

FINAL REPORT FOR:
INTERNATIONAL TROPICAL TIMBER ORGANISATION (ITTO)
regarding
Special Service Agreement No. (E) E12/04
21 June 2013

PROJECT TITLE: Bigleaf mahogany (*Swietenia macrophylla*) in the Brazilian Amazon: long-term studies of population dynamics and regeneration ecology towards sustainable forest management

CO-INVESTIGATORS: Drs. James Grogan (Yale University, New Haven, CT, USA) & Mark Schulze (University of Florida, Gainesville, FL, USA)

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DURATION (months) 14 months

START DATE 01 November 2011

REPORTING PERIOD: 01 November 2011 – 31 December 2012

BUDGET & ADDITIONAL SOURCES OF FINANCE

(a)	ITTO Contribution (in US\$)	\$19,560
(b)	US Government Contribution (USFS-IITF)	\$12,000

I. SUMMARY

This Activity has contributed directly to the Joint ITTO-CITES Timber Programme, specifically all activities under Outputs 2.2 (improved management) and 2.3 (promoting non-detrimental utilization), by extending through 2012 the longest-running research programme dedicated to big-leaf mahogany currently underway in South America. Transforming current logging practices in Amazonia into sustainable management systems requires comprehensive scientific understanding of how mahogany life history attributes interact with ecosystem processes to facilitate growth and recruitment in natural forests. This Activity has contributed towards establishment of a biological foundation for sustainable forest management systems for big-leaf mahogany across southern Amazonia (Brazil, Bolivia, Peru) based on long-term studies of growth, reproduction, and regeneration by natural populations in primary and logged forests; and communicated lessons learned to private industry and to government policy and regulatory institutions.

Activities and specific outputs during the reporting period included: recensus during the 2011 dry season of two natural mahogany populations under study since 1995 in southeast Amazonia; publication of scientific and technical syntheses of observational and experimental field data addressing both basic (demographic) and applied (silvicultural) management issues; technical extension to the private sector forest products industry and forest management regulatory agencies in Central and South America through translation into Spanish of the user interface and User Manual for the Big-Leaf Mahogany Growth & Yield Model; and continued protection and conservation of extremely valuable yet vulnerable natural mahogany populations in remote Amazonian regions through negotiation of terms for their long-term conservation and sustainable use.

II. CONTEXT

The last significant natural stocks of big-leaf mahogany are currently located across the southern rim of the Amazon Basin, in remote forests from the state of Pará in Brazil to eastern Peru. This Activity supported a long-term applied research programme on the ecology and management of big-leaf mahogany (*Swietenia macrophylla*) initiated in southeast Brazilian Amazonia in 1995 by Drs. James Grogan and Mark Ashton (Yale University, New Haven, CT, USA).

Full background details are provided in the original and first extension proposals to ITTO-CITES by Grogan & Schulze covering the period August 2008–January 2011, including institutions and private sector companies sanctioning and supporting this long-term research program since its inception.

III. OBJECTIVE

The objective of this applied research programme is to establish a biological foundation for sustainable forest management systems for big-leaf mahogany across southern Amazonia (Brazil, Bolivia, Peru) based on long-term studies of growth, reproduction, and regeneration by natural populations in primary and logged forests. Considering mahogany's listing on CITES Appendix II, our focus on establishing an empirical basis for evaluating the sustainability of current forest management practices for mahogany addresses the issue of non-detriment findings (NDF).

IV. ACTIVITIES DURING THE FUNDING PERIOD

Activities during the 14-month funding period fell into three categories: 1) fieldwork at long-term mahogany research sites; 2) data management, analysis, and synthesis for publication of research results; and 3) translation of the User Manual for the Big-Leaf Mahogany Growth & Yield Model and online user interface into Spanish to facilitate use by Central and South American forest managers and regulatory agencies.

1) During the 2011 field season we successfully recensused mahogany populations and outplanted seedlings at two forest field sites in southeast Pará. More than 420 trees > 10 cm diameter monitored annually since 1995 in an area of 2100 ha (Marajoara) and 650 ha (Corral Redondo) were remeasured for diameter growth increment, fruit production, and reproductive phenology. Several thousand seedlings and saplings in ten natural and artificial experiments established between 1995–1997 were also recensused for survival and growth.

2) Data management, analysis and synthesis for publication, including the website dedicated to big-leaf mahogany ecology and management (see www.swietking.org), required on-going effort by project Co-Investigators. Chris Free provided critical technical support during 2012 in the following fields: GIS analysis, growth & yield model updates, website completion & maintenance, and manuscript preparation. During the 14-month reporting period, three journal articles and book chapters were published by the Co-Investigators and collaborating scientists as detailed below. (See Annex 1 for abstracts of published articles. See Annex 2 for a complete list of publications associated with this research programme.) Four journal articles written during the reporting period were placed in review at the *Journal of Applied Ecology*, ITTO's *Tropical Forest Update*, the *American Journal of Botany*, and *Forest Ecology and Management*. Eleven additional manuscripts for scientific journals are currently in various stages of preparation (see Annex 2 section II for details).

Published, 1 journal article:

Grogan, J., Schulze, M. 2012. The impact of annual and seasonal rainfall patterns on growth and phenology of emergent tree species in southeastern Amazonia, Brazil. *Biotropica* 44: 331-340.

Published, 2 book chapters:

Norghauer, J.M., **Grogan, J.** 2012. The intriguing case of *Steniscadia poliophaea* (Noctuidae): potent moth enemy of young mahogany trees in Amazonian forests. In: Cauterruccio, L. (ed.), *Moths: Types, Ecological Significance and Control Methods*, pp. 39-74. Nova Science Publishers, Inc., Hauppauge, NY, USA.

Grogan J (2011) Mahogany, mogno (*Swietenia macrophylla* King). In: Shanley, P., Cymerys, M., Serra, M., Medina, G. (eds.), *Fruit Trees and Useful Plants in Amazonian Life*, pp. 101-108. Food and Agriculture Organization of the United Nations/Center for International Forestry Research/People and Plants International, Rome, Italy.

In review, 4 journal articles:

Grogan, J., Landis, R.M., Free, C., Schulze, M., Lentini, M., Ashton, M.S. Big-leaf mahogany *Swietenia macrophylla* population dynamics and implications for sustainable management. *Journal of Applied Ecology*.

Grogan, J., Schulze, M., Lentini, M., Zweede, J., Landis, R.M. Managing bigleaf mahogany in natural forests: lessons learned from the ITTO-CITES Timber Project. *ITTO Tropical Forest Update*.

Grogan, J., Loveless, M. Implications of flowering behavior for management of big-leaf mahogany *Swietenia macrophylla* in southeastern Amazonia, Brazil. *American Journal of Botany*.

Grogan, J., Schulze, M., Pantoja, F., Vidal, E., Lentini, M., Valle, D. Enrichment planting of big-leaf mahogany in logging gaps in Acre, Brazil. *Forest Ecology and Management*.

3) The User Manual for the Big-Leaf Mahogany Growth & Yield Model was professionally translated into Spanish for use by forest managers in Central and South America. A Spanish version of the User Manual will be more readily accessible to Brazilian users (Portuguese speakers) than a Portuguese version would be accessible to Spanish speakers. The Model interface was also translated into Spanish. The complete reference is as follows:

Free, C., Landis, R.M., Grogan, J. 2012. Manual del Usuario para el Modelo de Crecimiento y Rendimiento de la Caoba. Middlebury, VT, USA. 73 pp. Available at <http://www.swietking.org/spanish-model.html>.

V. DIFFICULTIES ENCOUNTERED & MEASURES TAKEN

This Activity assumed continued physical access to remote, privately owned field sites during 2011–2012. The attendant risk was that site owners would refuse authorization for dry season fieldwork. This risk was highest at our primary field site in southeast Pará, Marajoara, located 34 km northwest of Redenção. In 2011, we successfully negotiated access with site owner Sr. Claudiomar Vicente Kehrnvald through intervention by Sr. Evaristo Terezo, a respected member of the Association of the Timber Industries Exporters in the State of Pará (AIMEX). The second field site in southeast Pará, Corral Redondo, owned by Sr. Honorato Babinski, remains secure and accessible for the foreseeable future.

VI. CHANGES INTRODUCED DURING IMPLEMENTATION

No substantive changes in approach or outcomes were introduced during Project implementation. Minor adjustments were made to budget categories as explained in Financial Reports. These adjustments were necessitated by inevitable mismatches between anticipated and actual costs of labor and supplies.

VII. ACHIEVEMENTS / RESULTS

1) Long-term monitoring and protection of threatened mahogany populations

By successfully implementing the annual recensus of mahogany populations plus associated natural and experimental seedlings, we extended the longest running field studies of natural populations currently underway in South America. The value of annually recensusing survival, growth, and reproduction by natural mahogany populations cannot be over-emphasized. Little is known about the factors shaping population dynamics of natural populations. Through long-term monitoring of populations large enough to reflect the range of environmental conditions under which mahogany occurs in this region, we can determine how populations develop over time, observe the principal causes of mortality and variable growth rates, and predict population responses to a broad range of forest management practices. This improved basic and applied knowledge can then be synthesized in scientific and technical publications for broad dissemination.

Our return to research sites in southeast Pará ensured the continued survival of threatened mahogany populations. These populations survive in isolated patches of logged forest on a regional landscape where most natural forests have been converted to pasture and agricultural uses. In fact, within this larger region, where Brazil's richest mahogany stands occurred before logging began in the early 1970s, commercial stands have been almost completely extirpated. Natural populations comparable to those under study in this research program simply do not exist elsewhere in this region.

2) Improved scientific and technical understanding of mahogany population and regeneration dynamics

Scientific articles and technical documents published during the reporting period covered a range of topics directly relevant to Joint ITTO-CITES Timber Program Outputs 2.2 (improved management) and 2.3 (promoting non-detrimental utilization). Please see abstracts as published in Annex 1. All published articles accompany this report in electronic form.

ANNEX 1

ABSTRACTS OF PUBLISHED ARTICLES AND BOOK CHAPTERS

Grogan, J., Schulze, M. 2012. The impact of annual and seasonal rainfall patterns on growth and phenology of emergent tree species in southeastern Amazonia, Brazil. *Biotropica* 44: 331-340.

Understanding tree growth in response to rainfall distribution is critical to predicting forest and species population responses to climate change. We investigated inter-annual and seasonal variation in stem diameter by three emergent tree species (*Swietenia macrophylla*, *Hymenaea courbaril*, *Parkia pendula*) in a seasonally dry tropical forest in southeast Pará, Brazil. Annual diameter growth rates by *Swietenia* demonstrated strong positive correlation with annual rainfall totals during 1997–2009 ('growing year' totals = July to June; Pearson $r = 0.8682$, $p = 0.0003$). Over the same period, *Hymenaea* growth rates demonstrated weak positive correlation with annual rainfall totals while *Parkia* exhibited weak negative correlation during 1999–2009. For both *Swietenia* and *Hymenaea*, annual diameter growth rates correlated positively and significantly with rainfall totals during the first six months of the growing year (July to December; $p = 0.022$ & 0.0053 , respectively). Vernier dendrometer bands monitored at 4-week intervals during 3 to 5 years confirmed strong seasonal effects on stem diameter growth. Individuals of all three species expanded in unison during wet season months and were static or even contracted during dry season months. Stems of the deciduous *Swietenia* contracted as crowns were shed during the early dry season, expanded slightly as new crowns were flushed, and then contracted further during 3- to 5-week flowering periods in the late dry season by newly mature crowns. The three species' physiographic distributions patterns at the study site – *Swietenia* is restricted to alternately flood- and drought-prone low ground adjacent to seasonal streams while *Hymenaea* and *Parkia* are more broadly distributed on mid and upper slopes in more moisture-retentive soils – may partially underlie observed differences in annual and seasonal growth. With most global circulation models predicting conditions becoming gradually drier in southeast Amazonia over the coming decades, transitional forests such as those at the study site can be expected to respond relatively rapidly to climate change compared to wetter forests to the north and west. Under this scenario, species such as *Swietenia* that perform best on the 'wet end' of current conditions may experience reduced population growth rates unless drier conditions also increase recruitment rates through favorable alterations to disturbance regimes. However, in the near future, a species' capacity to survive and capitalize on conditions created by increasingly common dry season groundfires in natural forests may be the critical aspect of life history determining winners and losers on anthropogenic seasonal landscapes.

Norghauer, J.M., **Grogan, J.** 2012. The intriguing case of *Steniscadia poliophaea* (Noctuidae): potent moth enemy of young mahogany trees in Amazonian forests. In: Cauterruccio, L. (ed.), *Moths: Types, Ecological Significance and Control Methods*, pp. 39-74. Nova Science Publishers, Inc., Hauppauge, NY, USA.

The super-family Noctuidae is the most species-rich of Lepidoptera, and many appear to be specialized herbivores. Yet little is known about their abundance and ecological significance in diverse forests of the tropics. In this chapter we briefly review these two aspects in the context of diversity maintenance (Janzen-Connell hypothesis), and present the case of the South American moth *Steniscadia poliophaea*. This species feeds only on expanding leaf and stem tissues of seedlings and saplings of the prized timber tree, big-leaf mahogany (*Swietenia macrophylla*). We synthesize published research, observational reports, and anecdotal evidence about *S. poliophaea*'s life history, ecology, and impact on host mahogany populations across southern Brazilian Amazonia. This moth plays an important role in suppressing the early recruitment and growth, and hence potential local dominance, of the fast-growing *S. macrophylla*. We doubt this moth plays a contributing role in structuring local adult densities of *S. macrophylla* in Central America and Mexico where it has not been reported to occur. We compare the ecological significance of *S. poliophaea* to the better known shoot-boring moth, *Hypsipyla grandella* (Pyralidae) that is a major pest in mahogany plantations throughout the Neotropics. Finally, we consider the implications of these findings for host-competition and control in the recovery and sustainable management of threatened *S. macrophylla* populations in logged and unlogged South American forests. Moth herbivores in general, and Noctuidae in particular, warrant further investigation as potential drivers of Janzen-Connell effects on trees in species-rich tropical forests.

Grogan, J. 2011. Mahogany, mogno (*Swietenia macrophylla* King). In: Shanley, P., Cymerys, M., Serra, M., Medina, G. (eds.), *Fruit Trees and Useful Plants in Amazonian Life*, pp. 101-108. Food and Agriculture Organization of the United Nations/Center for International Forestry Research/People and Plants International, Rome, Italy.

Perhaps more than any other tree, mahogany connects Amazonian forests to the world outside through its gorgeous, durable wood. Many loggers have penetrated the heart of the forest in search of this valuable wood, often referred to as 'green gold'. Mahogany trees are easy to identify from the ground owing to their massive buttresses, up to 5 m high. Mahogany forms a broad crown from a few large branches, with leaves that shine like no others in the forest. It is distributed in southern and western Amazonia and in the forests along the Atlantic coast of Central America. Mahogany should be treated well as its timber is valued at four times the price of any other wood.

ANNEX 2

PUBLICATIONS AND TECHNICAL EXTENSION DIRECTLY OR INDIRECTLY DERIVED FROM BIG-LEAF MAHOGANY RESEARCH IN SOUTHEAST PARÁ AND ACRE, BRAZIL

I. Publications & submissions for review supported by the ITTO-CITES Timber Project (01 November 2011 – 31 December 2012)

1 Grogan, J., Landis, R.M., Free, C., Schulze, M., Lentini, M., Ashton, M.S. *In review.* Big-leaf mahogany *Swietenia macrophylla* population dynamics and implications for sustainable management. *Journal of Applied Ecology*.

2 Grogan, J., Schulze, M., Lentini, M., Zweede, J., Landis, R.M. *In review.* Managing bigleaf mahogany in natural forests: lessons learned from the ITTO-CITES Timber Project. ITTO *Tropical Forest Update*.

3 Grogan, J., Loveless, M. *In review.* Implications of flowering behavior for management of big-leaf mahogany *Swietenia macrophylla* in southeastern Amazonia, Brazil. *American Journal of Botany*.

4 Grogan, J., Schulze, M., Pantoja, F., Vidal, E., Lentini, M., Valle, D. *In review.* Enrichment planting of big-leaf mahogany in logging gaps in Acre, Brazil. *Forest Ecology and Management*.

5 Free, C., Landis, R.M., Grogan, J. 2012. Manual del Usuario para el Modelo de Crecimiento y Rendimiento de la Caoba. Middlebury, VT, USA. 73 pp. Available at <http://www.swietking.org/spanish-model.html>.

6 Grogan, J., Schulze, M. 2012. The impact of annual and seasonal rainfall patterns on growth and phenology of emergent tree species in southeastern Amazonia, Brazil. *Biotropica* 44: 331-340.

7 Norghauer, J.M., Grogan, J. 2012. The intriguing case of *Steniscadia poliophaea* (Noctuidae): potent moth enemy of young mahogany trees in Amazonian forests. In: Cauteruccio, L. (ed.), *Moths: Types, Ecological Significance and Control Methods*, pp. 39-74. Nova Science Publishers, Inc., Hauppauge, NY, USA.

8 Grogan J (2011) Mahogany, mogno (*Swietenia macrophylla* King). In: Shanley, P., Cymerys, M., Serra, M., Medina, G. (eds.), *Fruit Trees and Useful Plants in Amazonian Life*, pp. 101-108. Food and Agriculture Organization of the United Nations/Center for International Forestry Research/People and Plants International, Rome, Italy.

II. Publications in preparation (*contingent on long-term studies)

9* Free, C., Landis, R.M., Grogan, J., Schulze, M., Lentini, M., Dünisch, O. Management implications of longterm tree growth & mortality rates: a case study of big-leaf mahogany (*Swietenia macrophylla*) in the Brazilian Amazon. For *Forest Ecology and Management*.

10 Gribel, R., Lemes, M., Grogan, J. Long-distance pollen transport in a big-leaf mahogany population in southeastern Brazil: implications for genetic structure and forest management.

11* Grogan, J., Landis, R.M., Free, C., Schulze, M., Lentini, M. Mahogany (*Swietenia macrophylla*) seedling growth response to micro-scale variation in soil nutrient status in southeast Amazonia, Brazil. For *Forest Ecology and Management*.

12* Grogan, J., Loveless, M., Free, C., Schulze, M., Landis, R.M. Implications of fruiting behavior of big-leaf mahogany (*Swietenia macrophylla*) for sustainable management in Brazilian Amazonia. For *American Journal of Botany*.

13 Grogan, J., McKenna, J., Schulze, M., Free, C., Landis, R.M., Galvão, J., Ashton, M.S. Big-leaf mahogany (*Swietenia macrophylla*) physiographic associations in southeast Amazonia, Brazil. For *Journal of Tropical Ecology*.

14* Grogan, J., Schulze, M. Biomass, productivity, and structural dynamics of transitional dry forests in southeastern Amazonia, Brazil. For *Journal of Tropical Ecology*.

15* Landis, R.M., Free, C., Grogan, J., Schulze, M., Lentini, M. Management implications of seedling enrichment plantings for long-term timber production: a case study of big-leaf mahogany (*Swietenia macrophylla*) in the Brazilian Amazon. For *Forest Ecology and Management*.

16 Norghauer, J.M., Thomas, S.C., Malcolm, J.R., Zimmerman, B., Free, C., Grogan, J. Predation and herbivory drive distant- and density-dependent recruitment of a Neotropical emergent tree. For *Ecology Letters*.

17 Norghauer, J.M., Grogan, J. Allometric changes in reproductive effort with tree size in big-leaf mahogany (*Swietenia macrophylla*) in southeast Amazonia, Brazil. For *Plant Ecology*.

18* Schulze, M., Grogan, J. Population dynamics of commercial timber species in Brazilian Amazonia and implications for sustainable management of tropical forests. For *Forest Ecology and Management*.

19* Schulze, M., Grogan, J., Free, C., Landis, R.M., Lentini, M., Dünisch, O. Management implications of population structure for long-term timber production: a case study of big-leaf mahogany (*Swietenia macrophylla*) in the Brazilian Amazon. For *Forest Ecology and Management*.

III. Publications prior to the current ITTO-CITES Timber Project funding period

20 Free, C., Landis, R.M., Grogan, J. 2011. User Manual for the Big-Leaf Mahogany Growth & Yield Model. Middlebury, VT, USA. 69 pp. Available at <http://www.swietking.org/>.

21 Grogan, J., Peña-Claros, M., Günter, S. 2011. Managing natural populations of big-leaf mahogany In: Günter S, Stimm B, Weber M, Mosandl R (Eds.), *Silviculture in the Tropics*, pp. 227-235. Springer-Verlag, Berlin–Heidelberg, Germany.

22 Kelty, M., Cámara-Cabrales, L., Grogan, J. 2011. Red oak in southern New England and big-leaf mahogany in the Yucatan Peninsula: can mixed-species forests be sustainably managed for single-species production? *Journal of Sustainable Forestry* 30: 637-653.

23 Norghauer, J.M., Nock, C., Grogan, J. 2011 The importance of tree size and fecundity for wind dispersal of big-leaf mahogany. *PLoS ONE* 6: e17488 (<http://dx.plos.org/10.1371/journal.pone.0017488>).

24 Grogan, J., Schulze, M., Galvão, J. 2010. Forest canopy structure influences survival, growth and reproduction by big-leaf mahogany (*Swietenia macrophylla*) in Brazil. *New Forests* 40: 335-347 (<http://www.treearch.fs.fed.us/pubs/37823>).

- 25** Norghauer, J.M., **Grogan, J.**, Malcolm, J.R., Felfili, J.M. 2010. Long-distance seed dispersal helps big-leaf mahogany seedlings escape defoliation by a specialist caterpillar. *Oecologia* 162: 405-412.
- 26** Schulze, M.D., Lentini, M.W., Macpherson, A.J., **Grogan, J.** 2010. Certification, concessions, and biodiversity in the Brazilian Amazon: can an independent, market-based approach be wed to a large-scale government initiative? *European Tropical Forest Research Network (ETFRN) News* 51: 83-89.
- 27** **Grogan, J.**, Blundell, A.G., Landis, R.M., Youatt, A., Gullison, R.E., Martinez, M., Kometter, R.F., Lentini, M., Rice, R.E. 2009. Over-harvesting for commercial purposes leads to population decline: big-leaf mahogany in South America. *Conservation Letters* 3: 12-20.
- 28** **Grogan, J.**, Landis, R.M. 2009. Growth history and crown vine coverage are principal factors influencing growth and mortality rates of big-leaf mahogany *Swietenia macrophylla* in Brazil. *Journal of Applied Ecology* 46: 1283-1291 (<http://www.treesearch.fs.fed.us/pubs/30088>).
- 29** Keefe, K., **Schulze, M.D.**, Pinheiro, C., **Zweede, J.C.**, Zarin, D. 2009. Enrichment planting as a silvicultural option in the eastern Amazon: case study of Fazenda Cauaxi. *Forest Ecology and Management* 258: 1950-1959.
- 30** Martinez, M., Blundell, A.G., Gullison, R.E., **Grogan, J.** (Eds.) 2008. Historic range and current status of big-leaf mahogany (*Swietenia macrophylla*) in South America. Report for the Center for Applied Biodiversity Science–Conservation International, Washington, DC, USA.
- 31** Mejía, E., Buitrón, X., Peña-Claros, M., **Grogan, J.** 2008. Bigleaf mahogany (*Swietenia macrophylla*) in Peru, Bolivia and Brazil. Case Study for the International Expert Workshop on CITES Non-Detriment Findings, 17-22 November 2008, Cancún, Mexico.
- 32** Schulze, M., **Grogan, J.**, Uhl, C., Lentini, M., Vidal, E. 2008. Evaluating ipê (*Tabebuia*, Bignoniaceae) logging in Amazonia: sustainable management or catalyst for forest degradation? *Biological Conservation* 141: 2071-2085 (<http://www.treesearch.fs.fed.us/pubs/35404>).
- 33** Schulze, M., **Grogan, J.**, Landis, R.M., Vidal, E. 2008. How rare is too rare to harvest? Management challenges posed by low-density timber species in the Brazilian Amazon. *Forest Ecology and Management* 256: 1443-1457 (<http://www.treesearch.fs.fed.us/pubs/35402>).
- 34** André, T., Lemes, M., **Grogan, J.**, Gribel, R. 2008. Post-logging population-level loss of genetic diversity by big-leaf mahogany (*Swietenia macrophylla* King) in southeastern Amazonia, Brazil. *Forest Ecology and Management* 255: 340-345 (<http://www.treesearch.fs.fed.us/pubs/29953>).
- 35** **Grogan, J.**, Jennings, S.B., Landis, R.M., **Schulze, M.**, Baima, A.M.V., Lopes, J. do C.A., Norghauer, J.M., Oliveira, L.R., Pantoja, F., Pinto, D., Silva, J.N.M., Vidal, E., Zimmerman, B.L. 2008. What loggers leave behind: impacts on big-leaf mahogany (*Swietenia macrophylla*) commercial populations and potential for post-logging recovery in the Brazilian Amazon. *Forest Ecology and Management* 255: 269-281 (<http://www.treesearch.fs.fed.us/pubs/29979>).
- 36** **Grogan, J.**, **Schulze, M.** 2008. Estimating the number of trees and forest area necessary to supply internationally traded volumes of big-leaf mahogany (*Swietenia macrophylla*) in Amazonia. *Environmental Conservation* 35: 26-35 (<http://www.treesearch.fs.fed.us/pubs/35366>).
- 37** Schulze, M. 2008. Technical and financial analysis of enrichment planting in logging gaps as a potential component of forest management in eastern Amazonia. *Forest Ecology and Management* 255: 866-879.
- 38** Schulze, M., **Grogan, J.**, Vidal, E. 2008. Forest certification in Amazonia: standards matter. *Oryx* 42: 229-239.

- 39 Schulze, M., Grogan, J., Vidal, E.** 2008. Technical challenges to sustainable forest management in concessions on public lands in the Brazilian Amazon. *Journal of Sustainable Forestry* 26: 61-76.
- 40 Schulze, M., Grogan, J., Vidal, E.** 2008. O manejo florestal como estratégia de conservação e desenvolvimento socioeconômico na Amazônia: quanto separa os sistemas de exploração madeireira atuais do conceito de manejo florestal sustentável? In: Bensusan, N., Armstrong, G. (Eds.), *O Manejo da Paisagem e a Paisagem do Manejo*. IEB: Brasília, DF, Brazil, pp. 163-213.
- 41 Ward, S., Boshier, D., Grogan, J.** 2008. Introduction: Special issue on sustainable management of high-value timber species of the Meliaceae. *Forest Ecology and Management* 255: 265-268 (<http://www.treeseearch.fs.fed.us/pubs/30004>).
- 42 Lemes, M.R., Grattapaglia, D., Grogan, J., Proctor, J., Gribel, R.** 2007. Flexible mating system in a logged population of mahogany (*Swietenia macrophylla* King, Meliaceae): implications for the management of a threatened neotropical tree species. *Plant Ecology* 192: 169-180 (<http://www.treeseearch.fs.fed.us/pubs/29994>).
- 43 Valle, D., Phillips, P., Vidal, E., Schulze, M., Grogan, J., Sales, M.** 2007. Adaptation of a spatially explicit individual tree-based growth and yield model and long-term comparison between reduced-impact and conventional logging in eastern Amazonia, Brazil. *Forest Ecology and Management* 243: 187-198.
- 44 Grogan, J., Galvão, J.** 2006. Factors limiting post-logging seedling regeneration by big-leaf mahogany (*Swietenia macrophylla*) in southeastern Amazonia, Brazil, and implications for sustainable management. *Biotropica* 38: 219-228 (<http://treeseearch.fs.fed.us/pubs/30038>).
- 45 Grogan, J., Galvão, J.** 2006. Physiographic and floristic gradients across topography in transitional seasonally dry evergreen forests of southeastern Amazonia, Brazil. *Acta Amazonica* 36: 483-496.
- 46 Schulze, M., Zweede, J.** 2006. Canopy dynamics in unlogged and logged forest stands in the eastern Amazon. *Forest Ecology and Management* 236: 56-64.
- 47 Valle, D., Schulze, M., Vidal, E., Grogan, J., Sales, M.** 2006. Identifying bias in stand-level growth and yield estimations: a case study in eastern Brazilian Amazonia. *Forest Ecology and Management* 236: 127-135.
- 48 Grogan, J.** 2005. Mogno (*Swietenia macrophylla*, Meliaceae). In: Shanley, P., Medina, G. (Eds.), *Frutíferas e Plantas Úteis na Vida Amazônica*. Mulheres da Mata/IMAZON: Belém, PA, Brazil, pp. 115-122.
- 49 Grogan, J., Barreto, P.** 2005. Big-leaf Mahogany on CITES Appendix II: big challenge, big opportunity. *Conservation Biology* 19: 973-976 (<http://www.treeseearch.fs.fed.us/pubs/30087>).
- 50 Grogan, J., Landis, R.M., Ashton, M.S., Galvão, J.** 2005. Growth response by big-leaf mahogany (*Swietenia macrophylla*) advance seedling regeneration to overhead canopy release in southeast Pará, Brazil. *Forest Ecology and Management* 204: 399-412.
- 51 Grogan, J., Vidal, E., Schulze, M.** 2005. Apoio científico para os padrões de manejo de madeira na floresta amazônica – a questão da sustentabilidade. *Ciência & Ambiente* 32: 103-117.
- 52 Scheffler, P.Y.** 2005. Dung beetle (Coleoptera: Scarabaeidae) diversity and community structure across three disturbance regimes in eastern Amazonia. *Journal of Tropical Ecology* 21: 9-19.
- 53 Schulze, M., Vidal, E., Grogan, J., Zweede, J., Zarin, D.** 2005. Madeiras nobres em perigo: práticas e leis atuais de manejo florestal não garantem a exploração sustentável. *Ciência Hoje* 214: 66-69.

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IV. PhD & Masters theses derived from mahogany research sites

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- 2** **Schulze, M.** 2003. Ecology and behavior of nine timber tree species in Pará, Brazil: links between species life history and forest conservation and management. PhD, The Pennsylvania State University, University Park, PA, USA.

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V. TECHNICAL ADVISORY ROLES (J. Grogan)

1 4th Mahogany Working Group, Convention on International Trade in Endangered Species of Fauna and Flora (CITES), St. Elena, Petén, Guatemala, 7–11 November 2011.

2 Trees Working Group Co-Chairperson, International Expert Workshop on CITES Non-Detriment Findings, Convention on International Trade in Endangered Species of Fauna and Flora, Cancún, México, November 17–22, 2008.

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8 Comissão Regional de Monitoramento e Avaliação de Licenciamento Ambiental em Propriedade Rural, MMA, Brasília, DF, Brazil, October–November 2002 (with P. Barreto / IMAZON).

9 Steering Committee on Mahogany Inventory Initiative, Conservation International, Washington, DC, USA, 2001–2004.

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