pine	8	Western white pine
	142	Gr.Basin brstlcone pine	10	Ponderosa pine
21	103	Knobcone pine	8	Western white pine
22	112	Apache pine	10	Ponderosa pine
	114	Southwestern white pine	10	Ponderosa pine
	118	Chihuahua pine	10	Ponderosa pine
	137	Washoe pine	10	Ponderosa pine
	138	Four-leaf pine	10	Ponderosa pine
	139	Torreya pine	10	Ponderosa pine
	141	Arizona pine	10	Ponderosa pine
23	108	Lodgepole pine	5	Lodgepole pine
24	109	Coulter pine	10	Ponderosa pine
25	113	Limber pine	10	Ponderosa pine

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
26	122	Ponderosa pine	10	Ponderosa pine
	135	Arizona pine	10	Ponderosa pine
27	117	Sugar pine	10	Ponderosa pine
28	119	Western white pine	8	Western white pine
29	124	Monterey pine	10	Ponderosa pine
30	201	Bigcone douglas-fir	15	Douglas fir
31	202	Douglas-fir	15	Douglas fir
32	211	Redwood	19	Redwood
33	212	Giant sequoia	19	Redwood
34	263	Western hemlock	18	Western hemlock
35	264	Mountain hemlock	18	Western hemlock
36	116	Jeffrey pine	10	Ponderosa pine
38	64	Western juniper	10	Ponderosa pine
40	72	Subalpine larch	2	Western larch
	92	Brewer spruce	18	Western hemlock
	231	Pacific yew	18	Western hemlock
	232	Florida yew	18	Western hemlock
	251	Calif. torreya(nutmeg)	18	Western hemlock
	252	Florida nutmeg	18	Western hemlock
41	105	Jack pine	4	Jack pine
42	125	Red pine	11	Red pine
44	107	Sand pine	4	Jack pine
45	110	Shortleaf pine	6	Shortleaf pine
46	111	Slash pine	7	Slash pine
47	115	Spruce pine	4	Jack pine
48	121	Longleaf pine	9	Longleaf pine
49	123	Table Mountain pine	4	Jack pine
50	126	Pitch pine	4	Jack pine
51	128	Pond pine	12	Pond pine
52	131	Loblolly pine	14	Loblolly pine
53	129	Eastern white pine	13	Eastern white pine
54	132	Virginia pine	4	Jack pine
55	10	Fir sp.	1	Spruce-fir
	12	Balsam fir	1	Spruce-fir
	16	Fraser fir	1	Spruce-fir
58	97	Red spruce	1	Spruce-fir
59	43	Atlantic white-cedar	16	Northern white cedar
60	241	Northern white-cedar	16	Northern white cedar
61	221	Baldcypress	31	Sweetgum
	222	Pondcypress	31	Sweetgum
	223	Montezuma baldcypress	31	Sweetgum
63	66	Rocky Mountain juniper	10	Ponderosa pine

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
64	67	Southern redcedar	4	Jack pine
	68	Eastern redcedar	4	Jack pine
65	71	Tamarack (native)	1	Spruce-fir
66	260	Hemlock sp.	17	Eastern hemlock
	261	Eastern hemlock	17	Eastern hemlock
	262	Carolina hemlock	17	Eastern hemlock
70	70	Larch (introduced)	1	Spruce-fir
	91	Norway spruce	1	Spruce-fir
	136	Austrian pine	11	Red pine
	145	Italian stone pine	4	Jack pine
71	130	Scotch pine	4	Jack pine
72	144	Japanese black pine	4	Jack pine
81	802	White oak	29	Oaks and hickory
82	806	Scarlet oak	29	Oaks and hickory
83	823	Bur oak	10	Ponderosa pine
84	832	Chestnut oak	29	Oaks and hickory
85	833	Northern Red oak	29	Oaks and hickory
86	809	Northern pin oak	29	Oaks and hickory
	835	Post oak	29	Oaks and hickory
	840	Dwarf(sand) post oak	29	Oaks and hickory
87	813	Cherrybark oak,Swamp Rd	29	Oaks and hickory
	825	Swamp chestnut oak	29	Oaks and hickory
	834	Shumard oak	29	Oaks and hickory
	836	Delta post oak	29	Oaks and hickory
88	812	Southern red oak	29	Oaks and hickory
89	808	Durand oak	29	Oaks and hickory
	816	Bear oak, Scrub oak	29	Oaks and hickory
	819	Turkey oak	29	Oaks and hickory
	841	Dwarf live oak	29	Oaks and hickory
	842	Bluejack oak	29	Oaks and hickory
90	401	Water hickory	29	Oaks and hickory
	405	Shellbark hickory	29	Oaks and hickory
91	404	Pecan	29	Oaks and hickory
92	400	Hickory sp.	29	Oaks and hickory
	402	Bitternut hickory	29	Oaks and hickory
	403	Pignut hickory	29	Oaks and hickory
	406	Nutmeg hickory	29	Oaks and hickory
	407	Shagbark hickory	29	Oaks and hickory
	408	Black hickory	29	Oaks and hickory
	409	Mockernut hickory	29	Oaks and hickory
	410	Sand hickory	29	Oaks and hickory
93	521	Common persimmon	29	Oaks and hickory
	931	Sassafras	29	Oaks and hickory

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
94	972	American elm	36	Elm,ash,cottonwood
	975	Slippery elm	36	Elm,ash,cottonwood
	977	Rock elm	36	Elm,ash,cottonwood
95	316	Red maple	25	Red maple
96	314	Black maple	27	Maple,beech,birch
	318	Sugar maple	27	Maple,beech,birch
97	317	Silver maple	25	Red maple
98	370	Birch sp.	27	Maple,beech,birch
	371	Yellow birch	27	Maple,beech,birch
	372	Sweet birch	27	Maple,beech,birch
99	375	Paper birch	28	Paper birch
	376	Western paper birch	28	Paper birch
	377	Alaska paper birch	28	Paper birch
	378	NW paper birch	28	Paper birch
	379	Gray birch	28	Paper birch
100	461	Sugarberry	36	Elm,ash,cottonwood
101	500	Hawthorn	29	Oaks and hickory
	501	Hawthorn crus-galli	29	Oaks and hickory
	502	Hawthorn mollis	29	Oaks and hickory
	552	Honeylocust	27	Maple,beech,birch
	571	Kentucky coffeetree	25	Red maple
	641	Osage-orange	29	Oaks and hickory
102	531	American beech	27	Maple,beech,birch
103	541	White ash	33	Cherry,ash,yellow poplar
104	543	Black ash	33	Cherry,ash,yellow poplar
105	544	Green ash	36	Elm,ash,cottonwood
106	591	American holly	25	Red maple
107	601	Butternut	30	Black walnut
108	602	Black walnut	30	Black walnut
109	611	Sweetgum	31	Sweetgum
110	621	Yellow-poplar	33	Cherry,ash,yellow poplar
111	653	Sweetbay	25	Red maple
112	691	Water tupelo	31	Sweetgum
113	693	Blackgum	31	Sweetgum
114	694	Swamp tupelo	31	Sweetgum
115	460	Hackberry sp.	36	Elm,ash,cottonwood
	462	Hackberry	36	Elm,ash,cottonwood
	463	Netleaf hackberry	36	Elm,ash,cottonwood
116	731	Sycamore	36	Elm,ash,cottonwood
117	741	Balsam poplar	32	Aspen

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
118	740	Cottonwood sp.	36	Elm,ash,cottonwood
	742	Eastern cottonwood	36	Elm,ash,cottonwood
	744	Swamp cottonwood	36	Elm,ash,cottonwood
	745	Plains cottonwood	36	Elm,ash,cottonwood
	748	Rio Grande cottonwood	36	Elm,ash,cottonwood
	749	Narrowleaf cottonwood	36	Elm,ash,cottonwood
	752	Silver poplar	36	Elm,ash,cottonwood
119	743	Bigtooth aspen	32	Aspen
	746	Quaking aspen	32	Aspen
120	837	Black oak	29	Oaks and hickory
121	762	Black cherry	33	Cherry,ash,yellow poplar
122	901	Black locust	29	Oaks and hickory
123	920	Willow	25	Red maple
	921	Peachleaf willow	25	Red maple
	922	Black willow	25	Red maple
	924	Scouler willow	25	Red maple
	927	White willow	25	Red maple
	929	Weeping willow	25	Red maple
124	950	Basswood sp.	35	Basswood
	951	American basswood	35	Basswood
	952	White basswood	35	Basswood
	953	Carolina basswood	35	Basswood
125	831	Willow oak	29	Oaks and hickory
127	555	Loblolly-bay	25	Red maple
	721	Redbay	33	Cherry,ash,yellow poplar
128	822	Overcup oak	29	Oaks and hickory
129	373	River birch	28	Paper birch
130	312	Bigleaf maple	25	Red maple
131	351	Red alder	26	Red alder
132	361	Pacific madrone	29	Oaks and hickory
	362	Arizona madrone	29	Oaks and hickory
	363	Texas madrone	29	Oaks and hickory
133	431	Golden chinkapin	29	Oaks and hickory
134	807	Blue oak	29	Oaks and hickory
135	542	Oregon ash	33	Cherry,ash,yellow poplar
136	631	Tanoak	25	Red maple
137	747	Black cottonwood	36	Elm,ash,cottonwood
138	801	Coast live oak	29	Oaks and hickory
139	818	California black oak	29	Oaks and hickory
140	815	Oregon white oak	29	Oaks and hickory
141	981	California laurel	29	Oaks and hickory
142	805	Canyon live oak	29	Oaks and hickory
	839	Interior live oak	29	Oaks and hickory

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
143	828	Nuttall oak	29	Oaks and hickory
144	712	Paulownia, Empress tree	27	Maple,beech,birch
145	992	Melaluca	1	Spruce-fir
146	355	European alder	26	Red alder
	974	Siberian elm	36	Elm,ash,cottonwood
	993	Chinaberry	33	Cherry,ash,yellow poplar
	994	Chinese tallowtree	25	Red maple
	995	Tung-oil tree	25	Red maple
147	911	Sabal palm	29	Oaks and hickory
148	510	Eucalyptus	15	Douglas fir
149	989	Mangrove	25	Red maple
151	311	Florida maple	25	Red maple
	341	Ailanthus	25	Red maple
	374	Water birch	28	Paper birch
	381	Chittamwood,Gum bumelia	25	Red maple
	551	Waterlocust	25	Red maple
	692	Ogechee tupelo	31	Sweetgum
	722	Water elm,Planer tree	33	Cherry,ash,yellow poplar
	804	Swamp white oak	29	Oaks and hickory
152	310	Maple sp.	25	Red maple
	315	Striped maple	27	Maple,beech,birch
	319	Mountain maple	25	Red maple
	320	Norway maple	25	Red maple
	356	Serviceberry	25	Red maple
	367	Pawpaw	25	Red maple
	391	Am.hornbeam,musclewood	25	Red maple
	421	American chestnut	25	Red maple
	422	Allegheny chinkapin	29	Oaks and hickory
	423	Ozark chinkapin	29	Oaks and hickory
	450	Catalpa sp.	27	Maple,beech,birch
	451	Southern catalpa	27	Maple,beech,birch
	452	Northern catalpa	27	Maple,beech,birch
	471	Eastern redbud	25	Red maple
	650	Magnolia sp.	33	Cherry,ash,yellow poplar
	651	Cucumbertree	33	Cherry,ash,yellow poplar
	652	Southern magnolia	33	Cherry,ash,yellow poplar
	654	Bigleaf magnolia	33	Cherry,ash,yellow poplar
	655	Mountain magnolia	33	Cherry,ash,yellow poplar
	656	Ashe's magnolia	33	Cherry,ash,yellow poplar
	657	Pyramid magnolia	33	Cherry,ash,yellow poplar
	658	Umbrella magnolia	33	Cherry,ash,yellow poplar
	660	Apple sp.	29	Oaks and hickory
	661	Oregan crabapple	29	Oaks and hickory
	662	Southern crabapple	29	Oaks and hickory
	663	Sweet crabapple	29	Oaks and hickory
	664	Prarie crabapple	29	Oaks and hickory
	665	Apple	29	Oaks and hickory

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
152	680	Mulberry sp.	25	Red maple
	681	White mulberry	25	Red maple
	682	Red mulberry	25	Red maple
	683	Texas mulberry	25	Red maple
	684	Black mulberry	25	Red maple
	701	Eastern hophornbeam	25	Red maple
	702	Knowlton hophornbean	25	Red maple
	711	Sourwood	25	Red maple
	760	Prunus sp.	25	Red maple
	761	Pin cherry	25	Red maple
	763	Chokecherry	25	Red maple
	764	Peach	25	Red maple
	765	Canada plum	25	Red maple
	766	Wild plum	25	Red maple
	768	Bitter cherry	25	Red maple
	851	Mountain ash	25	Red maple
	900	Locust sp.	29	Oaks and hickory
	935	American mountain-ash	25	Red maple
	936	European mountain-ash	25	Red maple
	937	Northern mountain-ash	25	Red maple
	938	Greene mountain-ash	25	Red maple
	939	Western mountain-ash	25	Red maple
	970	Elm sp.	36	Elm,ash,cottonwood
	976	September elm	36	Elm,ash,cottonwood
153	330	Buckeye,horsechestnut	27	Maple,beech,birch
	331	Ohio buckeye	27	Maple,beech,birch
	332	Yellow buckeye	27	Maple,beech,birch
	333	California buckeye	27	Maple,beech,birch
	334	Texas buckeye	27	Maple,beech,birch
	335	Bottlebrush buckeye	27	Maple,beech,birch
	336	Red buckeye	27	Maple,beech,birch
	337	Painted buckeye	27	Maple,beech,birch
	345	Mimosa, silktree	36	Elm,ash,cottonwood
	346	Woman's tongue	36	Elm,ash,cottonwood
	350	Alder sp.	26	Red alder
	352	White alder	26	Red alder
	353	Mountain alder	26	Red alder
	481	Yellowwood	25	Red maple
	490	Dogwood sp.	25	Red maple
	491	Flowering dogwood	25	Red maple
	492	Pacific dogwood	26	Red alder
	540	Ash sp.	33	Cherry,ash,yellow poplar
	545	Pumpkin ash	33	Cherry,ash,yellow poplar
	546	Blue ash	33	Cherry,ash,yellow poplar
	547	Velvet ash	33	Cherry,ash,yellow poplar
	548	Carolina ash	33	Cherry,ash,yellow poplar
	549	Singleleaf ash	33	Cherry,ash,yellow poplar
	580	Silverbell	25	Red maple

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
	600	Walnut	30	Black walnut
	603	Calif. black walnut	30	Black walnut
	604	S. Calif. black walnut	30	Black walnut
	605	Texas walnut	30	Black walnut
	606	Arizona walnut	30	Black walnut
	730	California sycamore	36	Elm,ash,cottonwood
	732	Arizona sycamore	36	Elm,ash,cottonwood
	991	Salt cedar	25	Red maple
	996	Smoketree	25	Red maple
	997	Russian olive	25	Red maple
	999	Other, unknown	25	Red maple
156	475	Curlleaf mtn. mahogany	10	Ponderosa pine
	476	Alder-Leaf mtn.mahogany	33	Cherry,ash,yellow poplar
	477	Hairy mountain-mahogany	33	Cherry,ash,yellow poplar
157	755	Mesquite	10	Ponderosa pine
	756	W. honey mesquite	10	Ponderosa pine
	757	Velvet mesquite	10	Ponderosa pine
	758	Screwbean mesquite	10	Ponderosa pine
158	800	Oak-deciduous	10	Ponderosa pine
	814	Gambel oak	10	Ponderosa pine
	821	Calif.(valley) wht.oak	25	Red maple
	919	Western soapberry	25	Red maple
159	321	Rocky mountain maple	10	Ponderosa pine
	322	Bigtooth maple	10	Ponderosa pine
	323	Chalk maple	10	Ponderosa pine
	324	Vine maple	10	Ponderosa pine
	325	Amur maple	10	Ponderosa pine
160	300	Acacia	25	Red maple
	902	New Mexico locust	10	Ponderosa pine
	990	Tesota,Arizona ironwood	10	Ponderosa pine
161	57	Redcedar/juniper	3	Black spruce
	58	Pinchot juniper	10	Ponderosa pine
	59	Redberry juniper	10	Ponderosa pine
	60	Common juniper	3	Black spruce
	61	Ashe juniper	3	Black spruce
	62	California juniper	10	Ponderosa pine
	63	Alligator juniper	10	Ponderosa pine
	65	Utah juniper	10	Ponderosa pine
	69	Oneseed juniper	10	Ponderosa pine
162	106	Common pinyon	10	Ponderosa pine
	133	Singleleaf pinyon	10	Ponderosa pine
	134	Border pinyon	10	Ponderosa pine
	140	Mexican pinyon pine	10	Ponderosa pine
	143	Arizona pinyon pine	10	Ponderosa pine
163	127	Gray pine	10	Ponderosa pine

Table 3. Initial types with species assignment and stocking equation assignment to species.(cont.)

Initial type group	Species code	Species common name	Stocking equation code	Stocking equation name
201	820	Laurel oak	29	Oaks and hickory
202	817	Shingle oak	29	Oaks and hickory
203	838	Live oak	29	Oaks and hickory
204	827	Water oak	29	Oaks and hickory
205	830	Pin oak	29	Oaks and hickory
206	824	Blackjack oak	29	Oaks and hickory
207	826	Chinkapin oak	10	Ponderosa pine
208	313	Boxelder	36	Elm,ash,cottonwood
209	971	Winged elm	36	Elm,ash,cottonwood
	973	Cedar elm	36	Elm,ash,cottonwood
210	803	Ariz. white oak,Gray oak	10	Ponderosa pine
	810	Emery oak	10	Ponderosa pine
	811	Engelmann oak	10	Ponderosa pine
	829	Mexican blue oak	10	Ponderosa pine
	843	Silverleaf oak	10	Ponderosa pine
	850	Oak-evergreen	10	Ponderosa pine

Table 4. Stocking crown position adjustment factors

Crown class	Stocking Factor
Open grown, dominant, codominant	1.0
Intermediate	0.5
Overtopped	0.1

Table 5. Initial type assignment to combined type groups

Combined type groups	Initial type group
A. Softwoods	1-58,60,62-79,161,162
B. True firs and spruce	1-5,7,9,14,15,28,34,35
C. Spruce-subalpine fir	4,14,15
D. Engelmann spruce-subalpine fir	4,14
E. Subalpine fir	4
E. Engelmann spruce	14
D. Blue spruce	15
C. Western hemlocks	34,35
D. Western hemlock	34
D. Mountain hemlock	35
C. True firs	1-5,7
D. Pacific silver fir	1
D. White fir	2
D. Grand fir	3
D. Subalpine fir	4
D. Red fir	5
D. Noble fir	7
C. Alaska yellow cedar	9
C. Western white pine	28
B. Doug fir-larch-western white pine	8,10,11,13,23,24,26,27,30,31,36
C. Doug fir-western larch	11,13,31
D. Doug fir	31
D. Western larch	13
D. Western redcedar	11
C. Doug fir-western pines	8,10,23,24,26,27,30,31,36
D. Doug fir	31
D. Ponderosa pine	26,36
D. Port-orford cedar	8
D. Lodgepole pine	23
D. Sugar pine	27
D. Incense cedar	10
D. Jeffrey-Coulter pine-Bigcone Doug fir	24,30,36
C. Western larch-pine	13,23,26,36
D. Western larch	13
D. Ponderosa pine	26,36
D. Lodgepole pine	23
B. Sitka spruce-hemlock	11,18,34
C. Western hemlock	34
C. Sitka spruce	18
C. Western redcedar	11
B. Other western pines	6,12,19,20,21,22,25,29,40
C. Knobcone pine	21

C. Southwest white pine	22
C. Bishop pine	6
C. Monterey pine	29
C. Foxtail-bristlecone pine	20
C. Limber pine	25
C. Whitebark pine	19
C. Miscellaneous western softwoods	12,40
B. Redwoods	31,32,33
C. Redwood	32
C. Gian sequoia	33
C. Doug fir	31
B. Eastern pines	41,42,44-54,66
C. Red-white-jack pine	41,42,53,66
D. White pine-hemlock	53,66
E. Eastern white pine	53
E. Eastern hemlock	66
D. Red pine	42
D. Jack pine	41
C. Longleaf-slash pine	46,48
D. Longleaf pine	48
D. Slash pine	46
C. Loblolly-shortleaf pine	44,45,47,49-52,54
D. Loblolly pine	52
D. Shortleaf pine	45
D. Virginia pine	54
D. Sand pine	44
D. Table mountain pine	49
D. Pond pine	51
D. Pitch pine	50
D. Spruce pine	47
B. Pinyon-juniper	38,63,64,161,162
C. Eastern redcedar	64
C. Rocky mountain juniper	63
C. Western juniper	38
C. Juniper woodland	161
C. Pinyon-juniper woodland	161,162
B. Eastern spruce-fir	16,17,55,58,60,65
C. Upland spruce-fir	16,55,58
D. Balsam fir-red spruce	55,58
E. Balsam fir	55
E. Red spruce	58
D. White spruce	16
C. Lowland spruce-fir	17,60,65
D. Black spruce	17
D. Tamarack	65
D. Northern white cedar	60

B. Exotic softwoods	70,71,72
C. Scotch pine	71
C. Australian pine	72
C. Other exotic softwoods	70
A. Hardwoods	59,61,81-153,156-160,163,201-210
B. Oak-pine	41,42,44-54,64
C. Eastern redcedar	64
C. Shortleaf pine	45
C. Eastern white pine	53
C. Longleaf pine	48
C. Virginia pine	54
C. Loblolly pine	52
C. Slash pine	46
C. Jack pine	41
C. Red pine	42
C. Sand pine	44
C. Spruce pine	47
C. Table mountain pine	49
C. Pitch pine	50
C. Pond pine	51
B. Oak-hickory	81-86,88,89,92,93,101,108,110,120, 122,202,206,207
C. White oak	81
C. Bur oak	83
C. Chestnut oak	84
C. Northern red oak	85
C. Scarlet oak	82
C. Yellow poplar	110
C. Black walnut	108
C. Black locust	122
C. Red maple	95

COMBINATION GROUPS

C. Post-blackjack oak	86,206
C. Chestnut-black-scarlet oak	82,84,120
C. Yellow poplar-white oak-red oak	81,85,110
C. White oak-red oak-hickory	81,85,92,94,120,207
C. Southern scrub oak	89,203,206
C. Sweetgum-yellow poplar	109,110
C. Sassafras-persimmon	93
C. Mixed upland hardwoods	83,88,94,101,106,108,113,122,125, 201,202,203,204
B. Oak-gum-cypress	59,61,87,90,111,112,114,127,128,143
C. Swamp chestnut-cherrybark oak	87
C. Sweetgum-nuttall-willow oak	109,125,143,201,203,204

C. Cypress-water tupelo	61,112
C. Overcup oak-water hickory	90,128
C. Atlantic white cedar	59
C. Sweetbay-swamp tupelo-red maple	95,111,113,114,127
B. Elm-ash-cottonwood	91,97,100,104,115,116,118,123,129 135,137,208
C. Cottonwood	118,137
C. Willow	123
C. Red maple	95
C. River birch-sycamore	108,116,123,129
C. Sycamore-pecan-elm	91,94,109,116
C. Black ash-elm-maple	104
C. Silver maple-American elm	94,97
C. Sugarberry-elm-green ash	94,100,105,115,208,209
C. Cottonwood-willow	118,123,130,131,137
C. Oregon ash	135
B. Maple-beech-birch	66,96,98,107,110,122,124
C. Black cherry	121
C. Red maple	95
C. Black cherry-white ash	103,110,121
C. Maple-basswood	96,124
C. Elm-ash-locust	94,105,122
C. Maple beech-yellow birch	66,94,95,96,98,102,105,107,108
B. Aspen-birch	99,117,119
C. Aspen	119
C. Balsam poplar	117
C. Paper birch	99
B. Alder-maple	130,131
C. Red alder	131
C. Bigleaf maple	130
B. Western oaks	134,138,139,140,142,158,163,210
C. California black oak	139
C. Oregon white oak	140
C. Blue oak	134
C. Gray pine	163
C. Coast live oak	138
C. Canyon-interior live oak	142
C. Deciduous oak-woodland	158
C. Evergreen oak-woodland	210
B. Tan oak-laurel	133,136,141
C. Tan oak	136
C. California laurel	141
C. Giant chinkapin	133
B. Other western hardwoods	132,156,157,159,160
C. Pacific madrone	132
C. Mesquite woodland	157

C. Mountain brush woodland	156
C. Intermountain maple woodland	159
C. Miscellaneous western hardwoods	160
B. Tropical hardwoods	147,149
C. Sable pine	147
C. Mangrove	149
B. Exotic hardwoods	144,145,146,148
C. Paulownia	144
C. Melaluca	145
C. Eucalyptus	148
C. Other exotic hardwoods	146

SPECIAL COMBINED GROUPS AND ASSOCIATE SPECIES

Upland-lowland oaks	125,201,203,204
Upland-lowland hardwoods	95,103,105
Southern red oak	88
American elm	94
Winged-cedar elm	209
Silver maple	97
White ash	103
Eastern cottonwood	118
Black cherry	121
Black gum	113
Beech	102
Holly	106
Sweetgum	109
Pin oak	205
Total	1-163,201-210

Table 6. Local forest type composition of national forest type groups.

Forest type group code	National forest type group	Local forest type code	Local forest type
100	White-red-jack pine	101	Jack pine
		102	Red pine
		103	Eastern White pine
		104	White pine-hemlock
		105	Eastern Hemlock
120	Spruce-fir	121	Balsam fir
		122	White spruce
		123	Red spruce
		124	Red spruce-balsam fir
		125	Black spruce
		126	Tamarack
		127	Northern white cedar
140	Longleaf-slash pine	141	Longleaf pine
		142	Slash pine
160	Loblolly-shortleaf pine	161	Loblolly pine
		162	Shortleaf pine
		163	Virginia pine
		164	Sand pine
		165	Table-mountain pine
		166	Pond pine
		167	Pitch pine
		168	Spruce pine
180	Pinyon-Juniper	181	Eastern redcedar
		182	Rocky mountain juniper
		183	Western Juniper
		184	Juniper-woodland
		185	Pinyon-juniper woodland
200	Douglas fir	201	Douglas fir
		202	Port orford cedar
220	Ponderosa pine	221	Ponderosa pine
		222	Incense cedar
		223	Jeffry-Coulter-bigcone douglas fir
		224	Sugar pine
240	Western white pine	241	Western white pine
260	Fir-spruce-Mountain hemlock	261	White fir
		262	Red fir
		263	Noble fir
		264	Pacific silver fir
		265	Engelmann spruce
		266	Engelmann spruce-subalpine fir
		267	Grand fir
		268	Subalpine fir
		269	Blue spruce
		270	Mountain hemlock
		271	Alaska yellow cedar

Table 6. Local forest type composition of national forest type groups (cont.)

Forest type group code	National forest type group	Local forest type code	Local forest type
280	Lodgepole pine	281	Lodgepole pine
300	Hemlock-Sitka spruce	301	Western hemlock
		304	Western redcedar
		305	Sitka spruce
320	Western larch	321	Western larch
340	Redwood	341	Redwood
		342	Giant Sequoia
360	Other western softwoods	361	Knobcone pine
		362	Southwest white pine
		363	Bishop pine
		364	Monterey pine
		365	Foxtail-Bristlecone pine
		366	Limber pine
		367	Whitebark pine
		368	Misc. Western softwoods
370	California mixed conifer	371	California mixed conifer
380	Exotic softwoods	381	Scotch pine
		383	Other exotic softwoods
400	Oak-pine	401	White pine-red oak-white ash
		402	Eastern redcedar-hardwood
		403	Longleaf pine-oak
		404	Shortleaf pine-oak
		405	Virginia pine-southern red oak
		406	Loblolly pine-hardwood
		407	Slash pine-hardwood
		409	Other pine-hardwood
500	Oak-hickory	501	Post-blackjack oak
		502	Chestnut oak
		503	White oak-red oak-hickory
		504	White oak
		505	Northern red oak
		506	Yellow poplar-white oak-red oak
		507	Sassafras-persimmon
		508	Sweetgum-Yellow poplar
		509	Bur oak
		510	Scarlet oak
		511	Yellow poplar
		512	Black walnut
		513	Black locust
		514	Southern scrub oak
		515	Chestnut-black-scarlet oak
		519	Red maple-oak
		520	Mixed upland hardwoods

Table 6. Local forest type composition of national forest type groups (cont.)

Forest type group code	National forest type group	Local forest type code	Local forest type
600	Oak-gum-cypress	601	Swamp chestnut-cherrybark oak
		602	Sweetgum-Nuttall-willow oak
		605	Overcup oak-water hickery
		606	Atlantic white-cedar
		607	Bald cypress-water tupelo
		608	Sweetbay-swamp tupelo-red maple
700	Elm-ash-cottonwood	701	Black ash-American elm-red maple
		702	River birch-sycamore
		703	Cottonwood
		704	Willow
		705	Sycamore-pecan-American elm
		706	Sugarberry-hackberry-elm-green ash
		707	Silver maple-American elm
		708	Red maple-lowland
		709	Cottonwood-willow
		722	Oregan ash
800	Maple-beech-birch	801	Sugar maple-beech-Yellow birch
		802	Black cherry
		803	Cherry-ash-yellow poplar
		805	Hard maple-basswood
		807	Elm-ash-locust
		809	Red maple-upland
900	Aspen-birch	901	Aspen
		902	Paper birch
		904	Balsam poplar
910	Alder-maple	911	Red alder
		912	Bigleaf maple
920	Western oak	921	Gray pine
		922	California black oak
		923	Oregon white oak
		924	Blue oak
		925	Deciduous oak woodland
		926	Evergreen oak woodland
		931	Coast live oak
		932	Canyon-interior live oak
940	Tan oak-laurel	941	Tan oak
		942	California laurel
		943	Giant chinkapin
950	Other western hardwoods	951	Pacific madrone
		952	Mesquite woodland
		953	Mountain brush woodland
		954	Intermountain maple woodland
		955	Misc. western hardwoods
980	Tropical hardwoods	981	Sable Palm
		982	Mangrove
990	Exotic hardwoods	991	Paulownia
		992	Melaluca
		993	Eucalyptus
		995	Other exotic hardwoods

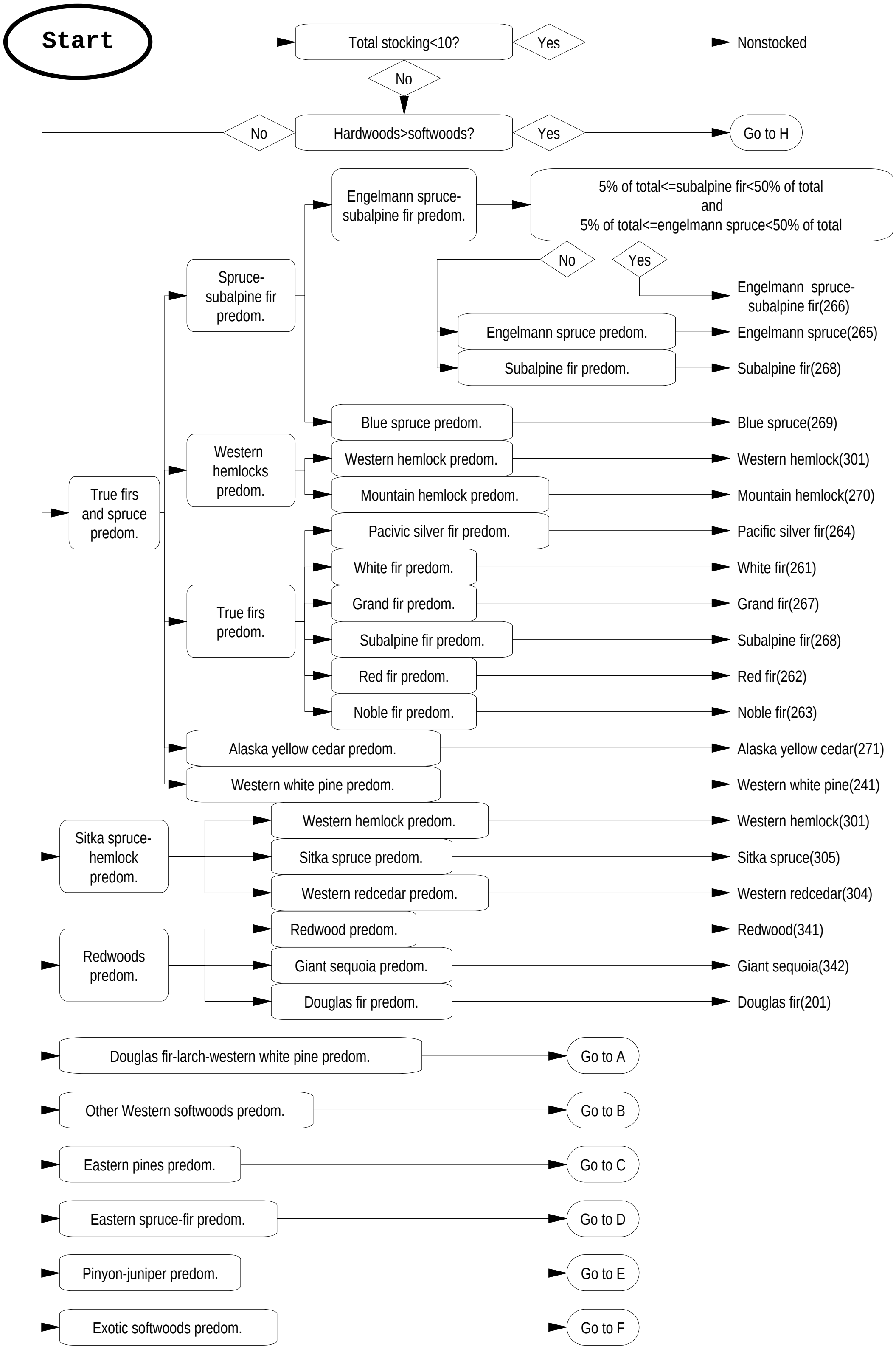


Fig. 1. Forest Inventory and Analysis forest type algorithm for the United States.

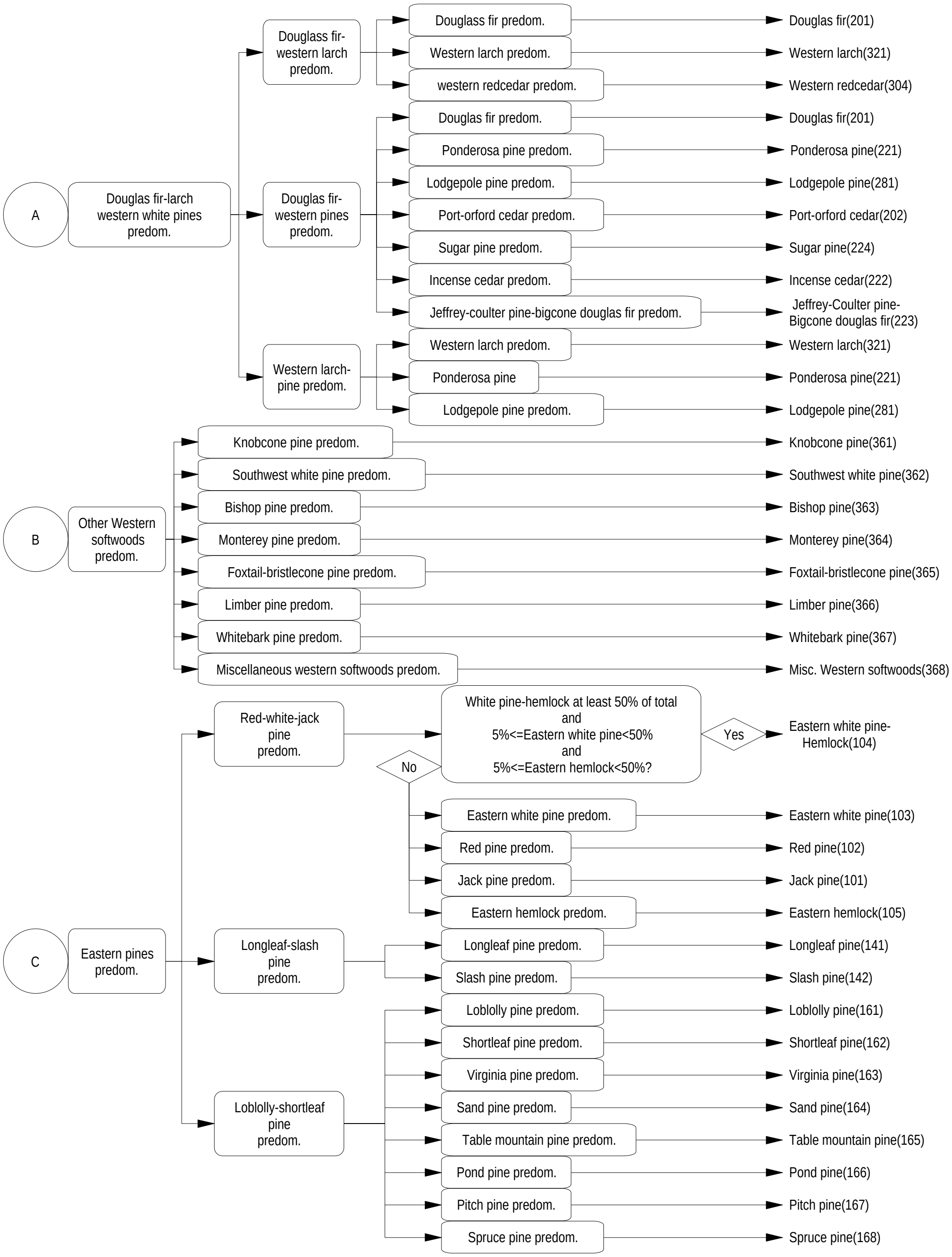

A
Douglas fir-larch western white pines predom.
Douglass fir-western larch predom.
Douglass fir predom.
Douglas fir(201)
Western larch predom.
Western larch(321)
western redcedar predom.
Western redcedar(304)
Douglas fir-western pines predom.
Douglas fir predom.
Douglas fir(201)
Ponderosa pine predom.
Ponderosa pine(221)
Lodgepole pine predom.
Lodgepole pine(281)
Port-orford cedar predom.
Port-orford cedar(202)
Sugar pine predom.
Sugar pine(224)
Incense cedar predom.
Incense cedar(222)
Jeffrey-coulter pine-bigcone douglas fir predom.
Jeffrey-Coulter pine-Bigcone douglas fir(223)
Western larch-pine predom.
Western larch predom.
Western larch(321)
Ponderosa pine
Ponderosa pine(221)
Lodgepole pine predom.
Lodgepole pine(281)
B
Other Western softwoods predom.
Knobcone pine predom.
Knobcone pine(361)
Southwest white pine predom.
Southwest white pine(362)
Bishop pine predom.
Bishop pine(363)
Monterey pine predom.
Monterey pine(364)
Foxtail-bristlecone pine predom.
Foxtail-bristlecone pine(365)
Limber pine predom.
Limber pine(366)
Whitebark pine predom.
Whitebark pine(367)
Miscellaneous western softwoods predom.
Misc. Western softwoods(368)
C
Eastern pines predom.
Red-white-jack pine predom.
White pine-hemlock at least 50% of total and 5%<=Eastern white pine<50% and 5%<=Eastern hemlock<50%?
Yes
Eastern white pine-Hemlock(104)
No
Eastern white pine predom.
Eastern white pine(103)
Red pine predom.
Red pine(102)
Jack pine predom.
Jack pine(101)
Eastern hemlock predom.
Eastern hemlock(105)
Longleaf-slash pine predom.
Longleaf pine predom.
Longleaf pine(141)
Slash pine predom.
Slash pine(142)
Loblolly-shortleaf pine predom.
Loblolly pine predom.
Loblolly pine(161)
Shortleaf pine predom.
Shortleaf pine(162)
Virginia pine predom.
Virginia pine(163)
Sand pine predom.
Sand pine(164)
Table mountain pine predom.
Table mountain pine(165)
Pond pine predom.
Pond pine(166)
Pitch pine predom.
Pitch pine(167)
Spruce pine predom.
Spruce pine(168)

Fig. 1. Cont.

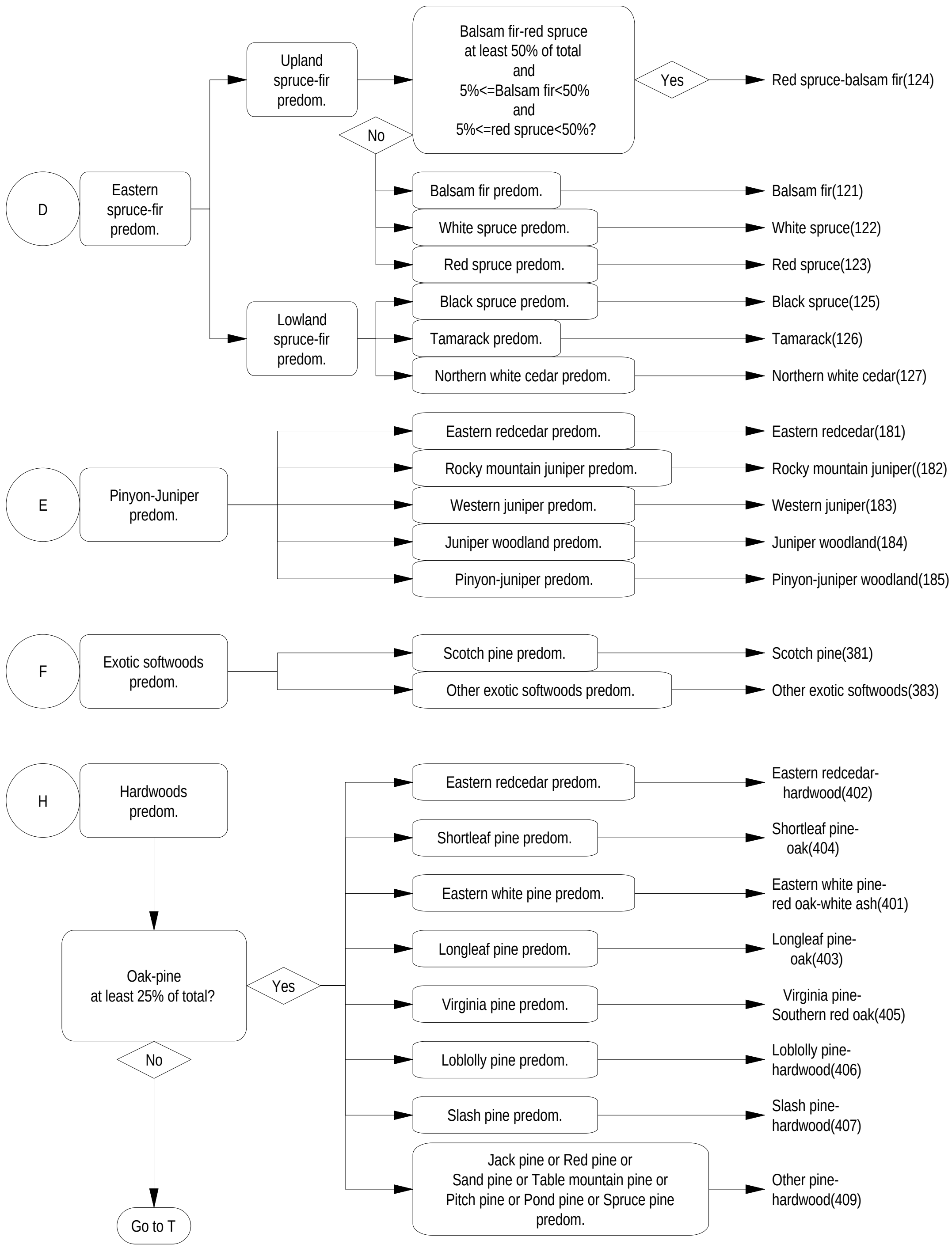

D
Eastern spruce-fir predom.
Upland spruce-fir predom.
Balsam fir-red spruce at least 50% of total and 5%<=Balsam fir<50% and 5%<=red spruce<50%?
Yes
Red spruce-balsam fir(124)
No
Balsam fir predom.
Balsam fir(121)
White spruce predom.
White spruce(122)
Red spruce predom.
Red spruce(123)
Lowland spruce-fir predom.
Black spruce predom.
Black spruce(125)
Tamarack predom.
Tamarack(126)
Northern white cedar predom.
Northern white cedar(127)
E
Pinyon-Juniper predom.
Eastern redcedar predom.
Eastern redcedar(181)
Rocky mountain juniper predom.
Rocky mountain juniper((182)
Western juniper predom.
Western juniper(183)
Juniper woodland predom.
Juniper woodland(184)
Pinyon-juniper predom.
Pinyon-juniper woodland(185)
F
Exotic softwoods predom.
Scotch pine predom.
Scotch pine(381)
Other exotic softwoods predom.
Other exotic softwoods(383)
H
Hardwoods predom.
Oak-pine at least 25% of total?
Yes
No
Go to T
Eastern redcedar predom.
Eastern redcedar-hardwood(402)
Shortleaf pine predom.
Shortleaf pine-oak(404)
Eastern white pine predom.
Eastern white pine-red oak-white ash(401)
Longleaf pine predom.
Longleaf pine-oak(403)
Virginia pine predom.
Virginia pine-Southern red oak(405)
Loblolly pine predom.
Loblolly pine-hardwood(406)
Slash pine predom.
Slash pine-hardwood(407)
Jack pine or Red pine or Sand pine or Table mountain pine or Pitch pine or Pond pine or Spruce pine predom.
Other pine-hardwood(409)

Fig. 1. Cont.

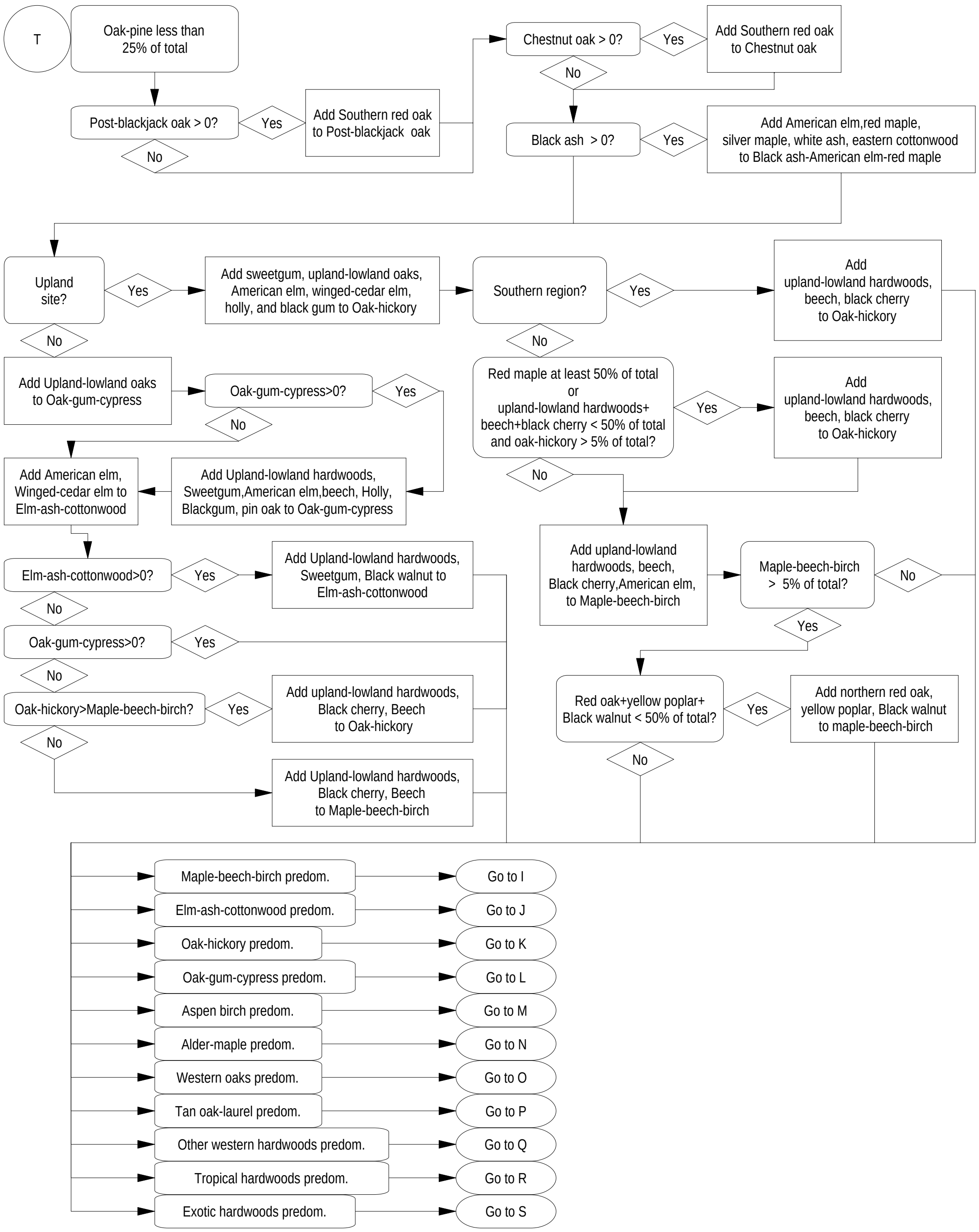

T
Oak-pine less than 25% of total
Post-blackjack oak > 0?
Yes
No
Add Southern red oak to Post-blackjack oak
Chestnut oak > 0?
Yes
No
Add Southern red oak to Chestnut oak
Black ash > 0?
Yes
Add American elm,red maple, silver maple, white ash, eastern cottonwood to Black ash-American elm-red maple
Upland site?
Yes
No
Add sweetgum, upland-lowland oaks, American elm, winged-cedar elm, holly, and black gum to Oak-hickory
Southern region?
Yes
No
Add upland-lowland hardwoods, beech, black cherry to Oak-hickory
Add Upland-lowland oaks to Oak-gum-cypress
Oak-gum-cypress>0?
Yes
No
Red maple at least 50% of total or upland-lowland hardwoods+ beech+black cherry < 50% of total and oak-hickory > 5% of total?
Yes
No
Add upland-lowland hardwoods, beech, black cherry to Oak-hickory
Add American elm, Winged-cedar elm to Elm-ash-cottonwood
Add Upland-lowland hardwoods, Sweetgum,American elm,beech, Holly, Blackgum, pin oak to Oak-gum-cypress
Elm-ash-cottonwood>0?
Yes
No
Add Upland-lowland hardwoods, Sweetgum, Black walnut to Elm-ash-cottonwood
Add upland-lowland hardwoods, beech, Black cherry,American elm, to Maple-beech-birch
Maple-beech-birch > 5% of total?
No
Yes
Oak-gum-cypress>0?
Yes
No
Oak-hickory>Maple-beech-birch?
Yes
No
Add upland-lowland hardwoods, Black cherry, Beech to Oak-hickory
Red oak+yellow poplar+ Black walnut < 50% of total?
Yes
No
Add northern red oak, yellow poplar, Black walnut to maple-beech-birch
Add Upland-lowland hardwoods, Black cherry, Beech to Maple-beech-birch
Maple-beech-birch predom.
Go to I
Elm-ash-cottonwood predom.
Go to J
Oak-hickory predom.
Go to K
Oak-gum-cypress predom.
Go to L
Aspen birch predom.
Go to M
Alder-maple predom.
Go to N
Western oaks predom.
Go to O
Tan oak-laurel predom.
Go to P
Other western hardwoods predom.
Go to Q
Tropical hardwoods predom.
Go to R
Exotic hardwoods predom.
Go to S

Fig. 1. Cont.

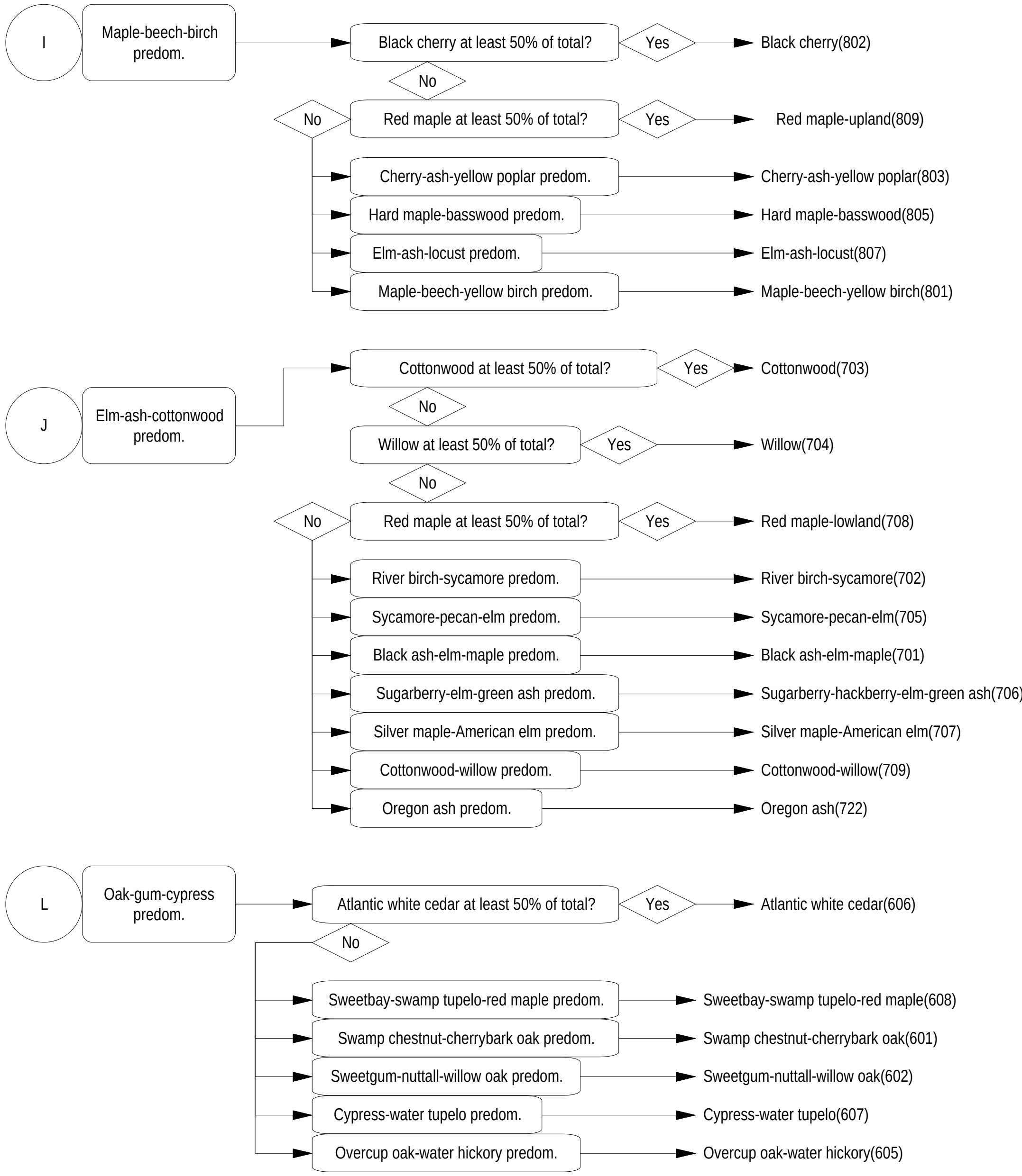

I
Maple-beech-birch predom.
Black cherry at least 50% of total?
Yes
Black cherry(802)
No
Red maple at least 50% of total?
Yes
Red maple-upland(809)
No
Cherry-ash-yellow poplar predom.
Cherry-ash-yellow poplar(803)
Hard maple-basswood predom.
Hard maple-basswood(805)
Elm-ash-locust predom.
Elm-ash-locust(807)
Maple-beech-yellow birch predom.
Maple-beech-yellow birch(801)
J
Elm-ash-cottonwood predom.
Cottonwood at least 50% of total?
Yes
Cottonwood(703)
No
Willow at least 50% of total?
Yes
Willow(704)
No
Red maple at least 50% of total?
Yes
Red maple-lowland(708)
No
River birch-sycamore predom.
River birch-sycamore(702)
Sycamore-pecan-elm predom.
Sycamore-pecan-elm(705)
Black ash-elm-maple predom.
Black ash-elm-maple(701)
Sugarberry-elm-green ash predom.
Sugarberry-hackberry-elm-green ash(706)
Silver maple-American elm predom.
Silver maple-American elm(707)
Cottonwood-willow predom.
Cottonwood-willow(709)
Oregon ash predom.
Oregon ash(722)
L
Oak-gum-cypress predom.
Atlantic white cedar at least 50% of total?
Yes
Atlantic white cedar(606)
No
Sweetbay-swamp tupelo-red maple predom.
Sweetbay-swamp tupelo-red maple(608)
Swamp chestnut-cherrybark oak predom.
Swamp chestnut-cherrybark oak(601)
Sweetgum-nuttall-willow oak predom.
Sweetgum-nuttall-willow oak(602)
Cypress-water tupelo predom.
Cypress-water tupelo(607)
Overcup oak-water hickory predom.
Overcup oak-water hickory(605)

Fig. 1. Cont.

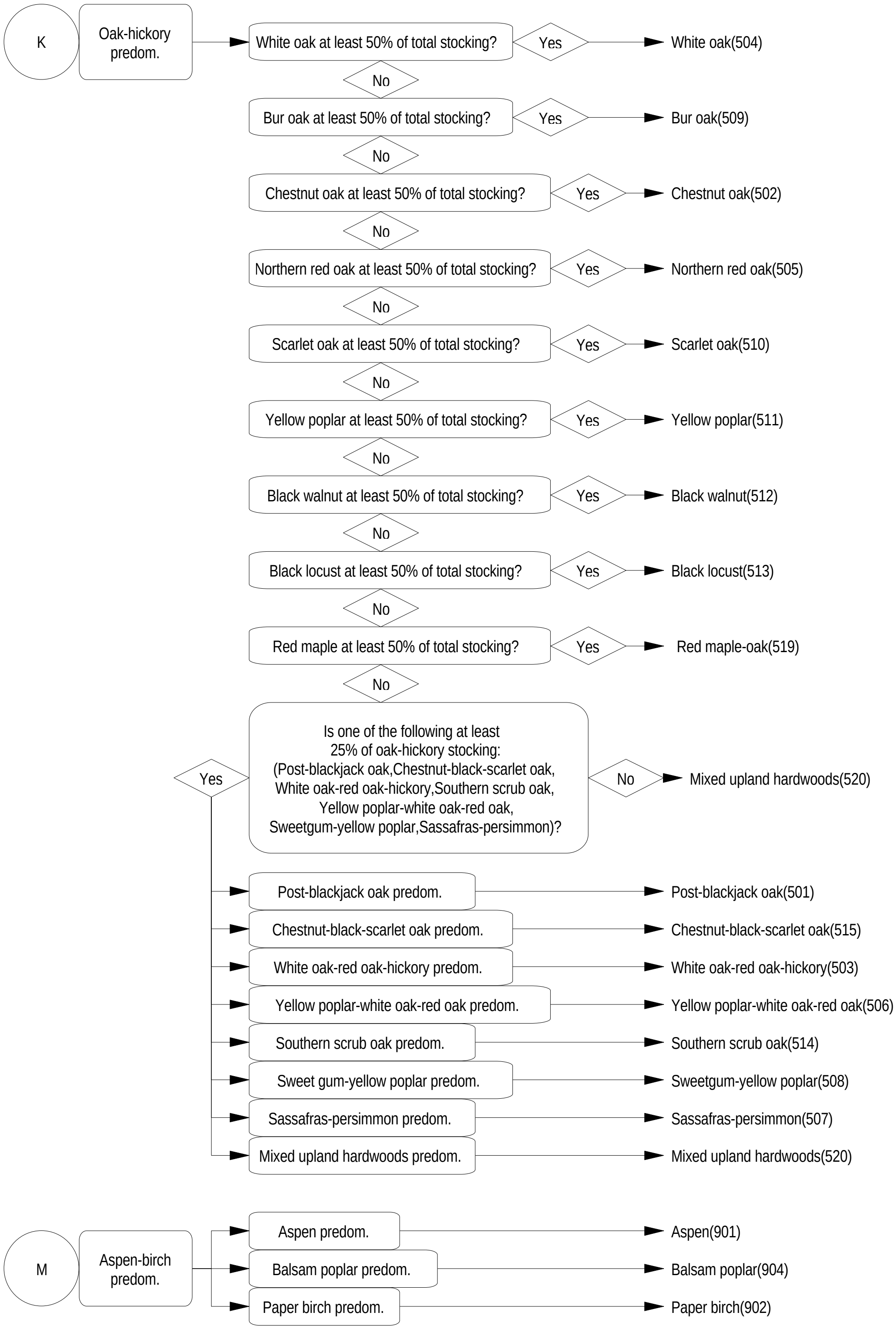
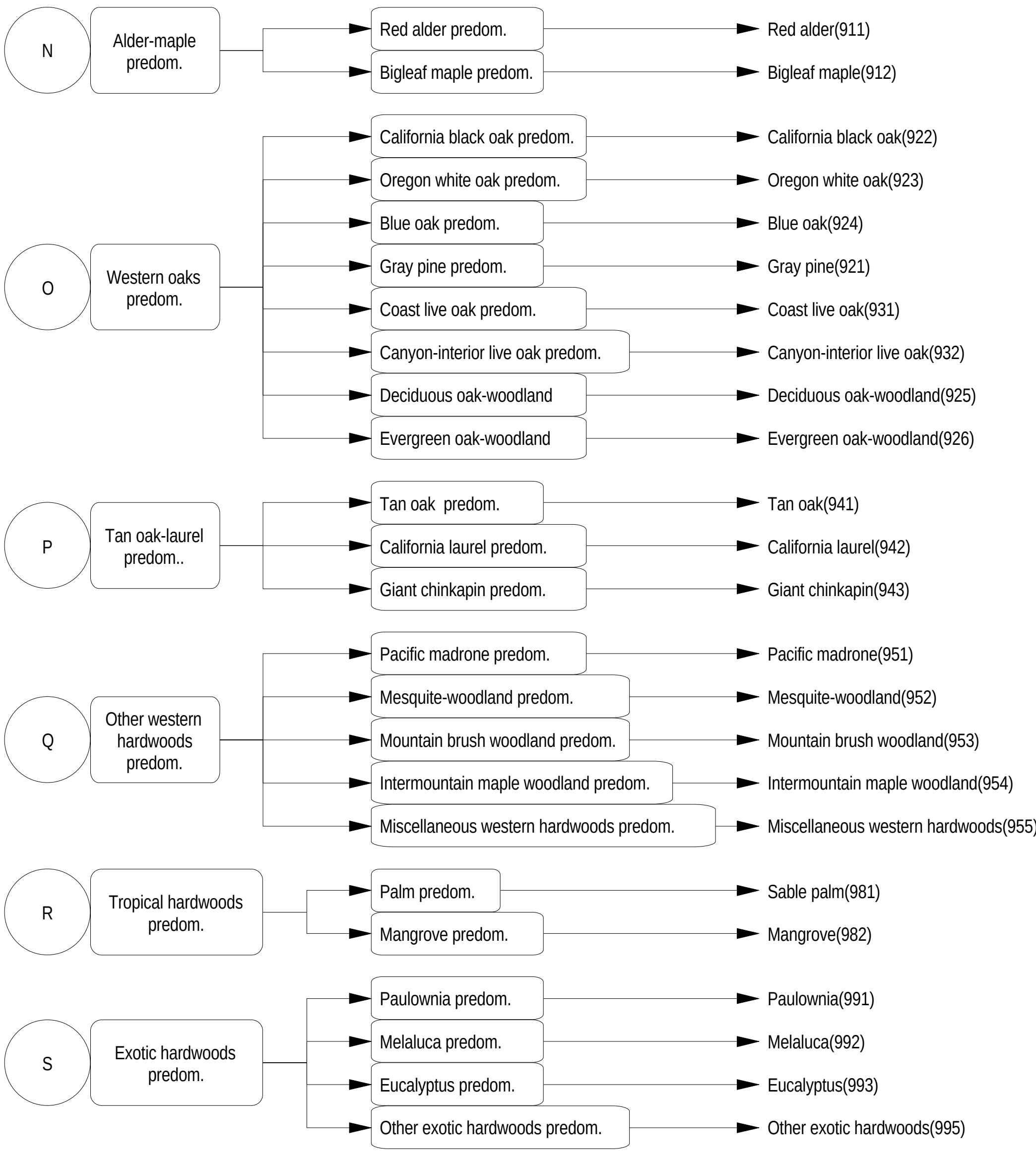

K
Oak-hickory predom.
White oak at least 50% of total stocking?
Yes
White oak(504)
No
Bur oak at least 50% of total stocking?
Yes
Bur oak(509)
No
Chestnut oak at least 50% of total stocking?
Yes
Chestnut oak(502)
No
Northern red oak at least 50% of total stocking?
Yes
Northern red oak(505)
No
Scarlet oak at least 50% of total stocking?
Yes
Scarlet oak(510)
No
Yellow poplar at least 50% of total stocking?
Yes
Yellow poplar(511)
No
Black walnut at least 50% of total stocking?
Yes
Black walnut(512)
No
Black locust at least 50% of total stocking?
Yes
Black locust(513)
No
Red maple at least 50% of total stocking?
Yes
Red maple-oak(519)
No
Is one of the following at least 25% of oak-hickory stocking: (Post-blackjack oak,Chestnut-black-scarlet oak, White oak-red oak-hickory,Southern scrub oak, Yellow poplar-white oak-red oak, Sweetgum-yellow poplar,Sassafras-persimmon)?
No
Mixed upland hardwoods(520)
Yes
Post-blackjack oak predom.
Post-blackjack oak(501)
Chestnut-black-scarlet oak predom.
Chestnut-black-scarlet oak(515)
White oak-red oak-hickory predom.
White oak-red oak-hickory(503)
Yellow poplar-white oak-red oak predom.
Yellow poplar-white oak-red oak(506)
Southern scrub oak predom.
Southern scrub oak(514)
Sweet gum-yellow poplar predom.
Sweetgum-yellow poplar(508)
Sassafras-persimmon predom.
Sassafras-persimmon(507)
Mixed upland hardwoods predom.
Mixed upland hardwoods(520)
M
Aspen-birch predom.
Aspen predom.
Aspen(901)
Balsam poplar predom.
Balsam poplar(904)
Paper birch predom.
Paper birch(902)

Fig. 1. Cont.



SPECIAL MIXED CONIFER TEST FOR CALIFORNIA - IMPLEMENTED AFTER FOREST TYPE IS DETERMINED.

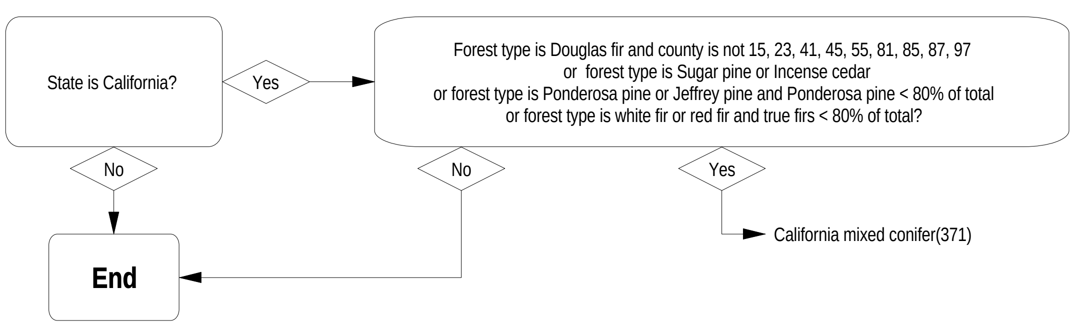


Fig. 1. Cont.