

SEARCHING FOR SUSTAINABILITY

FOREST POLICIES, SMALLHOLDERS, AND THE TRANS-AMAZON HIGHWAY

by **Eirivelthon Lima, Frank Merry, Daniel Nepstad, Gregory Amacher, Cláudia Azevedo-Ramos, Paul Lefebvre, and Felipe Resque Jr.**

It is a powerful and disturbing image: loggers driving roads deep into the forest to remove a few mahogany trees, with slash-and-burn settlers following closely on their heels. However, it no longer captures the whole picture of logging in the Brazilian Amazon. So, then, what is the role of logging in the impoverishment or potential conservation of the Amazon rainforest? The answer to this question is deceptively complex: To achieve a sustainable future in Amazon forestry, policy-makers and stakeholders must understand the physical, economic and political dimensions of competing land use options and economic interests. They must provide effective governance for multiple agendas that require individual oversight.

For simplicity's sake, suppose that forest governance can be approached from two angles: a preservation approach in which the land is tucked away, never to be used again; and a "use-it-or-lose-it" approach in which a well-managed forest



estate becomes part of a sustainable economic development scenario and competes successfully with other land use options. In fact, 28 percent of the Brazilian Amazon is already listed as some form of park, or as a protected or indigenous area.¹ But what of the forest without protection, found mainly on private lands or on as-yet undesignated government lands? For many, selective logging of these forests is a form of forest impoverishment that is only slightly less devastating than forest clear-cutting.² For others, the selective harvest of timber is the best way to make the long-term protection of standing forests economically and politically viable.³

Opponents base their argument on two points: The long-term selective logging of primary tropical forest is financially impracticable, and selective logging is the first step in a vicious cycle of degradation that includes settlement and land clearing.⁴ Advocates say that selective logging, when done well (called “reduced impact logging”), is renewable, economically viable, and may provide an important stream of revenue for government and private landowners that would encourage the maintenance of forest cover.⁵ These proponents contend that if tropical forestry is to compete successfully with other land use options and essentially push back against the encroaching line of deforestation, some conditions must be met: the removal of subsidies to other land use options; the breakdown of barriers to entry, such as complex forest management plans; the dissemination of information on forestry to all potential market participants; and the elimination of perverse incentives for deforestation—in particular the establishment of land titles through clearing to demonstrate active use. Furthermore, if forestry is deemed the least cost approach to maintaining forest cover outside parks and protected areas, then subsidies to forest management activities might also be appropriate.

There are vast forested areas in the Brazilian Amazon located outside parks and

protected areas, and a multitude of landowners, including state and federal governments, are controlling that forest. As a result, policies to manage forest resources must necessarily be comprehensive, flexible, and appropriate to varying conditions and agents. The Brazilian government has

be transformed from a force driving forest impoverishment to one driving forest conservation, and how this transition, in turn, carries important potential benefits for the semi-subsistence farmers who live along this corridor. To fully describe this transformation, it is necessary to place it



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Timber will always be one of the Amazon's most important exports. Will the industry have a sustainable future for loggers as well as smallholders?

recently identified, and is now beginning to implement, a strategy of timber concessions that should help to corral some part of the industry into a controlled region. This should make it easier to monitor and will hopefully reduce illegal logging. The policy, however, mostly ignores the sticky issue of forestry on private land, which, although complex, could provide the engine for sustainable economic development among the disenfranchised settlers of the Amazon frontiers. The settlers may straggle onto the frontier individually, but they eventually form communities, control large areas of land, and become an increasingly important component of the timber industry.

A major economic corridor in the Brazilian Amazon—the Trans-Amazon Highway—illustrates how logging can

in light of the history and current context of the timber industry of the Amazon, and with the understanding that the complexity inherent in the largest and most diverse tropical forest in the world makes forest governance a mighty task.

A Brief History of the Amazon Timber Industry

Understanding logging along the Trans-Amazon Highway depends upon the historical context of the timber industry in the Amazon, which can be roughly divided into three periods (see Figure 1 on page 29).⁶ The early production period lasted from the 1950s to the early 1970s and was followed by a transition or boom period, which lasted from the mid 1970s

to the late 1980s. A third period, industry consolidation and migration to new frontiers, started in the early 1990s but is now coming to an end. The current timber industry is in such disarray from political mismanagement that in October 2005 the federal police temporarily suspended the transport of all logs from the Amazon.

Early Days (1950s to mid-1970s)

In the 1950s, the island region of the Amazon delta in the state of Pará was the center of the wood industry in the Amazon. Through the 1960s, there were three large plywood mills and six large sawmills that controlled production. With no connection to the large domestic markets of southeastern Brazil and the dependence on fluvial transport to access raw materials and deliver products, these mills produced only for the export market. Limited shipping capacity and irregular delivery schedules hindered sales to ports in northeastern Brazil, which could be reached by ship along the Atlantic coast. The primary source of raw material was smallscale landowners who sold logs along the banks of rivers. The environmental impact of logging was minimal, as timber extraction was an integrated part of diverse smallscale family farming systems on the Amazon River floodplain. The two popular tree species harvested were *Virola* (*Virola surinamensis*) for plywood and *Andiroba* (*Carapa guianensis*) for sawnwood (the first stage of the log processing sequence in which logs are cut into boards, but not planed).

In the early and mid-1970s, a number of smaller sawmills began to appear in the island region and farther up along the upper Amazon River. Into the mid-1970s, the Amazon remained disconnected from domestic markets but the export market flourished. Estimated log consumption was in the region of 2.5 million cubic meters per year—all harvested by axe. Early reports on timber production in

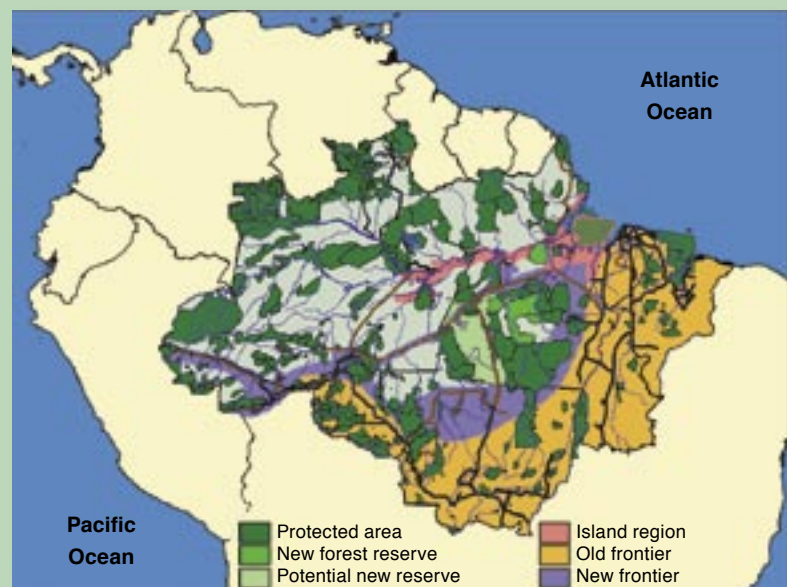
the Brazilian Amazon suggest this was a period of poor market access, poor quality of laborers, obsolete equipment, insufficient knowledge of local tree species, and scarce information on prices and markets for products.⁷

Transition Period (Late 1970s to Early 1990s)

A period of dramatic transition in the timber sector began in the late 1970s to early 1980s. Several highways were

completed to link the Amazon to domestic southeastern and northeastern Brazilian markets. The states of Rondônia, Mato Grosso, and Pará became connected through the BR364, BR163, and BR010 highways. Large public investment programs for the construction of dams, hydro-power plants, a railroad for the Carajás mining program, and the settlement of migrants from southern and northeastern Brazil changed the interfluvial forests of the Amazon, passively protected until that time by their inaccessibility.

Figure 1. Logging the Amazon



NOTE: The area along the Amazon River was first logged during the 1950s to 1970s. During the 1980s and 1990s, improved infrastructure and government policies encouraged logging on the “old” frontier, which mirrors the so-called “arc of deforestation.” As the stock declined on the old frontiers, firms have migrated west along the roads into the new frontiers. The map also shows the coverage of parks and protected areas of all types in the Amazon, including newly created parks.

SOURCE: Woods Hole Research Center, with data from Instituto Brasileira de Geografia e Estatística, Instituto Socioambiental, Instituto de Pesquisa Ambiental da Amazônia, Universidade de Minas Gerais.

Deforestation during this time was largely a response to government actions that either directly promoted or enabled land conversion from forests to other uses. The number and size of sawmills increased in response to the inexpensive primary resource and newly accessible markets, growing local demand, and the availability of cheap labor. Mechanization of harvesting, transport, and processing also contributed to the growth of sawn-wood output.

By the early 1980s, Paragominas (a city in Pará) became the most important mill center in the Amazon, producing mostly for the domestic market. The state of Mato Grosso also produced lumber for the domestic market, with important logging centers appearing in the towns of Sinop and Alta Floresta. Meanwhile, the island region continued to produce for the export market. In all, the transition period during the 1970s and mid-to-late 1980s was a turning point in the timber industry of the Brazilian Amazon.

Consolidation and Migration (mid-1990s to 2000s)

After the transition period, another (less dramatic) period of consolidation and expansion ensued along old and new logging frontiers.⁸ Old frontiers can now be found in eastern Pará (Paragominas and Tailandia) and in northern Mato Grosso (Sinop). In these areas, virgin forests have become increasingly scarce, and the logging industry became more diverse and efficient. The more inefficient logging firms exited the market, and those that remained became vertically integrated in an effort to capture value added in downstream processing.

Access to the old frontiers is generally good given the high density of paved roads. In contrast, new frontiers are characterized by a rapid inflow of mills and producers from the old frontier, poor government regulation, and high transport costs. The notable new logging frontier is in western Pará along the northern sec-

tion of the Santarém-Cuiaba Highway, the BR163.

The Industry Today

The current volume of wood produced in the Legal Amazon is between 20 and 30 million cubic meters, of which more than 50 percent is sold in the domestic Brazilian market.⁹ Prior to 2003, legal timber harvest was possible through the preparation of a forest management plan submitted to the government agency and

year, nearly all forest management plans were rejected.¹¹ The government, however, did not have an alternative readily available for the nearly 2,500 logging companies based in the Amazon, and an unintended side effect of the policy has been that more companies now simply operate illegally in such areas. Conflicts, protests, and widespread unregistered logging are now the norm.

To solve the problem of legalizing timber harvest and controlling the timber industry, the Brazilian government has



Sawmill technology in the Amazon (such as the bandsaw shown here) has not changed much since the 1950s. Efficiency is between 30 and 40 percent yield from log to boards.

approved with a temporary land title. All that was required by IBAMA, the Brazilian government environmental agency, was proof that a firm or individual had initiated a land legalization process with Brazilian land titling institutions such as the Institute of Colonization and Agrarian Reform (INCRA).¹⁰ Generally, land titling procedures took years, and they did not always result in legalization. By the time the land titling institution had made its decision, the harvest was already complete and the loggers had moved on to the next native forest stocks.

In 2003, the Brazilian government abruptly decided that management plans could no longer be approved on lands where property rights were not well established. That

proposed implementing forest concessions on public lands.¹² While this approach has some merit, and indeed has been debated extensively in the Brazilian public arena, large concessions controlled by a few companies may not be the best economic option in the regions where smallholders and other private landowners, including a large number of migrant settlers, are the predominant land users.¹³

The Case of the Trans-Amazon Highway

For two weeks in August 2003, the Trans-Amazon Highway was impassable: Angry loggers had blocked the road,

stopping traffic to protest a government-imposed timber shortage. A similar display occurred outside the town of Santarém, Pará, in January 2005 and recently on the BR163 Highway in western Pará. Tragically, access to timber was also one of the underlying reasons for the murder of Sister Dorothy Stang in the municipality of Anapú.¹⁴ Timber scarcity is a startling concept for the Amazon. How is it that a resource so apparently abundant can be the root cause of violent conflicts and protests?¹⁵ The answer lies partially in the sudden requirement by the Brazilian government that loggers provide proper legal documentation for land rights in areas where logs are extracted. But who owns the forests and logs along this frontier highway?

Built by General Emílio Garrastazu Médici (president of Brazil from 1969–1974), the main part of the Trans-Amazon Highway stretches approximately 1,000 kilometers from the town of Marabá to Itaituba on the banks of the Tapajós River.¹⁶ The highway is largely unpaved and virtually impassable for four months of the year during the rainy season. Homesteaders are usually allocated demarcated lots of 100 hectares apiece (approximately 250 acres) and then often battle the elements and wealthy land speculators to continue occupying the land.¹⁷ Still, migration to the region is relentless, as a constant stream of formal and informal land control followed early colonization projects in the late 1970s.¹⁸ INCRA, the federal land settlement agency, has formally settled approximately 30,000 families and an unknown number of informal squatters.

While it is commonly accepted that smallholders control vast areas of land along the Trans-Amazon Highway, the exact quantity of land is debatable. This question is taken up under the auspices of the Green Highways Project, an international multi-institutional project, led by the Brazilian nongovernmental organization Instituto de Pesquisa Ambiental da Amazônia (IPAM, Amazon Institute of

Environmental Research) with the support of the Massachusetts-based Woods Hole Research Center (WHRC) (see Figure 2 on this page).¹⁹ An area 100 kilometers (km) on either side of the Trans-Amazon Highway from the municipality of Itupiranga to Placas was mapped using satellite imagery and secondary data from Brazilian government sources. Land distribution was mapped and deforestation measured using 30-meter spatial resolution satellite images and secondary data from INCRA and the Brazilian Institute of Geography and Statistics (IBGE).²⁰ Images were classified into forest and non-forest classes by supervised classification and visual interpretation.²¹ The objective

was to identify where smallholders are located and where they will be located in the future.

Of the total 15.7 million hectares located within this buffer, 7.9 million are under the control of or are promised to smallholders. Of the total area within the 100-km study area, the land distribution is: 1.1 percent in demarcated settlements, 5.4 percent in current settlements, 11.4 percent as squatters (*posseiros*), 13.2 percent in old colonization projects, and 19.5 percent destined for future settlements by INCRA. Four percent of the land is in conservation areas, 7.6 percent in informal medium and large-scale land holdings, 15.4 percent in indigenous reserves,

Figure 2. The Trans-Amazon Highway



NOTE: Built in the 1970s, the highway stretches more than 3,000 km through the Amazon forest. It is mostly dirt and virtually impassable for much of the wet season (January to June). The study area, a 100-km zone between the towns of Marabá and Itaituba, is shown in the shaded region. The area in green is the “Legal Amazon” of Brazil.

SOURCE: Woods Hole Research Center.

and a final 21.2 percent is unclaimed government land.²² The number of smallholders currently residing in the 100-km zone was estimated by summing the area with active settlements, which includes current settlements, colonization, and squatters, and then dividing by an 82.6-hectare average lot size from survey results (see below), giving a total area of approximately 4.7 million hectares held by 57,000 smallholder families (see Figures 3 and 4 on this page and page 33).

Given the observed distribution of smallholders from the spatial analysis, the next logical question for the Green Highways Project was whether these agents could potentially supply the timber industry with wood. Demand for timber in the area is strong; the demand for logs on the Trans-Amazon Highway more than doubled over 12 years, increasing from roughly 340,000 cubic meters in 1990 to approximately 840,000 cubic meters in 2002. To determine whether smallholders can provide this quantity it is important to first estimate the growing stock potential of the forest held by smallholders, assuming that smallholders will in fact sell wood (this assumption will be revisited below). Using conservative (high) deforestation assumptions (for example, a range of 60 percent deforested for old colonization areas to 15 percent deforested for INCRA land allocated to future settlement) and a conservative stand volume of ten cubic meters per hectare, forest stock in active settlement areas is estimated to be 25.8 million cubic meters.²³ Using a harvest cycle of 30 years, this would give a sustained harvest volume of approximately 860,000 cubic meters, which matches current demand. At an estimated stumpage price of 10 Reais (R\$10) per cubic meter of standing trees (approximately US\$3.33 per cubic meter), this volume would generate R\$8.6 million per year.²⁴ To put this in perspective, if the smallholder forests within current settlements were used to their full potential right now, and the benefits distributed evenly to every family (recall there are an estimated 57,000),

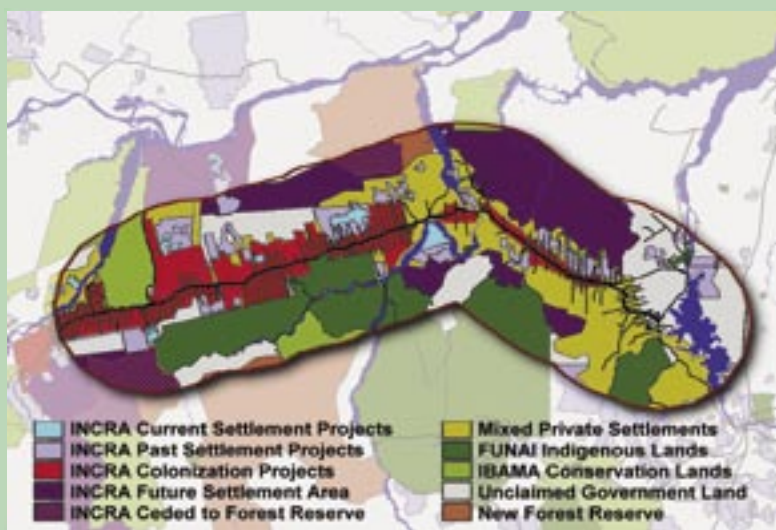
each smallholder household could receive R\$150 per year—a large sum given the discussion below.

Assuming that smallholders will eventually settle in areas set aside by INCRA, there will be an estimated forest stock of 52.6 million cubic meters, which could render a sustainable harvest of approximately 1.7 million cubic meters per year, more than double the current regional demand. Thus, there appears to be sufficient potential forest stock to meet the demand, and a tremendous opportunity

for a redistribution of wealth to the poor, should smallholders have an unhampered market to sell wood (see Table 1 on page 34).²⁵

However, one needs to ask if these estimates based upon government census data are consistent with data on the ground. To answer this question we make use of data generated from a recent comprehensive socioeconomic survey of smallholders along the Trans-Amazon Highway. Between June and December 2003, a total of nearly 3,000 families were

Figure 3. Land distribution map



NOTE: The spatial distribution of colonization and other formal settlements is based on information collected from the Brazilian government and analysis of satellite imagery. The main government land use agencies present in the region are INCRA^a (land settlement), IBAMA^b (environmental control) and FUNAI^c (indigenous areas).

^a Brazil's Instituto Nacional de Colonização e Reforma Agrária manages colonization and agrarian reform.

^b The Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis focuses on the environment and renewable natural resources.

^c The Fundação Nacional do Índio protects the rights of indigenous Brazilians.

SOURCE: Woods Hole Research Center and Instituto de Pesquisa Ambiental da Amazônia, with data from INCRA, IBAMA, and Instituto Brasileira de Geografia e Estatística.

interviewed, of which 2,441 lived within the 100-km zone shown in Figure 1.²⁶

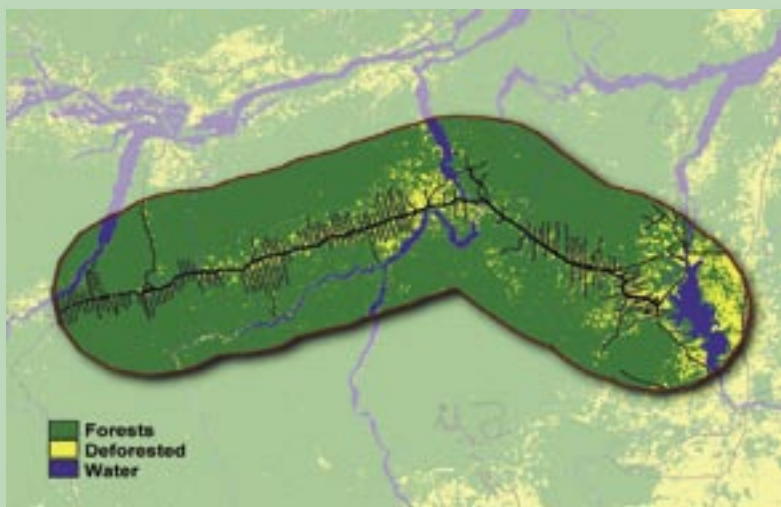
In the survey, smallholders were asked about their forest production, and socio-economic data were collected. The results add to the discussion above, showing that 26 percent had sold wood, and those sales had occurred largely within the last 5 years. There had been only one sale per lot. Ninety-six percent of the smallholders sold standing trees, and the average number of trees sold was 20 per smallholder, which corresponds to a harvest rate of

responds to R\$8.65 per tree or R\$1.73 per cubic meter.²⁷

Comparing these observations with the results from the geo-spatial analysis above, based on timber produced through legal deforestation and harvest of legal forest reserves (the area of smallholder land prohibited from clearing for crops), smallholders are selling approximately 1 cubic meter per hectare, and only 26 percent of them actually sell wood. At this harvest volume, it would take the harvest from 10,000 families per year—about 18

timber production from other studies. At a harvest intensity of 10 cubic meters per hectare, this participation requirement would be drastically reduced to only 1,000 families per year (which represents 1.8 percent of all families). This level of participation could be easily achieved without undue change in the smallholder system by subcontracting the timber industry to do much of the technical work associated with logging. The production of logs is dramatically low on smallholder lots because smallholders have limited knowledge of the forest potential and limited access to the financial resources required to manage the forests. This barrier can be overcome with a partnership between smallholders and the timber industry. For the successful implementation of such a partnership, however, it will be important for smallholders to understand the logging process and have adequate access to production information so that they can maintain a check on their industrial partners.

Figure 4. Land-use change



NOTE: Land use change within a 100-kilometer buffer of the Trans-Amazon Highway, showing large areas of available forest. The land cover map was produced from nine co-registered Landsat TM/ETM+ images (228-63, 227-63, 224-63, 226-63, 225-63, 225-62, 226-62, 227-62, 224-62). The images were classified into water, cloud, cloud/shades, forest and non-forest.

SOURCE: Woods Hole Research Center and Instituto de Pesquisa Ambiental da Amazônia.

Holding Back the Tide of Smallholder Forestry

From the perspective of community foresters, the current ideal is that individuals within the communities must work collectively and must control the entire chain of production through to sales of the final product. Formal interaction with the timber industry is anathema. Also, there is still the idea that forest management must happen in large, undisturbed, contiguous tracts of forests. This closely held and restrictive view has undermined the potential of community forestry in the Amazon. The reality is that there are more than 500,000 settlement families in the Brazilian Amazon who work individually or in community associations and who specialize (though perhaps not yet efficiently) in the supply of standing timber by working closely with logging companies (see Figure 5 on page 35).

However, most of the community-based forestry operations have two key

approximately 1 tree per 5 hectares and, assuming an average volume of 5 cubic meters of log per tree, an average sale volume of 100 cubic meters. The average total sale value was R\$173, which cor-

percent of the estimated total smallholder families—to sustain current demand from the area industry at current prices. This amounts to a harvest volume that is only 4 percent of current estimates for Amazon

problems. First, when dealing with smallholders on an individual basis, the loggers hold all the cards. They have more information about the species and value of timber, and they exploit the immediate financial needs of cash-poor smallholders. Second, logging on smallholder lots is legal only under two premises: smallholders have deforestation licenses that allow the clearing of 3 hectares per year and the sale of 60 cubic meters per year (up to 20 percent of the land area owned), or they may have the option to develop a forest management plan that must be approved by IBAMA. Of the sales registered in the surveys, 26 percent came from deforestation permits, and a startling 79 percent came from the “legal reserve” on each plot.²⁸ Because no formal forest management plans have been developed for these smallholder systems, this would imply that nearly 80 percent of log sales from smallholders are currently illegal by government rules; in addition, few smallholders get legal deforestation permits. Why are there no formal

plans? A forest management plan requires that the landowner hold legal title, and although 95 percent of smallholders surveyed claimed to be the landowner, we found only 26 percent held formal title; a statistic supported by previous research in the region.²⁹ This lack of coordination between agencies and resource users is a major barrier to overcoming illegal logging within smallholder systems and to the integration of smallholders into the formal timber market.

Small-Farm Family Forestry in the Amazon

Coordination between ministries is not an impossible task, however. For example, IBAMA, INCRA, and the Ministry of Public Works of the town of Santarém (in Pará) operating with limited resources but in partnership with loggers and smallholders, found a creative solution to this problem in the form of an equitable partnership between industry and

smallholders. In this case, the community associations subcontract the loggers to plan and implement harvesting, while the government ministries have the responsibility of expediting title and management approval. The land is owned individually, and management plans are done for each private 100-hectare lot, but the negotiations are between the logger and the community association. The community can demand higher prices by selling as a group, and the logger is assured of a long-term supply of timber. As a result, legal forest operations are taking place and smallholders are capturing a fair share of the benefits from the timber harvest on their land (see the box on page 37).³⁰

However, changes in government personnel and extreme inefficiency (the project industry coordinator has had management plans under review at IBAMA for more than a year) has made even this promising partnership tenuous. These types of projects are in danger of failing because government oversight is inefficient, inadequate, corrupt, and contradic-

Table 1. Timber potential from smallholder lots on the Trans-Amazon Highway

Smallholders	Total area (hectares (ha))	Percent land area	Forest cover (percent)	Total forest area (ha)	Timber stock (m ³)	Potential timber flow (m ³ /year)
Future settlement projects	3,055,000	19.5	85	2,596,000	25,965,000	865,000
Colonization projects	2,063,000	13.2	40	825,000	8,252,000	275,000
Informal settlement	1,792,000	11.4	60	1,075,000	10,750,000	358,000
INCRA settlements	852,000	5.4	80	682,000	6,815,000	227,000
Demarcated settlements	169,000	1.1	50	85,000	847,000	28,000
Total smallholders	7,931,000	50.6	-	5,263,000	52,629,000	1,753,000

NOTE: INCRA is Brazil's National Institute of Colonization and Agrarian Reform. The entire buffer area is 15,643,000 ha. The area not occupied by smallholders is comprised of unclaimed government land (21.2 percent), indigenous land (15.4 percent), medium and large informal settlement (7.6 percent), and conservation units (4.2 percent).

SOURCE: Instituto de Pesquisa Ambiental da Amazônia (the Amazon Institute of Environmental Research).

tory.³¹ There may be a partial solution to be found in timber concessions, but even with successful concessions, the large-scale problems of illegal logging will not disappear. Indeed, the problems of illegal logging will never be solved if IBAMA cannot control the industry or support it effectively, but there is no indication so far that IBAMA can do it alone. It is reasonable to assume, however, that the economic benefits of timber production on their private landholdings will stimulate smallholders to manage their forests and help control illegal activities.

What Does the Future Hold?

What do the results of the Green Highways Project have to say about the issue of loggers and forest policies? As mentioned above, the main thrust of the new forest policy centers around timber concessions on public lands with some allowances given to communities. This is an effective program for a portion of the industry, but there are two problems with the idea. First, the evidence presented above indicates that this approach is inadequate for some major economic corridors where there are many smallholders, such as in the case of the region surrounding the Trans-Amazon Highway; of the 80 percent of land available for harvest (for example, excluding conservation units and indigenous areas), the Green Highways Project shows that 64 percent is under the control of, or is promised to, smallholders. Second, it also shows that forestry is highly underutilized in these smallholder systems. This and the fact that there are more than 500,000 families settled in the Amazon region mean these results imply a very large economic loss to Brazilian society from not capturing a potential timber supply that would almost do away with the need for timber concessions on public lands.

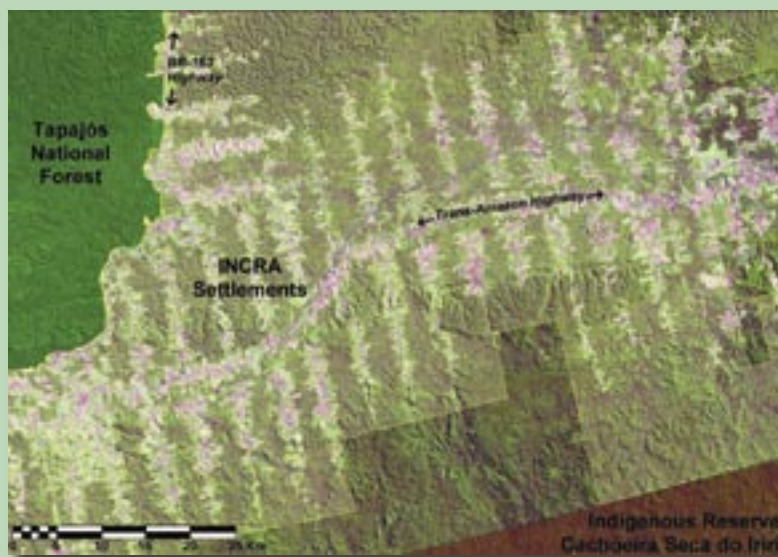
Further, by excluding smallholders from access to the timber industry through current management plan requirements,

smallholders are denied what could amount to a substantial and vital source of economic development. In some settlements, research has shown that the value of a single harvest can equal more than 15 years of agricultural production.³² And finally, even if only some portion of the demand for logs is met by concessions harvesting on public government lands, it may have a negative socioeconomic impact on the potential for small farm forestry by depressing overall prices.

To promote sustainable forestry, the evidence indicates that the government has to realistically deal with land titling, facilitate institutional coordination, and commit to stopping illegal logging through better enforcement. Invariably,

the causes of policy failure and poor governance are related to corruption and political auction of important positions in government institutions. An intricate net of political obligation, to the detriment of technical decisions, is commonplace, and even those individuals fiercely committed to their tasks (and there are many) struggle to make quality strategies a reality. A lack of efficiency in government agencies, whether through poor coordination or delays, increases transaction costs and makes formal forest management difficult. Also, by neglecting secure property rights, or making these difficult and costly to obtain, the government inadvertently creates incentives for smallholders and loggers to engage in illegal logging.

Figure 5. Patterns of smallholder settlement



NOTE: This image of the Trans-Amazon highway in western Pará shows the typical herringbone pattern of smallholder settlement. The highway meets BR163 (Santarém-Cuiabá highway) on the far left of the image. The feeder roads are 5 km apart and can stretch more than 50 km into the forest. The typical smallholder lot is 400 by 2,500 meters, so that two can fit between the feeder roads.

SOURCE: Woods Hole Research Center.

Forest management projects on smallholder settlement lots in the Brazilian Amazon will, if widely adopted, help move the region toward equitable forest-based economic development and a peaceful resolution to the problems now facing migrant families. This is not the only solution for the Amazon, but it is a step forward and one well within the reach of the current administration. Without change, however, we can expect further illegal degradation of the forest and a continuing struggle for economic development and social justice on the Amazon frontier.

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NOTES

1. This approach has been plied very successfully by large conservation organizations, in particular Conservation International, which solicits funds to buy up biodiversity “hot-spots.” For an analysis of the effects of parks and protected areas on fires in the Amazon, see D. Nepstad et al., “Inhibition of Amazon Deforestation and Fire by Parks and Indigenous Reserves,” *Conserva-*

tion Biology, In press, expected publication February 2006.

2. I. Bowles, R. E. Rice, R. A. Mittermeier, and G. A. B. da Fonseca, “Logging On in the Rain Forests,” *Science*, 4 September 1998, 1453–58; R. Rice, C. Sugal, and I. Bowles, *Sustainable Forest Management: A Review of the Current Conventional Wisdom*. (Washington, DC: Conservation International, 1998); R. Rice, R. Gullison, and J. Reid, “Can Sustainable Management Save Tropical Forests?” *Scientific American*, April 1997, 34–39.

3. D. Pearce, F. E. Putz, and J. Vanclay, “Sustainable Forestry in the Tropics: Panacea or Folly?” *Forest Ecology and Management* 172, no. 2 (2003): 229–247; M. Verissimo, A. Cochrane, and C. Sousa Jr., “National Forests in the Amazon,” *Science*, 30 August 2002, 1478; F. E. Putz, K. H. Redford, J. G. Robinson, R. Fimbel, and G. Blate, *Biodiversity Conservation in the Context of Tropical Forest Management* (Washington, DC: Biodiversity Studies, The World Bank, 2000), <http://world-bank.org/biodiversity>.

4. G. Asner, et al., “Selective Logging in the Amazon,” *Science*, 21 October 2005: 480–481. The Asner study claimed that the selective logging of the Amazon is far more widespread than previously thought. The authors suggest that the source of logs in the Amazon is not slash-and-burn deforestation—those logs are simply burned—but conventional poor-quality selective logging and that this is the first step in the economic and ecological degradation of the forest. According to the data, this

ANDRÉ DA SILVA DIAS REFLECTS ON THE FOREST FAMILIES PROGRAM

Forest management models that can contribute to the social, environmental, and economic development of smallholders and traditional populations have been the subject of many recent initiatives in the Amazon. The “Forest Families” program [in Santarém] works with a specific relationship that appears to be very common but little studied: smallholders and the timber industry. It is interesting to note some of the fundamental characteristics around which the program is built: the relationship between the smallholder and the industry already exists; its foundation is market-based; its actors are well-defined; and [it] is based on uncommonly strong legal and ethical rigor. The last characteristic alone makes one pay attention.

One can question whether this is community forest management or not. A pertinent doubt, but, in the end, there exists a forest and its resources and a people organized, or organizing, in communities. In fact, the smallholders are not directly managing their forests: they delegate this activity to a subcontractor and his team. And when they delegate they relinquish some personal control of the forest. However, they exercise their rights to the forest in a free manner, in

a negotiation process that strengthens the local organization, generates collective responsibility, creates a commonly used infrastructure, provides income and, most importantly, gives value to the standing forest. All of which are the principles that underlie community forest management.

It is possible to imagine a scenario in which they should manage their own forests in accordance with their capacity, limitation, abilities, and interests. Perhaps this will happen one day. But for right now, the reality is different. No better and no worse, this is just different than many other community forest management initiatives where the local residents play the role of managers. The fact is that they, the owners, are who should say whether this is how it should be. And they seem to be making this [decision] in an informed way, understanding their limitations, and identifying opportunities. It is interesting to observe a community and its people (in this case Santo Antonio) started barely two years ago by families of different origin, who until this point never knew each other, but who already have solid development plans and a growing autonomy in the formulation of local projects, rather than

just hope of better days.

I believe that one of the principal contributions that this program can lend to the discussion of local forest management is to define criteria and indicators of a healthy and egalitarian relationship between smallholders and the timber industry. To get there, some challenges that deserve more attention are:

- Improving local knowledge of good forest management practices.
- Identifying the impact of timber harvest on the supply of hunting and non-timber forest products.
- Analyzing the socioeconomic impact of the timber income on the smallholder systems.

SOURCE: André da Silva Dias, Executive Manager, Fundação Floresta Tropical, December 2003. This box was translated from the Portuguese by Frank Merry and first published in a report by Instituto de Pesquisa Ambiental da Amazônia (IPAM) for the International Institute for Environment and Development (IIED) as part of the IIED Power Tools Initiative: Sharpening Policy Tools for Marginalized Managers of Natural Resources. F. Merry, E. Lima, G. Amacher, O. Almeida, A. Alves, and M. Guimares, *Overcoming Marginalization in the Brazilian Amazon Through Community Association: Case Studies of Forests and Fisheries*, (Edinburgh, UK, 2004). It is reprinted with permission.



Directional felling, as shown here as part of a reduced impact logging program in the Tapajós National Forest, near Santarém, can reduce damage and help in the search for sustainability.

is more widely practiced and perhaps more damaging than previously thought.

5. Forest management and reduced impact logging (FM-RIL) guidelines are available from many sources: the Suriname Agricultural Training Center (CELOS); the International Tropical Timber Organization (ITTO); the Food and Agricultural Organization of the United Nations (FAO); the Institute of Humans and the Environment of the Amazon (IMAZON); and the Fundação Floresta Tropical (FFT, Tropical Forest Foundation). In addition, field models in Brazil demonstrate the improvements of FM-RIL practices over conventional selective logging. See the FFT website at <http://www.fft.org.br> and click "Research." There have been several studies on the economic benefits of reduced impact logging and comparisons with "conventional" selective logging. For a few examples see: S. Armstrong and C. J. Inglis, "RIL For Real: Introducing Reduced Impact Logging Techniques into a Commercial Forestry Operation in Guyana," *International Forestry Review* 2, (2000): 264–72; F. Boltz, D. R. Carter, T. P. Holmes, and R. Perreira Jr., "Financial Returns Under Uncertainty for Conventional and Reduced-Impact Logging in Permanent Production Forests of the Brazilian Amazon," *Ecological Economics* 39 (2001): 387–98; P. Barreto, P. Amaral, E. Vidal, and C. Uhl, "Costs and Benefits of Forest Management for Timber Production in Eastern Amazonia," *Forest Ecology and Management* 108, no. 1 (1998): 9–26; and T. P. Holmes et al., *Financial Costs and Benefits of Reduced Impact Logging Relative to Conventional Logging in the Eastern Amazon* (Washington, DC: Tropical Forest Foundation, 1999).

6. Thanks to Johan Zweede of the Instituto Florestal Tropical in Belém, Brazil, and Benno Pokorny of the University of Freiburg, Germany, for valuable comments on the history and context of the timber industry.

7. For an excellent review, see I. Sholtz, *Overexploitation or Sustainable Management: Action Patterns of the Tropical Timber Industry: The Case of Pará, Brazil, 1960–1997* (London: Frank Cass Publishers, 2001).

8. By definition the term "frontier," when applied to forests, implies the point at which new logging occurs. It is, however, common in the literature of logging in the

Amazon to differentiate frontiers by age. This is done partially out of custom, but also because logging on all "frontiers" is relatively new; even old frontiers are less than 30 years old.

9. The "Legal Amazon" is a geo-political definition of the Amazon region in Brazil and comprises the states of Amapá, Amazonas, Acre, Maranhão, Mato Grosso, Pará, Rondônia, and Tocantins. The volume of sawnwood destined for export is different across frontiers. More than 60 percent of logs from new frontiers are destined for the export market, whereas on the intermediate and old frontiers, that level dips to 50 and 15 percent, respectively, according to F. Merry et al., "Industrial Development on Logging Frontiers in the Brazilian Amazon," *International Journal of Sustainable Development*, in review. For a recent discussion of production volumes, see G. Asner et al., note 4 above.

10. The Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (<http://www.ibama.gov.br>) is the Brazilian government's environmental agency responsible for the forest sector and all issues of environmental control in the country. The federal land-titling agency is the Institute of Colonization and Agrarian Reform (INCRA). For more information, see <http://www.incra.gov.br>. Each state also has a local agency.

11. The forest management process includes a formal management plan that essentially states that the company intends to harvest in a given area (with accompanying maps and documentation) and subsequently an annual operating plan that delivers the details of each year's harvest operation. The term "forest management plan" includes both of these components of logging.

12. For more information on forest concessions, see A. Veríssimo, M. A. Cochrane, and C. Sousa Jr., "National Forests in the Amazon," *Science*, 30 August 2002, 1478.

13. The forest concessions issue has long been debated in the scientific literature. Both sides of the argument for Brazil can be explored in F. D. Merry et al., "A Risky Forest Policy in the Amazon?" *Science*, 21 March 2003, 1843 and in F. D. Merry et al., "Some Doubts About Concessions in Brazil," *Tropical Forestry Update*

13, no. 3 (2003): 7–9 (see <http://www.itto.or.jp/live/contents/download/tfu/TFU.2003.03.English.pdf>). See also F. D. Merry and G. S. Amacher, "Forest Taxes, Timber Concessions, and Policy Choices in the Amazon," *Journal of Sustainable Forestry* 20, no. 2 (2005): 15–44; and Veríssimo, Cochrane, and Sousa, note 12 above. For earlier discussion on concessions see J. A. Gray, *Forestry Revenue Systems in Developing Countries*, FAO Forestry Paper 43 (Rome, 1983); R. Repetto and M. Gillis, eds., *Public Policies and the Misuse of Forest Resources*, (Cambridge, UK: Cambridge University Press, 1988); J. R. Vincent, "The Tropical Timber Trade and Sustainable Development," *Science*, 19 June, 1992, 1651–1655; and J. A. Gray, "Underpricing and Overexploitation of Tropical Forests: Forest Pricing in the Management, Conservation and Preservation of Tropical Forests," *Journal of Sustainable Forestry* 4, no. 1/2 (1997): 75–97. The Ministry of Environment has created a new law on public forest management (Law 4776/05), which was approved by Brazil's Chamber of Representatives in July, is still awaiting the vote of the Senate. This law would create the national forest service, the forest development fund, and would regulate timber harvest on public lands. Three kinds of harvest are sought for production forests: direct government management of conservation units (such as national forests); local community use (such as extractive reserves); and forest concessions.

14. Dorothy Stang, a 73-year-old nun from Dayton, Ohio, a practitioner of liberation theology, and an ardent supporter of local settlers, was assassinated in broad daylight in February 2005 in a remote farm community near her home of 25 years in Anapú on the Trans-Amazon Highway. Her battle for equal rights for the poor, including legal land and resource ownership, brought her in direct conflict with loggers and ranchers. Her death triggered an avalanche of government response. Two thousand soldiers were sent to the region to crack down on illegal loggers and land speculators, and five million hectares of forest (an area the size of Costa Rica) were designated as parks and reserves in what may be the world's single greatest act of tropical rainforest conservation.

15. The estimate of forest stock for the Amazon is approximately 60 billion cubic meters. There are varying estimates of the flow from the forest: The IBGE, which is the government institute of geography and statistics (<http://ibge.gov.br>), estimates log demand in the north of Brazil to be about 17 million cubic meters; IBAMA, the environmental regulation agency of Brazil, estimates it to be around 25 million; and IMAZON, a local nongovernmental research organization, estimates it at about 24 million—down from 28 million in 1999.

16. The entire Trans-Amazon Highway runs approximately 3,300 kilometers, connecting the state of Tocantins to the state of Acre near the Peruvian border. Continuing westward from Itaituba to the town of Humaitá (a stretch which lies to the west of the Tapajós River) is virtually uninhabited, but may be the future frontier on which this story is replayed some years hence.

17. For an excellent discussion on property rights, violence and settlement on the Trans-Amazon Highway see L. J. Alston, G. D. Libecap, and B. Mueller, *Titles, Conflict, and Land Use: The Development of Property Rights and Land Reform on the Brazilian Amazon Frontier* (Ann Arbor: The University of Michigan Press, 1999); and L. G. Alston, G. D. Libecap, and B. Mueller, "Land Reform Policies, the Sources of Violent Conflict in the Brazilian Amazon," *Journal of Environmental Economics and Management* 39, no. 2 (2000): 162–188.

18. For more discussion of smallholder settlement in new and old settlements and the roles of community associations in economic development in migrant settlements see F. Merry and D. J. Macqueen, *Collective Market Engagement* (Edinburgh, International Institute for

Environment and Development, 2004), http://www.iied.org/docs/flu/PT7_collective_market_engagement.pdf.

19. Other institutions working on the Trans-Amazon Highway within the Green Highways Project are the Fundação Viver, Produzir e Preservar (FVPP) and the Instituto Floresta Tropical (IFT).

20. The principal source of government statistics for Brazil is the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE). Their website can be accessed at <http://www.ibge.gov.br>.

21. A supervised classification is a procedure for identifying spectrally similar areas on an image by pinpointing training sites of known targets and then extrapolating those spectral signatures to other areas of unknown targets. The signatures are quantitative measures of the spectral properties at one or several wavelength intervals. These measures include class maximum, minimum, mean and covariance matrix values. Training areas, usually small and discrete compared to the full image, are identified through visual interpretation and used to “train” the classification algorithm to recognize land cover classes based on their spectral signatures, as found in the image. The training areas for any one land cover class need to fully represent the variability of that class within the image.

22. The total area for squatters was 19 percent of the buffer zone, of which local extension agents estimated 60 percent to be smallholders. The remaining 40 percent were said to be medium- and large-size holdings.

23. The evidence also indicated that only one percent of the buffer area is currently deforested, so these estimates could be considered very conservative for deforestation.

24. The price of R\$10 is based on a conservative estimate of a formal logging contract between smallholders and the industry near the town of Santarém and the example of a forest concession (3-year cutting contract)

in the Tapajós national forest—an ITTO project run by IBAMA—where the average stumpage fee for three price categories in 2003 was R\$11.73. The exchange rate for the period of the survey was approximately R\$3 per US\$1, but is now at R\$2.2 per US\$1. For further commentary on the timber markets of Brazil, see A. Veríssimo and R. Smeraldi, *Acertando O Alvo: Consumo da Madeira no Mercado Interno Brasileiro a Promoção da Certificação Florestal* (Finding the Target: Consumption of Wood in the Brazilian Domestic Market and the Promotion of Forest Certification) and M. Lentini, A. Veríssimo, and L. Sobral, *Fatos Florestais da Amazônia* (Forest Facts of the Amazon) (Belém, Brazil: Imazon, 2003); E. Lima, and F. Merry, “Views of Brazilian Producers—Increasing and Sustaining Exports,” in D. Macqueen, ed., *Growing Timber Exports: The Brazilian Tropical Timber Industry and International Markets* (London: IIED, 2003), 82–102.

25. For an economic model of smallholder decision-making, production, and labor allocation, see F. D. Merry and G. S. Amacher, “Emerging Smallholder Forest Management Contracts in the Brazilian Amazon: Labor Supply and Productivity Effects,” *Environment and Development Economics*. Invited to revise and resubmit, expected publication 2006.

26. The preliminary results of the survey were presented in seminars to the smallholders in June 2004. Further details of this survey are available from the authors.

27. In comparison, the estimated price for logs at the mill gate in 2002 on the Trans-Amazon was R\$58 per cubic meter, and an unadjusted five-year average price for logs from 1998 to 2002 was R\$39 per cubic meter, but this is before accounting for harvest costs—which for intermediate frontiers such as the Trans-Amazon can run between 30 and 40 Reais per cubic meter and transportation costs; transport distances can run as far as 80 or 90 kilometers from log deck to mill.

28. The legal reserve (Reserva Legal) of a smallholder lot, or for that matter any private land holding in the

Brazilian Amazon, is 80 percent of the total land area. This “reserve” area can only be used for forestry with approved forest management plans or the collection of non-timber forest products.

29. Alston, Libecap, and Mueller, note 17 above. Only 11 percent of land owners hold formal title. In our survey, individuals were asked whether they held “definitive title,” not formal records.

30. This example is well documented. See D. Nepstad et al., “Managing the Amazon Timber Industry,” *Conservation Biology* 18, no. 2 (2004): 575–577; D. Nepstad et al., “Governing the Amazon Timber Industry,” in D. Zarin, J. R. R. Alavalapati, F. E. Putz, and M. Schmink, eds., *Working Forests in the American Tropics: Conservation through Sustainable Management?* (New York: Columbia University Press, 2004), 388–414.

31. Another example is the project Safra Legal (Legal Harvest) on the Trans-Amazon Highway. The objective of this project was to make use of the legal deforestation options available to smallholders. The idea of this project came from the forest management projects near Santarém and presented a wonderful alternative to smallholders who would have simply burned the trees where they planned to conduct agricultural activities. The project, however, has recently become embroiled in scandal as a conduit of illegal logging, see L. Coutinho, “More Petista Mud in the Ibama,” *VEJA*, 15 June 2005, 70. The problems behind the Safra Legal program were also described in L. Rohter, “Loggers, Scorning the Law, Ravage the Amazon Jungle,” *The New York Times*, 16 October 2005. These articles illustrate the far-reaching negative effects of corrupt government on the sustainable management of natural resources.

32. F. Merry et al., “Collective Action Without Collective Ownership: the Role of Formal Logging Contracts in Community Associations on the Brazilian Amazon Frontier,” *International Forestry Review*, in review. Drafts available from the authors.