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Potential Policy Options to Improve Sport Fishing in Balbina: A Choice Experiment Analysis

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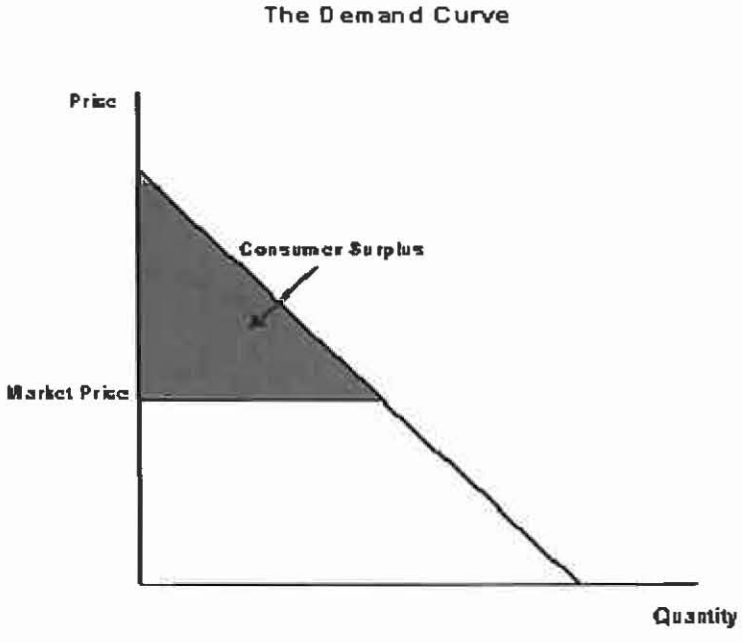
I. On the environment and its valuation

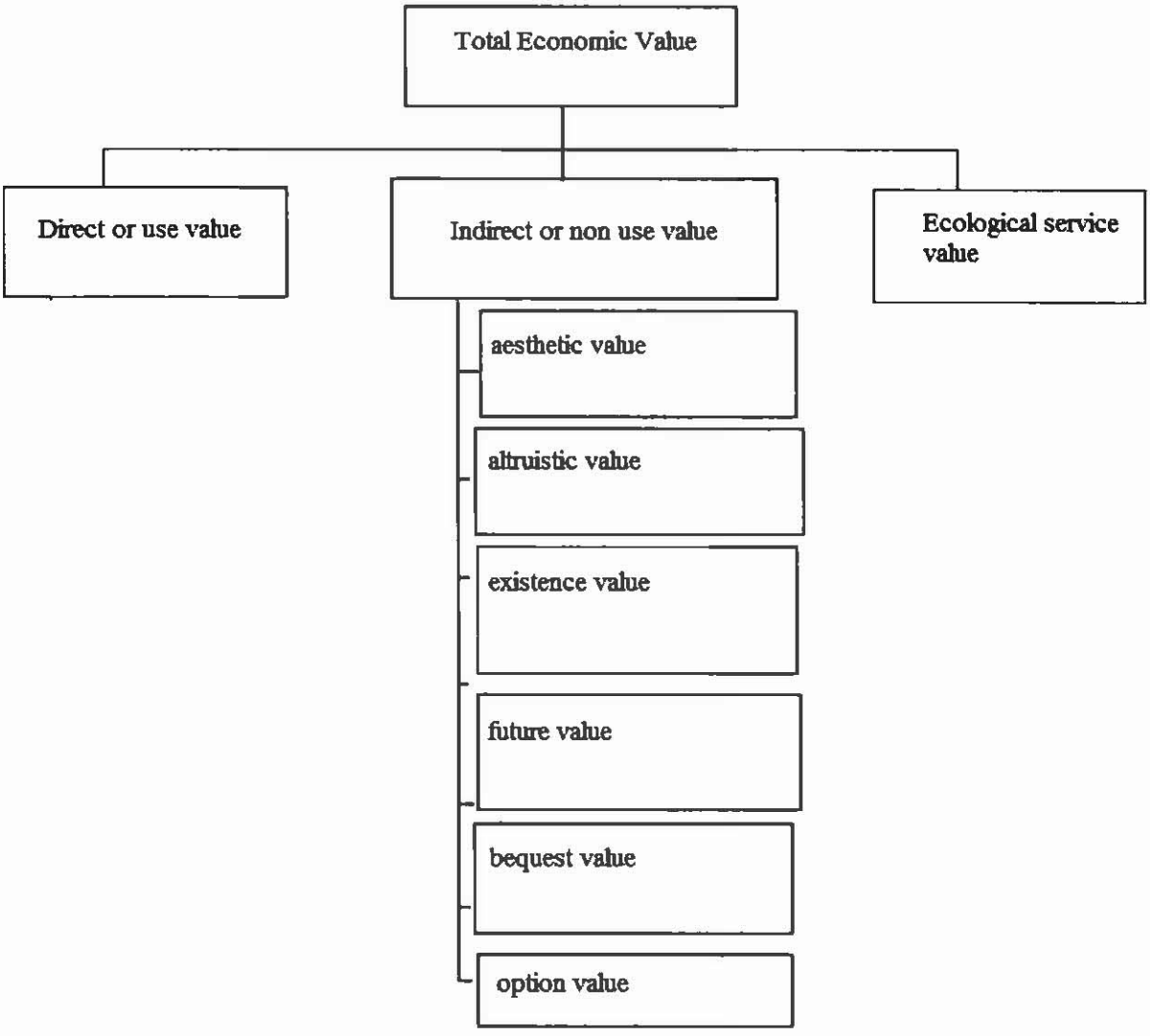
This research is developed within the framework of environmental economics, which attempts to value non market goods that provide individuals with specific values that are not elicited through market transactions. Environmental valuation attempts to find an analog to consumer surplus in standard economic approaches. Therefore, obtained monetary measures are not prices, but rather values. The difference is depicted in the graph below, where the price is the minimum amount that people are willing to pay for a good. However, people will only buy a certain good if their willingness to pay is equal or higher to the market's price and in this case the value exceeds the price. The difference between the price and the willingness to pay is called consumer surplus. Through environmental valuation, we obtain measures of willingness to pay in order to find values, rather than prices for specific environmental attributes.



*http://www.ecosystemvaluation.org/1-01.htm

Values can be of different types as shown through Chart 1 below, which depicts the classification of values according to Kahn (2005). The total economic value of a resource is the sum of use, non use, and ecological service values.

Chart 1. Total Economic Value



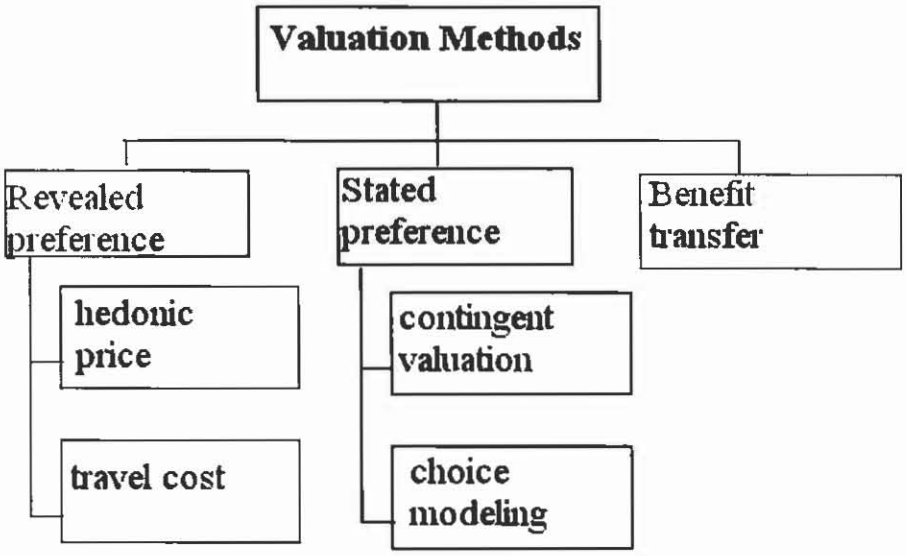
Direct or use values are the benefits individuals obtain from using natural resources. For instance output that can be directly consumed such as timber, wood, medicine, and recreation are

part of this category. Indirect use values refer to the benefits obtained passively when environmental resources are not directly utilized. The values that follow correspond to this category. Aesthetic value is the benefit obtained from the intrinsic beauty, and wilderness of the environment. Altruistic value refers to the utility gained from knowing that other individuals can enjoy natural resources. Existence value is the benefit obtained from knowing that a resource exists and is being conserved. Future value refers to the utility of knowing that one will have the chance of enjoying a natural resource in the future. Bequest value is the benefit individuals get from knowing that environmental resources will be kept for future generations to enjoy. Option value is the benefit obtained from maintaining natural resources for possible uses, some of which might not be known. Finally, the third category of values is ecological service values, which are the most complex and harder to measure, as they refer to the services provided by nature, such as watershed protection, flood control, storm protection, carbon sequestration, and climatic control.

In the case of Balbina, we try to measure the value of recreational fishing, which is a direct use value not captured by actual market transactions that generates utility for sport anglers. As Kahn explains, there are essentially three methods that can be used to measure the value of non market goods in environmental economics. The first is an indirect approach or revealed preference method, which consists on using individual´s behavior in actual or created markets in order to infer the value of an environmental good. One example is the hedonic price method, where one compares goods with different qualities and prices, generating a function that separates the value of each variable, including an environmental quality variable. Another example of an indirect approach is the travel cost method, where non market values are implied from expenditures travelers have when visiting a specific area. The second approach is direct and is called stated preference technique. This involves the use of questionnaires through which

individuals elicit their preferences and their willingness to pay for an environmental improvement or their willingness to accept compensation for an environmental deterioration. Both contingent valuation and choice modeling belong to this approach. Finally, the third method is called benefit transfer approach and as the name indicates, it uses previous environmental valuation studies and adapts them to the specific research in case. Chart 2 below summarizes the above mentioned instruments.

Chart 2. Valuation Methods



It is important to note that stated preference approaches are the ones able to capture total economic value whereas revealed preference methods are usually employed to get at use values only. Within stated preference approaches, we have chosen choice modeling for this study due to its advantages over contingent valuation.

One of the problems with contingent valuation is that respondents might give a WTP measure for a different good than the one they are being asked about. This is called embedding and can be minimized by reminding the respondent what good is being valued and what the

substitution possibilities are. This problem is minimized with choice experiments because in such surveys, individuals are asked to choose a set of attributes rather than a specific monetary value. The choice experiment setup, although cognitively more challenging than contingent valuation, is advantageous for several other reasons. First, it is useful to disaggregate values of environmental resources into attribute values. This is vital for policy making because one can estimate the value of a specific policy. Furthermore, if a certain policy has a marginal effect on a specific attribute of the ecosystem, one can also find its value. Disaggregation is also important for benefit transfer purposes because it makes it easier for researchers to translate results from one study to another that deals with some of the same attributes. In addition, a choice experiment analysis avoids the yea-saying problem of contingent valuation, where respondents say yes to a bid value higher than their willingness to pay to get an environmental vote. Finally, one can get a lot more information through the use of choice modeling because through the individuals' answers one can see which attributes influence choice, the ranking of such attributes, and the marginal WTP value for a change in each attribute level. Since each survey includes various sets of choices, one also gets a lot more observations than with a similar sample size in a contingent valuation study. Due to its advantages, this study is developed using the choice modeling stated preference technique to elicit non market values for sport fishing in Balbina and the trade-offs involved when considering different policy options to improve the reservoir.

I. Background on Balbina

Balbina is an artificial reservoir located on the Uatumã River, approximately 200 km away from Manaus, Brazil. It drains a basin of 19,100 km2 and its lake consists of "about 1500 islands separated by submerged, shallow valleys within a flooded water-surface area of 2400 km2" (Jung and Alsdorf, 2010).

The project was conceived during the oil crisis of the 1970s, when borrowing was inexpensive and finding ways to be less dependent on oil imports was a priority. Controversies over the Balbina dam began long before it started its operations in February 1989. It was clear that the environmental damages would be staggering and that the capacity would not be economically worthwhile due to the flatness of the land. The Balbina construction halted when Electronorte ran short of funds and its construction was only possible after a $500 million World Bank fund.

As expected none of the objectives for the Balbina dam construction were met. The first goal was to provide the growing city of Manaus with a source of electricity power. However, the dam's capacity is extremely low when compared with other similar sized dams in the same region. For instance, the Tucuruí hydroelectric dam has the capacity to produce up to 4,240 MW whereas Balbina can only produce up to 250 MW. According to Fearnside, this is due to the flat topography and the small size of the drainage basin. That is, Balbina was created without adequate geological studies and as a result, it has not been able to satisfy the increasing demand for energy from the capital city of Amazonas.

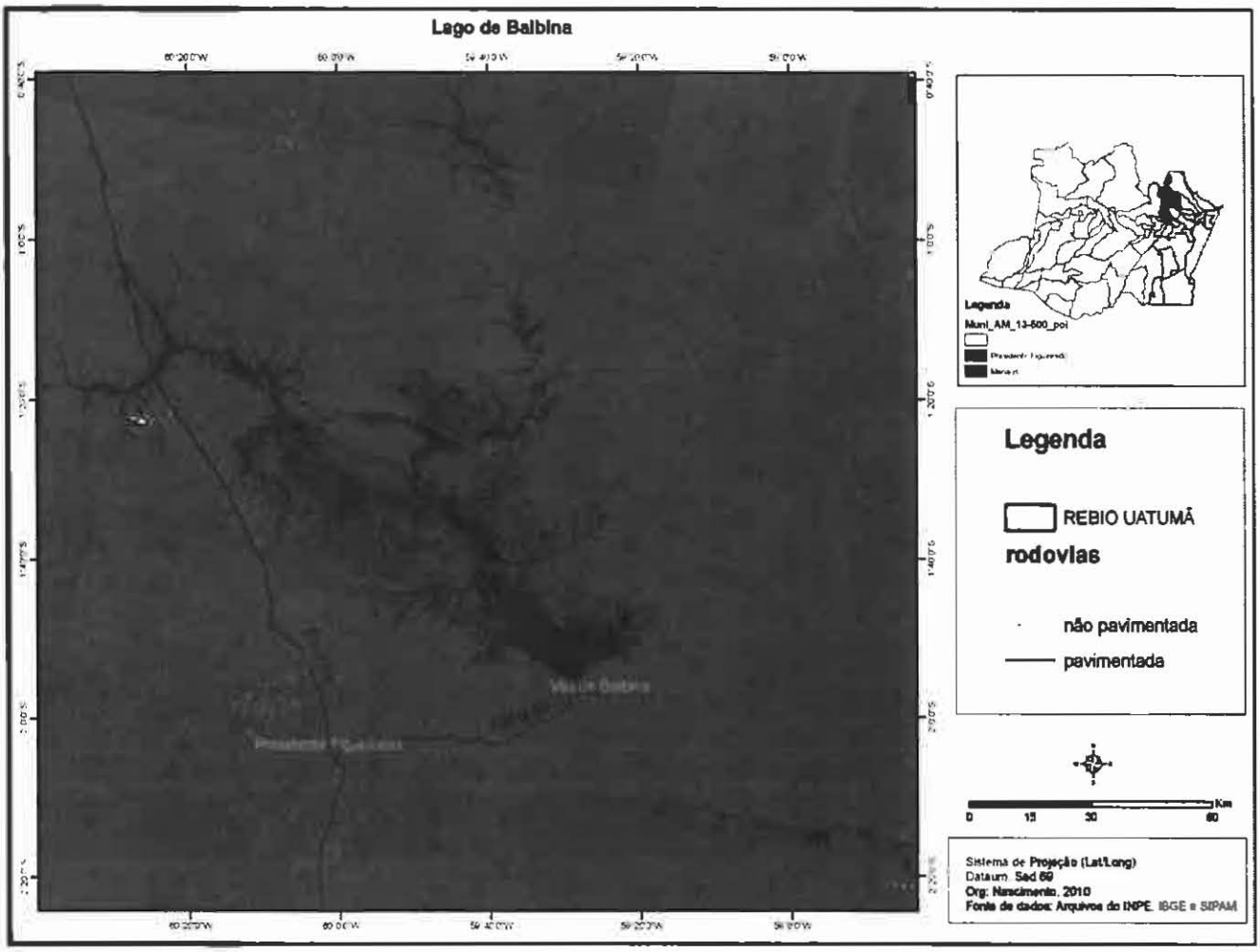
The second goal of the Balbina project was to create energy in an environmentally healthy manner, which was also not accomplished. The 2400 km2 of flooded area were not previously deforested, which has caused the decay and decomposition of large amounts of organic material, resulting in acidic, anoxic water that has been corroding the hydroelectric turbines. Even today, there are very high levels of methane in the water, which has contributed to global warming and has caused health problems for the local population. The Balbina dam's gas emissions are ten times higher than a similar sized coal thermoelectric. Hence, its energy is far from being green. As a result, Balbina is considered one of the biggest environmental catastrophes in the Amazon

region. As Alexandre Kemenes, (researcher at the Amazonian Research National Institute) expresses, "The Balbina dam, in the Amazonas region, is a historical error."

Despite all this, populations of peacock bass (Cichla temensis, Cichla melaniae, among others) have thrived in the lake and have formed the basis of both commercial and sport fishing in the Balbina municipality. As seen in Map 1, the eastern part of the reservoir is maintained as a biodiversity reserve, with all fishing prohibited. Both commercial and sport fishing are permitted in the western half of the lake, which is the study area of this research. Here, heavy harvests have increasingly diminished the population of tucunaré (peackock bass in Portuguese) as well as populations of other bigger fish. This has meant decreasing benefits for the 2,077 local residents (IBGE,2008), whose income depends partly on fish, either as a direct source of revenue from sales or as a national and international attraction for tourists seeking to practice sport fishing. Most importantly, however, adequate policies such as the implementation of an environmental service payment are needed so that a lot more income stays in the municipality. This is vital for Balbina because recreational activities such as sport fishing have an enormous potential to increase revenue so that the municipality invests in infrastructure and improvements of leisure for tourists.

If the right measures are put in place to restore the stock of peacock bass in the lake and increase income for the municipality, Balbina has the potential to recover itself and improve, potentially becoming a world class fishery, attracting even more tourists and new sources of revenue.

Map 1. Balbina



By André Zumak, 2010

This paper analyzes several policy options that could be implemented in Balbina. It does so through the use of a stated preference approach to environmental valuation called choice modeling, which uses conjoint analysis to generate results. As part of the process, questionnaires are designed containing different scenarios on potential policies to be applied in the reservoir as well as future possible states of the lake. Since it is difficult to determine exactly how much the fishery would improve, the questionnaires used are designed to elicit preferences given different levels of fishing success in the future.

Survey respondents are asked to choose between alternative policies and states of the reservoir based on a set of attributes with different levels. This elicits the trade-offs that individuals are willing to make regarding present catch policies and future expected catch. The data is then processed through a logit model that estimates a probability of choice function. This function in turn provides the necessary information to value the different attributes of the fishery in monetary terms. Afterwards, the different policy options are analyzed and the most beneficial ones are chosen for policy implementation purposes. The main objective of the research is therefore to provide the respective government agents in the state of Amazonas with useful information on environmental policies for both sport fishing and the local community's improvement.

II. Literature Review

The term "choice experiment" appears to have been coined by Louviere and Woodworth (1983), but such technique was first used in environmental management frameworks with Adamowicz et al. (1994). In this latter study, the authors employ the choice experiment as well as the travel cost method to evaluate individuals' preferences regarding fishing recreational sites in Alberta, Canada. There are eight attributes that make up the choice sets, out of which some of the most important are water quality, fish size, and terrain. Each attribute has either four or two levels and price is not included as part of the choice experiment. Rather, the travelling distance to the site is used as an approximation to estimate the price variable. Each survey contains sixteen different choice sets for the respondent to answer, where the choices are either the running water site, the standing water site, or none. The study shows that the most valued attributes are fish catch and water quality and that those are the variables that mainly determine the site choice. Consumer surplus per trip is estimated to be from CND $ 4.33 to CND $8.06.

Using a similar methodology, Boxall et. al. attempt to measure the use value of recreational hunting in Alberta. They use choice modeling as well as contingent valuation to examine the tradeoffs that moose hunters are willing to make. By using two different stated preference methods, the authors are able to compare the obtained welfare measures. The choice experiment contains six attributes: distance from home to hunting area, quality of road access, access within hunting area, encounters with other hunters, forestry management operations in the area, and moose population. On the other hand, the contingent valuation question asks respondents how much more they would be willing to incur as travel costs in order to hunt at a more moose populated site. In other words, the study includes a yes or no question to identify the individuals' willingness to pay for increases in moose population.

The choice experiment results show expected signs and significance for all variables except road quality and forestry management operations. The willingness to pay per trip for an increase in moose population was lower in the choice experiment than in the contingent valuation model. The authors believe that the reason for this could be that respondents do not consider substitution possibilities in the contingent valuation model. This is why they suggest that the choice model has an advantage over contingent valuation, as it captures substitution possibilities and incorporates a wide range of environmental attributes.

Environmental economics is an area that began in the 1960s and since then, many other studies have examined the welfare effects of fishing policies in different places, one of which was done by Lin, Adams, and Berrens. Through both a random utility model as well as a Poisson trip frequency model, the authors examine the welfare costs of a set of policies on recreational anglers and Native Americans in the Willamette River spring Chinook fishery in Oregon. The choice experiment is used to estimate the welfare change caused by quality changes at each

fishing site on a per trip basis. The Poisson trip frequency model is then employed to estimate the aggregate welfare changes during a specific season. Data is obtained from a survey of recreational salmon anglers financially supported by the Oregon Department of Fish and Wildlife.

As expected, results show that travel cost is inversely related to probability of site choice. However, they also find that congestion is positively related to site choice and the reason is that this urban fishery is also known for its unique atmosphere, where tourists enjoy socializing with each other. Regarding policy options, the first was to grant Native American tribes the right to catch 5,000 spring Chinook from March 31 to mid June and the second was to leave the upper river reach exclusively for the tribes. After developing and running the aforementioned models, the authors conclude that allocating a substantial number of fish to tribal fishery does not impose high welfare losses to recreational fishermen, as long as all fishing sites remain accessible to anglers.

Ditton and Oh also use a discrete choice conjoint model to examine anglers' preferences and trade-offs for different fishing policies in Texas Red Drum Fishery. The factorial design used in the study consists of 7 attributes combining both policy proposals and expectation variables. By including both of these types of attributes, the authors are able to determine whether anglers consider sustainability an important aspect for the fishery. Since fishermen are more likely to choose more restrictive scenarios, the researchers conclude that anglers are concerned about the future state of the lake and its sustainability. Their results also suggest that the two most valued attributes in terms of willingness to pay are average future catch from the expectations variable and bag limit from the regulations variables. Following what is done in this

study, the Balbina research also includes scenarios with both potential policies and future state of the lake variables in order to examine the way individuals react to inter-temporal trade-offs.

Although the previously mentioned studies are done in the United States, there is a vast number of research being done in less developed parts of the world, such as the Philippines. In the article called "Understanding Factors Considered by Fishermen in Marine Protected Area Planning and Management: Case Study of Claveria, Philippines," the authors develop choice experiments to identify the most important elements of management in Claveria. The attributes included are the size of the protected area, the expected increment in fish catch, and the patrol days per year. After developing a multivariate logit model, the authors conclude that respondents are not willing to trade off an uncertain increase in catch for a definite increase in size of the protected area. The most important element is the marine protected area, which the authors suggest should be extended, but with careful policies to compensate artisanal fishermen who would be banned from the area.

A more local and also very relevant study done in the area of environmental valuation is the working draft "Payments for Ecological Services and Sustainable Development in Barcelos, Amazonas, BR" already presented in the North American Regional Science Council in 2010 by Rivas et al. In this paper, the authors present the case study of sustainability in Barcelos, Amazonas, Brazil, which is a city with world-wide recognized sport fishery opportunities as well as one of the main ornamental fish exporters in Brazil. As the study mentions, the local community of Barcelos has not benefitted from its exuberant natural resources. The income coming into this municipality rarely benefits its own population, as most of the money goes to foreign owned fishing enterprises. Therefore, in 2010, the authors of this study implemented an environmental service

payment in this municipality in order to charge sport fishermen for each day of catch. The money is turned over to a local NGO and is used for infrastructure, human capital and social capital improvements.

The Barcelos study's goal is to "improve the quality of life of the citizens of the area in a way that eliminates future potential threats to the ecological integrity of the complex aquatic/terrestrial ecosystem" (pg. 4). Similarly, the study done in Balbina seeks to find effective policies that will improve the life of the Balbina citizens by increasing the income obtained from sport fishing activities. Since one of the choice experiment's attributes in the Balbina research is an environmental service payment, it is vital to revise this study by Rivas, where such a payment structure is already being discussed and applied.

In Barcelos, this payment attempts to capture some of the benefits produced by positive externalities generated by the environmental resources of the municipality. It is applied on sport fishermen because this is a segment of the population that Rivas and Freitas (2010) identify as having high consumer surplus and high willingness to pay if the money is invested in environmental and human capital improvement. It is important to note that the implementation of an environmental service payment in Barcelos was a process that had to be approved by local associations, cooperatives and government agents. The law, establishing that each sport angler would have to pay BR$38.30 for each fishing day was passed on September 1rst, 2010. The reference for the value of the payment is a tax collected in Fernando de Noronha's national park in Northeast Brazil. By November, 2010, 684 anglers made the payment, but there were mixed reactions from sport fishing agencies. Some support this new policy emphasizing its local contributions to Barcelos while others criticize its high cost to anglers. However, since this is

such a recent project, not enough feedback has been collected to properly judge its effectiveness and its impact on the Barcelos municipality.

III. Methodology

To collect the primary data used in the econometric model, we use a collection of 120 surveys that were applied in two different locations: the first were fishing stores in Manaus and the second was Balbina. The importance of applying questionnaires outside the main location of study is to gather data not only on tourists who go to Balbina because they perceive it as being worthwhile, but also to get insights on why some fishermen in the city of Manaus do not go to Balbina and prefer other fishing locations. Since each of these groups is likely to have different willingness to pay values for fishing improvement, it is important that we include both in our sample. Inside Balbina, surveys were applied in the various hostels and hotels of the village as well as in the main restaurant on the artificial lake. We applied the survey during a period of three months, from October to December.

Before the final version of the survey was applied, we developed a pilot questionnaire and applied it on 10 people. This served as a way of testing the clarity of the questions, the length, and the overall efficiency of the survey. After this, the appropriate changes were made until the last version was created. This version is composed of three parts: a section on people's socioeconomic characteristics, a second on individuals' perception of Balbina,, and the third one with six different choice experiments. The survey included mostly close ended questions, with only one open question regarding the mean daily catch of fish per angler. Due to the small flow of tourists coming to Balbina, we did not stratify our sample, but rather applied the survey to every tourist that agreed to respond.[1]

[1] An institutional review was obtained for the survey research

The choice experiment was at the end of the survey and consisted of a set of six choice sets where individuals had to make a choice between scenarios or status quo options. Table 1 below shows the attributes and levels used to generate the randomized choice sets.

Table 1. Attribute/Level table

Attributes	**Limit to catch**	**Commercial fishing**	**Environmental service payment per fishing day**	**Number of fish caught after lake improvement**	**Number of fish caught > 4kg after lake improvement**
Levels	- 4 kg -7kg -10kg	-Permitted -Prohibited with compensation -Prohibited without compensation	-0 reais -15 reais -30 reais	-less than 20 -from 20 to 40 -more than 40	-less than 4 -from 4 to 6 -more than 6

Since the number of combinations one can get with five attributes with three levels each is very large, we used SPSS software to create the experimental design to be used in the surveys. This software created 16 different choice scenarios, out of which we eliminated one because the level combination did not make sense. The excluded scenario contained the least stringent policies and the most favorable expected catch levels and therefore it was discarded for making no sense. At the end we used excel to randomly select combinations of scenarios to create the choice sets to

be included in the survey. Each choice set consisted of two scenarios chosen at random as well as the status quo option. This option was always included so that individuals would not be forced to make a choice, which would have caused bias in their responses. Screening was done so that each choice set would include scenarios that involved trade-offs and not scenarios that were obviously better in all attributes. Including such a flawed choice set would have been useless because trade-offs cannot be revealed when there is no choice to make. Six choice sets made part of each survey and a total of eight different questionnaire versions were made.

As can be seen in table 1 above, each scenario was the result of a combination of policies as well as future states of the lake so that individuals would have to consider the trade-off between more stringent policies in the present and increase in fish stock in the future. The first potential policy refers to the catch limit measured in kilograms, which is the amount of fish each tourist is allowed to take home. The current federal law allows each individual to take a maximum of 10 kg plus one specimen. We then include lower levels of 7 and 4 kg that make up the choice sets. The second attribute above is a policy regarding commercial fishing, which could continue to be allowed, could be prohibited without compensation, or could be banned with compensation towards the affected fishermen. Commercial fishing is normally banned for half the year, a period called "defeso," during which fishermen are compensated monetarily for lost income. However, since peacock bass is considered a nonmigratory species, it is not part of the defeso and therefore, commercial fishermen in Balbina are allowed to catch tucunaré during the entire year. This means that there is not a period of time during which the populations of peacock bass can be left alone for their reproductive period. Thus, commercial fishing has been a cause of fishing quality deterioration and we therefore include more stringent policy scenarios as part of the variables to be considered by respondents.

The implementation of such policies would result in more and bigger tucunaré in the reservoir within a few years. In other words, allowing less fish to be caught today will result in more fish being caught in the future. Therefore, the other two variables are concerned about the future expected catch. The first one includes a measure of the number of fish one would be able to catch on average if the lake improved. This variable has three levels: less than 20, between 20 and 40, and more than 40 fish. The second variable is a measure of expected size so it is the amount of peacock bass bigger than 4kg that one would be able to catch on average. The levels are: less than 4, from 4 to 6, and more than 6. It is vital that we include this latter set of expectation variables because this research aims at understanding how sport fishermen feel about the temporal trade-off between more restrictive policies today for better catch in the future.

IV. Theory and model

In this section we explore in further detail the theory and importance behind choice modeling. This valuation method is a type of conjoint analysis technique that is considered to have a comparatively stronger position in environmental applications than in other fields (Alriksson and Oberg, 2008). It consists on generating questionnaires that include a variety of choice sets with scenarios for the respondent to choose from. Each scenario contains a number of attributes with varying levels that characterize the artificial lake of Balbina. The respondent makes several choices throughout the questionnaire and therefore expresses his preferences regarding environmental quality and potential policies. The advantage of using this method for non market valuation is that individuals are familiar with such format as they routinely make choices among goods with multiple attributes. Thus, choice modeling was also chosen due to its friendly format, where the respondent is faced with a choice like any other he makes on a daily basis. This minimizes format bias and makes the task less burdensome than when one uses

contingent valuation methods, where the individual is explicitly asked to give a willingness to pay value.

Choice modeling is also advantageous for "multidimensional changes where varying the level of the attributes of each of the alternatives allows measurement of the individual's willingness to substitute one attribute for another" (Alberini and Kahn, 2009). That is, we will be able to analyze people's willingness to accept more stringent fishing policies in the present for higher stock of fish in the future.

The analysis of the respondents' choices is based on random utility theory. This approach, developed by Mc Fadden (1974), states that utility arises from consumption of goods and services that can be decomposed into attributes. Random utility models (RUMs) allow the research to estimate preferences based on individuals' choices. In such framework, the respondent's utility is modeled as equation 1 below:

Equation 1.

$$U_{ij} = V_{ij} + e_{ij}$$

Where utility U_{ij} of choice j for individual i has a deterministic or observable component V_{ij} and an unobservable or error term e_{ij}. When this latter unobservable part can be assumed to be random, then RUMs are theoretically applicable. If the respondent chooses scenario j, then it is implied that the utility of scenario j is higher than that of all other scenarios. If J represents all other scenarios, then the probability of individual i choosing scenario j is as follows:

Equation 2.

$$\Pr(j) = \Pr(V_j + e_j > V_k + e_k) \text{ for all other k in choice set J}$$

In this research we specify the deterministic component of utility V_j as:

Equation 3.

$$V_j = \beta_0 + \beta_1 four + \beta_2 seven + \beta_3 prohibited + \beta_4 with + \beta_5 20to40 + \beta_9 morethan40 + \beta_{10} 4to6 + \beta_{11} morethan6 + \beta_{12} price1 + \beta_{13} price2 + \beta_{14} price3 + \beta_{15} price4 + \beta_{16} price5$$

where the dependent variable takes the value of 1 for the chosen alternative and 0 for those not chosen by the respondent as it is a probability function. On the right hand side there are the independent categorical variables, which stand for different levels of attributes. "Four" and "seven" each take the value of 1 if the catch limit is reduced to 4 and 7 kg respectively. "Prohibited" and "with" take a 1 value if commercial fishing is prohibited without and with compensation respectively. "20to40" and "morethan40" take 1 values when expected catch is from 20 to 40 fish and more than 40 fish. "4to6" and "morethan6" take values of 1 when expected catch of peacock bass bigger than 4kg is from 4 to 6 and more than 6. The regression further includes interaction variables where price is interacted with each origin category, which classifies tourists according to their city of origin. For each attribute, 2 of the 3 levels were included so that there would be a base with which we could compare the estimated coefficients. The least desirable levels of the attributes were the excluded categorical variables and used as the reference levels, which means that signs are expected to be positive in all cases except for the kg limit, which excludes the most favorable option. Hence, we expect individuals to be more likely to choose scenarios with more favorable attributes. Regarding the interaction variables, we

expect them to have a negative sign, meaning that regardless of where the tourists come from, they would be less likely to choose a scenario when the price increases.

Assuming that the error terms are independently and identically distributed (IID) and that they follow an extreme-value distribution allows us to estimate utility functions with the multinomial logit (MNL) model ([McFadden, 1974] and [Shrestha and Alavalapati, 2004]). The MNL formula is as follows:

Equation 4.

$$\Pr(j) = \frac{\exp(\mu Vj)}{\sum_{k} \exp(\mu Vk)}$$

Where μ is a scale parameter often normalized to one.

Up to this point we have a probability function, which means that the obtained coefficients give us a measure of likeliness rather than value. In order to come up with a value we need to normalize the coefficients in the regression and to do so, we divide the attribute coefficient by the cost coefficient to get rid of the probability. This is depicted in Equation 5 below.

Equation 5.

$$W = -1\left(\frac{\beta_a}{\beta_c}\right)$$

Where β_a is the coefficient of any independent variable and β_c is the coefficient of the monetary variable used in the model. This eliminates the probability and gives us a value that corresponds to the Hecksian compensated variation (Kahn, 2006, pg.157). This value is also called a part worth utility or willingness to pay value. It represents the marginal rate of substitution between

an income change and a specific attribute change. Therefore it is the amount that individuals are willing to pay for a marginal change in a specific environmental attribute.

V. Results and Analysis

To analyze the data we run equation 6 above and show the results on table 2 below.

Table 2. Model results

variable	coefficient	part worths	standard error	p-value
four	-0,2675284	-25,1473289	0,16280551*	0,1003
seven	-0,1477268	-13,886129	0,18024676	0,4125
Prohibited	0,59580962	56,00535605	0,14973499***	0,0001
With	0,67730888	63,66618414	0,15163507***	0
20to40	0,34945946	32,84875038	0,1638088**	0,0329
morethan40	0,18612857	17,49585184	0,14221863	0,1906
4to6	0,35741092	33,59617764	0,16732858**	0,0327
morethan6	0,32766284	30,79989547	0,12758026***	0,0102
price1	0,00377673		0,00829232	0,6488
price2	-0,0106384		0,00627372*	0,0899
price3	-2,127E-06		0,02933957	0,9999
price4	0,01377997		0,0105263	0,1905
price5	0,02146448		0,01902364	0,2592

Attribute signs are as expected, meaning that individuals are more likely to choose scenarios where more favorable attribute levels are present. For instance, scenarios more likely to be chosen are those in which the kg catch limit of fish is higher, commercial catch is not allowed, and expected catch is higher. As expected, the significant price variable has a negative sign, which means that the higher the environmental payment, the less likely an individual is to choose a scenario.

Not every variable is significant. The attribute representing seven kg of catch limit is not significant, but the one for four kg is and it is negative. That means that there is no statistical significance between the probability of anglers choosing a scenario when the catch limit goes from 10 to 7 kg, but there is a statistically significant difference in the probability of anglers choosing a scenario when it goes from 4 to 10. In other words, individuals are sensitive to a big, but not a small chance in kg limit. A change in policy that restricts the limit to 7 kg would lie just below the sample average catch which is of 8,3 kg. Thus anglers are willing to lower their daily average catch by 16%. This is a very important result for policy purposes as I discuss later on.

Both variables regarding commercial fishing are statistically significant at a 99% confidence level. These were the most statistical significant variables and they elicit that people are more likely to choose scenarios in which commercial fishing is prohibited, either with or without compensation. The variable "20to40" was significant, but the one called "morethan40" was not, which reveals that fishermen are more likely to choose a scenario where expected fish catch goes from less than 20 to 20-40, but are not more likely to choose a scenario where the expected catch goes from less than 20 to more than 40. That is, higher expected catch is a valuable attribute until a certain point because anglers do not look for that much catch. However the significance of the variables measuring expected catch in size are both significant, meaning that anglers do consider size as a significant variable. They are more likely to choose scenarios where expected catch of fish bigger than 4kg goes from less than 4 to 4-6 and when it goes from less than 4 to more than 6 fish. In other words, fish size is significant in all levels whereas fish number is significant only at one of the levels.

Table 2 also shows part worth utilities in the second column. This was calculated with the coefficient of the interaction variable called price2, which represents price interacted with the

second category describing a tourist origin. This category corresponds to tourists living in Manaus. We use this monetary variable because it was the only significant one. It is also perhaps the most important one because it represents 52% of the total tourist surveyed population. Other groups such as tourists from Balbina, other Amazonian cities, other Brazilian states, and other countries represent 25, 2, 16, and 5 percent respectively. We hypothesize that a lot of the tourists corresponding to the non significant categories have a different behavior from those coming from Manaus. Most tourists from other cities and countries have other ties to the state of Amazonas such as jobs and training in the free trade zone of Manaus. They choose Balbina as a secondary destination point, whereas tourists from Manaus have Balbina as their main weekend destination. This difference in behavior makes tourists from Manaus more likely to be sensitive to price changes. We would have liked to include price by itself as an independent variable, but it was not significant because there were demand shifters such as socioeconomic and income factors that hid the effect of price changes.

Therefore, the part worth utilities are those corresponding to the biggest segment of the sample, which are tourists coming from Manaus. The table shows that the most valuable attribute (variable "with") is the policy corresponding to prohibiting commercial fishing with compensation to those fishermen. Anglers are willing to pay 56 brazilian reais per angler per day to change the situation and prohibit commercial fishing, without compensation. They are willing to pay more, 64 brazilian reais to prohibit commercial fishing with compensation for those affected by this policy. This is not surprising since the study focused on sport fishermen, which means that they are inclined for policies that affect commercial fishermen only. Although there is a higher part worth utility for the variable that compensates commercial fishermen, one has to analyze whether the two variables for prohibiting commercial fishing are statistically different

from each other. Only with those results is one able to conclude whether or not sport fishermen are showing preferences for social justice. If the two variables for prohibiting commercial fishing, with and without compensation, are statistically different from each other, that would show that sport fishermen consider social justice as an important decision making factor. In order to test this, we run another regression, with the same variables, except that we exclude the variable that accounts for prohibition with compensation. This way we can test for statistical difference between the prohibition variables by looking at the standard errors.

As we can see in Table 3 below, there is no statistical significance for the variable "prohibited", which shows that prohibition with and without compensation are not statistically different from each other.

Table 3. Testing for statistical difference

variable	Coefficient	standard error	p-value
permitted	-0,6773089	0,15163507***	0
prohibited	-0,0814993	0,15463103	0,5982

In other words, there is no statistical significance between the probability of anglers choosing a scenario when commercial fishing is prohibited without compensation and when it is banned with compensation. Statistical significance is only found between the probability of individuals choosing a scenario where commercial fishing is prohibited and allowed. Thus, there is no evidence to suggest that sport fishermen care about social justice when engaging in recreational activities in Balbina.

Going back to the analysis of table 2, it is also significant to note that the lack of significance in the seven kg variable indicates that anglers are willing to catch less and that does not affect

their probability of choice. However, although anglers are willing to restrict their catch limit to 7 kg, they would need a compensation of 25 brazilian reais per person per day to lower their catch limit from 10 to 4 kilograms.

The part worth utilities also indicate the willingness to pay of individuals for a change in expected catch. We see that the highest WTP value is for an increase in expected catch of fish bigger than 4kg of less than 4 fish to 4-6 fish. The value is BR$ 34 per person per fishing day. A very similar payment of BR$ 33 is the value anglers are willing to pay for an increase in the number rather than the size of expected catch. The third most valuable expected catch variable is the increase in big fish caught from less than 4 to more than 6. The lowest WTP variable is for an increase in the number of fish from less than 20 to more than 40, which is also not statistically significant. These results reveal that anglers in Balbina want to find more fish in the water, but most importantly, they want bigger fish in the lake.

VI. Conclusions on a sustainability plan for Balbina

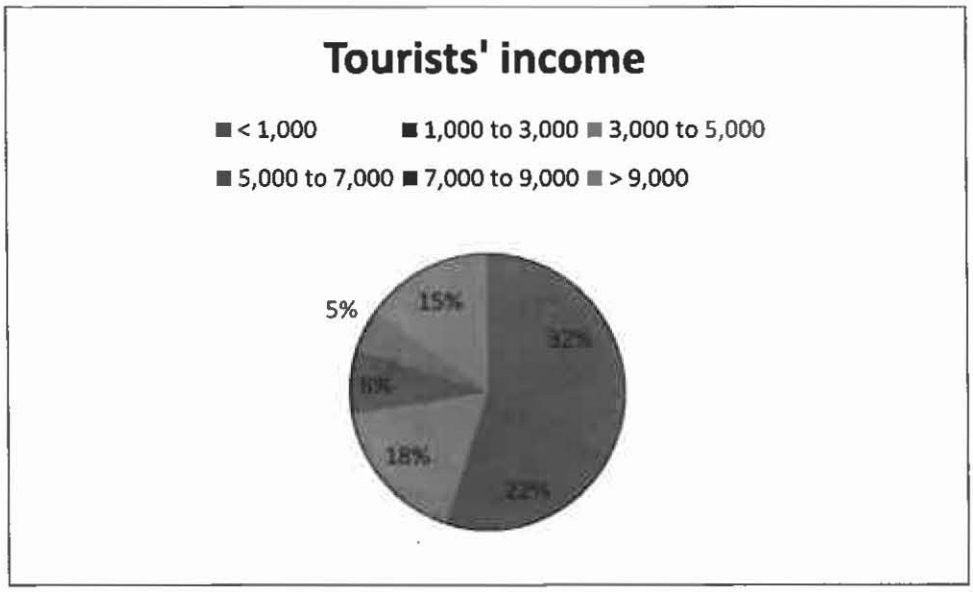
Several policies can be implemented in Balbina for a comprehensive approach to a more sustainable catch of tucunaré. As results show, Balbina could establish a lower catch limit of 7kg per person per day without hurting anglers. This will ameliorate the pressure on catch already existent in the lake. However, a lower catch limit needs to be accompanied by adequate monitoring because otherwise it will have no effect on fish stock.

The policy that generates the highest marginal utility is the prohibition of commercial fishing with compensation for undergone revenue. This is a policy that has to be carefully managed because commercial fishing is not only an economic, but also a cultural activity in Balbina. Fishermen are already restricted to fish during 6 months of the year, but this "defeso"

policy does not apply for peacock bass because it is not considered a migratory species. By including tucunaré as part of the species in "defeso" due to its decreasing population size, we would be limiting its catch while working within a system that commercial fishermen are already used to. This prohibition could also be limited to last for a specific number of years, depending on the rate of recovery of peacock bass populations.

In order to compensate fishermen for the opportunity cost of not fishing, Balbina could find self sustaining ways of getting revenue. One way is through the implementation of an environmental service payment. This system is already in place in other places of the Amazon state. Barcelos is the closest and most similar example, where sport fishermen have to individually pay BR$ 38 for each day of catch. As a way to monitor anglers, the local government issues a bracelet that shows one has made such payment. The money obtained from the environmental service payment is kept for local reinvestment in sustainability, infrastructure, social and human capital development. A similar system could be implemented in Balbina so that more of the benefits from sport fishing activities are internalized.

However, tourists who practice sport fishing in Balbina come from lower socioeconomic status and from closer geographical areas than those who fish in Barcelos. As seen in graph 1 below, 55% of the sampled tourists earn less than BR$ 3,000 per month, out of which 32% earn less than BR$1,000 per month.



This means that the environmental service payment would have to be lower than that applied in Barcelos. Results from the choice experiment show that anglers coming from Manaus, which are the biggest segment of tourists, are willing to pay an average of BR$ 32 per day for an increase in expected catch (both number and size). This is less the price charged in Barcelos, which is consistent with the type of tourists in each municipality. An amount like this could be set as the environmental service payment in Balbina so that tourists do not leave without contributing to the local population in the form of a payment that will allow the town to develop and improve the stock of fish and the facilities for anglers.

A system like this is significant in various ways. Rivas et al says, an ESP is "a social justice issue, allowing the local inhabitants to receive a share of the benefits of the environmental resources of which they are the guardians." Most importantly, an ESP provides with funds that, when used effectively, can increase the environmental as well as the human capital in Balbina. Money can be used to help finance commercial fishermen compensation so that these funds do

not need to come from the state or the federal government. The funds could also be used to improve monitoring and enforcement which is currently almost non-existent. Adequate salaries for officials and infrastructure for monitoring purposes should be a priority. Money should also be invested in human capital in the form of education and training programs which are also very precarious in this municipality. Better tourist facilities and signs on roads are part of infrastructure priorities that can also be funded through the money coming from the ESP.

For the system of environmental service payment to work well, it is necessary that those people involved in managing it are community members that form a type of cooperative to manage the system. This is important because people in charge of managing funds have to be people who know the daily life of the local population and are aware of what is lacking in Balbina. However, they should be selected based on their skills because such a cooperative will have to deal with technological and judicial issues for the practical implementation of the system.

VII. Limitations of the study

We recognize that there are several limitations to this study. First of all, there are concerns regarding the use of a choice experiment. Although the most widely used studies suggest that choice modeling is one of the most useful tools to find values of non market goods such as fishing recreation activities, there are several limitations to using such method. First, as noted by Lindberg, Dellaert, and Rassing (1999) there are potential hypothetical, information, strategic, and non response biases. Hypothetical bias occurs when respondents have to imagine hypothetical scenarios and they elicit values that are an overstatement when compared with what they would actually do. Information bias is when individuals are given detailed information

about the environmental good and can have unintended distortions as they might persuasively change the respondents' attitudes. Strategic bias is when individuals faced with a complex task such as a choice experiment design a strategy to respond the questionnaire and therefore bias their responses. Finally, non response bias happens when there is a lot of people who decide not to respond and these people have relevant characteristics that are different from those who decide to participate. Even though these biases could be minimized through adequate survey design and careful implementation, it is important to keep them in mind to make sure that results are interpreted with care.

There is also a question of whether the fishing lake in Balbina can be described in terms of its individual attributes. The value of the lake in its entirety might be bigger than the sum of the attribute values, which reveals the complexities of complex ecosystem valuation. Further, the study was done mostly on the weekends which means that if those tourists have special features different from tourists coming during the week, there is potential for selection bias.

The study also failed to gather enough data on fishermen in Manaus who had been or knew about Balbina, but decided to fish someplace else. This was due to the impracticality of applying surveys in fishing stores in Manaus as it was hard to get people to answer while they were doing business. Not enough responses from fishermen in Manaus mean that our results are likely to be an underestimation of willingness to pay measures because the people in the city who choose not to go are probably willing to pay more than those who go to Balbina. This is because those who choose not to go have higher expectations and are not satisfy with the quality of Balbina. Those who go fishing are less dissatisfied and would therefore be less likely to pay high amounts for an improvement. In other words, the marginal benefit of an improvement in Balbina is higher for those who choose not to go and thus, they are likely to be willing to pay more for improvements

in the lake conditions. By showing results that appear to be an underestimation of the anglers'willingness to pay it would be easier to convince authorities to implement an environmental service payment in Balbina with the presented values. Hence, this is not necessarily a problem.

Due to budget and time constraints, it was only possible to survey sport fishermen so results are for this segment only, but it would be interesting to see the responses from commercial fishermen's perspective. We also believe that the insignificance of the majority of the price variables can be partly due to a small sample size. Hence, increasing the number of observations would have also led to more significant price variables. In addition, our survey took place at the end of the year, which is the time when the Uatumã River has low water level. Further research should attempt to expand this study so that data is gathered all year round. Other attributes such as slot limit and catch and release policies can also be explored in future studies. That is, this study is only the start of choice modeling applications in Balbina.

VIII. Annexes

Annex 1. What follows is the English version of the survey applied to sport fishermen in Balbina

Sport Fishing in Balbina

As part of the PIATAM Institute, the Federal University of Amazonas, and Washington and Lee University we are developing this study to determine sport fishermen attitudes regarding fishing in Balbina. We will use the information in this questionnaire to think about potential public policies that could improve sport fishing opportunities in the region.

Your participation is absolutely voluntary and your answers will be kept confidential and anonymous. If you would like to receive a copy of the concluded study, please do not hesitate to send an e-mail to james.kahn@piatam.org.br . Thank you for your time and collaboration.

Part I. Socio economic characteristics

1. Age: _____ Gender: ( ) Masculine ( ) Feminine Marital status: ( ) single
   () married
   ( ) other

2. Regarding your academic level, you:

   ( ) started, but did not complete middle school
   ( ) completed middle school
   ( ) started, but did not complete high school
   ( ) completed high school
   ( ) started, but did not complete university
   ( ) completed university
   ( ) have a post graduate degree (specialization, masters, doctorate)

3. Your individual monthly income is:

   ( ) less than US$600
   ( ) between US$ 601 and US$1800
   ( ) between US$ 1801 and US$3000
   ( ) between R$ 3001 and US$ 4000
   ( ) between US$ 4001 and US$ 5000
   ( ) more than US$ 5000

4. Do you come from:

   ( ) Balbina or Presidente Figueiredo
   ( ) Manaus
   ( ) another city in Amazonas
   ( ) another Brazilian state

( ) another country

Part II. Perception and use of the reservoir

5. How would you assess the water quality in Balbina?

( ) very good
( ) good
( ) acceptable
( ) bad
( ) very bad
( ) I don't know

6. How would you assess the fishing quality in Balbina?

( ) very good
( ) good
( ) acceptable
( ) bad
( ) very bad
( ) I don't know

7. In your opinion, what should be the main priority for the respective authorities in Balbina?

( ) water quality improvement in the reservoir
( ) sanitary improvement of the place
( ) infrastructure improvement of Balbina
( ) policies to develop sustainable fishing of peacock bass
( ) I don't know
( ) other _____

8. Do you fish in the Balbina reservoir? (If you answered "no" to this question, go directly to Part III, if you answered "yes" you can continue as normal)

( ) yes
( ) no

9. Where do you fish in the Balbina reservoir?

( ) close to the hydroelectric dam
( ) in the superior part of the lake
( ) in both locations

10. Why do you not fish close to the hydroelectric dam? (You can skip this question if you do fish close to the dam)

( ) there is not a lot of peacock bass
( ) the peacock bass is too small
( ) I don't own a boat and the renting a boat or a hotel is too expensive
( ) it is hard to get there
( ) it is too hot and there are no shadows
( ) the quality of the environment and the water is bad

11. Why do you not fish in the superior part of the lake? (You can skip this question if you do fish in the superior part of the lake)

( ) there is not a lot of peacock bass
( ) the peacock bass is too small
( ) I don't own a boat and the renting a boat or a hotel is too expensive
( ) it is hard to get there
( ) it is too hot and there are no shadows
( ) the quality of the environment and the water is bad

12. In the last year, with what frequency did you visit the Balbina reservoir?

( ) never
( ) 1 time
( ) between 2 and 4 times
( ) between 5 and 10 times
( ) more than 10 times

13. On average, what is your total daily catch of peacock bass in Balbina?

_____

14. On average what is your total daily catch in Balbina, considering only peacock bass > 4kg?

( ) I have never caught fish that big
( ) 1
( ) between 2 and 3 fish
( ) more than 3 fish

15. When you fish in Balbina, you:

( ) keep all the peacock bass that you catch
( ) keep some of the peacock bass and release the rest, without any size or weight considerations
( ) release all of the peacock bass smaller than 12 inches
( ) release all the peacock bass you catch

( ) don't fish for peacock bass

Part III. Choice experiment

High levels of both sport and commercial fishing in Balbina have diminished the population of peacock bass as well as the abundance of bigger fish in the lake. There are, however, various potential policies to improve this situation, which could turn Balbina into a world class fishery.

Below you will find several hypothetical scenarios with different attributes, which are explained one by one below:

1. The first attribute of each scenario refers to a potential policy for sport fishing. It consists on the kilogram limit to the amount of peacock bass that can be caught per person per fishing day. The current federal limit is 10 kilograms plus one specimen.

2. The second attribute refers to commercial fishing, which could be banned. This could be done with or without compensation to commercial fishermen. Both are options you will find in the following choices.

3. The third attribute is a daily payment called "environmental service payment", which would be payed by sport fishermen and will be used to improve the reservoir as well as to keep fishing sustainable in Balbina.

The implementation of all or some of these policies will result, in a few years, in an increase in the number and size of peacock bass in the Balbina reservoir. This is because sacrificing current levels of catch will allow the fish population to recover, which translates into more and bigger fish in the future.

4. Therefore, the fourth attribute refers to the expected average daily catch of peacock bass after the implementation of the policies in Balbina.

5. Finally, the fifth attribute refers to the expected average daily catch of peacock bass bigger than 4kg after the implementation of the previous mentioned policies. It is important to mention that there will continue to be a catch limit for the angler so these two attributes are independent from each other.

Through this questionnaire and the choice experiments that follow we are trying to understand sport fishermen attitudes with respect to the temporal trade-offs mentioned above. Thus, we will appreciate if you could mark with an x the most favorable scenario in each set of choices below.

I prefer... (choose one)	15	6	
	☐	☐	☐ Neither scenario
Limit to catch	4 kg	4 kg	
Commercial fishing	Allowed	Allowed	
Payment	R$ 0	R$ 15	
Tucunaré caught after improvement of the reservoir	Less than 20 peacock bass	More than 40 peacock bass	
Tucunaré caught >4kg after improvement of the reservoir	Less than 4 peacock bass	Less than 4 peacock bass	

I prefer... (choose one)	1	15	
	☐	☐	☐ Neither scenario
Limit to catch	7 kg	4 kg	
Commercial fishing	Prohibited with compensation	Allowed	
Payment	R$ 15	R$ 0	
Tucunaré caught after improvement of the reservoir	From 20 to 40 peacock bass	Less than 20 peacock bass	
Tucunaré caught >4kg after improvement of the reservoir	Less than 4 peacock bass	Less than 4 peacock bass	

I prefer... (choose one)	15	7	
	☐	☐	☐ Neither scenario
Limit to catch	4 kg	10 kg	
Commercial fishing	Allowed	Allowed	
Payment	R$ 0	R$ 15	
Tucunaré caught after improvement of the reservoir	Less than 20 peacock bass	Less than 20 peacock bass	
Tucunaré caught >4kg after improvement of the reservoir	More than 40 peacock bass	More than 40 peacock bass	

I prefer... (choose one)	4	16	
	☐	☐	☐ Neither scenario
Limit to catch	10 kg	4 kg	
Commercial fishing	Prohibited without compensation	Prohibited with compensation	
Payment	R$ 30	R$ 0	
Tucunaré caught after improvement of the reservoir	More than 40 peacock bass	More than 40 peacock bass	
Tucunaré caught >4kg after improvement of the reservoir	More than 40 peacock bass	More than 40 peacock bass	

I prefer... (choose one)	1	12	
	☐	☐	☐ Neither scenario
Limit to catch	7 kg	7 kg	
Commercial fishing	Prohibited with compensation	Allowed	
Payment	R$ 15	R$ 0	
Tucunaré caught after improvement of the reservoir	From 20 to 40 peacock bass	More than 40 peacock bass	
Tucunaré caught >4kg after improvement of the reservoir	Less than 4 peacock bass	From 4 to 6 peacock bass	

I prefer... (choose one)	3	13	
	☐	☐	☐ Neither scenario
Limit to catch	4 kg	4 kg	
Commercial fishing	Prohibited with compensation	Allowed	
Payment	R$ 30	R$ 30	
Tucunaré caught after improvement of the reservoir	Less than 20 peacock bass	From 20 to 40 peacock bass	
Tucunaré caught >4kg after improvement of the reservoir	From 4 to 6 peacock bass	Less than 4 peacock bass	

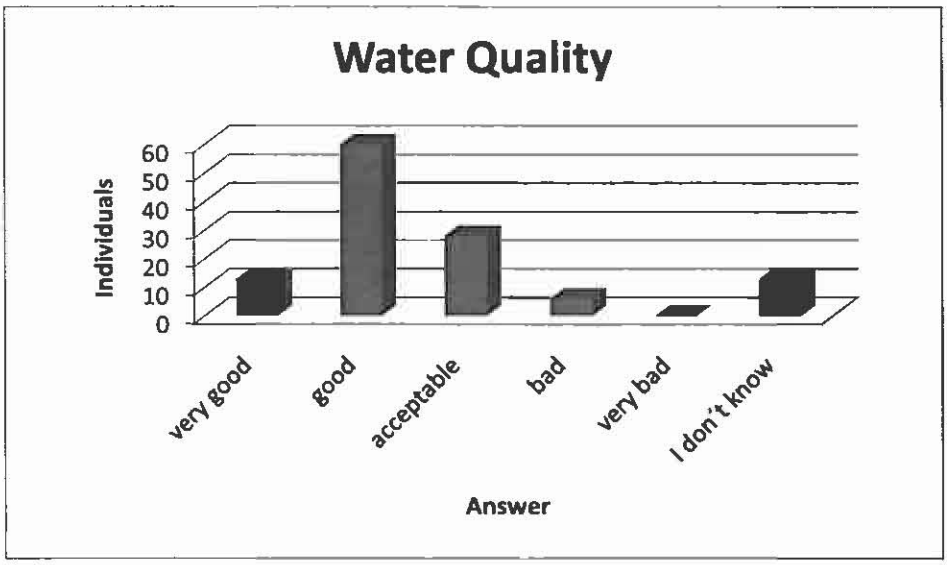
The questions above and the proposed policies limit the catch of tucunaré. Do you think it would be a good idea to go further and ban fishing, allowing only the catch and release of tucunaré?

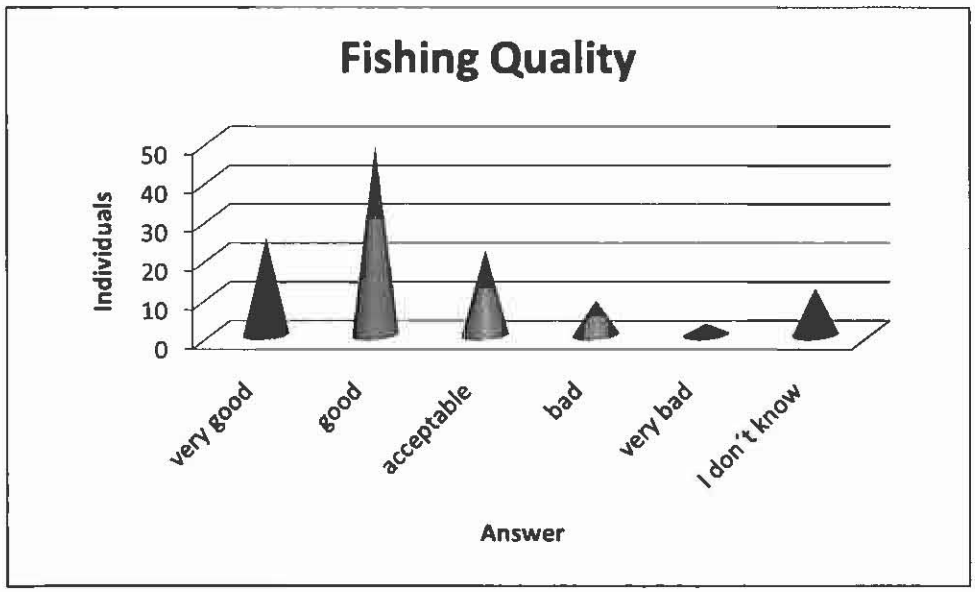
( ) I agree with this idea

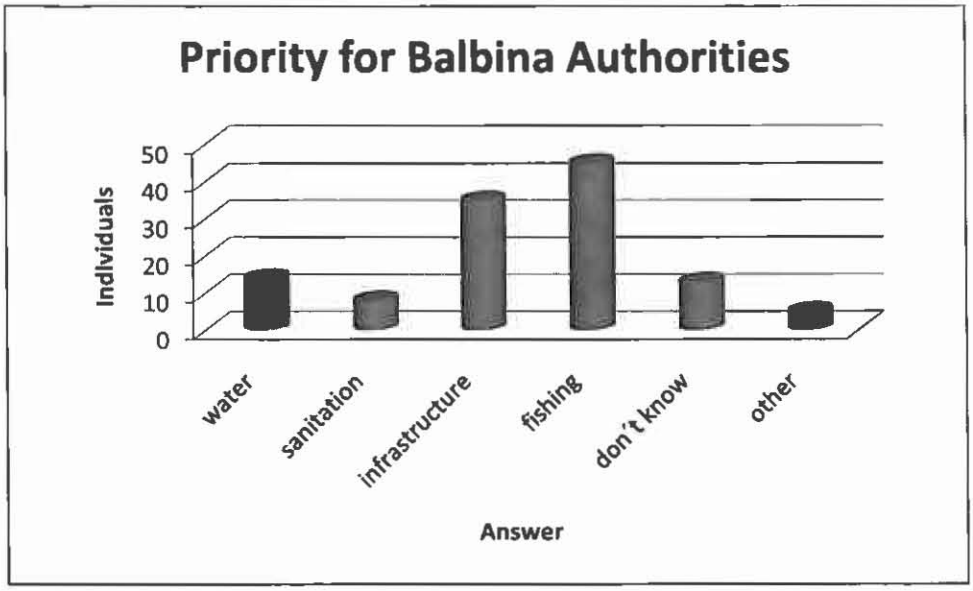
( ) I don´t know
( ) I do not agree with this idea

Annex 2. The following are results on perception and socio economic conditions of the sampled tourists.

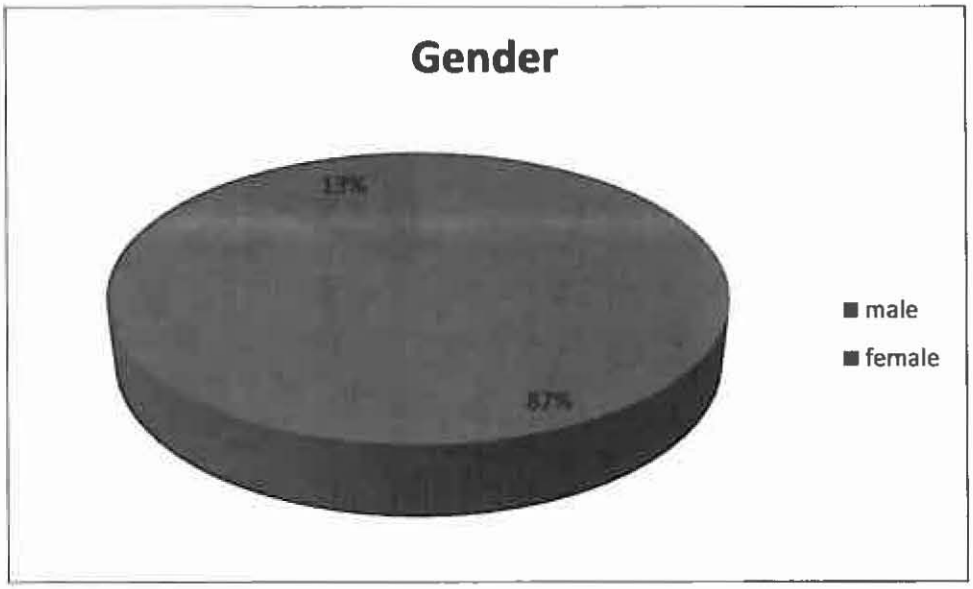
Perception

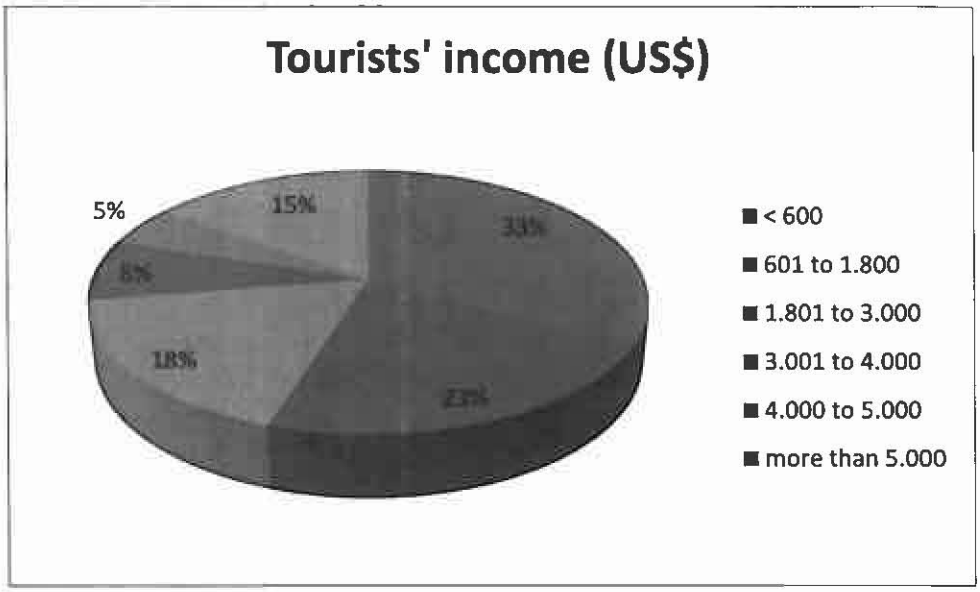


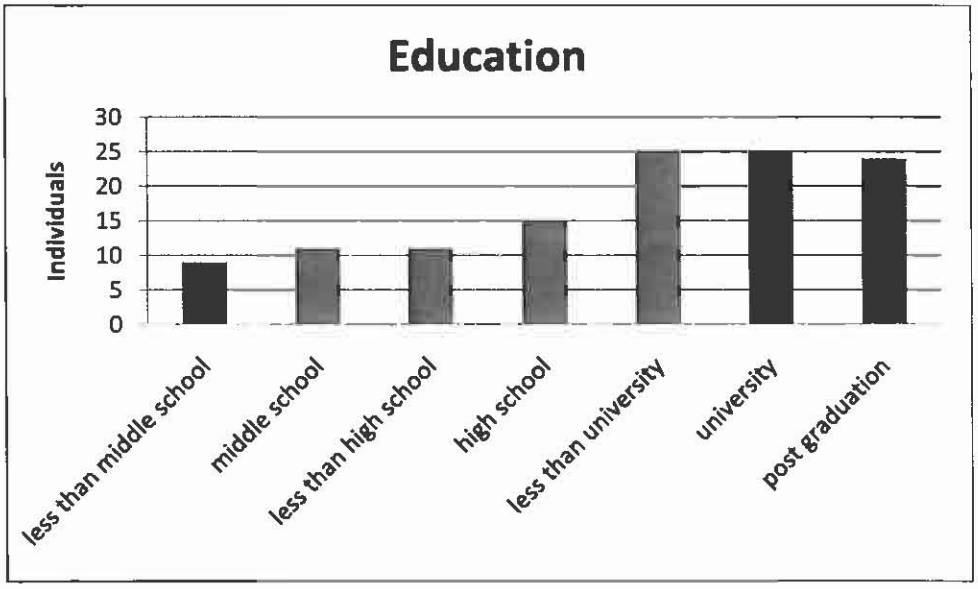




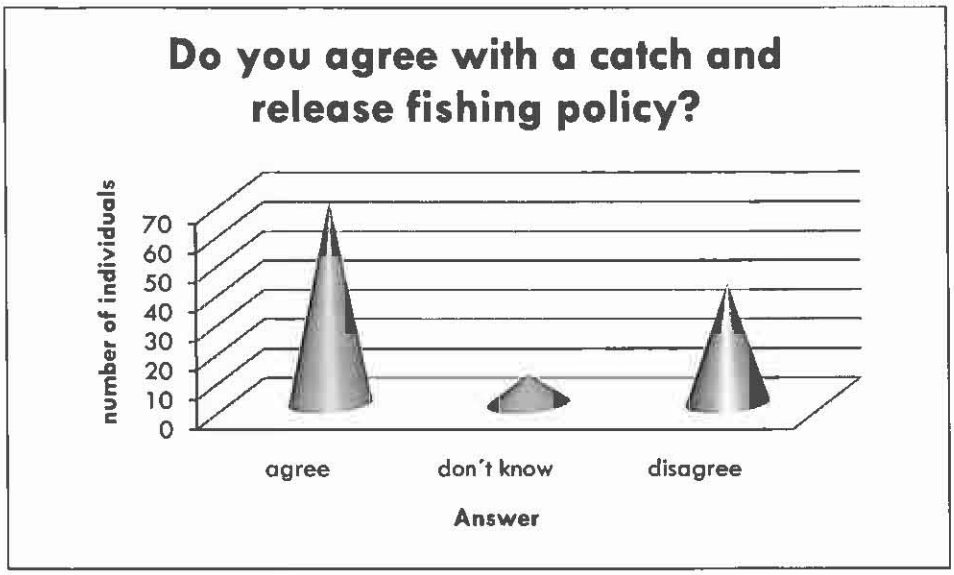
Socio economic characteristics







Potential Policy


Do you agree with a catch and release fishing policy?
number of individuals
70
60
50
40
30
20
10
0
agree
don't know
disagree
Answer

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