Timber production in selectively logged tropical forests in South America

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Selective logging is an extensive land-use practice in South America. Governments in the region have enacted policies to promote the establishment and maintenance of economically productive and sustainable forest industries. However, both biological and policy constraints threaten to limit the viability of the industry over the long term. Biological constraints, such as slow tree growth rates, can be overcome somewhat by management practices. In order to improve the likelihood of success for sustainable management, it is important to accept that forests change over time and that managed forests may be different than those of the present. Furthermore, education campaigns must convince decision makers and the public of the value of forest resources. We recommend that the forest sector be governed by simple, understandable regulations, based on sound science and consistent enforcement, and that governments work with, instead of against, industry. Problems of tropical forest management are far from being solved, so biological and social scientists should continue to generate new knowledge to promote effective management.

El aprovechamiento selectivo es una práctica extensiva del uso del suelo en Sudamérica. Los gobiernos de la región han establecido políticas para promover el establecimiento y mantenimiento de industrias forestales económicamente productivas y sostenibles. Sin embargo, tanto restricciones biológicas como políticas amenazan con limitar la viabilidad a largo plazo de esta industria. Las limitaciones biológicas, tales como una baja tasa de crecimiento de los árboles, pueden ser superadas parcialmente a través de prácticas de manejo. Para aumentar la probabilidad de éxito del manejo sostenible es importante reconocer que los bosques cambian en el tiempo y que los bosques manejados podrían ser diferentes a los bosques actuales. Asimismo las campañas de educación deben convencer a los tomadores de decisiones y al público en general del valor que tienen los recursos forestales. Recomendamos que el sector forestal esté regido por regulaciones sencillas y comprensibles, basadas en una ciencia sólida y con aplicación consistente, y que los gobiernos trabajen con, y no en contra de, la industria. Los problemas de manejo de los bosques tropicales están lejos de ser resueltos, por lo que los científicos de las áreas biológicas y sociales deben continuar generando nuevo conocimiento para promover un manejo forestal efectivo.

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The tropical lowland forests that cover millions of square kilometers in South America contain exceptionally high biodiversity. Considerable areas of Latin American tropical lowland forests have been cleared for agriculture and ranching and those forests left standing today are rapidly being logged. Because of the high diversity of trees and the low demand for most species in the market, a limited number of tree species are selectively cut and transported to saw mills. The remaining forest has suffered high levels of collateral damage (Verissimo *et al.* 1992; Jackson *et al.* 2002).

The history of industrial single-tree selection offers few examples of long-term sustainability (Putz *et al.* 2000). Tropical forest timber management is often little better than unsustainable mining, and some conservationists believe that the scarce resources for improving logging management and practice would be better spent on strict preservation (Bowles *et al.* 1998). Others have suggested that the best strategy for protecting biodiversity is to log forests once and then retire them for biological conservation (Rice *et al.* 1997). Regardless of the contentions of northern hemisphere conservationists, governments in South America have embarked on a variety of programs

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to promote conservation, maintain ecosystem services, and stimulate economic development, with forest policies that include plans for sustainable production of timber and non-timber forest products. Although there are many hurdles ahead, well-designed government programs may be the key to realizing the goal of ecosystem protection through sustainable timber production from natural tropical forests.

We take the viewpoint that maintenance of forest cover on a substantial portion of the tropical forest biome in South America is both desirable and achievable. We assume that some portion of this forest will be logged for more than a single cutting cycle. The challenges to the successful implementation of sustainable timber production programs in South America fall into two broad categories: (1) inherent biological limits related to forest diversity and productivity and (2) economic and policy limitations that control the forest sector. Applied biological science has a great deal to offer to forest management, both for sustained timber production and for other values of the forest, such as preservation of ecosystem carbon stocks and watershed protection. Policy hurdles may be more difficult to overcome than biological problems. Here, we examine logging in Brazil and Bolivia at the end of 2005, in an attempt to learn some lessons. We offer some general recommendations (Panel 1) below.

Table 1. Current (first harvest) and projected (second harvest) yields from four forest regions in Bolivia

Region	MCD (cm)	First harvest (m^3 ha^{-1})	Second harvest (m^3 ha^{-1})	%	Second harvest optimized (m^3 ha^{-1})	%
Dry forest	40	18.9	2.4	13	3.0	16
Transitional dry–moist forest	50	13.7	3.8	28	8.7	64
Pre-Andean Amazonian forest	50	16.7	0.6	3	1.4	9
Amazonian moist forest	50	11.8	2.5	21	2.6	22

Adapted from Dauber *et al.* (2005). Results of second harvests for typical minimum cut diameters (MCD) about 25 years after a first harvest, expressed in timber volume and in percentage of the first harvest for untreated and managed systems. Optimized conditions include management with liberation of all valuable second harvest trees.

Biological environment

There are three major biological limitations to the success of selective logging in lowland tropical forest systems: high species diversity, slow growth, and lack of regeneration. Here, we discuss the first two limitations. Markets currently accept timber that originates only from a few tree species. This limitation can be mitigated somewhat by modification of consumer preference through marketing of previously unfamiliar species. For an example of the effects of the second limitation, slow growth, on timber production, we can look to Bolivian forests in four climatic regimes (dry forest, transitional dry–moist forest, pre-Andean Amazonian forest, and Amazonian moist forest), where a minimum 20-year cutting cycle is required by government regulations. Dauber *et al.* (2005) modeled growth rates based on field data from an extensive network of plots with over 10 000 trees sampled. Tree growth was modeled for future crop trees of commercial species growing under normal forest conditions (no treatment) and for future crop trees growing under optimal conditions with high light levels and free of lianas. Optimal conditions can be achieved by applying silvicultural treatments where surrounding competitive trees and vines growing on future crop trees are killed. There are modest biodiversity trade-offs involved in this system, because silvicultural treatment will favor a few commercial tree species and will discriminate against vines. Table 1 shows second-cut scenarios about 25 years after the first cut. Because tree growth rates are too slow for forests to recover all of their economically valuable timber in 25 years, first harvest volumes are considerably larger than second harvest volumes for all regions. However, in the transitional eco-region, the second cut can reach 64% of the volume of the first cut if silvicultural treatments are applied, while the untreated forest in the same region yields only 28% of the first harvest volume. In the worst case, the pre-Andean Amazon shows only 9% recovery in the second cycle.

First harvests yield high volumes because they take place in forests that have not suffered human disturbance for hundreds of years. Cutting cycles of several centuries are not economically attractive. It is therefore inevitable that working forests will suffer some changes in structure and composition relative to their undisturbed state. One may either decry this change or consider the value of retaining managed forests as opposed to an alternative land use, such as cattle pasture.

Panel 1. Recommendations

(1) Society should understand that forests change over time and that managed forests may differ from their present state.
(2) The many values of forests should be explained to the general public, as well as to decision makers.
(3) Forestry should be governed by understandable, consistently enforced regulations that are based on sound science.
(4) Governments must work with industry to manage and protect forests.
(5) Biological and social scientists should continue to generate new knowledge to promote effective forest management through basic and applied research.

Policy

Do societies place an inherent value on forest land? If so, do government policies and spending reveal that value? Environmental historian Warren Dean observed that the European settlers of Brazil feared the forest and viewed it as an impediment to progress (Dean 1995). Dean's history of the Atlantic forest on the eastern coast of Brazil relates few efforts to retain the forest and many to destroy it. Today, only 10% of the original area of Brazil's Atlantic forest remains. Perhaps the most important lesson from Dean's work is that retention of forest requires recognition of the value of forests. Nowadays, we speak in terms of ecosystem services, such as carbon storage, watershed protection, and the maintenance of biodiversity. How can these and other values of forested lands be preserved in the face of the pressures for economic development in South America? We believe that educating decision makers and society about the value of forests is a necessary precondition for forest conservation.

Figure 1. *A forestry student learns to drive a skidder. All students train to operate this and other heavy equipment (such as loaders and crawler tractors), even though they will probably never operate heavy machinery as part of their duties as foresters. This hands-on learning provides an appreciation of true field conditions that students would not attain in a classroom.*

The most obvious answer to the question regarding the value of forests for the public and politicians involves currency and jobs. In Brazil, for example, the legal timber industry in the Amazon generated US$2.3 billion and 380 000 direct and indirect jobs (Lentini *et al.* 2005). In a region with 20 million inhabitants and a total annual regional product of about US$28 billion, these are impressive numbers. Given this situation, it is curious that current government policies and the commercial situation in Brazil make it impossible to obtain bank loans for timber operations. This contrasts with the situation for farmers and ranchers in the Brazilian Amazon region, who receive abundant credit.

A second, very serious problem for the timber industry in the Amazon region of Brazil is the difficulty in complying with government regulations. The laws and regulations are complex, so that, in addition to the transaction costs of complying with government bureaucracy, loggers are often faced with the choice of operating illegally or not at all. In 2005, this situation hit certified logging operations especially hard. A spectacular and highly publicized series of operations by the Brazilian Federal Police led to the arrests of over 100 industry and government personnel. Thereafter, permits from the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, the Brazilian federal agency responsible for oversight of logging, were all but impossible to obtain. Only 12 Forest Stewardship Council-certified operations engaged in selective logging in the Brazilian Amazon at the beginning of 2005 (Lentini *et al.* 2005), and at least three cancelled or suspended their certified operations during that year.

A third barrier to sustainable forest management in the Brazilian Amazon and elsewhere is the lack of trained personnel. Logging is often conducted in a haphazard manner with little or no planning. This leads to high costs and waste in equipment depreciation, fuel usage, timber recovery, forest damage, and, most importantly, in unsafe working conditions (Holmes *et al.* 2002). Currently, the largest training operation in managed forestry in the Brazilian Amazon, the Instituto Floresta Tropical, trains about 600 people per year (Figure 1). However, the needs are 10 times as great and the costs of training average about US$1000 per trainee. That may seem expensive in a country where the minimum wage is only about US$170 per month. However, the cost of training 5000 people per year would add up to only about US$0.33 per ha logged.

Overall, the lack of capital and the precarious regulatory environment leaves the logging sector in the Brazilian Amazon with inadequate technology, renders small- and medium-sized operations unable to take advantage of economies of scale, and promotes ubiquitous illegal operations. The long-term success of the Amazon forest industry requires that loggers have incentives to work, protect, and take care of the forests. In Brazil, such incentives are rare. A variety of management systems to correct these problems have been proposed, including a government-controlled concession system and the exploitation of timber on lands held by private landowners, who are required by law to maintain 80% of their land holdings in forests.

Under a well-managed system, timber concessions can provide a government with revenue and control over the timber industry. Bolivian forests have operated successfully with concessions for 10 years. A well-managed system of concessions can reduce illegal logging, allow socially equitable access to forests, improve forest management, and encourage the adoption of new technology

(Contreras-Hermosillas and Vargas-Rios 2002; Fredericksen *et al.* 2003). However, critics suggest that concessions may also have unforeseen and possibly undesirable outcomes. In the case of Brazil, it has been argued that the imposition of a concession system would result in a reduction of forest area under harvest and a consequent reduction in timber supply, a bias toward large firms, and a reduction in the value of timber on private lands. It could take years for any concession system to become effective, given the lack of trained government and industry personnel discussed above. This, in turn, could create an inefficient situation, with high costs and low benefits to society (Merry and Amacher 2005).

For Brazil, a possible alternative or complement to large concessions, and an example of the potential for logging on private lands, is the use of forests currently controlled by small-holders in the Brazilian Amazon. More than 500 000 families occupy plots of about 100 ha. They live in a human-dominated landscape that is already dissected by many roads. Yet the total smallholder area on one stretch of the Trans-Amazon highway from Marabá to Itaituba, for example, has the capacity to supply 1.75 million m^3 of roundwood per year, or about 6% of the roundwood production in the Brazilian Amazon (Lima *et al.* 2006). If the timber industry were given incentives, or at the very least had existing barriers removed (eg information, legal title on smallholder lots, government requirements and bureaucracy), then private land use could potentially hold back deforestation and provide an engine for economic development at the frontiers. Current policies and government action do not allow this to happen. Some argue that it would be very difficult to manage forestry on a large number of small parcels of land, especially when the owners are only able to take advantage of the timber resource once every 30 years.

Solutions are needed. Whether they come from concession forestry or from innovative use of the developing landscape, they must fulfill certain criteria. There is a clear need to reduce the costs of doing government business. Land tenure must be better organized and forest management practices should be made accessible to private landowners. The techniques of forest management should be demystified through the provision of information, outreach, and training to loggers. Only when these basic conditions of development are met can the application of ecological and silvicultural knowledge to tropical forests really be effective. Without them, unfettered and unsustainable forest exploitation, whether legal or illegal, will continue to dominate.

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References

Bowles IA, Rice RE, Mittermeier RA, and da Fonseca GAB. 1998. Logging and tropical forest conservation. *Science* **280**: 1899–1900.

Dauber E, Fredericksen TS, and Peña-Claros M. 2005. Sustainability of timber harvesting in Bolivian tropical forests. *Forest Ecol Manag* **214**: 294–304.

Dean W. 1995. With broadax and firebrand: the destruction of the Brazilian Atlantic forest. Los Angeles, CA: University of California Press.

Fredericksen TS, Putz FE, Pattie P, *et al.* 2003. Sustainable forestry in Bolivia: beyond planned logging. *J Forest* **101**: 37–40.

Holmes TP, Blate GM, Zweede JC, *et al.* 2002. Financial and ecological indicators of reduced impact logging performance in the eastern Amazon. *Forest Ecol Manag* **163**: 93–110.

Jackson S, Fredericksen TS, and Malcolm JR. 2002. Area disturbed and residual stand damage following logging in a Bolivian tropical forest. *Forest Ecol Manag* **166**: 271–83.

Lentini M, Pereira D, Celentano D, and Pereira R. 2005. Fatos florestais da Amazônia 2005. Belém, Brazil: Imazon.

Lima E, Merry F, Nepstad D, *et al.* 2006. Searching for sustainability: forest policies, smallholders, and the Trans-Amazon highway. *Environment* **48**: 26–37.

Merry FD and Amacher GS. 2005. Forest taxes, timber concessions, and policy choices in the Amazon. *J Sustain Forest* **20**: 15–44.

Putz FE, Dykstra DP, and Heinrich R. 2000. Why poor logging practices persist in the tropics. *Conserv Biol* **14**: 951–56.

Rice RE, Gullison RE, and Reid JW. 1997. Can sustainable management save tropical forests? *Sci Am* **276**: 44–49.

Verissimo A, Barreto P, Mattos M, *et al.* 1992. Logging impacts and prospects for sustainable forest management in an old Amazonian frontier: the case of Paragominas. *Forest Ecol Manag* **55**: 169–99.

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