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# A contingent valuation study of buriti (*Mauritia flexuosa* L.f.) in the main region of production in Brazil: is environmental conservation a collective responsibility?

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## ABSTRACT

The immature leaves of the buriti palm (*Mauritia flexuosa*) are widely harvested in the municipality of Barreirinhas, Maranhão, for the production of handicrafts, which are sold to locals and tourists. The increasing demand for these artisanal goods is stimulating the emergence of an informal market for immature buriti leaves, leading to an intensification of their extraction and resulting in negative effects on local buriti palm populations and the ecosystem. Thus, the objective of the present study was to assess the environmental value of the buriti palm tree based on the maximum willingness to pay (WTP) for its conservation, using the contingent valuation method. Among the respondents, 99.74% reported that the palm species should be protected and the majority of them (65.75%) agreed to pay for its conservation (annual WTP R\$ 179.49 ± 222.05). Multivariate analysis revealed that the WTP was not influenced by the socio-economic profile of the respondents. The main reasons for non-WTP are related to dissatisfaction with the government and the belief that financial contributions would not solve problems of environmental damage. Overall, the evaluated population believes that environmental conservation is not an obligation of the government or that of the population, but is a collective responsibility.

**Keywords:** contingent valuation, handicrafts, harvesting, non-timber forest products (NTFP), palm tree

## Introduction

*Mauritia flexuosa*, popularly known in Brazil as buriti (Henderson *et al.* 1995), is a dioecious species of palm with a solitary cylindrical trunk reaching up to 40 m in height. The plant produces its costapalmate leaves throughout the year, flowers synchronously from November to April, and produces fruits which take more than one year to mature (Henderson *et al.* 1995; Abreu 2001; Lorenzi *et al.* 2004). The species occurs in South America, including Brazil, where it

is abundant in the northeastern states of Ceará, Piauí, and Maranhão (Henderson *et al.* 1995; Oliveira Filho & Ratter 2000; Lorenzi *et al.* 2004). It grows mainly in areas popularly known as “veredas” or “buritizais,” which are swampy or flooded locations with poorly drained soils, (Ivanauskas *et al.* 1997; Toniato *et al.* 1998). In these environments it plays an important ecological role in the maintenance of water bodies and as a refuge and food source for animals (Bodmer 1991; Beck 2006; Sampaio 2011).

The palm is extensively harvested in the Northeast Region of Brazil. Its fruits are used as food and in traditional

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medicine (Sampaio *et al.* 2008; Santo & Coelho-Ferreira 2012; Ribeiro *et al.* 2014), and the oil extracted from seeds is used for frying food and making soap (Sampaio *et al.* 2008). The trunk is used in the construction of homes, small bridges, piers, fishing boats, and home furniture (Santo & Coelho-Ferreira 2012; Ribeiro *et al.* 2014), and its mature leaves and the fibers extracted from immature leaves are used as material for handicrafts (Magalhaes & Coelho-Ferreira 2007; Schmidt *et al.* 2007; Sampaio *et al.* 2008; Eichenberg & Scatena 2011).

The state of Maranhão in the Northeast Region of Brazil is the largest buriti fiber producer in the country (IBGE 2013). The fiber is obtained from immature leaves and each palm produces a single immature leaf per month. The city of Barreirinhas is the hub of this extraction activity, where the fruit is widely used in local cuisine and the handicrafts made from its fibers are popular with locals and tourists visiting Lençóis Maranhenses National Park. The municipality ranks as the largest buriti palm fiber producer in Brazil (104 t/year), which accounts for a significant part of the local economy (Instituto Meio 2010; IBGE 2012). An increasing flow of tourists is stimulating the emergence of an informal market for immature buriti leaves, leading to an intensification of their extraction (Keller 2011; Virapongse *et al.* 2014), which has affected buriti reproductive performance and promoted palm death (Saraiva 2009).

The intensive extraction of natural resources, such as non-timber forest products, is damaging to the natural environment, reducing its ecological benefits for the population and requiring the development of public policy strategies for environmental preservation. According to Mota (2001), natural resources subjected to a high demand urgently need conservation proposals to establish their monetary market-based value. The economic valuation of environmental assets assigns values to them at comparable market prices, quantifying in economic terms their environmental benefits and costs, to help policymakers reach more rational decisions on projects to preserve the environment (Benakouche & Cross 1994).

In recent years, the contingent valuation method (CVM) has been used to estimate economic values of entire ecosystems as well as that of individual species. The results are expressed as the willingness to pay (WTP) for conservation (Sattout *et al.* 2007; Monteiro *et al.* 2012). As examples, visitors to the Morro do Diabo State Park in the state of São Paulo, were willing to make a monthly payment of R\$ 0.19 for its conservation (Adams *et al.* 2008). In the Federal District, Morgado *et al.* (2011) reported that visitors to the Águas Claras Multiple Use Ecological Park were willing to contribute R\$ 11.59 per month for its recovery and conservation. Likewise, an average annual amount of R\$ 40.32 has been reported for the conservation of aroeira (*Myracrodruon urundeuva*) (Monteiro *et al.* 2012).

Within this context, the objective of our study was to assess the environmental valuation of the buriti

palm by residents of the municipality of Barreirinhas, Maranhão, using the contingent valuation method, and to evaluate the influence of personal preferences on the maximum willingness to pay (WTP) for the promotion of its conservation as a natural resource (Kniivila 2006).

## Materials and methods

### *Study area*

The municipality of Barreirinhas is located in the region of Lençóis Maranhenses, in the northeastern part of the state of Maranhão, Brazil (IBGE 2014) (Fig. 1). Its climate is tropical sub-humid with an annual rainfall of 1,500 to 1,700 mm, average annual temperatures of 26 °C and a dry season from June to December (Embrapa 2013). The soils are predominantly Quartzarenic Neosoils, and the vegetation is classified as Cerrado (Embrapa 2013). The vegetation of its *vereda* formations in the areas of watercourses and swamps is characterized by tree and shrub species, and dominated by the buriti palm (Monteles 2009).

### *Sample selection*

Inhabitants of Barreirinhas (estimated population in 2015 of 60,588 inhabitants, IBGE 2014), were surveyed by interview on days of street fairs in the downtown area of the city (June to August 2015). Persons over 18 years of age, residents in the municipality, and consumers or not of buriti products, and who claimed to know the species, were selected for interviewing. The sampling type was accidental according to the method described by Monteiro *et al.* 2012. To calculate the sample size, we used the formula of Krejcie & Morgan (1970) with 95% confidence and a 5% error margin. The minimum estimated number of respondents was calculated to be 382.

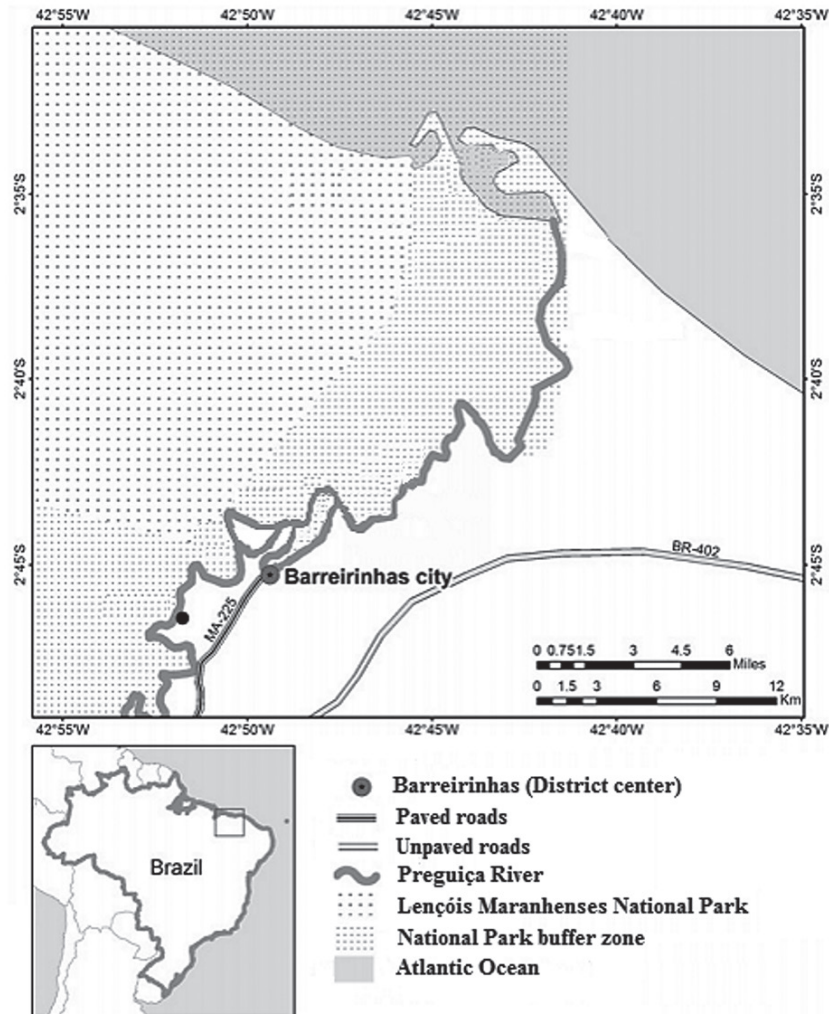
### *Ethics statement*

In compliance with legal requirements for research involving interviews (National Health Council Resolution 466/2012), our study was approved by the Committee for Research Ethics of Federal University of Piauí (no. 886193).

### *Method of evaluation and interview form*

Pre-interviews were conducted to confirm that the survey questions were cohesive and clear to the respondents, as recommended by the NOAA panel (Arrow *et al.* 1993). The questionnaire was based on that used by Monteiro *et al.* (2012) and was comprised of three parts: the first part intended to obtain socioeconomic data on the respondent; the second part aimed at formulating a hypothetical market, with a focus on familiarity with the species; and the third





**Figure 1.** Map of the study area (adapted from map created by Mariano González Roglich).

part quantified the maximum willingness to pay.

The contingent valuation method (CVM), which is considered a reliable method of environmental valuation (Motta 2006; Sattout *et al.* 2007), was used. Respondents were asked about their maximum willingness to pay (WTP) per month (in Brazilian reais – R\$) for conservation of the species and were informed that the amount would serve as a parameter for the adoption of policies for protecting the species (Adams *et al.* 2008; Monteiro *et al.* 2012). The monetary figures are cited in Brazilian currency, the real (R\$), for sake of comparison since the exchange rate with the dollar during the period to which these figures apply fluctuated between R\$ 3.5/US\$ to around R\$ 4.20/US\$.

Before asking respondents about their willingness to pay for buriti palm conservation, their level of knowledge of the plant and awareness of environmental conservation were assessed through some of the questions in the second part of the questionnaire, such as: *Have you ever used the buriti palm? What kind of use was this? Do you think the plant is important, and why? Are you in favor of environmental conservation?*

After the respondent answered these questions, they were reminded of the importance of the palm as described by them by repeating aloud their answers. This procedure ensures that all respondents receive the same level of questioning about the benefits of buriti, with the aim of determining a maximum willingness to pay closer to reality (Mattos & Mattos 2004; Monteiro *et al.* 2012). The respondents were then asked: *Considering all of your expenses and those of the people who live with you, including food, transportation, education, health, and leisure, how much would you be willing to voluntarily pay per month to preserve the buriti palm, knowing that the money would be applied correctly?*

### Data analysis

The resultant monthly WTP was used to determine the annual WTP of each respondent. The data on annual willingness, non-willingness (No-WTP) and total willingness to pay (WTP + No-WTP) for the conservation of buriti were checked for normality and submitted to multivariate linear

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regression. The socioeconomic profile of respondents, and their WTP or No-WTP, were analyzed by ANOVA and the Kruskal-Wallis test. For all evaluations,  $p < 0.05$  was defined as statistically significant. All the analyses were performed using the BioStat 5.0 software (Ayres *et al.* 2007).

### Results and discussion

#### *Socioeconomic profile of respondents and their maximum willingness to pay*

Interviews were conducted with 134 (35.08%) women and 248 (64.92%) men. Of the total, only 11 (2.88%) stated they did not use the palm species, with 371 (97.12%) confirming its use for various purposes. A total of 119 (31.15%) of the respondents cited its use as a food source, medicinal plant, for landscaping and in handicrafts, with 23 (6.02%) citing its use exclusively for craftwork, and 299 (59.95%) exclusively as food. Of the 11 current non-users, 10 mentioned family members using it and all of them had used it in the past.

All respondents confirmed that the palm has a close connection to their culture and that it plays an important role in maintaining environmental stability. They also stated they live in the vicinity of *Mauritia flexuosa* palm swamps and are aware of the environmental damage occurring as a result of intense harvesting of immature leaves. Such statements confirmed that the asset to be appraised was familiar to the respondents. Carson *et al.* (2001) and Kniivila (2006) state that knowledge about the asset to be valued, even without necessarily making use of it, is an indispensable condition for calculating a reliable WTP.

Among the respondents, 381 (99.74%) reported that the palm species should be protected, expressing its importance to their lives. Questioned about the possibility of it becoming extinct in their immediate environment given the current state of its conservation, 300 (78.53%) respondents gave a positive reply, whereas 82 (21.47%) expressed belief that the palm will not become extinct.

Willingness to pay (WTP) for the conservation of buriti was expressed by 263 (65.75%) respondents, with an average annual payment of R\$ 179.49, which represents about  $2.37 \pm 4.13\%$  of their annual income. No statistically significant differences were found between respondents who reported having used buriti (median WTP of R\$ 179.02  $\pm$  223.70) and those who reported not having used it (median WTP of R\$ 204.00  $\pm$  116.96) ( $p > 0.05$ ), demonstrating that the lack of use does not influence WTP valuation, a finding also reported by Monteiro *et al.* (2012) in relation to the valuation of *Myracrodruon urundeuva* in northeastern Brazil. Moreover, it was previously reported that the WTP is related to other variables, such as income, age and educational level (Sattout *et al.* 2007; Adams *et al.* 2008; Morgado *et al.* 2011; Monteiro *et al.* 2012), however, we found no significant correlation between the value of annual willingness to pay or not (No-WTP) and the other variables analyzed (Tab. 1). This suggests that conservation consciousness was a main determinant in our findings.

People aged 46 years and over showed less willingness to pay for the proposed conservation of buriti (Tab. 2), which corroborate the findings of other researchers that older people are less inclined to contribute financially to conservation proposals (Montgomery & Helvoig 2006; Monteiro *et al.* 2012). As argued by Mitchell & Carson (1989), older people are less willing to pay since they realize they will have less time to enjoy the benefits of conservation. In addition, older people usually help their children and grandchildren financially, a factor contributing to their unwillingness to reduce their disposable income in the cause of buriti conservation.

Previous studies have reported that married and divorced couples, households with a high number of people, low-income households, and unemployed people tend to be less willing to contribute to environmental conservation proposals (Cirino & Lima 2008; Silveira *et al.* 2013). We found no statistical differences among respondents with different household sizes, incomes, occupations, and marital status, and even between those who reported depending (or not) financially on harvesting palm leaves (Tabs. 1, 2).

**Table 1.** Multivariate analysis of respondents with an annual willingness (WTP) and unwillingness (No-WTP) to pay for the conservation of buriti (*Mauritia flexuosa* L.f), municipality of Barreirinhas, Maranhão state.

Explainable variables	WTP		No-WTP		WTP + No-WTP	
	Coefficients	p-value	Coefficients	p-value	Coefficients	p-value
Gender	-0.0048	0.7785	-0.3658	0.8878	0.1218	0.9491
Age	-0.0002	0.6833	-0.0552	0.5919	-0.0679	0.3518
Education level	-0.0017	0.3340	0.3825	0.1936	0.0991	0.6407
Monthly income	7.39E-07	0.9133	0.00184	0.0385	0.0009	0.1657
Number of people per household	0.0016	0.6177	-0.2931	0.5978	-0.0442	0.9118
Number of uses	0.0033	0.5779	-1.8157	0.0729	-1.1205	0.1249
Financial dependence on harvest	0.0795	0.0857	-2.1515	0.6520	-2.1374	0.5284
Occupation status	0.0057	0.8564	2.8448	0.6931	0.8180	0.8765
Civil state	0.0054	0.7919	-6.0800	0.0714	-3.7732	0.1255
Statistics summary R <sup>2</sup>	0.0929		0.0928		0.0237	
p-value	0.1714		0.1715		0.3973	



**Table 2.** Socioeconomic profile of respondents with annual willingness (WTP) and unwillingness (No-WTP) to pay for the conservation of buriti (*Mauritia flexuosa* L.f), municipality of Barreirinhas, Maranhão state.

Variables	WTP	No-WTP
	Number of respondents (mean WTP* ± SD)	Number of respondents
<b>Education level</b>		
Illiterate	12 (70.60±40.55 <sup>a</sup> )	1
Basic incomplete	77 (168.46±218.44 <sup>a</sup> )	22
Basic	33 (162.90±139.75 <sup>a</sup> )	13
High school incomplete	23 (202.95±258.28 <sup>a</sup> )	12
High school	97 (206.35 ±261.87 <sup>a</sup> )	<b>57</b>
University course incomplete	10 (165.60± 171.09 <sup>a</sup> )	5
University	11 (163.63±106.83 <sup>a</sup> )	10
<b>Number of people per household</b>		
1 to 2	40 (198.60±227.61 <sup>a</sup> )	31
3 to 5	166 (184.98±233.54 <sup>a</sup> )	<b>73</b>
More than 5	57 (149.05±181.11 <sup>a</sup> )	15
<b>Monthly income*</b> (monthly minimum wage R\$ 788.00)		
Less than 1 minimum wage	76 (153.63±205.8 <sup>a</sup> )	21
1 to 3 minimum wages	166 (173.20±185.97 <sup>a</sup> )	<b>75</b>
More than 4 minimum wages	21 (322.85±421.05 <sup>a</sup> )	23
<b>Financial dependence on extractivism</b>		
Dependent	28 (115.71±98.69 <sup>a</sup> )	13
Non-dependent	235 (187.09±231.38 <sup>a</sup> )	<b>106</b>
<b>Age range</b>		
18 to 25 years	66 (190.18±197.28 <sup>a</sup> )	30
26 to 35 years	71 (196.05±225.72 <sup>a</sup> )	<b>38</b>
36 to 45 years	58 (189.72±250.07 <sup>a</sup> )	19
46 to 55 years	43 (153.76±210.68 <sup>b</sup> )	16
Over 55 years	25 (124.80±228.86 <sup>b</sup> )	26
<b>Occupation status</b>		
Employed	254 (182.40±225.08 <sup>a</sup> )	<b>116</b>
Retired	9 (97.3368.78 <sup>a</sup> )	3
<b>Civil state</b>		
Single	30 (225.60±264.49 <sup>a</sup> )	19
Married	244 (173.78±218.17 <sup>a</sup> )	<b>95</b>
Divorced	7 (205.71±161.95 <sup>a</sup> )	4
Widowed	2 (36±33.94 <sup>a</sup> )	1

Mean values followed by a letter indicate statistical differences of WTP according to the Kruskal-Wallis test ( $p < 0.05$ ). \*WTP calculated in Real (R\$).

People with higher levels of education are believed to have a better understanding of the negative effects of human interference in the environment, with consequently higher levels of WTP (Morgado *et al.* 2011; Silveira *et al.* 2013). However, we found no significant differences in the levels of WTP of respondents with different levels of education (Tabs. 1, 2). We suggest that understanding the benefits of *Mauritia flexuosa* palm swamps, and the costs of environmental damage to them, among the respondents, along with their current proximity and familiarity with the appraised resource, contributed to the absence of statistical differences in the levels of WTP for the evaluated factors.

A total of 119 (31.15%) people were not willing to pay for the conservation proposal. The majority of these respondents were adults in the age range of 26 to 35 years

(31.93%), with high school education (47.89%), married (78.83%), employed (97.5%), with monthly income less than or equal to twice the minimum monthly wage (R\$ 788.00 at the time of the survey) (80.7%), and with up to five people per household (87.4%) (Tab. 2). The number of respondents and their personal reasons for unwillingness to pay were the following: (45) there already are governmental agencies responsible for environmental conservation; (38) economic valuation is not the best way to promote conservation; raising levels of public awareness is needed instead; (15) lack of the available financial means; (11) members of the buriti extraction chain are those who should pay; (6) it is a public good; (2) the species is still well preserved; (1) they intend to move from the municipality; and (1) those who do damage should pay.



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Several studies have shown that people entrust to the government the obligation to encourage and promote conservation (Mattos *et al.* 2007; Monteiro *et al.* 2012). Governmental responsibility to promote environmental preservation was also the main reason for the unwillingness to pay found in the present study. As suggested by Mattos *et al.* (2007), dissatisfaction with the government may prompt a form of protest through unwillingness to pay. Among our respondents, this form of protest was confirmed by several respondents who reported dissatisfaction with the performance of governmental agencies regarding environmental protection, conservation incentives, and raising of public awareness. This idea corroborates the observation that the distribution of the reasons why people were not willing to pay for preservation did not differ significantly ( $p > 0.05$ ) among socioeconomic factors.

Our respondents also reported that it would be better to raise the awareness of those directly involved in the extraction activity. They expressed the belief that the environmental damage is caused to a certain degree by improperly and/or intensively exploiting *Mauritia flexuosa* palm swamps, mainly by poor people who need the resource for their survival. Baldauf & Santos (2013) reported that market pressure and growing demand for a product, loss of traditional knowledge and the system of land tenure are factors that can influence changes in NTFP management systems. In addition, to being involved in the socioeconomic context of the buriti palm extraction, the inhabitants of Barreirinhas are aware of better ways to improve the

sustainable use of this palm species. However, the market pressure for producing handicrafts likely forces them to engage in inappropriate extraction practices, resulting in habitat damage.

*Respondents' opinions on the conservation of biodiversity*

Respondents' opinions on environmental preservation in Brazil were collected and grouped (Tab. 3). Even though 34.25% of respondents were not willing to pay for the proposal to conserve buriti palms, their opinions on environmental issues were similar to those of respondents who were willing to pay (Tab. 3).

Environmental valuation studies conducted in Brazil have found that people are aware of the need to conserve the environment and that for that purpose they must work together with the government (Monteiro *et al.* 2012), a conclusion that is also true for the residents of Barreirinha. All respondents agreed on the need for environmental preservation. Most of the respondents who were willing to pay (59.32%), and those who were not (66.39%), stated that environmental conservation is not an exclusive responsibility of the government or that of the population, but is a responsibility of both of them. A total of 35.36% of the respondents who were willing to pay and 29.41% of those not willing to pay assumed their own responsibility for environmental conservation, with a minority (WTP = 5.3%,

**Table 3.** Respondents' profile regarding environmental conservation in Brazil, municipality of Barreirinhas, Maranhão state. Data grouped according to the willingness to pay (WTP) for a buriti palm (*Mauritia flexuosa* L.f.) conservation proposal.

Questions	Answers	Total (%)	
		WTP	No-WTP
1. Are you in favor of environmental conservation?	Yes	263 (100%)	119(100%)
2. Who is primarily responsible for the environmental conservation in Brazil?	Government	14 (5.3%)	5 (4.20%)
	People	93 (35.36%)	35 (29.41%)
	Both	156 (59.32%)	79 (66.39%)
3. How do you assess government's performance regarding environmental conservation in Brazil?	Very bad	103 (39.16%)	58 (48.74%)
	Bad	102 (38.78%)	30 (25.21%)
	Normal	49 (18.63%)	31 (26.05%)
	Good	8 (3.04%)	0
	Very good	1 (0.38%)	0
	Don't know	0	0
4. What is the state of environmental conservation in Brazil?	Very bad	65 (24.71%)	32 (26.89%)
	Bad	107 (40.68%)	46 (38.66%)
	Reasonably	22 (8.37%)	37 (31.09%)
	Good	9 (3.42%)	4 (3.36%)
	Very good	1 (0.38%)	0
	Don't know	0	0
5. Are you in favor or against establishing legally protected areas?	In favor	247 (93.92%)	111 (93.28%)
	Against	16 (6.08%)	7 (5.88%)
	Don't know	0	1 (0.84%)
6. What was the difficulty level in understanding the questionnaire?	Easy	254 (96.58%)	118 (99.16%)
	Difficult	7 (2.66%)	0
	Don't know	0	1 (0.84%)



No-WTP = 4.20%) transferring that responsibility entirely to the government. These data suggest that the respondents recognize their importance as agents of environmental conservation.

Dissatisfaction with actions of the government, and the state of environmental conservation in Brazil, was found for both groups. A majority of the respondents (WTP = 93.92%; No-WTP = 93.28%) were in favor of creating permanent preservation areas for the protection of biodiversity in Brazil. Similar perspectives on environmental conservation have been reported for other Brazilian populations, where dissatisfaction with the government's role in environmental preservation, perception of environmental degradation, and support for protected areas were also found (Adams *et al.* 2008; Monteiro *et al.* 2012). This finding may be a reflection of the continuous reporting of pollution and environmental degradation in the media, as well as of the respondents' own environmental circumstances.

Despite the economic crisis facing Brazil at the time of the survey, most of the respondents were willing to pay for conservation of buriti palm swamps with amounts higher than those found in other national and international valuation studies of biological assets (Sattout *et al.* 2007; Adams *et al.* 2008).

The main reasons for unwillingness to pay are related to dissatisfaction with the government and the belief that financial contributions would not solve problems of environmental damage. On the other hand, the majority of respondents were willing to pay for buriti conservation and the mean WTP is considered high when compared to other studies, reflecting the importance of the buriti palm to their lives. Another relevant aspect found was the absence of an influence by the socioeconomic profile of the respondents on WTP. Besides this, the majority of the respondents stated that environmental conservation is not an exclusive obligation of the government or that of the population, but is a collective responsibility.

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