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CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

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This report gives 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 ends with a discussion of the thrust of the overall plan, 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. It became a national

forest in a unique manner. When Puerto Rico became part of the United States territory in 1898, the U.S. government obtained as a result 12,394 acres of Spanish Crown lands set aside in the Luquillo Mountains. Having been set aside in 1860, these lands 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 part of the Tropical Forestry Unit which reported directly to the FS Chief. To this end in 1956 the Unit developed for the Forest a Land Use Plan which identified land and research needs in reforestation, plantation care, forest improvement, utilization, agroforestry and watershed management Land not needed for research but suitable for applications of methods developed by past research was identified for a pilot demonstration management area. In this way sustained yield forest management began in the Forest. The plan also recognized recreation, wildlife, and water needs, In 1973 when research and

management functions of the Forest were separated from each other, the FS created an administrative and management staff under the direction of Region 8 in Atlanta, This enabled the Forest to deal better with the growing non-research demands on it. The

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management staff has grown slowly since then. The Institute of Tropical Forestry, now a unit of the Southern Forest Experiment Station in New Orleans, carries the responsibility for research activities on the Forest. Thus, two distinct parts of the FS direct the Forest's management and research activities.

Today, the Forest has 27,846 acres. It is located in the rugged Sierra de Luquillo, 25 miles southeast of San Juan, Elevation ranges from 100 to 3,433 feet above mean sea level while rainfall varies from 96 inches per year to 160 inches per year at the higher elevations.

Twenty-four percent of the Forest has slopes above 60%. The Forest vegetation consists of four forest types ranging from the lush

Tabonuco type at the lowest elevations to dwarf forest on exposed peaks and ridges. A total of 225 native tree species occur in the Forest, representing about two-fifths of the 547 species known from Puerto Rico and the U.S. Virgin Islands, Only the Tabonuco forest produces significant commercial wood products.

The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), as amended by the National Forest Management Act of 1976 (NFMA), requires that every administrative unit of the National Forest System develop a land and resource management plan. This plan would use a horizon of fifty years for planning purposes. It would be revised every fifteen years. Consequently, the Forest Service issued its draft plan for the Caribbean National Forest in December of 1984. Based upon public comments the Forest Service revised the Plan, issuing its final version in January of 1986.

This final plan chose among eight proposed management alternatives reflecting differing emphases on timber production, wildlife protection, scientific research, and recreation. Alternative C was chosen as the preferred alternative. According to the Plan, multi-use

management would provide a sustained yield of resources without compromising optimum production of quality water. This alternative highlights 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 from current plans. Conversion of natural stands to mahogany would cease and wildlife management would provide maintenance and recovery for endangered and sensitive species. The increased capacity for developed and dispersed recreation under th

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alternative would 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 they consist of a number of Puerto Rican organizations and national environmental groups. The

appellants cited a number of concerns ranging from (in their view) the failure to include all of the 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 unsuited for timbering, the insufficient protection of critical habitat and provision for recovery for the endangered Puerto Rican parrot, and the failure to assess adequately the environmental impacts of the Plan.

The paragraphs below present an analysis of, and some observations on, the Plan and some of the concerns of the appellants from the perspective of an economist. As such it is intended to be as nonpartisan and objective as possible. After an extended discussion the author concludes that several factors would seem to indicate that the FS should take time to gather data before committing itself to the implementation of Plan activities, such as timber harvesting, which would disrupt the Forest.

ALTERNATIVES A, C, AND G

To examine the choice of the preferred alternative, C, the author decided to obtain and analyze the data for alternatives A, C, and G.

Alternative A represents current direction in the sense that represents the plans and direction that the Forest Service has maintained up to now. It should be noted that currently there is no timber harvesting on the Forest. Alternative A describes timber harvesting which the Forest Service has planned to perform in the future (without the benefit up till now of comprehensive planning) but has not yet carried out. C represents a change in direction, especially in having more defined preservation areas/wilderness and less acreage devoted to timber. Alternative G basically eliminates timber harvesting while maintaining the rest of the timber program (uch as timber stand improvement). Conversion of forest to mahogany would end under C but continue under A. The justifications given for conversion under G when harvesting would cease bear mention. The first justification consists of a desire to

Justify past conversion to mahogany. Failure to continue conversion could be seen as a tacit admission that past conversion was wrong, even though the FS still believed that past conversion was

warranted. Second, should the timber industry infrastructure in the future improve to the point that timber harvesting would be warranted, the Forest would be prepared to harvest with a ready supply of mahogany.

In terms of analysis one of the author's chief concerns at the outset was that the choice of preferred alternative might be sensitive to the choice of the discount (interest) rate chosen. 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 given

In gathering the data to recalculate the PNV's Terry Tenold (the Forest's landscape architect and staff member in charge of the planning effort) and this author came to the conclusion that inadvertently certain capital expenditures had been omitted from the first period calculations. This occurred due to an intra-agency mix-up. The planning team originally used a seven period planning

horizon comprised of two five-year periods starting in 1980, four subsequent ten year periods, and one fifty year period. The results of the seventh period were never reported inasmuch as they lie outside of the document's planning horizon. At the time the draft planning documents were formulated the regional office determined that the use of five year periods was inconsistent and inappropriate. The two five year periods therefore were combined into one ten year period starting in 1981. However, since the Plan would not take effect until 1986, half of the first period actually would be invalid for scheduling activities or producing output. This eliminated the original, five year, Period 1. However, some capital expenses from this period still had to be incurred to permit subsequent activities in later periods. In the ensuing confusion these were omitted from the cost/benefit analyses. The calculations in this report include them. It should be noted here that the author suspects that there are various inconsistencies between the final versions of the published plan and various final computer printouts due to the lack of staff during the planning process and the need to go to Atlanta for rather grueling planning sessions there. The periods as they appear in the tables start in 1986. Thus, Period 1 is 1981-90, Period 2 is 1991-2000, and so on.

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Table 1 presents the author's cost-benefit calculations for these alternatives. The numbers are in thousands of dollars. There is not large difference between the three alternatives. However, this difference shrinks even further 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 enough to change the rankings.

These PNV's should be considered only as illustrative because of the many intangibles and the lack of data. Many estimated values are

Little more than educated guesses; others are for stateside activities whose values in Puerto Rico probably differ greatly from the RPA values used in the Plan. Other 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 far better to reflect the fact that any piece of land can produce several types of resource outputs. Wildlife and research outputs, however, were omitted from the model due to the uncertainty as to exactly which 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, along with the tenuous data and the need for analyzing the sensitivity ("reliability") of the model, implies that the resulting PNV's provide some useful but incomplete information which should not be taken too seriously at this point

Given the values used in the model, Table 2 shows 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 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,

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Table t

Costs and Benefits for Alternatives A, C, and

(numbers in thousands)

ALTERNATIVE A

em Period Period 2 Period 3 Period Period S 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 (\$38,087) 4

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

(of)

ALTERNATIVE

Period 1 Period 2 Period 3 Period 4 Period 5 Total NEV

Total cost \$9,917 \$18,613 \$18,500 \$20,602 \$20,515

Total Revenue | \$18,213 \$41,048 \$48,964 \$54,654 \$55,886,

Net Benefits \$8,296 \$22,435 \$30,464 \$34,052 \$35,371

Net Present

Value at 4% \$6,182 \$12,457 \$11,428 \$8,629 \$6,085 \$44,752

Net Present (\$43,568)

Value at 7.125% \$4,951 \$7,990 \$5,452 \$3,062 \$1,598 \$825,082

NA)

ALTERNATIVE 6.

Period 1 Period 2 Period 3 Period 4 Period 5 Total NEV

Total cost \$8,835 \$16,164 \$16,562 \$17,019 \$16,004

Total Revenue | \$15,215 \$32,940 \$37,390 \$42,660 \$44,080

Net Benefits \$6,380 \$16,776 \$20,828 \$25,641 \$28,076

Net Present

Value at 4% \$4,754 \$9,515 \$7,813 \$6,498 \$4,807 \$35,187

Net Present (\$32,290) 4

Value at 7.125% \$3,607 \$5,975 \$3,727 \$2,505 \$1,268 \$17,98

NA) 4}

?Includes extra expenditures for protection of Puerto Rican perrat

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inasmuch as this young mahogany already has been planted, it makes sense to maintain those stands as mahogany plantations, However, this attitude violates the principle of ignoring sunk cost,

In economies costs are sunk when they have been incurred at some time in the past. A decision-maker can do nothing about them. However, he/she can control present and future costs and benefits. Therefore, the rational course of action maximizes the difference between those costs and benefits that the decision-maker can control. Therefore, he/she should ignore sunk costs when deciding what to do. 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 natural stands, it would be helpful to correct some misconceptions. The first misconception is that timbering has never occurred on the Forest. In actuality, at one time the Forest had the most timber sales, albeit very small ones, of any national forest in the country. Before the demise of fuelwood and charcoal use on the island a lot of timber was sold, and processed on site, for charcoal production. In a similar vein it has been pointed out that the acreage proposed for timbering under the preferred alternative is the smallest amount of acreage the FS ever has proposed. Second, due largely to faulty terminology many readers of the Plan believe that timbering will occur on natural stands in advanced stages of natural succession. This arises from the use of the term "advanced" in describing some natural stands. In actuality, according to Jerry Bauer, the Forest's forester, all land proposed for

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timbering has been affected by man in a substantial way. For instance, much of the land in mahogany plantations once was heavily degraded farm land. Such land can take hundreds of years to reach climax via natural succession, ?The areas termed ?advanced? in the Plan are areas which, due to silvicultural treatment, have a much higher concentration of ?desirable? trees normally found in the mature forest than stands in a comparable stage of succession which have not been treated. In this sense they are not ?natural? stands at all because they have been silviculturally treated. Thus, the timber program in general, including the natural stand activities, is slated for areas which have been subject to human manipulation,

Table 3 shows the economics 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 taken, Analysis areas usually contain several geographic areas which are not contiguous. The last three digits of the prescription identify the exact treatment to be used,

A couple of prescriptions require clarification. According to the final Plan, prescription 17943 is supposed to be used. However, the author could not find any calculations for 17943 in the final computer runs or other calculations. It is assumed that the Plan documents are in error here. Note also that 20943 is included in 11943 in the calculations. 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 show a negative return, The figures given should be read as shown (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. Thereafter no revenue occurs until the first thin in period 6. The treatments in period 4 can be considered an investment for future returns beyond period 6. Prescription 15963 looks similar in that the only return over the fifty year period is in period 4. It is difficult to judge the

Profitability of these last two prescriptions without estimates of future revenues past period six. A similar story can be told for prescription 16943. The Plan appears to be realistic in that it appears to schedule road rebuilding every time a timber activity is scheduled. Given the steep terrain and high rainfall this schedule

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TABLE 5. TINGER ECONOTHCS OW NATURAL STANDS

Prescription 1193,

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Timber Sele Preparation 0? 74693 60,886 87596 94,862]

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TABLE 5. TIMBER ECONOMICS OF NATURAL STANDS,

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Prescription 130

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Timber Sale Preparation 0 35965 16,779 39830 43,133

Timber Harvest Administration © 11322 12260 13278 14377

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Nev AT 48 © -954640 -15203 23.888 11,617

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TABLE 3. TIMBER ECONOMIC DATA ON NATURAL STANDS,

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TABLE 3. TIMBER ECONOFICS ON NATURAL STANDS,

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Timber See Preveratn 0 19.461 38672 ° 0

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Loca Road Reconstruction 0 2487 0.356 ° q

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TOTAL REVENUE ° 0 192.560 ° q

TOTAL NET REVENUE © 64158 127591 -25675 q

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TABLE 3. TIMBER ECCHOTICS ON NATURAL STANDS,

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TABLE 3. TIMBER ECONOMICS ON NATURAL

STANDS, SUMMARY

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Prescription 400% 7.1258)

11943] 262,201 128,131

13943, 75,337 ?_§7.056

15943) 147,005 101.468

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16943) 761849 \$1,301

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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 a 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 that some below cost timber sales can be justified in that they may make more profitable sales possible later on. Also, roads may make possible other benefits such as recreation or wildlife improvements. In the cases in question I have

ignored all recreation benefits: 1) because the roads primarily are for timber although secondary benefits from recreation are planned, 2) recreation values and demand estimates are highly questionable as

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they stand in the Plan, and 3) other intangible costs and benefits from roads cannot be included. More bias may result from including recreation benefits than from excluding them.

Much of the question of the economic viability of the timbering Program revolves around the lack of timber industry infrastructure on the island. To the extent that the FS has to incur expenses to create such an infrastructure the program would appear to be less profitable than it appears to be. This topic, however, turns out to be far more complicated than it looks. It is discussed in the conclusions of this report.

RECREATION

This section will be brief. The whole area of recreation benefits needs a lot of work. The RPA values are for the country as a whole and as such bear no necessary relation to a particular region, much less a place as different as Puerto Rico, Here developed recreation such as picnicking may be valued more highly than dispersed recreation such as hiking. The opposite is true on the mainland, Certainly developed demand in P. R. far exceeds dispersed demand. Forest Service RPA values do not reflect the Puerto Rican reality.

The discussion of recreation benefits, both developed and dispersed, needs refinement, The FS's Analysis of the Management Situation provides a rough estimate that a little less than a quarter of the dispersed demand may be unsatisfied developed demand (p. 5-18). These recreational visitor days (RVD's) come primarily from? people playing in the water at most of the Forest's bridge sites. The FEIS Reports that these sites sustain much waterplay and picnicking (p. 3-5). If one adds 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. It is not known how many people at the undeveloped river sites do or do not want these areas to be developed. Those people who preferred the site to be undeveloped would sustain a loss of benefits from the site's development. Those who would prefer the site's being developed would gain only a marginal (additional) benefit from better sanitation, less trash, and so forth. For instance, if these people were

ling 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, for instance, Construction of new sites would give these

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people added benefits of \$1.25 per RVD, not \$5.25, plus the non-priced social benefit of decreased water contamination downstream, Thus, even using the unrealistic RPA values, the Plan miscalculates the value from developing additional sites.

A lot more information about the nature of recreation demand is desperately needed. The author would recommend that when the FS does its next double sampling for recreation (which should be done regularly) that it attempt to use 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 problems, as does any methodology, it may come closest to the mark in this case. The travel cost method, the other main alternative, does not work well for the Forest because of the fact that most people come along the same route from San Juan, This travel pattern fails to

Provide sufficient variation in visitor origin for use in the travel cost approach. The use of a bidding game approach would represent a large step forward for the Forest.

SEDIMENTATION

It has been feared that timbering activity and road construction would lead to downstream degradation of water quality due to increased sedimentation. The paragraphs below report on this issue.

First, the Plan does not report how the sediment estimates were made. A visiting FS hydrologist with experience on the island used his professional judgement and experience in other timber areas of Puerto Rico, along with figures for such parameters as average rainfall and slope lengths, to estimate sediment coefficients per unit of various activities. The Universal Soil Loss Equation was not used due to its general inapplicability in the tropics.

Second, the sediment figures given constitute average yearly estimates over the life of each period. However, timber treatments and road construction occur during discrete years within periods. Consequently, the amount of sediment will be much higher during

certain years of a period and lower during others. This has important consequences for stream wildlife.

Third, the Plan yields figures on a forestwide basis. In reality sediment production is concentrated in certain analysis areas. As a

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result, sediment production will be much higher in certain areas of the Forest than is given in the Plan,

Fourth, the Plan fails to take into account the possibility of large storms hitting at the time of road construction or of timber treatments. Such storms would raise sediment load dramatically over that estimated in the Plan. The FS states that it plans to do timbering during the dry season in order to avoid as much sedimentation as possible, This is crucial. The mitigation of effects

depend upon the rapidity of revegetation or other mitigative steps which can be taken,

Fifth, sediment estimates omit any mention of landslides. This area is very prone to sliding. The slide on Highway 191 gives eloquent testimony to this fact. The numerous small slides along roads add their witness. This omission leads to underestimates of the amount of sedimentation which will occur under the Plan.

Sixth, it appears that there will be few, if no, municipal water dams affected by sediment. Water goes 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. Because many water systems already fail to meet turbidity standards, and because the EPA is considering further tightening of such standards, 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. Consequently, the author has not attempted to estimate higher water treatment costs from sediment on the assumption that successful mitigative measures will be taken.

Seven, 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.

ght, 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 upon shore currents sediments also could end up on the currently degraded reef protecting Luquillo Beach. The Sabana and Canovanas Rivers also

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have affected watersheds in the Forest. These rivers also have a high probability of affecting the Luquillo reefs. Should sediment from timbering affect 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 leuiers preceding each number for an analysis area (AA) identify

specific component of that AA as marked on the author's map...

Interpretation of these sediment figures is tricky because they are estimated for five or ten year periods. 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 AA were first 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. Because of the lack of definite timber plans by specific 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

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sediment production rate of 0.05 tons/year/acre. However, the Plan's sediment producing timber activities occur over a much smaller portion of the Forest. If one uses only the 7,189 acres allocated for timber production in the preferred alternative (C), one obtains 0.19 tons/year/acre maximum allowable sediment Production per acre. A glance at the right-hand portions of Tables 4 & 5 and the acreage of each section (from the second column of the table) quickly reveals that most of the one year flows will exceed by far the per acre limits assumed in in the Plan. For instance, analysis area FI produces 170.12 tons in one year during period one over its 366.60 acres, or 0.46 tons/year/acre. These tables imply that the Forest Service may have difficulty meeting the limitations imposed by its worst case scenario. Of course, current Forest-wide sediment Production may be less than assumed, giving the timber program a wider margin to play with, However, it is illustrative of the problems involved in using Forest-wide and period averages that the FS may not be able to meet its own criteria, In this author's opinion the FS must demonstrate far more clearly that it will not exceed PR. water quality standards, especially given the other considerations mentioned at the beginning of this section...

SUMMARY AND CONCLUSIONS:

In summary the benefit-cost calculations show that the differences between the alternatives shrink when the higher discount rate is used, Relative rankings do not change, however. The timber Program of the preferred alternative appears to be marginally profitable. When the economics of the natural stand timber program is explored, one analysis area in particular appears to hold the potential for below cost timber sales. The natural stand program shows a net present value of between \$220,000 and \$416,000. The relative attractiveness of the mahogany versus the natural stands seems to shrink dramatically at the higher discount rate of 7.125%. The analysis of recreation suffers heavily from insufficient information and from the use of mainland RPA values with little relevance to Puerto Rico. Although timber management practices may be able to protect municipal water supplies from receiving

additional sediment load from timbering upstream, it appears likely that downstream coral reefs and stream organisms may be subject to high surges of sediment during timber operations. Due to the omission of landslides and other considerations, the Plan may have underestimated sediment loads. These sediment flows may exceed

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the limits the FS set for itself in order to avoid the possibility of exceeding the water quality standards for the island.

?The author recommends that in the future the FS load 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) onto floppy disks. These could be made available at cost to any citizens interested in analyzing the Plan, It would facilitate well-informed discussion.

These data easily can be analyzed using a spreadsheet program. The linear programming runs underlying these data, however, cannot.

The conclusions found below center around unclear agenda(s) and related considerations. It appears that there is far more on the collective mind of the FS than what it has been able to communicate effectively in the Plan. The paragraphs below attempt 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 consists of a decision on the part of the FS on the national level to engage in international training and demonstration in the area of tropical forestry. The new forest supervisor's higher GS rating (than his predecessors) reflects a broader mission now assigned to that office - outreach to developing tropical countries. The FS evidently plans to offer its experience on the Caribbean Forest to others as part of a cooperative program with the Agency for International Development (AID). Additional research, therefore, not only would aid the better management of the Forest itself but other countries with similar forests (see FLRMP, p. 4-61 for a brief discussion),

To undertake such a program the Caribbean Forest either would have to own its own harvesting equipment which it could operate 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. Neither would it be necessary for the entire operation to be profitable in strict dollars and cents inasmuch as the main output of the Forest timber program would be education and research. One person very knowledgeable about the

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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 were to 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 necessarily will 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 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 losses in wildlife, basic research, recreation, and aesthetics which might occur as a result? From an economic standpoint this question needs to be addressed.

At the moment only ten small sawmills exist on the island. None lie close to the Forest. A substantial demand appears to exist for the hardwoods and poles which 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. It then could train properly its own personnel, could be assured that experiments and demonstrations would be executed as desired, and eventually could spin off the operation to the private sector. This option would have the advantage of stimulating forestry on the island. Both Bauer and Wadsworth unofficially have supported this

possibility. Another option would have the DNR crews do the work

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under careful contractual arrangements. The advantage of this option would be the lack of additional investment required. Should the FS rely on commercial operators, until it could assure itself that commercial operators understand and use the methods the FS wants used on its land it would have to supervise very closely any contractors working on the Forest. This substantially would 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 meet more of that demand while creating some jobs. Currently the legislature considering the possibility of creating a governmental forestry corporation which would provide much of the lacking infrastructure.

Whether this corporation would be economically viable and able to avoid the bureaucratic waste which has plagued other Commonwealth operations is a matter beyond the scope of this report. Wadsworth mentioned another option, unofficially, that the FS could set up an "infant industry" which could be protected until such time that it could be spun off. It would vertically integrate 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 of these options have their costs and benefits as well as their own probabilities for success or failure. However, none of these costs and benefits have been included in the Plan.

Inasmuch as island outreach and international research and demonstration underpin the timber program, the rationale for each policy and the form of its implementation, as well as the associated costs and benefits, must be included explicitly in the Plan before a reasoned evaluation of the merit of the Plan by the FS or interested citizens can be formulated. It is absolutely necessary that the exact role the FS intends to play internationally and within Puerto Rico be

made explicit, Similarly, the management plan needs to be precise about who will be bearing the infrastructure costs of timbering, and for what reasons. Until the FS clarifies the above, interested citizens, as well as the FS itself, will have a difficult time assessing the Plan's economic rationality.

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Other considerations related to the above bear mention. First, as Population moves to San Juan from other parts of the island, Pressures on the Forest will increase beyond those mentioned in the Plan. This will increase the demand for recreation on the Forest, as well as the potential for timber poaching and crime. Should interstate highway funds or other federal funds make possible the improvement of the highway from San Juan to the Forest this probably will increase even further the nontimber demands it Feceives. Although this scenario affects the planning environment over the next fifty years in a substantial way, the Plan does not address it, These questions need to be considered seriously.

Moreover, the two main policy directions mentioned above raise many questions. What is the proper role of the Forest Service in promoting economic development, particularly the timber industry for the island? Are the approaches being considered proper development approaches? Is the allocation of funds to this effort likely to bring the desired results? A lot could be written on this subject. Similarly, is the use of the Forest for international demonstration a proper foreign aid emphasis? 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, though not directly related to forestry, might prove a more suitable use of Forest land for international purposes? For instance, inviting foreign universities and researchers to make extensive use of the Forest for research along with US counterparts could have a tremendous stimulative effect on forest research 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 which show promise and use our Forest for the development of methodologies? Is our Forest area so small that it might be a wiser allocation of resources to develop other countries? abilities directly, demonstrating on their larger tropical

land base, and to use our limited forest base for forestry-related research? Conceiving of the Forest in terms of Puerto Rican and international economic development programs brings many opportunities as well as serious policy questions.

The Plan, as well as the FS staff members with whom the author spoke, strongly states that research will follow every action associated with the timber program. Everyone acknowledges that

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the Plan is based almost entirely on estimates and best guesses due to the lack of any recent modern timber operations on 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 and plant and animal life, what impacts sediment will have on downstream organisms, and so forth. Consequently, everyone feels the need to examine closely what the early experiences of timbering will show us. 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 forthcoming to accompany any timber effort. The Plan should have some 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 staffers 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 itself in a certain direction both in terms of personnel, prestige, and dollar 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 believe that the FS is any less susceptible to institutional momentum than any other group of humans. Whether it truly will be willing and able to change direction in any drastic way, should such a change prove necessary, deserves serious consideration,

Institutional momentum may be involved already in some other areas. For example, from a forestry perspective it may make eminent sense to convert old farm land to mahogany. This, of course, is what has happened. However, given that the decision-makers in question largely were foresters, they likely would have tended to think in terms of growing trees for harvest, just as environmentalists would have tended to see that land as being 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 having any timber activities at all? Serious cases can be made for these alternatives by other professionals. It is

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not clear that these professionals were consulted sufficiently to allow a variety of perspectives in the decision-making on these questions. Similarly, the Plan made little mention of the tremendous demand for non-timber research on the Forest. Many universities and other groups make great use of the Forest for research activities of many kinds. Yet, this demand, which probably will grow over time as interest in tropical rain forests increases, received little explicit consideration in the Plan. This demand, along with recreation, timber, wildlife, and so forth, needs to be considered in the balance. It is not evident that it has been represented adequately 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 biological diversity of the Forest. 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 FS's

reply of August 29, 1986 to the appellants states that biological diversity will increase as the result of planned activities. Should the FS be correct, then the increased diversity would provide a substantial added intangible benefit to those benefits explicitly stated in the Plan. On the other hand, should the FS be wrong, the Plan's activities could impose a large negative intangible cost on society from the loss of genetic information due to having fewer individuals of certain species or to the extinction of other species.

?The uncertainty over the Plan's effect on biological diversity raises large questions as to what the prospective costs and benefits of the Plan will be. It also brings into question whether demonstration Projects as proposed in the Plan will demonstrate sufficient environmental sensitivity if they are pursued despite the scientific debate over the Plan's soundness. Should the critics be correct, planned timber demonstrations would teach approaches which decrease biological diversity, exactly the opposite result which the FS itself wishes to achieve. This, in turn, would decrease the intangible benefits accruing the the international outreach program.

The present staff on the Forest has demonstrated its willingness to engage in dialogue and its sensitivity to environmental and other citizen concerns. However, there is no guarantee that future staff will be as sensitive. Any plan should include safeguards which would ensure that future staff will follow environmentally sound polici attitude which seems to be imbedded in the Plan may be warranted between individuals. This attitude especially

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appears in the intention to proceed with commercial timbering with the understanding that the operations would be modified or eliminated if warranted environmentally, A more secure means of assuring environmentally sound timber programs would involve gathering sufficient data first and then making informed timber decisions. It is not clear, particularly in today's policy environment, that a "rust me" attitude is appropriate in a planning document of a public institution. This would seem particularly so given the issue of institutional momentum mentioned above. It is not inconceivable that some future staffers, under political or other pressure, might feel forced to engage in environmentally unsound policies with which they themselves might disagree. Written environmental safeguards

ina Plan or required by a Plan would protect future staffers as

well as the public

Finally, given that the timber program in purely economic terms does not appear to be a highly profitable venture, the Plan's effect on animal and plant species is under debate, the downstream effects of timbering appears to be underestimated, the extent of recreation benefits requires substantial research, the underlying policy directions of the Plan require clarification, and the effects of institutional momentum constitute a potential problem, the question of decision-making under uncertainty may be involved here. With a resource as precious as this particular Forest it is not clear why the country should rush into harvesting the Forest's timber. The timber market and the demand for international assistance still will be there ten years from now. At present, however, the costs and benefits from a timber program, as well as some other planned activities, are unclear. Potential irreversibilities may exist. It may prove more prudent for decision-makers to forgo activities now which may disrupt the Forest and to collect the information necessary to make a more informed decision ten or fifteen years from now when the Plan probably will have to be re-written anyway. In this way the FS

would have time to clarify its goals, as well as to avoid committing itself to a line of action it may have difficulty changing should future information so warrant,

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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 on the appeal is taken from the Statement of Reasons and Request for Stay issued by the appellants.
2. Fourteen world-famous tropical biologists attending the National Forum on Biodiversity in Washington D. C. signed a letter dated September 24, 1986 denouncing the timber plans for the Caribbean National Forest on the grounds that it is "an irreplaceable example of the forest types which were once widely distributed in the Caribbean region." In their view it represents an unexplored reservoir of biological diversity. More detailed statements dealing with biological

diversity may be found in the appellants? Statement of Reasons and the FS's reply.

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