Interactions between forest species as indicative of management and economic possibilities in the Amazon

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Gideão Costa dos Santos[1], Klewton Adriano Oliveira Pinheiro[2] and José Alessandro Belém Pimentel[3]

ABSTRACT

The floodplains of the Amazon estuary are environments recognized for their soils with a high level of water saturation, for the dominance of few tree species and the presence of a high number of palm trees that are important in the maintenance of riverside communities. The objective of this study was to highlight floristic composition and phytosociology as silvicultural tools for sustainable management in floodplain forest. For this, the study was carried out in a floodplain forest located on Conceição Island, Santa Bárbara do Pará, Pará State. Two hectares were randomly selected, divided into two plots of one hectare each, 100 x 100 m, where to facilitate the floristic survey, each hectare was subdivided into strips of 20 x 100 m. In each plot, individuals were sampled at 1.30 m from the ground with a CAP ≥ 30 cm, estimating the commercial height of the timber species; botanical identification was made in the herbarium João Murça Pires - MPEG for some species. The analysis was carried out through the horizontal structure of the forest with the parameters density, frequency, dominance and importance value index, all relative, as well as the number of individuals and basal area. It was found that the species with the highest phytosociological importance value index were *Euterpe oleracea*, *Pterocarpus officinalis*, *Symphonia globulifera*, *Hevea brasiliensis*, *Virola surinamensis* and *Carapa guianensis*, of which *E. oleracea* stands out as the species of greatest socioeconomic importance followed by *Carapa guianensis*. The values found regarding the number of individuals, relative density and importance value index, denote that the species, especially those of economic importance, are viable for management to increase production, requiring special management techniques in order to increase their volumes.

Keywords: Silviculture, Amazon forest, Floodplain economy, Forest management.

[1] Doctor in Agricultural Sciences/Federal Rural University of the Amazon - UFRA
Professor/IFPA/Castanhal
E-mail: gideao.santos@ifpa.edu.br
[2] Doctor in Agricultural Sciences/Federal Rural University of the Amazon - UFRA
Professor/IFPA/Castanhal
E-mail: klewton.adriano@ifpa.edu.br
[3] Post Graduation in Topography - FAMEESP
Company Terra Environment LTDA
E-mail: alessandropimentel19@gmail.com

INTRODUCTION

Part of the economy of countries, especially those in "development", is concentrated on the basis of natural resources, whether in the primary, secondary and even tertiary sectors. This has generated strong clashes and the strengthening of discussions around issues related to sustainable development, especially when it comes to equating problems between environmental sustainability and economic and social development. On the issue, Ehlers (1999) stressed that sustainable development must reconcile economic growth and the conservation of natural resources for long periods.

It cannot be denied that in the search to achieve excellence among the means of production in line with environmental conservation, efforts have been intensifying towards maximizing production with the minimization or mitigation of environmental damage. In this context, extractive communities in the Amazon, here in this study those that occupy the floodplain areas, are inserted in the process of using natural resources for profit or just family maintenance. Lima and Tourinho (1996) reported that the Amazon floodplains have been exploited since pre-Columbian times due to the economies of times such as rubber, cocoa and jute, today with multiple products, the authors emphasized that the search for açaí (*Euterpe oleracea* Mart.) has been since the beginning in the economic process. Ribeiro et al. (2004) highlighted that the Amazon floodplains have been exploited since the sixteenth century by Europeans and continue to the present day. According to Santos (2004), the availability of natural resources, such as various species of wood and especially the fruit and heart of palm of the açaí palm tree, have served to sustain varzeira and surrounding families.

The knowledge about shrub-tree potential in floodplain areas is given by the floristic survey, because it allows at first glance to have a view of the initial conservation status of the vegetation, from there, other analyses can be developed, such as the use of phytosociology that allows an understanding of the structural behavior that forest species establish among themselves as a function of biotic and abiotic variables and, especially, as a result of human action. For Santos (2012), the floristic survey and the study of the phytosociological behavior of species are of fundamental importance, as they allow us to understand the action or pressure of man on the main species and, from the point of view of science and traditional knowledge, to infer changes or adaptations in the best use of the species.

According to Leitão Filho (1987), the Amazonian vegetation is floristically quite distinct, representing an immense task its floristic study, even today, due to several factors such as territorial extension, floristic diversity itself, access to sampling areas, difficulty in collection, scarcity of taxonomists, among others. For Jardim et al. (2008), even today the floristic composition is little known due to some peculiarities such as species distribution, demography, preferential habitats and the dynamics itself, being important aspects to be considered in management and development, therefore, in order to contribute to the adoption of the best management, the authors reinforced that the use of phytosociology provides the first information about the dynamics of the stand, leading silvicultural decisions to have greater chances of success. Higuchi et al. (2012) reinforced by saying that when one wants to design conservation and restoration strategies, it is necessary to know the floristic and structural patterns of the forests, as well as the knowledge about the environmental variables that act on these patterns. For Pedreira and Sousa (2011), when it comes to flooded areas, studies in the interior of the country are still scarce, even for mistaken reasons of considering them as economically unattractive areas. Seeing the floodplains as economically unattractive is refuted by Lima and Tourinho (1996) because they have several economic species, be it wood, fruits, seeds, oils, latex, etc.

In order to strengthen knowledge about plant diversity and its dynamics in floodplain forests, especially in the Amazon estuary, it is possible to cite several studies such as (ANDERSON et al., 1985; CONCEIÇÃO, 1990; ANDERSON et al., 1995; JARDIM and VIEIRA, 2001; RABELO et al., 2002; JARDIM et al., 2004; SANTOS et al., 2004; SANTOS et al. 2014; FERREIRA et al., 2005; SANTOS and JARDIM, 2006; CARIM et al., 2008; BATISTA et al., 2011; SANTOS, 2012) in which they highlighted the floodplains as an ecosystem of low tree diversity, usually of high floristic similarity and with the presence of timber and non-timber species with high market potential, such as: *Euterpe oleracea,* (açaí); *Carapa guianensis* (andiroba); *Virola surinamensis* (virola); *Symphonia globulifera* (ananin); *Mauritia flexuosa* (buriti); *Hevea brasiliensis* (syringe) etc.

These species, due to their high occurrence in floodplain areas and commercial prominence, suggest that management should be carried out in order to ensure their sustainability. The definition of forest management according to the Brazilian Forest Code is "management of natural vegetation to obtain economic, social and environmental benefits, respecting the mechanisms of sustainability of the ecosystem, object of management, considering cumulative or alternative, the use of multiple timber species or not, multiple products and by-products of flora, as well as the use of goods and services. In this way, it is perceived in all the possibilities of use of the floodplain forest its previous knowledge and this permeates the floristic survey and phytosociological study as fundamental contributions to the adoption of management.

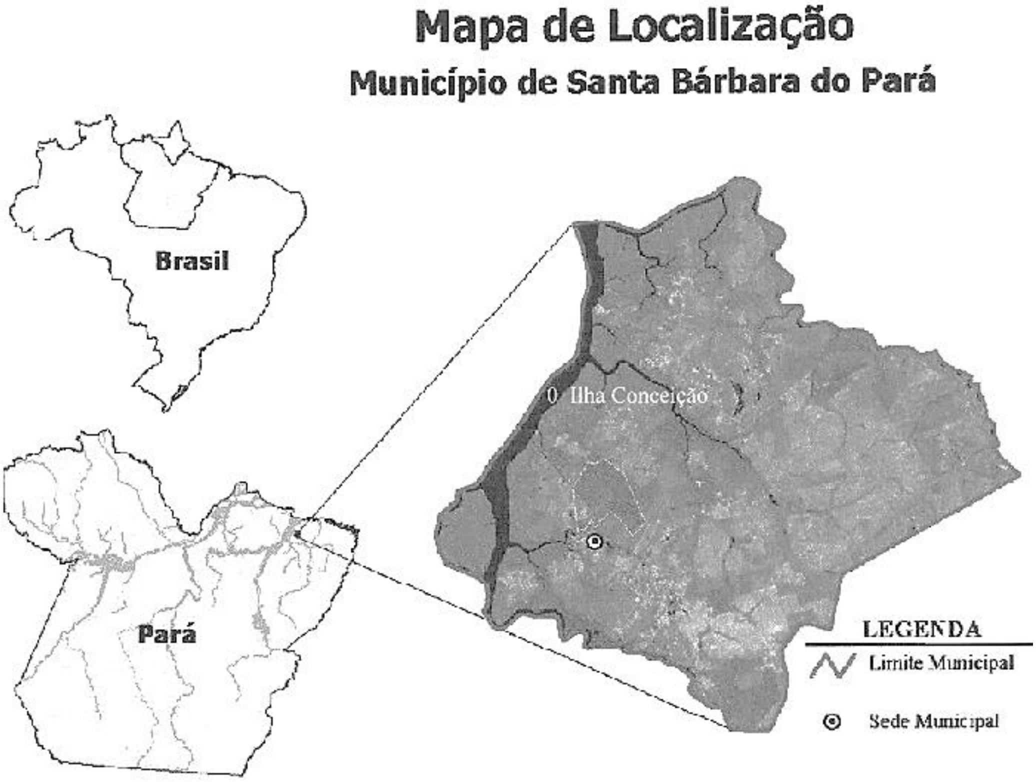
METHOD

PLACE OF STUDY

The study was conducted on Conceição Island, in the Furo das Marinhas community, in the municipality of Santa Bárbara do Pará, in the State of Pará (Figure 1). The municipality belongs to the metropolitan region of Belém (capital) only 40 km away by the PA 391 highway, better known as Belém-Mosqueiro. According to SUDAM (1993) it has an annual rainfall intensity with peaks in the months of January, February, March and April, with an average annual temperature of 26 º C with warmer months in September and October, the soil is of the Gley Low Humic Hydromorphic type, most of which is characterized as low-lying lowland soils where, it suffers floods daily according to the flooding of the tide. 2.500 mm

Conceição Island is cut by the hydrological flow of streams and the Furo das Marinhas River, its relief is predominantly lowland and its arboreal vegetation is composed of understory and canopy species, palm trees and vines. According to local residents there is the presence of animals such as: armadillo, paca, agouti, tapir, monkey etc. All this information from the biophysical environment is important because they act together in the establishment of forest species.

FIGURE 1: Location of Conceição Island in Santa Bárbara do Pará, in the State of Pará.



Source: Santos *et al.* (2014).

DATA ANALYSIS

2 ha of forests were delimited distributed in two plots of size 100 x 100 m () with a distance of approximately 200 m from each other. Each plot was subdivided into five 20 x strips only to facilitate the floristic survey, i.e., they did not have the function of sample subplots. In each plot, individuals with CAP (circumference at breast height) ≥ 30 cm to 1.30 m from the ground were sampled, estimating their heights from a 12 m graduated pole. In the case of the açaí palm (1 ha100 m*Euterpe oleracea*) as this occurs in clumps, each stem was considered as an individual, as each stem produces fruit bunches and seeds. The botanical identification carried out in the Herbarium of the Emílio Goeldi Museum of Pará. The floristic analysis was carried out by the horizontal structure

as proposed by Cottam and Curtis (1956), using the Mata Nativa 2 software, (CIENTEC, 2006). The parameters of the phytosociological horizontal structure served as indicators for possible practices that help in the development of the species.

RESULTS AND DISCUSSION

The two areas analyzed presented similar physiognomic characteristics such as the presence of lianas that dominate a certain area, preventing the development of other species, especially those in the understory, leaving herbaceous and arboreal canopy species. However, there are peculiarities, in area 1 there is evidence of traditional logging causing canopy opening; Area 2 is close to the creek, where the tide invades the soil twice a day, determining part of the gene flow and dynamics in the ecosystem.

The floristics found in the two sampled areas are composed of 31 species distributed among timber and multiple-use (wood, fruits, seeds and hearts of palm). By highlight of economic importance, the main exclusively timber companies are: *Virola surinamenis,* (ferrule); *Symphonia globulifera,* (Ananin); *Vatairea guianensis,* (Faveira); The multiple-use ones are: *Euterpe oleracea,* (açaí); *Carapa guianensis,* (andiroba); *Hevea brasiliensis,* (syringe); *American Genipa,* (genipap) and *I think it's a really good time to have a good time.* (Buriti).

In the first hectare (Table 1), 22 species were found, and are presented according to the highlight of the phytosociological importance value index (IVI) below:

TABLE 1: Species and phytosociology in 1 ha of floodplain, area 1 on Conceição Island, Santa Bárbara do Pará, Pará State, Brazil.

Scientific Name	N	G m²	DR	FR	DoR	IVI %
Euterpe oleracea	1758	9,56	87,33	4,55	31,89	41,26
Pterocarpus offcinalis	60	10,77	2,98	4,55	35,93	14,48
Symphonia globulifera	24	2,45	1,19	4,55	8,17	4,64
Hevea brasiliensis	28	1,11	1,39	4,55	3,72	3,22
Virola surinamensis	11	1,24	0,55	4,55	4,14	3,08
Carapa guianensis	25	0,73	1,24	4,55	2,45	2,75
Pachira aquatica	12	0,60	0,6	4,55	2,01	2,38
Licania blackii	13	0,55	0,65	4,55	1,83	2,34
Pentaclethra macroloba	14	0,50	0,7	4,55	1,68	2,31
American Genipa	4	0,60	0,2	4,55	2,00	2,25
Macrolobium angustifolium	13	0,33	0,65	4,55	1,11	2,10
Licania longistyla	10	0,23	0,50	4,55	0,79	1,95
Licania heteromorpha	9	0,16	0,45	4,55	0,53	1,84
Swartzia racemosa	5	0,19	0,25	4,55	0,66	1,82
Vatairea guianensis	5	0,19	0,25	4,55	0,64	1,81
Chamaecrista adiantifoli	6	0,17	0,30	4,55	0,58	1,81
Xylopia nitida	6	0,11	0,30	4,55	0,37	1,74
I think it's a really good time to have a good time.	1	0,15	0,05	4,55	0,52	1,71
Mora paraenesis	2	0,14	0,10	4,55	0,50	1,71
Platymiscium trinitatis	4	0,04	0,20	4,55	0,14	1,63
Licania macrophylla	2	0,07	0,10	4,55	0,24	1,63
Sterculia speciosa	1	0,02	0,05	4,55	0,10	1,56

Where: N = number of individuals; G = basal area; DR = relative density; FR = relative frequency; DoR = relative dominance; IVI = importance value index. Source: The authors.

Regarding the number of individuals, there is a wide dominance of *Euterpe oleracea* in relation to the other individuals of the other species, because this species occurs in clumps (several stems with a high concentration of shoots) and for production purposes, each stem is the source of several fruit clusters, from this perspective that each stem was considered as an individual. For the other species, *Pterocarpus officinalis* stands out in second position with 60 individuals, followed by *Hevea brasiliensis* with 28 individuals. Species of notorious appreciation in the timber market, such as *Carapa guianensis*, *Symphonia globulifera* and *Virola surinamensis*, occupied the fourth, fifth and ninth positions, respectively, in relation to the number of individuals.

Regarding the basal area, a parameter related especially to timber species, *Pterocarpus officinalis* was the most prominent, followed by *Euterpe oleracea.* In relation to the first species, this is not a kind of market, but at the local level for medicinal purposes; in relation to the second species, the basal area is influenced by the high number of stems that can be used in local rustic constructions such as bridges and animal shelters. Regarding the other phytosociological parameters, these species also dominated in positioning, a fact linked exclusively to the high number of individuals.

The importance value index (IVI) for the species *Symphonia globulifera, Hevea brasiliensis, Virola surinamensis* and *Carapa guianensis* deserve to be highlighted, which shows a good parameter to be considered for the timber management of these species, especially due to the good values presented in relative dominance. Santos and Pimentel (2023), analyzing the volumetric coverage of *Virola surinamensis* from its density in 6 floodplain areas, mention that the species in one of the areas showed good levels of recomposition in abundance and that this may be linked to a moderate exploitation of the species.

The species *Vatairea guianensis* and *Mora paraensis*, appreciable in the timber market, occupied the 15th and 16th positions in phytosociological importance and with only 5 and 2 individuals respectively, becoming information to be considered by silvicultural practices in order to increase their abundance and volumetric potential.

In the second area, the relationship of species and their phytosociological parameters are presented in table 2 below:

TABLE 2: Species and phytosociology in 1 ha of floodplain, area 2 on Conceição Island, Santa Bárbara do Pará, Pará State, Brazil.

Scientific Name	N	G m²	DR	FR	DoR	IVI %
Euterpe oleracea.	741	3,45	66,64	3,57	10,85	27,02
Pterocarpus offcinalis	86	11,49	7,73	3,57	36,08	15,8
Symphonia globulifera	37	2,55	3,33	3,57	8,04	4,98
Avicennia germinans	5	3,43	0,45	3,57	10,77	4,93
Hevea brasiliensis	32	1,85	2,88	3,57	5,82	4,09
Carapa guianensis	39	1,56	3,51	3,57	4,9	3,99
Virola surinamensis	19	1,68	1,71	3,57	5,3	3,53
Licania blackii	18	0,72	1,62	3,57	2,28	2,49
Pentaclethra macroloba	21	0,61	1,89	3,57	1,95	2,47
Swartzia racemosa	14	0,81	1,26	3,57	2,56	2,46
Macrolobium angustifolium	16	0,50	1,44	3,57	1,58	2,20
Licania heteromorph	17	0,29	1,53	3,57	0,93	2,01
Aquatic pachira	10	0,48	0,90	3,57	1,52	2,00
Chamaecrista adiantifoli	7	0,39	0,63	3,57	1,25	1,82
Licania macrophylla	9	0,32	0,81	3,57	1,03	1,80
Coccoloba latifolia	9	0,23	0,81	3,57	0,73	1,70
Gustavia Augusta.	10	0,18	0,90	3,57	0,58	1,68
Vatairea guianensis	4	0,31	0,36	3,57	1,00	1,64
Ficus maxima	2	0,31	0,18	3,57	1,00	1,58
Xylopia nitida	5	0,15	0,45	3,57	0,48	1,50
Ocotea dissimilis	1	0,15	0,09	3,57	0,50	1,39
American Genipa	1	0,07	0,09	3,57	0,24	1,30
Pthecelobium inaequale	2	0,04	0,18	3,57	0,15	1,30
Inga alba	2	0,03	0,18	3,57	0,11	1,29
The Manilkara Siqueli	2	0,03	0,18	3,57	0,11	1,29
Mora exelsa	1	0,04	0,09	3,57	0,13	1,26
Micropholis guianensis	1	0,02	0,09	3,57	0,09	1,25
Platymiscium trinitatis	1	0,01	0,09	3,57	0,03	1,23

Where: N = number of individuals; G = basal area; DR = relative density; FR = relative frequency; DoR = relative dominance; IVI = importance value index. Source: The authors.

In this area, most of the species found in area 1 were found, with the exception of *Sterculia speciosa*, *Mauritia flexuosa* and *Mora paraensis*. In area 2, ten species were found that did not occur in area 1, namely: *Avicennia germinans, Coccoloba latifolia*, *Gustavia augusta*, *Ficus maxima*, *Ocotea dissimilis*, *Pthecelobium inaequale, Inga alba*, *Manilkara siqueirali*, *Mora exelsa*, *Micropholis guianensis*. With the exception of *Avicenia germinans*, the others did not present high values of phytosociological importance, with the best placed being *Coccoloba latifolia* followed by *Gustavia augusta* with 1.70 and 1.68 % respectively.

It is noteworthy as an interesting fact the lower concentration of *Euterpe oleracea* (the açaí) with only 741 individuals in relation to the first area, a fact that may be conditioned by the presence of the species *Avicennia germinans* because its root system dominates a wide area making it difficult for other species to germinate and also by the tidal water that invades the soil carrying part of the seeds of the (açaí). *Avicennia germinans* , popularly known as ciriúba, despite the low number of individuals, had a high basal area, relative dominance and the fourth best index of importance value, facts linked to its good diametric development. This is information that constitutes good data for the economic management of the species.

The timber species *Symphonia globulifera*, *Hevea brasiliensis*, *Carapa guianensis* and *Virola surinamensis* had an increase in the number of individuals and consequently higher values for phytosociological parameters, keeping them in the first positions. Santos *et al.* (2014) cite in their study these same species as well represented numerically and with possibilities of economic use.

It is notorious in both areas that species of market timber potential such as *Vatairea guianensis*, *Ocotea dissimilis*, *Manilkara siqueirali* and *Mora exelsa* occurred in low densities, basal area and phytosociological representation, this denotes the need to adopt silvicultural practices in order to favor their development, especially with regard to the number of individuals and commercial volume.

Comparing the species found to those of other studies, Arina et al. (1998) mentioned that the possession of the resource is a conflicting factor because there is little incentive in programs for the management of wood and açaí trees in the floodplains and the lack of guarantees that the products will not be extracted by other people. The authors add that normally the "possession" of the land is based only on many years of occupation and when the areas are in the interior of the state, the lack of documentation is accentuated, due to the lower value of the land. Considering this reality, a good part of the floodplain areas functions only as a generator of resources, yielding to overexploitation mainly of wood and the heart of palm of açaí, causing the fragmentation of vegetation, reduction of species that generate food and income.

The fragmentation of the floodplain vegetation as a result of the non-use of sustainable practices for the extraction of resources, leads to the fragility of the environment and the multiplication of poverty in the riverside environment. Jardim et al. (2004) stated that in the Amazon estuary the process of forest fragmentation affects plant populations, causing a decrease in population density, especially of timber and/or extractive species, this is a considerable change in the local floristic composition. The authors pointed out that proximity to the consumer center may or may not be a factor that contributes to fragmentation, depending on the resource demanded. Santos and Jardim (2006), based on information from local residents, cited that due to the advent of the exploitation of the heart of palm in the floodplains of Santa Bárbara do Pará, there were changes in the physiognomy of the forest. According to Scipioni et al. (2012), the variation in forest diversity and structure is dynamic and constant, sometimes slow and natural, but also harsh when there is human intervention without adequate management, and can assume different proportions.

According to Anderson and Jardim (1989), when there are some management practices such as planting fruit trees, girdling undesirable species, favoring others of an economic nature and thinning, this leads to satisfactory and sustainable economic returns. In the case of the floodplain on the island of Conceição there are several species that, if well managed and marketed at a fair price, can promote the income of local residents, they are: *Euterpe oleracea* (açaí), *Symphonia globulifera* (ananin), *Hevea brasiliensis* (rubber tree), *Carapa guianensis* (andiroba), *Virola surinamensis* (virola/ucuuba), *Genipa americana* (genipap), *Mora paraensis* (pracuuba), *Vatairea guianensis* (faveira) among other species.

For the adoption of proper management, it is necessary before any decision making, the knowledge of what is intended to be managed and to outline the objectives well. For the timber and non-timber resources of the floodplain, the primary tool is the floristic survey. Thus, the floristics found in this study, in general 32 species, are in line with several studies carried out in the Amazon estuary, such as Santos and Jardim (2006), which found 31 species in one of the inventoried hectares; Ferreira et al. (2005), studying 1 hectare in flooded areas (igapó and floodplain), found 30 species in the igapó and 19 in the floodplain, considering half a hectare (0.5 ha) in each type of environment, about the greater richness in the igapó forest, the authors stated that it was conditioned to the geological origin of the two types of forests; Almeida et al. (2004), analyzing areas of different floodplains, both of 1 ha, found a variation between 36 and 78 species and pointed out that this variation in the number of species may be conditioned by flood height, soil erosion and salinity content; Queiroz et al. (2005), studying 1 ha of high floodplain with an inclusion level of 5 cm DBH or more, found 69 species and reported that the patterns of floodplain use influence the floristic composition.

According to Venzke et al. (2012), the low richness in flooded areas is conditioned by the ability of species to germinate and develop in high water saturation soils, being one of the main factors that act in natural selection regarding the occurrence and colonization of species in these environments. Santos and Jardim (2004), reported to species richness a variant dependent on environmental variation, such as soils with a high level of saturation, where only adapted species can survive and dominate the landscape, however, they emphasized that there are several adaptive mechanisms. Ferreira et al. (2005) commented that in flooded areas the maintenance of biodiversity is conditioned by physical and biological factors, especially hydrological cycles and sedimentation. Ferreira (2000) stated that the richness of tree species in the flooded areas of the Amazon is influenced by soil types, duration of the flood period, flood tolerance, erosion and sedimentation. Carim et al. (2008) mentioned that in the floodplains the soil fertility imposes intrinsic restrictions at the biotic and abiotic levels for their occupation.

Here in this study, the environmental factors that are possibly acting in the maintenance of floristic diversity are topographically low areas, flood height, flood time, efficient adaptation mechanisms, highly adapted reproduction mechanisms for some species and even anthropic factors such as tree cutting. Regarding the highly adapted adaptation and reproduction mechanisms, Santos and Jardim (2004) mentioned that the Leguminous and Arecaceae families harbor several species with this profile.

The environmental characteristics and others resulting from human action, such as fruit collection, logging and empirical management attempts, have contributed to the forest dynamics as well as to the possibilities of management in the floodplain areas of the Amazon, especially in relation to those species of economic value. In this study, the species of economic potential with the highest phytosociological importance value (IVI) indexes, between the two areas, were: *Euterpe oleracea*, *Symphonia globulifera*, *Hevea brasiliensis*, *Carapa guianensis* and *Virola surinamensis*, the result of the combination of density, frequency and dominance, where especially dominance suffers direct effects from the number of individuals and the basal area, which makes these species strong income potentials whether timber or non-timber. Other studies in the Amazon have confirmed the same species among those with greater phytosociological expressiveness (JARDIM and VIEIRA, 2001; SANTOS et al., 2004; QUEIROZ et al., 2005; QUEIROZ and MACHADO, 2008; ALMEIDA and JARDIM, 2011; BATISTA et al., 2011).

For these species, the concentration of individuals, the basal area and the other phytosociological parameters indicate good possibilities for the adoption of sustainable management, requiring the application of silvicultural treatments in relation to timber species in order to increase their basal areas and consequently the volumetric potential. Queiroz and Machado (2008) found in areas of low and high floodplain, good phytosociological indices for the species *Euterpe oleracea*, *Carapa guianensis* and *Virola surinamensis*, emphasizing that these have a good capacity to adapt to the environment, influencing their densities. Gama et al. (2005) found that these same species and also *Hevea brasiliensis, Symphonia globulifera*, *Licania heteromorfa* and *Vatairea guianensis* were reported at high densities and frequencies, calling attention to the existence of adaptability mechanisms. Maués (2006), studying the reproduction strategy of some species in the Amazon, mentioned that *Symphonia globulifera* has a reproduction mechanism and adaptability favored by the dispersion of its fruits, either by birds still in the tree canopy or by mammalian animals. This justifies the good values of the number of individuals, relative density and value of phytosociological importance found in this work, which would facilitate its management for conservation or economic production purposes.

Jardim and Vieira (2001) cited *Euterpe oleracea* as dominant in the floodplain environment, with emphasis on its relative density, which is more than 50 % of the individuals when compared to individuals of other species, and this advantage is a function of environmental and structural factors such as luminosity, soil nutrients and tillering capacity. This information was proven here in this study, which makes this species a high potential for sustainable management, new business and income generation. Almeida et al. (2004) cited *Euterpe oleracea, Hevea brasiliensis* and *Virola surinamensis* as the ones that contributed the most to 51.94% of the individuals inventoried.

Santos et al. (2004) highlighted *Euterpe oleracea*, *Virola surinamensis*, *Hevea brasiliensis* and *Carapa guianensis* as outstanding species in density, frequency, dominance and importance value, however, they stressed that the simple availability of the natural resource, in itself, is not attractive, it is necessary to use technologies for market purposes. In the case of the floodplains analyzed here in this work, it is understood as technologies for species of phytosociological prominence, management technologies, especially those of community forest management, as these can offer a product in better quantity, quality and competitiveness in the market, without depleting resource stocks.

Mota et al. (2001) cited *Virola surinamensis* as having high concentrations in floodplains and igapó in the Amazon and of recognized economic value through the oil of the seeds and wood, the authors emphasized that the pressure on this species has led to investment in research, especially on conservation and management. One of these pieces of information is the use of phytosociology that informs patterns of structural behavior as seen here in this research, which showed for this species a good development, easy adaptability to the environment and that, if added to other studies such as market research, can strengthen conservation practices and economic management.

Pinã-Rodrigues (2000), analyzing the exploratory process of Virola *surinamensis populations,* showed that the unmanaged activity affected the productive system of the riverside dwellers and showed that the stocks vary according to the practices to which they are submitted. The author mentioned that in the low floodplain high densities of ferrule were found, but with a small commercial volume, she also stressed that it is necessary to define control, protection and technical parameters in the evaluation of impacts. The density found in this research is in agreement with what was reported by the author and the basal area also suggests the concentration of individuals with low volumetry, requiring attention from silvicultural interventions. Santos and Pimentel (2023) reported that extractive logging of ferrule wood without management results in a decrease in the volumetric stock.

Gama et al. (2002), when analyzing structural and floristic patterns in a floodplain environment, cited among other species, *Euterpe oleracea*, *Symphonia globulifera, Gustavia augusta* and *Virola surinamensis* among those of greatest importance in biocenosis, they also mentioned *Hevea brasiliensis*, *Licania macrophylla* and *Inga alba* As potential species for the non-timber market, all these species were found here in the current study. Other species of recognized value in the market can stand out in quantities and importance, thus, Queiroz et al. (2005) cited *Mora paraenses* in high concentrations and high basal area, calling attention to the ways of using the estuarine environment that interfere in the floristic structure, as well as the attempts at empirical management.

For Queiroz and Machado (2008), empirical management attempts cause a reduction in the number of individuals and changes in the floristic structure, as well as phytosociological. This fact is evidenced by Queiroz et al. (2007) who detected significant reductions in the populations of *Euterpe oleracea* and *Carapa. guianensis* because they are the target of local practices aimed at greater quantities for the market. In the present work, such practices were also observed and with the same purpose, especially in relation to species of economic value such as *Euterpe oleracea*, *Symphonia globulifera*, *Carapa guianensis*, *Virola surinamensis*, *Ficus maxima*, *Mora exelsa* among others. It is important to observe the floristic and phytosociological aspects as guidelines for practices related to management, especially for production and marketing purposes.

In this sense, Pereira and Tonini (2012) reported that no action of exploitation of natural resources can be sustainable over time if there is no scientific research on the ecology of species with economic potential and that the sustainability of forest management aiming at the multiple use of tropical forests must have criteria and indicators that guarantee the genetic variability of the species and the processes involved.

Several studies on the ecology of tree species in floodplain environments have been observed, one of them is on *Carapa guianensis*, a species found in high abundance and with good phytosociological importance in this work. Regarding this abundance and floristic importance, Pereira and Tonini (2012) showed that it is related to fruit dispersal (fruit drop) and seed dispersal in the rainy season, with germination and seedling establishment benefiting from soil water and organic matter. Another important observation in the abundance of this species is, according to Maués (2006), the dispersion carried out by tidal water, especially in low areas where the water reaches the base of the producing plant. This is an event that occurs daily in the place studied and that possibly has fundamental importance in the establishment and adaptation of this species.

In these terms, the floristic survey and the phytosociological analysis of the tree component linked to the knowledge of the autoecology of the species, serve as good indicators for the adoption of good management practices in floodplain environments, whether for the purposes of species conservation, income generation and also, especially for the sustenance of riverside populations. It is important to emphasize that when the economic maintenance of lowland families is desired, it is also important to consider the hidden, parallel or underground economy and, on this subject, Postea and Achim (2023) postulate some methods for evaluating the participation of this economy in a more systemic context.

CONCLUSIONS

The floodplain studied has an abundance of several species of local, regional, national and international economic prominence and that exert phytosociological relevance, indicating aptitudes for timber and non-timber management, requiring the effective participation of the local government as a facilitator of the production process.

The basal area values of timber species indicate that the adoption of management, if there is an interest in boosting commercialization by extractivists, should include silvicultural treatments in order to increase both the quantitative and qualitative volumetric potential of these species.

Among the fruit-producing species, the açaí *Euterpe oleracea stands out* as highly promising for management, justified by the high occurrence of palm trees, in order to increase the production and quality of the fruits. Following the same reasoning, the management of the andiroba *Carapa guianensis* is recommended , as the oil of its fruits is medicinal and of high marked value.

Floristics and phytosociology are suitable as preliminary tools for the analysis of forest populations, providing current information on the dynamic state and serving to assist in the definition of management practices aimed at the conservation and use of species.

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