Monitoring mahogany

An ITTO project studies mahogany distribution in Peru and factors affecting harvest quotas

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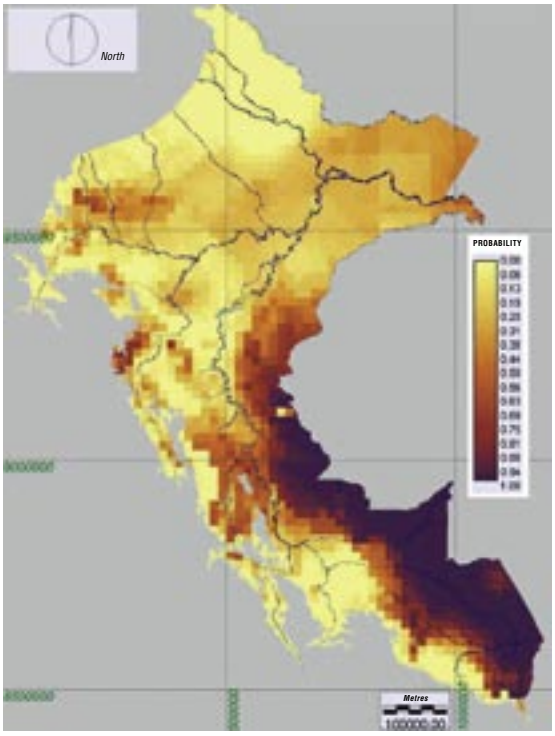
SWIETENIA MACROPHYLLA (mahogany) is the most important commercial forest species in Peru and is subject to intense logging due to the high prices that it commands in international markets. This has also encouraged a significant level of illegal logging of the species to the detriment of both forest concession holders who are operating legally and native communities that in some cases receive very low prices for the harvesting of their forests.

The harvesting of Peruvian mahogany began towards the end of the second decade of the last century, when it was exported as logs. In 1930, a ban was imposed on log exports to generate employment and encourage the value-added processing of products of this timber species, and the sector moved to the export of sawnwood, a situation that prevails to date.

Up to the 1940s, harvesting areas were situated along river areas that were accessible from the city of Iquitos, where the major sawmills were located. From the 1950s to the 1970s, timber production areas rapidly increased, as production regions became more accessible due to the construction of access roads, and the timber was not only shipped out via Iquitos, but could be shipped from other ports as well. During the 1980s and 1990s, timber prices for this species

Where to find it

Figure 1: Climate probability map indicating the presence of mahogany trees in Peru



Note: probability scale ranges from yellow (low) to orange to red to purple (high).

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Conclusion and recommendations

The East Province's forest is being continuously degraded and local communities derive little profit from forest activities. Illegal logging is continuously increasing. Groups like the *Aladji* are at the centre of a system of excessive pit sawing of often illegally harvested timber from community forests, largely to supply the northern provinces with timber products. The traditional export oriented forest sector has largely ignored the domestic demand for timber, with the result that a growing demand is being largely met by the informal sector.

An open dialogue involving the state forest administration, the *Aladji*, and the local population needs to be initiated. This is a precondition not only for reducing social tensions between forest officers and villagers, but also to solve the inequalities of the agreements entered into by communities with groups like the *Aladji*. An open dialogue would enable local communities to improve their chances of obtaining a fair and equitable share of the proceeds from forest harvesting.

The forest administration should be provided with additional staff, adequate training, and the means to control forest activities so as to regulate and organise the local timber market in the East Province and throughout the country.

The authors acknowledge those who helped in providing information during the field investigation, particularly the Eastern Provincial Delegate of Forest and Wildlife, Mr Mbandji Jacques and his staff, and the President of GIC-DOH.

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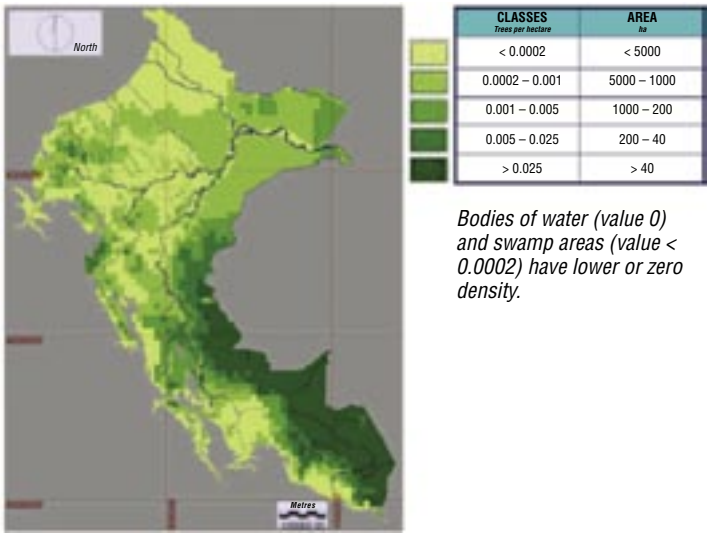
Before access

Figure 2: Natural mahogany tree density map



Bodies of water (value 0) and swamp areas (value < 0.0002) have lower or zero density.

soared, forest harvesting operations were intensified and, in some cases, illegal practices such as chainsaw quartering and encroachments into reserve and native community areas became more prevalent.

In November 2002, the Conference of the Parties of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), held in Santiago, Chile, adopted a decision to transfer mahogany from Appendix III to Appendix II of CITES, which meant that the survival of this species was being threatened and that it was necessary to adopt corrective measures to avoid the extinction of wild populations of this valuable resource.

This restriction entered into force in November 2003, and meant that exports were only possible if the CITES Scientific Authority in Peru issued a non-detriment finding for the species, a function which in this case is performed by the National Agrarian University of La Molina (Universidad Agraria La Molina—UNALM) through its Faculty of Forestry Science (Facultad de Ciencias Forestales—FCF). At the time of the Appendix II listing FCF stated that it could not issue such findings as there was not enough reliable information available on the current status of the natural populations of mahogany.

In 2006, UNALM, with the support of the International Tropical Timber Organization (ITTO), began to implement a project to ascertain the status of mahogany populations and verify the accuracy of a natural distribution model developed by FCF. The information obtained by the project will benefit forest concession holders and native and rural communities who still have harvestable mahogany stocks within their territories, and it will allow the government forest authority (Institute for Renewable Natural Resource—INRENA) to implement actions aimed at the conservation of this species in the country.

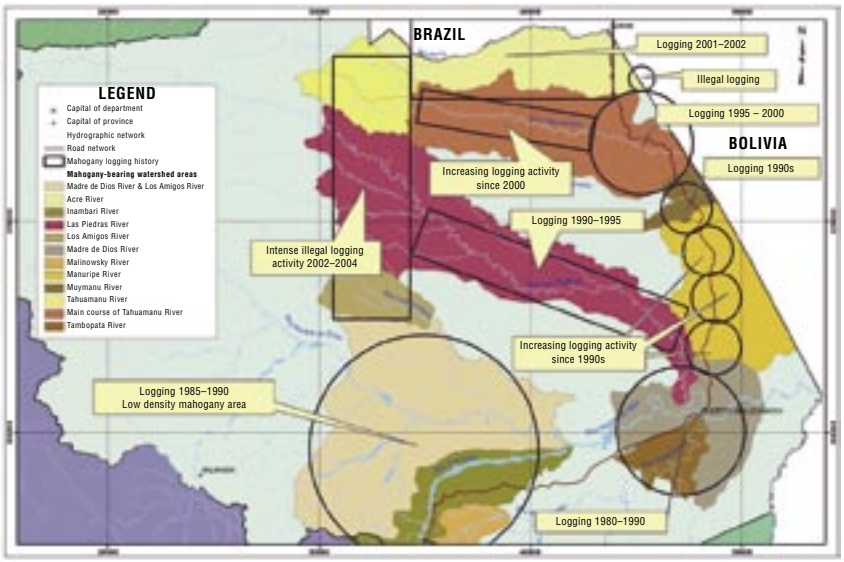
Furthermore, the information obtained will help to establish an allowable cut in accordance with the capacity of permanent production and community areas. This will reduce the rate at which this species is losing its genetic potential and will provide data on mahogany range areas as well as mahogany population density and status.

The current Forestry and Wildlife Law (Act No 27308) only allows logging operations to be carried out in areas under General Forest Management Plans (GFMP) and Yearly Plans of Operation (YPO) that have been duly approved by the competent authority (Forest Department and Technical Forest Administrations), and stipulates that only trees with a minimum DBH of 75 cm can be logged while 10% of seed trees for each harvesting unit must be retained.

The results obtained to date have indicated that 40% of the individuals of this species have a DBH of less than 75cm and the remaining 60% are over this minimum cutting diameter, a situation that is not sustainable over time. It was therefore recommended that the maximum harvest level should be 1200 trees, as long as concession holders and/or native communities include silvicultural plans in their YPOs for the rehabilitation of this species. INRENA has established an export quota for 2007 of 13 476 m^3 of sawnwood, which amounts to approximately 1600 trees based on the current distribution of tree sizes and an assumed 50% sawnwood yield, about one-third more than the recommended harvest level. The size of trees in terms of volume has gradually decreased from one decade to the next, with a decline of 34% recorded over the 87-year period for which detailed

After access

Figure 3: Mahogany-bearing watershed areas and logging history in Madre de Dios



Madre de Dios biometrics

Table 1: Form and volume for individual tree specimens in Madre de Dios

DIAMETER CLASS	NUMBER OF TREES		(FF) *Form factor*	STEM HEIGHT (m)			REAL VOLUME*			% VOLUME DIFFERENCE	WEIGHTED AVERAGE VOLUME**	
	Trees	*%*		*Minimum*	*Maximum*	*Average*	*With bark (m^3)*	*Without bark (m^3)*	*Difference*	*With & without bark*	*With bark (m^3)*	*Without bark (m^3)*
10–19.99	2	1.18	0.8918	7.75	8.00	7.88						
20–29.99	5	2.96	0.8343	4.50	8.50	6.30	0.2575	0.2415	0.0160			
30–39.99	7	4.14	0.8027	6.00	17.00	9.29	0.6991	0.6621	0.0370			
40–49.99	13	7.69	0.7704	4.50	18.00	10.69	1.2678	1.1988	0.0690			
50–59.99	11	6.51	0.6646	6.25	19.00	12.25	1.9020	1.7576	0.1444			
60–69.99	22	13.02	0.7328	7.00	25.00	13.26	3.1266	2.8954	0.2312			
70–74.99	8	4.73	0.7654	6.50	16.00	10.71	3.2487	3.0849	0.1638			
75–79.99	5	2.96	0.8322	8.00	14.00	11.88	4.6042	4.3774	0.2268	4.9259	23.0210	21.8870
80–89.99	7	4.14	0.7203	8.00	21.25	15.05	6.0181	5.7020	0.3161	5.2525	42.1267	39.9140
90–99.99	17	10.06	0.6587	10.00	19.00	14.29	6.6008	6.1945	0.4063	6.1553	112.2136	105.3065
100–109.99	19	11.24	0.7710	8.00	18.00	13.87	9.0715	8.5693	0.5022	5.5360	172.3585	162.8167
110–119.99	10	5.92	0.7999	10.25	20.00	14.53	11.5331	10.8797	0.6534	5.6654	115.3310	108.7970
120–129.99	9	5.33	0.7199	12.00	22.00	16.56	14.2779	13.7344	0.5435	3.8066	128.5011	123.6096
130–139.99	11	6.51	0.6973	9.00	22.50	15.28	14.3200	13.6927	0.6273	4.3806	157.5200	150.6197
140–149.99	8	4.73	0.7207	9.00	18.50	13.75	16.5228	15.8227	0.7001	4.2372	132.1824	126.5816
150–159.99	1	0.59	0.6453	13.75	13.75	13.75	16.5276	15.6488	0.8788	5.3172	16.5276	15.6488
160–169.99	3	1.78	0.7804	12.00	17.00	14.83	23.6001	22.8780	0.7221	3.0597	70.8003	68.6340
170–179.99	2	1.18	0.7243	14.00	18.00	15.83	26.3209	25.0600	1.2609	4.7905	52.6418	50.1200
180–189.99	5	2.96	0.7365	13.00	14.00	13.50	26.7052	25.2231	1.4821	5.5499	133.5260	126.1155
190–199.99	3	1.78	0.7445	12.00	14.00	12.67	27.7166	26.5110	1.2056	4.3497	83.1498	79.5330
200–209.99	0	0.00										
210–219.99	1	0.59	0.6739	12.00	12.00	12.00	28.6816	27.7110	0.9706	3.3841	28.6816	27.7110
TOTAL	**169**	**100.00**	**10.2249**			**197.79**	**TOTAL** *101 commercial trees*			**66.4106**	**1268.581**	**1207.294**
TOTAL *Number of commercial trees*	**101**	**AVERAGE** *FF commercial trees*	**0.73035**			**14.1279**	**WEIGHTED AVERAGE VOLUME**			**4.7436122**	**12.56021**	**11.95341**

*Note: *The volumes shown are average volumes by diameter class; the volume of each individual was calculated by aggregating the real volumes of the sections of each individual (real volume with and without bark); **The sum of all trees that make up the diameter class.*

records of mahogany logging exist (a total of 259 540 specimens have been logged and officially recorded during this period).

Modeling species occurrence probability

A distribution model was developed to determine the number of mahogany individuals at the national level, using the *FloraMap* program, which is a tool used for predicting the distribution of natural organisms on the assumption that the climate in the collection points of a group of individuals is representative of the environmental range of that organism. In the case of plant species, the information can be obtained from herbaria that have registered the samples collected and can thus provide a set of collection points for the required calibration that is then supplemented with information from the locations where the inventories were taken.

A total of 489 trees/collection points were studied, originating from five different information sources:

1) from a review of the YPOs: 228 trees/points were identified;
2) from herbarium databases: 151 trees/points were identified;
3) personal communication: 9 trees/points;
4) forest inventory documents: 9 trees/points; and
5) WWF documents: 92 trees/points.

Figure 1 shows the natural range of the species in Peru and indicates that the highest occurrence probability is in the southern part of the country, particularly in the regions of Ucayali and Madre de Dios, with some possible occurrence in Loreto, which in many cases coincides with native community areas and lands of indigenous peoples living in isolation.

Mahogany occurrence maps

Preliminary results can be seen in the model developed, which combines tree density with the probability of finding the species in a given region.

Figure 2 shows the mahogany tree density in different parts of the country before forest logging or harvesting operations took place. In contrast, *Figure 3* shows the main mahogany-bearing

Ucayali biometrics

Table 2: Form and volume for individual tree specimens in Ucayali

DIAMETER CLASS	NUMBER OF TREES		(FF) Form factor	STEM HEIGHT (m)			REAL VOLUME*			WEIGHTED AVERAGE VOLUME**	
	Trees	%		Minimum	Maximum	Average	With bark (m^3)	Without bark (m^3)	Difference	With bark (m^3)	Without bark (m^3)
30–39.99	1	0.98	0.8606	5.00	5.00	5.00	0.4880	0.3804	0.1076		
40–49.99	1	0.98	0.7983	8.00	8.00	8.00	1.0846	0.8722	0.2124		
50–59.99	4	3.92	0.7499	10.50	5.25	8.94	1.4730	1.3390	0.1340		
60–69.99	9	8.82	0.7224	14.00	9.00	11.22	2.7772	2.4931	0.2842		
70–74.99	3	2.94	0.8634	13.00	10.00	11.00	4.0286	3.6714	0.3572		
75–79.99	4	3.92	0.8820	15.00	11.00	12.94	5.4367	5.0492	0.3875	21.7469	20.1970
80–89.99	10	9.80	0.8379	19.50	8.00	11.95	5.6555	5.2665	0.3890	56.5550	52.6646
90–99.99	12	11.76	0.8076	16.50	5.00	11.10	6.1616	5.7599	0.4017	73.9391	69.1189
100–109.99	11	10.78	0.8142	15.50	9.50	13.02	9.0358	8.2934	0.7423	99.3933	91.2276
110–119.99	7	6.86	0.8739	19.00	8.00	12.43	11.5257	10.8689	0.6567	80.6796	76.0824
120–129.99	7	6.86	0.7609	16.00	8.00	12.79	11.7960	11.1057	0.6902	82.5719	77.7402
130–139.99	10	9.80	0.8127	17.00	7.00	12.10	14.0062	13.1120	0.8941	140.0615	131.1202
140–149.99	4	3.92	0.6601	19.00	12.50	16.25	16.6590	15.7953	0.8637	66.6360	63.1812
150–159.99	7	6.86	0.7706	20.00	10.00	14.21	20.3437	19.2720	1.0717	142.4057	134.9037
160–169.99	4	3.92	0.7825	14.00	9.00	11.75	19.4011	18.4711	0.9300	77.6042	73.8843
170–179.99	1	0.98	0.7431	12.00	12.00	12.00	20.8403	20.3240	0.5163	20.8403	20.3240
180–189.99	3	2.94	0.7312	16.00	14.00	14.67	28.8038	28.1758	0.6280	86.4113	84.5273
190–199.99	2	1.96	0.8152	14.00	10.00	12.00	28.9975	27.3653	1.6322	57.9949	54.7305
200–209.99	0	0.00									
210–219.99	1	0.98	0.7647	12.00	12.00	12.00	33.3162	32.7299	0.5862	33.3162	32.7299
220–229.99	0	0.00									
230–239.99	0	0.00									
240–249.99	1	0.98	0.7067	14.00	14.00	14.00	46.6418	46.2049	0.4368	46.6418	46.2049
TOTAL	**102**	**100.00**	**11.7634**						**TOTAL** *84 commercial trees*	**1086.7977**	**1028.6367**
TOTAL *Number of commercial trees*	**84**	**AVERAGE** *FF commercial trees*	**0.7842246**						**WEIGHTED AVERAGE VOLUME**	**12.9381**	**12.2457**

*Note: *The volumes shown are average volumes by diameter class; the volume of each individual was calculated by aggregating the real volumes of the sections of each individual (real volume with and without bark); **The sum of all trees that make up the diameter class.*

watershed areas in the Madre de Dios region that have been logged over time, and how harvesting areas have gradually moved further away from population centers and access roads.

The current density of mahogany populations in Peru has obviously been affected by the accessibility factor, as new access roads have been opened up in the Amazon region. Natural mahogany populations have been affected and the species range area has been reduced. Furthermore, natural habitats have been destroyed, making rehabilitation more difficult, particularly where cleared lands have been used for agriculture and cattle breeding.

The current status of the species was estimated on the basis of its natural density being affected by the construction of access roads and by deforested areas, where it is clear that the possibility of finding the species has been reduced. Its range is now limited to the most remote locations, thus resulting in the fragmentation of mahogany populations.

In most of these areas, agricultural and cattle-breeding activities have destroyed the habitats of different species that used to occupy these sites, including mahogany. The rehabilitation of these sites should be started so that these species can once again colonize these spaces and thus recover their original range areas.

Associated species

A field data analysis for sample plots was carried out in the Madre de Dios region, with forest types divided into three groups: the first group included sample plots in harvested areas; the second comprised areas with standing mahogany timber trees; and the third was the control area (seed stand).

Based on a simplified inventory of the first group of sample plots, associated species included *Brosimum alicastrum* (mashonaste), *Dipteryx micrantha* (shihuahuaco), *Ceiba pentandra* (lupuna) and *Ficus* spp (renaco).

In the second group of sample plots, the species associated with mahogany included *Ceiba pentandra* (lupuna), *Myroxylon balsamun* (estoraque), *Brosimum guianensis* (manchinga), *Brosimum alicastrum* (mashonaste) and *Aspidospermas macrocarpon* (pumaquiro).

Heart rot: A timber sample of a standing mahogany tree obtained with the Pressler borer. *Photo: I. Lombardi*

In the control group, the species associated with mahogany included *Hevea brasiliensis* (shiringa), *Manilkara bidentata* (red quinilla), *Brosimum alicastrum* (mashonaste), *Amburana* spp (ishpingo), *Myroxylon balsamun* (estoraque) and *Dipteryx micrantha* (shihuahuaco).

Form and volume factors

The project also carried out detailed studies on the form and volume of a sample of commercial mahogany trees harvested from the two major production areas. *Tables 1* and *2* show the results obtained in terms of form and volume of trees and their degree of tapering (form factor), which reduces the total commercial volume of trees. The difference between volume with and without bark for each diameter class is also shown.

The calculations took into account only commercial trees and indicated that the average form factor for the Madre de Dios region is 0.7304 and the difference between volumes with and without bark is an average of 4.75% (0.6068 m^3), ranging from 0.2268 m^3 in smaller diameter trees to 1.4821 m^3 in larger diameter trees. For the Ucayali region, the average form factor is 0.7842 and the difference between volumes with and without bark is an average of 8.96% (0.6924 m^3), ranging from 0.3875 m^3 in smaller diameter trees to 1.6322 m^3 in larger diameter trees. The difference between with bark and without bark volumes for each tree can be used to mask illegally sourced timber.

Hollow trees

Through the assessment of growth rings, it was possible to determine a tree's health status *(see photo)*. It was found that over 21% of the individuals studied in Ucayali and 16% of those studied in Madre de Dios have a central hollow section, while 7–8% of the individualsin both regions are in the process of core decomposition (rotting timber).

The percentage of trees with central hollow sections and the degree of deterioration of each specimen ranges from 42% to 92% across diameter classes. Furthermore, it was found that there is no relation between the size of the hollow section and DBH. In the first tree section (up to 30 m height), it is estimated that the loss could be as much as 84.72% of the volume, which could represent up to 2.68 m^3. In Madre de Dios, the loss could reach 78.69%, representing a loss in volume of up to 3.63 m^3.

Conclusions

Evidence collected by the project shows that higher mahogany tree densities are found increasingly further away from accessible areas, with pressure being exerted on intermediate diameter populations of 75–120 cm DBH. Increasing the minimum cutting diameter should be considered.

According to the analysis carried out using the field data collected by the project, it is necessary to correct the calculation method for production volumes of trees to include volume deductions for bark, damage and disease, which will require further studies. The setting of export quotas on sawnwood when these and other factors (eg conversion efficiency) remain unknown or unquantified leaves concession operators many loopholes to harvest (and legalize) more mahogany trees than anticipated by the quota-setters. For the establishment of logging quotas, not only should more accurate sawnwood yield percentages be calculated and taken into account but also the percentages to be deducted from gross volume to take account of the factors identified above and so arrive at a more realistic merchantable volume.

Such indicators (form factors, percentage of trees with hollows) must be used by INRENA to make the necessary adjustments when calculating the volumes that should be authorized for logging, and concession holders and native communities should be trained and monitored to ensure their volume calculation methods include the necessary reductions.

The setting of export quotas on sawnwood when these and other factors (eg conversion efficiency) remain unknown or unquantified leaves concession operators many loopholes to harvest (and legalize) more mahogany trees than anticipated by the quota-setters.

A longer version of this paper (including references) as well as other project outputs are available from the ITTO Secretariat (rfm@itto.or.jp; Spanish only).