Quality Improvements to OAKSIM and NE-TWIGS

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ABSTRACT

Methods to estimate present and future tree quality have been added to the OAKSIM and NE-TWIGS growth and yield simulators. These additions allow better estimates of stand value and thinning options.

The individual-tree growth and yield simulators, NE-TWIGS and OAKSIM, now report yields and values based on Forest Service tree grades. NE-TWIGS is a generalized growth and yield model developed for mixed species stands of the Northeastern United States (Kentucky to Maine), (Hilt and Teck 1989). OAKSIM was designed to make growth and yield predictions for the even-aged, upland-oak forest type (Hilt 1985a).

Many timber cruisers use proprietary tree classifications to help estimate the differences in tree value based on tree quality, but no one tree quality classification system has become an industry standard. The Forest Service hardwood tree grading system is based on the National Hardwood Lumber Association lumber grades and involves the identification of the length and width of clear cuttings (rectangular areas free from defect), and d.b.h. of the tree (Hanks 1976).

The use of Potential Tree Grade (Gp), (Yaussy 1991) allows the software to predict the future quality of the trees being "grown" by the simulators. The Forest Service tree grading standards include d.b.h. restrictions of 16 inches for a grade 1 tree and 13 inches for grade 2. Gp disregards these d.b.h. restrictions and surface defects that will disappear as the tree grows. Gp is defined as the actual Forest Service tree grade that a tree will attain when it grows into the 16-inch diameter class. When a tree enters the 16-inch class, Gp and actual tree grade will be identical. Gp is a discrete variable with four categories: grade 1, grade 2, grade 3, and below grade. Actual tree grade for hardwoods can be determined directly from Gp and d.b.h. For example, a tree with Gp of 1 and d.b.h. of 12.4 would have an actual grade of 3. As d.b.h. increases beyond the 12.6- and 15.6-inch thresholds, the actual grade would change to 2 and then to 1. When collecting Gp in the field, the timber cruiser would determine what grade the tree will be when it grows to 16 inches.

The new data formats used in NE-TWIGS and OAKSIM allow the user to include field measurements of Gp for each tree (Figures 1 and 2). If these measurements are not recorded in the field, equations in the program will assign Gp based on species, d.b.h., and age or site index, depending on the simulator (Yaussy 1991, 1992). The programs then report the sawlog volumes at the end of each growth cycle by actual Forest Service tree grade (Figures 3 and 4). The economics package included with the NE-TWIGS program now allows the user to input stumpage values by tree grade (Figure 5).

In addition to reporting yields by tree grade, the programs make use of Gp in simulating thinning. OAKSIM provided the user with a routine that simulated the actual thinning process used by foresters. Trees were removed from all diameter classes in the stand based on desired residual stocking and the number of trees in each diameter class, therefore, some of the larger trees were removed. The addition of Gp does not alter the number of trees removed from each diameter class; however, lower quality trees are more likely to be removed (Figure 6), (Yaussy 1991).

NE-TWIGS has many different thin-

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1                                                    TYPE OF INPUT DATA
  1 6075                                             STAND NUMBER, AGE,&SITE
5                                                    NUMBER OF SPECIES GROUPS
1  2 1 1 091 0881 0056       01   04   00   00   00   00   00   00
2  2 2 2 090 0832 0103       02   03   00   00   00   00   00   00
3  3 2 3 090 0000 0000       10   14   27   00   00   00   00   00
4  2 1 3 090 0000 0000       12   18   00   00   00   00   00   00
5  2 1 4 090 0000 0000       23   24   00   00   00   00   00   00
2 4 0                                                CUBIC VOLUME TOP DIBS
210 8                                                BDFT TOP DIBS
4.0  8.0                                             MINIMUM CUBIC & BDFT LENGTHS
 4.5511.55                                           SAPD,POLED
1                                                    DCLASS SIZE 1 OR 2 INCHES
10                                                   NUMBER OF PROJECTIONS
 1 0 0 0 0                                           NUMBER THINNINGS & THINLV
060 60
2                                                     PRINT OPTIONS
    1 10. 0
    1 10. 0
    2 16. 2
    2 13. 1
    2  8. 0
    3 14. 3
    3 12. 2
    3 10. 0
    3  9. 0
    .
    .
    .
   23  3. 0
   24  6. 0
   24  3. 0
   27  5. 0
   27  3. 0
   27  3. 0
```

Figure 1. Example of input file for OAKSIM. In the lower half of the figure, the last column contains the Gp of the trees. For the definition of the other columns and rows, see Hilt 1985b.

```
BALDROCK          PLOT 2      1962      80      23      0      156
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0  64   0   0   0   0   0   0   0   0
  1  23 802  16.1   4.0      .8   1  20   3
  2  23 802  14.5   4.0      .8   1  20   2
  3  23 802  13.6   3.9      .7   1  20   2
  4  23 802  11.0   3.8      .7   1  20   0
  5  23 802  12.7   3.9      .7   1  20   3
  6  23 802  12.3   3.9      .7   1  20   2
  .
  .
  .
148  23 802  18.7   4.1      .9   1  20   4
149  13 316   6.0   4.7      .5   1  20   0
150  23 802  20.8   4.2      .9   1  20   2
151  17 400  15.8   4.3      .8   1  20   3
152  23 802   9.4   3.7      .6   1  20   0
153  23 802  11.0   3.8      .7   1  20   0
154  23 802   9.7   3.7      .6   1  20   0
155  23 802   9.7   3.7      .6   1  20   0
156  31 355   5.0   3.5      .7   1  20   0
```

Figure 2. Example of input file for NE-TWIGS. The last column contains the Gp of the trees. For the definition of the other columns and rows, see Miner and others 1988.

STAND NUMBER 1 SITE INDEX 80.

SUMMARY STAND STATISTICS: INITIAL CONDITIONS FOR STAND AT AGE 80.

SPECIES :	1	2	3	4	5	TOTALS
N TREES:						
SAP	10.0	.0	2.0	21.0	17.0	50.0
POLE	40.0	5.0	.0	18.0	5.0	68.0
SAW	31.0	29.0	.0	2.0	3.0	65.0
TOTAL	81.0	34.0	2.0	41.0	25.0	183.0
BA:						
SAP	.8	.0	.1	1.4	1.0	3.3
POLE	15.9	3.0	.0	5.0	1.1	24.9
SAW	37.9	40.4	.0	1.9	5.2	85.4
TOTAL	54.6	43.4	.1	8.3	7.2	113.7
PS:						
SAP	1.1	.0	.1	1.9	1.4	4.6
POLE	14.6	2.6	.0	4.9	1.1	23.3
SAW	29.6	31.0	.0	1.6	3.9	66.1
TOTAL	45.3	33.6	.1	8.4	6.4	93.9
AVG DBH:						
SAP	3.8	.0	2.9	3.4	3.3	3.4
POLE	8.3	10.5	.0	6.9	6.2	7.9
SAW	14.7	15.7	.0	13.3	17.7	15.2
CVOB 4.0:						
SAP	1.4	.0	.0	2.4	1.2	4.9
POLE	523.1	109.4	.0	145.2	25.0	802.6
SAW	1571.4	1661.6	.0	80.4	227.8	3541.1
TOTAL	2095.8	1771.0	.0	228.0	253.9	4348.7
CVIB 4.0:						
SAP	1.2	.0	.0	1.9	1.0	4.1
POLE	449.6	91.6	.0	117.6	20.2	679.1
SAW	1344.1	1383.1	.0	65.1	184.5	2976.8
TOTAL	1794.9	1474.7	.0	184.7	205.7	3659.9
CVOB .0:						
SAP	18.4	.0	2.1	32.7	24.1	77.3
POLE	575.9	114.7	.0	174.4	33.5	898.5
SAW	1593.1	1682.2	.0	81.9	229.5	3586.6
TOTAL	2187.3	1796.9	2.1	289.0	287.1	4562.4
CVIB .0:						
SAP	15.9	.0	1.7	26.5	19.5	63.5
POLE	493.2	95.6	.0	141.3	27.2	757.2
SAW	1361.5	1398.2	.0	66.4	185.9	3011.9
TOTAL	1870.5	1493.8	1.7	234.1	232.5	3832.6
BFVOL 10.0:						
GR 1	2312.9	2890.9	.0	.0	661.5	5865.4
GR 2	1969.5	645.2	.0	135.6	.0	2750.3
GR 3	519.3	868.6	.0	.0	252.7	1640.6
BELO	.0	1226.2	.0	.0	.0	1226.2
TOTAL	4801.7	5630.9	.0	135.6	914.3	11482.5
BFVOL 8.0:						
GR 1	2537.9	3066.3	.0	.0	727.1	6331.3
GR 2	2525.4	845.1	.0	190.9	.0	3561.4
GR 3	1462.3	1500.8	.0	98.6	290.2	3352.0
BELO		1729.3	.0	.0	.0	1934.7
TOTAL	6731.1	7141.5	.0	289.5	1017.3	15179.4

Figure 3. Sample output from OAKSIM reporting board-foot volumes by tree grade.

STAND VOLUME

	SAWLOG		PULPWOOD		TOTAL MERCHANTABLE	RESIDUE	
SPECIES GR.	CUFT	BDFT	CUFT	CORDS	CUFT	CUFT	TONS
WHITE ASH	0	0	12	.2	12	6	.1
GRADE 1	0	0					
GRADE 2	0	0					
GRADE 3	0	0					
BELOW GR	0	0					
WHITE OAK	191	936	1187	15.0	1378	733	21.3
GRADE 1	0	0					
GRADE 2	57	281					
GRADE 3	107	523					
BELOW GR	27	132					

Press <ENTER> for more

Figure 4. Sample NE-TWIGS report of volume by tree-grade.

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CURRENT STUMPAGE RATES FOR WHITE OAK

OPTION  VALUE   DESCRIPTION
   A    $120.00 Per 1000 board feet of grade 1 sawtimber.
   B    $100.00 Per 1000 board feet of grade 2 sawtimber.
   C    $ 50.00 Per 1000 board feet of grade 3 sawtimber.
   D    $ 10.00 Per 1000 board feet of below grade sawtimber.
   E    $ 10.00 Per cord of poletimber.
   F    $  7.00 Per 100 cuft of residue.

Type option letter or type  Z  to continue:
```

Figure 5. Sample NE-TWIGS screen for entering stumpage values by tree-grade.

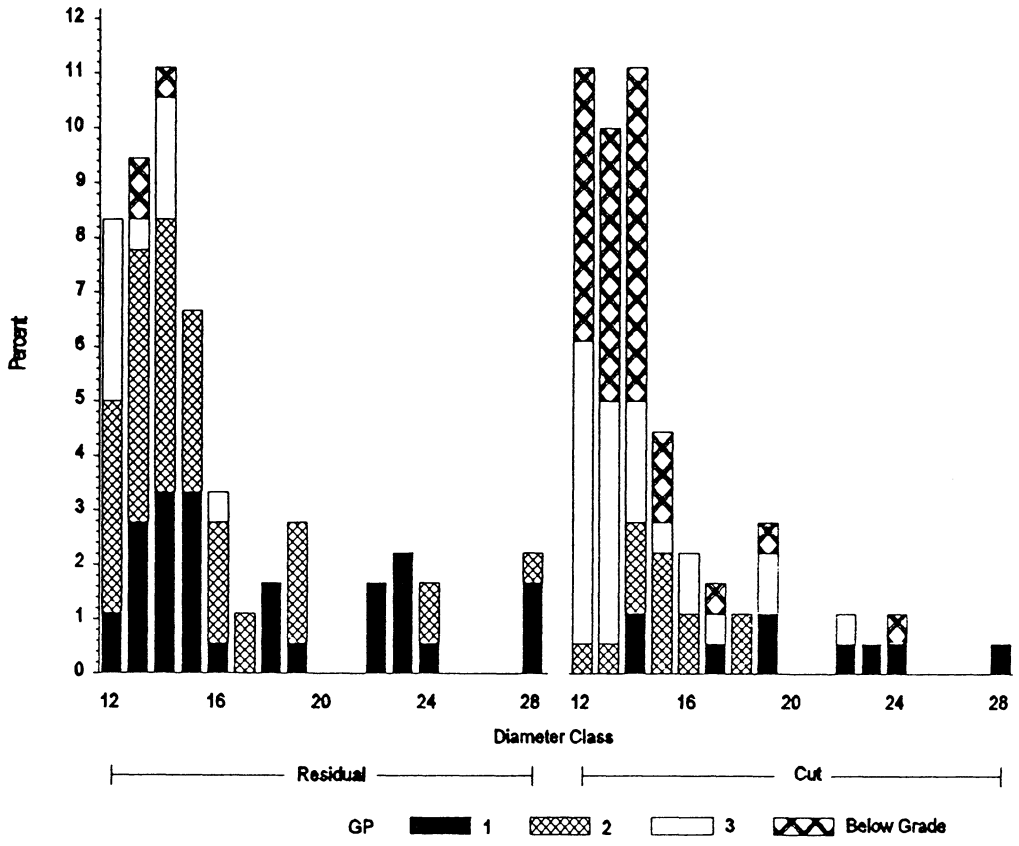

Figure 6. Example of trees thinned from a plot by OAKSIM with preference given to trees with a higher quality.

```
Each tree in the tree list will be displayed in order
of increasing diameter to allow you to decide if it should be cut.

Press:  <ENTER> to leave the tree as it is.
        C <ENTER> to cut the tree.
        U <ENTER> to uncut the tree.
        S <ENTER> to skip the rest of the tree list.

Remember to note tree status (STAT):  (1=alive, 2=cut tree)



STAND BASAL AREA=    99.7  TREES/AC= 173.3

SEQ USFS SPECIES                                      TREE TREE CROWN POT.  YEAR
NUM CODE GRP NAME       DBH   CAI   TREES/AC  BA/AC STAT CLAS RATIO GRADE CUT
  5  837  BLACK OAK     16.3  .05      29.6     9.1   1   20   4.1     2    0

Type: "<ENTER>" leave tree as is, C)ut, U)ncut, S)kip the rest:
```

Figure 7. Example of individual tree harvesting screen for NE-TWIGS. Each tree in the tree list will be displayed in order of increasing diameter to allow you to decide if it should be cut.

ning options: removal of an entire species, removal of all trees from the smallest or largest diameter classes until the desired stocking is reached, or removal of individual trees. When removing individual trees from the tree list, Gp is displayed (Figure 7). This allows the user to select trees based on potential quality.

In summary, the addition of tree quality measurements to the OAKSIM and NE-TWIGS simulators does not fundamentally change the operations of the software; but gives the user more information about stand quality in the standard reports and thinning options.

These programs can be obtained from FORS.

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