

Estimating the value of ecotourism

in the Djoudj National Bird Park in Senegal

Oumou K. Ly, Joshua T. Bishop, Dominic Moran and Mamadou Dansokho



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The translation of this document into English was completed with great care by Carole Small Diop.



Executive summary

This report presents the results of an economic study of the willingness-to-pay (WTP) of recreational visitors to the Djoudj National Bird Park (DNBP), in northern Senegal, based on interviews with 647 visitors to the park conducted in early 2003. The study forms part of a broader economic analysis of the costs and benefits of the park.

Located in the centre of the Senegal River Delta, the DNBP was declared a national park in 1971 and has since obtained Ramsar site status as a wetland of global importance. The situation in the area today must be understood as the culmination of a complex historical process, including notably the construction of two major dams on the upper and lower reaches of the Senegal River. Since at least 1964, this infrastructure has profoundly altered the traditional production systems based on migrant herding, traditional artisanal fishery, and gathering wild resources.

Since 1994, conservation efforts in the area have focused on regenerating natural resources in degraded environments, defining rights of use in and around the park, and capitalizing on local knowledge about ecosystem uses. Since 2000, activities in and around DNBP have been managed under a three-year integrated plan (*Plan Triennal de Gestion Intégrée*) as part of a project financed by the governments of the Netherlands, through IUCN, Germany, through GTZ and Senegal through DPN (*Direction des Parcs Nationaux*). Beyond its impact on flora and fauna, the management project has sought to improve the social conditions of the local population and to promote sustainable development in the Senegal River Delta region.

The objective of the economic analysis, of which this report forms part, is to estimate the value added arising from the creation and implementation of the park management plan, in

order to inform future investment and development decisions. The focus of this report on WTP for recreational uses of the park, using the contingent valuation method, is appropriate to the extent that very little direct, extractive use is made of the resources found within the park. In short, most of the economic benefits of the park arise from non-consumptive uses and non-use values.

The study findings suggest that the price of visitor admission to the DNBP could be increased substantially, from the current official price of 2000 FCFA (about Euros 3) per person, in line with the WTP expressed by visitors. Specifically, based on responses to alternative proposed entry fees (closed-end question), the study estimated a median WTP of 12 000 FCFA (about Euros 18). Using an alternative, open-ended question to elicit maximum WTP, the analysis suggests that visitors would be willing to pay up to 6642 FCFA, on average (Euros 10).

Even allowing for a decline in visitor numbers if the entry price was increased in line with WTP, the study estimates that total annual revenue in 2002 would have been in the range of 78–150 million FCFA, compared to actual revenue in the same year of about 20 million FCFA, at the current entry price. However, it is also important to take account of the fact that visitors expressed a desire for improvements in the quality of services provided at the DNBP.

The conditions at the site also explain another finding of the study, namely that visitor stays at DNBP tend to be of very short duration. Improved facilities and services at the site could encourage visitors to stay longer and spend more on-site, for the benefit of both the park and local populations. Finally, it should be noted that few Senegalese nationals visit DNBP and of course the overall objective of nature preservation needs to be maintained.



Photo © Gaël Gillibert

Introduction

The present study focuses on the Willingness to Pay (WTP) of recreational visitors to Djoudj National Bird Park (DNBP), a strict nature reserve in northern Senegal, specifically through tours of the site and bird-watching.¹ This report is part of a broader study initiated in 2002, which sought to establish the economic value of DNBP and DNP, Diawling National Park located in Mauritania (Ould Moulaye Zein *et al.*, forthcoming), two neighbouring wetland reserves of international importance. Other components of the broader study included a cost-benefit analysis of the restoration and direct uses of the DNP, where the exploitation of natural resources is authorized (Ly *et al.*, forthcoming).

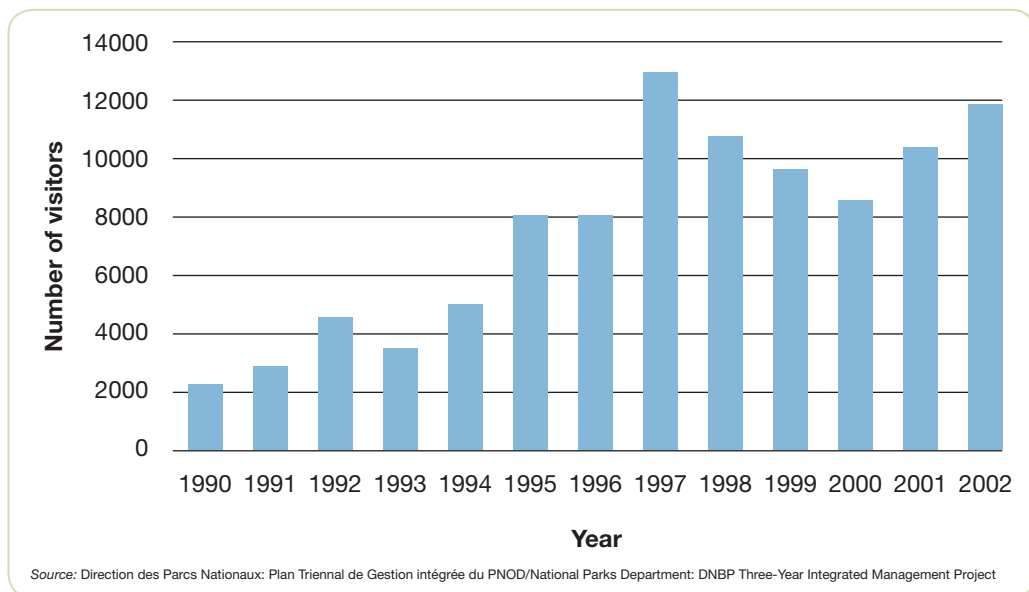
The overall aim of the broader study, to which this report contributes, is to identify potential areas of intervention and development upon which to focus future *in situ* and *ex situ* activities aimed at the conservation and sustainable use of resources in the two parks. Furthermore, the study seeks to provide

arguments that could influence wider national policies on park management in Senegal and Mauritania. The specific objective of this sub-study was to discover the price that recreational visitors to DNBP might be willing to pay, over and above the current entry fee.

Djoudj National Bird Park

Founded in 1971, DNBP is entirely located within the Senegal River Delta ecosystem, 60 km outside the city of Saint-Louis. It is one of the first stops for migrating Western Palearctic and Afro-tropical waterbirds after they cross the Sahara. Made up of lakes, marsh creeks, fords and sand dunes, DNBP has a surface area of 16 000 hectares. It was designated a Wetland of International Importance in 1977, under the terms of the Ramsar Convention on Wetlands. Due to its exceptional nature, it is considered a major bird sanctuary and was recognised as a World Heritage Site in 1981. The site is an important tourist destination and attracts a growing number of visitors each year, as shown in Figure 1.

Figure 1. Tourist visits to DNBP (1990–2002)



¹ The park is an important migratory stop for birds of the Western Palearctic Region. These and most other resources occurring in the park are not directly useable under existing management restrictions. Hence non-consumptive uses dominate.

Review of the literature

It is well known that recreational visitors to areas of natural beauty are prepared to pay significant amounts for the privilege. Typically, where such areas are public property, the potential WTP of recreational visitors is not captured fully (or in some cases at all) by government management agencies. The result can be chronic under-funding of protected areas and under-investment in public amenities (Emerton *et al.*, 2006).

In response, environmental economists and protected area managers have developed a range of methods to estimate the 'true' WTP of visitors and others for protected areas, or for other non-market goods and services (Bockstael *et al.*, 1991). Based on such estimates, protected area management agencies in many countries have revised their fee scales for recreational visitors and other users, with a view to increasing revenue and investing in new facilities.

One of the most commonly used methods for estimating consumer WTP for recreation is the Contingent Valuation Method (CVM), which consists of directly questioning a sample of individuals in order to generate estimates of compensated variation in well-being, in the absence of a market. Faced with a situation where the utility level they derive from an environmental good or service could be increased or decreased, individuals may agree to pay for increased utility or accept compensation for decreased utility, so that the payment or compensation restores their original utility level. The apparent simplicity of this method, combined with recent improvements in procedures for ensuring a certain level of reliability, explain the wide popularity of CVM with economists. It is undoubtedly the method of valuing natural assets most frequently applied in recent years, not least because it can be used to measure

both use and non-use values of natural resources.²

Initially applied to the valuation of natural assets for recreational use, CVM has been extended to a range of issues such as valuation of the risks linked to waste management (McClelland *et al.*, 1989), air quality (Johansen, 1987) and water supply (Howe *et al.*, 1990). However, CVM can only provide accurate values if the data are properly gathered and processed – a minimum set of rules needs to be followed. If, on the other hand, the method is believed to contain bias or systematic error, the best analysis in the world will not yield reliable values (Kahneman and Knetsch, 1992).

Methodology

This study used CVM and, in particular, a closed-ended approach to reveal WTP, based on a survey of visitors to DNB. The closed-ended method consists of proposing a random value to individuals: either the price is lower than or equal to their WTP and the individual accepts the amount proposed, or the price is higher and the person rejects the amount. The closed question was followed by a second, open-ended question, asking the maximum amount that each individual would be willing to pay for admission to the park. The rest of the survey questionnaire gathered general information about the visitors and their perceptions of the site.

The survey was administered towards the end of the tourist season (from 29/03/2003 to 5/04/2003). During that period, a total of 647 people were interviewed: 47% in the nearby city of Saint-Louis, by three interviewers, and 53% at DNB itself, by three other

² For a general overview of the economic value of ecosystems and the practical uses of valuation methods see: Pagiola, Stefano, von Ritter, Konrad and Bishop, Joshua. (2004). *Assessing the Economic Value of Ecosystem Conservation*. Environment Department Paper No. 101, The World Bank, Washington, D.C. See also: Ozdemiroglu, Ece, Tinch, Robert, Johns, Helen, Provins, Allan, Powell, Jane C., Twigger-Ross, Clare. (2006). *Valuing Our Natural Environment*. Final Report NR0103 for Department for Environment, Food and Rural Affairs. 20th March 2006. www.eftec.co.uk

interviewers. It was decided early on that three interviewers would remain in Saint-Louis rather than basing them all at the park. This approach was adopted as a precaution in order to ensure consistency across responses and to avoid the bias that could spring from the fact that people interviewed in Saint-Louis who had already been to the park and back could have a different view of things, perhaps because they might be distracted by other activities or sites visited since then, whereas visitors interviewed on-site at DNBP had only made the trip out and would have different perceptions.

The deployment of interviewers was also motivated by the need to ensure that enough questionnaires could be completed, given that the survey took place at the end of the tourist season. It was recommended that the interviewers make courtesy calls on hotel receptionists in Saint-Louis, in order to facilitate contacts with the visitors. Finally, the interviewers were given an opportunity to tour the DNBP wetlands before starting their work, which proved to be an incentive for them.³

³ The interviewers were provided with copies of the questionnaire as well as a handout explaining the purpose of the study and the background for the hypothetical choice.

Nile Crocodile (Crocodylus niloticus) in the DNBP



Photo © Gaél Gillibert

I. General visitor information

Sample size and gender breakdown

The study is based on a sample of 647 people, divided almost equally between men and women. Individuals were selected at random in locations where enumerators were most likely to encounter them. Thus the survey was administered at the car parking lot in front of the DNBP gates, at the pier where visitors embark on boat tours of the park, in the canoes while touring, and at the on-site restaurant and eco-museum following the tour. Note that very few tourists visit other parts of the park. Finally, those visitors interviewed in Saint-Louis were met in hotels, in the street and in known tourist locations in the city.

Table 1. Distribution of visitors by gender

Gender	Number	Frequency (%)
Male	327	50.6
Female	319	49.4
Total	646	100

Nationality

The majority of the visitors surveyed were of French nationality (73%). They were followed by the Senegalese (7%, including Senegalo-Lebanese, Senegalo-Mauritians and Franco-Senegalese), Belgians (5%) and Italians (4%). Overall, Europeans made up 88% of the group, while Africans made up just 8% of those surveyed.⁴

Level of education

Out of 642 visitors for whom full or partial interviews were completed, more than half (54%) reported some high education (post-secondary). Those who reported no formal education at all represented about 1% of the sample (Table 2).

⁴ There may have been some bias in the selection of respondents, particularly in Saint-Louis, where enumerators may have been more inclined to approach individuals who seemed (superficially) likely to be foreigners and therefore tourists.

Table 2. Level of education of the visitors

Level of education	Number	Frequency (%)	Cumulative frequency
None	7	1.1	1.1
Primary	52	8.1	9.2
Secondary	236	36.7	45.9
Higher	347	54.1	100
Total	642	100	

Principal source of visitor income

Of 644 respondents, 341 were salaried employees (53%). Of the rest, almost 10% were self-employed, 7% relied on family assistance, 1.5% lived off their personal savings, and 1% relied on government assistance. Over 27% of respondents stated that their principal sources of income were other than those indicated in the questionnaire.

Table 3. Principal sources of visitor income

Principal sources	Number	Frequency (%)
Employees	341	53
Family assistance	48	7.4
Self-employed	62	9.6
Government assistance	7	1.1
Personal savings	10	1.5
Other	176	27.4
Total	644	100

Average monthly income

578 people answered the question about their monthly income. 22% stated that they earned a monthly income of 500 000 FCFA (about Euros 760) or less, while nearly 15% reported earning more than 2 000 000 FCFA per month. By comparison, the average annual income per capita in Senegal was reported to be 490 US Dollars, equivalent to Euros 434 or 284 641 FCFA in 2003 (World Bank, 2003).

Table 4. Distribution of visitors according to their average monthly income

Average income (FCFA)	Number	Frequency (%)	Cumulative frequency
0-50 000	37	6.4	6.4
50 001-100 000	18	3.1	9.5
100 001-150 000	15	2.6	12.1
150 001-200 000	12	2.1	14.2
200 001-300 000	17	2.9	17.1
300 001-500 000	30	5.2	22.3
500 001-1 000 000	135	23.3	45.6
1 000 001-1 500 000	160	27.7	73.3
1 500 001-2 000 000	70	12.1	85.4
2 000 001-3 000 000	42	7.3	92.7
3 000 001-4 000 000	22	3.8	96.5
4 000 001 or more	20	3.5	100
Total	578	100	

Pelicans fishing in the DNBP



II. Visitor behaviour

Prior knowledge of DNBP

In response to the question as to whether or not they had previously heard of DNBP, 253 of the 303 people asked said yes, or 83%. The remaining 50 individuals had never heard of the park beforehand.⁵

Table 5. Prior knowledge of the park

Knew about the park	Number	Frequency (%)
Yes	253	83.5
No	50	16.5
Total	303	100

⁵ Due to an omission during the typing of the first draft, not all the questionnaires included this preliminary question.

Number of visits to DNBP

Of the 645 people who answered questions regarding their visits to the park, about 80% had visited the site at least once before. Of these, over 90% were visiting the park for the second time only. About 20% of respondents stated that they had never visited the park before.

Table 6. Previous visits to DNBP

Number of visits	Number	Frequency (%)
Never visited	126	19.5
Once	473	73.1
Twice	18	2.8
Three times	3	0.5
Four or more times	27	4.1
Total	647	100

The city of Saint-Louis, Senegal



Means of travel

Most of the visitors (56%) travelled to the site via commercial tour operators. 14% of the sample stated that they travelled to the site using their own means.

Table 7. Means of travel of the visitors

Means of travel	Number	Frequency (%)
Tour operator	290	55.7
Own means	74	14.2
Business trip	3	0.6
Saint-Louis Tourism Office	12	2.3
Other	142	27.2
Total	521	100

Point of departure, travelling time and time spent on-site

Most of the visitors started their journey to DNBP at Saint-Louis (60%). If we add those coming from Dakar (20%) and other regions of the country (5%), then approximately 85% of all visitors reported a point of departure within Senegal. As for visitors coming from abroad, nearly all departed from Europe (15%). However, it is quite likely that the majority of the people who indicated Saint-Louis as their point of departure were in fact not residents of the city, but tourists staying in Saint-Louis for part of their trip.

Table 8. Point of departure of the visitors

Point of departure	Number	Frequency (%)
Saint-Louis	312	60
Dakar	104	20
Other regions of Senegal	24	4.6
Africa	1	0.2
Europe	79	15.1
Other	1	0.1
Total	521	100

Nearly half of the people interviewed who stated that they had travelled to DNBP, had taken less than two hours to reach the site. Some took over four hours (approximately 25%), or even over 10 hours (over 12%), or more than half a day (approximately 8%). On average, however, mean travel time from the point of departure to DNBP was a little less than half a day (11 hours and 50 minutes).

Over 75% of those who had visited the park had spent at least two and a half hours at the site. Nearly 12% of visitors had spent at least half a day, and approximately 3%, at least a full day. The average amount of time spent in the park was a little over 4 hours.

Table 9. Time spent by visitors in the park

Time (hours)	Number	Frequency (%)
≤ 2	367	72.0
2–4	81	15.9
5–12	28	5.5
> 12	34	6.7
Total	510	100

Desired improvements

Visitors were asked about the quality of services provided in the park. Many expressed a wish for improvements in the Park's equipment and infrastructure. More specifically, 18 respondents (out of 133) called for improvements in reception and signage, 30 wished for improvements in the dugout canoes, and 6 said they would like to see an eco-museum opened at the site.⁶ According to 32 people, a better or additional pier should be built. Finally, 47 respondents called for general improvements to equipment and infrastructure, including improvements in the type of accommodation, roads, etc.

⁶ A small eco-museum is located at the entry to DNBP. Evidently some visitors were not aware of it.

Table 10. Types of improvements called for by visitors

Types	Number	Frequency (%)
Reception and signage	18	13.5
Dugouts	30	22.6
Shop and Eco-museum	6	4.5
Pier	32	24.1
Equipment and infrastructure	47	35.3
Total	133	100

Visitor expenses

Transport

Spending on transportation revealed a large dispersion of the data provided by 157 visitors who responded to questions on the subject (see Table 11). Average spending per person on transportation was approximately 312 400 FCFA.

Table 11. Spending on transport to the park

Cost of transportation (FCFA)	Number of visitors	Frequency (%)
≤ 25 000	26	16.6
25 000–100 000	21	13.4
100 000–300 000	29	18.5
300 000–500 000	53	33.8
≥ 500 000	28	17.8
Total	157	100

Admission price

162 people were questioned as to the amount they paid for admission to the park. Approximately 90% stated that they had paid the official posted price of 2000 FCFA, whereas over 10% had paid more: for instance, over 3% paid 2500 FCFA, and nearly 5% over 3500 FCFA. Total income from entrance fees for the 162 people asked this question amounted to 344 000 FCFA.

On-site accommodation

84 out of 521 people questioned reported paying for accommodation at the site (i.e., overnight stays). Spending on accommodation ranged from 1000 to 280 000 FCFA, with about half spending no more than 15 000 FCFA.

Dugout canoe hire

About 80% of the people interviewed paid the official price of 3500 FCFA to hire a dugout canoe during their visit. Approximately 10% paid more (in several cases, over five times the posted price) whilst, on the other hand, nearly 10% paid a lower price.

Guided tour

Similar trends were observed as with the dugout hire price: only half of the respondents paid the official rate of 5000 FCFA. Nearly 20% paid less, whilst almost one-third paid more.

Spending on food

69 people stated that they had spent money on food during the trip. Expenses varied between 1000 and 75 000 FCFA, with 78% of respondents spending up to 10 000 FCFA. 42% of the respondents said they had spent at least 7000 FCFA to purchase food on-site. A little under 40% of the respondents had spent at least 8000 FCFA and less than 10% at least 15 000 FCFA. Mean on-site spending on food was about 8 000 FCFA per person.

Purchases of craft items

Of a total of 521 people questioned on this subject, 70 replied that they had purchased craft items, i.e. 13% of the visitors. Half of those purchased the items in a shop, 10 at the hotel, and the rest elsewhere.

Packages

Service packages generally include transportation to the site (e.g., airline ticket), transportation on site, food and accommodation. 339 of the 521 people

interviewed had purchased these service packages, i.e. 65% of the sample. Of that number, 6% had paid for services totalling 220 000 FCFA. 15% spent up to 500 000 FCFA, 45% paid for a package worth at least 700 000 FCFA, and nearly 10% over 975 000 FCFA. The average value of the packages was 666 402 FCFA.⁷

Additional spending

For the 27 people who responded to this question, additional spending above and beyond the aforementioned amounts ranged from 1000 to 131 000 FCFA. One third of the respondents spent a maximum of 5500 FCFA on additional needs, and a little more than half

up to 20 000 FCFA. About 40% of the visitors in question spent 50 000 FCFA or more. Mean additional spending was about 29 000 FCFA.

Visits to other parks or reserves in the area

Finally, over 90% of the people interviewed stated that they had not visited another site in the area. Amongst those who had visited other parks or reserves nearby (about 10%), the most commonly visited site was the Diawling National Park (58% of respondents) followed by the Langue de Barbarie Park and the Guembeul Reserve in combined visits and the Ndiayel Reserve.

⁷ The more expensive tour packages probably included visits to several attractions, in addition to the DNBP.

III. Visitor values

The Willingness to Pay (WTP) of visitors to the DNBP was first elicited using a closed-ended question approach. This consisted of putting forward a random value corresponding to an hypothetical admission fee for the park to a group of individuals: either this price is less than or equal to their WTP and the person accepts the amount proposed, or else the price is higher and the person rejects it. Specifically, the following hypothetical situation was put to visitors: *“Under the current circumstances, the income generated by the park is not sufficient to cover its operating and maintenance costs. If the prices of the dugout rental and the guided tour remained unchanged, would you be willing to pay X amount for the admission fee if it had to be increased?”* Each person was then faced

with a single proposal; according to the type of questionnaire, the value was either 2500, 5000, 10 000, 15 000 or 20 000 FCFA (equivalent to Euros 4, 8, 15, 23 and 30 respectively).

A second, open-ended question, complementary to the first, was also posed. The latter question focused on the maximum amount that individuals would be willing to pay for admission. Specifically, the following question was asked: *“What is the maximum amount that you are willing to pay to visit the park?”*

Population interviewed

Of the total sample of 647 individuals, 644 were asked their Willingness to Pay (i.e. 99%).

Water lilies in the DNBP



Table 12. Distribution of the sample by type of questionnaire submitted

Questionnaire type	Total responses	Frequency (%)	Total interviewees
2 500 FCFA	135	21	136
5 000 FCFA	129	20	130
10 000 FCFA	130	20.2	130
15 000 FCFA	127	19.7	128
20 000 FCFA	123	19.1	123
Total	644	100	647

Note: More conventionally, these offers should have been spaced according to a normal distribution, with fewer respondents answering questionnaires with the highest and lowest values and more in the middle range.

Willingness to Pay by bid value

Overall, 55% of the sample or 355 people agreed to pay a price at least equal to that put forward by their questionnaires. In response to

the open-ended question, the maximum amount that respondents were willing to pay was 6642 FCFA, on average. Moreover, as expected:

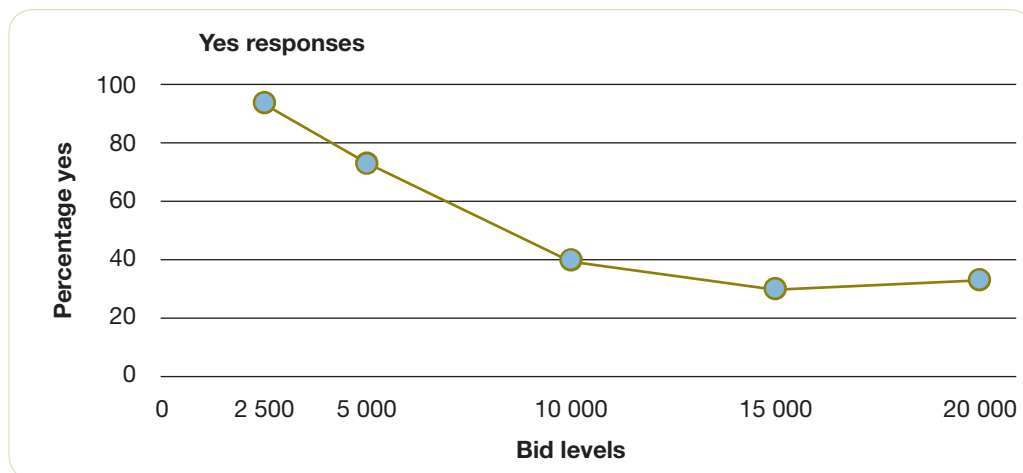
- WTP declined as the amount of the closed question increased, from a 94% acceptance rate for 2500 FCFA (which is already a 25% increase over the official price) to 33% acceptance at 20 000 FCFA (see Figure 2).
- The maximum bid (in response to the open-ended question) increased as the amount of the closed question increased.

Interestingly, the median WTP was fairly constant at 5000 FCFA for four out of five sub-groups. In other words, half of all respondents were willing to pay a maximum of more than 5000 FCFA, and half were willing to pay less than this amount.

Table 13. Selected statistics by type of questionnaire submitted

Questionnaire type (FCFA)	Yes (%) (closed-ended)	Median (FCFA) (open-ended)	Minimum (FCFA)	Maximum (FCFA)
2 500	94	5 000	500	20 000
5 000	74	5 000	500	15 000
10 000	41	5 000	1 000	20 000
15 000	31	5 000	1 000	75 000
20 000	33	6 000	2 500	50 000

Figure 2. Plotted percentages of positive responses



Willingness to Pay by gender

The people who were asked about the maximum amount they would be willing to pay were made up of almost equal proportions of men and women (respectively 51% and 49%). On average, the percentage of positive responses to the prices proposed by the various types of questionnaires was higher among women (57% as compared to 53% among men).

Despite their greater likelihood to answer yes, women’s mean WTP in response to the open-ended question was lower than men’s (6362 FCFA as compared to 6937 FCFA). Medians for both groups were identical (5000 FCFA). In other words, half of all men and half of all women are willing to pay that price. However, the range of responses was broader among men than among women: 1000–25 000 FCFA for women and 500–75 000 FCFA among men.

Table 14. Responses to the closed-ended question by gender

Gender	Men (%)		Women (%)	
	No	Yes	No	Yes
2 500 FCFA	10.3	89.7	2.7	97.3
5 000 FCFA	25.4	74.6	36.7	73.3
10 000 FCFA	62.9	37.1	55.2	44.8
15 000 FCFA	69.4	30.6	69.4	30.6
20 000 FCFA	64.5	35.5	68.9	31.1
Total	47	53	42.9	57.1

Table 15. Maximum WTP by gender (in FCFA)

Gender	Average	Median	Min.	Max.
Men	6937	5 000	500	75 000
Women	6362	5 000	1 000	25 000

IV. Estimated Willingness to Pay

The following analysis uses the closed-ended data to generate the mean WTP for visits to the park. The WTP of visitors to DNBP was assessed using a Logit model to identify the determinants of the following responses⁸: “Yes, I am willing to pay X” or “No, I am not willing to pay X”, where “X” refers to the amount of the closed-end bid in each case.

This model relates the 1 (yes) and 0 (no) response variable to the bid levels faced by each respondent. The model generates coefficients to describe a curve that fits through the line in Figure 2 above, using the best statistical (maximum likelihood) model to

describe this data. The procedure is described in detail in an annex to this report, but the general form of the model is expressed by the following equation:

$$P_y = \frac{1}{1 + e^{-\alpha + \beta A}}$$

Using a Logit regression to relate individual responses to bid values results in estimates of the coefficients for *alpha* and *beta* in the above equation. These can be used to derive the mean WTP.

Table 16. Logit Model Results

Logit output results			
Convergence achieved after 3.00000 Iterations			
Log likelihood = -366.04611			
Sample size = 635.00000 12 missing observations			
Variable	Coefficient	Std error	T-stat
Alpha	1.92466	0.18426	10.44544
Beta	-0.00016	0.00002	-10.79820
Number of cases where Y = 1 : 350.00000			
Number of cases where Y = 0 : 285.00000			
Chi-squared test for significance of regression = 141.53950			
Krinsky and Robb confidence intervals using 10000.00000 repetitions			
99% C.I. = 11352.42593 to 14430.66798			
95% C.I. = 11641.40139 to 13926.16933			
90% C.I. = 11797.86130 to 13693.81495			
Average of the Krinsky and Robb CS values = 12700.70002			
Median of the Krinsky and Robb CS values = 12671.95364			
Restricted WTP point estimate = 12655.59617			

⁸ About 20% of respondents stated that they had never visited the park. This was not sufficient to detect differences in their WTP, i.e., to determine whether people’s stated WTP is dependent upon a previous visit to the park.

Based on the model output, the first important result is that the *beta* coefficient (in other words the response of yes or no to the bid amount) is negative and significant (absolute value of t-stat >2), as expected. The estimated mean WTP for the sample is 12 655 FCFA, with a 95% confidence interval of 11 641 to 13 926. Overall, this single variable model is well estimated and the confidence interval is tight.

From the regression results it is possible to take the values of the *alpha* and *beta* coefficients and substitute them into the model to predict the probabilities associated with varying bid levels (A in the equation):

$$P_y = \frac{1}{1 + e^{-\alpha + \beta A}}$$

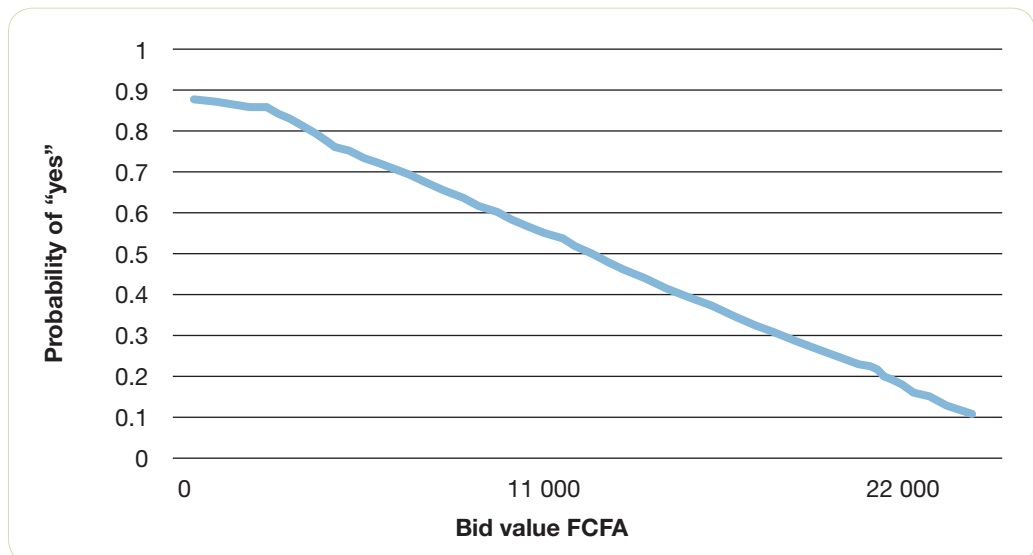
Figure 3 below shows the predicted bid function, while the data in the plot are listed in Table 17. From the data and the plot we can see that a value of 12 000 FCFA is associated with a probability of 0.5 (i.e. 50% acceptance

to pay this value), which is the median WTP. In other words, for any sample of visitors to this park, 50% will decline to pay this value.

Table 17. Distribution of WTP

Estimated WTP	Probability of "Yes"
0	0.87
500	0.86
1 000	0.85
3 000	0.81
5 000	0.75
6 000	0.72
7 000	0.69
8 000	0.65
9 000	0.62
10 000	0.58
11 000	0.54
12 000	0.50
13 000	0.46
14 000	0.42
15 000	0.38
16 000	0.35
17 000	0.31
18 000	0.28
19 000	0.25
20 000	0.22
22 000	0.17
24 000	0.13
26 000	0.10

Figure 3. Predicted probability function



Comparing open- and closed-ended results

The responses to the open-ended question about maximum WTP may be calculated as an arithmetic mean, as reported in the following tables and the box plot diagram (Figure 4). The box plot reveals the wide dispersion of responses to the open-ended question. Trimming these observations to eliminate outliers would significantly reduce

the estimated mean value. Even so, there is clearly a significant disparity between the untrimmed mean from the open-ended data and the model results using the closed-ended data (FCFA 6642 versus approximately 12 000, respectively). This is a very common finding in the CV literature, which reports many studies finding an upward bias between the two methods.

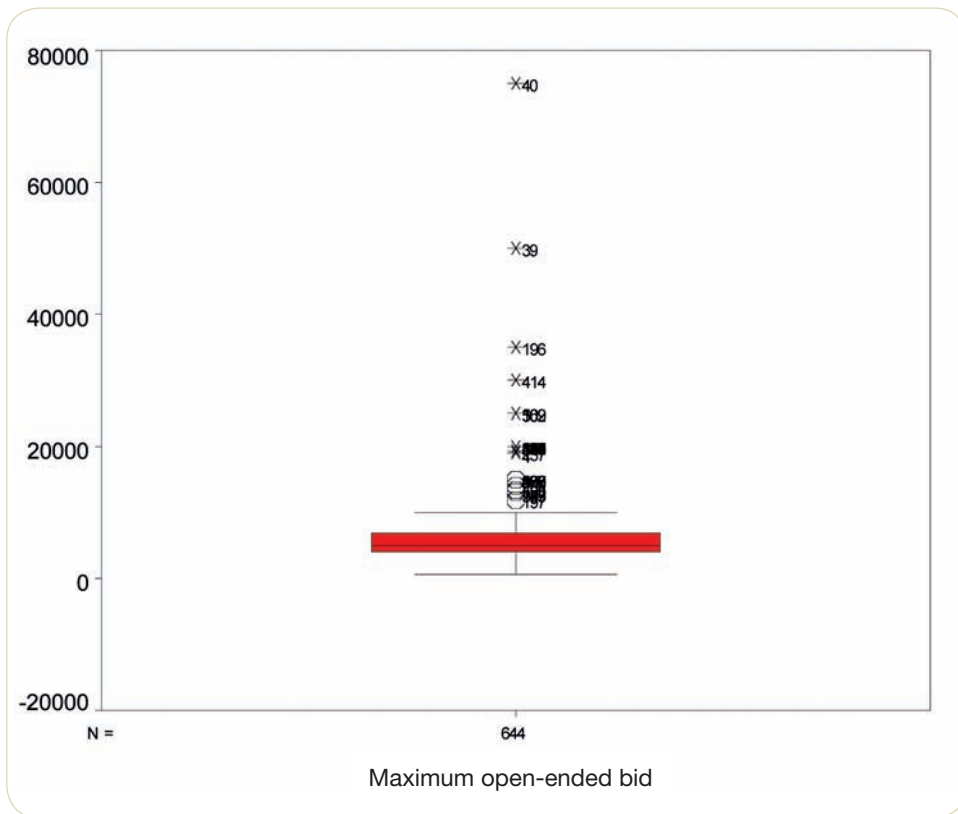
Table 18. Descriptive statistics

	N	Minimum	Maximum	Mean	Standard deviation
Maximum WTP	644	500	75 000	6642.43	5411.90
Valid N (listwise)	644				

Table 19. Descriptive statistics

			Statistic	Standard error
Maximum WTP	Mean		6642.43	213.26
	95% Confidence Interval for Mean	Lower Bound	6223.66	
		Upper Bound	7061.20	
	5% Trimmed Mean		5947.59	
	Median		5000.00	
	Standard Deviation		5411.90	
	Minimum		500	
	Maximum		75 000	
	Range		74 500	
	Interquartile Range		3000.00	
	Skewness		5.144	.096
	Kurtosis		47.583	.192

Figure 4. Distribution of maximum WTP responses⁹



Total annual WTP

The open-ended versus closed-ended disparity is clearly a problem for subsequent calculation. On balance (and drawing on the literature) one should favour the closed-ended estimate. But a prudent course of action would be to calculate the range of total economic value using both estimates. In other words, we may derive an aggregate value range by multiplying each estimate by the total annual number of visits to the DNB, as in Table 20.¹⁰

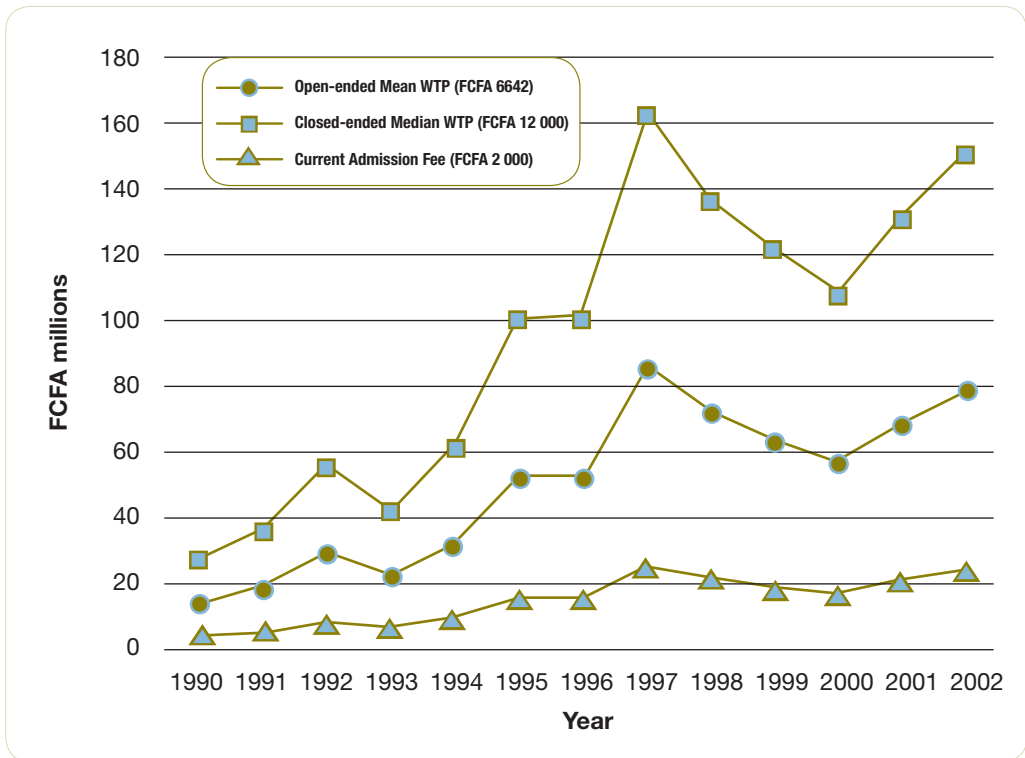
Table 20 shows actual and potential receipts from visitor admission fees over the period 1990 to 2002, based on the official price (FCFA 2000) as well as the estimated WTP based on responses to the open-ended (mean FCFA 6642) and closed-ended (median FCFA 12 000) questions. The table shows the disparity between current and potential revenue if the price of admission were revised in line with WTP. The same point is illustrated graphically in Figure 5.

⁹ The thin box marks out the 25th to 75th percentiles; the dash within the box marks the median; a line marks the outer part of the distribution, and outside dots or stars mark outliers.
¹⁰ Note that the estimated mean WTP is a measure of central tendency which implicitly accounts for any potential reduction in total demand that may result from increasing the entry fee.

Table 20. Total annual visits to DNBP and estimated annual revenues from entry fees

Year	Total visitors	Total WTP (in FCFA millions, based on open-ended mean WTP – FCFA 6642)	Total WTP (in FCFA millions, based on closed-ended median WTP – FCFA 12 000)	Actual revenue (in FCFA millions, based on official fee – FCFA 2000)
1990	2 226	14.8	26.7	4.5
1991	2 899	19.3	34.8	5.8
1992	4 465	29.7	53.6	8.9
1993	3 393	22.5	40.7	6.8
1994	4 891	32.5	58.7	9.8
1995	7 951	52.8	95.4	15.9
1996	7 987	53.0	95.8	16.0
1997	12 891	85.6	154.7	25.8
1998	10 797	71.7	129.6	21.6
1999	9 631	64.0	115.6	19.3
2000	8 526	56.6	102.3	17.1
2001	10 375	68.9	124.5	20.8
2002	11 860	78.8	142.3	23.7

Figure 5. Comparing actual revenue with potential WTP (1990–2002)



Potential survey bias

The estimates of maximum WTP leave some doubt as to the existence of a starting point bias. This can be observed by comparing the maximum WTP expressed by respondents to the preceding, closed-end question in each case.

As noted on Table 21, these results indicate a positive relationship between bid values and the maximum WTP expressed by respondents.

Table 21. Relationship between open-ended WTP and closed-ended bid values

Questionnaire type	Maximum amount respondents are Willing to Pay		
	Mean	Median	Mode
2 500 FCFA	5049	5000	5000
5 000 FCFA	5170	5000	5000
10 000 FCFA	6424	5000	5000
15 000 FCFA	8143	5000	5000
20 000 FCFA	8617	5000	5000

The road to the DNBP



V. Conclusion

After the city of Saint-Louis itself, DNBP is the principal tourist attraction in the Saint-Louis region, although it is rarely visited by Senegalese tourists. The fact that French tourists were more numerous may be due to the centuries-old ties that exist between Saint-Louis and the French mainland.

The biggest suppliers of tourists to DNBP are tour operators, which explains the high proportion of package costs in tourist spending. The inn at Djoudj derives substantial income from providing accommodation, dugout rental and other services. Local villagers also benefit to a lesser extent by providing crafts for sale in the DNBP shop, dugout canoes and guides for visits, as well as accommodation starting in the tourist season 2002–2003.

Finally, the amounts paid in admission fees constitute a portion of the income generated by DNBP for the State.

The study has established that admission fees to DNBP could easily be increased without significantly affecting tourism demand. However, it is also important to note that visitors expressed a desire for improvements to the quality of services provided (e.g. dugout canoes, signage, pathways, etc.). The conditions and facilities at the DNBP site explain another finding of the study, namely that visits are typically of very short duration. Finally, one should not lose sight of the fact that very few Senegalese nationals visit DNBP and of course the overall objective of nature preservation must be maintained.



Appendix A

Terms of reference of the DNBP and DNP valuation studies



Terms of Reference

Environmental economic assessment study of Djoudj National Bird Park (Parc National des Oiseaux du Djoudj), Senegal and Diawling National Park (Parc National du Diawling), Mauritania

1. Context of the study

Djoudj National Bird Park (Parc National des Oiseaux du Djoudj)

The desire to carry out an assessment study of the main economic values linked to the existence value and the management of Djoudj National Bird Park (DNBP) comes at a stage in the Three-Year Integrated Management Project (République du Sénégal, 2002) where it appears fundamental to capitalize on the experience related to the management of the Park in order to be able to identify – based on reliable data – the areas of intervention and the possible developments that conservation and sustainable use promotion activities in and ex situ should focus on. Moreover, the economic analysis should provide economic arguments capable of influencing Senegal's national policies for park management.

Established in 1971, DNBP is entirely located within the delta ecosystem of the Senegal River, 60 km from Saint-Louis. It is one of the first refuges providing fresh water that Palearctic and Afrotropical migratory waterfowl come to after crossing the Sahara. Made up of lakes, backwaters, fords and sandbanks, DNBP covers 16,000 ha. In 1977, it was designated a Wetland of International Importance under the Ramsar Convention. Due to its exceptional character, it is considered a key ornithological sanctuary and became a World Heritage Site in 1981.

Located in the Middle Delta of the Senegal River, DNBP is directly influenced by the ecological and socio-economic dynamics of the Upper and Lower Delta. The prevailing situation in this area is the result of a complex historical evolution, which has greatly changed and disrupted the traditional production systems based on nomadic pastoralism, fishing and foraging. In 1964, a dyke was erected on the left bank of the Senegal River, stretching for 80 km between Saint-Louis and Richard-Toll. The aim of this dyke was to allow partial control of the floodwaters, within the framework of the development of irrigated crops in the delta, and represented the first element of a system that was implemented progressively and was finally completed in 1986 with the opening of the Diama Dam. Since then, DNBP has become an ecological site that is currently going through a process of transformation and is unstable, which makes its management extremely complex and difficult. Changes in the quality of the

water, the invasion of man-made lakes by floating vegetation and a decline in the biodiversity, are the main ecological problems facing the Park. In addition, there is pressure on the natural resources relating to agriculture, demographic growth and the non-existence of grazing land for the livestock.

Since 2000, DNBP's activities have followed the Three-year Integrated Management Plan (PTGI), whose financial partners are the Netherlands, through IUCN, and Germany, through the GTZ.

The overall aim of the project is "to preserve a representative and unique example of the Middle Delta of the River Senegal through the conservation of DNBP's ecosystems and the promotion of sustainable development on the outskirts of the Park".

Diawling National Park (Le Parc National du Diawling)

The desire to carry out an assessment study of the main economic values linked to the existence value and the management of Diawling National Park (DNP) comes at a stage in the restoration project where it appears fundamental to capitalize on the experience related to the management of the Park in order to be able to identify – based on reliable data – the areas of intervention and the possible developments that conservation and sustainable use promotion activities *in* and *ex situ* should focus on. Moreover, the economic analysis should provide economic arguments capable of influencing Mauritania's national policies for park management.

Created in 1990, Diawling National Park (DNP) is situated around 300 km south of Nouakchott on the right bank of the Lower Delta of the River Senegal. It covers 16,000 ha and forms an integral part of a larger ecological unit from which it cannot be separated. However, hydroelectric schemes, established almost 25 years ago within the framework of Senegal River Development Organization (OMVS) project, have greatly changed the functioning of River Senegal estuary. The first and main consequence of these changes is the loss of biodiversity and the fall in the overall productivity of an environment that was formerly characterized by a mixture of fresh and salt water.

One of the main aims of Diawling National Park since its creation has been the restoration, conservation and sustainable use of the natural resources of the Park and its surrounding area. Thus, a return to the ecological balance that existed before the dam requires the restoration of the water system and a better knowledge of the circulation of the water, which is largely dependent on the seasons, the volume of floodwater and the releases in the OMVS works (Diama Dam, Manantali Dam and the dyke works on the right bank).

It is for this reason that the managers of Diawling National Park set up an artificial water regime beginning in 1989 in order to monitor and regulate the water levels in the different hydrological units in this area.

2. What is at stake for these projects

Djoudj National Bird Park (Le Parc National des Oiseaux du Djoudj)

The DNBP site is surrounded by a population (estimated at 3,000 inhabitants) made up of Wolofs (who form the majority), Moors and Fulas, whose lives are very closely linked to the Park. This

population, who lived on the current site of the Park before being driven off when the Park was created, is now concentrated on narrow, enclosed areas. This situation explains the confrontational nature of the relationship between these ethnic groups and the Park officers with regard to the main economic activities: agriculture, fishing, livestock farming, craft industry, trade, hunting and tourism. However, in 1994, a new natural resource management policy, based on cooperation with the different stakeholders in general and the population living in the area around the Park in particular, replaced the systematic suppression aimed at assuring the protection of the Park's resources. Henceforth, the aim has been to develop land and regenerate natural resources in impoverished environments, as well as to define the usage rights and promote the local knowledge regarding the use of the different ecosystems.

Today, the overall objective of the project is divided into five specific goals, which are also issues related to the proper running of the Park:

1. Strengthening institutional capacities (reinforcing the interventional capacities of the National Parks Management Department (DPN), of DNBP and the Information Bureau (BI).
2. Development and sustainable management of the Park (to carry out the restoration and upkeep of the Park's ecological and socio-economic functions by a rational development of its resources).
3. Action research (to provide the Park managers with the relevant scientific and technical information necessary for the conservation of the site's biodiversity and the sustainable management of its resources).
4. Development of the periphery (to contribute to the development of villages on the outskirts of the Park with a view to their participation in the sustainable management of their natural resources).
5. Environmental education (to inform and raise the awareness of the public on a local, national and international level about the Park's resources and the issues regarding their conservation).

In general, the economic assessment of the goods and services produced by the Park and its surrounding area will provide information useful for the development and sustainable management of the Park, as well as the development of the surrounding area. Today it is therefore a question of seeing to what extent the net benefits linked to the current method of management could be increased by an extension of these management activities (the development of new conservation activities, the improvement of the water regime, cooperation with the local populations regarding the definition of and respect for the rules regarding the sustainable exploitation of resources, the promotion of eco-development activities, etc.).

Diawling National Park (Le Parc National du Diawling)

The water regime, influenced by the Diama Dam, whose main aim is to prevent the dry season intrusion of salt water along the river bed, has several harmful results. On the one hand, the salinisation of the land and certain water bodies has made them impossible to use by the local populations or by the fauna and flora. On the other hand, the creation of a large area of fresh water above the dam has favoured the growth of invasive freshwater plants (*Salvinia*, *Typha*) as well as water-related diseases, which affect the fauna and, above all, the human population. As a result, this is one of the areas with the highest incidence of bilharzia and malaria in the world. The costs

of these diseases in terms of medical care and loss of labour resources, as well as the loss of productivity from livestock and the cost of veterinary care has not been assessed. Likewise, the Manantali Dam hasn't lived up to the expectations of meeting the original goals to generate artificial floodwater in order to substantially enhance the productivity of the irrigated crops and drain the basins affected by growing salinisation. On the contrary, the absence of a concerted management approach for the different water requirements from a range of stakeholders and activities (irrigated crops, agri-businesses, livestock farming) have led to a regrettable method of management, which imposes a constant maximum water level in the river all year long.

Seriously degraded when the Park was created, the ecosystems have regained most of their functions, thanks to the large amount of restoration work that has been carried out. In general, the improvement in the availability of natural resources in the few sites favoured by the development of the Park has allowed native species to resume their normal functions and has also attracted exotic species. These are now competing with the indigenous species in fishing, agriculture, livestock farming and foraging; a synergy that leads to the excessive or accelerated exploitation of resources. Moreover, the fight against invasive species (*Salvinia*, *Typha*) has been quite successful.

However, a great deal of work must still be done in order to avoid these plants invading other basins. What's more, this problem could be considerably reduced if the management of the Diama Dam allowed salt water from the Delta to flow up the riverbed periodically. Finally, the partial restoration of the ecosystems has also allowed several families to be reunited; some of their members were forced to leave their villages in the hope of diversifying the family's economic activities.

In general, the economic assessment of the goods and services produced by the Park and its surrounding area should provide information useful for the development and sustainable management of the Park, as well as the development of the surrounding area. Today it is thus a question of seeing to what extent the net benefits linked to the current method of management could be increased by an extension of these activities involving the restoration and development of other areas of the River Senegal Valley; for example through the creation of a cross-border Biosphere Reserve, as is currently being implemented.

3. Objectives and subobjectives

3.1 Identifying, assessing and quantifying the resources for direct and indirect usage and non-usage

3.1.1 Direct costs

- public investments (State, donors), private investment
- capital and running

3.1.2 Identifying and assessing in monetary terms all the uses (costs and benefits)*

Djoudj	Diawling
<ul style="list-style-type: none"> • Existence value • Drinking water supply • Agriculture • Fishing • Livestock farming • Tourism • Hunting • Craft industry • Transport • Foraging • Energy • Habitat • CO₂ sequestration • Research, education • Biodiversity conservation • Health 	<ul style="list-style-type: none"> • Existence value • Drinking water supply • Agriculture • Fishing • Livestock farming • Tourism • Hunting • Craft industry • Transport • Foraging • Energy • Habitat • Refilling the water table • CO₂ sequestration • Research, education • Biodiversity conservation • Health

*Non-assessed values: Cult value

3.2 Identification of the stakeholders and distribution of the profits

- 3.2.1 Spatial analysis (local, national, etc.)
- 3.2.2 Channel analysis and distribution of the value added
- 3.2.3 Poverty profile analysis; relative importance of natural resources (NR) for households
- 3.2.4 Assessment of the contribution of the two parks in the fight against poverty
- 3.2.5 Assessment of the contribution of the two parks in promoting women's rights
- 3.2.6 Employment, strengthening abilities
- 3.2.7 Reduction of the cost of credit
- 3.2.8 Identification of non-monetizable impacts
- 3.2.9 Social capital

3.3 Assess the profitability of the two parks compared with the past, with alternative uses of the NR (and prospective activities)

- 3.3.1 Establish a referential socio-economic situation before setting up the two parks (files, surveys)
- 3.3.2 Compare the referential situation with the current use of the study area
- 3.3.3 Identify and assess alternative use scenarios for the NR (farming, rice, market gardening, hunting, fishing)

3.4 Pass on the results to the stakeholders (decision-makers, managers, populations)

- 3.4.1 Promote new research areas (based on prospective reflection)
- 3.4.2 Provide arguments and negotiation tools for conservation in order to ensure the permanence of the parks
- 3.4.3 Help achieve a greater awareness of conservation policies within national development policies and vice versa (also on a local level)
- 3.4.4 Raise awareness and improve the consideration of the population's concerns
- 3.4.5 Facilitate a consensus on the parks' reports (existence value, management) in order to define the fields of action

Areas of reflection

- Identification of the potential for self-financing
- New activities
- Private management

Appendix B

WTP Survey Questionnaire

Questionnaire: Willingness to Pay to visit the Djoudj National Bird Park

Instructions:

Introduce yourself to the interviewee: "I am carrying out a survey for IUCN. Your opinions and the information you provide us will be used to improve the quality of the services offered by Djoudj National Bird Park. The accuracy of your replies is an essential element for the success of this research project with a view to the future development of DNBP."

Name of the interviewer: _____

Date: ____ / ____ / 2003

Contingent Valuation Methodology

I Visitor behaviour

1. In 2003, how many times did you visit DNBP (please tick the relevant box)?

- 1
- 2
- 3

2. How did you get to DNBP?

- 1 through a tour operator
- 2 by minibus
- 3 on a public service mission
- 4 through the St-Louis tourist information office
- 5 by your own means

3. How much did you spend on ecotourism in 2003?

_____ FCFA

4. Where are you from?

- 1 St-Louis
- 2 Dakar
- 3 Other parts of Senegal
- 4 DNP (RIM)
- 5 Africa
- 6 Europe
- 7 America
- 8 Asia

5. From your point of departure to DNBP, how much did you spend on the following items?

- 1) Transport _____ FCFA
- 2) Food _____ FCFA
- 3) Accommodation _____ FCFA
- Total _____ FCFA

Did you buy any handicrafts? If your answer is Yes

Where? Shop, Hotel, Other _____

Type of objects _____

How much did you spend? _____ FCFA

6. What type of improvements would you like to see in DNBP?

Park facilities and infrastructure

- Guardhouses
- Command post
- Means of locomotion
- Biological research station (accommodation)
- Catering
- Communication
- Training of park officers
- Fight against invasive plants
- Shop
- Ecomuseum
- Sick bay

Development in the park

- Pier
- Lookout points
- Nest-boxes
- Dugout canoes
- Trails
- Security

Information on DNBP

- Maps
- Plans
- Tourist information centre

Hotel

- Accommodation
- Catering
- Information

Sanitation

II The visitor's willingness-to-pay

A. If the park needs more resources to improve the services it offers visitors, how do you think these services should be financed?

- 1) Increase entry fees
- 2) Increase the budget
 - State
 - Private
- 3) Make donations to DNBP
- 4) Other means

At present, the entry fee is X, the fee for hiring a dugout canoe is X, and the price of a guided tour is X.

B. What is the maximum amount you would be willing to pay to visit the park?

- Entry fee _____ FCFA
- Dugout canoe hire _____ FCFA
- Guided tour _____ FCFA
- Total amount in CFA Francs per adult/visit _____ FCFA

III General information about the visitor

1) Nationality _____

2) Profile

Male

Female

Age _____

3) Marital status

Single

Married

Divorced

Widower/widow

4) Profession

Public administration

Private sector

Student

Retired

Other

5) Level of education

None

Primary

Secondary

Higher

6) Monthly income in Euros or FCFA _____

Appendix C

Willingness to Pay Study Design

This Annex describes the basis for the Willingness to Pay (WTP) methodology used in the analysis of demand for visits to the Djoudj National Bird Park.

Contingent Valuation Study Design

The Dichotomous Choice (DC) format has become the method of choice in most CV applications and the focus of rapid empirical development. Analysis using the DC in CVM questionnaires originates with Bishop and Heberlein's (1979) original goose-hunting experiment, which has evolved into a referendum variant, offering respondents the opportunity of saying (or voting) yes/no to the following type of question:

"Would you be willing to pay \$X? Or, if there were a vote tomorrow on a programme that would cost you/your household \$Y would you vote yes or no?"

Amounts X and Y are pre-specified and systematically allocated to sub-samples of respondents. We use a variant of this simple payment proposition in this study.

Responses provide qualitative data (yes =1/no =0) censoring the respondent's true WTP within bounds and can be modelled using a variety of methods developed in bioassay, product reliability and labour economics. It is possible to model responses within the utility-theoretic framework. Using an indirect utility function, a 'yes' response to the DC question "are you willing to pay \$A?" reveals that:

$$v(1, Y-A; S) + \epsilon_1 > v(0, Y; S) + \epsilon_0$$

The left-hand side of the equation represents the economic utility associated with enjoying the good (or product) at the cost of a certain amount of income (A). In the example presented here, this is greater than the utility expressed by the right-hand side of the equation (i.e. not having the good but retaining the original income Y).

$$v(1, Y-A; S) - v(0, Y; S) > \epsilon_0 - \epsilon_1$$

In other words, the random WTP probability depends on a utility difference part (ΔV) and a stochastic error component represented by some distribution function $F\eta$, where $\eta = \epsilon_0 - \epsilon_1$. The latter is typically assumed to be logistically distributed and using the cumulative form of this distribution yields a common logit model wherein the probability of an event taking place (in this case a positive WTP response), is monotonically linked to the selected utility difference known as the index function.

$$P_y = (1 + e^{-\Delta V})^{-1}$$

Alternatively $P_y = F\eta(\Delta V)$ and $P_n = 1 - P_y$, can be modelled parametrically using any one of a number of distributions including the normal distribution giving a probit model.

The acceptance (rejection) of a bid amount by respondent 't' in a DC format only allows the investigator to determine that the respondent's true Willingness to Pay is above or below the offer amount. Treating the respondent's true Willingness to Pay as a (for now generically distributed) random variable, it has been shown that the expected value of this random variable can be expressed in continuous form as:

$$E(WTP) = \int_{-\infty}^{\infty} bf(b)db = \int_0^{\infty} [1-F(b)]db - \int_{-\infty}^0 F(b)db$$

where F(b) is the cumulative density function representing the probability of a 'no' response and d(b), the probability density function. Since most subjects of a CV study are assumed to give positive utility, negative WTP is generally ruled out. In other words, the continuous form of the random variable is typically restricted to non-negative values.

$$E(WTP) = \int_0^{\infty} [1-F(b)]db$$

The expectation described by this function assumes that F(b) has a lower limit at zero (i.e. nobody will say no at WTP \$0) and an upper limit at 1, as bid amounts tend to infinity (that is there is some bid amount high enough to induce a certain negative response). Graphically, this implies a sigmoid function and suggests that the range of bids offered to individual respondents should be selected to insure that the extremes of the integral are 'banged down'.

The integrals are typically solved using Simpson's rule, or approximated by some trapezoidal equivalent (see Loomis, 1988). Using the parameters of the appropriate functional form – estimated in this case using a logit model – Hanemann (1984, 1989) defines mathematically equivalent formulas for the mean and median WTP. Assuming responses to be distributed logistically and using a commonly employed utility difference, Table C.1 provides the appropriate formulas using the parameters alpha and beta for a commonly-used univariate linear model such as:

$$P_y = \frac{1}{1 + e^{-\alpha+A}}$$

We use this basic form in the analysis of the WTP.

Estimation by maximum likelihood provides parameters for the chosen model that maximize the likelihood of observing the responses that were actually observed. Using the non-linear logit command in canned routines such as LIMDEP involves regressing the log of odds ratio $\ln(\pi_i/1-\pi_i)$ on A where π_i is the proportion of yes answers (Kristrom, 1990). The method estimates parameters maximizing the (log) likelihood function with respect to the model parameters, that is:

$$\ln L = \sum_{i=1}^n y_i \ln P_i + (1-y_i)\ln(1-P_i)$$

where P_i is the probability of the i^{th} individual responding 'yes' and is, in a parametric approach such as a logit model, also a function of the distributional parameters.

For the model which is linear in income (see below), it can be shown that integration is unnecessary to obtain the expected Willingness to Pay (see Kristrom, 1990, for a proof). Where the model is estimated with additional covariates, the conditional mean/median formula using alpha over beta for a model with a linear functional form can be calculated using the grand coefficient alpha which is composed of the constant plus the coefficients of the other variables multiplied by the mean value of the appropriate variable. Beta is the coefficient on the bid amount variable.

Table C.1. Welfare measures

Utility difference ΔV	Median WTP	Mean WTP	Mean WTP (positive predicted values only)
$(1)\alpha - \beta A$	$\frac{\alpha}{\beta}$	$\frac{\alpha}{\beta}$	$\frac{\log(1 + e^\alpha)}{\beta}$
$(2)\alpha + \beta \log(1 - A/Y)$	$Y[1 - e^{-\frac{\alpha}{\beta}}]$	$Y[1 - e^{-\frac{\alpha}{\beta}} \frac{\pi}{\beta \sin \frac{\pi}{\beta}}]$	no solution
$(3)\alpha_0 - \alpha_1 \log A$	$\frac{\alpha_0}{e^{\alpha_1}}$	$\frac{e^{\alpha_0} \pi}{\alpha_1 \sin \frac{\pi}{\alpha_1}}$	$\frac{e^{\alpha_0} \pi}{\alpha_1 \sin \frac{\pi}{\alpha_1}}$

Notes: Alpha and beta are model parameter estimates. The last column provides WTP estimates excluding negative part of the integral. Note that with the log transformation of bid (A), $-1 < \beta < 0$ the mean of the distribution is undefined or infinite. Even with β less than -1 the right hand tail may be given disproportionate weight.

Some percentile of the total distribution may be an appropriate point of truncation (Hanemann, 1989; Moran, 1994), in which case the expectation can be defined as:

$$E(WTP) = X_{\max} - \int_0^{X_{\max}} P(X) dX$$

$$P_y = \frac{1}{1 + e^{-\alpha + \ln A}}$$

The log-logistic – including $\ln(A)$ – was in fact the form used in Bishop and Heberlein's (1979) permit experiment.

One issue that seems to be fundamental in achieving a well-defined response curve is the choice of the bid vector to cover the relevant location of the true WTP represented by the sample mean or median. The general view is that careful choice of bid vector obviates the need to truncate a fat tail (thereby potentially underestimating $E(WTP)$), or the need to rely on the median.

Essentially, bid design is tantamount to selecting one of the explanatory variables, which, along with the underlying parameters of the assumed distribution of the WTP and the sample size, endogenously determine the efficiency and bias of the model parameters used to determine mean WTP. This is not a regular procedure in econometric research. The choices can be governed by the information sought, such that if the median is of primary interest, then we should ideally seek information close to it. This is the case with the estimate of the WTP in the present study. A bid vector can also be selected from an initial open-ended pre-test if resources are available. Alternatively, the vector (say five starting point bids), can be distributed roughly normally around a figure that the researcher may estimate as the mean. In other words, if there is an engineering cost estimate that makes a particular public project viable, it makes sense to distribute the bid range around this value to see if the benefits are sufficient to warrant the costs.

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