Illegal logging in the Alto Purús Reserved Zone along the Las Piedras river in Madre de Dios, Peru.

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Introduction

Conservation of tropical rainforests is challenging because of the apparent incompatibility of different interests. On one side, conservationists fight for the unique biodiversity (*e.g.*, Terborgh 1999) and anthropologists campaign for the livelihood of native people (*e.g.*, Castillo 2002). On the other side, impoverished societies fight for their right to use their natural resources, even in the face of devastating social and ecological impacts.

The Las Piedras River in the department of Madre de Dios provides an example par excellence of this unfortunate constellation of interests. The pristine forest in its headwaters is home to endangered wildlife, such as bigleaf mahogany (*Swietenia macrophylla*), jaguar (Felis onca) and giant river otter (*Pteronura brasiliensis*), as well as some of the last uncontacted Indians in the world. Apart from a temporary impact caused by oil exploration in the early 1990s, the area's remoteness has prevented local people and international companies from entering and causing substantial impact. However, since 1999 the situation has changed and a supposedly large number of illegal loggers has invaded the forest in their search for precious mahogany. This invasion coincided with an increase in market value of mahogany that lured local people, who on the whole lack alternative work opportunities, into the forest (A. Vera, personal communication).

The impact of mahogany extraction on the species itself has been described in detail by Verissimo *et al.* (1995) and Rodan *et al.* (1992). Sustainable mahogany extraction in the wild does not exist due to poor regeneration (Gullison *et al.* 1996) and has resulted in commercial extinction of the species throughout most of its range (CITES 2002). The recent inclusion of mahogany in CITES Appendix II will not prevent trade but aims to ensure the survival of the species *in situ* through controlled trade, a strategy with high risks as outlined by Blundell & Rodan (2003).

Mahogany has been described as a catalytic species that facilitates wider impact through the likely encroachment of human settlements after the forest is opened (Fearnside 1997). However, in the short term, subsistence hunting by loggers might be of greater concern due to its strong impact on wildlife. This particular case has not been thoroughly researched to date, but strong evidence of the devastating effects of bushmeat extraction by native communities on mammal populations has been presented by Peres (2000) and Bodmer *et al.* (1997), among others. They showed that large-bodied game is prone to extinction close to human settlements and less preferred game, such as small mammals, substantially increase in biomass, inverting natural community structures. More recent work has focused on the synergistic effects of both habitat fragmentation (*e.g.*, that caused by timber extraction) and subsistence hunting by native people on game species (Peres 2001, Cullen *et al.* 2001, Escamilla *et al.* 2003) and concluded that the impact of hunting was amplified in fragmented forests.

Native people in the headwaters of the Las Piedras rely on bushmeat for their protein intake (Stearman & Redford 1995). A strong impact of loggers on game species deprives native people of their dietary needs and poses a serious threat to their survival (Stearman 1995). Since Indians on the Alto Purús live without any physical or social contact with the civilised world, they do not share the same diseases with people who live in civilisation and therefore their immune system can not deal with viruses transmitted, for example, by illegal loggers or other intruders. In the last decade many Indians have died in their natural habitat after having encountered loggers or oil prospectors (Alfredo Garcia, TReeS, personal communication).

Faced with the above social and environmental threats, the Peruvian government signed the "International Tropical Timber Agreement" of the ITTO (International Timber Trade Organisation) and therewith agreed to prevent the export of tropical timber, such as mahogany, from unmanaged areas. In 2000, a new forest and fauna law (No. 27308) was passed by congress, outlawing the extraction of tropical timber outside managed

timber concessions. The law is a new approach to formalising timber extraction and provide incentives for sustainable management via ensuring property rights over an area as large as 40,000 ha for 40 years. In the same year, the Zona Reservada Alto Purús in the upper reaches of the Las Piedras river was created, in part to protect uncontacted Indians in this area. In 2002, timber concessions were assigned across southern Peru and the Reserva del Estado para Indigenas en Aislamiento Voluntario in the middle reaches of the Las Piedras river created after reports of sightings of "calatos" (naked people) by loggers on the Las Piedras and on the border with Brazil increased. Police were used to force illegal loggers out of the new concessions and protected areas. However, many loggers were unprepared for the abrupt change in natural resource policy and did not apply for concessions, which made them criminals overnight. In June and July 2002 these illegal loggers organised a strike in Puerto Maldonado, which virtually paralysed all economic and civic activities for several weeks.

This chapter describes the social and ecological impact of illegal timber extraction in the Zona Reservada Alto Purús along the Las Piedras. It focuses on the geographic organisation of timber extraction, encounters between uncontacted people and timber personnel, loggers' attitudes towards managed forestry, the extraction of mahogany and the impact of logging activity and associated subsistence hunting on large diurnal mammals.

Methodology

Interviews

Between the 1st of May and the 21st of June 2002, 107 structured and semi-structured interviews with timber personnel were conducted in logging camps and ports along the Las Piedras river and whenever timber personnel were encountered while travelling on the river. The interviews were conducted as far upstream as the confluence of the Las Piedras river with the Quebrada Bolognesi, inside the Zona Reservada Alto Purús, approximately 14 days of non-stop travelling with a 16HP motor from Puerto Maldonado. Tributaries of the Las Piedras river were not entered due to the low water level typical of the dry season. The interviews were conducted by two rotating people. The questions were read from a standardised sheet, in order to standardise data collection across people. Every encountered logging camp, up to the native community of Montesalvado was entered. Beyond Montesalvado not all camps were visited due to time constraints. However, the time and date when the boat passed a camp was always recorded and signs of recent activity, *e.g.* boat or intact camp (mostly visible from the water) were used to distinguish between active and inactive logging camps.

Number of camps and timber personnel in Alto Purús

The number of timber camps in the Alto Purús Reserved Zone along the Las Piedras river was recorded via direct counts during the boat journey. The total number of timber camps in the Alto Purús was estimated from the number of recorded camps along the Las Piedras river and from data on the proportional distribution of timber camps in the main river and in the tributaries. The latter was investigated during interviews with timber personnel. The number of timber personnel was estimated by multiplying the mean number of loggers per camp with the estimated number of camps in the area. The large number of interviews conducted at the logging port Curiacu (the commercial centre of Las Piedras at the time of the investigation, where loggers from all parts of Las Piedras bought new supplies and sold their wood), in addition to the interviews conducted with loggers travelling on the Las Piedras river, ensured that the collected data were representative for the Las Piedras region as a whole.

Timber extraction and subsistence hunting

In order to assess the scale of timber extraction, interviewed timber personnel were asked to state the tree species and the amount of wood harvested during the month prior to the investigation. Statements were commonly made in board feet and subsequently converted to cubic meters with 423.8 board feet being equivalent to one cubic meter. The same approach was used to investigate the harvest of bushmeat and interviews asked to state the species and number of individuals hunted during the month prior to the investigation. The monthly harvest of bushmeat, i.e. animals and biomass, and wood in Alto Purús was extrapolated from average values per camp obtained from interviewed loggers. The body mass for adult animals was calculated from FAO (1996), Peres (1997, 1999, 2000), Robinson *et al.* (1986a, 1986b) and Terborgh *et al.* (1990).

Mammal census

From the 15th of July until the 21st of September 2002, standardised un-bounded line transect censuses (Bodmer *et al.* 1997, Peres 1999) were conducted along six transects. The transect length ranged from 4.3 to 5.3 km. The cumulative distance sampled at each site varied from a minimum of 130 km (transect D) to a maximum of 232 km (transect E), with a total of 1,104 km censused. Two transects per site were utilised, one on each side of the river, in a random direction. Transect A & B started at S12^{0}03’24’’, W69^{0}31’42, transect C & D at S12^{0}02'47", W69^{0}40'36", and transect E & F at S12^{0}02’07’’, W 69^{0}50’47’’. All sites were chosen in terra firme (non-inundated) forest in order to minimise the differences in soils and forest structure between sites, which can alter patterns of mammal assemblage (Emmons, 1984). Although environmental factors cannot be excluded, we assume that logging and associated subsistence hunting were the dominant factors influencing mammal communities, since the species under investigation have broad ecological tolerances (Eisenberg & Redford 1999, Emmons 1984). Because of the difficulty of assessing precise logging regimes and extraction rates, hunting history and rate of game recovery, and varying habitat productivity (Peres 1999), the sites were roughly classified into active and inactive sites. Two sites that were

logged and hunted during the time of the data collection (site B) or until two months prior to the investigation (site E) were compared with four sites which loggers had abandoned at least three years ago (A, C, D & F). Confirmation of the roughly assigned impact categories or indices was reconsidered during the field period using the following techniques: interviews with loggers, direct evidence of hunting activity, state of decay of felled trunks and stumps, recovery of vegetation close to logged canopy openings. Transects were prepared during July 2002 using a standardised technique, following White & Edwards (2000) and Peres (1999). Due to difficult terrain, transects D & E incorporated sections of previous logging trails. This was justified, given the non-significant difference of perpendicular distance of encountered mammals, such as *A. belzebuth* groups (Mann-Whitney test, n=151, z=-0.743, p= 0.458) between transects cut by the investigators and transects that had been cut by timber personnel for logging and hunting purposes. None of the other tested species showed a significant difference. The comparison of sites with different logging histories appeared to be problematic due to supposedly different visibility at the sites of different regeneration stages, which would influence the detection probability. However, I argue that the patchiness of the distribution of mahogany stands and therefore logged sites does not support this argument. The encounter probability, as mirrored in the perpendicular distance at which the animals were encountered, was not significantly different between the sites (Kruskal Wallis test for large primates grouped: df=5, chi-square=8.256, p=0.143, all tested individual species p>0.05). Where logging trails were used for the census, they were checked for their general linearity and special attention paid to whether or not the loggers had followed animal trails, since this would introduce a bias in the data collection.

Census Technique

Mammal census followed the standardised methodology described by Peres (1999). Transect censusing involved two trained observers. Data collection was carried out in both directions, i.e. on the outbound and inbound stretches. The groups started monitoring at 6:00 am. In accordance to the standardised methodology (Peres 1999), data collection finished at approximately 11:30 am, since activity patterns and therefore encounter probability dropped off towards midday and early afternoon. The data collected in the morning did not differ significantly from the data collected in the afternoon, hence the encounter probability due to potentially different activity pattern did not differ significantly and the two data sets could be merged. Mann-Whitney tests were performed on *Ateles belzebuth* (n=151, z=-0.930, p=0.352), *Cebus apella* (n=211, z=-1.264, p=0.206) and *Saguinus fuscicollis* (n=118, z=-0.843, p=0.399). Daily rotation of observer and sites minimised observer-dependent bias. The total number of encounters per species per transect was converted into encounters per ten walked kilometres. Relative biomass was calculated for all recorded species. See Peres (1999) for more detailed information on the methodology.

Results

Number of timber camps and loggers

A total of 39 timber camps were recorded inside the Alto Purús Reserved Zone along the Las Piedras river. On average, 8.76 loggers worked in one camp, hence at least 342 loggers were working in the recorded camps at the time of the investigation. The estimated total number of timber camps and loggers, inside the Alto Purús, including camps we saw and camps we did not see that were extrapolated from interview data, was 127 and 1110, respectively.

Timber extraction

Mahogany was the only harvested timber species inside the Alto Purús. On average, 11.2 m^3 were harvested per month per camp. For the recorded number of timber camps in Alto Purús, this equalled 436.8 m^3, worth S/. 1.258.788 on the market in Puerto Maldonado at that time. For the estimated total number of camps in Alto Purús, the figures were 1.419,6 m^3 and S/. 4.091.060. A commonly stated value of 4,72 m^3 per tree resulted in an estimated monthly harvest of 93 and 301 mahogany trees for the recorded and the extrapolated number of timber camps, respectively. Including the conservative figure of 50% (80% was often stated) of trees that were felled but not harvested due to rotten wood inside the trunk raised the above number of logged mahogany trees to 185 and 602 respectively.

Encounters between loggers and un-contacted Indians

17.3% of all interviewed loggers reported having personally seen voluntarily isolated Indians. This is equivalent to 18 independent encounters, which is a minimum estimate, since most contacts had occurred in tributaries. Interviewing a greater number of people working in those areas would most likely have resulted in a higher number of encounters. The majority of reported encounters (58.8%) in Las Piedras occurred between January 2002 and May/June 2002 (Table 1).

Table 1 Location and date of encounters between loggers and un-contacted Indians

	Date	Number of Indians encountered
Las Piedras		
Chanchamayo	May 2002	12
San Francisko	April 2002	1
San Francisko	April 2002	4
Curiacu	March 2002	6
Curiacu, 6 days upstream	March 2002	15
Curiacu	February 2002	40
Curiacu	February 2002	80
Pingachari	February 2002	7
7 islas	January 2002	1
Ceticayo	20 January 2002	300
Ronsocco	August 2001	50
Unspecified	August 2001	4
Communidad 1900	July 2001	400
Communidad Montesalvado	16 July 2001	300
Unspecified	1999	40
Compania Petrolera	1999	14
Santa Elena	1993	2
Los Amigos		
Unspecified	April 2002	7

Loggers' attitude towards their work and towards timber concessions

Roughly equal proportions of the loggers interviewed reported liking their work (37%), disliking their work (26%), or having no strong feelings towards it (37%) (Figure 1&2). Many interviewees noted the drawbacks to working as a logger, including the associated dangers, the difficulty of the work and the low salary, and blamed the hopeless employment situation in Puerto Maldonado for their decision to work as loggers. In striking contrast to the widespread lack of strong opinions concerning their own work, the vast majority (84%) of timber personnel strongly objected to the idea of their sons becoming loggers. Only a small fraction (7%) supported this idea.

Considering the problems regarding the introduction of the concessions scheme in Madre de Dios, i.e., the loggers' strike of 2002, it was surprising that 80.8% of all interviewed loggers confirmed that they would consider working in a timber concession.

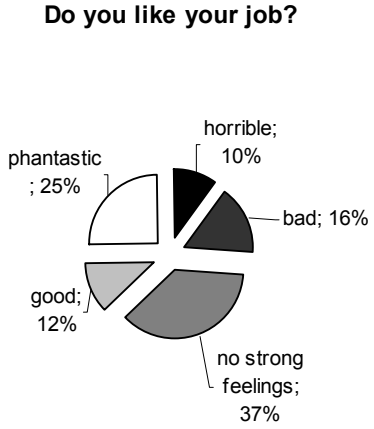

Figure 1 (left) The distribution of interviewee statements regarding their attitude towards their job; N=96. **Figure 2** (right) The loggers' response towards the prospect of their sons becoming loggers; N=94.

Hunting associated with logging activity in Alto Purús

The estimated monthly harvest of bushmeat, including mammals and birds, in the estimated 127 timber camps inside the Alto Purús Reserved Zone was 2426.5 animals, or 23071.8 kg. In terms of the number of animals hunted, mammals and birds were equally impacted; mammals contributed 52.4% and birds 47.6% to the total harvest. However, the vast majority (90.5%) of extracted biomass came from mammals and only a small percentage (9.5%) was contributed by birds. Each logger consumed 345 g of edible meat per day.

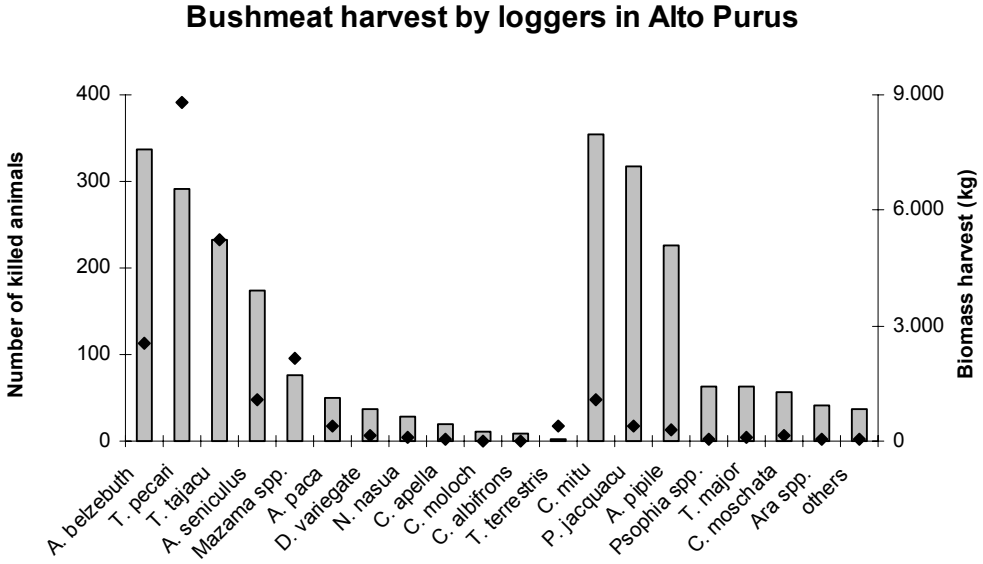

Figure 3 Estimated number of killed mammals and birds (bars) and corresponding biomass harvest (dots) for the estimated 127 timber camps for a one month period. The species were grouped into mammals and birds and thereafter ranked according to the number of animals killed.

Mammals were roughly allocated into two groups of different hunting pressure, separated by the bold line in Table 3. The most commonly hunted mammal species were *A. belzebuth* (336.0), followed by *T. pecari* (291.0), *T. tajacu* (231.7) and *A. seniculus* (174.6). These four species comprised 81.7% and 84.3% of the total harvest in terms of numbers of animals and biomass respectively. The species hunted with less intensity were led by *Mazama americana* (75.9). The greatest single biomass harvest experienced *T. pecari* with 42.1% of the total harvest followed by *T. tajacu* with 24.9%. In addition to mammals, 1161,3 birds were killed per month in the 127 logging camps. This was equivalent to 2162.7 kg of biomass or 32.5 g of edible meat per person per day. *C. mitu*, *P. jacquacu* and *A. pipile* were the most severely hunted species and comprised 77.4% of all killed birds and 81.6% of the total avian biomass harvest.

Table 2 Estimated bushmeat harvest of mammals and birds hunted in the estimated 127 camps inside the Alto Purús Reserved Zone during the month of April 2002 . Columns titled N, min, max, mean and Std. Dev. state results calculated from interview data. Data in columns titled Sum and biomass harvest were extrapolated using the average number of animals killed per camp per month and the estimated number of timber camps in the protected areas. The total hunted biomass was calculated from the number of animals killed and their mean body mass. The amount of fresh edible meat harvested was calculated using 0.5 as a conversion factor[1] and subsequently converted into consumption per day per person.

	N	*Min.*	*Max.*	*Mean*	*Std. Dev*	*Sum*	*Mean body mass (kg)*	*Biomass harvest (kg)*	*Consumption per person per day (g)*
A. belzebuth	96	0	15	2.65	3.10	336.0	7.50	2520.2	37.7
T. pecari	96	0	15	2.29	2.39	291.0	30.25	8804.0	131.9
T. tajacu	97	0	10	1.82	1.92	231.7	22.50	5214.2	78.1
A. seniculus	96	0	15	1.38	2.28	174.6	6.27	1094.9	16.4
M. americana	97	0	5	0.60	0.95	75.9	28.05	2130.1	31.9
A. paca	97	0	6	0.39	1.17	49.8	8.11	403.5	6.0
D. variegate	97	0	10	0.30	1.24	38.0	4.10	155.7	2.3
N. nasua	97	0	5	0.22	0.67	27.5	3.49	96.0	1.4
C. apella	97	0	10	0.15	1.05	19.6	3.05	59.9	0.9
C. brunneus	97	0	5	0.08	0.55	10.5	1.11	11.6	0.2
C. albifrons	97	0	5	0.06	0.52	7.9	2.36	18.5	0.3
T. terrestris	97	0	1	0.02	0.12	26	152.97	400.6	6.0
SUM						**1265.2**		**20909.1**	**313.2**
C. mitu	97	0	20	2.79	3.68	354.8	3.06	1085.7	16.3
P. jacquacu	97	0	24	2.51	3.85	318.2	1.28	407.2	6.1
A. pipile	96	0	15	1.81	2.66	226.5	1.20	271.8	4.1
P. leucoptera	96	0	8	0.50	1.41	62.8	0.99	62.2	0.9
Tinamus spp.	96	0	8	0.50	1.21	62.8	1.17	73.5	1.1
C. moschata	96	0	15	0.44	1.66	56.3	3.00	168.9	2.5
Ara spp.	96	0	8	0.33	1.17	41.9	1.13	47.3	0.7
Others	53	0	10	0.55	1.92	38.0	1.21	45.9	0.7
SUM						**1161.3**		**2162.7**	**32.4**
TOTAL SUM						**2426.5**		**23071.8**	**345.6**

[1] FAO: http://www.fao.org/docrep/T0750E/t0750e05.htm

Mammal census

The total number of recorded mammal species was 27, comprising six orders: Artiodactyla (4 species), Carnivora (6), Perissodactyla (1), Primates (9), Rodentia (4) and Xenarthra (3). The size-classes ranged from 0.22 kg (*S. ignitus*) to 153 kg (*T. terrestris*). The highest and lowest number of mammal species recorded (including visual and auditory encounters, tracks & faeces) at any transect were 23 and 15 respectively.

Biomass allocation in the mammal community

The average relative biomass of encountered mammals at active sites was 9.0% or 32.2% lower than at inactive sites, depending on whether *T. pecari* was included or excluded from the analysis. The biomass of small mammals (< 3kg) was reduced by only 8.9% (Figure 4). Although large mammals experienced a greater reduction in biomass, their average contribution to the total biomass at the active and inactive sites was 85.2% and 87.7%, respectively. *T. pecari* was the dominant mammal species in terms of biomass. At sites where the species was encountered it comprised on average 66.7% of the total mammalian biomass.

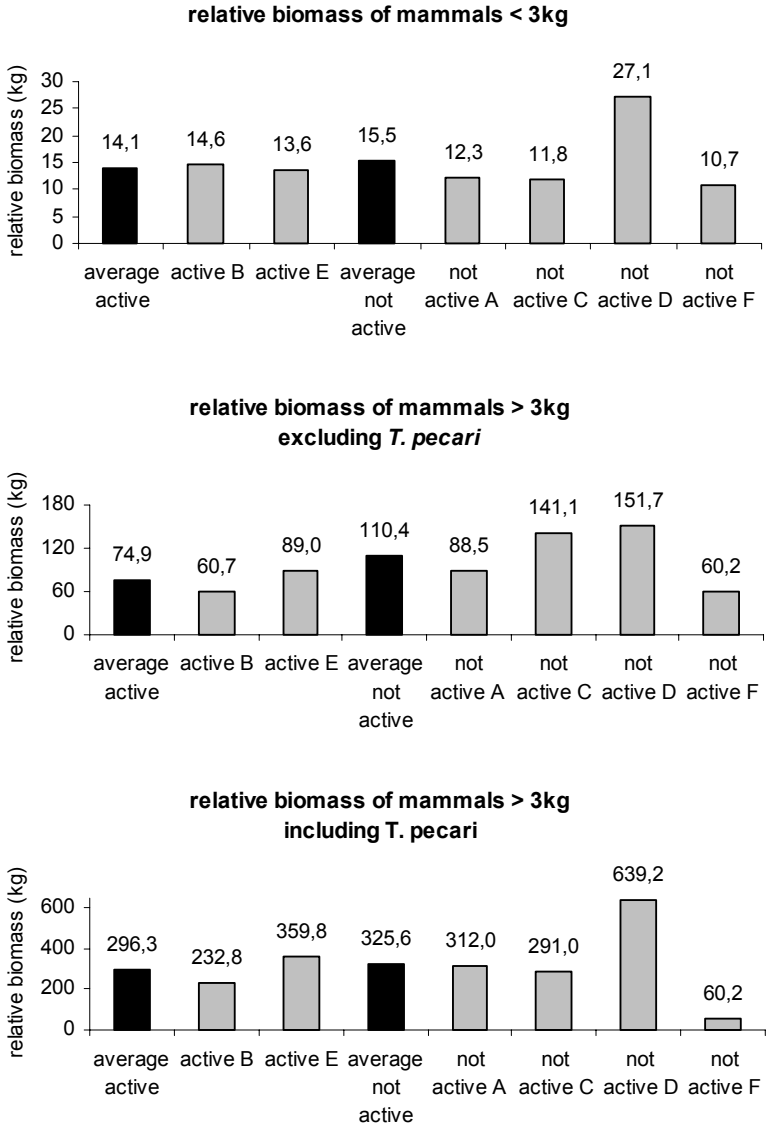

Figure 4 Biomass distribution of small (< 3kg, first figure) and large (> 3kg excluding T. *pecari*, 2nd figure; > 3kg including *T. pecari* 3rd figure) mammals displayed as animal biomass encountered per 10 walked kilometres at active and inactive sites. The black bars show the average value per treatment and the grey bars show the values for individual sites.

None of the different taxonomic groups showed a substantial difference in biomass contribution between the treatments. Primates increased by 9.4% after cessation of the logging and hunting impact and ungulates decreased slightly, mainly due to the lack of encounters of *T. pecari* at one of the inactive sites, although the species was recorded via tracks.

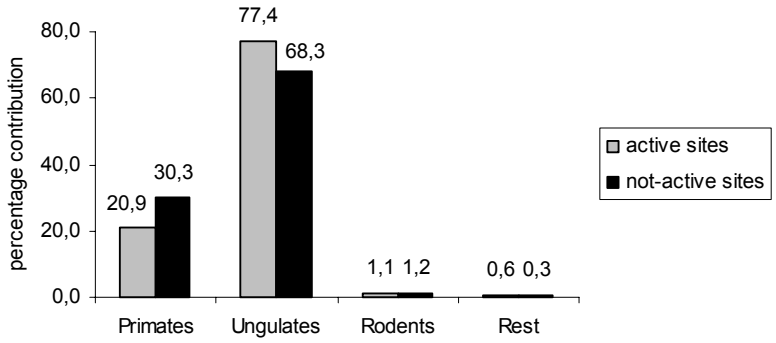

Figure 5 Relative biomass contributions of four taxonomic groups at sites with different logging histories.

1. Discussion

So far the Alto Purús Reserved Zone has not been successful in protecting uncontacted Indians and wildlife in Madre de Dios. Mahogany has again proven to be an irresistible temptation for local people. The frequency of logging camps along the Las Piedras river increased with increasing distance from Puerto Maldonado, showing a pattern of resource extraction close to the market first and expanding its radius once the resources are depleted. The high price of mahogany at the time of the investigation permitted financial gain with transportation times of timber of more than 30 days. The remoteness of the Alto Purús did not prevent invasion by illegal loggers, it only delayed it.

The total number of timber camps in the Alto Purús was estimated using data that was representative for the whole river and not parts of it. This was due to the geographical change in resource availability along the Las Piedras river, i.e., less mahogany was encountered close to the Las Piedras river in its middle reaches than in its upper reaches (Alto Purús). This encourages loggers who work in the middle reaches to explore tributaries that enable them to cut wood a great distance from the Las Piedras river, whereas mahogany could still be found relatively close to the Las Piedras river inside the Alto Purús. Data of the distribution of timber camps used for the above estimation cannot be regarded as accurate and provides only an idea of the scale. The high number of camps along the Las Piedras river is accurate and can best be seen as a minimum number of camps.

The impact of illegal logging activity on the environment was manifold but showed qualitative differences between different taxa as will be outlined below. Due to the naturally low density of mahogany, i.e. 0.1-0.3 trees per ha with a patchy distribution (CITES 2002, Gullison *et al.* 1996, Zimmerman *et al*. 2001) and the lack of heavy machinery for timber extraction, the number of impacted sites and the impact on individual sites were relatively low as the existing literature indicates (*e.g.* Whitman *et al*. 1997). For the whole forest this form of land use does not alter forest structure and function. The changes lie well within the bounds of natural perturbation (Verissimo *et al*. 1995). However, for mahogany the impact was potentially devastating. Unfortunately, it was not possible to assess the area from which the estimated amount of wood was extracted and therefore assess the current situation of the species. But the history of mahogany harvest does not give rise to much hope, mainly due to the absence of natural regeneration (*e.g.*, Gullison *et al.* 1996). Extinction appears inevitable in the near future, which is a harsh repercussion for current political successes, i.e. introduction of mahogany in CITES appendix II.

A large number of game species were impacted by subsistence hunting for prolonged periods, with higher per capita harvest than reported for native communities (Alvard *et al.* 1996, Souza-Mazurek *et al.* 2000). However, the widely documented devastating impact of subsistence, inversion of biomass in mammal communities and extinction of game species such as *T. pecari* (see Peres 1996, including an interesting description of the migratory ecology of the species), could not be observed in this study. Possible explanations for this result are the failure of the experimental design in capturing this pattern and difficulties in allocating exact land use histories (see Schulte-Herbrüggen & Rossiter 2003 for a more detailed discussion) but the small scale of timber extraction, and its proximity to the main rivers and tributaries suggest that intact source populations migrate into hunted areas as soon as the loggers leave or even before.

The impact of loggers on uncontacted native communities in Alto Purús is difficult to assess due to the lack of precise information. However, the presented results clearly show that a large number of illegal loggers had invaded the reserves intended to protect Indians in Las Piedras, including the Alto Purús, and that encounters have frequently occurred. Although, transmission of diseases is not very likely since it requires close contact and most interviewees stated that they had seen Indians at great distance or stumbled over them while searching for bushmeat, Indians have died because of diseases transmitted by invaders and will in the future if encounters are not prevented. As a reaction to the invasion of their territory, logging camps were frequently destroyed by Indians, forcing the loggers to retreat (Andres Vera, logger, personal communication). This again resulted in violent conflicts between the two parties, with an unknown number of casualties. A consequence of this invasion that is easily overlooked is the migration of Indian communities into the territories of neighbouring communities, leading to lethal fights as reported *e.g.* from Manu (Caesar Moscosso, personal communication). For a detailed description of the potential social changes following a period of contact see the website of the Cabeceras Aid Project (www.cabeceras.org).

The case of illegal logging in Alto Purús clearly shows that the conservation of Neotropical forests is unlikely to succeed without incorporating local people and respecting the local socio-economic situation. Conservationists do not work inside a vacuum but can only succeed when a more holistic approach to current problems in resource management is applied. The surprising results of loggers' attitudes towards their work (mixed), towards the prospect of their sons becoming loggers (overwhelmingly negative), and towards the new concession system (overwhelmingly positive) highlight several crucial factors. First, the lack of rebellion against their own working conditions in the forest and the hopeless employment situation in the town might be due to an inner capitulation. People have given up trying to improve their own development but wish to create a better future for their children. One of the loggers employed by our project said good-bye to his children at the start of the investigation with the words "estudia, estudia, estudia". The perceived intervention of foreign organisations, given that timber concessions are sold in US$ (personal observation & Eckersley 2003), and the exclusiveness of the new forestry law, make people fear for their children's future. Although they do not want them to become loggers, they know that the only way for their children to get a proper profession is through education, which has to be paid for by cutting mahogany.

I do not feel to be in a position for proposing solutions, since other people are better equipped for this but would like to emphasise the crucial role that I think local NGOs could play in the process of improving the situation. During the investigation I encountered many very sensible loggers who appreciated that someone was interested in their life and wanted to discuss the problems with them. NGOs should actively seek the discussion with individual loggers, regain their trust by showing an honest interest in their problems and promote the exchange of information between the clashing parties. The recent flare up of strikes in Puerto Maldonado shows that people are willing to fight against their exclusion of development and I would be surprised if this energy could not be channelled into positive action.

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References

Alvard, M. S., Robinson, J. G., Redford, K. H., & Kaplan, H. (1997) The sustainability of subsistence hunting in the Neotropics. *Conservation Biology* **11,** pp. 977-982

Blundell,A.G. & Rodan, B. D. (2003) Mahogany and CITES: moving beyond the veneer of legality. *Oryx* **37,** pp. 85-90

Bodmer, R. E., Eisenberg, J. F., & Redford, K. H. (1997) Hunting and the likelihood of extinction of Amazonian mammals. *Conservation Biology* **11,** pp. 460-466

Brockelman, W. Y. & Ali, R. (1987) Methods of surveying and sampling forest primate populations. *Primate Conservation in the Tropical Rain Forest* (eds Marsh, C. & Mittermeier, R. A.), pp. 23-62. Alan R. Liss, New York

Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L., & Thomas, L. (2001) *Introduction to distance sampling - estimating abundance of biological populations*. Oxford University Press, Oxford

Carrillo,E., Wong, G., & Cuaron, A. D. (2000) Monitoring mammal populations in Costa Rican protected areas under different hunting restrictions. *Conservation Biology* **14,** pp. 1580-1591

Castillo, B. H. (2002) *Los pueblos indigenas en aislamiento - su lucha por la sobrevivencia y la libertad*. Grupo Internacional De Trabajo Sobre Asuntos Indigenas, Denmark

Chapman, C. A., Balcomb, S. R., Gillespie, T. R., Skorupa, J. P., & Struhsaker, T. T. (2000) Long-term effects of logging on African primate communities: a 28-year comparison from Kibale National Park, Uganda. *Conservation Biology* **14,** pp. 207-217

Convention on International Trade in Endangered Species of Wild Fauna and Flora-CITES (2002). *Consideraton of proposal for amendment of Appendices I and II*. Prop. 12.50, pp. 20

Cullen,L., Bodmer, R. E., & Valladares-Padua, C. (2001) Ecological consequences of hunting in Atlantic forest patches, Sao Paulo, Brazil. *Oryx* **35,** pp. 137-144

Eckersley, W. (2003) *Changing opportunities and obligations: Peru's new forestry law as an attempt to formalise logging in Sepahua.* BSc Thesis, Cambridge University

Eisenberg, J. F. & Redford, K. H. (1999) *The Central Neotropics. Volume 3. Ecuador, Peru, Bolivia, Brazil*. The University of Chicago Press, Chicago

Emmons, L. H. (1984) Geographic-variation in densities and diversities of non-flying mammals in Amazonia. *Biotropica* **16,** pp. 210-222

Escamilla, A., Sanvicente, M., Sosa, M., & Galindo-Leal, C. (2003) Habitat mosaic, wildlife availability, and hunting in the Tropical forest of Calakmul, Mexico. *Conservation Biology* **14,** pp. 1592-1601

Fearnside, P. M. (1997) Protection of mahogany: a catalytic species in the destruction of rain forest in the American tropics. *Environmental Conservation* **24,** pp. 303-306

Food and Agricultural Organisation of the United Nations-FAO (1996). Wildlife Utilization in Latin America: Current Situation and Prospects for Sustainable Management. (FAO Conservation Guide - 25). Rome.

Gullison, R. E., Panfil, S. N., Strouse, J. J., & Hubbell, S. P. (1996) Ecology and management of mahogany (*Swietenia macrophylla* King) in the Chimanes Forest, Beni, Bolivia. *Botanical Journal of the Linnean Society* **122,** pp. 9-34

Peres, C. A. (1997) Primate community structure at twenty western Amazonian flooded and unflooded forests. *Journal of Tropical Ecology* **13,** pp. 381-405

Peres, C. A. (1999) General guidance for standardizing line transect surveys of tropical rainforest primates. *Neotropical Primates* **7,** pp. 11-16

Peres, C. A. (2000) Effects of subsistence hunting on vertebrate community structure in Amazonian forests. *Conservation Biology* **14,** pp. 240-253

Peres, C. A. (2001) Synergistic effects of subsistence hunting and habitat fragmentation on Amazonian forest vertebrates. *Conservation Biology* **15,** pp. 1490-1505

Robinson, J. G. & Redford, K. H. (1986) Body size, diet, and population density of Neotropical mammals. *American Naturalist* **128,** pp. 665-680

Robinson, J. G. & Redford, K. H. (1986) Intrinsic rate of natural increase in Neotropical forest mammals - relationship to phylogeny and diet. *Oecologia* **68,** pp. 516-520

Rodan, B. D., Newton, A. C., & Verissimo, A. (1992) Mahogany conservation - status and policy initiatives. *Environmental Conservation* **19,** pp. 331-338

Schulte-Herbrüggen, B. and Rossiter, H. (2003) Project Las Piedras 2002: socio-ecological investigation into the impact of illegal logging in Las Piedras, Madre de Dios, Peru. University of Edinburgh.

Souza-Mazurek, R. R., Pedrinho, T., Feliciano, X., Hilario, W., Geroncio, S., & Marcelo, E. (2000) Subsistence hunting among the Waimiri Atroari Indians in central Amazonia, Brazil. *Biodiversity and Conservation* **9,** pp. 579-596

Stearman, A. M. & Redford, K. H. (1995) Game management and cultural survival: the Yuqui ethnodevelopment project in lowland Bolivia. *Oryx* **29,** pp. 29-34

Terborgh, J., Robinson, S. K., Parker, T. A., Munn, C. A., & Pierpont, N. (1990) Structure and organization of an Amazonian forest bird community. *Ecological Monographs* **60,** pp. 213-238

Terborgh, J. (1999) *Requiem for nature*. Island Press, Washington D.C.

Verissimo, A., Barreto, P., Tarifa, R., & Uhl, C. (1995) Extraction of a high-value natural-resource in Amazonia - the case of mahogany. *Forest Ecology and Management* **72,** pp. 39-60

White, L. & Edwards, A. (2000) Methods for assessing the status of animal populations. *Conservation Research in the African Rainforest a technical Handbook* (eds White, L. & Edwards, A.), The Wildlife Conservation Society, New York

Whitman, A. A., Brokaw, N. V. L., & Hagan, J. M. (1997) Forest damage caused by selection logging of mahogany (*Swietenia macrophylla*) in northern Belize. *Forest Ecology and Management* **92,** pp. 87-96

Zimmerman, B., Peres, C. A., Malcolm, J. R., & Turner, T. (2001) Conservation and development alliances with the Kayapo of south-eastern Amazonia, a tropical forest indigenous people. *Environmental Conservation* **28,** pp. 10-22