CEER-T-226 REPORT ON THE FINAL PLAN FOR THE CARIBBEAN NATIONAL FOREST BY ROBERT R. GOTTFRIED, DEPARTMENT OF ECONOMICS, THE UNIVERSITY OF THE SOUTH, SEWANEE, TENNESSEE 37375 ON OCTOBER 23, 1986. CENTER FOR ENERGY AND ENVIRONMENT RESEARCH.

REPORT ON THE FINAL PLAN FOR THE CARIBBEAN NATIONAL FOREST BY ROBERT R. GOTTFRIED, DEPARTMENT OF ECONOMICS, THE UNIVERSITY OF THE SOUTH, SEWANEE, TENNESSEE 37375 ON OCTOBER 23, 1986.

This report presents the results of an examination of the Final Environmental Impact Statement (FEIS) and Final Land and Resource Management Plan (FLRMP) for the Caribbean National Forest. The report begins with a brief background of the Forest, the Plan, and its appeal and then discusses the cost-benefit analyses of various alternatives. Next, it examines the economics of the timber program and recreation. After discussing the sedimentation issue, the report concludes with a discussion of the overall plan's direction, observations, and conclusions.

BACKGROUND: The Caribbean National Forest is unique among our national forests in many respects. Not only is it our smallest national forest, but it is the only tropical rain forest in the system. Its establishment as a national forest was unique. When Puerto Rico became part of the United States territory in 1898, the U.S. government acquired 12,394 acres of Spanish Crown lands set aside in the Luquillo Mountains. These lands, set aside in 1860, constitute one of the oldest reserves in the Western Hemisphere. Teddy Roosevelt officially proclaimed this land a U.S. Forest Reserve in 1903.

Since the Reserve's establishment, it has experienced several use and administrative changes. Reforestation started in the 1930's, covering several thousand acres by 1942. The Civilian Conservation Corps built most of the Forest's recreation facilities during the 1930's. From 1943-73, the Forest Service managed the Forest for research purposes, emphasizing studies on the major forest problems facing Puerto Rico. The Forest was managed as...

The text pertains to the Tropical Forestry Unit, which reported directly to the Forest Service Chief. In 1956, the Unit crafted a Land Use Plan for the Forest, identifying land and research needs in various areas, including reforestation, plantation care, forest improvement, utilization, agroforestry, and watershed management. Land that was not required for research but was suitable for the application of methods developed by prior research was earmarked for a pilot demonstration management area. This approach initiated sustained yield forest management within the Forest. The plan also accounted for recreational, wildlife, and water needs.

In 1973, when the research and management functions of the Forest were detached from one another, the Forest Service created an administrative and management staff under the direction of Region 8 in Atlanta. This organizational change facilitated the Forest's ability to cope with escalating non-research demands. The management staff has gradually expanded since then.

The Institute of Tropical Forestry, presently a part of the Southern Forest Experiment Station in New Orleans, bears the responsibility for research activities within the Forest. Consequently, two distinct segments of the Forest Service direct the Forest's management and research activities.

Currently, the Forest spans 27,846 acres and is situated in the rugged Sierra de Luquillo, 25 miles southeast of San Juan. The elevation ranges from 100 to 3,433 feet above sea level, while the annual rainfall fluctuates from 96 inches to 160 inches in higher elevations. Approximately 24% of the Forest has slopes exceeding 60%. The vegetation within the Forest comprises four types of forests, from the lush Tabonuco type at the lowest elevations to the dwarf forest on exposed peaks and ridges.

The Forest harbors 225 native tree species, which constitutes about two-fifths of the 547 species known from Puerto Rico and the U.S. Virgin Islands. Remarkably, only the Tabonuco forest generates substantial commercial wood products.

The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), as modified by the National Forest Management Act of 1976 (NFMA), necessitates...

Every administrative unit of the National Forest System is required to develop a land and resource management plan. This plan should utilize a planning horizon of fifty years and be revised every fifteen years. In line with this, the Forest Service issued its draft plan for the Caribbean National Forest in December 1984. After considering public comments, the Forest Service revised the Plan and released its final version in January 1986.

The final plan selected from eight proposed management alternatives, each reflecting different emphases on timber production, wildlife protection, scientific research, and recreation. Alternative C was chosen as the preferred option. According to the Plan, multi-use management would ensure a sustained yield of resources without compromising the optimum production of quality water.

This chosen alternative underscores the development of a moderate timber harvesting program, which would produce a regulated forest of natural and planted stands. Harvesting would be limited to Tabonuco forests with slopes below 60%, and road construction would be reduced compared to current plans. Conversion of natural stands to mahogany would stop, and wildlife management would ensure maintenance and recovery for endangered and sensitive species.

The increased capacity for developed and dispersed recreation under this alternative may increase the impact of timber management activities.

As has occurred with other Forest plans, a group of organizations has appealed the Final Plan. In this case, the appellants consist of several Puerto Rican organizations and national environmental groups. They cited numerous concerns, which in their view, include the failure to designate the entire El Toro Roadless Area as wilderness, the introduction of commercial timber production and additional road construction, the identification of timber lands in areas physically and economically unsuitable for timbering, and the insufficient protection of critical habitat and provision for recovery for the endangered Puerto Rican parrot.

The text is critiquing the lack of adequate environmental impact assessments for a specific Plan. The following paragraphs will provide an analysis and observations on the Plan and the appellants' concerns from an economist's perspective. It aims to remain as nonpartisan and objective as possible. The author concludes, after an extended discussion, that several factors suggest the

Forest Service (FS) should gather data before committing to implementing Plan activities. These activities, such as timber harvesting, could disrupt the Forest.

The author chose to examine and analyze the data for Alternatives A, C, and G to understand the preference for Alternative C. Alternative A represents the current direction, reflecting the plans and strategies that the FS has maintained up to this point. It's worth noting that there is currently no timber harvesting in the Forest. Alternative A describes future timber harvesting plans that the FS intends to execute, though it has not yet done so, and has not had the benefit of comprehensive planning.

Alternative C represents a change in direction, particularly with its increased emphasis on defined preservation areas/wilderness and reduced acreage allocated to timber. Alternative G essentially eliminates timber harvesting while maintaining the rest of the timber program, such as timber stand improvement. The conversion of forests to mahogany would cease under Alternative C, but continue under Alternative A.

The reasons given for conversion under Alternative G, even when harvesting would stop, are worth mentioning. The first reason involves a desire to justify past conversion to mahogany. Discontinuing the conversion could be interpreted as a tacit admission that previous conversions were a mistake, even though the FS still believes they were justified. Secondly, if the timber industry infrastructure improves in the future to the point where timber harvesting becomes feasible, the Forest would be prepared to harvest with a readily available supply.

The text is written in the context of mahogany. One of the initial primary concerns of the author during the analysis was the potential sensitivity of the preferred alternative selection to the chosen discount (interest) rate. Present net value (PNV) calculations are notoriously sensitive in this regard. The Plan stated that calculations were performed using both 4% and 7.125%. However, the results for the latter rate were not provided. While gathering data to recalculate the PNVs, Terry Tenold (the Forest's landscape architect and team member responsible for the planning effort) and the author concluded that certain capital expenditures had been unintentionally omitted from the first period calculations due to an intra-agency mix-up.

The planning team originally used a seven period planning horizon, consisting of two five-year periods starting in 1980, four consecutive ten-year periods, and one fifty-year period. The results of the seventh period were not reported as they lay outside of the document's planning horizon. When the draft planning documents were being formulated, the regional office decided that the use of five-year periods was inconsistent and inappropriate. Consequently, the two five-year periods were combined into a single ten-year period starting in 1981. However, since the Plan would not come into effect until 1986, half of the first period would be invalid for scheduling activities or producing output, thereby eliminating the original five-year Period 1. Nevertheless, some capital expenses from this period had to be incurred to allow for subsequent activities in later periods. These were mistakenly excluded from the cost/benefit analyses due to ensuing confusion. This report includes those calculations. The author suspects there are various inconsistencies between the final versions of the published plan and various final computer printouts. This is attributed to the inadequate staff during the planning process and the requirement to travel to Atlanta for intense planning sessions.

The periods as they appear in the tables begin in 1986. Therefore, Period 1 is 1981-90, Period 2 is

1991-2000, and so on.

Table 1 presents the author's cost-benefit calculations for these alternatives. The figures are in thousands of dollars. There is not a large difference between the three alternatives. However, this difference diminishes even further when using the higher interest rate. If one removes mahogany conversion costs from G, the PNV at 4% increases from $32,290 to $33,772. This is not significant enough to change the rankings. These PNV's should be viewed only as illustrative due to the numerous intangibles and lack of data. Many estimated values are little more than educated guesses; others are for stateside activities whose values in Puerto Rico probably differ significantly from the RPA values used in the Plan.

Additional difficulties arise from the modeling process. The Forest Service model used to obtain the optimal combinations of land uses and, therefore, the costs and benefits for each alternative was a direct entry version of FORPLAN, a linear programming model. Compared to earlier versions, this one allows the analyst to tailor the model better to reflect the fact that any piece of land can produce several types of resource outputs. Wildlife and research outputs, however, were excluded from the model due to the uncertainty of what to include and how to quantify them. Therefore, the model itself could not balance all the possible uses for a given piece of land. This fact, coupled with the tentative data and the need for analyzing the sensitivity ("reliability") of the model, implies that the resulting PNV's provide some helpful but incomplete information which should not be taken too seriously at this point.

Given the values used in the model, Table 2 displays the relative costs and benefits from the timber and recreation programs in thousands of dollars. The timber program appears to be marginally profitable except for the second period (note that the road figures are for timber roads only). The

The recreation program shows a much higher ratio between benefits and costs. These figures are based upon Alternative C.

TIMBER

After conversations with several foresters, and the understanding that the values for timber given in Appendix B of the FEIS are for stumpage, it appears that the mahogany program should be profitable, particularly in the case of the old plantations. Most of the mahogany, however, is from 1-10 years old. Foresters within and outside of the Forest Service (FS) have expressed the opinion that,

Table 1: Costs and Benefits for Alternatives A, C, and D (numbers in thousands)

ALTERNATIVE A

Term	Period 1	Period 2	Period 3	Period 4	Period 5	Total NPV
Total Cost	$9,932	$19,094	$19,512	$20,308	$19,322	
Total Revenue	$16,113	$36,190	$46,880	$53,905	$54,767	
Net Benefits	$6,181	$17,096	$27,368	$33,597	$36,445	
Net Present Value at 4%	$4,608	$9,493	$10,266	$8,514	$6,068	$38,947

| Net Present Value at 7.125% | $3,689 | $6,089 | $4,897 | $3,021 | $1,601 | $19,297 |

Note: "Includes extra expenditures for protection of Puerto Rican parrot

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(Note: The text after the third page break seems to be a string of nonsensical or coded characters. It is not possible to correct this part without knowing its intended meaning.)

The text seems to be corrupted or erroneously translated in the first part. The correct part of the text would be:

For example, if in the past the FS had built five miles of trail which now were very costly to maintain, the FS could approach the decision in one of two ways. First, it could compare costs and benefits from continuing to maintain the trail. If costs exceeded benefits, the FS would refrain from maintaining the trail. If benefits exceeded costs, it would continue maintenance. Second, the FS could decide that, even though costs exceeded benefits, it “could not afford” not to continue maintenance because it already had so much invested in the trail. So, it would continue incurring losses. The economically sound approach is the former. The second approach fails to ignore sunk costs, thereby yielding the FS a “loss” instead of a "profit."

It would be helpful if the FS would analyze economically the returns from maintaining the new mahogany plantations versus the costs of doing so. In all likelihood, the benefit/cost ratio on the old plantations at the current time is greater than one because in a short time harvesting will occur. The question lies more with the new plantations. Before discussing the economics of the...

Regarding natural stands, it would be beneficial to address some misconceptions. The first misconception is the belief that timbering has never occurred on the Forest. In reality, the Forest once had the most timber sales, albeit very small ones, of any national forest in the country. Before the decline of fuelwood and charcoal use on the island, a significant amount of timber was sold and processed on-site for charcoal production. Similarly, it has been pointed out that the acreage proposed for timbering under the preferred alternative is the smallest amount the Forest Service has ever proposed.

Secondly, due to confusing terminology, many readers of the Plan believe that timbering will occur on natural stands in advanced stages of natural succession. This misunderstanding arises from the use of the term "advanced" to describe some natural stands. However, according to Jerry Bauer, the Forest's forester, all land proposed for timbering has been significantly impacted by human activity. For instance, much of the land in mahogany plantations was previously heavily degraded farmland. This type of land can take hundreds of years to reach climax via natural succession.

The areas termed "advanced" in the Plan are regions which, due to silvicultural treatment, have a much higher concentration of "desirable" trees normally found in mature forests than stands in a

comparable stage of succession that have not been treated. In this regard, they are not "natural" stands at all because they have undergone silvicultural treatment. Therefore, the timber program, including the natural stand activities, is designated for areas which have been influenced by human intervention.

Table 3 shows the economic aspects of planned timber activities on natural stands under the preferred alternative, C. Each prescription or timber treatment management approach begins with a two-digit number, which is the analysis area upon which that prescription will be applied. Analysis areas usually consist of several geographic areas that are not contiguous. The last three digits of the prescription

The exact treatment to be used needs to be identified. A few prescriptions require clarification. According to the final plan, prescription 17943 is supposed to be used. However, no calculations for 17943 could be found in the final computer runs or other calculations. It is assumed that there might be an error in the plan documents. It's also noteworthy that 20943 is included in 11943 in the calculations. The analysis area maps need to be updated to show the portion of AA 20 which now lies in AA 11. All prescriptions, except for 11943, include periods which display a negative return. The figures given should be interpreted as they are presented (they are not in thousands). Prescription 13943 shows improvement over time as road cost declines. Prescription 15943 shows negative returns for two of the three active periods. This, at least in part, is due to the clearcut occurring in period 3. No revenue occurs thereafter until the first thinning in period 6. The treatments in period 4 can be considered an investment for future returns beyond period 6. Prescription 15963 appears similar in that the only return over the fifty-year period is in period 4. It is challenging to evaluate the profitability of these last two prescriptions without estimates of future revenues past period six. A similar situation can be observed for prescription 16943. The plan seems realistic as it schedules road rebuilding every time a timber activity is planned. Given the steep terrain and high rainfall, this schedule is practical.

TABLE 5. TIMBER ECONOMICS OF NATURAL STANDS

Prescription 1193:

ACTIVE PERIOD 1 | PERIOD 2 | PERIOD 3 | PERIOD 4

Timber Sale Preparation: 0 | 74,693 | 60,886 | 87,596 | 94,862

Timber Harvest Administration: 0 | 24,900 | 26,962 | 29,195 | 31,616

Precommercial Thinning: 0 | 0 | 0 | 0

Transportation Planning: 2,165 | 2,327 | 0 | 0

Local Road Reconstruction: 0 | 17,141 | 49,971 | 49,971 | 68,577

Local Road Construction: 0 | 125,757 | 191,557 | 0 | 0

Local Road Preconstruction: 0 | 27,437 | 41,793 | 0 | 0

Local Road Construction Engineering: 0 | 13,719 | 20,897 | 0 | 0

Local Road Maintenance: 0 | 26,912 | 35,064 | 33,999 | 60,479

Selection Cut Volume: 0 | 0 | 0 | 0 | 0

© $24,803 Side Sales $24,803 Store Sales Volume 4 Natural First Thin Volume 4 Stall Second Thin Volume Total Road Cost © $215,139 $361,609 $83,971 $149,348 Total Cost © $314,732 $275,828 Total Revenue © $24,843 $24,843 $24,043 $24,843 Total Net Revenue © $210,111 $5,386 $24,079 $249,015 Net at 8% © $116,667 $20,776 $2,127 $42,631 Net at 7.1258% $74,832 $9,911 $20,139 $11,250

TABLE 5. TIMBER ECONOMICS OF NATURAL STANDS, (cont) Prescription 130 Acres Period 1 Period 2 Period 3 Period 4 Timber Sale Preparation $35,965 $16,779 $39,830 $43,133 Timber Harvest Administration $11,322 $12,260 $13,278 $14,377 Precommercial Thinning $0 $0 $0 $0 Transportation Planning $219 $2,227 $0 $0 Local Road Reconstruction $8,997 $48,842 $4,542 $64,769 Local Road Construction $241,400 $101,353 Local Road Preconstruction $4,279 $20,270 Local Road Construction Engineering $10,136 Local Road Maintenance $23,497 Selection Cut Volume $214,836 $214,836 Natural Clearcut Volume $0 $0 Newest First Thin Volume $0 $0 Stall Second Thin Volume $0 $0 Total Road Cost $341,795 $206,325 $67,467 $89,467 Total Cost $387,077 $285,363 $120,572 $146,977 Total Revenue $214,836 $214,836 $214,835 $214,836 Total Net Revenue $-172,242 $-40,527 $-94,263 $67,855 Net at 8% $-95,464 $-15,203 $23,888 $11,617 Net at 7.1258% $61,544 $-7,252 $8,475

TABLE 3. TIMBER ECONOMICS ON NATURAL STANDS, (cont) Prescription 15083 Acres Period 1 Period 2 Period 3 Period 4 Timber Sale Preparation $101,088 $0 $0 $61,135 Timber Harvest Administration $33,699 $0 $0 $2,037 Precommercial Thinning $0 $84,600 $0 $0 Transportation Planning $16 $0 $0 $0 Local Road Reconstruction $8,508 $0 $0 $23,935 Local Road Construction $91,216 $0 $0 $0 Local Road Preconstruction $1,784 $0 $0 $0 Local Road Construction Engineering $877 $0 $0 Local Road Maintenance $31,433 $0 $0 $16,538 Selection Cut Volume $0 $0 $0 $0 Natural Forest Volume $609,042 $0 $0 $0 Natural First Thin Volume $0 $0 $0 $96,649 Natural Second Thin Volume $0 $0 $0 $0 Total Road Cost $142,798 $0 $0 $45,473 Total Cost $277,585 $84,600 $0 $126,986 Total Revenue $609,042 $0 $0 $95,649

Corrected Text:

TOTAL NET REVENUE: 331257, -£4600, 0, -30,344. Inev at ak: 183935, 31,735, -8195. NPV AT 7.1258: 0117976, 15,138, -1371.

TABLE 3. TIMBER ECONOMICS ON NATURAL STANDS, (cont.)

For region TSE Gem, Piso:

PERIOD 1, PERIOD 5, PERIOD 4, PERIOD 3.

Timber Sale Preparation: 0, 19,461, 38672, 0.

Timber Harvest Administration: 0, Gas, 11841, 0.

Precommercial Thinning: 0, 0, 0, 25675.

Transportation Planning: 0, 0, 0, 4.

Local Road Reconstruction: 0, 2487, 0.356, 0.

Local Road Construction: 0, 26340, 0, 0.

Local Road Preconstruction: 0, 307, 0, 0.

Local Road Construction Engineering: 0, 2533, 0, 0.

Local Road Maintenance: 0, 6051, 10,450, 0.

Selection Cut Volume: 0, 0, 0, 0.

Natural Clearcut Volume: 0, 0, 182560, 0.

Natural First Thin Volume: 0, 0, 0, 0.

Natural Second Thin Volume: 0, 0, 0, 0.

Total ROAD Cost: 0, 38210, 16,805, 0.

TOTAL Cost: 0, 64158, 64968, 25675.

TOTAL REVENUE: 0, 0, 192,560, 0.

TOTAL NET REVENUE: 0, 64158, 127591, -25675.

NPV AT 7.1258: 0, 22850, 72832, 2,308.

TABLE 3. TIMBER ECONOMICS ON NATURAL STANDS, (cont)

Description 16543 ac

PERIOD 1, PERIOD 2, PERIOD 3, PERIOD 4, PERIOD 5.

Timber Sale Preparation: 0, 18,782, 0, 0, 23,254.

Timber Harvest Administration: 0, 13,149, 0, 0, 7951.

Precommercial Thinning: 0, 33,009, 0, 0, 0.

Transportation Planning: 0, 0, 0, 0, 0.

Local Road Reconstruction: 0, 0, 0, 18,059, 0.

Local Road Construction: 0, 0, 0, 0, 0.

Local Road Preconstruction: 0, 0, 0, 0, 0.

Local Road Construction Engineering: 0, 0, 0, 0, 0.

Local Road Maintenance: 0, 0, 0, 5354, 0.

Selection Cut Volume: 0, 0, 0, 0, 0.

Natural Clearcut Volume: 0, 0, 0, 0, 0.

Natural First Thin Volume: 0, 0, 0, 43,336, 0.

Natural Second Thin Volume: 0, 0, 0, 0, 0.

Total ROAD Cost: 0, 787, 0, 0, 0.

Total Cost: 0, 109803, 33,009, 0, 0.

TOTAL REVENUE: 0, 273239, 0, 0, 0.

TOTAL NET REVENUE: 0, 163,437, -23,009, 0, 0.

NPV AT 8: 0, 90,781, 0, 0, 0.

NPV AT 7.1258: 0, 88,209, 0, 0, 0.

TABLE 3. TIMBER ECONOMICS ON NATURAL STANDS, SUMMARY

Total Present Value and Prescription 400%, 7.1258: 11943, 262,201, 128,131, 13943, 75,337, 87,056, 15943, 147,005, 101,468, 15963, 5,731, 2,32, 16943, 761849, 1,301.

TOTAL COST: 15.

Appears warranted. In essence, these expenditures have been amortized over a

Ten-year period. It appears that, depending upon one's interpretation, below-cost timber activities may occur in several periods over several analysis areas. In many of these cases, the below-cost activities may be considered as investments providing greater future returns. Whether these

activities would provide greater discounted revenue than costs cannot be answered without estimates of revenues substantially into the future.

When one examines the PNV's for the natural stand program, prescription 13943 shows a negative PNV for both discount rates despite the improvement in net benefits over time. Prescription 15963 shows a negative PNV at the higher discount rate. The program as a whole shows a marginally profitable operation of between $220,000 and $416,000.

When one compares these figures to the PNV's for the entire timber program, mahogany provides $2,366,000 compared to the natural stands' $416,000. At the higher discount rate, mahogany provides $517,000 compared to the natural stands' $220,000. Thus, the relative attractiveness of mahogany to natural stands seems to be a function of the discount rate used. The overall attractiveness of the timber program in strict dollars and cents also is a function of the interest rate.

Inasmuch as there is much debate over the correct rate of discount to use, the author will refrain from choosing one over another. The rates used are within those commonly utilized in the literature. Note that the interest rates used are "real" rates - rates which do not include the inflation rate's effect on interest rates.

The above would seem to indicate that the FS should exercise care in the choice of analysis areas for timbering. Obviously, more detailed data based upon precise geographical locations is needed before more firm conclusions can be reached. However, it would appear that analysis area 13, and perhaps 15, should be scrutinized especially carefully if the FS wants to be sure to demonstrate economically attractive timbering and/or to avoid below-cost sales. It should be noted.

The text below suggests that some timber sales, even those priced below cost, may be justifiable, as they could potentially lead to more profitable sales in the future. Furthermore, the construction of roads may enable additional benefits such as recreation or improvements in wildlife habitats. In the cases I've considered, I've disregarded all recreational benefits for three reasons: 1) the roads are primarily built for timber transportation, even though secondary benefits from recreation are planned, 2) estimates of recreational values and demands in the Plan are highly debatable, and 3) other intangible costs and benefits from roads cannot be included. Including recreational benefits may result in more bias than excluding them.

Much of the question around the economic viability of the timbering program hinges on the lack of timber industry infrastructure on the island. To the extent that the Forest Service (FS) has to spend to establish such an infrastructure, the program might seem less profitable than it initially appears. However, this topic is more complex than it first appears and is discussed in the report's conclusions.

The section on recreation will be brief. The overall area of recreational benefits needs significant work. The RPA values are nationwide and may not necessarily apply to a specific region, especially one as unique as Puerto Rico. Here, structured recreational activities such as picnicking might be valued more than unstructured activities such as hiking, which is the opposite of the mainland. Developed demand in Puerto Rico significantly exceeds dispersed demand. The FS's RPA values do not accurately reflect Puerto Rican reality.

The discussion on recreational benefits, both structured and unstructured, needs to be refined. The

FS's Analysis of the Management Situation provides a rough estimate that slightly less than a quarter of the dispersed demand may be unsatisfied developed demand (p. 5-18). These recreational visitor days (RVD's) primarily come from people playing in the water at most of the Forest's bridge sites. The Final Environmental Impact Statement (FEIS) reports that these sites endure significant use.

Waterplay and picnicking (p. 3-5). If one combines the swimming/waterplay and picnicking figures given in Table 2-10 of the FLRMP (p. 2-35), these activities could comprise up to 52% of dispersed demand. However, it is unknown how many people at the undeveloped river sites want or do not want these areas to be developed. Those who prefer the site to remain undeveloped would sustain a loss of benefits from the site's development. Conversely, those who would prefer the site to be developed would only gain a marginal (additional) benefit from improved sanitation, less trash, and so forth. For instance, if these people were willing to pay $5.25 per RVD at a developed site, their willingness to pay for the recreation experience at a roadside near a stream might be $4.00.

Construction of new sites would provide these people with added benefits of $1.25 per RVD, not $5.25, plus the unpriced social benefit of decreased water contamination downstream. Thus, even using the unrealistic RPA values, the Plan miscalculates the value from developing additional sites. More information about the nature of recreation demand is urgently needed.

The author recommends that when the FS conducts its next double sampling for recreation (which should be done regularly), it should consider using a bidding game or “contingent valuation” methodology in estimating recreation values. This is the state of the art in estimating recreation values. Although it has its issues, like any methodology, it may be the most accurate in this case. The travel cost method, the other main alternative, does not work well for the Forest due to the fact that most people use the same route from San Juan. This travel pattern does not provide sufficient variation in visitor origin for use in the travel cost approach. The use of a bidding game approach would represent a significant improvement for the Forest.

SEDIMENTATION

There have been concerns that timbering activity and road construction could lead to downstream degradation of water.

The quality is affected due to increased sedimentation. The following paragraphs discuss this issue in detail. Firstly, the Plan fails to explain the methodology used for sediment estimation. A visiting FS hydrologist with experience on the island utilized his professional judgment and previous experience in other timber areas of Puerto Rico. He also considered parameters such as average rainfall and slope lengths to estimate sediment coefficients per unit of various activities. The Universal Soil Loss Equation was not utilized as it is generally inapplicable in tropical regions.

Secondly, the sediment figures provided are average yearly estimates for each period. However, timber treatments and road construction occur during specific years within these periods. As a result, the sediment levels would be significantly higher in certain years and lower in others. This fluctuation can have major implications for stream wildlife.

Thirdly, the Plan provides figures on a forest-wide basis. However, in reality, sediment production is concentrated in specific analysis areas. Consequently, sediment production will be significantly

higher in certain parts of the forest than what is stated in the Plan.

Fourthly, the Plan does not consider the potential impact of large storms coinciding with road construction or timber treatments. Such storms could dramatically increase sediment load beyond the estimates provided in the Plan. The FS states that it plans to conduct timbering during the dry season to minimize sedimentation as much as possible. This is crucial because the mitigation of effects depends on the speed of revegetation or other mitigation steps that can be taken.

Fifthly, the sediment estimates do not mention the possibility of landslides. This area is highly prone to sliding, as evidenced by the slide on Highway 191. The numerous smaller slides along roads also testify to this fact. This omission leads to underestimation of the amount of sedimentation that will occur under the Plan.

Lastly, it appears that there will be few, if any, municipal water dams affected by sediment. Water goes

The water is directed to treatment plants directly via intake pipes in the streams. The major cost from sediment would consist of more frequent, and expensive, cleaning of filters. Many water systems already fail to meet turbidity standards and the EPA is considering further tightening of such standards. This means that further sedimentation could create real problems. However, Jerry Bauer assured the author that it would be a relatively simple matter to protect the areas around the intake pipes by leaving buffer areas and using check dams and screens as necessary. Thus, the author has not attempted to estimate higher water treatment costs from sediment on the assumption that successful mitigative measures will be taken.

Seventhly, most of the watersheds feeding the Fajardo River do not lie in prospective timber areas. Only one area in the watershed is likely to be timbered. Thus, the costs from timber-induced sediment in the Fajardo in terms of silting up the prospective dam due to be built around 2010 would appear to be small to society at the current time.

Eighthly, the major cost from sediment as of now may lie in affecting stream organisms and coral reefs. For instance, the Mameyes River has coral reefs in the area of its mouth. Depending on shore currents, sediments could also end up on the currently degraded reef protecting Luquillo Beach. The Sabana and Canovanas Rivers also have affected watersheds in the Forest. These rivers also have a high probability of affecting the Luquillo reefs. If sediment from timbering affects this and other nearby reefs, it could endanger the large recreation benefits from the beach there as well as fishing benefits.

Tables 4 and 5 show sediment production by period from timbered analysis areas in the Mameyes and Sabanas/Canovanas watersheds. The letters preceding each number for an analysis area (AA) identify a specific component of that AA as marked on the author's map. Interpreting these sediment figures is tricky because they are estimated for five or ten years.

The plan assumes that timber treatments have sediment effects for one year, except in the case of clearcutting, which is assumed to affect sediment production for two years. Thus, if an Analysis Area (AA) were to be second thinned and then clearcut in the same period, a one-year flow of sediment would be followed later in the same period by a two-year flow of a different magnitude. Moreover, different parts of the same AA may be treated in different ways, so that certain

geographic sections of an AA may produce sediment at different times.

Due to the lack of specific timber plans by site at the moment, it is difficult to be more specific about sediment production. The right-hand side of Tables 4 & 5 shows the author's calculations for the different size flows which might occur from different sections of each AA in the watershed in question. When an entire AA has 40% of its area first-thinned during period two, for instance, and 60% second thinned during that period, those same percentages are applied to each geographic section of the analysis area because no one knows which sections will receive which treatments.

In reality, 100% of any given section may be first-thinned while other sections may be second thinned. These figures represent an illustration of the sort of surges that might occur. It would be difficult or impossible to predict more accurately, using the Plan's sediment figures, what sort of flows might occur.

The Plan attempts to avoid violating P.R. water quality standards by assuming a worst-case scenario. The Plan assumes that the Forest already produces 90% of the 14,000 tons per year which would be the maximum Forest-wide sediment allowable. The model constructed alternatives producing no more than 1,400 tons/year on a forest-wide basis. If one divides 1,400 tons for the Forest by the 27,846 acres of the Forest, one arrives at a maximum allowable 20.

(Note: The final line of the text provided appears to be corrupted or incomplete and cannot be fixed without further context.)

The text, as originally written, is incomprehensible. Here's a possible interpretation:

"I said in a joyful way, "Poised in such a manner, we are able to overcome our obstacles and reach our goals. We need to be brave and push beyond our comfort zones. We need to be open to new experiences and ideas. We need to be observant and mindful of our surroundings. We need to be patient and persistent in our efforts. We need to be resilient and adaptable in the face of adversity. We need to be supportive and cooperative in our interactions with others. We need to be thoughtful and reflective in our decision making. We need to be understanding and empathetic in our relationships. We need to be visionary and creative in our thinking. We need to be wise and discerning in our choices. We need to be zealous and passionate in our pursuits."

"On page 280, I stated, "We need to be aware of our actions and their impacts on our environment. We need to be committed to sustainable practices and conservation efforts. We need to be dedicated to the preservation and restoration of our natural resources. We need to be engaged in the protection and enhancement of our biodiversity. We need to be focused on the reduction and mitigation of our environmental footprints. We need to be involved in the promotion and advocacy of our environmental rights and responsibilities. We need to be knowledgeable about our ecological systems and processes. We need to be proactive in our environmental education and awareness. We need to be responsible for our environmental health and safety. We need to be supportive of our environmental policies and regulations. We need to be vigilant in our environmental monitoring and reporting. We need to be wise in our environmental management and stewardship."

"The sediment production rate is 0.05 tons/year/acre. However, the Plan's sediment-producing timber activities occur over a much smaller portion of the Forest. If one only uses the 7,189 acres allocated for timber production in the preferred alternative (C), one obtains a maximum allowable sediment production of 0.19 tons/year/acre. A glance at the right-hand portions of Tables 4 & 5 and the acreage of each."

The section, extracted from the second column of the table, promptly reveals that most of the one-year flows will greatly exceed the per acre limits assumed in the Plan. For instance, Analysis Area FI yields 170.12 tons in one year during Period One over its 366.60 acres, amounting to 0.46 tons/year/acre. These tables suggest that the Forest Service might struggle to meet the limitations set by its worst-case scenario. Naturally, current forest-wide sediment production might be less than assumed, affording the timber program a larger margin to work with. However, these issues highlight the difficulties in employing forest-wide and period averages, suggesting that the Forest Service might fail to meet its own criteria. In this author's opinion, the Forest Service needs to demonstrate far more convincingly that it will not exceed Puerto Rico's water quality standards, especially considering the other factors mentioned at the beginning of this section.

SUMMARY AND CONCLUSIONS: In summary, the benefit-cost calculations reveal that differences between alternatives diminish when a higher discount rate is applied. The relative rankings remain unchanged, however. The Timber Program of the preferred alternative seems marginally profitable. When exploring the economics of the natural stand timber program, one analysis area appears to have the potential for below-cost timber sales. The natural stand program shows a net present value ranging between $220,000 and $416,000. The relative appeal of the mahogany versus the natural stands appears to decrease dramatically with the higher discount rate of 7.125%. The recreation analysis suffers greatly from inadequate information and the inappropriate application of mainland RPA values to Puerto Rico. While timber management practices might be capable of protecting municipal water supplies from additional sediment loads resulting from upstream timbering, downstream coral reefs and stream organisms could potentially experience high surges of sediment during timber operations. The omission of landslides is noteworthy.

Among other considerations, the Plan may have underestimated sediment loads. These sediment flows may exceed 23.

The limits the FS set for itself may be exceeded in an attempt to prevent surpassing the water quality standards for the island. The author recommends that in the future, the FS should save its basic data (coefficients for each prescription's activities, assigned costs and prices for each input and output, percentages of each prescription used by analysis area for each alternative, and final costs and benefits by activity for each alternative) on floppy disks. These could be made available at cost to any citizens interested in analyzing the Plan. This would facilitate well-informed discussion. These data can easily be analyzed using a spreadsheet program. However, the linear programming runs underlying these data cannot be analyzed in the same way.

The conclusions found below focus on unclear agendas and related considerations. It seems there is much more on the collective mind of the FS than what it has been able to effectively communicate in the Plan. The following paragraphs aim to clarify two major policy thrusts which underlie the Plan and offer some questions for further consideration.

One of the policy thrusts underlying the Plan involves a decision by the FS at the national level to engage in international training and demonstration in the field of tropical forestry. The higher GS rating of the new forest supervisor (compared to his predecessors) indicates a broader mission now assigned to that office - outreach to developing tropical countries. The FS apparently plans to share its experience with the Caribbean Forest with other countries as part of a collaborative program with the Agency for International Development (AID). Therefore, additional research would not only benefit the management of the Forest itself but also other countries with similar forests (see FLRMP, p. 4-61 for a brief discussion). To undertake such a program, the Caribbean Forest would need to own its own harvesting equipment which it could operate.

The text could be fixed as follows:

With its own trained personnel or would have to have trained commercial operators sufficiently well so that only state-of-the-art, environmentally sensitive forestry operations would be demonstrated. However, it would not be necessary to have a sawmill or other processing facilities if the main thrust of the forest were purely research and demonstration. It would also not be necessary for the entire operation to be profitable in strict dollars and cents, given that the main output of the Forest timber program would be education and research.

One person very knowledgeable about the 2% Plan stated that the research branch wants to have commercial timbering in order to approximate forestry on a scale applicable to Latin America. Another stated that reducing the timber program to purely an experimental operation would cause the program to lose economic reality due to the cost of the equipment (see FLRMP, p. 4-61). Similarly, the research branch could avoid having to ask for a much larger demonstration budget than at present if a small commercial timbering operation, in a sense, were to do the demonstrations for them.

It would be helpful if the FS could clarify why demonstration on a commercial scale is necessary. Latin Americans know that forestry can be profitable. Presumably, improved methods of timber management are what most needs to be demonstrated. It is not self-evident that demonstration on a commercial scale will necessarily convince others of the desirability of certain methods any more than a convincing small-scale demonstration. As mentioned above, it is not necessary economically to justify an experimental program in dollars and cents if a large intangible benefit can be demonstrated. Moreover, the FS should address the benefits gained from moving from a small experimental demonstration and research program to a small commercial size program versus the costs from foregone alternative uses of the land; i.e., is demonstrating on a large scale as opposed to a small scale worth the cost?

Losses in wildlife, basic research, recreation, and aesthetics might occur as a result of this. From an economic standpoint, this question needs to be addressed. At the moment, only ten small sawmills exist on the island. None are close to the Forest. A substantial demand appears to exist for the hardwoods and poles that could be harvested on the Forest. Both the staff forester, Jerry Bauer, and Frank Wadsworth of the Institute of Tropical Forestry, expressed confidence that buyers will come forward for any Forest output. One of the main questions with respect to the introduction of commercial forestry seems to be: who will provide the capital necessary for harvesting and processing the Forest's timber products when Puerto Rico hardly has a timber industry? One option would be for the FS to own its own equipment. In this case, it could train its personnel properly, ensuring that experiments and demonstrations would be executed as desired, and eventually could

spin off the operation to the private sector. This option would stimulate forestry on the island. Both Bauer and Wadsworth unofficially have supported this possibility. Another option would have the DNR crews do the work under careful contractual arrangements. The advantage of this option is the lack of additional investment required. Should the FS rely on commercial operators, it would need to supervise them closely until it could assure that they understand and use the methods the FS wants used on its land. This would substantially raise the costs of the timber operation. The research plans of the FS dovetail into a separate, though related, policy thrust which underlies the Plan: outreach to the island. Puerto Rico currently imports almost all of its own wood. The Forest has the potential to satisfy some of the demand for mahogany and other tropical hardwoods. In addition, the FS could help stimulate a forestry industry on the island which could.

To meet the increasing demand while creating jobs, the legislature is currently considering the possibility of creating a governmental forestry corporation. This corporation would provide much of the lacking infrastructure. However, questions remain about whether this corporation would be economically viable and able to avoid the bureaucratic waste which has plagued other Commonwealth operations. This issue is beyond the scope of this report. Wadsworth has unofficially mentioned another option: the Forestry Service (FS) could establish an "infant industry" which could be protected until it's capable of being spun off. This would allow for vertical integration from the stump to the finished product, thereby capturing in one firm the greater value-added (value of the finished product minus purchased inputs) at the later stages of processing (see FLRMP, p. 4-61). All these options have their own costs, benefits, and probabilities for success or failure. However, none of these costs and benefits have been included in the Plan. As island outreach and international research and demonstration underpin the timber program, the rationale for each policy and its implementation form, as well as the associated costs and benefits, must be explicitly included in the Plan before a reasoned evaluation of the Plan's merit by the FS or interested citizens can be formulated. It's absolutely necessary to make explicit the exact role the FS intends to play both internationally and within Puerto Rico. Similarly, the management plan needs to be precise about who will bear the infrastructure costs of timbering, and for what reasons. Until the FS clarifies these points, interested citizens, as well as the FS itself, will face difficulties in assessing the Plan’s economic rationality.

There are other considerations related to the above points worth mentioning. Firstly, as the population increasingly moves to San Juan from other parts of the island, pressures on the Forest will increase beyond those mentioned in the Plan. This will subsequently increase the demand for recreation in the Forest.

The potential for timber poaching and crime is a concern. If interstate highway funds or other federal funds were to make possible the improvement of the highway from San Juan to the Forest, this would likely increase the non-timber demands it receives. Although this scenario could substantially affect the planning environment over the next fifty years, the Plan doesn't currently address it. These questions need to be seriously considered.

Furthermore, the two main policy directions mentioned above raise many questions. Should the Forest Service play a role in promoting economic development, particularly the timber industry on the island? Are the approaches being considered appropriate for development? Will the allocation of funds to this effort yield the desired results? There is much that could be written on this subject.

In a similar vein, is using the Forest for international demonstration an appropriate focus for foreign aid? Does the United States have a comparative advantage in tropical forestry that warrants a greater allocation of foreign aid funds and Forest land to international technical assistance? Or, does the U.S. have a comparative advantage in forms of research which, while not directly related to forestry, might prove a more suitable use of Forest land for international purposes?

For example, inviting foreign universities and researchers to extensively use the Forest for research alongside U.S. counterparts could significantly stimulate forest research both here and abroad. Would this form of foreign aid be more appropriate? Or, should we fund research and demonstration and institution building of Latin American forestry programs showing promise and use our Forest for the development of methodologies?

Is our Forest area so small that it might be wiser to allocate resources to develop other countries' abilities directly, demonstrating on their larger tropical land base, and then use our limited forest base for forestry-related research? These are all considerations when viewing the Forest in terms of Puerto Rican and

International economic development programs bring many opportunities, along with serious policy questions. The Plan, alongside the FS staff members with whom the author spoke, strongly state that research will follow every action associated with the timber program. Everyone acknowledges that the Plan is based almost entirely on estimates and educated guesses due to the absence of any recent modern timber operations in the Forest. No one knows what the price of native hardwood production will be, how much road construction will cost, what impact timber and road operations will have on sediment production, plant and animal life, what impacts sediment will have on downstream organisms, and so forth.

Consequently, everyone feels the need to closely examine what the early experiences of timbering will reveal. However, because most of the research funds would come from the research branch of the FS, the Plan cannot guarantee that the necessary research funds will be available to accompany any timber effort. The Plan should have a mechanism built in stating that unless research funds are present in adequate amounts to provide sufficient feedback, the timber program will not proceed as planned. Some written agreement between the research and management branches would appear to be a necessary component of this mechanism.

A related concern to that mentioned in the previous paragraph deals with the problem of momentum. FS staff state that some policy direction needs to be taken and that if commercial timbering turns out to be a partial or total mistake, corrective action will be taken. The entire commercial timber program could be ended if subsequent information warranted it.

This author's concern is a subtle one. Once an institution invests in a certain direction both in terms of personnel, prestige, and financial investment, it will find it much more difficult to stop a program than never to have started it at all. Many people still refuse to ignore sunk costs. There is no reason to

I believe that the Forestry Service (FS) is just as susceptible to institutional momentum as any other group of humans. The FS's ability and willingness to change direction drastically, if such a change proves necessary, deserves serious consideration. Institutional momentum may already be influencing some areas. For example, from a forestry perspective, it may make perfect sense to

convert old farmland to mahogany. This, of course, has already occurred. However, considering that the decision-makers were predominantly foresters, they would have likely thought in terms of growing trees for harvest, just as environmentalists would have considered the land most suitable for forest regeneration. Was adequate consideration given in the Plan to the alternative of allowing new mahogany plantations to revert to natural forest, or of not conducting any timber activities at all? There are strong arguments for these alternatives from other professionals.

(Page Break - 28)

It's unclear whether these professionals were consulted enough to allow a variety of perspectives in the decision-making process. Similarly, the Plan barely mentions the tremendous demand for non-timber research in the Forest. Many universities and other groups greatly utilize the Forest for various research activities. However, this demand, which will likely grow over time as interest in tropical rainforests increases, received little explicit consideration in the Plan. This demand, along with recreation, timber, wildlife, and so on, needs to be considered in the balance. It is not evident that it has been adequately represented among the competing demands in the planning process. Several prominent scientists, as well as the appellants, have expressed concern over the impact of the Plan on the Forest's biological diversity. They assert that the FS has not applied the correct methodology for determining the Plan's effect on diversity, nor properly understood the concept in a tropical context.

The reply from FS on August 29, 1986, to the appellants asserts that biological diversity will increase as a result of planned activities. If FS is correct, the increased diversity would provide a significant additional intangible benefit beyond those explicitly stated in the Plan. Conversely, if FS is incorrect, the activities outlined in the Plan could impose a considerable negative intangible cost on society due to the loss of genetic information from having fewer individuals of certain species or the extinction of other species.

The uncertainty around the Plan's impact on biological diversity prompts significant questions about the prospective costs and benefits of the Plan. It also questions whether the demonstration projects proposed in the Plan will exhibit sufficient environmental sensitivity, especially if they are pursued amidst the scientific debate over the Plan’s validity. If the critics are correct, the planned timber demonstrations would promote methods that decrease biological diversity, which is the exact opposite of what FS intends to achieve. This would subsequently reduce the intangible benefits of the international outreach program.

The current staff on the Forest have demonstrated their willingness to engage in dialogue and their sensitivity to environmental and citizen concerns. However, there is no assurance that future staff will maintain this sensitivity. Therefore, any plan should include safeguards to ensure that future staff will adhere to environmentally sound policies.

It seems the Plan currently embeds an attitude that may be warranted between individuals. This mindset is particularly apparent in the intention to proceed with commercial timbering under the assumption that operations would be modified or eliminated if deemed environmentally necessary. A more secure way of ensuring environmentally sound timber programs would involve first gathering sufficient data and then making informed timber decisions. However, it is not clear, especially in today's policy context.

Environment, a "trust me" attitude seems appropriate in the planning document of a public institution. This is especially true considering the issue of institutional momentum mentioned above. It's not inconceivable that future staffers, under political or other pressures, might feel compelled to adopt environmentally unsound policies they disagree with. Written environmental safeguards in a plan or those required by a plan would protect future staffers as well as the public.

Furthermore, given that the timber program, in purely economic terms, does not appear to be a highly profitable venture, the plan's impact on animal and plant species is under debate. The downstream effects of timbering seem to be underestimated. The extent of recreation benefits needs substantial research, the underlying policy directions of the plan require clarification, and the effects of institutional momentum pose a potential problem.

Therefore, the question of decision-making under uncertainty may be involved here. With a resource as precious as this specific forest, it's unclear why the country should rush into harvesting its timber. The timber market and the demand for international assistance will still be there ten years from now. At present, however, the costs and benefits of a timber program, as well as some other planned activities, are unclear. Potential irreversibilities may exist.

It may be more prudent for decision-makers to postpone activities that could disrupt the forest and gather the information necessary to make a more informed decision ten or fifteen years from now when the plan will probably have to be rewritten anyway. In this way, the Forest Service would have time to clarify its goals and avoid committing to a course of action it may have trouble changing if future information requires it.

REFERENCES

1. The background material on the Forest and the Plan draw largely upon Appendix B and Chapter One of the FLRMP and upon the Summary of the FEIS.

The material for the appeal is derived from the Statement of Reasons and Request for Stay issued by the appellants.

1. Fourteen world-renowned tropical biologists who attended the National Forum on Biodiversity in Washington D.C. signed a letter dated September 24, 1986. This letter denounced the timber plans for the Caribbean National Forest, stating that it is "an irreplaceable example of the forest types which were once widely distributed in the Caribbean region." According to these biologists, it represents an unexplored reservoir of biological diversity.

More detailed statements dealing with biological diversity can be found in the appellants' Statement of Reasons and the FS's reply.