ESSAY 15D
Evaluating the Opportunity Costs of Establishing a Nature Reserve
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For poor countries, any decision to restrict the use of natural resources, and thereby possibly forgo revenue, must be made carefully. If land with potential value for timber production is proposed as a nature reserve, a key question of government officials and local stakeholders will be, “What are the trade-offs?” When projects are evaluated by resource economists, these trade-offs are measured as the opportunity cost, the value forgone from the next best alternative use. If timber harvests are reduced or eliminated in a nature reserve, the forgone net revenue from timber sales represents the opportunity cost of the reserve. We provide an example from Belize to show how opportunity costs can be used to evaluate proposed nature reserves.

The proposed Bladen Reserve is located in a basin of the Bladen Branch, a major arm of the Monkey River, in southern Belize, Central America. Its steepness, inaccessibility, and distance from population centers have spared it from major deforestation and heavy hunting pressure, thereby preserving an unusually intact moist forest ecosystem (Brokaw and Lloyd-Evans 1987). Proposals were made throughout the 1980s to set aside approximately 35,000 ha of the Bladen as a nature reserve for wildlife conservation and tourism. The government of Belize, although sympathetic to the idea of creating more nature reserves, expressed concern over the economic trade-offs involved in designating a large reserve at Bladen Branch. What would be the impact on Belize’s timber industry? How much timber revenue for the government would be forgone? Would the economic value of nontimber activities (research, tourism) be sufficient to offset the forgone timber income?

Our overall impression of the region of which Bladen is a part is that it is poised for dramatic changes in the near future. This relatively underdeveloped region is becoming inundated with colonists and refugees from other countries, who practice subsistence, slash-and-burn agriculture in competition with larger landholders controlling the better arable land. Similar scenarios have been played out throughout Central America, and the results are generally disastrous for environmental integrity. Farming moves to lower-quality, higher-elevation lands, which are quickly depleted. Hunting pressure kills much of the wildlife, and overall biological diversity becomes degraded.

Forestry Activities in the Region
The primary timber species harvested from the area are mahogany (Swietenia macrophylla), cedar (Cedrela mexicana), and pine (Pinus caribaea). In addition, some precious and luxury hardwoods are also harvested in the area: rosewood (Dalbergia stesoni), bastard rosewood (Swartzia spp.), mayflower (Tahebua rosea), and granadillo (Platymiscium yucatanum). Secondary hardwoods are also harvested, or have the potential for being harvested, including banak (Vi-
partly rests with the perceived inaccessibility of the area for commercial timber operations. Physical accessibility generally relates to the steepness of the slopes, the characteristics of the soil, and whether safe access for workers and equipment currently exists. Economic accessibility is more varied, as it has a value component and a temporal component. If sufficient timber quantities or values exist, most physical limitations can, to some extent, be overcome. Roads can be built and logging systems can be developed that physically allow access to the timber for harvesting.2

Due to the difficult physical access, the effective government policy has been that the steep granitic area on the slopes of the Maja Mountains be maintained in “protection forest.” Only in the alluvial floodplains of the small tributaries and on the Bladen itself was small-scale agriculture or forestry even contemplated (Wright et al. 1959). The most recent land use study confirmed and expanded these recommendations (King et al. 1986). In line with this belief, only 4% of the granitic soil types in the Bladen area forest reserves were considered accessible, with an additional 16% considered partially accessible (Johnson and Woods 1976).

Stocking of the primary and precious hardwood species, based on the 1976 study, is very low. For trees greater than 50 cm (20 in), only 7.5 mahogany stems and 2.9 cedar stems per 100 ha were estimated for the limestone soils, and none for the granitic soils. With normal good stocking of merchantable trees considered 1 tree per ha, this must be considered very low stocking.

Accessible Timber Area and Volume

Four areas of relatively accessible timber within the upper Bladen Branch watershed are proposed for the reserve. Accessibility is relative, however—although these areas may be harvestable, it may be quite expensive to get to them. The accessible harvesting area is approximately 3000 ha, with virtually all of it on the limestone-derived soils. Using the average volumes taken from Johnson and Woods (1976) for the primary species and allowing for growth since the survey, the standing volume of primary species would be at most 45,000 ft^3. For the secondary species the total volume is larger, but more difficult to calculate; most are currently not harvested for processing. The total estimated harvestable volume of currently or potentially utilizable secondary species is 3,857,500 ft^3. Allowing for the potential of utilizing other species and for ingrowth, we estimate an expected harvestable volume of 4,500,000 ft^3.

Direct Costs and Benefits of Timber Production

The potential government royalty revenue from the likely-to-be-harvested standing timber is B$567,000 (B$560/ft^3 x 45,000 ft^3 + B$512/ft^3 x 4,500,000 ft^3). Even if we assume higher stocking than the average described by Johnson and Woods, or more hectares available for harvesting, and increase the volumes by a further 25%, the total royalty revenue would be only B$708,500. Naturally, this value could increase further if the government raises its royalty rates, but the ultimate effect of this would be uncertain, as it might reduce the total amount of timber harvested. Using current and proposed milling capacities, it would optimistically take at least ten years to harvest the timber from the area. Harvesting equal volumes over a period of ten years would give a present value (the value in current dollars) of B$320,367 (B$567,000/10 x 5.6502) at a 12% discount rate, or B$417,318 (B$567,000/10 x 7.3601) at 6%.

Only rough estimates of the other costs of production can be made. These costs include extraction and milling labor and equipment, road building, additional forest management costs, and capital costs. Arnold et al. (1989) present high and low estimates for logging and milling costs for primary and secondary hardwoods that range between a low of B$0.55/bf and a high of B$0.90/bf. Using these costs and the available timber results in a total production cost of B$15,000,000 to B$24,500,000 (B$0.55/bf or B$0.90/bf x 6 bf/ft^3 x 4,545,000 ft^3). Given that much of the timber lies in difficult terrain and is far from existing roads, it is likely that the production costs will be on the high side.

The value of the final timber product from this harvest comes from the sale of lumber and veneer on the wholesale market. Using government-controlled prices, the timber has a current lumber-equivalent value of B$21,127,500 (B$1.25/bf x 6 bf/ft^3 x 45,000 ft^3 + B$0.77/bf x 6 bf/ft^3 x 4,500,000 ft^3). Because there is relatively little volume in primary or precious species in the area, the Bladen’s timber is not of great importance to the export market.

Comparing the costs and revenues gives an idea of the relative value of the standing timber. Ignoring the royalty...
costs for the moment, the net total value of the timber ranges from $34,750 (BS$0.75/t^{3}) to $61,250 (BS$1.35/t^{3}). It is difficult to calculate a present net value for the timber, as certain expenditures (primarily road building and equipment costs) must be in place prior to initiation of timber removals. However, we will optimistically assume that half of the total costs are spread out equally over the first four years and the remaining half over the remaining six years. Assuming that revenues occur equally over the ten-year harvesting period and that all prices and costs stay constant in real terms results in a \( \text{VPN} \) (present net value) that, at a 12% discount rate, ranges from $53,000,000 to $52,700,000 (BS$4,200,000 to $53,000,000 at 6%) or $50,66/ft^{3} to $59.92/ft^{3} to $55.66/ft^{3}.

If we include the royalty costs, they will naturally lower the present net value derived from timber production by at least 10% and possibly much more, depending on the assumed costs. Likewise, given that the high-cost scenario gives negative returns, it is unlikely that a significant amount of harvesting would be performed in the currently inaccessible areas, as those would be considered high-cost (i.e. low-profit) areas. Thus, it is likely that the only steeper-sloped areas that would be logged would be those that contain high amounts of the primary species. Because the Bladen Branch has relatively low stocking levels of these species, under current price and cost conditions, the steep-sloped granitic and limestone areas will remain economically submarginal.

Indirect Costs and Benefits of Timber Production

A number of indirect costs and benefits, either intended or unintended, result when timber harvesting takes place. Often these results are difficult to quantify in economic terms and are ignored in economic analyses. However, it is important to consider both the positive and negative effects that timber harvesting may have on development of the upper Bladen Branch resource.

Clearly, the most immediate effect of harvesting is the physical removal of trees and the building of roads and trails to bring out the trees. Given the current Forest Department policy of strict diameter limit cutting rules, the harvesting itself would have relatively little effect on the ultimate composition of the remaining forest. Some feel that this policy will cause the forest to degrade over time, as favored species may have difficulties regenerating under forest cover (Arnold et al. 1989). However, more thorough cutting practices may in fact cause additional regeneration problems by favoring low-density, nonmarketable, fast-growing species (Johnson and Woods 1975). An additional benefit of the selective cutting method is that relatively little runoff occurs. As a smaller percentage of the ground is left bare, the high quality of Belize's streams, even though timber harvesting has been going on for over 150 years, is a direct result of these practices (Hartshorn et al. 1984).

The major long-term effect of timber harvesting, especially in an isolated area such as the Bladen, is due to road construction. Roads open up an area, allowing access for purposes other than logging. The most serious potential problem for this area is an influx of hunters and unplanned milpa farming activity. The resulting damage to the exceptional wildlife population in the Bladen from these activities could be dramatic. At the same time, improved access is needed if the Bladen is to develop as a tourist attraction.

Another concept that should be considered when the development of an irreplaceable asset such as the Bladen is contemplated is its option value. This is a term used in economics to emphasize the idea that, once irreversible development of an asset occurs, the owner (in this case the Belize government) loses the option of developing the area for other uses. Thus, there is a value in delaying any irreversible activity, such as logging, until better, more complete information on all options is available. Because the Bladen is considered one of the least disturbed large forest areas in Central America, its option value for research, tourism, biodiversity, and wilderness is high. Barring extensive hurricane damage, its timber values will not diminish over time, as worldwide supplies of high-quality tropical timbers continue to decline and prices rise. The cost of forgoing conservation options must be balanced against the benefits from any planned activities for the area that would foreclose these options.

Conclusions

From this analysis, timber harvesting in the Bladen Branch area seems a marginal operation at best. The government of Belize, in the end, agreed with these results and declared a 393 km² portion of the Bladen Branch an official Nature Reserve in 1990. The area has been set aside strictly for research, and receives only minimal tourist use. Thus, the Belize government has in effect determined that the option value of the Bladen is sufficient to justify reserve status. Because this is not an irrevocable act, the government maintains the option of changing the use of the Bladen at some time in the future.

The power of an economic analysis in evaluating the opportunity costs of land use choices is that it can make explicit the costs of various decisions. The implication of this study is that it is not always the case that forests will be harvested for the immediate returns that timber can provide.

1. Royalty income is calculated using an average royalty payment of BS$ 20/ft^{3} and a conversion factor of 6 board feet to 1 cubic foot.

2. A former logger in the Bladen Branch area recounted how he actually drove a tractor over the Maya Mountain divide, winching his machine from tree to tree up the mountainside, at times hanging the tractor in midair. Clearly, even if this account is not strictly accurate, this area would not be considered "economically accessible."