

### The Future of the Atlantic Forest

Cardoso da Silva and Tabarelli (2000) recently argued that about 34% of tree species in the Atlantic forest of northeastern Brazil would become extinct in small forest fragments due to dispersal failure. The authors' arguments are based on the fruit size and gape size of their main fruit-eating birds, their putative seed dispersers. Fruits larger than 15 mm would be more sensitive to extinction because large-gaped birds, such as toucans, trogons and cotingas, are usually absent in such forests. Although it seems possible that dispersal failure may affect tree recruitment, I wish to point out some problems in predicting the future of the Atlantic forest flora with the data presented.

First, most tree species have multiple dispersers, so the loss of one (or more) of them is not necessarily the loss of all dispersal. In fact, we know too little of who eats what and where in the Atlantic forest to assume that large fruits are dispersed only by birds. Second, evidence that the particular species in question are experiencing reproductive failure (for whatever reason) is lacking. Cardoso da Silva and Tabarelli do not provide any evidence of plant recruitment in the forest fragments of northeastern Brazil. Chapman and Chapman (1995) estimated that 60% of the 25 tree species could be lost if all frugivores were removed in an African forest, and they presented information on plant recruitment of the tree species affected. Third, trees can experience reproductive failure for many reasons. Some researchers have found, for example, that pollination is deficient in forest fragments (Aizen & Feinsinger 1994). Fourth, the authors did not mention historical effects on the fragments analyzed. The Atlantic forest of northeastern Brazil is one of the forests most affected by selective logging, and we know little about the origi-

nal flora. Fifth, some tropical tree species that lost their putative seed dispersers for more than 10,000 years BP (Janzen & Martin 1982) are still thriving in such forests, probably because dispersal is not a key factor for maintaining some populations. Finally, several large fruit-eating birds are migratory (cotingas and even toucans), and their role in long-distance seed dispersal must be mentioned (Loiselle & Blake 1991).

There is a lot of speculation on the role of frugivores in maintaining the recruitment of the flora but still not enough (good) data to predict the future of the Atlantic forest. We agree that some species will probably go extinct, at least locally in particular fragments. But to say that the reason can be predicted in advance without evidence on the current pattern of tree recruitment is no better than waving one's arms in the air and crying wolf.

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### Tropical Logging and Human Invasions

Selective logging is an enormously important issue in the tropics. Each year, nearly 6 million ha of tropical forest are logged—an area twice the size of Belgium—most of which is virgin forest (Whitmore 1997). Forest tracts currently allocated for logging are at least 8-10 times larger than the limited areas set aside as nature reserves (Johns 1997). The management or mismanagement of logging operations is emerging as one of the most vital and hotly debated issues in tropical forest conservation (e.g., Rice et al. 1997; Bowles et al. 1998; Frumhoff & Losos 1998; Gascon et al. 1998; Sizer & Plouvier 2000).

Even ardent logging advocates acknowledge that most logging operations in the tropics are poorly managed, resulting in excessive environmental damage. In a recent issue of *Conservation Biology*, Putz et al. (2000) present an insightful assessment of why so few tropical loggers have begun to employ reduced-impact logging (RIL) methods. These methods are well established and have been shown, under some circumstances, to be cheaper and more effective than traditional logging. As Putz et al. demonstrate, however, RIL can actually be more expensive than traditional logging, especially when loggers are prohibited from cutting on steep slopes or in wet weather. Inadequate training for loggers and weak enforcement of harvest operations further weaken efforts to promote RIL methods. Putz et al. conclude that international assistance, such as carbon-offset funds and other financial incentives, may be needed to promote sustainable logging in the tropics.

Although Putz et al. (2000) make a truly meaningful contribution to the tropical logging debate, one key issue requires further consideration: the problem of forest invasion. Loggers create labyrinths of roads that

greatly increase physical access to forests for hunters, ranchers, miners, and slash-and-burn farmers. In West Africa and Borneo, for example, logging has led to drastic increases in hunting pressure on larger vertebrates (Wilkie et al. 1992; Bennett 2000). In frontier areas of the Amazon, Southeast Asia, and Africa, logging has sharply increased rates of forest colonization, often leading to large-scale forest destruction (Rice et al. 1997; Kaimowitz & Angelsen 1998; Laurance 1998, 1999). Logged forests are also prone to catastrophic wildfires, especially during droughts (Cochrane et al. 1999; Nepstad et al. 1999).

The secondary effects of logging—drastically increased forest access—are actually far more destructive to forests than is the logging operation itself. As a result, no meaningful discussion of strategies to promote RIL can take place without also consideration of the dilemma of forest invasion.

How can we stop—or at least strongly inhibit—forest invasions after logging? I do not pretend to have an answer to this question, but it is one that the advocates of “sustainable forest management” (RIL logging and related silvicultural practices) must address in a practical way before their arguments can be taken more seriously. Forest roads can persist for decades. Can physical barriers be created after logging (e.g., establishing locked gates with forest guards, destroying key bridges) that prevent forest colonization? Will these be effective, or will they be so expensive to implement and maintain that they will be impractical? If implemented, does the political will exist

in developing countries to ensure that initiatives to reduce invasions are actually enforced?

The simple truth is that, unless hunting pressure is severe, most wildlife populations can persist in logged forests, although their abundances may be reduced for considerable periods (Johns 1997; Fimbel et al. 2000). Few forest species can survive, however, in the mosaic of farmland and degraded scrub that remains after large-scale forest invasion. In my view, the invasion issue lies at the heart of the tropical logging debate. Without practical solutions to limit invasions, logging will continue to pose a major, if indirect, threat to the survival of tropical forests.

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