EVALUATING SOME PROPOSED MATRICES FOR SCORING SUB-OPTIMAL RED-COCKADED WOODPECKER FORAGING HABITAT IN RELATION TO THE 2003 RECOVERY PLAN

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Abstract—We have used RCWFAT (an ARC-INFO program that evaluates RCW habitat) to examine the 2003 Red Cockaded Woodpecker (RCW) Recovery Plan, which will influence silvicultural activities on large tracts of southeastern forests. The new plan includes 11 specific characteristics of forest stands that constitute "Good Quality Foraging Habitat" (GQFH) and requires 120 to 200 acres of GQFH for each RCW group. To evaluate the criteria requires a minimum data set that is not met by most product-based forest inventory data. The criteria of GQFH also define ideal RCW habitat. When used as a pass-fail system, the criteria of the Recovery Plan are a poor ecosystem management tool. On the Oakmulgee Ranger District, where the RCW population is declining, only 2 of 189 clusters had sufficient GQFH. On Ft. Bragg, NC, where the RCW population is increasing, only 19 of 496 clusters had sufficient GQFH. Few foraging areas met all of the criteria, and few would meet the criteria after a single silvicultural treatment. An effort has been underway to develop a method to rank less-than-ideal habitat. We examine three alternatives considered in the pursuit of such a method. Scoring of individual stands has proven relatively consistent in all three alternatives. Due to the complexity of interaction among the 11 criteria, efforts to establish scores for entire cluster forage partitions have produced inconsistent results.

INTRODUCTION

Management of Red-cockaded Woodpeckers (*Picoides borealis*) (RCW) has guided silvicultural treatment on a portion of the southern pine forest since the species was listed in 1970. The 2003 Recovery Plan (U.S. Fish and Wildlife Service 2003) has a goal of 13,101 active clusters on federal lands. Each cluster should have a minimum of 120 acres of foraging habitat, requiring that the federal forests be managed to maintain at least 1.6 million acres of foraging habitat at all times. The 1985 Recovery Plan (U.S. Fish and Wildlife Service 1985) and the Henry (1989) guidelines have been used to formulate management of Federal lands for the last two decades. Central to these guidelines was the requirement of 8,490 square feet of pines ≥ 10 inches d.b.h. within ½ mile of each cluster center. However, recent studies have been unable to demonstrate that the basal area of pines > 10 inches d.b.h. has any relation to the success of RCW, measured either as group size or number of young fledged (Beyer and others 1996, Wigley and others 1999). The latest thinking has focused on creation of forest structure that benefits RCW foraging (James and others 2001). The 2003 Recovery Plan (p. 188 and 189) has developed new criteria for RCW foraging habitat based on forest structure.

Since 1998, we have been developing the Red-cockaded Woodpecker Forage Analysis Tool (RCWFAT) to map and evaluate RCW forage (Lipscomb and Williams 1998a, 1998b). This ARC-INFO, AML program has been routinely used to evaluate RCW foraging habitat across the Southeast (Lipscomb and Williams, in press). Prior to 2003, it evaluated potential RCW forage against the Henry (1989) guidelines to determine forage quality for each RCW cluster on a forest. The program has proven most valuable on large, densely clumped RCW populations found on DOD installations.

Following publication of the 2003 Recovery Plan, RCWFAT has been used for two aspects of management on forests with RCW. On the Oakmulgee Ranger District (RD), AL, the RCW population has been declining, and RCWFAT was used in the preparation of an EIS for habitat restoration. In this case, RCW clusters were mapped and evaluated by the 2003 criteria. Although little of the forest met all criteria, the program was used to target stands for silvicultural treatments that would move those stands toward the desired structure. On Ft. Bragg, NC, the population is increasing, and the need was to evaluate proposed military projects. In this case, habitat is compared before and after a proposed project to assure the project does not result in a net loss of habitat value. These two forests present a significant contrast in population trends. The Oakmulgee RD population is at only 30 percent of its recovery goal and has had a steady decline in number of active clusters. At Ft. Bragg, NC, the population is nearly 80 percent of the recovery goal and has had had a steady increase in active clusters (U.S. Fish and Wildlife Service 2003).

In this paper, we will review application of the 2003 Recovery Plan guidelines on these two forests. The Recovery Plan proposes foraging habitat criteria as a recovery standard. We will first examine the Recovery Plan criteria as a pass-fail system. The Recovery Plan does not present a method to evaluate stands and clusters that do not meet this standard. We will examine three draft alternatives that have been suggested during progress toward such a system to score quality of less-than-ideal habitat. The first alternative simply scores stands and partitions by producing five categories of criteria ranges that range from 1 (poor) to 5 (excellent) for each criterion of good quality foraging habitat (GQFH; table 1). This system will be designated "stand scores" for further discussion. The second alternative added a weighting factor to each criterion based on expert opinion as to the importance of the criterion. This alternative also contained a series of criteria, scores, and weights to evaluate foraging partitions of each cluster (table 2). This system will be designated as "weighted

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Table 1—Systems to score stands in relation to criteria specified in 2003 recovery plan[a]

Stand characteristic	Score 1	2	3	4	5	WS	WS2
Number 14” + pine stems	<5	5-8	9-12	13-17	18+	10	0.152
Basal area 14” + pines	<5	5-9	10-14	15-19	20+	9	0.139
Basal area 10-14” pines	>55	51-55	45-50	41-45	0-40	3	0.038
Basal area < 10” pines	>30	23-29	16-22	10-15	0-10	2	0.025
Number pines < 10”	>40	33-39	26-32	20-25	0-20	1	0.013
Basal area of pine > 10”	<20	21.26	27-32	33-39	40+	4	0.051
Percent vegetative ground cover	<10	10-19	20-29	30-39	40+	6	0.101
Hardwood midstory:	T-D	M-M	M-S	L-M	L-S		
Tall = T (>15’), Dense = D	M-D	T-S	L-D				
Medium = M (7-15’)	T-M					7	0.114
Low = L (<7’) Sparse = S							
(hardwood pulpwood BA)	>30	22-30	16-22	10-16	<10		
Percent canopy hardwoods							
longleaf stands	>30	23-29	16-22	10-15	<10	5	0.063
loblolly/shortleaf stands	>50	43-49	36-42	30-35	<30		
Stand age	30	31-39	40-49	50-59	60+	9	0.139
Fire return interval (year)	7+	6	5	3-4	<3		0.089
Season of burn			NGS		GS		0.076

[a] Stand score-uses 10 stand characteristic criteria. For each criterion meeting the values specified for GQFH, a score of 5 was assigned. Smaller scores were assigned to values of the stand characteristic further from the criterion. If all 10 criteria were measured, a score from 10 to 50 would be assigned to the stand (a stand that qualified as GQFH would score a 50 in this system). Weighted score (WS)-The importance of each criterion was determined by committee agreement, and a weighting factor was assigned from 1 to 10. Each weighting factor was multiplied by the stand score for each criterion and summed to produce the weighted stand score. In this system stands could score from 56 to 280 if all criteria were evaluated. Weighted stand score 2 (WS2)-the weighted system was re-evaluated and changed by adding two burning criteria. The weights were reduced to fractional values with the same ranking of importance but not exactly proportional to the previous weights. In this system, scores ranged from 1 to 5 if all 12 criteria were used.

scores” for further discussion. The third alternative was developed later as a revision of stand weights (table 1) and revised criteria and weights to evaluate partitions (table 3). This revision will be designated “weighted scores 2” for further discussion.

We will examine these in relation to their value for evaluating silvicultural alternatives for forests with RCW populations. If we assume habitat differences are responsible for the population growth at Ft. Bragg, NC, and the decline on the Oakmulgee, a scoring system should differentiate habitat conditions on the two forests. The system should also allow differentiation of stand and cluster habitat quality. Finally, scores should be usable to prioritize silviclutural treatments by their value for improving foraging habitat.

Table 2—Partiton scoring and partition score for weighted score system[a]

Forage partition characteristic	Score 1	2	3	4	5	Weighting factor
Total acres GQFH[b] in partition	<75	75-89	90-104	105-120	120+	6
Total acres pine in partition	<120	120-146	147-173	174-199	200+	1
Total acres GQFH within ¼ mile	<40	40-60	61-90	91-119	120+	5
Last prescribed burn (*years*)	>6	6	5	4	1-3	4
Season of last burn			NGS		GS	2
# of contiguous foraging acres	<75	75-89	90-104	105-119	120+	3
If in sandhills	<75	75-116	116-157	158-199	200+	

[a] The partition is defined as all area within ½ mile of the cluster center minus any area that is closer to an adjacent cluster. This system evaluates burning as a partition characteristic and defines GQFH as any stand that has a weighted score of at least 175 from table 1. Foraging acres are any stand with a weighted score of at least 56 from table 1. The partition score is calculated as the sum of the criteria scores. The weighted partition score is the sum of the products of criteria scores and weighting factors. Any partition with a weighted score over 74 was considered adequate forage in the weighted system.
[b] GQFH — Sum of acres in stands that scored over 175, used for weighted partition score only.

Table 3—Partition scores for weighted scoring system 2[a]

Forage partition characteristic[b]	SI[c]	Score 1	2	3	4	5	Weighting factor
Total acres GQFH in partition		<75	75-89	90-104	105-120	120+	0.4
Total acres pine (30 years or older) in partition	L	<100	100-150	150-200	200-250	250+	
	M	<100	100-125	125-150	150-175	175+	0.1
	H	<90	90-105	105-120	120-135	135+	
Total acres GQFH[a] within ¼ mile		<40	40-60	61-90	91-119	120+	0.3
Number of contiguous foraging acres in partition	L	<100	100-150	150-200	200-250	250+	
	M	<100	100-125	125-150	150-175	175+	0.2
	H	<90	90-105	105-120	120-135	135+	

[a] In this system, GQFH is only those stands that score a 5 from table 1. The weighted score is also calculated as the sum of the criteria scores and weighting factors which varies from 0.1 to 0.4.
[b] GQFH=Sum of acres in stands that scored 5 (in table 1 with this method), used for weighted partition score only.
[c] SI =Site index age 50,L ≤ 50, M=50-75, H=75+.

METHODS

The 2003 Recovery Plan does not change the geometric designation of RCW foraging habitat. Potential foraging habitat is circumscribed by a ½-mile-radius circle around the cluster center, with overlap of circles (when cluster centers are closer than 1 mile apart) partitioned by a bisector of the overlapping arcs. This corresponds to the original geometric definition of foraging habitat in RCWFAT (Lipscomb and Williams 1995). There is a new criterion that involves evaluation of habitat within ¼ mile of the cluster. A new routine was added to create a similar habitat map using a ¼-mile-radius circle instead. For each cluster of cavity trees, RCWFAT now produces two unique areas, a polygon determined by a ½-mile-radius circle and bisectors of any overlapping circles from adjacent clusters and a similar polygon formed by a ¼-mile-radius circle and bisectors of overlapping circles. These two areas will be referred to as the ½- and ¼-mile foraging partitions for the remainder of the paper. In the final step in the geometric section of RCWFAT, these foraging partitions are overlayed on a stand map (with required data in the attribute table) to populate a stand table with data needed to evaluate forage quality within that partition.

The four different evaluation techniques reported in this paper were produced by reprogramming the original report module of RCWFAT (Lipscomb and Williams 1998a). Each system required differing modifications as described below.

Recovery Plan Criteria as a Pass-Fail System

The 2003 Recovery Plan lists criteria of GQFH. These can be listed as 11 minimum stand values and 4 minimum partition values.

Stand requirements (from stand data):

1. Pine type
2. BA (basal area) of pines ≥ 14 inches d.b.h. is > 20 square feet per acre
3. 18 or more pine stems per acre ≥ 14 inches d.b.h. and over age 59
4. BA of pines ≥ 10 inches d.b.h. and < 14 inches d.b.h. is between 0 and 40 square feet per acre
5. BA of pines < 10 inches d.b.h. is < 10 square feet acre
6. Stems of pines < 10 inches d.b.h. is < 20 stems per acre
7. BA of all pines ≥ 10 inches d.b.h. is ≥ 40 square feet per acre
8. Native plants ≥ 40 percent of ground cover and dense enough to carry a growing-season burn once every 5 years
9. Stand age ≥ 30 years
10. No hardwood midstory or sparse and < 7 feet tall
11. Canopy hardwoods ≤ 10 percent in longleaf and ≤ 30 percent in other pine types

Partition requirements (from partition summaries of stand data) are: (1) for site index ≥ 60, 120 acres of GQFH within ½ mile of cluster; (1a) for site index of < 60, 200 to 300 acres of GQFH within ½ mile; (2) half of the above acres of GQFH within ¼ mile; (3) the above GQFH can be separated by no more than 200 feet of non-foraging areas; and (4) 200 acres of pine type within ½ mile.

The first step in evaluation was production of a stand data table that had variables corresponding to each of the 11 stand criteria listed. Ft. Bragg, NC, had stand data from which criteria 2 to 7 could be measured directly; the data from the Oakmulgee RD did not include diameter distributions. These were derived from the listed data (total basal area and average tree diameter in sawtimber and pulpwood size classes) and data on the whole forest diameter distribution (Lipscomb and Williams 2004). Neither forest had data that could be used to evaluate native ground cover, and this criteria was not tested in any of the following systems. Neither forest had data on midstory hardwoods as listed in the guidelines but did have hardwood pulpwood basal area. We assumed that hardwood pulpwood over 10 square feet per acre did not meet the requirement. Finally, we calculated overstory hardwood percent from percent hardwood sawtimber basal area.

The reporting section of RCWFAT was modified to evaluate each stand in relation to the 11 criteria. Type and age were used as screens, and all non-pine stands and pine stands < 30 years old were removed from further analysis. A series of tests were applied to each criterion to produce a logical yes/no as to whether that criterion met the guidelines. For all stands where the results were all “yes”, the stand was assigned a “yes” in a new attribute item. New attributes were also added for six reasons why the stand failed: (1) “lacks large pine” — criteria 2,3; (2) “10-14 inch pine basal area”, criterion 4; (3) “pine understory,” criteria 5,6; (4) “lacks total basal area”, criterion 7; (5) “hardwood midstory” criterion 10; and (6) “hardwood overstory”, criterion 11. Following the stand analysis, each cluster was then evaluated against the four cluster criteria to determine the status of the entire cluster.

Alternative One — Simple Score

The simplest scoring system utilizes the first 6 columns and 10 criteria in table 1. A stand score is determined as the sum of the scores of each criterion. A stand that had minimal value in all criteria would score 10 in this system, and one meeting the guidelines would score 50. Since these criteria are similar to the Recovery plan criterion, it required a minimal reprogramming of the pass/fail system. The section that evaluated pass/fail and reason was replaced with a section that assigned a value for each criterion based on the criterion value and summed these for the stand. In our evaluation, scoring for stand age was not included and ground cover was not available, so our maximum score was 40 instead of 50.

In addition to scoring stands, this system also scored partitions. Six criteria were used for scoring partitions (table 2). A contiguous forage area was calculated and was used on each partition to select those stands scoring 40 and contiguous to the center to determine GQFH within ½ mile. These stands were then clipped with the ¼-mile forage polygon to get GQFH within ¼ mile. Total pine acres were defined as acres in all pine type stands in the ½-mile partition. Total contiguous pine foraging was also calculated from the contiguous polygon-partition intersection. There were two new partition criteria added: burn return interval and season of burning. These were added as criteria to the partition evaluation. This proved quite problematic for automated evaluation since burn boundaries did not correspond to partition boundaries, and a single partition could have several different burn histories. The Oakmulgee data did not include any burn information so we simply assigned all partitions with a 4 year, non-growing season burn. At Ft. Bragg, NC, burning is done on large rectangles, and we had to assign a dominant burn year and season to each stand in a partition.

Alternative Two — Weighted Scoring

The next alternative suggested added weighting factors to each of the stand and partition criteria (table 1- column 7, table 2 - last column). These weighting factors were determined by group consensus on the importance of each criterion by a group of knowledgeable scientists and managers. In addition to weighting factors, the definition of GQFH to be used in partition evaluation was changed to include stands that scored over 175 of the maximum 280 points in the stand scoring system. This system required a substantial reprogramming of the reporting function. During that reprogramming, age was programmed into a variable criterion like all the others. Stands were again screened for type and age over 30. In this case, each pine type stand was evaluated for each of the remaining nine criteria and assigned a score based on the criteria value. Each score was then multiplied by the appropriate weighting factor, and the products were summed to produce a stand score. For a complete analysis, the maximum score was 280. Since we did not have ground cover data, the maximum was 250.

Partition scoring (table 2) also required a new program to select all stands with scores over 175 rather than 250 (equivalent of 40 in the simple score system). Calculation of total pine acres and contiguous acres were not changed. We did not use the larger contiguous acreages required for the sandhills in order to run both data sets with the same program.

Alternative Three — Weighted Score 2

During 2004, the above weighted scoring system was further refined (table 1- last column, table 3). This refinement provided substantial changes to both the mechanics of calculation and the definition of criteria. Again the changes required a substantial reprogramming of the reporting module. The largest changes were moving burning from a partition evaluation to a stand evaluation. The weighting values were changed from 1-10 to 0-1, and the 2 burning categories added to make 12 criteria scored. Burning information is not generally stored as part of the stand inventory but as maps of burn units. We only had this information for Ft. Bragg, NC, so the evaluation of the Oakmulgee only includes the nine criteria used in the weighted system. On Ft. Bragg, NC, burning is done on large rectangles, so we were required to overlay the burn maps on the stand boundaries to create a new map of stand polygons with unique burn history. This overlay resulted in a stand map with over 18,000 stand polygons. Each stand polygon was evaluated for 11 criteria for Ft. Bragg, NC. A score of 3.67 on the Oakmulgee corresponded to meeting all 9 criteria, while a score of 4.495 on Ft. Bragg, NC, corresponded to meeting all 11 criteria.

Partition scoring reverted to only four criteria. Only stands that scored five on all criteria were considered GQFH for this system. “Total pine acres” was also changed to only include pine stands over 30 rather than all pine type in the partition. Both total pine and contiguous pine now have three separate criteria ranges depending on the site index. For our analysis, we chose to use only the medium site index range, since we did not have site index data on the Oakmulgee and testing for site index would have required an additional level of programming. Since site index was recorded on the stand level, a method to determine the dominant site index for each partition prior to evaluation would also be needed for partition evaluation.

The Oakmulgee and Ft. Bragg, NC, data were each evaluated by all four systems of stand and partition evaluation. The comparisons are not completely exact pairings due to the variation of the original data. Since the two weighted systems were developed in the NC Sandhills, they are much more likely to include data as it was collected on Ft. Bragg, NC. The Oakmulgee data was collected from the standard USFS inventory system, which we adapted to evaluate the recovery plan criteria (Lipscomb and Williams 2004).

RESULTS

The pass/fail system simply evaluated each stand to determine if it met the guidelines as specified on pages 188 and 189 of the Recovery Plan. We did not have ground cover data for either forest and could not evaluate stands in relation to this criterion. For this reason, the number of stands represented as meeting the guidelines is a maximum, and it is likely that the total number meeting the guidelines would decrease if ground cover data were available. Only 6,793 acres (13.9 percent) on the Oakmulgee and only 20,102 acres (18.8 percent) on Ft. Bragg, NC, met all criteria of GQFH. Of the 86.7 percent of the stands on Oakmulgee and 81.2 percent on Ft. Bragg, NC, that failed to meet the guidelines, there was more than one reason for failure (fig. 1). If we sum the area represented by all 6 reasons, it totals 191 percent of Ft. Bragg, NC, and 193 percent of the Oakmulgee, indicating that most stands fail for at least two reasons on both forest. The number of partitions passing is even smaller than the number of stands at 2.3 percent and 3.4 percent. Over 80 percent of the partitions on both forests lack GQFH in both the ½- and ¼-mile ranges (fig. 2). Also, over 40 percent of the Oakmulgee partitions and nearly 60 percent of the partitions on Ft. Bragg, NC, have fewer than 200 acres in pine stands.

All three scoring alternatives are summarized in figures 3 and 4. Examining the stand scores (fig. 3), the two forests are similar with the exception of the larger portion of Oakmulgee (43 percent) in stands that do not provide forage. Ft. Bragg, NC, has only 29 percent in stands that do not provide forage. Since non-forage is based on stand type and age, all three scoring systems identify the same non-forage areas. The scored stands are listed in 5 categories that represent 20 percent increments of the possible range of scores for that system. All three scoring systems agree fairly well and identified differences in stand properties. Since over 50 percent of the failing stands in both forests had too many stems or too much basal area of small pines, the low weighting of these factors tended

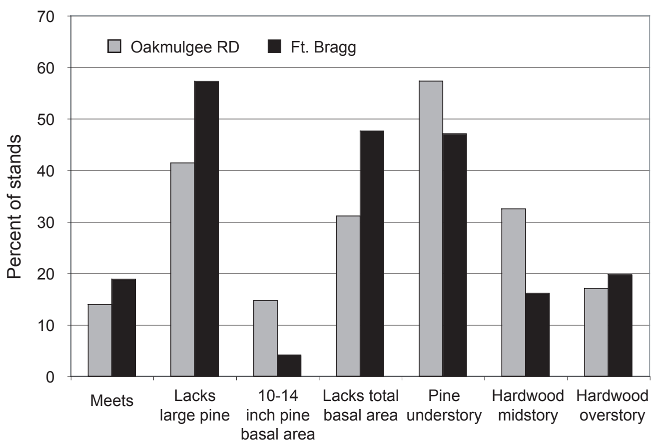

Figure 1—Distributions of stands that meet the Recovery Plan guidelines and those that fail to meet for 1 of 6 reasons developed by combination of the 11 criteria. A stand may fail for more than one reason, and the sum of all failing stands exceeds 100 percent.

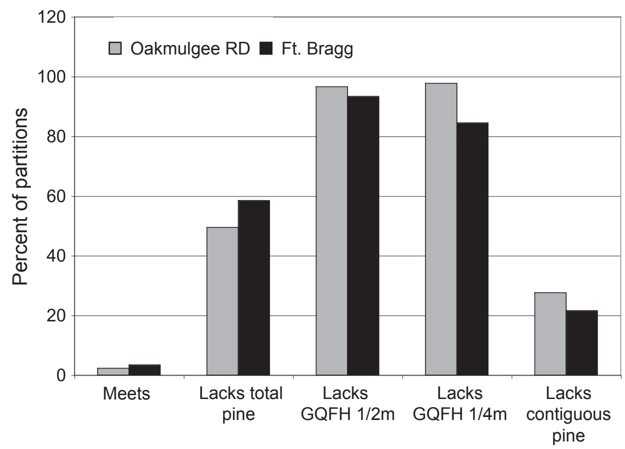

Figure 2—Distribution of foraging partitions that meet the Recovery Plan guidelines and those that fail to meet one of four criteria. A partition may fail more than one criteria, and the sum of failing partitions will exceed 100 percent.

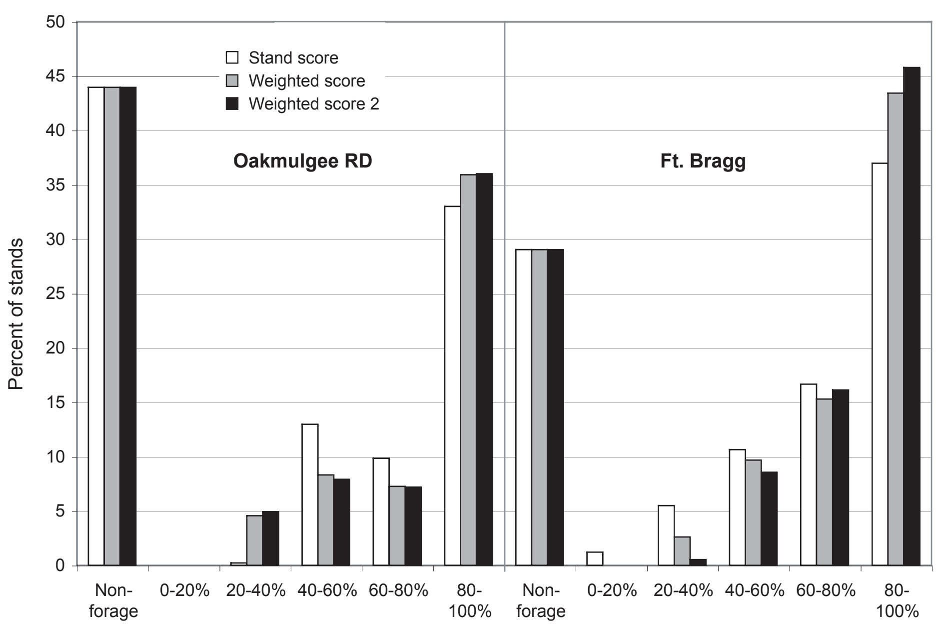

Figure 3—Distribution of stand scores evaluated by all three alternative scoring methods. Non-forage are all stands that are not pine or pine < 30 years old. For each method, scores of foraging stands were separated into five ranges such that each bracket represented 20 percent of the range from lowest to highest possible score for that method.

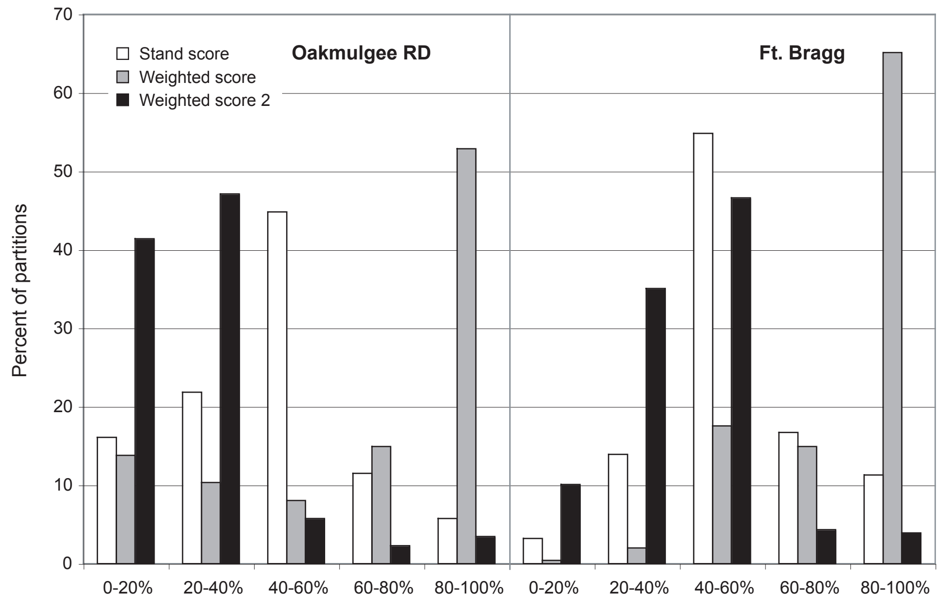

Figure 4—Distribution of partition scores evaluated by all three alternative scoring methods. For each method, scores of partitions were separated into five ranges such that each bracket represented 20 percent of the range from lowest to highest possible score for that method.

to increase the scores in the two weighted systems. With the exception of the burning criteria, both weighting systems had similar priorities, and on the Oakmulgee (where we assigned medium burn criteria) these systems are quite close. Even with the burn criteria included on Ft. Bragg, NC, there was only a 5 percent difference in the overall stand evaluations. All systems ranked individual stands nearly identically (table 4).

The similarity of the stands' scores is not found in the three alternatives when partitions are evaluated (fig. 4). Partition scores vary considerably between systems. The weighted system shows 52 percent of the partitions on the Oakmulgee and 65 percent on Ft. Bragg, NC, to be in the upper 20 percent of the range, when only 2 and 3 percent, respectively, actually met the guidelines. On Ft. Bragg, NC, much of the area had received a growing season burn in the last 3 years. With the weights in table 2, it is obvious two burn parameters are weighted as heavily as the amount of GQFH in the whole partition. The altered definition of GQFH in this system also increases the overall scores as seen on the Oakmulgee, where burning was assumed to non-growing season and 4 year return. The weighting system 2 results are even more difficult to interpret. On both forests, this system produces the highest stand scores, with more stands in the highest ranges. Yet, it produces the lowest partition scores of any system. The distribution on the Oakmulgee is most difficult. Less than 5 percent of the stands are in the lowest 40 percent of the stand score range, yet over 85 percent of the partitions are in the lower 40 percent of the range.

CONCLUSIONS

It has been possible to modify the RCWFAT program to include the criteria in the revised habitat guidelines of the Recovery Plan. The program has successfully examined 87 clusters on the Oakmulgee RD and 496 clusters on Ft. Bragg, NC. On both data sets, we used hardwood pulpwood basal area as a surrogate for the density-height criteria of hardwood mid-story. Also, neither dataset contained information that could be used to evaluate native ground covers, and the U.S. Forest Service inventory data on the Oakmulgee did not contain diameter distributions for individual stands. The data requirements of the criteria in the Recovery Plan are not met by traditional product-based inventory information. Data manipulation required to execute the program now requires custom programming for individual data sets. RCWFAT has allowed analysis of large data sets and can be used to indicate the implications of alternative methods to evaluate foraging habitat. This ability to examine many RCW clusters allows insight that was not available during deliberations of those developing RCW guidelines.

The Recovery Guidelines present a very exacting definition of GQFH. Less than 5 percent of the cluster foraging partitions meet all of the requirements of this exacting definition. This is

Table 4—Regression equations of the stand scores by three scoring systems. For each regression the first listed system is used as the x variable. WFR is the weighting factor ratio the score expected for a score of one in the x system

	Oakmulgee equation	r^2	Ft. Bragg equation	r^2	WFR
Stand score vs weighted	y = 6.266x -1.683	0.993	y = 6.09x- 2.807	0.998	6.22
Weighted vs weighted 2	y = 0.0147x - 0.003	0.999	y = 0.0178x + .0401	0.993	00177
Stand score vs weighted 2	y = 0.919x - 0.026	0.991	y = 0.1086x - .0206	0.989	0.1008

true for both a declining and an increasing population with very little difference in the percentage that met the guidelines in either forest. The stringent definition results in a rejection of most stands. In fact, most stands fail to meet two or more criteria. Simply examining the number of stands or partitions meeting the guidelines will provide little guidance to the forest manager. Without some method to score the quality of less-than-ideal habitat, it will also be difficult to demonstrate progress in habitat management over short time periods. It may take several decades to show substantial progress in the percentage of passing stands or partitions.

Three alternatives have been suggested during efforts to develop a system to evaluate less-than-optimal forage. These alternatives were devised without the ability to examine the implications of choices on large areas. When individual stands or partial stand polygons were examined, all alternatives produced similar results. The data in table 4 indicates that the slopes of the regressions were almost identical to the average weighting factors between the systems. The usable message in this is that any of these systems can be used to rate how close a particular stand is to meeting the guidelines. Therefore, any of them can be used to set priority for silvicultural action. Also, if the changes in the criteria values resulting from silvcultural plans can be quantified, a new stand score can be calculated to rank these plans for quality of RCW foraging.

The three suggested alternatives also included techniques to score cluster forage partitions. Applying these alternatives to a large number of clusters produced highly inconsistent results. The choice of technique had more influence on the results than any factor in the data. Using identical stand scores, the techniques showed variation of three to five fold in the number of partitions in any evaluation from poor to good. These differences were much larger than any differences between the forests. None of these alternatives could be used to confidently assign priority to clusters for silvicultural treatment. It would seem that simply overlaying the partition outlines on a map of stand scores would allow better qualitative assessment of cluster forage than any of these quantitative alternatives.

We have found that there is a reliable method to rank stands that do not meet all the criteria of GQFH in the 2002 Recovery Plan. Any of the three alternatives described here will produce a ranked list of stands from very good to poor. Combined with a simple listing of which criteria are responsible for the low score, this ranking can form the foundation of a silvicultural plan to improve RCW foraging habitat. However, alternatives to establish a quantitative method to evaluate forage within partitions have resulted in highly inconsistent results. For now, the silviculturalist will be able to evaluate the plans in relation to habitat quality of individual stands but not implications to quality of forage for groups of birds.

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LITERATURE CITED

Beyer, D.E.; Costa, R.; Hooper, R.G.; Hess, C.A. 1996. Habitat quality and reproduction of red-cockaded woodpecker groups in Florida. Journal of Wildlife Management. 60: 826-835.

Henry, V.G. 1989. Guidelines for preparation of biological assessments and evaluations for the red-cockaded woodpecker. Atlanta, GA: U.S. Fish and Wildlife Service, Southeast Region. 95 p.

James, F.C.; Hess, C.A.; Kicklighter, B.C.; Thum, R.A. 2001. Ecosystem management and the niche gestalt of the red-cockaded woodpecker in longleaf pine forests. Ecological Applications. 11: 854-870.

Lipscomb, D.J.; Williams, T.M. 1995. Use of geographic information systems for determination of Red-cockaded Woodpecker management areas. In: Kulhavy, D.L.; Hooper, R.G.; Costa, R., eds. Red Cockaded Woodpecker symposium III: species recovery, ecology and management. Nacogdoches, TX: Steven F. Austin State University, Center for Applied Studies in Forestry: 137-145.

Lipscomb, D.J.; Williams, T.M. 1998a. RCWFAT: an Arc/INFO AML program to assist in evaluating RCW foraging habitat. In: SOFOR GIS '98: second southern forestry GIS conference. Athens, GA: University of Georgia: 43-56.

Lipscomb, D.J.; Williams, T.M. 1998b. Spatial changes in RCW management constraint areas over a ten year period on Hobcaw Barony. In: SOFOR GIS '98: second southern forestry GIS conference. Athens, GA: University of Georgia: 57-68.

Lipscomb, D.J.; Williams, T.M. 2004. Examining RCW management changes in the 2003 recovery plan using habitat mapping. In: Proceedings of the southern forest GIS conference 2004. [CD-ROM]. Athens GA: Southern Regional Extension Forestry.

Lipscomb, D.J.; Williams, T.M. [In press]. Development of a geographic information system based model of Red Cockaded Woodpecker habitat. In: Costa, R.A., ed. Red-cockaded Woodpecker symposium IV. U.S. Fish and Wildlife Service.

Wigley, T.B.; Sweeney, S.W.; Sweeney, J.R. 1999. Habitat attributes and reproduction of red-cockaded woodpeckers in intensively managed forests. Wildlife Society Bulletin. 27: 801-809.

U.S. Fish and Wildlife Service (USFWS). 1985. Red-cockaded woodpecker recovery plan. Atlanta, GA: U.S. Fish and Wildlife Service, Southeast Region. 460 p.

U.S. Fish and Wildlife Service. 2003. Recovery plan for the red-cockaded woodpecker (*Picoides borealis*): second revision. Atlanta, GA: U.S. Fish and Wildlife Service. 296 p.