FINAL PROJECT REPORT

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Anthropogenic Land-use Change and the Dynamics of Amazon Forest Biomass

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Summary of the Project

This project was focused on assessing the effects of prevailing land uses, such as habitat fragmentation, selective logging, and fire, on biomass and carbon storage in Amazonian forests, and on the dynamics of carbon sequestration in regenerating forests. Ancillary goals included developing GIS models to help predict the future condition of Amazonian forests, and assessing the effects of anthropogenic climate change and ENSO droughts on intact and fragmented forests. Ground-based studies using networks of permanent plots were linked with remote-sensing data (including Landsat TM and AVHRR) at regional scales, and higher-resolution techniques (IKONOS imagery, videography, LIDAR, aerial photographs) at landscape and local scales.

The project's specific goals were quite eclectic and included:

- Determining the effects of habitat fragmentation on forest dynamics, floristic composition, and the various components of above- and below-ground biomass
- Assessing historical and physical factors that affect trajectories of forest regeneration and carbon sequestration on abandoned lands
- Extrapolating results from local studies of biomass dynamics in fragmented and regenerating forests to landscape and regional scales in Amazonia, using remote sensing and GIS
- Testing the hypothesis that intact Amazonian forests are functioning as a significant carbon sink
- Examining destructive synergisms between forest fragmentation and fire
- Assessing the short-term impacts of selective logging on aboveground biomass
- Developing GIS models that integrate current spatial data on forest cover, deforestation, logging, mining, highways and roads, navigable rivers, vulnerability to wildfires, protected areas, and existing and planned infrastructure projects, in an effort to predict the future condition of Brazilian Amazonian forests over the next 20-25 years
- Devising predictive spatial models to assess the influence of varied biophysical and anthropogenic predictors on Amazonian deforestation

Scientific Productivity

This investigation was among the most dynamic of all LBA-funded projects in terms of scientific productivity. In total, this project yielded:

- 81 refereed publications overall
- 8 papers in *Science* and *Nature*
- 44 articles in other leading international journals (*Ecology, Ecological Applications, Trends in Ecology and Evolution, Journal of Ecology, Journal of Applied Ecology, Conservation Biology, Biological Conservation, Environmental Conservation, Biodiversity and Conservation, Forest Ecology and Management, Biotropica, Journal of Tropical Ecology, Environmental Monitoring and Assessment, Journal of Vegetation Science, American Journal of Botany, Journal of Biogeography, Soil Biology and Biochemistry*).

There was excellent progress toward the original objectives of this project, particularly in terms of:

- Documenting the impacts of forest fragmentation on carbon storage, cycling, and production of atmospheric carbon emissions (Laurance 1998b, 1998c, 1999a, 2001d; Laurance et al. 1997, 1998a, 1998c, 1998d, 2000a; Nascimento and Laurance 2002, in press).
- Assessing the impacts of habitat fragmentation on plant-community composition, forest structure, and forest dynamics (Ferreira and Laurance 1997; Laurance et al. 1998b, 1998c, 1999b, 2001c; Laurance and Delamonica 1998; Mesquita et al. 1999; Gascon et al. 2000; Ickes and Williamson 2000; Delamonica et al. 2001; Laurance 2000a, 2000b, 2001f, 2002a; Cochrane and Laurance 2002).
- Studying the temporal trajectories of succession and biomass accumulation in secondary forests of varying ages and disturbance histories (Mesquita et al. 1998, 2001; Mesquita 1999; Nelson et al. 1999; Williamson et al. 1999a, 1999b; Williamson and Costa 2000; Williamson and Mesquita 2001; Ganade et al., in press; Monaco et al., in press).
- Evaluating the effects of inter-annual weather variability and potential anthropogenic climate change on fragmented and intact Amazonian forests (Phillips et al. 1998, 2002; Williamson et al. 2000; Laurance and Williamson 2001; Laurance et al. 2001d, 2002a; Malhi et al. 2002).
- Developing GIS models to predict the local and regional effects of Amazonian development activities (Laurance et al. 2001b, 2002b, 2002c, in press; Albernaz et al., submitted).

- Evaluating current development trends and policies in Brazilian Amazonia (Laurance 1998a, 1999c, 2000c, 2002b; Laurance and Fearnside 1999, 2002; Laurance and Vasconcelos 2000; Bierregaard et al. 2001; Gascon et al. 2001, 2003; Fearnside and Laurance 2002; Ferreira et al., in press; Laurance et al. 2000b, 2001a, 2001d, 2002a, 2002b, 2002c) and throughout the tropics (Laurance 2000d, 2001a, 2001b).

Additional studies focused on relationships between soils and Amazon forest biomass (Laurance et al. 1999a), on the use of high-resolution remote-sensing in tropical forest management and research (Read et al. 2003), on the density of large trees (Williamson et al. 1999b) and ecological determinants of wood density in Neotropical forests (Wiemann and Williamson, in press; Williamson and Wiemann, submitted), on the ecological impacts of selective logging on forest biomass (Rittl and Laurance 2002), and on the general ecology of fragmented Amazonian forests (Laurance 1998d, 1999b, 2001c, 2001e, 2001g; Laurance and Cochrane 2001; Lovejoy et al. 2001; Laurance et al. 2002d, 2003; Laurance and Vasconcelos, in press).

Training and Education

As part of this project, we maintained very active training programs for graduate students, postdoctoral fellows, and undergraduate interns. Our project provided financial support and advanced training in rainforest ecology, remote sensing, and GIS applications for:

- 6 Brazilian graduate students (Henrique Nascimento, Ph.D. completed; Carlos Rittl, Ph.D. completed; Leandro Ferreira, Ph.D. completed; Luciana Mônaco, M.Sc. completed; Adriana Rubenstein, M.Sc. completed; Marcelo Moreira, M.Sc. completed)

- 2 Brazilian postdoctoral researchers (Dr Eduardo Venticinque, Dr Ana Albernaz)

- 8 Latin American interns and research assistants (Marcelo Moreira, Sammya D'Angelo, Tito Fernandes, Ana Andrade, Carlos Da Costa, Adriano Jerozolinski, Juan Rodriguez, Rachael Silva)

- 2 U.S. graduate students (Morgan Schmidt, Scott Bergen).

We also sponsored a number of short-courses, symposia, and workshops for decision-makers and undergraduate and graduate students, designed to improve scientific capabilities and environmental management in the Amazon (partially support by the U.S. Agency for International Development), including:

- February 2000: *Forest Fragmentation in the Amazonian Landscape.* This was a three-week course for 20 undergraduate students from Amazonian universities, which focused on the causes and impacts of habitat destruction in the Amazon.

- May 1999-2001: *Amazonian Decision-makers Course.* This intensive four-day course is designed for those whose jobs have a direct impact on the natural resources in the Amazon. This year the course was held in Silves and Itacoatiara, Amazonian cities where development projects on eco-tourism and sustainable forestry are under way. Twenty professionals, representing governmental and non-governmental agencies from Amazonas, Pará, Acre, Roraima and Brasília, attended the course.

- July-August 1998-2001: *Ecology of the Amazonian Forest.* This month-long field-course provides advanced training in ecology, field biology, and conservation science for graduate students from Latin America and the U.S. Twenty students from five countries participated this year.

- September 2001: *Enhancing Comparative Research Opportunities for Young Scientists in Tropical and Subtropical Plant Ecology.* This program facilitates a free exchange of young scientists among six intensively studied sites in tropical and subtropical ecosystems, where senior Mellon Foundation-funded plant ecologists have long-term research interests.

- January 2002: *The Future of the Amazon: Impacts of Deforestation and Climate Change.* This three-day event at the Smithsonian Tropical Research Institute in Panama involved a public symposium (attended by an audience of about 150 people that included the Brazilian and Ecuadorian Ambassadors to Panama) and an intensive two-day workshop. It brought together nearly two dozen leading ecologists, climatologists, and ecosystem modelers who focused on assessing the interactions of deforestation and regional climate change in the Amazon.

Finally, we had an active outreach program to communicate our scientific findings to the general public in Brazil and elsewhere. This was achieved by:

- Many popular and semi-technical publications in Portuguese (e.g. Laurance and Delamonica 1998; Mesquita 1999; Williamson et al. 1999b; Laurance and Vasconcelos 2000; Delamonica et al. 2001; Laurance 2001c; Fearnside and Laurance 2002; Laurance et al. 2002b; Monaco et al., in press).

- Numerous seminars and public lectures in Manaus, Belêm, Brasilía, and elsewhere in Brazil.

- Frequent interviews with Brazilian and international newspapers, radio, and TV news programs.

- Invited testimony before the Brazilian Congress (Camera de Deputatos) on the conservation of Amazonian forests.

Data and Metadata Submissions to LBA-DIS

This project is continuing under LBA Phase II, which will be completed at the end of 2005.

To date we have consistently met all LBA requirements for data archival. We have compiled extensive, long-term datasets (>20 years) on the dynamics of aboveground biomass of large trees (≥10 cm diameter) and lianas within 69 1-ha plots in fragmented and continuous forests in the central Amazon (these plots are currently being georeferenced using differential GPS). Detailed data on >20 soil chemistry and texture parameters have also been collected for most plots. All of these data have been lodged on the LBA-DIS metadatabase system, and are available to LBA investigators.

In addition, we maintain a website with a publication list and up-to-date information on our project, including a description of our LBA-related activities (www.inpa.gov.br/pdbff).

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