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EXPLORAÇÃO ILEGAL DE MADEIRA NO ARQUIPÉLAGO DE ANAVILHANAS (AMAZÔNIA CENTRAL): VARIÁVEIS HUMANAS QUE DETERMINAM A DISTRIBUIÇÃO ESPACIAL DA EXPLORAÇÃO E EFEITOS ESTRUTURAIS SOBRE OS TÁXONS MAIS EXPLORADOS.

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Sinopse:

A fim de propor estratégias de controle da exploração ilegal de madeira no arquipélago de Anavilhanas esse estudo avaliou a distribuição espacial da exploração das espécies madeireiras. Além disso, avaliou a influência das distâncias das comunidades humanas e do valor da madeira na intensidade de exploração e analisou os efeitos da exploração na estrutura das populações das espécies exploradas. Os resultados mostram uma tendência de mudança na estrutura das populações com o aumento da intensidade de exploração para *V. surinamenis*, Lauraceae spp., enquanto para Heveae spp. e *M. acaciifolium* o aumento na intensidade de exploração não promoveu um efeito negativo na abundância dos indivíduos. A distribuição espacial das comunidades humanas não indicou efeito da intensidade de exploração, enquanto que o valor da madeira parece ter um efeito na seleção dos locais explorados.

Palavras-chave: estrutura populacional, distribuição diamétrica de classes, crescimento de árvores, dendrocronologia, áreas inundáveis, uso de recursos.

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“Áreas protegidas cercadas por pessoas irritadas, com fome e que se descrevem como inimigos da conservação estão sujeitas ao fracasso.”

Mark Dowie (2004)

RESUMO

O Parque Nacional de Anavilhanas é uma unidade de conservação amazônica que enfrenta atualmente o desafio de controlar a exploração ilegal de madeira. Por isso é imprescindível a obtenção de informações a respeito da geografia e dos efeitos da exploração sobre as populações alvo dos extratores. Assim, o presente trabalho teve como finalidade determinar (1) as densidades dos táxons explorados e sua distribuição espacial; (2) a distribuição e intensidade da exploração; (3) o efeito da exploração sobre a estrutura das populações desses táxons; (4) as taxas de crescimento das árvores e (5) testou a hipótese de que a distribuição espacial da exploração está relacionada com a distribuição espacial das comunidades humanas residentes na zona de amortecimento do parque e com o valor da madeira. Para isso, foram registrados todos os indivíduos arbóreos com DAP > 10 cm dos 5 táxons mais explorados e os vestígios de exploração, em 84 transectos distribuídos uniformemente pelo arquipélago de Anavilhanas. As taxas de crescimento foram obtidas por análises dendrocronológicas. *V. surinamensis* e Lauraceae spp. apresentaram modificações na estrutura da população com o aumento de exploração. Como a taxa de crescimento de *Ocotea cymbarum* (Lauraceae) foi alta, esta espécie pode se recuperar rapidamente caso a pressão de exploração cesse. Para *C. brasiliensis* não houve evidência de efeito da exploração sobre a estrutura populacional, mas a sua baixa taxa de crescimento e distribuição agrupada sugerem que poderá ser afetada caso a exploração se mantenha. Em *M. acaciifolium* e *Hevea* sp. o aumento da exploração não promoveu efeitos negativos em suas populações e, além disso, suas altas taxas de crescimento e grandes densidades indicam que poderiam ser manejadas. A exploração concentra-se na região sul do arquipélago, próximo às concentrações humanas, para a maior parte das espécies, mas não para Lauraceae spp., cuja madeira tem maior valor econômico. Os modelos testados não indicaram relação entre a intensidade de exploração e as distâncias geográficas até as comunidades, mas sim uma tendência de maior intensidade de exploração onde há maior concentração de recursos mais valiosos. Assim, uma estratégia para controle da exploração ilegal no arquipélago de Anavilhanas seria apoiar o manejo florestal nas unidades de conservação que ficam na zona de amortecimento do parque e estimular a concentração do turismo na região sul do arquipélago, já que a presença de turistas pode inibir as atividades ilegais.

Palavras - chave: estrutura populacional, crescimento de árvores, pressão humana, dendrocronologia, áreas inundáveis.

ABSTRACT

The Anavilhanas' National Park is an Amazonian protected area facing nowadays the challenge of controlling illegal logging. To aid this task, this study aimed to determine (1) the densities of the exploited species in this area; (2) the spatial distribution of logging; (3) the effect of logging on population structure; (4) the growth rate of each species and (5) analyze the effects of human communities' distance and wood value in the logging intensity. All trees with DBH >10 cm of the five most exploited species and the logging vestiges were registered on 84 transects uniformly distributed over the Anavilhanas Archipelago. Growth rates were measured by dendrocronology. Medium and large sized trees (10-30 and > 60cm DBH) of *Virola surinamensis* and Lauraceae spp (10-30 cm DBH) decreased in abundance as harvesting intensity increased. However, since growth rates of *Ocotea cymbarum* (Lauraceae) were high, it may recover fast if harvesting pressure stops. There was no evidence of negative effects of harvesting on the population structure of *Calophyllum brasiliense*, but its low growth rate and grouped distribution suggest that continued exploitation may endanger the population. There were no negative effects of logging for *Macrolobium acaciifolium* and *Hevea spp*., and their high growth rates and high abundances indicate that these species have a potential for management. Harvesting is concentrated in the southern region of the archipelago, next to the human concentrations, for most species, except for Lauraceae spp., whose timber is more valuable. The model tested indicated no relationship between the intensity of harvesting activities and the geographic distances to human communities, but a trend to choose harvesting places with greater concentration of more valuable resources. Thus, a strategy to control the illegal logging in the Anavilhanas Archipelago would be to encourage a sustainable logging plan on the buffer zone of the Park and to stimulate tourism on the South of the archipelago, where tourist presence could inhibit illegal activities.

Key-words: population structure, growth trees, human press, dendrocronology, floodplains.

SUMÁRIO

Introdução

A floresta amazônica é hoje um dos principais fornecedores de madeira mundial, e por isso o setor madeireiro é importante para a economia, com grande geração de renda e empregos para essa região (Lentini *et al.*, 2005). Contudo, benefícios econômicos geralmente estão associados a custos ambientais. A exploração madeireira é um dos principais fatores responsáveis pelo desmatamento na Amazônia (Fearnside, 2010). A exploração convencional de madeira afeta a estrutura e composição das florestas (Veríssimo *et al*., 1992; Johns *et al*., 1996; Monteiro *et al.*, 2004), aumenta a suscetibilidade a incêndios (Holdsworth & Uhl, 1997; Nepstad *et al.*, 1999), reduz a biomassa acima do solo (Gerwing, 2002), aumenta o acesso humano às florestas, facilitando a extração de recursos e a caça e por fim, afeta a fauna, modificando a abundância, riqueza, composição e comportamento de diversos grupos animais (Laurance, 2001).

Com a finalidade de minimizar os impactos ambientais associados à exploração madeireira e garantir sua sustentabilidade, já foram propostas uma série de medidas de exploração de impacto reduzido (Putz & Pinard, 1993; Amaral *et al*., 1998). Tais melhorias técnicas e logísticas diminuem significativamente os danos de exploração (Putz *et al.*, 2008) e são economicamente rentáveis (Barreto *et al*., 1998). Porém, a maioria da exploração na Amazônia, aproximadamente 62%, permanece sem planejamento e se estendendo continuamente para novas áreas (Lentini *et al.*, 2005), devastando a floresta e comprometendo o comércio de madeira em longo prazo. Isso se deve principalmente ao fato de que a maioria da exploração madeireira na Amazônia ainda ocorre ilegalmente (Fearnside, 2010). Segundo Higuchi (*com pess*.) atualmente cerca de 70 % da madeira é comercializada sem ter sua origem identificada.

A ilegalidade da exploração madeireira dificulta localizar e quantificar a madeira que está sendo retirada das florestas, principalmente porque muitas vezes a retirada não forma grandes clareiras que possam ser visualizadas em imagens de satélites (Nepstad *et al*., 1999). Esse problema é intensificado quando consideramos a exploração em regiões que não deixam vestígios que possam ser capturados por satélites, como a exploração em áreas alagáveis, na qual a madeira é transportada pelos rios sem a necessidade de abertura de estradas e pátios de estocagem (Schöngart & Queiroz, 2010, no prelo). Técnicas modernas de sensoriamento remoto (eg. Projeto DETEX_INPE) permitem a visualização de exploração seletiva em imagens de satélite (www.inpe.br), porém em poucos anos o dossel se fecha e fica difícil identificar as clareiras (Asner *et al*., 2005). Além disso, nem sempre é possível determinar se a clareira foi aberta devido à extração seletiva ou à queda natural de árvores. Por isso, estudos de campo são imprescindíveis para complementar e validar análises de sensoriamento remoto para a localização da distribuição de atividades de extração ilegal de madeira, principalmente em escala local.

O padrão de distribuição espacial de exploração de recursos geralmente está relacionado com a maneira como determinado recurso é explorado. Comumente a exploração é inversamente proporcional à distância em que se encontra o recurso de interesse (Murali *et al.*, 1996; Uma Shaanker *et al*., 2002), dado que quanto maior a distância de sua fonte, maior o gasto associado de tempo e combustível para obtê-lo. Contudo, essa tendência pode ser modificada dependendo do valor monetário associado a cada tipo de recurso, já que aqueles mais valiosos podem justificar maiores gastos. Os modelos para entender os padrões de exploração de recursos naturais muitas vezes estão baseados em modelos ecológicos para o comportamento de animais e de microeconomia, que têm sido utilizados na ecologia humana para prever padrões de comportamento (Begossi, 2009). Um destes modelos, o de forrageamento ótimo, pressupõe um balanço entre o benefício e o custo associado à busca do alimento.

Modelos de forrageamento ótimo têm sido utilizados para analisar comportamento de exploração de recursos por diferentes populações humanas, como por exemplo, pescadores (Begossi, 2005). O uso desses modelos pode ser útil para compreender os fatores que definem o padrão de distribuição espacial de uso dos recursos florestais pelas populações humanas.

Para entender os impactos ecológicos e propor medidas de controle da exploração ilegal de madeira em escala local, além de entender a distribuição espacial da exploração e os padrões de exploração que a definem é imprescindível identificar seus efeitos não só em relação à estrutura e composição das florestas, mas também sobre as populações das espécies exploradas. Na Amazônia, algumas espécies já mostram sinais de insustentabilidade frente às taxas de extração praticadas, como por exemplo, o Mogno, *Swietenia macrophylla* (Meliaceae) (Veríssimo, 1995) e a Virola, *Virola surinamenisis* (Myristicacae). O estudo de Macedo e Anderson (1993) na Ilha de Marajó mostrou uma queda abrupta na abundância de *Virola surinamensis* devido à sobre exploração.

A principal causa da extinção das espécies exploradas é a modificação da estrutura etária de suas populações pela redução do número de indivíduos adultos que fornecem propágulos (Martini *et al.*, 1998). Conseqüentemente, essa redução pode levar à diminuição de indivíduos jovens, devido à dificuldade de regeneração pela redução ou ausência da chuva de sementes ou por alterações nas condições ambientais que garantem a regeneração e o estabelecimento da espécie. Em uma população com altos níveis de recrutamento, ocorre uma diminuição exponencial na densidade de indivíduos nas classes de maiores diâmetros, sendo que uma alteração nesse padrão de distribuição pode indicar a modificação na estrutura etária da população. Peres *et al.* (2003)

mostraram que a pressão pela coleta de sementes de Castanha-do-Pará (*Bertholletia excelsa*, Lecythidaceae), fez com que as populações em áreas exploradas tenham um menor aporte de indivíduos jovens, caracterizando um gargalo populacional, o que pode levar a espécie à extinção local. Existe uma lacuna de conhecimentos sobre estrutura das populações, crescimento e reprodução de espécies madeireiras, que possam ser aplicados para compreender os efeitos da extração seletiva sobre as populações e para definição de níveis de corte que sejam sustentáveis ecologicamente (Nebel & Meilby, 2005).

O conhecimento das taxas de crescimento e processos de regeneração das espécies exploradas é um dos aspectos imprescindíveis a serem avaliados para garantir a sustentabilidade da produção madeireira (Brienen & Zuidema, 2006). O GOL - "Growth - Oriented Logging" (Schöngart, 2008) é um modelo de manejo florestal que propõe um diâmetro mínimo de corte (DMC) baseado na taxa de incremento anual de cada espécie, obtido através da análise de anéis de crescimento. O uso de análises dos anéis de crescimento em ambientes tropicais é bastante discutido, mas tem sido amplamente utilizado em áreas inundáveis, já que a variação do crescimento em períodos de cheia e seca possibilita a formação de anéis anuais visíveis (Worbes & Junk,1989). Estudos utilizando esse modelo demonstram que a taxa de incremento em diâmetro das árvores nas florestas de igapó é muito baixa (Schöngart *et al*., 2005; Fonseca Jr. *et al*., 2009), o que alerta sobre a sensibilidade desses ambientes à extração seletiva de madeira (Schöngart, 2010, no prelo). Contudo a necessidade crescente por madeira amazônica para o mercado de compensados e na construção civil tem aumentado a pressão sobre as áreas inundáveis, pois nesses locais há uma alta concentração de madeira leve (Macedo e Anderson, 1993; Lima *et al*., 2005), como é o caso do arquipélago de Anavilhanas.

O arquipélago de Anavilhanas está localizado no Baixo Rio Negro, Amazônia Central e faz parte do Parque Nacional de que se encontra sob grande pressão de exploração madeireira. Dentre os fatores que contribuem para isso estão a proximidade do Parque à cidade de Manaus, importante centro consumidor e o fato do rio Negro ser uma importante hidrovia, que facilita o acesso dos infratores ao local. Ao mesmo tempo, a extensão do arquipélago e a quantidade de vias fluviais entre as ilhas dificultam a fiscalização. Diante da ameaça à conservação de espécies madeireiras, os gestores sentiram a necessidade de conhecerem a distribuição espacial da exploração ilegal de madeira no arquipélago, o padrão de comportamento dos extratores que definem essa distribuição e os efeitos estruturais da exploração sobre as populações das espécies exploradas com a meta de melhorar o controle e fiscalização das atividades ilícitas e garantir a conservação das espécies exploradas na unidade de conservação.

Objetivo Geral

Analisar a distribuição espacial e a densidade da exploração madeireira no arquipélago de Anavilhanas, suas potenciais causas, os impactos estruturais sobre as populações e a potencialidade de recuperação e sustentabilidade mediante as taxas de crescimentos dos táxons mais explorados.

Objetivos Específicos

(1) determinar a densidade e a distribuição espacial das espécies madeireiras mais exploradas no Arquipélago de Anavilhanas;

(2) determinar a distribuição espacial e intensidade da exploração madeireira;

(3) testar a hipótese de que a estrutura populacional dos táxons mais explorados será alterada mediante o aumento da intensidade de exploração madeireira;

(4) obter as taxas de crescimento das espécies estudadas e

(5) testar a hipótese de que a distribuição espacial da exploração está relacionada com a distribuição espacial das comunidades humanas residentes na zona de amortecimento do parque e com o valor de mercado das madeiras.

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Title: The spatial distribution of illegal logging in the Anavilhanas Archipelago (Central Amazonia) and logging impacts on the primary timber species

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SUMMARY

The Anavilhanas National Park is an Amazon protected area facing nowadays the challenge of controlling illegal logging. To aid this task, this study aimed to determine (1) the densities of the exploited species in this area; (2) the spatial distribution of logging; (3) the effect of logging on population structure; (4) the growth rate of each species and (5) analyze the effects of human communities' distance and wood value in the logging intensity. All trees with DBH > 10 cm of the five most exploited species and the logging vestiges were registered on 84 transects uniformly distributed over the Anavilhanas Archipelago. Growth rates were measured by dendrocronology. Medium and large sized trees (10-30 and > 60cm DBH) of *Virola surinamensis* and Lauraceae spp (10 - 20 cm DBH) decreased in abundance as harvesting intensity increased. However, since growth rates of *Ocotea cymbarum* (Lauraceae) were high, it may recover fast if harvesting pressure stops. The was no evidence of negative effects of harvesting on the population structure of *Calophyllum brasiliense*, but its low growth rate and grouped distribution suggest that continued exploitation may endanger the population. There were no negative effects of logging for *Macrolobium acaciifolium* and *Hevea* spp., and their high growth rates and high abundances indicate that these species have a potential for management. Logging is concentrated in the southern region of the archipelago, next to the human concentrations, for most species, except for Lauraceae spp., whose timber is more valuable. The optimal foraging model tested indicated no relationship between the intensity of harvesting activities and the geographic distances to human communities, but a trend to choose harvesting places with greater concentration of more valuable resources. Thus, a strategy to control the illegal logging in the Anavilhanas Archipelago would be to encourage a sustainable logging plan on the buffer zone of the Park and to stimulate tourism on the South of the archipelago, where tourist presence could inhibit illegal activities.

Introduction

The Amazonia is one of the world's leading suppliers of timber, and the Amazonian timber industry is an important source of jobs and income for the region's economy (Lentini *et al.*, 2005). These economic benefits, however, come with environmental costs, as logging is one of the leasing drivers of Amazonian deforestation (Fearnside, 2010). Conventional timber harvests affect forest structure and composition (Veríssimo *et al*, 1992; Johns *et al*, 1996; Monteiro *et. al.*, 2004), increase forests' susceptibility to fire (Holdsworth & Uhl, 1997; Nepstad *et al.*, 1999), reduce above-ground biomass (Gerwing, 2002), and facilitate access to forests, increasing hunting and resource extraction and thus changing the abundance, richness, composition and behavior of various animal groups (Laurance, 2001).

Foresters have proposed various measures to minimize the environmental impacts of logging and to guarantee its sustainability (Putz & Pinard, 1993; Amaral *et al*., 1998). While these technical and logistical improvements significantly reduce logging impacts (Putz *et. al*., 2008) at a low economic cost (Barreto *et. al*, 1998), ~62% of logging in the Amazon remains unplanned and continues to expand to new areas (Lentini *et. al.*, 2005), a situation that damages both the forest and the timber industry in the long run. Indeed, most timber harvests in the Amazon remain illegal (Fearnside, 2010), with 70 % of the Amazonian timber currently sold lacking a clearly identified origin (Higuchi, pers. comm.).

The illegal nature of timber harvests makes it hard to locate and quantify the timber being removed from forests, in large part because logging often does not generate large clearings visible in satellite images (Nepstad *et. al*., 1999). The situation is even more problematic in regions where other logging impacts are not visible either (e.g. flooded forests where timber can be extracted without logging roads or stockyards;

Schöngart & Queiroz, 2010, in press). Modern remote sensing techniques (e.g. the DETEX - INPE project) are capable of detecting selective logging in satellite images, but only for a few years before the canopy closes and hides the clearings (Asner *et al*, 2005). Even then, it is not always clear whether a given clearing is the result of selective logging or a natural treefall. Field studies are thus essential to complement and validate remote sensing analyses that seek to map the distribution of illegal timber harvests, and especially at local scales.

The spatial distribution of resource harvests is typically determined by the manner in which a given resource is harvested. Harvest intensity is often inversely proportional to the distance to the resource (Murali *et al.*, 1996; Uma Shaanker *et. al.*, 2002), since the time and energy required to extract it increase with distance. However, this pattern can vary depending on the economic value of the resource, since more valuable resources justify greater extraction expenses. Models constructed to understand resource extraction patterns are often based on ecological models that describe animal behavior and microeconomics which have been used in human ecology to estimate human behavior patterns (Begossi, 2009). One such model, the optimal foraging model, assumes a trade-off between the cost and benefit associated with the search for food. Optimal foraging models have been used to analyze resource extraction behavior for various human populations, such as fishermen (Begossi, 2005). These models can be useful tools for understanding what drives the spatial distribution of forest resource use by human populations.

Determining the ecological impacts of illegal logging at the local scale, proposing control measures, and understanding the spatial distribution of harvests and harvest drivers requires quantifying their effects not just on forest structure and composition but also on the populations of targeted species. Some Amazonian species, such as longleaf mahogany, *Swietenia macrophylla* (Meliaceae; Veríssimo, 1995) and *Virola surinamenisis* (Myristicacae) are already showing signs of unsustainable logging. A study by Macedo and Anderson (1993) on Marajó Island documented a sharp drop in the abundance of *Virola surinamensis* due to overexploitation.

The primary cause of extinction among timber species is a shift in population age structure, as the adult individuals that supply most seeds are removed (Martini *et al.*, 1998). This leads to a drop in young individuals, as regeneration is compromised by the lack of seeds or by the loss of environmental conditions suited for seedling establishment. In populations with a high recruitment rate, stem density drops exponentially with increasing diameter, and departures from this pattern can indicate an alteration in age structure. Peres *et al.* (2003) showed that overharvesting Brazil nut seeds (*Bertholletia excelsa*, Lecythidaceae) reduced the number of young trees in harvested stands, representing a population bottleneck that can lead to local extinction. But little remains known about the population structure, growth rate, and reproduction of timber species. All of these variables could potentially help understand the population-level effects of selective logging and to define ecologically sustainable cutting levels (Nebel & Meilby, 2005).

Determining the growth rates and life histories of timber species is one essential step to guaranteeing sustainable logging (Brienen & Zuidema, 2006). Growth-Oriented Logging (GOL; Schöngart, 2008) is a forestry management model that proposes a minimum cutting diameter (MCD) based on the annual increment rate of each species, obtained by analyzing growth rings. Growth ring analyses in tropical forests remain controversial but have been widely used in flooded areas, where variation in growth between high and low water periods generates easily discernible annual rings (Worbes

& Junk, 1989). Studies based on this model have shown that the rate of diameter growth in trees of flooded forests of black water is very low (Schöngart *et al*, 2005; Fonseca Jr. *et al*, 2009), thus highlighting the vulnerability of these communities to selective logging (Schöngart, 2010, in press). However, the growing demand for Amazonian timber in the plywood and construction industries has increased pressure on flooded forests like those in the Anavilhanas Archipelago, which typically have a high concentration of lightweight timber (Macedo & Anderson, 1993; Lima *et. al*., 2005).

The Anavilhanas Archipelago is located in central Amazonia, on the lower Negro river, inside Anavilhanas National Park. Logging pressure on the park is strong due to its proximity to the city of Manaus, an important timber market, and because the Negro river provides easy access to loggers. Likewise, the archipelago's size and the complex maze of waterways between the islands make it difficult to enforce laws against illegal logging. In order to guarantee the long-term survival of timber species and effectively curb illegal activities in the park, authorities require better information about the spatial distribution of illegal logging in the archipelago, the behavior of loggers, and the effects of logging on the population structures of the most sought-after species.

The objectives of this study were to: (1) determine the stand densities and spatial distributions of the most sought-after timber species in the Anavilhanas Archipelago; (2) describe the spatial distribution and intensity of logging; (3) determine whether current logging levels are altering the size structures of timber species populations; (4) quantify the growth rates of the study species; and (5) test the hypothesis that the spatial distribution of logging coincides with the spatial distribution of human communities in the park's buffer zone.

Methods

Study area and study taxa

The Anavilhanas Archipelago is located in Brazil's Anavilhanas National Park in Central Amazonia (Figure 1), and its southern border is ~40 km northwest of the city of Manaus (03º 02'S 60º 22'W). The park protects roughly 450 islands, in addition to a large block of upland forest, for a total area of 350,000 ha. The archipelago is situated in the channel of the Negro river, a black-water river poor in nutrients, but the eastern bank receives some nutrients from the Branco river (Irion *et. al.*, 1997). Flooded forests on the islands are subject to a flooding cycle in which water level can vary up to 10 m between low and high water periods (Junk, 1989). Mean annual rainfall is 1750 - 2500 mm, with most rain falling between October and March, and mean annual temperature is 24-26ºC (IBAMA, 1999).

The islands are elongate, with sediment accumulating on one side and the current actively eating away the other (Leenheer & Santos, 1980). Vegetation physiognomy varies with island size. Larger islands typically have three forest strata, the highest of which is composed of trees approximately 25 m tall, while smaller islands generally have lower vegetation that may be entirely underwater during floods (Piedade *et a*l, 2005). Plant species on the islands are distributed non-randomly with respect to topography, based on their varying adaptations to flood dynamics (Ferreira, 2000).

The most sought-after timber species at present, according to confiscation records of the responsible authority, The Instituto Brasileiro do Meio Ambiente (2008), are rubber trees (*Hevea spp*., Euphorbiaceae), represented by *Hevea guianensis* Aubl. And *Hevea spruceana* Muell Arg; *virola* (*Virola surinamensis* (Rol.) Warb. Myristicaceae); *arapari* (*Macrolobium acaciifolium* (Benth.) Benth, Fabacaeae); *jacareúba* (*Calophyllum* *brasiliense* Camb, Clusiaceae); and species of Lauraceae, including *louro inamuí* (*Ocotea cymbarum* Kunth.), *louro preto* (*Nectandra* sp.) and *louro abacate* (*Aniba* sp.; IBAMA,1999). These species are tolerant to flooding, especially *M. acaciifolium,* which can survive floods of up to 7 m (Wittman, in press). The fruits of these species are important food resources for the local fauna.

The timber of *Hevea* spp., *M. acaciifolium* and *V. surinamensis* has low wood density (0.40-0.50 g/cm³; Schöngart & Queiroz, 2010, in press) and is used as *pau-de-escora* in construction. *C. brasiliense* and Lauraceae species are considered hardwoods, with wood density of approximately 0.60 g/cm³, and are typically used as flooring or for furniture.

Sampling design

In order to ensure systematic and homogeneous sampling across the entire archipelago, we used ArcGIS 9.2 software to superimpose a grid made up of 3 x 3 km cells over a georeferenced LANDSAT satellite image (scale = 1: 900.000 m) of the study area during dry season. Points that coincided with islands were chosen as the location for 84 transects. Transects measured 100 m long, except on islands with a width of less than 100 m, in which case the transects measured the width of the island. Transects were placed perpendicularly to the long axis of each island in order to capture the topographic variation from edges to interiors. Data were collected in January - February 2009, and between August 2009 and January 2010.

Stand density. Stand density for each target species was quantified via density estimates that were corrected with detection probability, using the method of distance sampling along linear transects. In this method an observer walks a trail searching the targeted species and recording the perpendicular distance from the trail of each individual found. One of the fundamental assumptions of the method is that the probability of detecting an item decreases with its increasing distance from the trail (Buckland *et. al.*, 1993). This method allows one to select the optimal detection function and thereby estimate the proportion of undetected individuals (Thomas *et. al.*, 2002). To this end, all trees of the target species measuring > 10 cm dbh (diameter at breast height, or 1.3 m) sighted from the trail were marked and their dbh and perpendicular distance from the trail measured. We used liana cover and tree size (dbh) as co-variables that influenced detection. The coverage of lianas in front of each tree, which hampered detection, was quantified in the following three categories: 1 for 10-30% coverage, 2 for 30-60%, and 3 for >60%.

Logging distribution and intensity. We georeferenced every stump found in the transects and during boat trips between transects. Harvest intensity was obtained in the same manner as live tree density, by correcting estimated density with detection probabilities (this was only done with stumps found on transects). Some species, such as the Lauraceae spp. and rubber trees, Weir grouped into higher taxa for analysis, because it was not possible to identify the older felled trees to the species level. Therefore, density estimates of live trees Weir also based on these higher taxa, in order to comparable to the estimates of felled trees.

Distances from human communities to islands. Approximately 50 human communities and smaller settlements (2-3 houses) currently exist within the buffer zone of Anavilhanas` National Park. For the 30 human communities closest to the park border, we used SIG tools and a dry-season LANDSAT image to calculate the shortest river distances from each town to each transect, using the most likely travel routes, and then calculated a mean distance for each human communities. Communities that were very close to each other (up to 5 km apart) were grouped together due to high spatial correlation, and these groups used as sampling units in the analyses. We used the same methods to calculate river distances from the transects to the Manaus city.

Commercial timber value. The mean market value of timber was obtained via 15 interviews carried out in sawmills in the towns of Novo Airão, Manacapuru, and Manaus. The accumulated value of timber per transect was calculated by multiplying the mean market value of sawn timber of each species by the number of individuals of that species found in the transect, and summing these values.

Tree growth rate. Growth rates were estimated via dendrochronological methods, using 20 samples for each species. We restricted analysis of the Lauraceae species to *Ocotea cymbarum* Kunth. and analysis of the rubber species to *Hevea spruceana* Muell Arg, in order to avoid species-level variation in growth rates. Wood samples were collected using a dendrochronological drill, then glued to a wooden support and polished with different grades of sandpaper. The height of each tree was measured in the field using a clinometer. Wood samples were analyzed in the INPA/Max-Planck dendrochronological laboratory. Rings were identified by their anatomic structures and measured with a LINTAB measuring system and TSAP-Win software (*Time series analyses and presentation,* Rintech, Heidelberg, Germany).

Data analyses

We estimated stand density for each taxon with the program DISTANCE 6.0 (Buckland *et al.*, 1993), after testing different models for the distributions of detection distances. The model that best fitted the data for *V. surinamensis* and *C. brasiliense* was the key-function uniform and the serie expansion coseno; for *M. acaciifollium* a key-function hazard-rate and the serie expansion coseno; for *Hevea* spp. the key-function half-normal and the serie expansion simple polynomial; and for Lauraceae spp. the key-function uniform e o the serie expansion simple polynomial. Stump densities for each species were estimated using the same method described above. The best-fitting model for estimating stump density was a key-function uniform and the serie expansion coseno. To improve the fit of detection curves and thus the density estimates, it was necessary to truncation the distributions of *C. brasiliense*, *M. acaciifolium* and *Hevea* spp. to 30 m and the distributions of Lauraceae spp. to 23 m. In the preliminary analyses we included tree size and liana coverage as covariables, but they did not have much impact on the fit and were left out of the final models. To estimate total logging intensity for the entire archipelago we used all stumps recorded in the transects, regardless of species. The best-fitting model was the key-function and serie expansion coseno with truncation at 30 m.

To produce logging maps we used stumps recorded both in and outside of transects. Logging intensity for each point was quantified as the number of stumps in a cell of 3 km² of a grid superimposed on the satellite image. The harvest map was superimposed on the species stand density maps.

The effect of logging intensity on the stem densities of three size classes (10-20, 20-40, and >40 cm; except for *V. surinamensis*, for which the classes were 10-30, 30-60, and >60 cm) was analyzed for each species using regression via a Generalized Linear Model (GLM). Logging intensity here refers to the combined harvests of all targeted species, under the assumption that the harvest of any one species can potentially affect the populations of others. Since these are count data with high variance and a large number of zeros, for the regressions we used a Poisson error and a logarithmic function.

The model we tested to determine the relationship between the spatial distribution of human communities and logging intensity for all species incorporated as independent explanatory variables the river distance between human communities and transects and the accumulated value of timber in each transect. The model was built as a multiple regression and tested via permutation (1000 permutations). We also tested another version of this model in which river distances between transects and human communities were substituted by river distances between transects and Manaus city.

To obtain the mean rates of annual increment for the target species, we used annual rates of radial increment based on measurements of growth ring thickness. The rate of mean increment was calculated for each sample and these data used to generate a mean value for each species. With the annual increment rates for each sample and the estimated age for each sample, we built cumulative growth curves. These individual cumulative curves were used to model a mean, non-linear (sigmoidal) curve with the equation y = a/(1+(b/x)c) (Schöngart, 2008). The MCD and the adequate harvest cycle for each species were obtained using methods proposed by Shöngart *et. al*. (2008).

Results

Spatial distribution of stand densities and illegal logging

We marked 2,332 trees in a total 8 km of linear transects. The most abundant taxon was *Hevea* spp. (1,365 individuals), followed by *V. surinamensis* (410) and *M. acaciifolium* (315). Lauraceae spp. and *C. brasiliense* were less common, with 164 and 79 individuals respectively. The density estimates follow the same ranking. *Hevea* spp. had an estimated density of 41.5 trees/ha (CI= 56.199), followed by *V. surinamensis* (14.9 trees/ha, CI= 24.567), *M. acaciifolium* (12.3 trees/ha, CI = 18.58), Lauraceae spp. (5.2 trees/ha, CI = 8.3171), and *C. brasiliense* (2.1 trees/ha, CI = 4.6021).

Our estimates indicate that 3.2 trees/ha were cut illegally in the region

(CI=4.4272). The taxa for which we found the greatest evidence of past logging were: Lauraceae spp. (28.5%), *Hevea* spp. (17.9%), *V. surinamensis* (12.0%), *M. acaciifolium* (10.4%), and *C. brasiliense* (4.8%). Together, the target species in this study accounted for 73.6% of all stumps. Other species accounted for 10.2% of stumps. These included *castanharana* (*Eschweilera ovalifolia*), *cajurana* (*Simaba* sp.), *itaúba da várzea* (*Mezilaurus itauba*), *munguba* (*Pseudobombax munguba*), *itaubarana* (*Acosmiumn nitens*), and *tento* (*Ormosia* sp). The remaining 16.2% of stumps were too old and decayed to be identifiable.

The mean market value of timber in the sawmills of Novo Airão, Manacapuru and Manaus was \$197/m³ for lightweight timber species (*V. surinamensis*, *Hevea* spp., and *M. acaciifolium*), \$492/m³ for *C. brasiliense*, and \$591/m³ for Lauraceae spp. These values reflect the price of processed timber sold to the final consumer, and are thus higher than those used by loggers.

The maps of spatial distribution of species and logging indicate different patterns for each species. For *V. surinamensis* (Figure 2A), stand densities and logging intensity are both highest in the central and northern regions of the archipelago. *M. acaciifolium* (Figure 2B) is widely distributed throughout the archipelago, with densities that typically vary from one to five individuals/transect, but logging is essentially restricted to the southern region. The estimated stem density of *C. brasiliense* (Figure 2C) is low throughout the area and the species was absent from a large number of transects; the few stumps we found were also concentrated in the southern region. Lauraceae spp. (Figure 2D) populations are concentrated on the western banks of the archipelago, but logging of those species is scattered throughout the study area, in contrast to the other target species. Finally, the most abundant taxon, *Hevea* spp. (Figure 2E), was present in almost every transect, generally at a density exceeding five trees/transect; logging pressure on these species was concentrated in the southern portion of the archipelago.

Optimal foraging model applied to illegal timber harvests

The first model tested to explain the intensity of illegal timber harvests in the Anavilhanas` archipelago included as variables river distance from human communities and the accumulated timber value in each sampling unit. That model had low explanatory power for logging intensity. There was no relation between logging intensity and river distance (Figure 3A), but there was a slight positive effect of timber value (b_{st} = 0.029, P <0.05, Figure 3B). The second model tested included as variables river distance from Manaus and timber value. Again there was no relation between distance and logging intensity (Figure 3C), and timber value was the most important variable in the model (b_{st} = 0.030, P <0.05, Figure 3D).

Effects of logging on population structure

Our analysis of the effects of logging intensity on diameter class densities revealed some species have suffered negative impacts of past logging, but some surprisingly had positive impacts. For *V. surinamensis*, density of both the smallest stems (R^2 = 0.13, P < 0.01, Figure 4A) and the largest stems (R^2 = 0.18, P = 0.03, Figure 4A) declined with increasing logging intensity. Lauraceae spp. also showed a drop in the density of the smallest size class (10-20 cm dbh; R^2= 0.17, P < 0.05, Figure 4B), but an increase in the density of the largest size class (>40 cm dbh). *M. acaciifolium* showed a trend towards higher densities of the intermediate size class with increased logging (R^2= 0.08, P < 0.05, Figure 4C). For the smallest and intermediate diameter classes of *Hevea* spp., stem density increased with logging intensity (10-20 cm dbh: R^2 = 0.14, P <<0.001; 20-40 cm dbh: R^2 = 0.13, P <<0.001, Figure 4D). For *C. brasiliense* there was no effect of logging intensity on any diameter class.

Tree growth rates

The mean yearly increment rate by species varied from 4.14 to 7.78 mm (Table 1). The fastest-growing species was *O. cymbarum* (Lauraceae) and the slowest-growing *C. brasiliense*. Mean age varied from 66 to 101 years. The youngest trees were *M. acaciifolium* and the oldest *C. brasiliense.*

In order to determine the MCD and the harvest cycle (Table 1) we initially examined relationships between dbh and tree height. These were significant for *O. cymbarum* (R^2 = 0.25, P <0.005), *C. brasiliense* (R^2 = 0.32, P <0.01), and *M. acaciifolium* (R^2 = 0.26, P <0.05). The other species did not show a significant relationship between dbh and height, which made it impossible to construct cumulative volume curves.

Discussion

Distribution of timber species' diameter size and logging pressure

The maps of logging intensity show higher pressure on most species in the southern region of the archipelago. Adapting optimal foraging theory to logger behavior in Anavilhanas, we expected that logging intensity would be highest near the human communities in the park buffer zone, since loggers would seek to minimize the cost of travel. However, there was no significant relationship between river distances and logging intensity. The trend towards higher logging intensity in the south may not be related to travel costs but rather to the lower cost and risk associated with transporting timber to Manaus, the principal market in the region, which is also located south of the archipelago. However, we also found no relationship between the river distances separating the transects from Manaus and logging intensity.

Thus, while distributional maps indicate a trend towards more illegal logging in the southern portion of the archipelago, analyses of river distance do not show the same pattern. This shows that while logging intensity was not higher closer to human communities, the number of logging sites was. As proposed by Murali *et. al*. (1996) and Uma Shaanker *et. al*. (2002), there was a spatial relationship between the distribution of human populations and resource extraction. This relationship is not based only on spatial distances, but also depends on socioeconomic variables like the different kinds of resource extraction practiced by different communities and the different methods used. In this way, simply being a short distance from human communities does not guarantee that a resource will be harvested, since not all towns extract the same resources. In addition, since logging in the region is an illegal activity, pinpointing which human communities are most involved in the practice is difficult.

One optimal foraging model used in the social sciences is known as a "central place foraging model" (Bird & Bird, 1997). This model predicts that the farther away harvests are the more resources are harvested in order to compensate greater harvest costs. Thus, a long-distance harvest can be more advantageous because costs are optimized through higher gains. The regression model that we used showed an effect of timber value on logging intensity, but with a low explanatory power (2%). However, when we analyzed the harvest map of Lauraceae spp. (one of the most valuable taxa), logging was evenly distributed across the archipelago, in contrast to less valuable species that are preferentially harvested close to human communities. Thus, while the analyses only detected a small effect of timber value on logging distribution, logging distribution maps suggest that the economic value of the timber available at each point does influence decisions of where to log.

Effects of logging on target species populations

Increased logging intensity was associated with lower densities of the youngest stems of Lauraceae spp. and of the youngest and oldest stems of *Virola surinamensis*. Likewise, increased logging intensity was associated with higher densities of *Hevea* spp. and *Macrolobium acaciifolium* and showed no effect on *Calophyllum brasiliense*. The results for *Hevea* spp. and *M. acaciifolium* suggest that these species are pioneers, since sites with higher logging intensity also showed higher stem densities, and they also showed high growth rates. Given that we studied the effects not only of conspecific logging but of logging in general, we hypothesize that the greater densities of these species in logged areas reflect high recruitment following an increase in light levels caused by those historical logging events. It is also worth noting that in the field we observed large numbers of *M. acaciifolium* and *Hevea* spp. seedlings. While only a fraction of these will eventually reach maturity, their abundance suggests that both species are reproducing successfully.

The density of both the largest and the smallest *V. surinamensis* stems decreased with increasing logging intensity. This suggests that illegal timber logging has altered the population structure of this species in the Anavilhanas archipelago and could compromise its long-term persistence in the region if present harvest levels continue. Worries about the overexploitation of *V. surinamensis* are long-standing, in part because it is one of the most commonly logged timber trees in the Amazon (Anderson, 1998) and in part because other studies have shown that logging can severely reduce seedling abundance (e.g. Macedo and Anderson [1993] on Marajó Island).

The taxon for which the largest number of stumps was found was Lauraceae spp. This does not necessarily mean that it is the most sought-after timber, since the result could also be explained by a slower stump decomposition rate. Decomposition rates are inversely related to wood density (Chambers *et al*., 2000) and Lauraceae spp. have the highest wood density (~ 0.60 g/cm^3) of the taxa we studied.

Although the issue of stump age makes it hard to affirm that Lauraceae spp. were more widely logged than other taxa, other evidence suggests that this is the case. The low density estimate and the stand distribution map indicate that this taxon grows most densely on the western banks and is practically absent from the eastern banks. However, there is a large number of stumps on the eastern banks, which could indicated that Lauraceae spp. were historically abundant there but essentially wiped out by logging.

Logging intensity was negatively correlated with the density of the youngest class of Lauracaeae spp. but positively correlated with the density of the oldest class. According to local loggers, this taxon was cut earlier than the other target species, an account supported by the age of the stumps we found in the field. Loggers also noted that Lauraceae spp. are now less sought after than in the past, because of other illegal timber sources in upland forests. For that reason, the higher densities of larger size classes in more heavily logged areas could be related to reduced logging pressure along time, which allowed younger stems to grow and reach the largest size classes without being harvested. Likewise, it may be that this size class has not yet reached reproductive age, which would explain the lower densities of smaller size class stems.

C. brasiliense was very rare in the transects, which made it difficult to analyze the effect of logging intensity on the species' population structure. This reflects the fact that *C. brasiliense* has a strongly clumped distribution, which means that even our large sampling effort was insufficient to sample the population effectively. We found few stumps of this species, and no change in the densities of different size classes with increasing logging intensity.

Tree growth rates

Tree growth rates are strongly related to wood density, with higher rates in species with lower-density wood and lower rates in species with higher-density wood (Schöngart, 2008). However, one of the species with the highest wood densities (*O. cymbarum*: 0.59 ± 0.05 g/cm³) showed the highest mean annual increment rate (7.78 mm/year). This appears to be a result of the species' preference for higher elevations, where it is subject to shorter periods of flooding and thus fewer interruptions of growth. While this species shows an altered population structure and a low stem density in the Anavilhanas Archipelago, its high growth rate suggests that it could potentially recover quickly.

The two other species with the highest growth rates were *Hevea* spp. and *M. acaciifolium*. These species also show no negative effects from illegal logging to date, and have high estimated stem densities across the archipelago. Taken together, these facts suggest that these two species are not threatened by current rates of logging.

C. brasiliense had the highest wood density (0.62 ± 0.06 g/cm³) and the lowest mean incremental diameter growth rate (4.14 mm/year). While the results of this study do not show an effect of logging on this species, its ecological attributes suggest that it could be potentially threatened by illegal logging. Given that its distribution is strongly clumped, it is possible that loggers are harvesting large volumes of this species in sites where stands are present. Because it grows slowly, recovering historical stocks of the species will take a long time.

In addition to the variation in growth rates between species, there is also significant variation in growth rates between different flooded forests, with flooded by nutrient poor black water showing the lowest growth rates and forests flooded by nutrient rich white-water having high growth rates (Shongart, 2010, in press). However, species growing in more nutrient rich water forests may show higher growth rates. Thus, thanks to the nutrient inputs from the Branco river, the Anavilhanas` archipelago has higher growth rates than other black water forests (Table 2). Some species there thus require less time to reach the DMC, which makes the region structurally less susceptible to logging compared to other black water forests.

Conclusions

Guaranteeing the long-term conservation of timber species in the Anavilhanas Archipelago requires focusing enforcement efforts in areas with large stands of *V. surinamensis*, Lauraceae spp. and *C. brasiliense*, as our study shows that these taxa face the highest risk under current logging conditions. Another promising idea is to encourage tourism activity in the southern portion of the archipelago, as this would both inhibit illegal logging and provide local communities with an alternative source of income. As Fletcher (1990) has pointed out, such a strategy would not only help provide a sustainable income for human communities inside conservation areas, but also make it harder for illegal loggers based in Manaus. While Brazilian law does not permit management activities inside national parks like Anavilhanas, one strategy to reduce illegal logging pressure on the archipelago would be to promote sustainable forestry programs in the park's buffer zone, focusing on light-weight timber species that could provide a substitute for timber currently harvested in black water forest.

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References

Amaral, P., Veríssimo, A., Barreto, P., Vidal, E. (1998) *Floresta para sempre: um manual para a produção de madeira da Amazônia*. Imazon, WWF and USAID, Belém.

Anderson, A.B., Mousasticoshvily Jr., I. & Macedo, D.S. (1998) Logging of *Virola surinamensis* in the Amazon floodplain: impacts and alternatives. In: Padoch, C., Ayres, J.M., Pinedo-Vasquez, M., Henderson, A. (Eds.), *Várzea: Diversity, Development, and Conservation of Amazonian's Whitewater Floodplains.*, pp. 119–133. The New York Botanical Garden Press.

Asner, G., Knapp, D., Broadbent, E., Oliveira, P., Keller, M., Silva, J. (2005) Selective logging in the Brazilian Amazon. *Science* **310**: 480 – 481.

Barreto, P., Amaral, P., Vidal, E. & Uhl, C. (1998) Costs and benefits of forest management for timber production in eastern Amazon. *Forest Ecology and Management* **108**: 9-26.

Begossi, A., Silvano, R.A.M. & Ramos, R. M. (2005) Foraging behavior among fishers from the Negro and Piracicaba rivers: implication for management. In: *River*

Management III, C. ABrebbia & J.S. Antunes do Carmo (Eds.), WIT Press, Southampton, UK, 2005. WIT Transactions of Ecology and Environment **83**:503-513, 2005.

Begossi, A., Clauzet, M., Hanazaki, N., Lopes, P., Ramires, M., Silvano, R. (2009) Fishers' decision making, optimal foraging and management. *III Seminário de Gestão Socioambiental para o Desenvolvimento Sustentável da Aqüicultura e da Pesca no Brasil* **3**:1-5.

Bird, D.W. & Bliege Bird, R.L. (1997) Contemporary shellfish gathering strategies among the Merriam of the Torres Strait Islands, Australia: testing predictions of a Central Place Foraging Model *Journal of Archaeological Science* **24**: 39- 63.

Brienen, R.J.W. & Zuidema, P.A. (2006) The use of tree rings in tropical forest management: projecting timber yields of four Bolivian tree species. *Forest Ecology and Management* **226**:256–267.

Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. (1993) *Distance sampling: Estimating abundance of biological populations*. Chapaman & hall 1st ed London, UK.

Chambers, J.Q., Higuchi, N., Schimel, J., Ferreira, L. & Melack, J. L. (2000) Decomposition and carbon cycling of dead trees in tropical forests of the central Amazon. *Oecologia* **122**: 380-388.

Fearnside, P.M. (2010) Recursos madeireiros na Amazônia brasileira: Impactos e sustentabilidade da exploração. In: A.L.Val & G.M. dos Santos (eds.) *Grupo de Estudos*

*Estratégicos Amazônicos (GEEA)***.** Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas.

Ferreira, L.V. (2000) Effects of flooding duration on species richness, floristic composition and forest structure in river margin habitat in Amazonian black water floodplain forests: implications for future design of protected areas. *Biodiversity and Conservation* **9**:1-14.

Fletcher, S.A. (1990) Park, protected areas and local population: New international issues and imperatives. *Landscape and Urban Planning* **9**(2): 197-201

Fonseca Jr., S.F., Piedade, M.T.F. & Schöngart, J. (2009) Wood growth of *Tabebuia barbata* (E. Mey.) Sandwith (Bignoniaceae) and *Vatairea guianensis* Aubl. (Fabaceae). In: *Central Amazonian black-water (igapó) and white-water (várzea) floodplain forests. Trees – Structure and Function* **23**(1): 127–134.

Gerwing, J.J. (2002) Degradation of forests through logging and fire in the eastern Brazilian Amazon. *Forest Ecology and Management*. **157**:131-141.

Holdsworth, A.R. & Uhl, C. (1997) Fire in Amazonian selective logged rain forest and the potential for fire reduction. *Ecological applications* **7**: 713-725.

IBAMA (1999) *Plano de Manejo da Estação Ecológica de Anavilhanas, Instituto do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal.* Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Brasília. 153pp.

Irion, G., Junk, W. J. & Mello, J. (1997) The large central of Amazonian river floodplains near Manaus: geological, climatological, hydrological, and geomorphological aspects. In: Junk, W.J. (Ed.) *The Cental Amazon Floodplain. Ecology of a Pulsing System*. Springer, Berlin , 23-42.

Johns, J.S., Barreto, P., Uhl, C. (1996) Logging damage during planned and unplanned logging operations in the eastern Amazon. *Forest Ecology and Management* **89**: 59-77.

Junk, W.J. (1989) Flood tolerance and tree distribuition in central Amazonian floodplains. In: Holn-Nielsen, L.B., Nielsen, I.C., Balslev, H (eds). *Tropical Forests. Botanical Dynamics, Speciation and Diversity* pp: 47-64. Academic Press.London.

Laurance, W.F. (2001) Logging and wildlife research in Australasia: Implications for tropical forest management. In: Grajal, A., Fimbrel, R, Robinson, J.G. (Ed.), *The cutting edge: Conserving wildlife in logged tropical forests:* 559-574. New York, Chichester, West Sussex: Columbia University Press

Leenheer, J.A. & Santos, H. (1980) Considerações sobre os processos de sedimentação na água preta ácida do Rio Negro, Amazonia Central. *Acta Amazônica* **10**(2): 343-355.

Lentini, M., Verísimo, A. & Pereira, D. (2005). A expansão madeireira na Amazônia. *Imazon - O estado da Amazônia* 1-4

Lima, J.R., dos Santos, J. & Higuchi, N. (2005) Situação das indústrias madeireiras do estado do Amazonas em 2000. *Acta Amazonica* **35**(2):125–132

Macedo, D. & Anderson, A. (1993) Early ecological changes associated with logging in an Amazonian floodplain. *Biotropica* **25**(2) 151-163.

Martini, A., Rosa, N.A., Uhl, C. 1998. Espécies de árvores potencialmente ameaçadapela atividade madeireira. *Imazon* **11**: 1-34.

Monteiro, A.L.S., Souza Jr., C.M.D., Pantoja, F.L.S., Gerwing, J.J. (2004) Impactos da exploração madeireira em floresta de transição da Amazônia Legal. *Scientia florestalis* **65**:11-21.

Murali, K., Uma Shankar, R., Uma Shaakeer, K., Ganeshaiaah, K.N., Bawa, K.S. (1996) Extraction of non-timber forest products in the forests of Biligiri Rangan Hills, India. 2 Impact of NTFP extraction on regeneration, population structure, and species composition. *Economic Botany* **50** (3): 252 – 269.

Nebel, G. & Meilby, H. (2005) Growth and population structure of timber species in Peruvian Amazon Foodplains. *Forest Ecology and Management* **215**: 196-211

Nepstad, D., Veríssimo, A., Alencar A., Nobre, C., Lima E., Lefebvre, P., Schlesinger, P., Potterk, C., Moutinho, P., Mendoza, E., Cochrane, M., Brooks, V. (1999) Large-scale impoverishment of Amazonian forests by logging and fire. *Nature* **398**: 505-507.

Peres, C., Baider C., Zuidema, P.A., Wadt, L.H.O., Kainer, K.A., Gomes-Silva, D.A.P. Salomão, R.P., Simões, L.L., Franciosi, E.R.N., Valverde, F.C., Gribel, R., Shepard Jr., G.H., Kanashiro, M., Coventry, P., Yu, D.H., Watkinson, A.R., Freckleton, R.P. (2003) Demographic Threats to the Sustainability of Brazil Nut Exploitation. *Science* **302**:2112-2114.

Piedade, M.T.F., Junk, W.J., Adis, J. & Parolin, P. (2005) Ecologia, zonação e colonização da vegetação arbórea das ilhas Anavilhanas. *Pesquisas Botânica*s 56: 117-144.

Putz, F. & Pinard, M. (1993) Reduced-impact logging as a carbon-offset method. *Conservation. Biology* **7**: 755–757.

Putz, F.E., Sist, P.; Fredericksen, T.; Dykstra, D. (2008) Reduced-impact logging: Challenges and opportunities. *Forest Ecology and Management* **256**:1427-1433.

Rosa, S.A. (2008) *Modelos de crescimento de quarto espécies madeireiras de floresta de várzea da Amazônia Central*. Dissertação de Mestrado pp. 77 - INPA/UFAM, Manaus.

Schöngart, J., Piedade, M.T.F., Ludwigshausen, S., Horna, V. & Worbes, M. (2002) Phenology and stem-growth periodicity of tree species in Amazonian floodplain forests. *Journal of Tropical Ecology* **18**: 581–597.

Schöngart, J., Piedade, M.T.F., Wittmann, F., Junk, W.J., Worbes, M. (2005) Wood growth patterns of *Macrolobium acaciifolium* (Benth.) Benth.(Fabaceae) in Amazonian black-water and white-water floodplain forests. *Oecologia* **145**: 454–461.

Schöngart, J. (2008) Growth-Oriented Logging (GOL): A new concept towards sustainable forest management in Central Amazonian várzea floodplains. *Forest Ecology and Management* **256**: 46–58.

Schöngart, J. (2010) Growth-Oriented Logging (GOL): The use of species-specific growth information for forest management in central Amazonian floodplains. In: Junk, W. J., Piedade, M.T.F.; Wittmann, F., Schöngart, J., Parolin, P. (eds). *Amazonian floodplain forests: Ecophysiology, biodiversity and sustainable management*. Ecological Studies, Springer Verlag, Heidelberg (em prensa).

Schöngart, J. & Queiroz, H.L. (2010) Timber extraction in the Central Amazonian floodplains. In: Junk, W. J., Piedade, M. T. F., Wittmann, F., Schöngart, J., Parolin, P. (eds). *Amazonian floodplain forests: Ecophysiology, biodiversity and sustainable management. Ecological Studies, Springer Verlag, Heidelberg* (em prensa).

Thomas, L., Buckland, S.T., Burnham, K.P., Anderson, D.R., Laake J.L., Borchers, D.L; Strindberg, S. (2002) Distance sampling. *Encyclopedia of Environmetrics* **1**: 544-552.

Uma Shaanker, R., Ganeshaiah, K.N., Nageswara M.R., Aravind, N.A. (2002) Ecological Consequences of Forest Use: From Genes to Ecosystem. A Case Study in the Biligiri Rangaswamy Temple Wildlife Sanctuary, South India. *Conservation and Society* **22:**347–363.

Veríssimo, A., Barreto, P., Mattos, M., Tarifa, R. & Uhl, C. (1992) Logging impacts and prospects for sustainable forest management in an old Amazonian frontier: the case of Paragominas. *Forest Ecology and Management* **55**: 169-199.

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

Worbes, M. & Junk, W.J. (1989) Dating tropical trees by means of ^{14}C from bomb tests. *Ecology* **70**: 503–507.

Wittmann, F., Schöngart, J., Brito, J. M., Oliveira Wittmann, A., Piedade, M.T.F., Parolin, P., Junk, W.J., Guillaumet; J. (in press) *Manual of trees from Central Amazonian várzea floodplains: Taxonomy, Ecology, and Use*. INPA, Manaus.

Figures legend

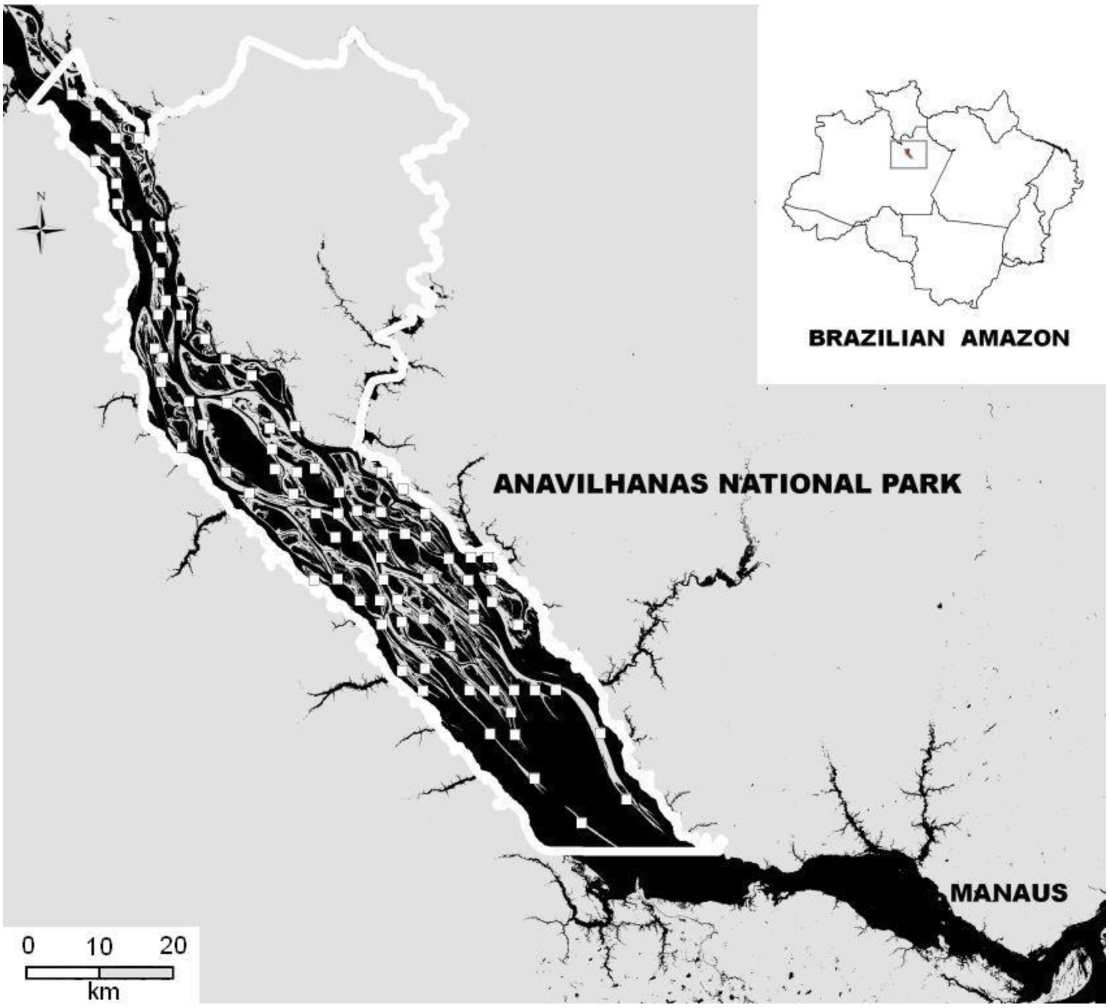
Figure 1. Study area. The white line represents the border of Anavilhanas` National Park. The squares represent the location of transects. In black is the Negro river. In grey are the islands and the land. Scale: 1: 900.000 m

Figure 2. Spatial disrtibution os density and logging intensity (A) *V. surinamensis*, (B) *M. acaciifolium*,(C) *C. brasiliense*,(D) Lauracaeae ssp.,(E) *Hevea spp* in the Anavilhanas` archipelago.

Figure 3. Parcial regression – logging intensity and (A) communities distance, (B) wood value for model 1, (C) Manaus city distance (D) wood value for model 2

Figure 4. Individuals density of *V. surinamensis* (A), Lauraceae ssp. (B), *M. acaciifolium* (C), *Hevea spp* (D), *C. brasiliense* (E) in transects with differentes dbh and logging intensity

Figure 1



N
BRAZILIAN AMAZON
ANAVILHANAS NATIONAL PARK
MANAUS
0 10 20
km

Figure 2

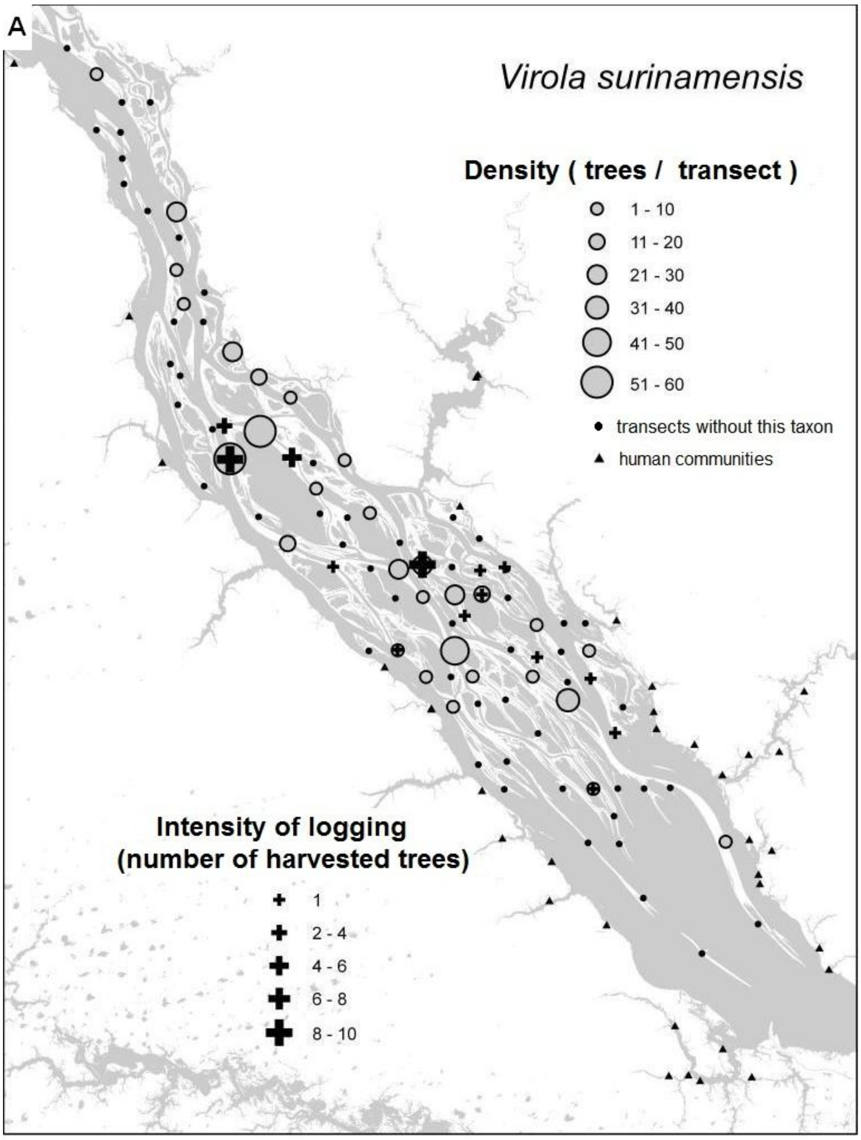

A
Virola surinamensis
Density (trees / transect)
1 - 10
11 - 20
21 - 30
31 - 40
41 - 50
51 - 60
transects without this taxon
human communities
Intensity of logging
(number of harvested trees)
1
2 - 4
4 - 6
6 - 8
8 - 10

Figure 2

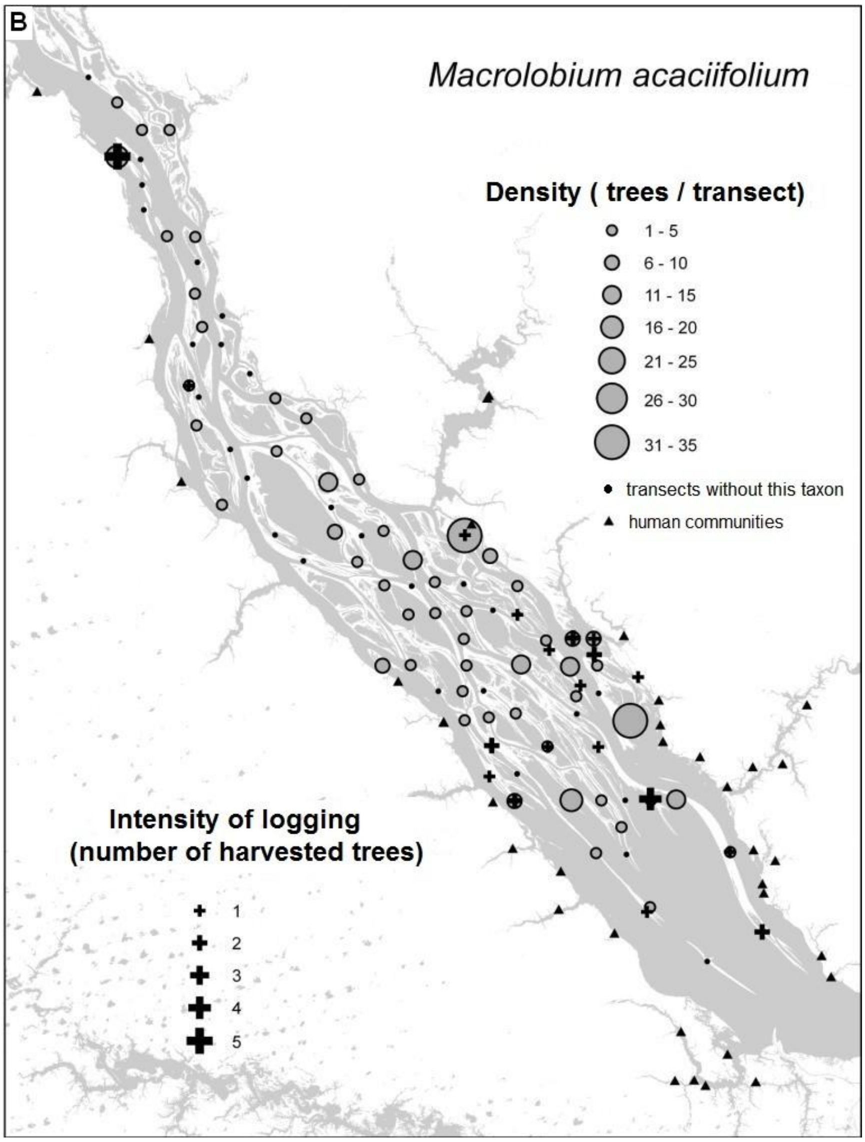
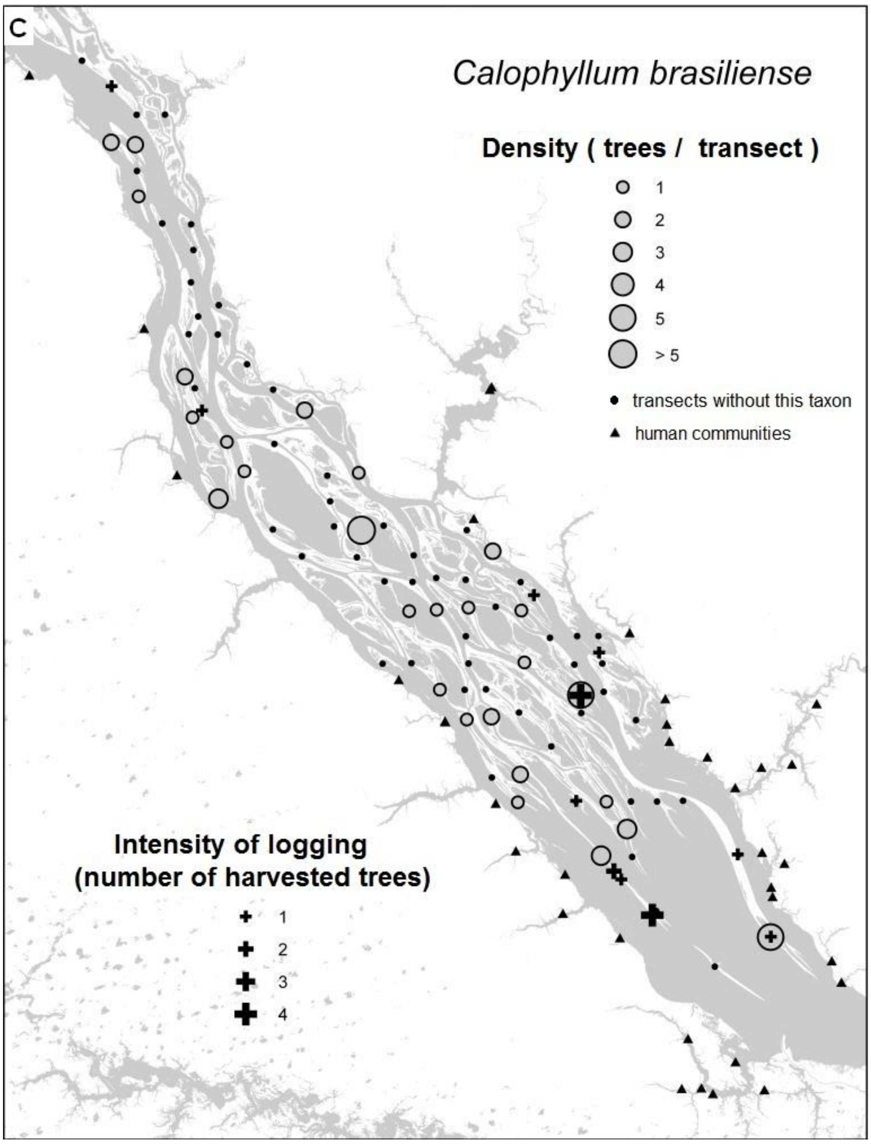

B
Macrolobium acaciifolium
Density (trees / transect)
1 - 5
6 - 10
11 - 15
16 - 20
21 - 25
26 - 30
31 - 35
transects without this taxon
human communities
Intensity of logging
(number of harvested trees)
1
2
3
4
5

Figure 2



C
Calophyllum brasiliense
Density (trees / transect)
1
2
3
4
5
> 5
transects without this taxon
human communities
Intensity of logging
(number of harvested trees)
1
2
3
4

Figure 2

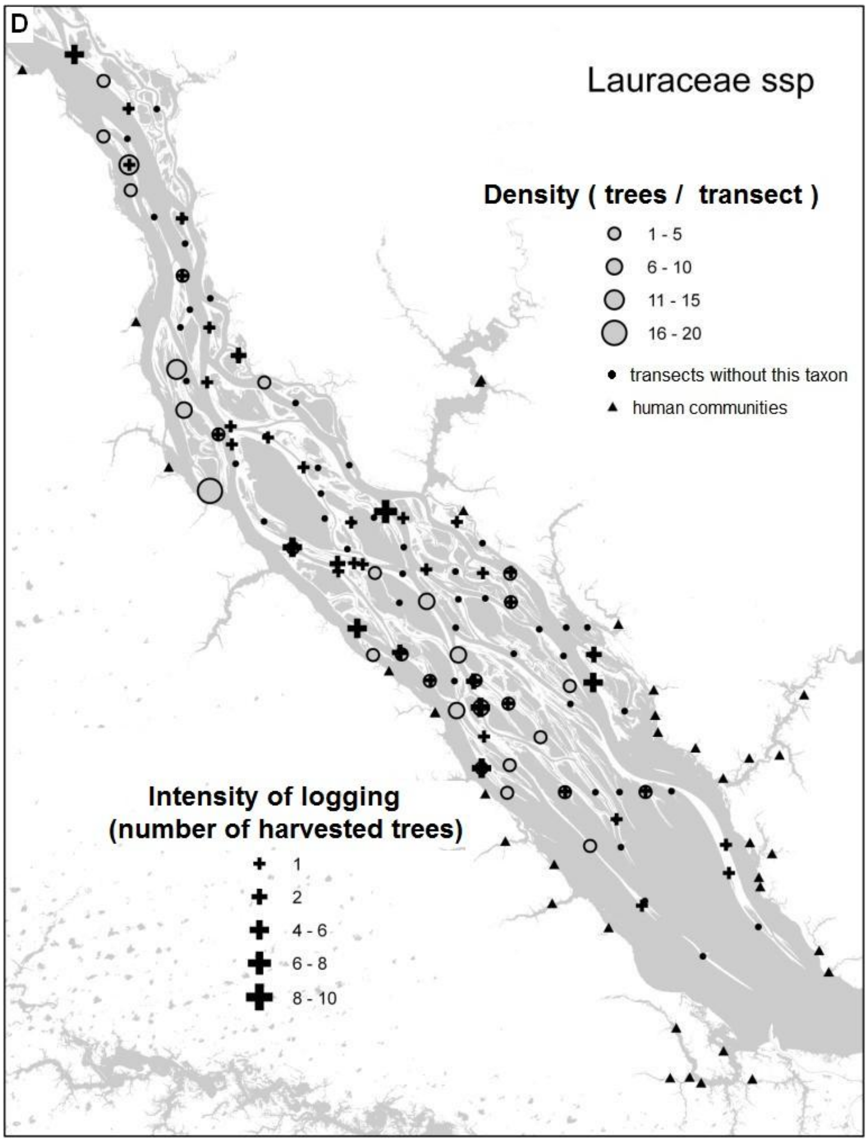

D
Lauraceae ssp
Density (trees / transect)
1 - 5
6 - 10
11 - 15
16 - 20
transects without this taxon
human communities
Intensity of logging
(number of harvested trees)
1
2
4 - 6
6 - 8
8 - 10

Figure 2

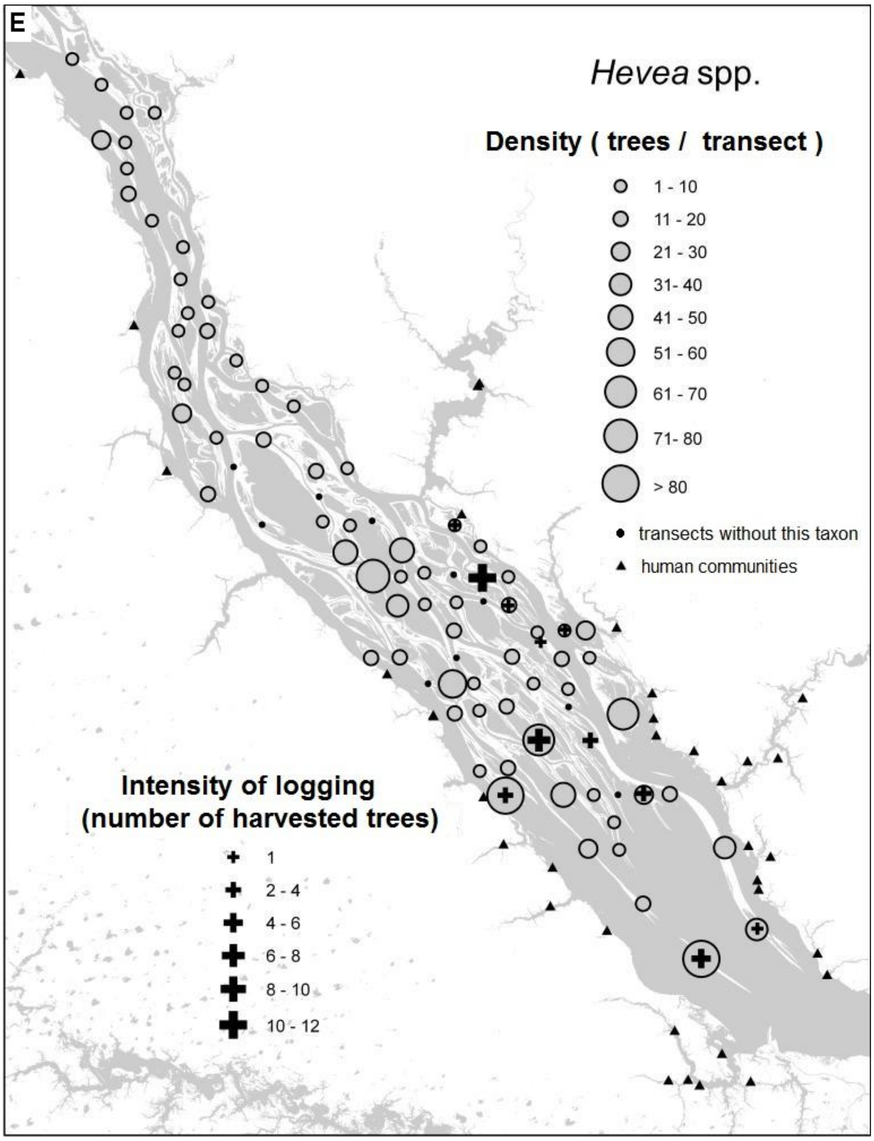

E
Hevea spp.
Density (trees / transect)
1 - 10
11 - 20
21 - 30
31- 40
41 - 50
51 - 60
61 - 70
71- 80
> 80
transects without this taxon
human communities
Intensity of logging
(number of harvested trees)
1
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12

Figure 3

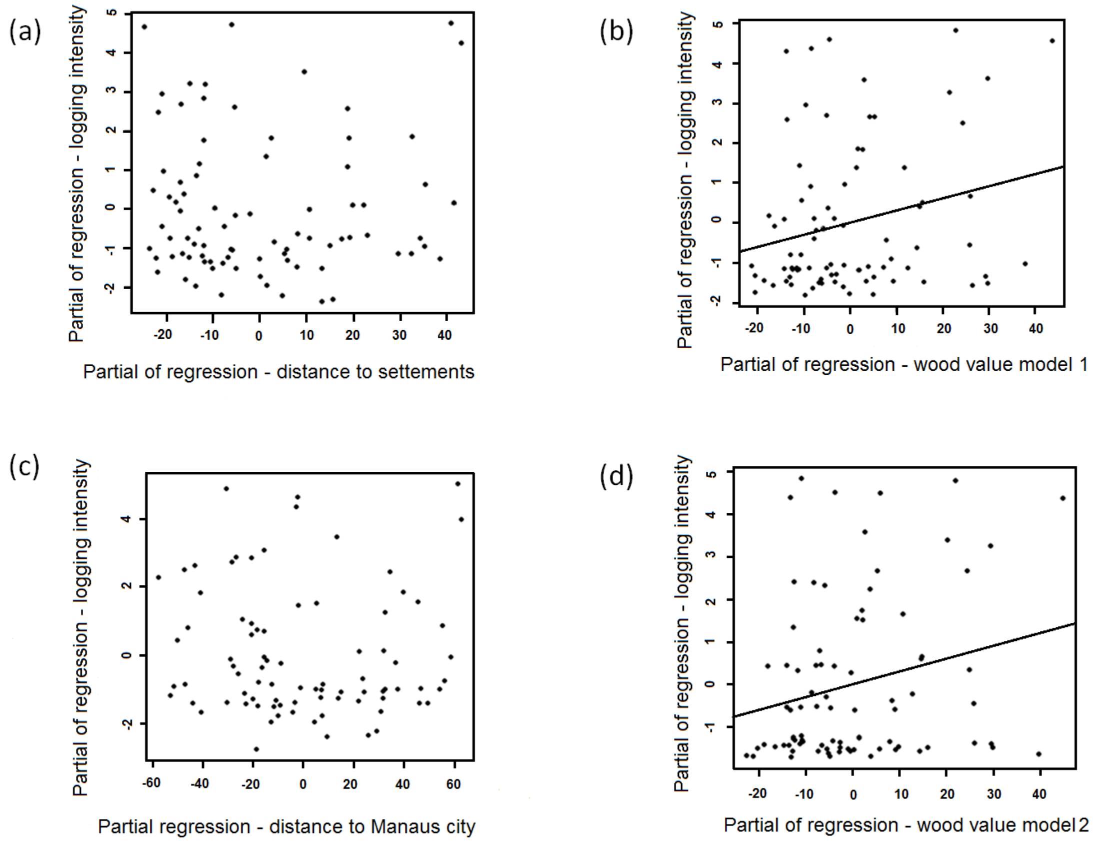

(a)
Partial of regression - logging intensity
Partial of regression - distance to settements
(b)
Partial of regression - logging intensity
Partial of regression - wood value model 1
(c)
Partial of regression - logging intensity
Partial regression - distance to Manaus city
(d)
Partial of regression - logging intensity
Partial of regression - wood value model 2

Figure 4

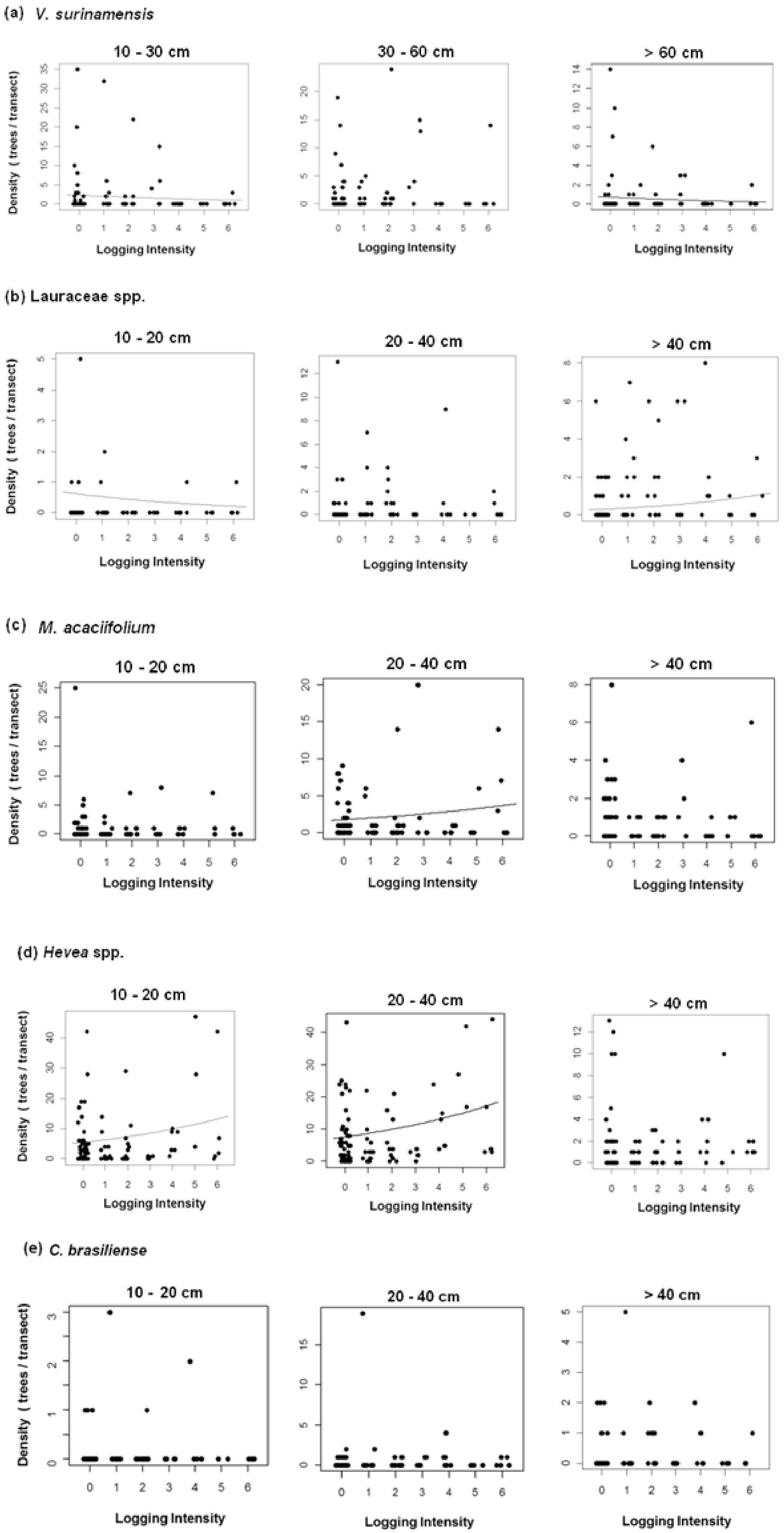

(a) V. surinamensis
10 - 30 cm
30 - 60 cm
> 60 cm
(b) Lauraceae spp.
10 - 20 cm
20 - 40 cm
> 40 cm
(c) M. acaciifolium
10 - 20 cm
20 - 40 cm
> 40 cm
(d) Hevea spp.
10 - 20 cm
20 - 40 cm
> 40 cm
(e) C. brasiliense
10 - 20 cm
20 - 40 cm
> 40 cm
Density (trees / transect)
Logging Intensity

Table 1: Annual mean growth (IC), wood density, Mean Diameter Breast Height (DBH) and Mean Age of five primary timber species harvested in Anavilhanas National Park, Central Amazon

Family	Species	Equation of growth curve	IC mean (mm)	Min - Max (mm)	Wood density (g/cm³)	Mean DBH (cm)	Mean Age (years)	MCD (cm)	C.C. (years)
Fabaceae	*M. acaciifolium*	$Y = 123.63/(1+109.13/x)^{1,33}$ (R^2=0.81)	6.46 ± 1.68	4.47 – 12.77	0.46 ± 0.052	37.4 ± 11.4	66	58.2	17.2
Myristicacea	*V. surinamensis*	$Y = 62.98/(1+56.87/x)^{1,61}$ (R^2=0.83)	5.40 ± 0.99	4.06 – 7.42	0.34 ± 0.033	45.6 ± 11.66	84	*	*
Clusiaceae	*C. brasiliense*	$Y = 69.79/(1+102.48/x)^{1,23}$ (R^2=0.67)	4.14 ± 1.12	2.62 – 7.71	0.62 ± 0.062	41.5 ± 11.50	101	35	29.4
Euphorbiaceae	*H. spruceana*	$Y = 151.88/(1+281.15/x)^{0,85}$ (R^2=0.66)	6.18 ± 1.83	3.16 – 10.19	0.38± 0.0053	41.5 ± 11.50	73	*	*
Lauraceae	*O. cymbarum*	$Y = 170.51/(1+173.60/x)^{0,85}$ (R^2=0.84)	7.78 ± 2.28	4.87 – 13.56	0.59 ± 0.47	49.3 ± 13.2	72	73.7	18.7

IC mean (mm): annual mean increment and standard deviation ;

Min - Max: minimum and maximum growth of the wood's rings,

Mean age: mean age of this species. (n=20 per specie).

MCD (cm): Minimum Cutting Diameter C.C. (years): Cutting Cycle

***** For this taxa was not possible to deternine MCD and C.C.

Table 2: Comparative mean growth in DBH, MCD and C.C. in different floodplains

Specie	**Water**	**Site**	**IC (mm)***	**DMC(cm)**	**Cutting Cycle (years)**	**Source**
C. brasiliense	black water	Anavilhanas Archipelago	4,14	35	29,4	This study
C. brasiliense	black water	Median Negro river	1,88	55	52,7	Schöngart (2010)
M. acaciifolium	black water	Anavilhanas Archipelago	6,65	58	17,2	This study
M. acaciifolium	black water	RDS Amaná	3,04	83	39,3	Schöngart et al. (2005, 2010)
M. acaciifolium	white water	RDS Mamirauá	10,40	62	10,5	Schöngart (2003, 2008)
O. cymbarum	black water	Anavilhanas Archipelago	7.78	74	18,7	This study
O. cymbarum	white water	RDS Mamirauá	9,47	53	11,6	Rosa (2008)

Conclusões

Para garantir a conservação das espécies estudadas no arquipélago de Anavilhanas é necessário concentrar esforços na fiscalização de áreas com maiores abundâncias de *V. surinamensis*, Lauraceae ssp e *C. brasiliense*, pois esse estudo demonstrou serem os táxons que potencialmente serão mais prejudicados caso a exploração se mantenha. Além disso, seria interessante concentrar as atividades turísticas na região sul do arquipélago, como forma de inibir os infratores e envolver os comunitários nessas atividades para geração de renda local, assim como sugere Fletcher (1990) como uma alternativa sustentável de tratar a questão da presença humana nas unidades de conservação, além de dificultar o acesso dos infratores que vem de Manaus. A legislação brasileira não permite atividades de manejo em Parques Nacionais, categoria à qual pertence a área estudada. Assim, uma possível estratégia para minimizar a pressão de exploração ilegal de madeira sobre o arquipélago seria estimular o manejo florestal sustentável nas unidades de conservação da zona de amortecimento do parque, utilizando espécies de madeira leve que poderiam substituir aquelas exploradas em igapó.

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Curso: ECOLOGIA
Nível: MESTRADO
Orientador(a): FLÁVIA COSTA

Título:

"Distribuição e intensidade da extração ilegal de madeira e a relação com a presença humana na zona de amortecimento do Parque Nacional Anavilhanas, Amazônia Central

BANCA JULGADORA:

TITULARES:
Rita Mesquita (INPA)
Bruce Nelson (INPA)
Henrique Nascimento (INPA)

SUPLENTES:
Wilson Spironello (INPA)
José Luís Camargo (PDBFF)

EXAMINADORES	PARECER	ASSINATURA
Rita Mesquita (INPA)	(X) Aprovado ( ) Reprovado	
Bruce Nelson (INPA)	(x) Aprovado ( ) Reprovado	
Henrique Nascimento (INPA)	(X) Aprovado ( ) Reprovado	
Wilson Spironello (INPA)	( ) Aprovado ( ) Reprovado	
José Luís Camargo (PDBFF	( ) Aprovado ( ) Reprovado	

Manaus(AM), 12 de março de 2009

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Avaliação de dissertação de mestrado

Título: **Exploração ilegal de madeira no arquipélago de Anavilhanas (Amazônia Central) : distribuição espacial, efeitos sobre populações exploradas e comportamento dos exploradores**

Aluno(a): **ANDRESSA BÁRBARA SCABIN**

Orientador(a): **Flávia Regina Capellotto Costa** Co-orientador(a): -----

Avaliador: **Ana Luisa K. M. Albernaz**

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Revisão bibliográfica	( )	(x)	( )	( )
Desenho amostral/experimental	( )	(x)	( )	( )
Metodologia	( )	(x)	( )	( )
Resultados	( )	( )	(x)	( )
Discussão e conclusões	( )	( )	(x)	( )
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Desenho amostral/experimental	( )	(✓)	( )	( )
Metodologia	( )	( )	(✓)	( )
Resultados	( )	( )	(✓)	( )
Discussão e conclusões	( )	( )	(✓)	( )
Formatação e estilo texto	(✓)	( )	( )	( )
Potencial para publicação em periódico(s) indexado(s)	( )	( )	(✓)	( )

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Orientador(a): **Flávia Regina Capellotto Costa** Co-orientador(a): **-----**

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	Muito bom	Bom	Necessita revisão	Reprovado
Relevância do estudo	(x)	( )	( )	( )
Revisão bibliográfica	( )	(x)	( )	( )
Desenho amostral/experimental	( )	(x)	( )	( )
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Potencial para publicação em periódico(s) indexado(s)	( )	(x)	( )	( )

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Brasilia,	**27/06/2010,**	
Local	**Data**	**Assinatura**

Comentários e sugestões podem ser enviados como uma continuação desta ficha, como arquivo separado ou como anotações no texto impresso ou digital da tese. Por favor, envie a ficha assinada, bem como a cópia anotada da tese e/ou arquivo de comentários por e-mail para pgecologia@gmail.com e claudiakeller23@gmail.com ou por correio ao endereço abaixo. O envio por e-mail é preferível ao envio por correio. Uma cópia digital de sua assinatura será válida.

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PG·ECO·INPA
PÓS-GRADUAÇÃO EM ECOLOGIA

INPA
INSTITUTO NACIONAL DE PESQUISAS DA AMAZÔNIA

ATA DA DEFESA PÚBLICA DA DISSERTAÇÃO DE MESTRADO DO PROGRAMA DE PÓS-GRADUAÇÃO EM ECOLOGIA DO INSTITUTO NACIONAL DE PESQUISAS DA AMAZÔNIA.

Aos 27 dias do mês de outubro do ano de 2010, às 15:00 horas, no auditório do Programa de Pós-Graduação em Entomologia PPG-ENT/INPA, reuniu-se a Comissão Examinadora de Defesa Pública, composta pelos seguintes membros: **Dr. José Luis Campana Camargo**, do Projeto Dinâmica Biológica de Fragmentos Florestais, **Dra. Andréia Pinto**, do Instituto do Homem e Meio Ambiente da Amazônia, **Dr. José Júlio de Toledo**, do Instituto Nacional de Pesquisas da Amazônia, tendo como suplentes o Dr. William Ernest Magnusson, do Instituto Nacional de Pesquisas da Amazônia, e o Dr. Renato Cintra Soares, do Instituto Nacional de Pesquisas da Amazônia, sob a presidência do(a) primeiro(a), a fim de proceder a argüição pública da **DISSERTAÇÃO DE MESTRADO** de **ANDRESSA BARBARA SCABIN**, intitulada "Distribuição espacial da exploração ilegal de madeira no Arquipélago de Anavilhanas (Amazônia Central), relação com as populações humanas e efeitos estruturais sobre os taxa mais explorados", orientada pela Dra. Flávia Regina C. Costa, do Instituto Nacional de Pesquisas da Amazônia.
Após a exposição, o(a) discente foi argüido(a) oralmente pelos membros da Comissão Examinadora, tendo recebido o conceito final:

- [x] APROVADO(A)
- [ ] REPROVADO(A)
- [x] POR UNANIMIDADE
- [ ] POR MAIORIA

Nada mais havendo, foi lavrada a presente ata, que, após lida e aprovada, foi assinada pelos membros da Comissão Examinadora.

Dr(a). José Luis Campana Camargo ______________________

Dr(a). Andréia Pinto Andréia Cristina Brito Pinto

Dr(a). José Júlio de Toledo ______________________

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Coordenação PPG-ECO/INPA