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A Tract Rating System for Harvesting Hardwood Timber in the South Delta Region of Louisiana.

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A TRACT RATING SYSTEM FOR HARVESTING HARDWOOD TIMBER IN THE SOUTH DELTA REGION OF LOUISIANA

A Dissertation

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by

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ABSTRACT

Based on a survey of forest products industries and logging contractors, the factors that affect harvesting costs and stumpage values on hardwood timber tracts in the South Delta Region of Louisiana were identified. Responses were evaluated with a scale value representing the relative importance of each factor. The majority of the respondents felt that physical and stand factors were the most important while contractual and legal factors were the least important. Presence and absence of roads, terrain, accessibility, product class, and timber quality were the top five factors. A second questionnaire containing weights and rankings for 32 selected factors was mailed to the respondents. They were asked for their opinions and suggestions regarding the ranking scheme, and 83 percent of them agreed with it. Proposed changes were analyzed and incorporated into the model.

The Tract Rating System computes individual ratings for each factor and total ratings for an entire tract. Total ratings for two or more tracts of interest can then be compared and a decision can be made as to which tract to purchase. The performance of the system was tested with actual data from 14 hardwood tracts harvested recently, and

the computed ratings were compared with the prices paid for stumpage on those tracts. Although the system performed well for some tracts, no correlation was found between ratings and historic stumpage prices. Reexamination of weights and rankings and verification by a larger number of respondents are recommended.

The final product was a user-friendly, flexible, and universal computer spreadsheet that performs all of the necessary calculations to arrive at the tract ratings. The spreadsheet accepts any number of factors, weights, and rankings; it computes scale values, selects and sorts factors, calculates individual and total ratings, and summarizes results for statistical manipulation.

The Tract Rating System can predict whether harvesting a particular hardwood tract is feasible and affordable, given the pertinent constraints. Once total ratings are obtained for several target tracts, the appropriate harvesting system(s) can be assigned to those tracts where they would perform best.

INTRODUCTION

Most southern hardwood stands are characterized by trees of low stumpage value. Many stands consist of small tracts containing low volumes in small trees. Many productive hardwood stands are located on wet sites where soil conditions prevent the use of conventional logging equipment, or in remote areas that are economically inaccessible for harvesting. Road construction and maintenance in wet areas are very expensive. Thus, the cost of harvesting these stands is relatively high, and potential buyers usually offer low bids for the stumpage. This situation --high harvesting costs and low stumpage prices-- discourages the landowner as well as the logging contractor, and is largely responsible for the under-development of the hardwood manufacturing industry.

Other factors that adversely affect the utilization of southern hardwoods include slow growth rates, many wood defects, and limited labor supply. Hardwoods are often small in diameter and have short and crooked boles (Koch 1985). The low volume per stem, highly variable species mix from stand to stand, and low volume per hectare are partly reponsible for high harvesting costs and the low price received for standing timber. Furthermore, knots and other defects, short stems, and small diameters prevent

sawing quality lumber in standard lengths. Labor shortages due to the seasonal character of harvesting activities and to fluctuations in the demand for hardwoods have a significant impact on independent logging contractors. In addition, many contractors face a technological problem in that most harvesting systems are designed for pine (*Pinus* sp.), not for hardwoods (Brignac 1982).

Recent survey data of the timber situation in the United States reveal that more than 76 million hectares, or 40 percent of the country's commercial forestland, are found in the South (USDA Forest Service 1982). Nearly 56 million hectares, or over 73 percent, of this land area support pine forests while the remaining 21 million hectares are covered by hardwoods.

In 1970, 12 southern states, from Virginia to Oklahoma and Texas, contained 2.6 billion m^3 of hardwood, or about 43 percent of the total national hardwood growing stock of 6.1 billion m^3 (USDA Forest Service 1974). Murphy and Knight (1974) and Christopher et al. (1976) estimated this volume at 3.1 and 3.2 billion m^3, respectively, in trees 13 cm or larger in diameter at breast height (dbh). The latest report published by the USDA Forest Service (1982) projects this figure to 3.7 billion m^3 by 1990 and 4.0 billion m^3 by the year 2000. The trend of these estimates shows a steady increase in the southern hardwood resource and suggests that the South will continue to be a major

source of supply. With regards to forest products, the same source indicates that the South produced 46 percent of the pulpwood, 30 percent of the lumber, and 34 percent of the plywood used in the nation in 1977, and its share is anticipated to increase continually over the next decades.

In Louisiana, commercial forestland totals about 5.6 million hectares, with pine and hardwood occupying 2.0 and 3.6 million hectares, respectively (May and Bertelson 1986). These forests support 239 million m^3 of hardwood growing stock, one-fourth of which (59.7 million m^3) is sawtimber.

Hardwood forests, particularly those occupied by bottomland hardwoods, are a largely ignored resource in Louisiana, often converted to other land uses to increase economic returns (e.g., soybeans in the late 1970s and early 1980s). Difficult logging, low stumpage prices, poor markets, mill closures, and overestimated high-value alternative uses are primarily responsible for this situation. When other uses fail, much of the land reverts to hardwoods, especially in the South Delta Region (Figure 1). This resource is characterized by unmanaged stands of noncommercial species, with poor stocking and low productivity.

The harvesting and manufacturing aspects of the situation need to be briefly described. The logging

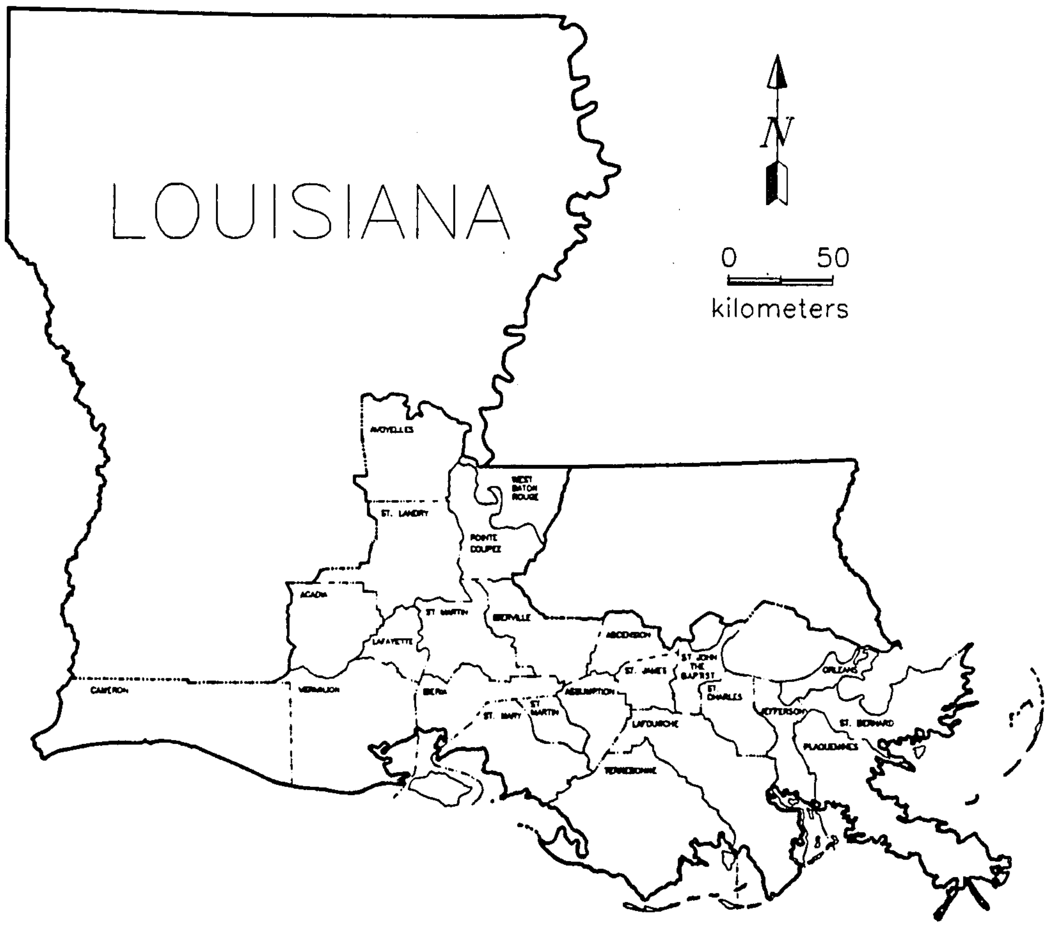

Figure 1. The South Delta Region of Louisiana.

equipment and systems presently used are not specifically designed for wet areas or for hardwoods. In addition, logging profits are often marginal because of poor stocking, and there are legal and environmental constraints that must be adhered to, such as the permits stated by Section 208 of the Clean Water Act. The potential to damage the site through soil disturbance and stream siltation further aggravates the hardwood logging scenario. Finally, hardwood sawmills in Louisiana's South Delta are generally small and family-operated, and no coordinated effort exists among mills and landowners to increase the resource base or improve its management.

If the hardwood forests of the South Delta Region are to become economically available, it is essential to have (1) a thorough knowledge of the resource base potential and (2) specific logging machines and systems. The forest products industry and landowners must know what resource is available at a certain stumpage price. By knowing their harvesting and transportation costs, mill managers can decide how much to offer for stumpage. In turn, if harvesting and transportation costs could be reduced through appropriate technology and more efficient logging practices, stumpage prices would increase, thus providing the landowner an incentive to grow hardwoods.

In spite of the problems associated with harvesting and utilization, the hardwoods of the South Delta have some

important advantages, including large acreage and wide distribution. Thus, hardwoods offer an opportunity for increasing Louisiana's timber supply and meeting future demands for wood products. The present situation might change if landowners managed their hardwoods and processing facilities based on this raw material were established in the area. An additional advantage is the possibility for hardwood-using plants to become energy self-sufficient by using noncommercial biomass and wood wastes to generate their own heat and/or electricity.

Forest products companies, through their procurement foresters, usually bargain with the landowner over the price of his standing timber, and then negotiate cut and haul rates with independent logging contractors. Variations in volume, quality, distance to the mill, logging costs, and restrictions placed upon the logger by the landowner, exist among tracts of timber. Such variations preclude assigning a universal price to stumpage (Stenzel et al. 1985). Consequently, the value of stumpage is the result of negotiations between the buyer and the seller, while cut and haul rates result from negotiations between the procurement forester and the logger. Often the forest landowner is not very knowledgeable about markets, prices, and costs, which may put the stumpage buyer at an advantage. On the other hand, while the logger's objective is to get a harvesting rate that allows him a fair margin

of profit, the stumpage buyer wants to minimize procurement costs. These conflicting interests render contract negotiations difficult and often lead to problems.

A major cause of such problems is that the persons involved in the negotiations generally do not have adequate information concerning the various factors affecting the harvesting costs and the value of a particular tract. Moreover, as no two tracts of timber are exactly the same, no standard procedure exists for estimating the monetary value of standing timber on any given tract. Therefore the value of stumpage must be determined for each tract. Thus, a Tract Rating System (TRS) seems to be a valid approach to the problem. Indeed, by incorporating all pertinent variables or factors into the rating system the user can rank two or more logging chances as to their cost, value, and suitability for harvesting. Based on the results of this ranking a procurement forester can decide which tracts may present the most problems, which one is the best, and which one to buy.

A TRS could potentially provide the procurement forester with a valuable decision-making tool to determine the value of stumpage on any given tract of hardwood timber, while serving, at the same time, as an elementary optimization technique for stumpage acquisition. The rating model developed here, however, is applicable primarily to hardwoods in the South Delta.

The purpose of this study was to develop a Tract Rating System for harvesting hardwood stands in Louisiana's South Delta Region. Specifically, the objectives were:

(1) **Factor identification.** To identify physical stand characteristics as well as biological, environmental, economic, legal, political, and social factors that affect stumpage value on hardwood timber tracts in the South Delta Region of Louisiana.

(2) **Factor selection.** To select those factors considered most relevant in estimating stumpage value.

(3) **Ranking procedure development.** To develop a systematic procedure to rank these timber tracts based upon the relative effect of the above factors on stumpage value.

(4) **Rating system design.** To create a tract rating system of potential universal application.

One important advantage of this approach is that a TRS reduces some of the subjectivity normally involved in assigning monetary values to stumpage in timber sales transactions. In addition, since the user only needs to enter the appropriate data into the model in order to obtain the tract ranking, the TRS is fairly inexpensive and easy to use. Furthermore, this management tool can benefit

landowners as well as the forest products industry. The former can determine how much his timber is worth and decide how much to accept or how much to ask for his stumpage. The latter will probably be more willing to utilize hardwood timber, knowing that it will be available and that its value can be estimated more objectively, which could raise the demand for hardwood stumpage. Consequently, the forest landowner will have an incentive to practice intensive management of their hardwood stands. In turn, this might encourage greater utilization of hardwood timber by the existing wood-processing plants and probably attract new industries that can utilize the South Delta's hardwood resource.

LITERATURE REVIEW

The value of standing timber is affected by a multitude of factors, including physical, biological, environmental, economic, sociological, political, and legal. Little relevant information concerning the effect of all of these factors upon the value of hardwood stumpage is available in the literature. Most published work deals primarily with harvesting cost analysis, productivity studies, and the relationship between physical stand variables and harvesting system cost and performance. Numerous prediction equations and simulation models to evaluate the cost and productivity of harvesting machines and systems have been developed, and abundant information on these topics is presently available, as can be seen below.

Systematic procedures for estimating fixed and operating costs of individual logging machines were presented by Warren (1977) and Miyata (1980). Part of this information was later used by Cubbage (1981) to calculate machine rates and develop productivity tables for equipment commonly found in harvesting operations in the South. Recently, Werblow and Cubbage (1986) resorted to the same source to determine fixed and operating costs of harvesting equipment for generalized applications.

Plummer (1977) determined logging costs of three harvesting systems employed in southern pine stands. The cost per unit volume for each harvesting function was calculated for a shortwood, a longwood, and a whole-tree chipping system operating on natural stands and plantations.

Although a large number of variables influence the value of standing timber and logging system performance, only a few appear to have a statistically significant effect. For example, White (1969) assessed the effect of 20 independent variables on the productivity of tree shear productivity, using site, weather, timber, equipment, and operator characteristics. Average volume of trees cut and operator skill were significant in predicting the volume cut per hour. Herrick (1976) used 22 independent variables to analyze the success of logging operations in the Northeast. He identified haul distance, total volume harvested, type of timber, and crew size as key indicators of successful logging jobs.

Tufts (1977) analyzed five major factors that affect logging system selection and harvesting costs, including men, money, machines, markets, time, and logging chance. Under logging chance, he discussed the importance of factors that pertain to the timber tract such as: tree size, volume per tree, brush condition, ground condition, slope, species, limbiness, obstacles, and road condition.

Haggard (1981) found that the productivity of a whole-tree chipping system, in terms of average loads of chips per day from a given tract, was related to haul distance, tract size, terrain, and average skidding distance. This author indicated that volume per hectare and season of the year did not significantly affect the performance of the system. However, this conclusion does not agree with the findings of other researchers (Hamilton et al. 1961, Cubbage 1983a, Blinn et al. 1986, Spencer et al. 1986) who emphasized the importance of the variable ***volume per hectare*** on cost and productivity.

Average harvest costs for 10 harvesting systems used in southern pine stands were estimated by Cubbage and Granskog (1982) using computer simulation models. The sensitivity of the systems to factors affecting harvesting costs --machine costs, fuel prices, wage rates, and tract size-- was examined to determine trends in harvesting systems and costs in the South. They concluded that highly mechanized full-tree systems had the lowest average cost per unit volume while shortwood systems exhibited the highest costs and therefore were not cost-competitive in southern pine pulpwood harvesting conditions.

Most investigators agree that tract size and tree size impact the cost and productivity of harvesting operations. Cubbage (1983b) found that highly mechanized, capital-intensive systems are more strongly affected by tract size

than are small labor-intensive systems. He reported that, in southern pine stands, the bobtail system was the most economical method up to 7 hectares, whereas the highly-mechanized full-tree system and the whole-tree chip system became the least costly methods at 7 hectares or more. Clearly, harvesting small tracts means that the contractor has to move more often, and this has highly negative effects on large, highly-mechanized systems. Mannes (1981) pointed out that in this case the logger has to absorb the cost of dismantling, transporting, and reassembling the equipment, in addition to income foregone due to lost production during the move. Also, the greater the degree of mechanization and the smaller the tract, the greater the moving cost.

The relationship between tree size (expressed as mean dbh, average volume per tree, or number of trees per unit volume) and harvesting costs and productivity has been investigated by several researchers, including Silversides (1960), Dibbdee (1965), Tufts (1977), Hypes (1979), Stuart (1982), and Blinn et al. (1986). They agree that a system performs more efficiently and costs are generally lower when larger trees are harvested.

The equations and models discussed in the preceding paragraphs fail to incorporate all the factors that contribute to a more realistic determination of stumpage value on a particular logging chance. Furthermore, they

pertain almost exclusively to harvesting productivity and costs and are mainly applicable to southern pine. A tremendous variety of factors render the determination of stumpage value a formidable task. Apart from those already mentioned, such factors include: underbrush and weather conditions (Hamilton et al. 1961); soil type and drainage (Dibbdee 1965); existing facilities (improvements and installations), ownership, owner's objectives, and legal constraints (Wackerman et al. 1966); road conditions and haul distance (Conway 1976); timber species and quality, accessibility, terrain, logging methods, markets, and type and conditions of the timber sale (Stenzel et al. 1985); labor supply (Koch 1985); merchantable height of growing-stock trees, sawtimber volume per hectare, percent of cull trees in the stand, and distance from the stand to a maintained road (Spencer et al. 1986); and many others.

The methodology used in the real estate business and in land use planning and management for identifying factors and assessing their importance can be valuable in achieving the first objective of this study. A brief discussion of these methods follow.

Several approaches are used for property valuation in the real estate business. The value of property (i.e. land as nature provided plus all man-made improvements to it) can be determined under the cost, market, and income approaches. Among the numerous factors influencing value,

Ring (1972) mentioned: topography and physical improvements (terrain, features of natural beauty, soil quality, drainage, and condition and contour of roads), nature and characteristics of population, and economic data.

Land use planners and managers employ several different techniques when determining land suitability for various types of developments. The ecological approach to land use planning (Baldwin 1985) emphasizes the inventory and analysis of environmental factors and the integration of these factors. He suggested that the following should be considered:

Physical factors:	Geology, topography, climate, hydrology, soils, and hazards (erosion, subsidence, etc.).
Biological factors:	Ecological functions, endangered species, biological resources, community characteristics, and fire hazards.
Human factors:	Land use patterns and conflicts, land ownership patterns, and existing laws and regulations.

Marsh (1978) presented several approaches for identifying the evaluative factors that may be important in a particular land planning situation. He included checklists, matrices, personal contacts, public meetings, opinion surveys, listening sessions, and workshops. Some of these methods can be useful in identifying what factors to include in a tract rating system.

Stumpage is part of the land but its value is not realized until it is harvested (Stenzel et al. 1985). For this reason standing timber requires a special treatment when one tries to determine its value. Therefore, the techniques discussed thus far are not suitable for accomplishing the stated objectives.

A tract rating model for evaluating the performance of a longwood harvesting system was developed by Mannes (1981). His model included four tract variables, namely, average stand dbh, number of trees per hectare, average skid distance, and ground conditions. The harvesting cost per unit volume on any given tract could be estimated with the model, and this cost could then be compared to the cost of harvesting a standard tract (the norm). Finally, the resulting ratio could be used to determine the rating of that particular tract.

Spencer et al. (1986) developed a method for evaluating the operability and location of Minnesota's timberlands. Operability was defined as "the relative ease or difficulty of managing or harvesting timber because of physical conditions in the stand or on the site." The authors selected seven major operability components and assigned physical values to each. The components were stand area, growing-stock volume and sawtimber volume per hectare, percent of cull trees, average dbh of growing-stock trees, merchantable height of growing-stock trees,

and distance to a maintained road from the stand. This procedure allows the user to separate timberland into operability classes (i.e., good, medium, poor) by forest type, volume per hectare class, stand age class, ownership class, and distance from wood-using center.

METHODS AND PROCEDURE

Study Area

The main objective of this study was to develop a Tract Rating System for harvesting hardwood timber in Louisiana's South Delta Region. This region, identified as Forest Survey Unit 2 by the USDA Forest Service, was chosen as the study area because of the prevalence of hardwoods, especially the oak-gum-cypress (*Quercus-Liquidambar-Taxodium*) forest type.

The South Delta Region of Louisiana encompasses 24 parishes (Figure 1) and covers 4.50 million hectares. After a significant decline of 74,000 hectares over the previous 10 years, only 21 percent of the land area was forested in 1984 (Table 1), according to Rosson and Bertelson (1986). These authors warned that the loss of timberland continues in the region.

The Forest Statistics for South Delta Louisiana Parishes (Rosson and Bertelson 1986) indicate that 97 percent (942,000 hectares) of the timberland is covered by hardwoods, including oak-gum-cypress, which is the dominant type in the region and occupies 83 percent of the forestland. The most abundant species in terms of growing stock volume are tupelo (*Nyssa* spp.), red oak (*Quercus* spp.), sweetgum (*Liquidambar styraciflua* L.), ash (*Fraxinus* spp.), black

Table 1. Land area of Louisiana's South Delta Region[1].

Parish	Forestland	Nonforest land	Total
	---------- Thousand hectares ----------		
Acadia[2]	39.5	540.6	580.1
Ascension	34.4	44.1	78.5
Assumption	58.3	36.7	95.0
Avoyelles	67.3	156.6	223.9
Cameron	0.0	427.5	427.5
Iberia	60.3	102.8	163.1
Iberville[3]	134.6	87.0	221.6
Jefferson	0.0	156.8	156.8
Lafayette[2]	0.0	0.0	0.0
Lafourche	58.2	277.3	335.5
Orleans	0.0	90.5	90.5
Plaquemines	0.0	365.0	365.0
Pointe Coupee	57.5	95.5	153.0
St. Bernard	0.0	193.4	193.4
St. Charles	23.8	81.7	105.5
St. James	32.1	33.6	65.7
St. John Baptist	38.9	50.4	89.3
St. Landry	76.4	166.8	243.2
St. Martin	123.6	88.1	211.7
St. Mary	56.4	122.6	179.0
Terrebonne	42.4	376.1	418.5
Vermilion[2]	0.0	0.0	0.0
West Baton Rouge[3]	0.0	0.0	0.0
West Feliciana	64.2	46.3	110.5
All parishes	967.8	3539.5	4507.3

[1] Source: Rosson and Bertelson (1986).
[2] Lafayette and Vermilion included in Acadia.
[3] West Baton Rouge included in Iberville.

willow (*Salix nigra* Marsh.), red maple (*Acer rubrum* L.), and elm (*Ulmus* spp.).

Eighty-eight percent (828,000 hectares) of the hardwood forests is owned by nonindustrial private landowners while the balance (114,000 hectares) is equally divided between industrial and public holdings. The volume of growing stock totals 72 million m^3, or 66 percent of the land area. Over 18 million m^3 (62 percent of the region's total) of hardwood sawtimber, exclusive of baldcypress (*Taxodium distichum* (L.) Rich.), are presently available for harvest, and two-thirds of this volume is in trees 38 cm and larger in dbh (Rosson and Bertelson 1986).

In 1973, the South Delta supplied raw material for 19 manufacturing facilities utilizing hardwoods: eight large sawmills (with an annual output of 7080 m^3 or more), seven small sawmills, two pulpmills, and two veneer plants (Bertelson 1974). Hardwoods accounted for 4.5 percent of the sawlogs, 1.9 percent of the pulpwood, and 0.3 percent of the veneer production for the entire state. In 1981, the Louisiana Office of Forestry reported the existence of 11 sawmills (eight large and three small), one pulpmill, and one veneer plant, all utilizing exclusively hardwoods (King and Nachod 1981). At present, only nine sawmils, one pulpmill, and two part-time specialty mills remain in business.

These statistics suggest that the situation has not improved since 1973. High harvesting and transportation costs and low stumpage values render much of this timber practically unavailable to potential purchasers and manufacturers. In fact, many loggers are not willing to cut hardwood stands because the harvesting costs are too high and the delivered price of wood to the mill is too low. At the time this study began, few land-owners wished to sell or even manage their hardwood timber chiefly because of low stumpage prices.

Tract Rating Methodology

In order to achieve the objectives of this study, a systematic procedure similar to one prepared by the USDA Soil Conservation Service (1966) was used. Essentially, this approach involved (1) the identification of factors or variables that affect stumpage value on any given timber tract and (2) the evaluation of the relative weight and impact of such factors.

Identification and selection of the variables

A great number of factors influence stumpage value. Physical, biological, environmental, economic, legal, political, and sociological factors were considered in this study. However, due to the difficulty in including some factors in a particular category and because the

interactions among them often mask the individual effects, no attempt was made to classify them at first. An extensive list of the factors, together with the elements considered, is presented below.

1. Terrain: rocky, firm, soft; dry, wet, muddy, boggy, swampy.

2. Topography: flat, hilly, mountainous; gentle, steep; slope.

3. Accessibility: rights-of-way; presence or absence of roads, types of roads (inter-state highway, primary, secondary, tertiary; private, public); maintained or not; kilometers to be traveled on each type; distance from tract to maintained road.

4. Soil type (texture): gravel, sand, silt, clay, organic.

5. Drainage: well, moderately, or poorly drained.

6. Tract size and shape: large, medium, small; circular, square, rectangular, irregular.

7. Stand density: number of stems per hectare.

8. Diameter at breast height of growing-stock trees.

9. Diameter distribution of merchantable trees.

10. Growing-stock volume per hectare.

11. Sawtimber volume per hectare.

12. Average volume per merchantable stem.

13. Height range and mean merchantable height.

14. Species composition: percent of each species or forest type.

15. Limbiness: excessive, moderate, slight.

16. Underbrush conditions: heavy, moderate, light.

17. Types of product by species: sawtimber, veneer logs, pulpwood, poles, posts, crossties, etc.

18. Volume of each product type.

19. Timber quality: cull volume, defects, deductions on scale.

20. Daily and annual volume required by mill(s).

21. Existing facilities and improvements: fences, buildings, power lines, etc.

22. Weather: maximum and minimum temperatures, amount and frequency of rainfall, number of inoperable days due to weather or fire danger.

23. Ownership: public, company, small private.

24. Owner's policy: intensive, extensive, or no management.

25. Type of operation: logging contractor or company operation.

26. Woods labor availability.

27. Logging system deemed appropriate: shortwood, longwood, full-tree, whole-tree chipping, cable, helicopter, etc.

28. Number and size of landings necessary to harvest the tract.

29. Type of harvest: clearcut, partial cut, salvage cut, thinning, etc.

30. Haul distance to closest mill or woodyard.

31. Harvesting costs.

32. Markets for hardwood raw material and products.

33. Type of timber sale: lump sum, unit of volume.

34. Conditions of sale: time and method of payment, duration of the operations, marked or unmarked timber, merchantability limits, scaling, cull log determination, slash disposal.

35. Environmental, legal, and social constraints: minimum stump height, harvesting method and type of cut permitted, road construction specifications, maximum size and distribution of clearcuts, limitations on highways (load, size, and speed), compliance with safety standards, slash disposal regulations, forest protection (against fire, soil erosion and compaction, and stream siltation), damage to residual stand, use of "screen" forest strips, preservation of wildlife habitats and food sources, preservation of esthetic values, penalties for non-compliance, etc.

The Tract Rating System Survey

The purpose of the Tract Rating System (TRS) Survey was to identify and estimate the relative importance of factors that affect the cost of harvesting hardwood timber in Louisiana's South Delta Region. A questionnaire containing 36 major entries totalling 55 factors was devised to encompass eight major categories of variables, namely: physical, stand, environmental, legal, social, economic, operational, and contractual (Appendix I). Also included in the survey were general questions aimed at characterizing the respondent and his activity. Because the survey targeted two major groups of people --loggers and manufacturers-- there were slight differences in the contents of the questionnaires, but the list of 55 factors was exactly the same for both groups. Loggers were asked questions concerning type of timber cut, type of raw material delivered, and harvesting system configuration while industry people were asked about land ownership,

of supply, type of raw material processed, and forest products manufactured.

The questionnaire was mailed to 25 hardwood-using industries and to 16 logging contractors serving these companies, and was followed in many cases by phone call and/or personal interview. According to the Directory of the Forest Products Industry (1986), these were the only firms operating in the South Delta which were dealing with hardwoods at the time this study began.

From a consolidated list of the variables generally found in the literature, the respondents were asked to rank each factor as to its importance in estimating harvesting costs and stumpage value. The responses were given by circling a number on a 1 - 10 scale, with **1** indicating a factor of least importance and **10** a factor of utmost importance.

Evaluation of the responses was achieved by a scaling method used in the social sciences. Indeed, the method of equally-appearing intervals (Edwards 1983) was used to compute a **scale value** (**S**), which indicates the relative importance of each factor. **S** is calculated with the formula:

$$S = L + i[(0.50 - \Sigma F_b)/F_w]$$

where:

S = scale value

L = lower limit of the interval in which the median falls

i = width of the interval

ΣF_b = cumulative frequency below the interval in which the median falls

F_w = relative frequency within the interval in which the median falls

In essence, **S** is equivalent to the median of a set of grouped observations and, as such, it is a numerical descriptive measure of the central value of a set of observations. In this case, the scale value is a quantitative expression of the relative importance of each factor. Thus, large **S** values reflect high importance of a given factor whereas low **S** values show that the factor was deemed unimportant.

The **interquartile range** ($Q=Q_3-Q_1$), or the difference between the third quartile and the first quartile, was used as a measure of dispersion. Agreement among respondents is indicated by low **Q** values; i.e., small spread of the middle 50 percent of the responses. Conversely, large **Q** values are the result of relative disagreement about the importance of a given factor. The **Q** values were generated by a SAS univariate procedure (SAS Institute 1985).

The next step involved the creation of classes or categories and a ranking scheme for each selected factor. While the numerical values used in this phase of the study were obtained from the literature or through expert

opinion, the qualitative categories assigned to the majority of the factors were somewhat arbitrary and based on personal experience.

Evaluation of the variables

Upon selecting the rating variables and devising the ranking procedure, each variable was assigned a weighting factor based on the magnitude of the effect that the variable has on the value of standing timber, relative to the other variables. For the sake of simplicity, the weight was made equal to the **s** value. Thus, the score or **rating** (**r**) for a given variable equals its ranking (**k**) multiplied by its scale value, hereinafter noted as **w**.

A second questionnaire containing the 32 selected factors and the ranking scheme (i.e., the categories within each factor) was developed and mailed to the respondents. Factors and categories were arranged in descending order of importance (Appendix II). This time I asked the respondents their opinions about the ranking scheme and solicited suggestions that could help improve the Tract Rating System. The questionnaire provided space for the respondents to indicate their agreement or disagreement as well as an alternative scheme of their own and some pertinent comments.

Evaluation of each individual factor or variable on a given tract of timber can be accomplished by computing a **rating** (r) or score according to the following scheme:

Tract No	Factor	Weight	Ranking	Rating
1	1	w_1	k_1	$r_{1,1}=k_1w_1$

Likewise, ratings can be computed for the remaining factors on the same tract:

1	2	w_2	k_2	$r_{2,1}=k_2w_2$
	3	w_3	k_3	$r_{3,1}=k_3w_3$
	.	.	.	.
	.	.	.	.
	.	.	.	.
	32	w_{32}	k_{32}	$r_{32,1}=k_{32}w_{32}$

A similar procedure can be used to compute ratings or scores for any number of factors and tracts:

Tract No	Factor	Weight	Ranking	Rating
2	1	w_1	k_1	$r_{1,2}=k_1w_1$
.	2	w_2	k_2	$r_{2,2}=k_2w_2$
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	32	w_{32}	k_{32}	$r_{32,2}=k_{32}w_{32}$
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
m	n	w_n	k_n	$r_{n,m}=k_nw_n$

Finally, the total score or **total rating** for a particular hardwood timber tract (j), can be obtained by:

$$R_j = \sum_{j=1}^{n} \sum_{i=1}^{n} k_i w_i = \sum_{j=1}^{n} r_{ij}$$

where:

R_j = total rating of tract j (j = 1, 2, 3, ..., m)

k_i = ranking of factor i (i = 1, 2, 3, ..., n)

w_i = weight of factor i

r_{ij}= rating of factor i on tract j

The maximum and minimum total scores possible for a given tract is dependent upon the sum of the weights of the factors involved and the ranking of each individual factor. If the highest and lowest rankings and weights for a given tract are known, then the upper and lower limits of R for that tract can be established. The example below illustrates the use of the ratings.

Let us assume that the "ideal" or "perfect" tract is one where the total weight is Σw_i=248 and all the factors receive the highest rankings (k=5 in most cases); i.e., this tract has a total rating of R=1250. We can now arbitrarily define the following **tract classes**:

Class 1: R = 1000-1250 *superior*

Class 2: R = 750-1000 *good*

Class 3: R = 500-750 *medium*

Class 4: R = 250-500 *poor*

If a particular tract receives an actual total rating of 997, for example, then it will be classified as a *good* tract as far as its logging cost, harvesting feasibility, and stumpage value. An identical procedure can be followed for all the tracts of interest.

To take full advantage of this technique, the user needs all the pertinent data on each of the factors for a given logging chance. The 1984 forest inventory of the South Delta parishes of Louisiana, conducted by the USDA Forest Service (Rosson and Bertelson 1986), contains tree and stand information that can be used for this purpose. Other data may not be readily available or easy to get, and that may limit the usefulness of the Tract Rating System. At any rate, as long as (s)he has access to the necessary data, a procurement forester or any other user simply has to select the apropriate ranking for each variable in order to obtain the individual and total scores. The final product, i.e., the Tract Rating System proper, is a computer spreadsheet called **STUMPAGE** which computes the ratings for the tracts of interest.

The last step in the rating process is to compare the total scores for all the tracts under consideration, either numerically or by classes, and decide which tract of timber

to purchase. Indeed, based on the value of **R**, the decision maker can select the best among two or more prospective tracts that (s)he may wish to acquire.

The STUMPAGE spreadsheet

In designing the Tract Rating System, the main objective was to build a spreadsheet of universal application; i.e., one that any person or company can use for any tract of timber, regardless of location, for any number of factors or variables affecting the stumpage in question, and for any range of weights and rankings that the user may want to choose. The spreadsheet will make it possible to rate any number of variables in order of importance (a procedure similar to the the one used in the original questionnaire), to summarize the results for statistical manipulation, to compute scale values (S) and interquartile ranges (Q), to select the factors based on a predetermined criterion, to arrange them according to the S values, and to calculate individual ratings (r) for the selected factors and total ratings (R) for the tracts of interest. To make the final product more attractive and to generate interest among a wide range of potential users (e.g., landowners, loggers, and manufacturers), the **STUMPAGE** spreadsheet is complemented by a user's manual with detailed, step-by-step instructions.

RESULTS AND DISCUSSION

Results of the TRS Survey

A 56-percent response rate was achieved from the TRS survey. Out of 41 persons or companies solicited, 23 completed the questionnaire, 10 were out of business, six agreed to complete the questionnaire (when contacted by phone) but did not return it, and two simply did not respond. Of the 23 respondents, 13 (56 percent) returned the questionnaire by mail and I personally interviewed 10 (43 percent) of them; 14 (61 percent) were manufacturers (either owners or managers in forest products companies) while nine (39 percent) were logging contractors. Eight non-respondents (35 percent) were loggers who were contacted several times via mail and phone, and the others were small forest industries, mostly sawmills, that had gone out of business.

Characteristics of the respondents

Fourteen forest products industries and nine loggers participated in the TRS survey. In the first group, one manager reported that his company had its own logging equipment and crew and provided 40 percent of the raw material utilized by the mill. Besides ranking the factors from 1 to 10, the respondents were asked other questions

which were different for both groups. Their answers made it possible to characterize manufacturers and logging contractors.

The forest products industry. The majority of the forest products manufacturers who completed the TRS survey processed almost exclusively hardwoods (Table 2). Of the 14 participants, two were utilizing only cypress and one only pine, but they all had previous experience with hardwoods. As to the sources of supply of the raw material, over 70 percent of the respondents purchased either standing timber or logs, and only one company was mostly dependent upon fee-land timber. Except for one specialty mill that made pallets and hardwood squares, all the participating forest industries produced lumber and/or chips. Other products reported were timbers, crossties, planks, shavings, sawdust, and pulp. Only five respondents provided information concerning forest land ownership: four had holdings of more than 4,000 ha and one owned 200 ha.

The logging contractors. In contrast with the industry, only four loggers dealt almost exclusively with hardwoods; another four harvested mostly pine and one cut nothing but cypress (Table 3). Loggers delivered three types of raw material to the wood products industry: tree lengths, logs, and pulpwood bolts. According to the survey, logs are the most commonly delivered form. Eight

Table 2. Selected characteristics of the forest products manufacturers who completed the TRS survey.

No.	Raw material processed			Source of Supply		
	Hardwoods	Cypress	Pine	Purchased timber	Fee-land timber	Logs
	Percent					
1	100	0	0	70	0	30
2	100	0	0	70	0	30
3	100	0	0	0	0	100
4	0	100	0	75	0	25
5	0	0	100	0	0	100
6	100	0	0	100	0	0
7	80	0	20	N/A[1]	N/A	N/A
8	50	0	50	50	50	0
9	90	10	0	90	0	10
10	95	5	0	50	0	50
11	100	0	0	20	80	0
12	0	100	0	0	0	100
13	90	10	0	0	0	100
14	90	10	0	0	0	100

[1] N/A= Information not available.

Table 3. Selected characteristics of the loggers who completed the TRS survey.

No.	Timber type harvested			Raw material delivered		
	Hardwoods	Cypress	Pine	Pulpwood	Tree-lenghts	Logs
	Percent					
1	0	100	0	0	50	50
2	5	0	95	70	10	20
3	2	0	98	50	50	0
4	40	0	60	0	100	0
5	0	0	100	20	0	80
6	100	0	0	0	0	100
7	100	0	0	50	0	50
8	100	0	0	0	0	100
9	95	0	5	0	50	50

loggers used mechanized logging systems, while one small operator performed only manual felling and bucking. Crew size varied from three to eight, depending upon the logging system used. With regards to harvesting system configuration, loggers use a wide range of machines, including skidders (cable and grapple), bulldozers, logging tractors, marsh buggies, forwarders, "big-stick" loaders, knuckleboom loaders, bobtail trucks, and logging trucks and trailers.

The last question was related to the characteristics of the average timber tract normally harvested and those of an "ideal" tract (based on the capacity of the logging system currently in use). Only four persons replied to this question. (See Table 4.)

Comparison of respondents. The people who completed the TRS survey were loggers and manufacturers; some of them were personally interviewed while others returned the survey by mail. In order to determine whether these two groups of respondents differed in terms of the S values computed from their answers to the first questionnaire, two separate t-tests were performed using the SAS GLM procedure (SAS Institute 1985). A comparison between logging contractors and people in the forest products industry resulted in no significant difference between these two groups at the α=0.0001 level. The other t-test revealed identical results: No significant difference exists, at

Table 4. Actual and ideal tract size and volume per hectare as perceived by loggers who completed the TRS survey.

No.	Major timber type harvested	Tract size		Volume per hectare	
		Actual	Ideal	Actual	Ideal
		--- hectares ---		---- m^3/ha ----	
1	Cypress	65	100	9	40
2	Pine	4	8	15	25
3	Hardwood	50	120	17	30
4	Hardwood	40	120	25	60
5	Hardwood	8	40	7	15

the α=0.0001 level, between the respondents who were interviewed and those who returned the completed questionnaire by mail. These results lead to the conclusion that, when completing the first questionnaire, both groups of respondents agreed in their perception of the importance of the variables that affect harvesting costs and stumpage value.

Selection of the variables

The calculated **S** values were the basis for ranking the responses. Of the original 55 variables or factors included in the questionnaire, 32 were selected based on the magnitude of the scale value (**S**), which ranged from 2.748 to 9.247. A numerical example will help understand how to compute and interpret the **S** and **Q** values.

Suppose that a tally of the responses for the variable ***terrain*** yielded the following frequencies:

Value	Frequency, F_i
1	0
2	0
3	2
4	0
5	3
6	0
7	1
8	5
9	1
10	11
	ΣF_i=23

The values in the first column represent the importance that the respondents attributed to the factor *terrain* and those in the other column are the frequencies of the responses. Thus, two of the 23 respondents gave *terrain* an importance of 3 (on a 1-10 scale), while 11 of them felt that *terrain* deserved an importance index of 10 (i.e., the variable *terrain* is of utmost importance in estimating harvesting costs and stumpage value).

To compute the scale value **S** we now build a table that contains class intervals and cumulative frequencies:

Value	Class interval (i=1)	Relative frequency F_i	Cumulative frequency ΣF_i	F_i/n	$(\Sigma F_i)/n$
1	0.5-1.5	0	0	0.000	0.000
2	1.5-2.5	0	0	0.000	0.000
3	2.5-3.5	2	2	0.087	0.087
4	3.5-4.5	0	2	0.000	0.087
5	4.5-5.5	3	5	0.130	0.217
6	5.5-6.5	0	5	0.000	0.217
7	6.5-7.5	1	6	0.043	0.261
8	7.5-8.5	5	11	0.217	0.478
9	8.5-9.5	1	12	0.043	0.522
10	9.5-10.5	11	23	0.478	1.000
	Totals:	n=23		1.000	

To find the interval which contains the scale value or the median, we must find the first interval for which the cumulative frequency exceeds 0.50. For our data, the interval from 8.5 to 9.5 satisfies this condition, the

corresponding value is $F_i=F_w=1$, and the cumulative frequency below the interval containing the median is $\Sigma F_i=\Sigma F_b=11$. Now we can compute **S** using these values divided by the total number of responses (n=23):

$$S = L + i[(0.50 - \Sigma F_b)/F_w]$$

$$S = 8.5 + 1[(0.50 - 0.478)/0.043] = 9.012$$

Consequently, the midpoint of the observations for the variable ***terrain*** is the value 9.012; i.e., the center of the distribution of the responses is about 9.

Since the interquartile range **Q** is the difference between the third and first quartiles (the 75th and 25th percentiles, respectively) and these percentiles are computed in exactly the same manner as the median, we can use a similar procedure to obtain Q_3 and Q_1 for the variable ***terrain***.

$$P_{75}=Q_3=L+i[(0.75-\Sigma F_b)/F_w]=9.5+[(0.75-0.522)/0.478]=9.977$$

$$P_{25}=Q_1=L+i[(0.25-\Sigma F_b)/F_w]=6.5+[(0.25-0.217)/0.043]=7.267$$

The results indicate that 75 percent of the responses for the variable ***terrain*** fall below 9.98 and 25 percent below 7.25. Now the interquartile range becomes:

$$Q = Q_3 - Q_1 = 9.977 - 7.267 = 2.710 \approx 3.00$$

The conclusion is that 50 percent of the responses lies approximately between 7 and 10, or within three units of the scale value **S**=9.012. In terms of the factor in question, one can interpret the results by stating that about one-half of the respondents attributed the variable ***terrain*** an importance index between 7 and 10.

The 32 factors selected for inclusion in the Tract Rating System were the upper half of the **S** values; i.e., factors with **S** values greater than the mid-range of 5.998. The majority of the respondents agreed that physical and stand factors have the greatest effect on harvesting cost and stumpage value, while contractual and legal factors are the least important (Table 5). More specifically, the top five factors were: (1) ***presence or absence of roads***, (2) ***terrain***, (3) ***accessibility***, (4) ***product class***, and (5) ***timber quality***. ***Compliance with safety standards*** --a legal constraint-- was selected as the tenth most important factor (with a rating between 7 and 10) by 74 percent of the respondents. On the other hand, ***slash disposal provisions in the timber sale deed*** was deemed the least important of all variables. Operational factors were considered relevant by some respondents and irrelevant by others. However, more people agreed that they were relevant factors, as reflected by the lower interquartile range (**Q**) shown below:

Haul distance S=7.601 Q=4.000

No. & size of landings S=4.668 Q=6.000

A careful examination of the responses to the first questionnaire revealed that the Q values ranged from 1.500 to 8.000. ***Penalties for non-compliance*** and ***slash disposal provisions in the timber sale contract*** were the variables that exhibited the highest Q values (8.000 and 7.000, respectively), suggesting ambiguity in the wording of the question or in the respondents' interpretation of the question. Although these factors were not among those selected, the way in which they were presented in the questionnaire was not clear to the respondents. In addition, eighteen other factors seem to have caused confusion among the respondents, but only seven of them were among the 32 selected for the model. On the other hand, 10 of the selected variables displayed Q values less than 3.250 and posed no ambiguity problem. In order to minimize confusion, the descriptions of the variables with Q values greater than 5.000 were revised and the changes were incorporated in the second questionnaire.

When two or more variables had the same S value, greater importance was attributed to the one with the lowest Q value because it reflected less ambiguity as to the interpretation of the question. For example, ***haul distance*** (S=7.601, Q=4.000) was ranked as more important than

Table 5. Final variables of the Tract Rating System.

No	Category[1]	Variable description	S	Q
1	P	Presence or absence of roads	9.247	3.00
2	P	Terrain	9.012	3.00
3	P	Accessibility	8.874	5.50
4	S	Product type	8.374	5.00
5	S	Timber quality	8.313	2.00
6	S	Product volume	8.126	3.00
7	P	Drainage	8.000	4.00
8	S	Species composition	7.995	5.00
9	S	Volume/hectare to harvest	7.901	4.25
10	L	Compliance with safety standards	7.874	4.00
11	S	Diameter at breast height	7.812	1.50
12	P	Road class	7.750	3.75
13	Op	Haul distance to mill	7.601	4.00
14	Ec	Availability of markets	7.601	5.00
15	S	Limbiness	7.126	4.00
16	P	Weather	7.002	6.00
17	S	Mean merchantable height	7.000	2.50
18	Ec	Volume required by mill	7.000	4.00
19	P	Road maintenance requirements	7.000	4.50
20	S	Mean volume/merchantable stem	6.918	4.00
21	S	Number of trees/ha to harvest	6.874	3.00
22	C	Diameter limit	6.750	3.00
23	Ec	Existing facilities	6.748	5.00
24	P	Soil type	6.747	4.00
25	S	Diameter distribution of trees	6.626	3.00
26	En	Wildlife habitat preservation	6.632	4.00
27	S	Growing-stock trees volume/ha	6.169	4.00
28	Op	Type of harvest	6.145	3.00
29	P	Tract size	6.126	2.00
30	L	Highway restrictions	6.000	4.25
31	Ec	Woods labor availability	6.000	5.25
32	Op	Logging system deemed necessary	5.998	3.25

[1] Categories are: C=contractual, Ec=economic, S=stand, En=environmental, L=legal, Op=operational, P=physical.

availability of markets (S=7.601, Q=5.000) because its lower Q value indicated more clarity and less dispersion of the responses about the calculated S value.

The results of the first questionnaire were used to compute the total rating **R** for any given tract. The value of **R** ranged from 248.043 for the lowest rankings (k=1) to 1239.571 for the highest (k=6), while the weights (w) varied between 5.998 and 9.247, for the least important and the most important factor, respectively.

The Tract Rating System was designed in such a manner as to avoid manual calculations. The spreadsheet **STUMPAGE** automatically computes frequencies, scale values, inter-quartile ranges, and other necessary values. It is flexible enough to allow user changes and input.

Description of the selected variables

Before developing the ranking scheme, most of the variables to be included in the second questionnaire were carefully described or explained in order to minimize confusion or errors of interpretation. The 32 selected variables, in descending order of importance, as determined by the **S** value, are listed and briefly described below. In some cases, the name of the factor is self-explanatory.

1) Presence or absence of roads: Refers to roads suitable for log transportation to and within the property, from an existing road also suitable for log transportation. This

factor is expressed as the length of road to be built.

2) Terrain: Refers to prevailing topographic conditions that affect logging equipment regardless of the season, and expresses how much limitation the terrain poses on machinery use.

3) Accessibility: Refers to easements or rights-of-way to and from the property where the timber is to be harvested. It considers the cost in dollars and the time lost in negotiations.

4) Product class: The type of forest product for which the majority of the stumpage on the tract can be used.

5) Timber quality of the trees within the sale: This factor is expressed as the percentage of the total hardwood volume in hardwood cull trees (i.e., rough and rotten trees).

6) Volume: Refers to average volume per hectare of the major product class for which the stumpage can be used.

7) Drainage characteristics of the tract: Includes average drainage conditions and effect of seasonal drainage variations on conventional equipment use. Considers how much limitation drainage poses on equipment use and time of year when drainage is most restrictive.

8) Species composition: Expressed as percent of total hardwood volume, considers the major species or groups of species in ascending order of economic importance.

9) Volume per hectare of hardwood veneer logs and/or sawtimber to be harvested.

10) Compliance with safety standards: Relates to the cost of adherence to federal, state, and private safety regulations, not to the indirect cost due to accidents.

11) Average dbh of merchantable hardwood trees.

12) Class of road to and from the mill: This variable is expressed as the percent of total distance from stump to mill on each road class.

13) Availability of markets: Refers to the proportion of the hardwood raw material generated in the woods that can be sold to a mill.

14) Haul distance to mill.

15) Limbiness: Refers to the limbiness of the trees to be harvested in the major product class, as this relates to harvesting cost.

16) Weather: Refers to meteorological conditions during the course of the sale and considers seasonal sensitivity of the harvesting system to adverse weather factors.

17) Road maintenance requirements: Relates to cost, time spent, and lost production due to road maintenance.

18) Volume required by mill: Indicates the dependency of a mill on the volume of timber cut from a given tract to secure raw material during the harvest, and is expressed as the percent of the daily volume of hardwood timber required by the mill from this tract.

19) Mean merchantable height: Depending upon the product class, this factor is expressed as the number of 16-foot logs (for sawtimber) or as the number of 5-foot bolts (for pulpwood).

20) Mean volume per merchantable stem.

21) Number of trees to be harvested per hectare.

22) Diameter limit: Refers to trees of certain diameters (at stump height) that may not be cut if so specified in the timber deed.

23) Facilities and improvements: Includes buildings, fences, power lines, and other man-made obstacles that may restrict normal logging operations.

24) Soil type: Dominant textural components of the soil in the tract.

25) Diameter distribution of trees in the tract.

26) Preservation of wildlife habitats: Refers to logging restrictions resulting from habitat preservation clauses established in timber deed.

27) Volume per hectare of growing-stock trees.

28) Type of harvest.

29) Tract size.

30) Labor availability at the time the tract can be harvested.

31) Highway regulations.

32) Logging system deemed appropriate.

The ranking scheme

The definitive Tract Rating System developed from the results of the first questionnaire consisted of the 32 factors or variables that the respondents considered more important. The midrange of the **S** values was the selection criterion: Factors with **S** values greater than the midrange (5.998) were selected for inclusion in the TRS. The numerical expression of importance was given by the **S** values, which ranged from 5.998 to 9.247. ***Presence or absence of roads*** and ***harvesting system*** received the highest and the lowest **S** values, respectively.

In order to quantify or to better characterize the selected variables, four to six categories were created for each variable. Such categories are the rankings for each factor, with one representing the worst or least desirable situation and the highest value (four, five, or six) indicating the best or most desirable situation for a given factor. Let us take the variable ***terrain*** again as an example. From the **S** and **Q** values, it is evident that one-half of the respondents attributed this variable an importance index of 9.012 (on a 1-10 scale), and that the spread of the responses was 1.5 units to each side of the central value (Q=3.000).

How does this variable come into play in a stumpage acquisition situation? The timber buyer knows that it is

an important factor, but how important is it? (S)he will probably look at the topographic conditions of the area where the tract of interest is located and consider the limitations that the terrain places on the logging equipment. The ideal situation would be no limitations imposed by the terrain, whereas the other extreme would be a tract where the topography severely restricts or prohibits the use of conventional logging machinery. Following the same line of reasoning, five categories were created for the factor *terrain*: the first one for severe restriction and the last one for no limitation. Accordingly, the first category was given a ranking of one (least desirable) and the last category received a ranking of five, as the most desirable situation for the variable *terrain*. If one were to decide between two tracts, based solely on the terrain, the choice would naturally be the tract with the highest ranking. An analogous rationale was used to devise categories for the other factors.

The second questionnaire (Appendix II), which was mailed to the 23 respondents of the first one, contained the selected variables and the categories or rankings. The objective of obtaining opinions and suggestions about the ranking scheme was only partly accomplished.

In spite of numerous phone calls and a follow-up letter, only 12 persons (52 percent) completed and returned

the second questionnaire. The responses to this questionnaire provided more specific details as well as suggestions and comments regarding the selected variables and the categories. This additional contribution of the respondents was carefully analyzed and incorporated into the spreadsheet. One manufacturer, for example, observed that the categories for some of the selected variables were not clearly worded. Consequently, the name and/or number of categories for some factors was changed in order to avoid confusion. Thus, the five categories of the factor ***compliance with safety standards*** were reduced to four because there was no clear distinction between "very strict" and "strict." Likewise, the category "extremely sensitive" under ***weather*** was eliminated since it could not be differentiated from "very sensitive." Under the factor ***diameter limit***, the column heading "diameter at stump height" (DSH) was substituted for "diameter at breast height" (DBH) because DSH is more appropriate for diameter-limit cuts. Another respondent indicated his disagreement with the numerical values defining the various categories for several factors, and, based on his personal experience in the hardwood industry, suggested other values to be used instead. Following his observations, the upper limit of ***haul distance to mill*** was increased from 75-100 to >75. Finally, ***mean merchantable height***, originally expressed in units of

length, was changed to "number of sawlogs" or "number of pulpwood bolts", based on the recommendation of one manufacturer.

In all cases, comments and suggestions were duly considered and modifications were made (see Appendix III) before the definitive spreadsheet was built. However, the returned questionnaires revealed that 83 percent of the respondents agreed with the original rating scheme.

Testing the results

To test the reliability and accuracy of the procedure, the revised rating scheme was used to compute ratings with historical data from actual timber sales on 14 hardwood tracts in the region. Four manufacturers and one logging contractor were interviewed in order to obtain the necessary information for this verification stage. Each respondent was given three copies of the revised rating scheme and asked to complete them using data from three recently logged hardwood tracts in the South Delta Region. Their task consisted of circling the appropriate ranking for each factor according to their records or best recollection. In addition, they reported the total volume harvested and the unit price paid for stumpage on each tract.

Although the respondents had previously expressed their opinions about the rating system and had suggested

some modifications [all of which were duly made], two of them provided new comments and recommended additional changes while I was interviewing them. They told me that such changes would render the system more general. For example, one manufacturer suggested a more detailed breakdown for the factor *species composition*. He added that baldcypress (*Taxodium distichum* (L.) Rich.) and tupelogum (*Nyssa aquatica* L.) should be in one category while sweetgum (*Liquidambar styraciflua* L.) and blackgum (*Nyssa sylvatica* Marsh.) should be placed together in another one. This same person pointed out that the maximum value for the categories under *mean merchantable height* should be reduced to four (instead of greater than five) because hardwoods in the region seldom yield four 16-foot sawlogs or more. He further explained that, in the logging business, diameter at stump height is usually expressed in even numbers. Consequently, he recommended changing the ranges under *diameter* limit to absolute even integers. Another respondent suggested that combination of soil types be included under this factor since two or more soil types can often be found in the same tract.

During the course of this last series of interviews I noticed that the diameter ranges under *diameter distribution of trees* were not appropriate in some cases. For instance, one

interviewee reported diameter values (between 51 and 61 cm) which could not be included in any of the existing categories. In addition, the categories under *type of harvest* may cause confusion because the fourth category, diameter limit cut, applies to both selection cut and clearcut. Furthermore, the factor *diameter limit*, selected by the respondents of the first questionnaire as factor number 22, with an importance index of 6.750, is not always applicable because it is not a common clause in most timber deeds.

All major discrepancies were noted and necessary adjustments were made to improve the accuracy and enhance the usefulness of the Tract Rating System. These changes were incorporated into the **STUMPAGE** spreadsheet.

Comparing tract ratings with stumpage prices

The ratings obtained after the verification of results were compared with actual prices paid for stumpage on recently harvested hardwood tracts. In the case of one manufacturer, the ratings coincided with the prices paid for the three tracts considered (Table 6). In four other cases, the tract with the lowest rating was the one with the lowest stumpage price, which suggests that the Tract Rating System was successful at predicting the "worst" or "least desirable" of the three tracts being compared. In an a priori situation, a procurement forester or a decision

Table 6. Comparison of tract ratings and stumpage prices.

Respondent ID	Tract No.	Rating	Price[1]
A	1	691	105
A	3	758	110
A	2	838	140
B	1	878	103
B	2	882	73
B	3	901	65
C	1	698	50
C	2	797	81
C	3	841	70
D	1	707	87
D	2	748	97
D	3	800	88
E	1	824	175
E	2	828	300

[1] Expressed in dollars per unit volume.

maker can look at these ratings as a warning. Assuming that the Tract Rating System performs as expected, the lowest **R** value can help him/her decide which tract not to buy. On the other hand, the highest calculated ratings were in agreement with the actual prices paid for stumpage in five of the 14 tracts. Indeed, the tracts that received the highest **R** values were the ones for which the highest prices were paid by two of the five participating firms.

Based on the results obtained for 14 tracts, no statistical correlation was found between ratings and prices. The calculated R^2 was extremely low: 0.01875.

Comparing the ratings with actual stumpage prices neither proved the usefulness of the Tract Rating System nor indicated that its performance is not satisfactory. This may be due to the small sample size used for the verification of results. In fact, while 12 persons completed the second questionnaire and indicated their agreement or disagreement with the proposed rating scheme, only five of them participated in the final stage, for it was not possible to make contact and/or to arrange for interviews with the others. In addition, three of the respondents based their answers on their "best recollection", not on their records of timber purchases.

Although the 23 people who completed the second questionnaire generally agreed with the rating scheme, I feel that greater refinement is needed with the rankings.

The number of categories under each factor may not be sufficient to reflect minor changes or to fit every particular situation; therefore, more categories (at least 10) would probably produce better results. The opinions, comments, and suggestions of a larger number of respondents should be sought and the numerical values defining categories for some factors should be revised accordingly.

The scale value **S**, a numerical expression of the importance of each variable, was chosen as the weighting coefficient for the rating calculations. However, the **S** values may be inadequate as weights, and an alternate weighting procedure should be devised. Therefore, I recommend to reexamine the use of **S** as weight as well as the number of categories and their numerical ranges for each factor. Finally, the performance of the revised Tract Rating System should be reevaluated by using historical data from a greater number of harvested tracts, and the variation in performance should be analyzed after verification.

The important achievement of the Tract Rating System is the development of a procedure to identify and select the relevant factors, to assign weights to those factors, and to rank their effect on stumpage. Furthermore, the **STUMPAGE** spreadsheet is flexible enough to allow input of any number of factors, categories, and weights.

SUMMARY AND CONCLUSIONS

Hardwoods are generally an ignored resource in Louisiana mainly because of low stumpage, difficult logging, and depressed markets. In the South Delta Region, poor knowledge of the resource base potential and technological, economic, and environmental problems have resulted in lack of interest among landowners in growing hardwood timber, which, in turn, has caused the under-development of the hardwood-processing industry.

To properly address such a complex problem, it is essential to know: (1) the existing hardwood resource, (2) the harvesting and transportation costs, (3) the factors affecting such costs, and (4) how much to offer for stumpage.

Only one aspect of the problem was approached in this study. Indeed, the objectives were to identify and select the relevant factors or variables that may impact harvesting costs and stumpage value on hardwood timber tracts in the South Delta Region of Louisiana and to design a Tract Rating System of universal application. Identification of the variables was accomplished through literature review while selection was the result of a survey of people in the forest products industries and in the logging business. The survey containing 55 variables

in eight major categories (physical, economic, stand, stand, environmental, operational, social, contractual, and legal) was mailed to 25 manufacturers and 16 loggers in the region. A 56-percent response rate was achieved, with only 14 manufacturers and nine logging contractors completing and returning the questionnaire. If those who were out of business are excluded, the response rate becomes 74 percent. Ten respondents were personally interviewed and 13 returned the completed survey by mail.

Each variable in the questionnaire was associated with numbers from 1 to 10 which indicated, in ascending order, its relative importance. The respondents were asked to circle the number that represented, in their opinion, how important each individual factor was as to its effect on harvesting costs and stumpage value.

The responses were evaluated with two parameters commonly used in the social sciences, the scale value **S** and the interquartile range **Q**. The former represents the central value of a set of grouped observations while the latter measures the spread of the middle 50 percent of the observations about the central value. Specifically, **S** expresses the relative importance of each factor and **Q** the agreement or disagreement of the responses and also the degree of ambiguity of a question. The **S** values computed from the results of the survey ranged from 2.748 for the variable *slash disposal provisions in timber sale deed* (the least

important) to 9.247 for the variable ***presence or absence of roads*** (the most important). Using the midrange of the **S** values as the selection criterion, 32 variables with scale values greater than 5.998 were chosen for inclusion in the Tract Rating System. The majority of the respondents felt that physical and stand factors are the most important while contractual and legal factors are the least important. The top five variables, in descending order, were: ***presence or absence of roads, terrain, accessibility, product class***, and ***timber quality***. On the other hand, Q exhibited values from 1.500 to 8.000 for the variables ***dbh*** and ***penalties for non-compliance***, respectively. If only the selected variables are considered, however, the highest value of Q becomes 6.000 which corresponds to the variable ***weather*** and indicates unclear wording of the question and hence ambiguity in its interpretation.

The next step involved creating categories, devising a ranking scheme, and assigning weights to each selected factor. This done, the rating **r** for a particular factor on a given tract can be obtained by multiplying the weight **w** (equal to **S**) by the ranking **k**. Then, evaluation of an entire tract can be accomplished by computing the total rating **R** as the sum of the individual ratings.

By using a similar procedure, total ratings for other tracts of interest can be calculated and the resulting values can be compared to one another. The real

usefulness of this technique is that, based on the **R** values of several tracts, the decision maker can select which one is the best as far as harvesting feasibility and stumpage value. Naturally, (s)he will want to purchase the tract with the highest **R** value.

With the selected variables, the weights, and the rankings, a second questionnaire was prepared and mailed to the 23 respondents. The objective now was to inform these people about the results of the TRS survey, to ask for their opinions about the ranking scheme, and to solicit suggestions that could help improve the rating system. Only 12 persons (52 percent) returned this questionnaire in spite of the effort to achieve 100 percent response. Although the majority expressed general agreement with the rating scheme, minor modifications were proposed. These, as well as some suggestions and comments, were analyzed and incorporated into the rating model when appropriate. (See Appendix III.)

The performance of the Tract Rating System was tested by computing ratings with historical data from actual timber sales on 14 hardwood tracts in the region and then comparing these ratings with actual prices paid for stumpage on tracts harvested recently. Although the trends of ratings and prices appeared to coincide in some tracts, no correlation was found between the two sets of values (R^2=0.01875). I strongly recommend further examination of

weights and rankings and verification of system performance using data from the records of a larger number of respondents.

The final product of this study was a computer spreadsheet named **STUMPAGE** that performs all of the aforementioned calculations. This spreadsheet is user-friendly, flexible, universal, and is accompanied by a user's manual; it accepts any number of variables and any number of weights and rankings. In fact, **STUMPAGE** can compute **S** and **Q**, select and sort the variables, calculate individual and total ratings, and summarize results for statistical manipulation.

Once total ratings are obtained for several target tracts, then the appropriate harvesting system(s) can be assigned to those tracts where they would perform best. An advantage of the Tract Rating System is its ability to predict whether harvesting a particular tract is feasible and affordable, given the pertinent constraints.

Extension of research in this area should involve the development of a geographic information system (GIS) spatial and temporal database that includes physiography, land uses, forest types, ownership patterns, transportation network, location of manufacturing facilities, and other physical and stand variables concerning hardwood timber tracts. From this current database, all tracts could be rated as to their harvesting costs and stumpage value

(i.e., the price the landowner can be offered). In addition, one could determine what hardwood resource is available and where it is located. Furthermore, if a wood procurement model could be designed, it would be possible to know how much of the resource is available at a certain stumpage price. The GIS database can also be used in conjuntion with the Tract Rating System, for planning for future resources as well as maintaining and enhancing the present resource. For example, a forest products company can learn from the database about areas with poor-quality timber or with no timber at all. Knowing the harvesting and transportation costs --from the Tract Rating System-- and the delivered price, this firm could offer the landowner an incentive to practice intensive management of his hardwood stands or to grow hardwoods on his land, thus increasing the available resource base. Future timber availability will dictate whether existing mills stay in business or not. With knowledge of the present and future resource base, existing forest industries might be encouraged to utilize more hardwood timber whereas other firms might find it attractive to come to the South Delta with manufacturing facilities that will utilize the region's hardwood resource.

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APPENDIX I

THE TRACT RATING SYSTEM SURVEY

(First Questionnaire)

LOUISIANA STATE UNIVERSITY

SCHOOL OF FORESTRY, WILDLIFE, and FISHERIES

TRACT RATING SYSTEM QUESTIONNAIRE

For each question circle the appropriate answer or fill-in the blanks as instructed.

A. What type of raw material does your Company normally process at this location? Please indicate approximate percentages.

1) pine .....%   2) hardwood .....%   3) other ....%

B. What are your Company's major sources of supply? Please indicate approximate percentages.

1) purchased timber .... %   2) fee land timber .... %

3) logs .... %   4) chips .... %   5) other ....%

C. What forest products are primarily manufactured by your Company at this location? (Circle more than one if appropriate.)

1) lumber   2) timbers   3) crossties   4) pallets

5) plywood   6) veneer   7) shavings   8) chips

9) pulp   10) paper   11) other (specify ....)

D. If your Company owns forest land in the South Delta Region, please indicate the parish(es) and the acreage category.

Parish(es): ....

1. under 80 acres   2. 80 - 499 acres

3. 500 - 4,999 acres   4. 5,000 - 9,999 acres

5. over 10,000 acres

E. The following factors may affect timber harvesting costs and stumpage value. (The term stumpage refers to standing timber.) Based on the importance that you feel each factor has on the determination of harvesting cost and stumpage value, rate each one of them on a scale of 1 to 10 by circling the rating of your choice. A **1** means "least important"; a **10** indicates that the factor is of utmost importance. Again, remember that we are only dealing with hardwoods in the South Delta.
PLEASE NOTICE THAT WE ARE NOT CONCERNED WITH ADVERSE OR BENEFICIAL FACTORS BUT ONLY WITH THE MAJOR CONSIDERATIONS IN ESTABLISHING HARVESTING COST AND STUMPAGE VALUE.

No.	F A C T O R	R A T I N G
1)	**Terrain**: rocky, firm, soft, dry, wet, etc.	1 2 3 4 5 6 7 8 9 10
2)	**Topography**: flat, hilly; gentle, steep, etc.	1 2 3 4 5 6 7 8 9 10
3)	**Accessibility**:	
	Presence or absence of roads.	1 2 3 4 5 6 7 8 9 10
	Class of road: primary, secondary, etc.	1 2 3 4 5 6 7 8 9 10
	Road ownership: private, public.	1 2 3 4 5 6 7 8 9 10
	Road maintenance.	1 2 3 4 5 6 7 8 9 10
4)	**Soil type**: gravel, sand, silt, clay, etc.	1 2 3 4 5 6 7 8 9 10
5)	**Drainage**: well, moderately, poorly drained.	1 2 3 4 5 6 7 8 9 10
6)	**Tract size & shape**: large, medium, small; circular, square, rectangular, irregular.	1 2 3 4 5 6 7 8 9 10
7)	**Stand density**: number of stems per acre.	1 2 3 4 5 6 7 8 9 10
8)	**Diameter at breast height** (dbh).	1 2 3 4 5 6 7 8 9 10
9)	**Diameter distribution** of trees.	1 2 3 4 5 6 7 8 9 10
10)	**Volume per acre** of growing-stock trees.	1 2 3 4 5 6 7 8 9 10
11)	**Volume per acre** of sawtimber.	1 2 3 4 5 6 7 8 9 10
12)	Average **volume per** merchantable **stem**.	1 2 3 4 5 6 7 8 9 10
13)	**Height** range or mean merchantable height.	1 2 3 4 5 6 7 8 9 10

No.	F A C T O R	R A T I N G
14)	**Species composition:** % of each species or forest type.	1 2 3 4 5 6 7 8 9 10
15)	**Limbiness:** excessive, moderate, slight.	1 2 3 4 5 6 7 8 9 10
16)	**Underbrush:** heavy, moderate, light.	1 2 3 4 5 6 7 8 9 10
17)	**Type of raw material:** sawtimber, pulpwood, chip & saw, peelers, poles.	1 2 3 4 5 6 7 8 9 10
18)	**Volume** of each type of raw material.	1 2 3 4 5 6 7 8 9 10
19)	**Timber quality:** cull volume, defects, deductions on scale, and others.	1 2 3 4 5 6 7 8 9 10
20)	Daily & annual **volume required by mill.**	1 2 3 4 5 6 7 8 9 10
21)	Existing **facilities** and improvements.	1 2 3 4 5 6 7 8 9 10
22)	**Weather:** maximum and minimum temperatures, amount & frequency of rainfall, fire danger.	1 2 3 4 5 6 7 8 9 10
23)	**Ownership:** public, small private, company.	1 2 3 4 5 6 7 8 9 10
24)	**Owner's policy:** intensive, extensive, or no management.	1 2 3 4 5 6 7 8 9 10
25)	**Type of operation:** contractor or company.	1 2 3 4 5 6 7 8 9 10
26)	Woods **labor availability.**	1 2 3 4 5 6 7 8 9 10
27)	**Logging system** deemed appropriate: shortwood longwood, full-tree, whole-tree chipping, cable, helicopter, etc.	1 2 3 4 5 6 7 8 9 10
28)	Number and size of **landings** needed.	1 2 3 4 5 6 7 8 9 10
29)	**Type of harvest:** clearcut, partial cut, salvage cut, thinning, etc.	1 2 3 4 5 6 7 8 9 10
30)	**Haul distance** to closest mill or woodyard.	1 2 3 4 5 6 7 8 9 10
31)	**Availability of markets** for hardwood raw material and products.	1 2 3 4 5 6 7 8 9 10
32)	**Type of sale:** lump-sum or unit of volume (stump-side) basis.	1 2 3 4 5 6 7 8 9 10

No.	F A C T O R	R A T I N G
33)	**Conditions of sale:**	
	Time and method of payment.	1 2 3 4 5 6 7 8 9 10
	Duration of operations.	1 2 3 4 5 6 7 8 9 10
	Marked vs. unmarked timber.	1 2 3 4 5 6 7 8 9 10
	Merchantability limits (diameter).	1 2 3 4 5 6 7 8 9 10
	Slash disposal provisions.	1 2 3 4 5 6 7 8 9 10
	Other contract provisions.	1 2 3 4 5 6 7 8 9 10
34)	**Environmental constraints:**	
	Forest protection against fire, soil erosion and compaction, and stream siltation.	1 2 3 4 5 6 7 8 9 10
	Damage to residual stand.	1 2 3 4 5 6 7 8 9 10
	Preservation of wildlife habitats.	1 2 3 4 5 6 7 8 9 10
35)	**Sociological constraints:**	
	Controversial methods (i.e. clearcut).	1 2 3 4 5 6 7 8 9 10
	Use of "screen" forest strips.	1 2 3 4 5 6 7 8 9 10
	Preservation of esthetics/water quality.	1 2 3 4 5 6 7 8 9 10
36)	**Legal constraints:**	
	Minimum stump height.	1 2 3 4 5 6 7 8 9 10
	Type of cut permitted.	1 2 3 4 5 6 7 8 9 10
	Road construction specifications.	1 2 3 4 5 6 7 8 9 10
	Size and distribution of clearcuts.	1 2 3 4 5 6 7 8 9 10
	Highway limitations (load, size, speed).	1 2 3 4 5 6 7 8 9 10
	Compliance with safety standards.	1 2 3 4 5 6 7 8 9 10
	Slash disposal regulations.	1 2 3 4 5 6 7 8 9 10
	Penalties for non-compliance.	1 2 3 4 5 6 7 8 9 10

F. Timber harvesting companies (logging contractors) and landowners will also participate in this study. They will be asked to answer parts D and E. In order to make the data collection more complete and reliable, could you supply the names of 5 timber harvesting companies and landowners with whom your Company has done business over the last two (2) years?

NAME	ADDRESS	PHONE
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

G. If your Company would like a summary of the results of this survey, please indicate name, address and phone number.

Name: ....

Address: ....

Phone No. ....

THANK YOU FOR YOUR HELP!!

APPENDIX II

TRACT RATING SYSTEM SELECTED FACTORS

(Second Questionnaire)

LOUISIANA STATE UNIVERSITY
SCHOOL OF FORESTRY, WILDLIFE, AND FISHERIES

TRACT RATING SYSTEM - SELECTED FACTORS

Out of the original 55 factors contained in the questionnaire, 32 were selected by the majority of the respondents. Subsequently, we developed the ranking scheme presented below. Please read each item carefully and indicate whether you agree or disagree with our ranking scheme. You may propose an alternative scheme (with any number of classes or categories) and include suggestions or comments if you wish.

NOTE: The numerical values under some of the factors apply exclusively to sawlogs, and are included only for illustrative purposes. The actual values will depend upon the major product on each particular tract.

I) **PRESENCE OR ABSENCE OF ROADS**: Refers to roads suitable for log transportation to and within property from an existing road suitable for log transportation. (Expressed as proportion of total road length to be built.)

Roads to be built	Your opinion	Alternative scheme
1. All		....
2. > ½	___ OK (agree)	....
3. ½	___ Unclear wording	....
4. < ½	___ Disagree with classes	....
5. None	___ Both	....

Comments: ....
....
....
....

II) **TERRAIN**: Refers to predominant topographic conditions that affect logging machinery activity regardless of season. (Expresses how much limitation terrain poses on machinery use.)

Average Terrain	Your opinion	Alternative scheme
1. Restricts normal use		....
2. Heavy limitation	___ OK (agree)	....
3. Moderate limitation	___ Unclear wording	....
4. Slight limitation	___ Disagree w/classes	....
5. No limitation	___ Both	....

Comments: ....
....
....
....

III) ACCESSIBILITY: Refers to easement/right-of-way (ROW) to and from the property where the timber is to be harvested. (Considers cost in dollars and time lost.)

ROW requirement	Your opinion	Alternative scheme
1. Requires legal action	___ OK (agree)	....
2. ROW at high cost/time	___ Unclear wording	....
3. ROW at low cost/time	___ Disagree w/classes	....
4. ROW at no cost	___ Both	....
5. No ROW required		....

Comments: ....
....
....

IV) PRODUCT CLASS. Type of forest product that the majority of the stumpage on the tract can be used for.

Class	Your opinion	Alternative scheme
1. Pulpwood (roundwood)	___ OK (agree)	....
2. Firewood and/or fuelwood	___ Unclear wording	....
3. Posts,piling,and/or ties	___ Disagree w/classes	....
4. Sawtimber	___ Both	....
5. Veneer logs		....

Comments: ....
....
....

V) TIMBER QUALITY of trees within sale. Quality is expressed as % of total standing hardwood volume in hardwood **cull** trees (i.e., rough and rotten trees).

% cull	Your opinion	Alternative scheme
1. > 50	___ OK (agree)	....
2. 35 - 50	___ Unclear wording	....
3. 20 - 35	___ Disagree w/classes	....
4. 5 - 20	___ Both	....
5. < 5		....

Comments: ....
....
....

VI) VOLUME: Average volume/acre of major product class that the standing timber can be used for.

Volume	MBF/acre	Your opinion	Alternative scheme
1. Very low	< 1	___ OK (agree)	....
2. Low	1 - 3	___ Unclear wording	....
3. Medium	3 - 6	___ Disagree w/classes	....
4. High	6 - 10	___ Both	....
5. Very high	>10		....

Comments: ....
....
....
....

VII) DRAINAGE CHARACTERISTICS ON THE TRACT. Answer Parts **A** and **B**, unless you answer **A.5**.

A. Average drainage conditions, regardless of seasonal variations. (How much limitation drainage poses on conventional equipment use.)

Limitation		Your opinion	Alternative scheme
1. Restricts equip. use	(***GO TO*** VII.B)	___ OK (agree)	....
2. Severe limitation	(***GO TO*** VII.B)	___ Unclear wording	....
3. Moderate limitation	(***GO TO*** VII.B)	___ Disagree w/classes	....
4. Slight limitation	(***GO TO*** VII.B)	___ Both	....
5. No limitation	(***If you answer this, skip VII.B and go to VIII.***)		....

Comments: ....
....
....

B. Effect of seasonal drainage variations on equipment use. They are most restrictive during:

		Your opinion	Alternative scheme
1. Winter	___	OK (agree)	....
2. Fall	___	Unclear wording	....
3. Spring	___	Disagree w/classes	....
4. Summer	___	Both	....
5. No seasonal variations			....

Comments: ....
....
....

VIII) SPECIES COMPOSITION. (Percent of total hardwood volume.)

	Your opinion	Alternative scheme
1. Miscellaneous hardwoods ___%	___ OK (agree)	....
2. Tupelo-blackgum ___%	___ Unclear wording	....
3. Sweetgum ___%	___ Disagree w/classes	....
4. White oaks ___%	___ Both	....
5. Red oaks ___%		....
6. Ash ___%		....

Comments: ....
....
....

IX) VOLUME PER ACRE OF HARDWOOD **VENEER LOGS and/or SAWTIMBER** TO BE HARVESTED. (Based on a total of 12,144 million board feet and 1,772,600 acres).

MBF/acre		Your opinion	Alternative scheme
1. < 2.0	___	OK (agree)	....
2. 2.0 - 3.5	___	Unclear wording	....
3. 3.5 - 5.0	___	Disagree w/classes	....
4. 5.0 - 6.5	___	Both	....
5. > 6.5			....

Comments: ....
....
....
....

X) COMPLIANCE WITH SAFETY STANDARDS: This relates to the cost of adherence to federal, state, and private regulations, not to the indirect cost due to accidents.

Enforcement of regulations	Your opinion	Alternative scheme
1. Very strict	___ OK (agree)	....
2. Strict	___ Unclear wording	....
3. Moderate	___ Disagree w/classes	....
4 Little	___ Both	....
5. None		....

Comments: ....
....
....
....

XI) Average diameter at breast height, **DBH** (in inches) of merchantable hardwood trees.

DBH Class	Your opinion	Alternative scheme
1. < 8	___ OK (agree)	....
2. 8 - 12	___ Unclear wording	....
3. 12 - 16	___ Disagree w/classes	....
4. 16 - 20	___ Both	....
5. >20		....

Comments: ....
....
....
....

XII) CLASS OF ROAD TO AND FROM THE MILL. Expressed as percent of total distance from stump to mill on each road class.

Road Class		Your opinion	Alternative scheme
1. Unimproved dirt road	___ %	___ OK (agree)	....
2. Improved dirt road	___ %	___ Unclear wording	....
3. Secondary highway	___ %	___ Disagree w/classes	....
4. Primary highway	___ %	___ Both	....
5. Interstate highway	___ %		....

Comments: ....
....
....

XIII) AVAILABILITY OF MARKETS FOR THE RAW MATERIAL GENERATED IN THE WOODS. Refers to the % of the stumpage that can be sold profitably to a mill.

% stumpage	Your opinion	Alternative scheme
1. 0 - 20	___ OK (agree)	....
2. 20 - 40	___ Unclear wording	....
3. 40 - 60	___ Disagree w/classes	....
4. 60 - 80	___ Both	....
5. 80 - 100		....

Comments: ....
....
....

XIV) HAUL DISTANCE TO MILL (in miles).

	Sawlogs	Your opinion	Alternative scheme
1.	75 -100	___ OK (agree)	....
2.	50 - 75	___ Unclear wording	....
3.	35 - 50	___ Disagree w/classes	....
4.	0 - 35	___ Both	....

Comments: ....
....
....

XV) LIMBINESS of trees harvested in the major product class.

		Your opinion	Alternative scheme
1.	Excessive	___ OK (agree)	....
2.	Moderate	___ Unclear wording	....
3.	Slight	___ Disagree w/classes	....
4.	None	___ Both	....

Comments: ....
....
....

XVI) WEATHER. Average meteorological factors (not soil conditions or drainage) during the course of the sale.

A. Sensitivity of harvesting system to shutdown from adverse weather factors.

			Your opinion	Alternative scheme
1.	Extremely sensitive	(*GO TO* XVI.B)	___ OK (agree)	....
2.	Very sensitive	(*GO TO* XVI.B)	___ Unclear wording	....
3.	Sensitive	(*GO TO* XVI.B)	___ Disagree w/classes	....
4.	Slightly sensitive	(*GO TO* XVI.B)	___ Both	....
5.	Insensitive	(***Skip XVI.B and go to XVII***)		....

Comments: ....
....
....

B. Seasonal sensitivity of the harvesting system. Refers to the driest season of the year that affects system. (For example, if tract is still wet in summer then this tract will be the hardest to log and will have the lowest value.)

		Your opinion	Alternative scheme
1.	Sensitive in summer	___ OK (agree)	....
2.	Sensitive in spring	___ Unclear wording	....
3.	Sensitive in fall	___ Disagree w/classes	....
4.	Sensitive in winter	___ Both	....
5.	Insensitive		....

Comments: ....
....
....

XVII) ROAD MAINTENANCE REQUIREMENTS. This relates to cost, time spent, and lost production while performing road maintenance.

Amount of maintenance required	Your opinion	Alternative scheme
1. High	___ OK (agree)	....
2. Medium	___ Unclear wording	....
3. Low	___ Disagree w/classes	....
4. Very low	___ Both	....
5. None		....

Comments: ....
....
....

XVIII) PERCENT OF DAILY VOLUME OF RAW MATERIAL REQUIRED BY MILL from this tract during the time the tract is being harvested. (Indicates dependency of mill on this tract's volume to supply raw material during harvest).

Degree of dependency	Percent	Your opinion	Alternative scheme
1. Very high	80-100	___ OK (agree)	....
2. High	60-80	___ Unclear wording	....
3. Medium	40-60	___ Disagree w/classes	....
4. Slight	20-40	___ Both	....
5. Low	0-20		....

Comments: ....
....
....

XIX) MEAN MERCHANTABLE HEIGHT (in feet).

Height range	Your opinion	Alternative scheme
1. 16 - 32	___ OK (agree)	....
2. 32 - 48	___ Unclear wording	....
3. 48 - 64	___ Disagree w/classes	....
4. 64 - 80	___ Both	....
5. >80		....

Comments: ....
....
....

XX) MEAN VOLUME (in board feet) **PER MERCHANTABLE STEM** (for sawtimber).

Volume range	Your opinion	Alternative scheme
1. < 100	___ OK (agree)	....
2. 100 - 250	___ Unclear wording	....
3. 250 - 500	___ Disagree w/classes	....
4. > 500	___ Both	....

Comments: ....
....

XXI) NUMBER OF TREES to be harvested PER ACRE.

Trees/acre	Your opinion	Alternative scheme
1. 1 - 10	___ OK (agree)	....
2. 11 - 20	___ Unclear wording	....
3. 21 - 30	___ Disagree w/classes	....
4. 31 - 40	___ Both	....
5. > 40		....

Comments: ....
....
....

XXII) DIAMETER LIMIT (in inches) ESTABLISHED IN TIMBER DEED. Trees having the diameter range specified below may not be cut.

DBH range	Your opinion	Alternative scheme
1. > 30	___ OK (agree)	....
2. 25 - 30	___ Unclear wording	....
3. 19 - 24	___ Disagree w/classes	....
4. 12 - 18	___ Both	....
5. < 12		....

Comments: ....
....
....

XXIII) FACILITIES AND IMPROVEMENTS FOUND ON THE TRACT. Includes fences, buildings, power lines, and other man-made obstacles that may restrict normal logging operations.

Restrictions	Your opinion	Alternative scheme
1. Severe	___ OK (agree)	....
2. High	___ Unclear wording	....
3. Moderate	___ Disagree w/classes	....
4. Low	___ Both	....
5. None		....

Comments: ....
....
....

XXIV) SOIL TYPE: Predominant textural components of soil in the tract.

	Your opinion	Alternative scheme
1. Organic clay	___ OK (agree)	....
2. Clay	___ Unclear wording	....
3. Silt	___ Disagree w/classes	....
4. Sand	___ Both	....
5. Gravel		....

Comments: ....
....
....

XXV) DIAMETER DISTRIBUTION OF TREES.

Diameter range	Min DBH	Max DBH		Your opinion	Alternative scheme
1. Very high	8 -	30	___	OK (agree)	....
2. High	10 -	20	___	Unclear wording	....
3. Moderate	14 -	20	___	Disagree w/classes	....
4. Slight	14 -	18	___	Both	....
5. Uniform	18				....

Comments: ....
....
....

XXVI) PRESERVATION OF WILDLIFE HABITATS. Refers to logging restrictions resulting from habitat preservation clauses established in timber deed.

Logging restrictions		Your opinion	Alternative scheme
1. Severe	___	OK (agree)	....
2. High	___	Unclear wording	....
3. Moderate	___	Disagree w/classes	....
4. Slight	___	Both	....
5. None			....

Comments: ....
....
....

XXVII) VOLUME PER ACRE OF GROWING-STOCK TREES.

Volume	MBF/acre		Your opinion	Alternative scheme
1. Very low	< 1	___	OK (agree)	....
2. Low	1 - 3	___	Unclear wording	....
3. Medium	3 - 10	___	Disagree w/classes	....
4. High	10 - 15	___	Both	....
5. Very high	>15			....

Comments: ....
....
....

XXVIII) TYPE OF HARVEST.

		Your opinion	Alternative scheme
1. Sanitation cut	___	OK (agree)	....
2. Salvage cut	___	Unclear wording	....
3. Selection cut	___	Disagree w/classes	....
4. Diameter limit cut	___	Both	....
5. Clearcut			....

Comments: ....
....
....

XXIX) TRACT SIZE.

	Acres		Your opinion	Alternative scheme
1.	< 10	___	OK (agree)	....
2.	10-50	___	Unclear wording	....
3.	50-100	___	Disagree w/classes	....
4.	100-300	___	Both	....
5.	> 300			....

Comments: ....
....
....

XXX) WOODS LABOR AVAILABILITY at the time the tract can be harvested.

			Your opinion	Alternative scheme
1.	Very low	___	OK (agree)	....
2.	Low	___	Unclear wording	....
3.	Medium	___	Disagree w/classes	....
4.	High	___	Both	....
5.	Very high			....

Comments: ....
....
....

XXXI) HIGHWAY REGULATIONS in load, size, and mud.

	Enforcement mode		Your opinion	Alternative scheme
1.	Strictly	___	OK (agree)	....
2.	Frequently	___	Unclear wording	....
3.	Normally	___	Disagree w/classes	....
4.	Seldom	___	Both	....
5.	Never			....

Comments: ....
....
....

XXXII) LOGGING SYSTEM(S) DEEMED APPROPRIATE.

	System	Cords/week		Your opinion	Alternative scheme
1.	Manual-shortwood	< 25	___	OK (agree)	....
2.	Manual-mechanized	25 - 50	___	Unclear wording	....
3.	Mechanized-manual	50 - 100	___	Disagree w/classes	....
4.	Mechanized	100 - 200	___	Both	....
5.	Highly mechanized	> 200			....

Comments: ....
....
....

APPENDIX III

TRACT RATING SYSTEM DEFINITIVE FACTORS

(Revised Questionnaire)

LOUISIANA STATE UNIVERSITY
SCHOOL OF FORESTRY, WILDLIFE, AND FISHERIES

TRACT RATING SYSTEM - DEFINITIVE FACTORS

Out of the 55 factors in the original questionnaire, 32 were selected by the majority of the respondents as being important in estimating stumpage value. These 32 factors are now included in the Tract Rating System, which consists of a computer spreadsheet where the user can input the necessary parameters to obtain rating(s) for the tract(s) of interest. The spreadsheet is designed to allow the user to rate tracts by product class of the major product coming from the tract. Therefore, three types of factors are included in the spreadsheet, namely, ***general, sawlogs, pulpwood,*** and ***other*** factors.

I) PRESENCE OR ABSENCE OF ROADS: Refers to roads suitable for log transportation to and within the property from an existing road suitable for log transportation. (Expressed as number of miles of road to be built.)

Roads to be built
1. > 1 mile
2. 1 - ½ mile
3. ½ - ¼ mile
4. < ¼ mile
5. None

II) TERRAIN: Refers to predominant topographic conditions that affect logging machinery activity regardless of season. (Expresses how much limitation terrain poses on machinery use.)

Terrain
1. Prohibitive
2. Heavy limitation
3. Moderate limitation
4. Slight limitation
5. No limitation

III) ACCESSIBILITY: Refers to easement/right-of-way (ROW) to and from the property where the timber is to be harvested. (Considers cost in dollars and time lost.)

ROW requirement
1. Requires legal action
2. ROW at high cost/time
3. ROW at low cost/time
4. ROW at no cost
5. No ROW required

IV) PRODUCT CLASS. Type of forest product that the majority of the stumpage on the tract can be used for. (Although baldcypress is not a hardwood, its products are also included here because they are manufactured in the same facilities as hardwood products.)

Class
1. Pulpwood (roundwood)
2. Firewood, fuelwood, posts
3. Poles and piling
4. Sawtimber and crossties
5. Veneer logs

V) TIMBER QUALITY of trees within sale. Quality is expressed as % of total standing volume in hardwood **cull** trees (i.e., rough and rotten trees).

% cull
1. > 50
2. 35 - 50
3. 20 - 35
4. 5 - 20
5. < 5

VI) VOLUME: Average volume/acre of major product class that the standing timber can be used for.

Volume	SAWLOGS (MBF/ac)	PULPWWOD (cords/ac)	OTHER
1. Very low			
2. Low			
3. Medium			
4. High			
5. Very high			

VII) DRAINAGE CHARACTERISTICS ON THE TRACT. Answer Parts **A** and **B**, unless you answer **A.5**.

A. Average drainage conditions, regardless of seasonal variations. (How much limitation drainage poses on conventional logging equipment.)

Limitation
1. Prohibits equipment use (Go to VII.B)
2. Severe limitation (Go to VII.B)
3. Moderate limitation (Go to VII.B)
4. Slight limitation (Go to VII.B)
5. No limitation (If you answer this, skip VII.B and go to VIII.)

B. Time of year when seasonal drainage variations affect equipment use.

1. Year round
2. During fall, winter and spring
3. During fall and winter
4. During winter
5. No effect

VIII) SPECIES COMPOSITION expressed as percent of total hardwood volume. (Although not a hardwood, baldcypress is included here because it occurs in association with bottomland hardwoods.)

1. Miscellaneous hardwoods ___%
2. Gum-cypress ___%
3. White oaks ___%
4. Red oaks ___%
5. Ash ___%

IX) VOLUME PER ACRE OF HARDWOOD **VENEER LOGS and/or SAWTIMBER** TO BE HARVESTED.

MBF/acre

1. < 2.0
2. 2.0 - 3.5
3. 3.5 - 5.0
4. 5.0 - 6.5
5. > 6.5

X) COMPLIANCE WITH SAFETY STANDARDS: This relates to the cost of adherence to federal, state, and private regulations, not to the indirect cost due to accidents.

Enforcement of regulations

1. Strict
2. Moderate
3. Little
4. None

XI) Average diameter at breast height, DBH (in inches) of merchantable hardwood trees.

DBH Class

1. < 8
2. 8 - 10
3. 11 - 16
4. 17 - 20
5. 21 - 24
6. >24

XII) CLASS OF ROAD TO AND FROM THE MILL. Expressed as percent of total distance from stump to mill on each road class.

Road Class

1. Unimproved dirt road ___ %
2. Improved dirt road ___ %
3. Secondary highway ___ %
4. Primary highway ___ %
5. Interstate highway ___ %

XIII) AVAILABILITY OF MARKETS FOR HARDWOOD RAW MATERIAL generated in the woods. (Percent of stumpage that can be sold to a mill.)

	<u>% stumpage</u>
1.	0 - 20
2.	20 - 40
3.	40 - 60
4.	60 - 80
5.	80 -100

XIV) HAUL DISTANCE TO MILL (in miles).

	Sawlogs	Pulpwood	Other
1.	> 100	> 80	
2.	75 -100	60 - 80	
3.	50 - 75	40 - 60	
4.	35 - 50	20 - 40	
5.	0 - 35	0 - 20	

XV) LIMBINESS of trees harvested in the major product class.

1. Excessive
2. Moderate
3. Slight
4. None

XVI) WEATHER. Average meteorological factors during the course of the sale. (Refers to soil conditions as affected by weather.)

A. Sensitivity of harvesting system to shutdown from adverse weather factors.

1. Highly Sensitive (<u>Go to XVI.B</u>)
2. Sensitive (<u>Go to XVI.B</u>)
3. Slightly sensitive (<u>Go to XVI.B</u>)
4. Insensitive (<u>Skip XVI.B and go to XVII</u>)

B. Seasonal sensitivity of the harvesting system. (Refers to time of year when weather affects harvesting system performance.)

1. Year round
2. During fall, winter and spring
3. During fall and winter
4. During winter
5. No effect

XVII) ROAD MAINTENANCE REQUIREMENTS. This relates to cost, time spent, and lost production while performing road maintenance.

Degree of maintenance required
1. High
2. Medium
3. Low
4. None

XVIII) PERCENT OF DAILY **VOLUME** OF RAW MATERIAL **REQUIRED BY MILL** from this tract during the time the tract is being harvested. (Indicates dependency of mill on this tract's volume to supply raw material during harvest.)

Degree of dependency	Percent
1. Very high	80-100
2. High	60-80
3. Medium	40-60
4. Slight	20-40
5. Low	0-20

XIX) MEAN MERCHANTABLE HEIGHT expressed as the number of 16-foot logs (for sawlogs) or as the number of 5-foot bolts (for pulpwood).

	SAWLOGS No. of logs	PULPWOOD No. of bolts
1.	1 - 2	2 - 3
2.	2½ - 3	3 - 4
3.	3½ - 4	4 - 5
4.	4½ - 5	5 - 6
5.	>5	> 6

XX) MEAN VOLUME PER MERCHANTABLE STEM.

	SAWLOGS (BF/ac)	PULPWOOD (cords/ac)	OTHER
1.	< 100	< 1	
2.	100 - 200	1 - 2	
3.	201 - 300	2 - 3	
4.	300 - 500	3 - 5	
5.	> 500	> 5	

XXI) NUMBER OF TREES to be harvested PER ACRE.

	Trees/acre
1.	1 - 10
2.	11 - 20
3.	21 - 30
4.	31 - 40
5.	> 40

XXII) DIAMETER LIMIT ESTABLISHED IN TIMBER DEED. Trees having the diameter at stump height specified below may not be cut.

	Diameter at stump height (inches)
1.	< 12
2.	< 14
3.	< 16
4.	< 18
5.	< 20

XXIII) FACILITIES AND IMPROVEMENTS FOUND IN TRACT. Includes fences, buildings, power lines, and other man-made obstacles that may restrict normal logging operations.

Restrictions
1. Severe
2. High
3. Moderate
4. Low
5. None

XXIV) SOIL TYPE: Predominant textural components of soil in tract.

1. Organic clay
2. Clay
3. Silt
4. Sand
5. Gravel

XXV) DIAMETER DISTRIBUTION OF TREES.

Diameter range	Min DBH	Max DBH
1. Very high	8 - 30	
2. High	10 - 20	
3. Moderate	14 - 20	
4. Slight	14 - 18	
5. Uniform	16 - 18	

XXVI) PRESERVATION OF WILDLIFE HABITATS. Refers to logging restrictions resulting from habitat preservation clauses established in timber deed.

Logging restrictions
1. Severe
2. High
3. Moderate
4. Slight
5. None

XXVII) VOLUME PER ACRE OF GROWING-STOCK TREES.

	Volume	Sawlogs (MBF/ac)	Pulpwood (cords/ac)
1.	Very low	< 1	< 1
2.	Low	1 - 3	1 - 2
3.	Medium	3 - 10	2 - 3
4.	High	10 - 15	3 - 5
5.	Very high	> 15	> 5

XXVIII) TYPE OF HARVEST

1. Sanitation cut
2. Salvage cut
3. Selection cut
4. Diameter limit cut
5. Clearcut

XXIX) TRACT SIZE

	Acres
1.	< 10
2.	10-50
3.	50-100
4.	100-300
5.	> 300

XXX) LABOR AVAILABILITY at the time the tract can be harvested.

Availability
1. Low
2. Medium
3. High

XXXI) HIGHWAY RESTRICTIONS (load, size, and mud).

Enforcement mode
1. Strictly
2. Frequently
3. Normally
4. Seldom
5. Never

XXXII) LOGGING SYSTEM(S) DEEMED APPROPRIATE

Logging system	Productivity cords/week	Productivity MBF/week
1. Manual-shortwood	< 25	
2. Manual-mechanized	25 - 50	
3. Mechanized-manual	50 - 100	
4. Mechanized	100 - 200	
5. Highly mechanized	> 200	

CURRICULUM VITAE

Carlos Orlando Turc was born in Catamarca, Argentina, on May 10, 1954. He attended private catholic schools in Santiago del Estero, Argentina, and graduated from the Instituto San Pedro Nolasco in December 1970. The following fall he came to the United States as an exchange student and attended Holland Central High School in Holland, New York, where he graduated in June 1972.

In March 1973, he began forestry studies at the Universidad Nacional de Santiago del Estero (UNSE), Argentina, graduating in May 1980 with a Forest Engineering degree. During his undergraduate career, he served as teaching assistant in the departments of Forest Conservation and Technical English.

From August 1980 to August 1982, he undertook graduate studies at the University of Missouri-Columbia, where he received a Master of Science degree in Forestry. While in Missouri, he worked first as an instructor of Spanish in the Romance Language Department and later as a research technician with the Department of Atmospheric Science.

Upon returning to Argentina in August 1982, he became Assistant Professor of Timber Harvesting at UNSE. While serving in this capacity he was appointed Forestry Advisor

to the Minister of Economy in the Province of Santiago del Estero, and held this position from October 1982 to May 1984.

Carlos Turc returned to the United States in 1984 to continue his education. He entered Stephen F. Austin State University in Nacogdoches, Texas, in September 1984 and transferred to Louisiana State University (LSU) in January 1986. He is majoring in the field of Forestry and specializing in Timber Harvesting, with a secondary emphasis in Environmental Science. He has held a research assistantship since the beginning of his graduate studies at LSU. He is now a candidate for a Ph.D. degree in December 1989.

Carlos Turc is an active member in the Society of American Foresters, the Forest Products Research Society, the International Society of Tropical Foresters, Xi Sigma Pi, Gamma Sigma Delta, the Council on Forest Engineering, the Colegio de Graduados en Ciencias Forestales (Santiago del Estero, Argentina), and the Asociación Forestal Argentina.

Carlos is married to Graciela Inés Carabajal, and they have two children, Claudia Josefina and Ernesto Gabriel, aged 14 and 7, respectively.

DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Carlos Orlando Turc

Major Field: Forestry

Title of Dissertation: A Tract Rating System for Harvesting Hardwood Timber in the South Delta Region of Louisiana

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

November 29, 1989