Socio-economic valuation of the goods and services of the Paraná Delta wetland

Carlos Galperín, Verónica Fossati and María V. Lottici

WETLANDS INTERNATIONAL

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Nature, Economics, and Environmental Policy Non-Profit Organization[1]

[1] The mission of NEPA (Nature, Economics, and Environmental Policy Non-Profit Organization), founded by Natalia Machain and Carlos Gaspar, is to motivate nature conservation and the development and intelligent use of natural resources, while trying to understand the conflicts and interrelationship between human interests and needs, offering a critical vision of today's reality and the future from the perspective of politics and economics. It was started as a non-profit organization on 6 June 2008.

Prólogue

The complex structure of the Paraná Delta harbours an underlying conflict, which is visible and open to questions about the balance between economic development and the preservation of social, cultural, and environmental interests. The region contains wealth and poverty and a great variety of resources, yet it is at risk of disappearing and vulnerable to people's difficulty in making consensus decisions, among other things.

This study is the result of ideas that were built up over the course of dialogues that came about as we tried to play a part in the understanding of the environmental problems caused by current development in the Paraná Delta by using economic instruments to contribute certain lines of thought regarding the impacts such policy decisions may have, with the intention of their being used in the planning process.

The team of authors that NEPA called upon to carry out this research has worked hard in their quest for suitable information that would enable them to pinpoint the problems of the Delta, in their study of the various activities that go on there and the interrelationships between them, and in their efforts to analyse and understand how wetland systems work so as to appropriately interpret economic data.

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Special thanks go to Fundación Humedales for its willingness to generate knowledge about new fields, and to the Ecosystem Alliance Programme within which this study was undertaken and which made it possible.

The resulting publication is valuable not only because of its findings and the original contribution it has made to the research on ecosystem description and valuation, but above all because of the potential for future research that takes this study as a starting point, not only in terms of data and references that remain to be added to those included here, but also – and above all – in terms of the possibility of asking new questions about the social and economic value of the activities that take place in the Delta and about future economic and social perspectives on these activities.

Natalia Machain

Nature, Economics, and Environmental
Policy Non-Profit Organization
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Preface and Acknowledgments

The economic valuation of natural resources can influence policy decision-making, despite the difficulties inherent in this valuation process. It has been said that one of the reasons for the damage caused to wetlands is that there is no price on many of their functions, which therefore have no economic value for decision makers.

This study begins by presenting a brief introduction to the economic valuation of natural resources. After detailing the economic activities that take place in the Paraná Delta, an estimate is given of the economic value of both these activities and of the ecosystem goods and services the Delta provides, so as to provide resources to inform public decisions about the use of the Delta, as these often tend not to take environmental effects fully into account. Given the importance of the goods and services provided by the Paraná Delta, the publication concludes with a series of reflections on the importance of considering this type of approach for decision-making on wetland management.

First of all, we wish to thank the Ecosystem Alliance initiative (Netherlands Committee for the IUCN, Wetlands International, and Both Ends) for their support for this publication.

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Executive Summary

Environmental problems can be analysed from different complementary points of view, from the perspectives of both the exact and natural sciences and the social sciences. From an economic point of view, one issue that often receives attention is the resource-allocation decisions that are taken by people, since these are what result in nature being cared for or damaged.

In order to make the environmental and natural resource management policy decision that will most benefit society whilst using the least possible resources, the consequences of such a decision and the resources it requires must be evaluated. To do so, a common unit of measurement is needed so that the different values that people assign to natural resources can be added up.

Indicating the value of a resource in monetary terms can help care for it by explicitly establishing the cost of carrying out activities which are incompatible with the conservation or preservation of said resource. With regard to ecosystems, the valuation of natural resources can influence policy decision-making despite the difficulties that characterize the valuation process, such as the uncertainty inherent in the way ecosystems function and that which originates in the incompleteness of the information available on the various processes involved.

It has been said that one of the reasons for the damage caused to wetlands is that there is no price on many of their functions, which therefore have no economic value for decision makers. This is the cause of what is called an information failure, that is, the value of wetlands is not properly understood because politicians and the general public are unaware of the role wetlands play and the consequences of the economic activities undertaken in them or nearby.

This is why the economic valuation of ecosystem goods and services has become more important in recent years. In the specific case of the Paraná Delta, the area's value is also affected by the economic activities that take place there, some of which have a long history. Some of these activities – such as fishing, hunting, and recreational and tourism-related activities – would suffer negative impacts if the wetland was not appropriately managed.

The objective of this study is to present an estimate of the value of the economic activities taking place in the Paraná Delta and of the ecosystem goods and services this wetland provides, in order to create a resource to inform public decisions about the use of the Delta, as such decisions often tend not to take environmental effects fully into account.

Such economic valuations of ecosystems are scarce, especially in Argentina. As such, both the description and the economic valuation of goods and services of the Delta contained in this study are an original research contribution. They constitute an initial approach to information that will be of interest to various fields and may serve to 'kick-start' other related new challenges. Opening the way for people to look at the Delta differently is yet another way of contributing to its protection, and is an important first step that will enable further examination of those aspects that arouse most interest and most need to be developed.

While it is not the objective of this work to analyse the sustainability of economic activities that take place in the Delta, those that are in clear conflict with the conservation of the area have not been taken into account, as is the case with oilseed production, a characteristic agricultural activity of the Pampean region adjoining the Delta. However, the valuation process does consider activities such as cattle raising, which may or may not impinge on the conservation of the wetland, depending on the type of management practices that are followed.

The valuation task is relatively simple for those economic activities for which data is available on the characteristics of the relevant goods and services, the supply of these, and the prices paid for them. However, the quality and quantity of this information is not always sufficient for the necessary calculations to be made.

This problem is even greater for ecosystem goods and services, which are generally non-market goods. In this case, the scale of the goods and services provided by the wetland over a certain period of time is based on estimates, and the values of these were obtained using a range of methods that attempt to estimate the intensity of people's preferences for these goods and services, as revealed by their behaviour or their answers to surveys, or by alternative means.

This valuation is more complex in the case of an ecosystem because of the multiple services it provides, the interrelationships between its components, and the uncertainty about the effects of human intervention on it.

The Paraná Delta provides multiple services and supplies a wide range of goods to those who live in or near it or who visit it frequently. However, the Delta also provides benefits for people who are not usually directly involved with it, as is the case with services such as climate regulation, flood control and storm buffering, the provision of habitat for wild flora and fauna, and the conservation of biodiversity.

Due to its size, the Paraná Delta includes areas with different supplies of ecological goods and services (wetland ecological units), which enable a range of productive activities to be carried out in the region. This makes the valuation process more complex than that of smaller, less diverse wetlands.

Any valuation relies on a prior assessment of the goods and services the area provides. In the case of the Paraná Delta, this study has compiled and summarized the information available on the main economic activities that take place there, such as apiculture, fishing, hunting, forestry, cattle raising, and recreation and tourism. In some cases, the existing data was supplemented by interviews with, or surveys of, the people who undertake these activities and the experts that study them.

In spite of this, a thorough characterization and valuation of the activities in question was prevented by the incomplete and biased nature of the data that it was possible to gather. Most of these activities were valued using the total income method, which consists of multiplying the quantity produced or extracted by the unit price of a product or service.

With regard to the ecosystem goods and services provided by the Delta, the benefit transfer method was used, which is based on estimates that have been made for other wetlands in order to obtain the value of the wetland to be studied. This procedure requires less time and resources than other more complex ones and is recommended for obtaining an initial approximation of the value of a resource, on the basis of which the appropriateness of an original valuation can then be assessed. Of the different benefit transfer options available, a meta-analysis function transfer was chosen, as this has been shown to provide better estimates than alternative methods.

The value that was estimated for the selected economic activities ranged from a minimum of USD 187/ha/year to a maximum of USD 372/ha/year. More than 80% of this value corresponds to cattle raising. In turn, the values obtained for the ecosystem goods and services provided by the Paraná Delta ranged from a minimum of USD 1,169/ha/year to a maximum of USD 1,277/ha/year. The sum of these two sets of values is the total economic value of these wetlands, which lies between USD 1,356/ha/year and USD 1,649. This is an initial approximation of the value of the Paraná Delta and constitutes the main original contribution of this study.

These results show the value of a set of economic activities and environmental goods and services provided by a single hectare of the Paraná Delta. Certain observations should be made regarding this. First, this calculation does not reveal the value of the modification of the study area through the loss or gain of a hectare of wetland, which is known as the marginal value and which may be higher or lower than the average value depending on the ecological and socio-economic characteristics of the area in which the hectare in question is located. Second, given the heterogeneity and size of the Delta, this average value for the region as a whole is likely to differ from the average per-hectare value within each of the ecological units the Delta is made up of. Third, this type of estimate is suitable for obtaining an initial approximation of the order or magnitude of the value in question, which makes it useful for decision-making regarding natural resource management policy, notably for land-use planning. However, it does not contribute to calculating the value of environmental damage such as the loss of a hectare of Delta due to an accident or an economic activity being undertaken that is incompatible with its conservation. This would require a site-specific valuation.

Given the importance of the goods and services of the Paraná Delta, it should be borne in mind that the information provided by this valuation is useful for decision-making on wetland management, but that it alone is not enough to ensure wetland conservation. Achieving this would require mechanisms that provide incentives to preserve these areas and maintain their supply of goods and services. This is what is known as internalization of externalities, but in more recent literature is referred to as capturing ecosystem benefits.

The valuation process carried out for this study has also revealed the shortage of the data that would be necessary to be able to value the services provided by the Delta more precisely. This is the cause of the 'information failure' mentioned at the start of this study, which is that those who make resource management decisions do not possess all the relevant information.

To correct this 'failure' it would be necessary, in the first place, to undertake a systematic survey of the available information on the production and subsistence activities that take place in the Delta, so as to reach a better understanding of them and estimate their value more rigorously. In particular, the statistical surveys carried out by government agencies would need to distinguish how much of each activity corresponds to the islands that form part of the Delta, which is not common practice.

On the other hand, in relation to ecosystem services, valuing the services of each ecological unit of the Delta would provide a more complete picture, as it is very likely that value per hectare differs according to which unit the land belongs to.

In conclusion, all of these issues relating to the valuation and use of this information contribute to the debate between the various stakeholders in the Paraná Delta, be they direct or indirect users of its goods and services, and whether or not they carry out activities that may be incompatible with care for the region, are interested in its conservation *per se* or are in charge of the design and implementation of policy measures that are instrumental to the care of the Delta and of sectoral policies relating to the economic activities that take place there.

CHAPTER ONE

Introduction

Environmental problems can be analysed from different complementary points of view, from the perspectives of both the exact and natural sciences and the social sciences. From an economic point of view, one issue that often receives attention is the resource allocation decisions that are taken by people, since these are what result in nature being cared for or damaged.

These resource allocation decisions may be taken by individuals acting within the market without state intervention, or the state may be involved to differing degrees. With regard to the problems of pollution and natural resource management, it is often argued that a certain degree of state intervention is necessary, be it through the application of active policies or the definition of legal and contractual frameworks such that people's decisions contemplate the possible consequences they may have on nature and other people.

From the economic perspective, to make the environmental and natural resource management policy decision that will most benefit society whilst using the least possible resources, the consequences of such a decision and the resources it requires must be evaluated. In other words, a cost-benefit analysis must be undertaken. To do so, a common unit of measurement is needed so that the different values that people assign to natural resources can be added up.

For economic theory, the best unit of measurement is market price, because it reveals how people value the limited resources available to them. This is not to say that market price is the only factor to be taken into consideration – what Fullerton and Stavins (1998) called the myth of market price – as many of nature's goods and services are not traded on the market and are valued by people on the basis of certain characteristics that are independent of the current or potential use that can be made of them, such as valuing an animal species that is in danger of extinction simply because its existence is important.

However, expressing all these values as units of currency facilitates their comparison, which allows the different policy measures for the care of a given natural resource to be evaluated, and influence to be exerted when decisions are made regarding sectorial economic policy measures that do not take environmental consequences into account. Indicating the value of a resource in monetary terms can help care for it by explicitly establishing the cost of carrying out activities which are incompatible with the conservation or preservation of said resource (Pearce and Turner 1990, Toman 1998). With regard to ecosystems, the valuation of natural resources can influence policy decision-making despite the difficulties that characterize the valuation process, such as the uncertainty inherent in the way ecosystems function and that which originates in the incompleteness of the information available on the various processes involved (Bingham *et al.* 1995). That is, ecosystem valuation may be necessary for effective policy decision-making but be insufficient for this and thus may need to be supplemented by other factors.

In recent years, the economic valuation of ecosystem goods and services has become more important. These services have been defined as the benefits that people obtain from ecosystems (Millennium Ecosystem Assessment 2005), where the term 'services' includes both services themselves and also goods. One particularly well-known classification (Millennium Ecosystem Assessment 2005) has divided these into provisioning services – *e.g.*, food, fibre, water; regulatory services – *e.g.*, floods, climate, water purification; cultural services – *e.g.*, recreation, tourism, cultural heritage, landscape appreciation; and supporting services, which aid the execution of other services – *e.g.*, soil formation, primary production, nutrient and water cycling.

Wetlands provide a wide range of these goods and services. For the Paraná Delta, the following services have been particularly noted: flood control, water purification, primary productivity, conservation of biodiversity, fisheries, livestock forage, native forests, uses for the area's vegetation, beekeeping, wildlife, and tourism and recreation. For a detailed description of ecosystem goods and services of the Parana Delta see Kandus *et al.* (2010).

Standard practice in the economic valuation of wetlands is to focus on the ecosystem goods and services they offer. In the case of the Paraná Delta, the area's value is also affected by the economic activities that take place there, some of which have a long history. Some of these activities are based on the ecosystem goods and services the wetland provides, as is the case for fishing, hunting, and recreational and tourism-related activities, which would suffer negative impacts if the wetland was not appropriately managed.

The objective of this study is to detail the economic activities taking place in the Paraná Delta and to present an estimate of the economic value of these activities and of the ecosystem goods and services the area provides, in order to create a resource to inform public decisions about the use of the Delta, as such decisions often tend not to take environmental effects fully into account.

Such economic valuations of ecosystems are scarce, especially in Argentina. As such, both the description and the economic valuation of goods and services of the Delta contained in this study are an original research contribution. They constitute an initial approach to information that will be of interest to various fields and may serve to 'kick-start' other related new challenges.

Opening the way for people to look at the Delta differently is yet another way of contributing to its protection, and is an important first step that will enable further examination of those aspects that arouse most interest and most need to be developed.

To this end, Chapter Two presents the problem of the economic valuation of natural resources in relation to the allocation of resources in society, their uses, the types of value that are estimated, the particular problems inherent to the valuation of an ecosystem, and the valuation methods to estimate this. As a preliminary step for the valuation of goods and services of the Paraná Delta, a characterization of the Delta is presented in Chapter Three, based on a review of available data, supplemented by information obtained through interviews with key local players and questionnaires sent out by email.

With regard to the valuation of the Delta, the value of a set of selected economic activities is estimated in Chapter Four, while the focus of Chapter Five is estimating the value of a set of ecosystem goods and services through the benefit transfer method using meta-analysis functions. In Chapter Six the total economic value of the Delta is estimated, which is the sum of the values estimated in the previous two chapters. Finally, the conclusions of the study are presented in Chapter Seven, together with recommendations regarding how it should be used in policy decision-making.

While it is not the objective of this work to analyse the sustainability of economic activities that take place in the Delta, those that are in clear conflict with the conservation of the area have not been taken into account, as is the case with commercial oilseed production, a characteristic agricultural activity in the Pampean region adjoining the Delta. However, the valuation process does consider activities such as cattle raising, which may or may not impinge on the conservation of the wetland, depending on the type of management practices that are followed (Quintana and Bó 2010a).

It is key to the economic valuation of wetlands to consider the importance of services such as freshwater provision, flood control, and water purification.

Rubén D. Quintana

CHAPTER TWO

Economic valuation of natural resources and allocation decisions

EWhen analysing social phenomena from an economic standpoint, resource allocation decisions are one of the aspects that are taken into account. In order to make these, decision makers consider different indicators, such as resource prices. Prices show the exchange ratio between two goods, and this ratio results from the decision-making processes that take place on both the supply and demand sides. This means that prices are the result of people's preferences, resource availability, and existing technology, as well as of other factors that have an impact on the supply and demand of goods.

Prices thus have two functions: an informative function, since they summarize the information related to decisions made on both the supply and demand sides; and an allocative function, for they are key elements in the resource allocation process.

How does the resource allocation process work in the case of non-market resources, which are therefore non-priced? This is the case for many natural resources which have two characteristics that make the decision-making process somewhat different from what occurs with market goods.

First, they are public goods, which means that it is very difficult to limit their use (lack of exclusion) and that two people may use them simultaneously without affecting one another (lack of rivalry in consumption). In particular, the lack of exclusion deters people from supplying this type of good, since limiting people's demand of them is not possible, and therefore a price cannot be charged for their use. This characteristic is associated with the presence of free riders – people who benefit from a certain resource without having to bear the maintenance cost of it – and as such the intensity of free riders' preferences for these goods is unknown. This is usually the case with rivers, lakes, forests, and wild flora and fauna in general.

Second, natural resources are a source of externalities, that is, they provide services that have an impact on the resource allocation decisions of a great number of people, but this impact is not reflected in any price, since they are non-market goods. For example, a river is a source of water for consumption and irrigation, and also works as a waste dump; however, in general, people who use its water and dispose of their waste in it do not usually pay for these services, and thus do not consider them sufficiently when they come to use them.

These two characteristics usually lead to an inadequate use of natural resources and, in many cases, to their degradation. In addition to this, the idea of preserving them often competes with the idea of using them for the supply of market goods, as is the case with agricultural and industrial products. When there is no valuation of natural resources, the decision to carry out economic activities outweighs the option for resource conservation or preservation. During decisions to undertake economic activities, the valuation of natural resources improves the possibility of considering the importance of such resources along with the impact these activities may have on the status of the resources in question.

This is what Freeman III (2003a) defines as the 'management problem': when managing the environment, societies must opt for the combination of environmental and non-environmental services that ensures the greatest human well-being. To this end, decision makers need to have information about the value of both market and non-market goods and services.

In the case of wetlands, one of the reasons for their degradation has been said to be the lack of market price for many of their functions, therefore, lack economic value for decision makers (Schuyt and Brander 2004, Pearce and Turner 1990). This is what Turner *et al.* (2000) call an information failure, that is, the value of wetlands is not properly understood because politicians and people in general are unaware of the role wetlands play and the consequences of the economic activities undertaken in them or nearby. For this reason, governments have fostered many activities which have been detrimental to wetland conservation, such as policies that subsidize the conversion of wetlands into agricultural lands or lands for urban development, and this is known as government failure[1].

However, resource valuation alone is not enough to enhance resource conservation. First, it may occur that people still find that the decision to carry out economic activities outweighs conservation, preservation, or sustainable use. Second, if no mechanisms exist to enable people to be aware and take advantage of the

1 This is known as government failure because the problem originates in a public policy intervention. In addition to this, there exist the traditional failures associated with the above-mentioned characteristics of public goods and externalities; these are known as market failures, because it is the market that fails to provide the appropriate signs for the decision-making process..

Rubén D. Quintana

One of the reasons for damage to wetlands has been said to be the fact that many wetland functions have no market price and, therefore, lack economic value for decision makers.

value of natural resources, then even a resource valuation showing that conservation is of greater value than the economic activities competing with it will not be enough to modify the decision in favour of preservation. According to Turner *et al.* (2000), 'the lack of a market for these off-site wetland functions limits the incentive to maintain the wetland, since the private benefits derived by the owner do not reflect the full benefits to society.' One way in which people who offer those benefits could 'take advantage' of this value is by earning an income in return, for example, in the form of payments for the environmental services provided[2].

Economic valuation of natural resources

The economic valuation of natural resource goods and services aims to estimate the value of these resources by considering how such goods and services contribute to human well-being, that is, it is an instrumental value since the goods and services are valued as a means to achieve another goal (Freeman III 2003a). This differs from other ways of understanding the value of a resource (Pearce and Turner 1990). One of these ways is to see it as an intrinsic value, that is, the resource is valued in itself and not as a means to achieve another goal, regardless of the fact that there may be people who can somehow enjoy or benefit from the resource in question. Another alternative is to consider it as a value derived from people's preferences, which are people's views on how resources should be allocated within society. These values are the basis of legal regulations and government decisions.

Most methods for the economic valuation of natural resources assume that it is people who value the resources in terms of their subjective and individual preferences. In general, these methods seek to estimate people's willingness to pay for the resource, which constitutes a measure similar to the price of market goods. Both measures indicate how much money a person is willing to pay for the resource in question. However, the resource is assumed to have a higher value than the sum of money that will be given in return (price) or that a person is willing to give in return (willingness to pay). For this reason, both price and willingness to pay show a lower bound of the economic value of the resource. Of these two measures, willingness to pay is usually greater than price paid[3]. Valuation methods which estimate willingness to pay thus result in higher values than those methods which use market prices.

2 This issue is analysed further in Chapter Seven..

When this type of valuation is made, different issues should be taken into account: the intended use, the type of value to be estimated, and the estimation method to be used. In turn, ecosystem valuation entails some additional complexities to the valuation of other types of resource. These four complexities are analysed below.

Uses of monetary valuation

This type of valuation may have different uses (Navrud and Pruckner 1997, Pearce 1992), such as:

i. project assessment: the first use of monetary valuation was its inclusion in project assessment as part of the cost-benefit analysis. The monetary valuation of environmental impacts makes it possible to compare these impacts – be they positive or negative – with economic aspects through the use of the same unit of measurement, and thus determine the economic viability of the project.

ii. environmental policy assessment: valuation was first used to assess environmental policies retrospectively; then, especially in the United States, valuation was used as a step prior to the definition and implementation of a new standard.

iii. determination of the value of damage claims: valuation is increasingly being used to determine the value of environmental damage claims. Thus, valuation methods have been developed as a result of the debates held on their application in court cases.

iv. estimation of environmental cost: it may be used to influence the decisions made by companies, either investment decisions or decisions taken during normal operation of companies, as a way to prompt them to "internalize" environmental externalities.

v. inclusion of environmental issues in national accounts estimates: for some time, ways have been sought to include environmental services and natural capital depreciation in national accounts estimates, the best-known indicator of which is gross domestic product.

vi. demonstration of the importance of natural resources for development strategies and the economy in general: valuation makes it possible to show how important natural resources and their preservation are for the development strategies of a certain region or country, and thus allows the costs related to environmental degradation to be taken into account (Pearce 1992).

Ecosystem valuation studies have been used for several of these purposes (Cropper 2000), in particular to estimate damage claims, to plan land use, and to define regulatory measures against pollution.

Value types and total economic value

In the valuation of natural resources, two types of value are estimated: use and non-use values. Use values are related to the way people use a resource. This use may be direct or indirect. Direct use values include extractive and recreation activities and those activities in which the resource is used as human habitat, i.e., resources for housing purposes. In the case of wetlands, direct use values are: fishing, agriculture, cattle raising, timber extraction, recreation, transport, and the use of wild flora and fauna (Table 1). Many of these activities are trade-related, that is, they are traded on the market and therefore priced. For this reason, both private agents and governments find it easier to value them and take them into consideration when making decisions (Barbier *et al.* 1997).

In turn, indirect use values involve ecosystem services, defined as the benefits people obtain from ecosystems (Evaluación de los Ecosistemas del Milenio 2005)[4] and which enable them to develop other activities, be they production- or consumption-related. Examples of these services are flood control, storm buffering, aquifer recharge, nutrient retention, local climate regulation, and riparian protection, among others (Table 1). Indirect use values are more difficult to quantify and are therefore usually disregarded in wetland management decisions (Barbier *et al.* 1997).

Use values also include the option value, which is the value that people place on a resource to preserve it for future use, either direct or indirect.

Non-use values refer to the value assigned to a resource merely because it exists, regardless of any type of intended present or future use. Examples of non-use values may be the importance given to a resource as part of a people's culture and tradition, the appreciation of wild flora and fauna, and the recognition of the intrinsic value of nature beyond the way in which people make use of it[5].

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[3] The difference between the value corresponding to willingness to pay and the actual price paid is called consumer surplus.

[4] This definition includes both goods and services. According to Turner *et al.* (2008), in order to carry out the valuation it is more appropriate to consider that ecosystem goods and services are those aspects of ecosystems that are consumed and/or used to bring about human well-being.

[5] For some authors, non-use values should also include the value of a resource as a legacy for future generations or as a gift to other people who may use it now or in the near future. Nevertheless, according to Pearce and Turner (1990), these two potential functions of a resource are related to use values, even when the person using the resource is not the one who assigns value to it.

This classification may be combined with a more widely used classification, such as the Millennium Ecosystem Assessment; this combination was presented in de Groot (2007). Thus, direct use values correspond to provisioning services – e.g., food, fresh water, raw materials – and cultural and recreational services – e.g., tourism, recreation, landscape appreciation; indirect use values correspond to regulation services – e.g., flood control, climate regulation, aquifer recharge; existence values correspond to certain support services – e.g., habitat maintenance for resident or migratory species; and option values correspond to any of these services. However, this is not the only possible combination, since some support services – such as nutrient recycling and retention as well as habitat – may be part of the indirect use value of a wetland.

The total economic value of a resource is then made up of use and non-use values (Pearce and Turner 1990), but two issues should be taken into account: first, values of competing activities and services should not be added up, since an activity that transforms a resource by using it may reduce the services that such a resource provided before that transformation (Pearce 1992). By way of example, an unsustainable agricultural activity may affect wild flora and fauna habitat in a way that is incompatible with their conservation. Second, when adding up the value of several services that derive from the same function, double accounting is likely to occur. For example, the service of nutrient retention is required if that of conservation of biodiversity is to be provided; however, if the individual estimations of the values of the two services are added up, the value of the nutrient retention service will be counted twice, since it is part of the value assigned to that of biodiversity (Turner *et al.* 2000)[6].

Schuyt and Brander (2004) present an estimation of some of these values at the aggregate level for a set of 89 wetlands of different types, located in countries in different continents, and with different levels of development. The highest value corresponds to amenities and recreational services, flood control, recreational fishing, and water filtering – i.e., waste treatment – (Table 2). The median per-hectare value for the wetlands analysed is US dollars (USD) 170, whereas the average value is USD 3,000, which arises from the presence of some studies with very high values[7]. It should be borne in mind that this estimation: i) does not include estimates of other wetland services due to the lack of available reliable estimates; ii) the importance of the different functions only reflects the wetlands considered; and iii) not every function has been estimated for every wetland.

Table 1.- Examples of the total economic value of a wetland.

Use value			Non-use value
Direct use value	Indirect use value	Option value	
· fishing · agriculture · fodder for livestock · timber extraction · recreation · landscape appreciation · transport · use of wild flora and fauna · water for human consumption	· flood control · storm buffering · aquifer recharge · water quality improvement · nutrient retention · climate regulation · riparian protection · pollination	· potential future uses	· culture · appreciation of flora and fauna · wild biodiversity conservation

Source: Own elaboration based on Barbier *et al*. 1997 and Brander *et al*. 2006.

[6] This occurs when adding up the values of the goods and services used directly by people (referred to as 'final' in the accounting systems of the economic activity of a region or country) and the values of the goods and services required for the existence of other goods and services (referred to as 'intermediate'). These issues are analysed further in the following section.

[7] These values are similar to those estimated by Brander *et al.* (2006): the median per-hectare value for the 80 studies reviewed is USD 150, and the average value is USD 2,800, in both cases measured at constant 1995 USD.

Table 2.- Economic value of wetland services in USD/ha/year, at 2000 prices.

Service	Median*
Amenity and recreation	492
Flood control	464
Recreational fishing	374
Water Filtering	288
Biodiversity	214
Habitat Nursery	201
Recreational hunting	123
Water Supply	45
Resources (e.g., food and wood)	45
Fuel wood	14
Total (all services)	170

* Median of the values estimated in primary studies of 89 types of wetlands in countries in different continents and with different levels of development, converted to purchasing power parity dollars and then to 2000 prices. *Source:* Schuyt and Brander (2004).

The relative importance of the different services varies depending on the study. For example, in a previous study using a different methodology and with a lower degree of precision, Costanza *et al*. (1997) estimate that flood control, water purification, and water provision are the most highly valued services. Woodward and Wui (2001) estimate that services such as birdwatching, commercial fishing, and water quality control add greater value to a wetland. Brander *et al*. (2006) find that water quality control and flood control services are the most highly valued. Ghermandi *et al*. (2009) find the most highly valued services to be water quality control, natural habitat, biodiversity, and leisure, whereas Brander *et al.* (2012) estimate that habitat and biodiversity services are the most highly valued, followed by flood control, water quality control, and recreational services.

These values also differ in terms of wetland type, which depends on the different functions of the wetland and the characteristics of the population of the place where the wetland is – e.g., income level. For example, non-vegetated sediments are the most highly valued, whereas freshwater wetlands and mangroves are the least valued (Table 3)[8].

Table 3.- Economic value by type of wetland in USD/ha/year, at 2000 prices.

Wetland type	Median*
Unvegetated Sediment	374
Freshwater Wood	208
Salt/Brackish Marsh	165
Freshwater Marsh	145
Mangrove	120

* Median of the values estimated in primary studies of 89 types of wetlands in countries in different continents and with different levels of development, converted to purchasing power parity dollars and then to 2000 prices. *Source:* Schuyt and Brander (2004).

Ghermandi *et al.* (2009) estimate the importance of different services for different types of wetlands. They find that leisure, water quality control, and water provision are the most highly valued services in marsh wetlands; whereas in riverine wetlands, the most highly valued services are commercial fishing and hunting, followed by leisure; and in estuaries the most highly valued services are water quality control and leisure.

Economic valuation of ecosystems

Ecosystem valuation entails some additional complexities due to the characteristics of the object of study. The most common practice when valuing environmental issues is to estimate the value of a particular type of resource or the environmental impact human actions have on a resource, on people's health, and on related economic activities, such as fishing, agriculture, cattle raising, buildings. However, for over 20 years, ecosystem valuation has been gaining importance due to academics' interest in improving the methods for estimating the value of environmental goods, and also to government regulations that have begun to contemplate the impact of human activities on ecosystem integrity, in particular in the United States (Bockstael *et al.* 2000).

Ecosystem valuation requires knowledge of the multiple services the ecosystem provides; some of these services may be directly linked to the production of market goods, such as fishing or hunting, and to non-market goods, such as water provision. Moreover, the process involves final services – which benefit people directly – and intermediate services – which benefit people indirectly since they are necessary for the provision of other final services.

8 A similar order by type of wetland can be found in Brander *et al*. (2006); however, according to the average value, freshwater wetlands rank second with a value of around USD 2,000/ha. In an estimation for the United States based on 34 primary studies of the country's wetlands, Randall *et al*. (2008) estimate the average value of freshwater wetlands at USD 1,048/ha, at constant 2007 prices.

Differentiating between ecosystem services and ecosystem functions is useful for the valuation process: whereas ecosystem functions are defined as an ecosystem's capacity to provide goods and services that satisfy human needs (de Groot *et al.* 2002), ecosystem services are understood as the benefits that societies obtain from ecosystem functions. The most common practice is to value the goods and services that people take advantage of (Ansink *et al.* 2008), since it is people who carry out the valuation[9].

Additionally to this, there are other issues that make ecosystem valuation more difficult (Table 4). First, an ecosystem may provide multiple services at the same time, known as joint service provision, that is, each component of the ecosystem may provide different services (Freeman III 2003b), which in economic theory is known as multi-product production systems. In these cases, the value of an ecosystem component is equal to the sum of the value of all the services that component provides. However, it is important to consider the problems mentioned in the previous section, namely: i) the sum of values – the total value of the ecosystem is not always equal to the sum of the values of all the services when some are incompatible with others; and ii) double accounting – the value of a function that an intermediate service provides to a final one is part of the value assigned to the final service.

Table 4.-	Additional difficulties in ecosystem valuation.
1.	Joint service provision
2.	Substitute and complementary relationships between services
3.	Difficulty in understanding all existing interrelationships
4.	Differentiation between the value of a marginal change and the value of a complete change
5.	Non-linear ecosystem response to an external shock
6.	People's difficulty in perceiving services with indirect use value

Joint service provision is also related to the problem of assigning a value to a natural resource management policy involving an ecosystem. In this case, estimating the value of each of the benefits of such a policy separately and then adding them up may lead to an overestimation of the overall benefit (Hoehn and Randall 1989). This occurs because a basic aspect of valuation is being disregarded: the value that people place on the goods and services they receive is limited by their income, the so-called budget constraint. In these cases, it is appropriate to calculate the value that people place on the services involved as a whole and not the sum of the value of each separate service.

Second, in an ecosystem there may be substitute and complementary relationships between services that affect the valuation method (Freeman III 2003b). When two services are complementary, a human activity that affects the provision of services might lead, at the same time, to a decline in the complementary service, which implies that the value of the affected service will be greater when this complementary relationship is taken into account than when it is ignored. On the other hand, in substitute relationships, a service may be substituted by the service provided by other element of the same ecosystem or of a nearby ecosystem. In this case, the value of a service will be lower when there is a substitute than when there is not, and the sum of the value of each of the services considered separately will be lower than the value of the two considered together[10] Therefore, valuing a service without considering the remaining services may yield different results than when these interrelationships are taken into account.

Third, the difficulty in understanding all the interrelationships existing in an ecosystem so as to be able to assess the complete impact of a certain human intervention leads to not all the services affected being valued and thus to benefits of ecosystem protection being undervalued (Bockstael *et al.* 2000).

Fourth, for ecosystem management policy decisions to be made, the relevant issue is the value of the marginal change and not that of a complete change. This is based on the fact that when people assign value to a certain good, they think about the value they are willing to pay for an additional unit of said good, known as a marginal unit, which in an ecosystem could be a hectare. In this sense, this approach may help to determine whether the value of an additional hectare which will be given over to an economic activity is greater or not than the value of the economic activity to be carried out there (Fisher *et al.* 2008). The marginal unit is the relevant unit for the decision-making process in each case. For this reason, it is important to define the size of the marginal change to be considered in each situation[11].

[9] In this way, ecosystem functions are valued by considering the value of the goods and services provided by an ecosystem, since these functions can be compared to a stock of natural capital that produces a flow of goods and services that people take advantage of (Costanza *et al.* 1997, Ansink *et al.* 2008).

[10] This is the case because if the resource that provides a certain service is affected, there is an alternative to replace it, whereas if both resources are affected simultaneously, people stop receiving the service.

[11] These types of issues came up in the debate started by Costanza *et al.* (1997), who estimated the value of all the ecosystems in the world. One of the criticisms they received was that the total number of ecosystems is not a relevant unit for people's decisions when comparing two alternative situations, which, in this case, would be the presence or absence of ecosystems in the world. Thus, it would be pointless for a natural resource management policy to know how much people are willing to receive as compensation to prevent

Due to the difficulty found in defining both the marginal unit that is affected and the complexity of the interrelationships between ecosystem functions, empirical studies usually assess the value of the services provided by an average hectare[12] and not by a marginal hectare (Fisher *et al.* 2008), and so do the studies on wetlands (Brander *et al.* 2006). Using average values gives the impression that each hectare of the ecosystem has the same value, which is not necessarily the case (Brander *et al.* 2006). This can be observed in two results obtained from empirical studies. First, in economic theory the assumption is that the scarcer a resource, the greater its value. It is for this reason that empirical studies usually find that the value of the loss of a hectare in a large ecosystem is lower than the value of such a loss in a small ecosystem; this phenomenon is known as decreasing returns to scale. And, second, marginal values per hectare tend to be higher than average values per hectare[13].

Fifth, the interrelationship of the different ecosystem functions prevents the response to an external shock from always being linear and able to be extrapolated to previous experiences. For this reason, the valuation of ecosystems has been focused more on changes to their physical size than on changes to other characteristics (Freeman III 2003b). This is related to the above-mentioned issue of determining the size of the marginal unit, since certain changes may lead to significant modifications of the whole ecosystem, either because the change is large or because it is small but capable of reducing the provision of ecosystem services to below a certain threshold or minimum essential level for normal ecosystem functioning (Fisher *et al.* 2008). In turn, the greater the change, the more complex its effects will be and, therefore, the greater the difficulty in estimating monetary value (Bockstael *et al.* 2000).

Lastly, services with indirect use value need indicators that associate them with other activities which can be more easily interpreted and perceived by the people who value the resource (Cropper 2000). For example, it is easier to interpret the service of nutrient retention by looking at the effects it has on fishing and agricultural and forestry activities than by looking at the service in itself.

Valuation methods

Taking into account the economic concept of value used at the beginning of this chapter – that is, the subjective value assigned by people according to their preferences – a certain value can be calculated by using a range of methods that differ from one another in terms of type of approach and degree of complexity.

A recent classification divides valuation methods according to the way in which they estimate people's preferences for the resource, namely: i) revealed preference methods and ii) stated preference methods.

With revealed preference methods, the estimation is carried out by observing people's behaviour through the demand for market goods which are related to the non-market resource that is to be valued. For example, the value of the impact of an activity affecting the fish in the wetland is estimated by means of a dose-response function that relates human action with the variation in the number of fish, and that variation is then multiplied by the price at which fish are sold (change in production method). If the wetland is seen as an input for an economic activity, the value of the contribution of wetland services to such an activity may be estimated by subtracting the cost of the other inputs used from the total income of such an activity (net factor income method). The value of flood protection services may be estimated by considering the costs of the works and other actions that would need to be carried out for flood protection if the wetland cannot provide this service (avoided cost method). The value of a protected area can be roughly estimated by considering visitors' costs in reaching it (travel cost method). Furthermore, people owning real estate close to a resource benefit from the services it provides, which may be reflected in the price of the property (hedonic pricing method).

Likewise, the value of a service can be estimated by considering the total revenue generated by an activity such as apiculture (total income or market price method). This is a simple and user-friendly method when a market good needs to be analysed; however, on the one hand, it may underestimate the value of this good since it cannot estimate how much consumers are willing to pay above the price they actually pay (consumer surplus) and, on the other hand, it may overestimate its value if the production or capture cost is not subtracted (overestimation of producer surplus). When no market price is available, the price of a similar good may be used (substitute price method).

In turn, stated preference methods estimate value by directly eliciting people's responses, thus simulating a hypothetical resource market. The best-known stated preference method is the contingent valuation method, which elicits people's responses with respect to their willingness to pay for the resource. Another, more recent, stated preference method is the contingent behaviour method, which elicits people's answers with

every ecosystems in the world from disappearing, because the alternative would be 'nothing', that is, these ecosystems are essential for human life and the value of essential goods is infinite (Bockstael *et al.* 2000).

[12] The average value is calculated by dividing the total value of ecosystem services by the ecosystem area.

[13] This difference can be explained by the fact that the value of a marginal change will be less limited by people's income than the total value of the ecosystem from which average values are estimated (Brander *et al.* 2012). This implies that people's willingness to pay is limited by their income, as is also the case with the demand for market goods.

Table 5.- Most widely used methods for valuing different wetland services. PF: production function / factor income; MP: market price / total income / substitute price; AC: avoided cost; TC: travel cost HP: hedonic prices; CV: contingent valuation / contingent behaviour.

Servicio del humedal	PF	MP	AC	TC	HP	CV
Flood control and storm buffering	●		●		●	●
Water provision	●	●		●	●	●
Water quality	●					●
Recreational and commercial fishing and hunting	●	●		●		●
Harvesting of natural materials	●	●				
Recreation and leisure		●		●	●	●
Biodiversity and habitat conservation				●	●	●
Carbon sequestration			●			

Source: Own elaboration based on Woodward and Wui (2001), Brander *et al.* (2006), and Turner *et al.* (2008).

respect to the actions they would take in relation to the resource. These actions can then be associated with a market price – e.g., the value of a park can be estimated by calculating the travel cost to similar alternative destinations they would visit if the park was affected.

Estimations of revealed preference methods usually require less time and fewer resources, but they only allow use values to be calculated. Stated preference methods are more complex, but they also allow for the estimation of non-use values. Therefore, the choice of method will depend on what is to be valued and on the availability of time and other resources.

These methods come up against some common problems which usually arise in the valuation of different resources, especially when what is to be estimated is the value of a wetland (Turner *et al.* 2008). The most common problems are: lack of data; use regulations that modify the price paid for the goods extracted from the wetland and the services it provides; an incomplete understanding of the relationship between the wetland and the quality of the services that users and consumers receive; and the difficulty in understanding the different interrelationships between the multiple elements of the wetland.

Both revealed preference methods and stated preference methods have been used to estimate the value of wetland services (Table 5). Of these, the methods that best approximate the total value of a wetland are the stated preference methods, since they allow for the estimation of both use and non-use values and ensure a more appropriate consideration of consumer surplus (Turner *et al.* 2008).

An alternative method for reaching a rough estimate of the value of a resource without having to conduct a primary study of the area of interest is the benefit transfer method. Since this is the method used in this study, it is described in full in the following section.

Benefit transfer

The benefit transfer method uses the estimate of the value of a given site (known as the study site) to calculate the value of a similar resource at another site (known as the policy site).

This method is highly useful in cases in which there is either not much time to make a decision or very few resources to conduct a primary study on the site to be valued. It is used to i) assess policy measures that affect natural and environmental resources; ii) conduct a preliminary assessment of the value of negative environmental impacts; and iii) determine whether an original estimate of the policy site is required or not (Rosenberg and Loomis 2003).

Benefit transfer valuation is recommended in cases in which the need for precision is not great, because this type of valuation may differ considerably from the valuation that would result from a primary study (Navrud 2000). For example, it is recommended for the preliminary assessment of projects and policies in which an initial approximation of the value of the resource may be enough to determine whether the policy is convenient, but it proves less suitable for determining environmental costs and damage claims.

There are two types of transfer methods: i) value transfer, and ii) function transfer (Rosenberg and Loomis 2003). In value transfer, a certain measure of the value of the study site – either the value of another site or the average value of different sites – is applied to the policy site. In function transfers, the function used for the estimation is transferred: the parameters estimated in other sites are applied to the values of the variables of the site to be valued. In general, function transfers are considered to provide better estimates than value transfers, since the estimate can be adapted to the characteristics of the policy site (Rosenberg and Loomis 2003).

However, the benefit transfer method usually presents three types of errors: generalization, measurement, and publication selection errors (Rosenberg and Stanley 2006). The generalization error occurs when the value of the study site is adapted to estimate the value of the policy site. The greater the similarity between the two sites in terms of their physical characteristics and the social, cultural, and economic factors that surround them, the smaller this error will be. It will also be smaller if a function transfer rather than a value transfer is made. The measurement error is inherent to the estimation process in primary studies and is related to the method chosen and the data used. Lastly, the publication selection error refers to the fact that the only research studies that are usually published are those which are innovative from the methodological point of view and not those that do not provide any new approach despite their results being useful for benefit transfer. In addition to these three errors, Hoehn (2006) considers that there is a research priority selection bias, since research studies are carried out according to the priority placed on them by those who finance them and to the degree of importance the ecosystem has for a certain segment of the public.

A more recent variant of the function transfer is the so-called meta-analysis function transfer. Meta-analysis is a procedure that was originally designed to statistically analyse the results of different quantitative estimations and relate them with the variables that can affect such results; however, it can also be used to estimate the values of other sites. It is used to study different issues, such as the monetary valuation of natural resources, for example.

In order to use it for benefit transfer, the values of the estimated function need to be adjusted to the characteristics of the site to be valued. After this adjustment has been made, the resulting value is calculated. For this purpose, there is a need for meta-analysis estimates that have valued the same type of resource and that include – as explanatory variables – both information about the estimation methods used and also the characteristics of the sites featured in the studies reviewed, e.g. area, services provided by the resource, and socioeconomic aspects[14].

According to Bergstrom and Taylor (2006), the type of variable included in the meta-analysis function affects the strength of the theoretical basis for the estimate. For example, an estimate based principally on utility theory[15] should include core economic variables, such as the prices of market goods, household incomes, and household characteristics (strong structural utility theoretic approach). In turn, the theoretical basis will be weaker if variables relative to the estimation method are included, as these are not linked to the utility people derive from the resource (weak structural approach to utility theory); and it would not be based on utility theory if it lacked core economic variables (non-structural utility theoretic approach).

Meta-analysis for benefit transfer has some advantages over function transfer from a single study. First, it reduces the impact that the characteristics specific to each study have on the average value that is estimated. Second, it makes it possible to consider the differences resulting from the valuation methods used in the studies reviewed and the differences between the characteristics of the study sites and those of the policy site (Lindhjem and Navrud 2008). Furthermore, in addition to these generalization and measurement errors, it has been claimed that meta-analysis can also correct publication selection and research priority selection errors, since a greater number of studies can be considered (Hoehn 2006, Rosenberg and Stanley 2006).

In the case of meta-analysis regressions for wetlands, the studies carried out by Woodward and Wui (2001), Brander *et al.* (2006), Ghermandi *et al.* (2009) and Brander *et al.* (2012) stand out and are all suitable for benefit transfer. There are two key differences between these studies. First, the most recent ones include more primary valuations in their estimates – that is, they do not include studies which used benefit transfer. Second, the last three studies mentioned include socioeconomic population characteristics, the geographic characteristics of the wetland, and the type of wetland under study as explanatory variables in the meta-analysis regression. Therefore, according to Bergstrom and Taylor's approach (2006), all these studies have a strong theoretical basis.

An additional issue, known as international benefit transfer, refers to whether or not it is appropriate to use benefit transfer to make estimates for policy sites located in a different country to that of the study site. This type of transfer is increasingly sought after because most primary studies correspond to the United States and Europe, but demand for resource valuation is on the rise in other regions.

To this end, it is recommended that some adjustments be made when carrying out international benefit transfer (Ready and Navrud 2006), namely that: i) a common currency be used by converting the currencies in the different studies through the purchasing power parity exchange rate; ii) the differences between the population income of the policy site and that of the study site be adjusted; iii) cultural differences be taken into account (it is preferable for studies to concern similar populations in countries with similar characteristics); iv) the most recent studies be chosen over older ones as valuations change over time; v) the size of the population involved in the valuations be taken into consideration, along with their distance from the resource to be valued (that is, whether they consider the resource to be national or local).

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[14] The objective of some meta-analysis studies is to assess the impact different valuation methods have on the estimated value, and thus these studies are not suitable for benefit transfer (Navrud 2000).

[15] Utility theory intends to relate the goods a person can access with the level of satisfaction of their needs. In this case, the willingness to pay for an environmental resource is associated with the utility people derive from this resource.

According to some validity studies on international benefit transfer which compare the value obtained through benefit transfer with the value resulting from a primary study, Ready and Navrud (2006) conclude that the estimation error may be between 20% and 40% if average values are used, whereas it may be over 100% if a value transfer is made. In a meta-analysis study of international benefit transfer, Lindhjem and Navrud (2008) find errors within the margins mentioned above[16]. A margin of error of nearly 70% has been claimed to be acceptable when the estimate is required to make a decision in favour of wetland conservation (Brander *et al.* 2006).

[16] However, in their analysis of a specific case, Lindhjem and Navrud (2008) also find that using meta-analysis for international benefit transfer does not necessarily yield fewer errors than a transfer of local and international average values.

CHAPTER THREE

Characterization of the area of study

The aim of this chapter is to carry out a preliminary socioeconomic characterization of the Paraná Delta, as a preliminary step for the valuation of the area's main goods and services.

As stated in the Environmental Baseline Study entitled 'Comprehensive Strategic Plan for the Conservation and Sustainable Exploitation of the Paraná Delta (PIECAS-DP)' (Environmental and Sustainable Development Secretariat 2011), there are different approaches regarding the geographic area this region occupies[1]. The definition used herein will be that of Appendix II to the document entitled 'Comprehensive Strategic Plan for the Conservation and Sustainable Exploitation of the Paraná Delta (PIECAS-DP)' (Environmental and Sustainable Development Secretariat 2008), according to which the Paraná Delta encompasses the area delimited by the north-eastern end of Buenos Aires province, the south of Entre Ríos province and a relatively small strip to the west of Santa Fe province. In Entre Ríos, the Delta covers part of the departments of Paraná, Diamante, Victoria, Gualeguay, Gualeguaychú, and the entire department of Islas de Ibicuy. In Buenos Aires province, it includes parts of the districts of San Nicolás, Ramallo, San Pedro, Baradero, Zárate, Campana, Escobar, Tigre, and San Fernando. In Santa Fe, it stretches across the departments of San Jerónimo, San Lorenzo, La Capital, and Rosario.

The surface area considered by this study totals approximately 22,587 km^2 (Environmental and Sustainable Development Secretariat 2011). Most of this is located in Entre Ríos province (82.2%), whereas the rest corresponds to the provinces of Buenos Aires (16.3%) and Santa Fe (1.5%).

The Paraná Delta basin consists of three main regions between Diamante and the river estuary: the Upper Delta, which stretches from Diamante, Entre Ríos, to Villa Constitución, Santa Fe; the Middle Delta, from Villa Constitución to Ibicuy, Entre Ríos; and the Lower Delta, also known as the area under formation, from Ibicuy to the estuary (Environmental and Sustainable Development Secretariat 2008). Strictly speaking, the region lying north of Diamante up to the department of La Capital is the Pre-Delta and Middle Paraná Islands (Environmental and Sustainable Development Secretariat 2011).

The Paraná Delta region lies close to Argentina's greatest urban-industrial belt. Paradoxically, the area is perceived as underdeveloped and marginal due to how difficult it is to reach and the harshness of life on the islands. Detailed socioeconomic information for this particular region is scarce and fragmentary. As such, the data that is available on different scales will be used to characterize the area (Figure 1).

i) General data: information available at national or province level (for the provinces of Buenos Aires, Entre Ríos and Santa Fe).

ii) Delta Matrix: information at the level of the 19 departments/districts[2] that make up the Paraná Delta region. This is the matrix of the Pampa region, which encompasses the Paraná Delta region.

iii) Paraná Delta: specific information on the delta itself; that is, data referring to the islands belonging to the 19 departments that comprise the Paraná Delta.

Population

In 2010, the population of the districts comprising the Paraná Delta matrix totalled 3,784,938 inhabitants, 9.4% of the country's total population (Table 6). The population growth rate between 2001 and 2010 was at 9.5%; that is, 1.1 percentage points below the national average.

The largest cities are the capital districts of Santa Fe and Entre Ríos provinces, Rosario in Santa Fe province, and Tigre and Escobar in Buenos Aires province. The latter two cities showed the greatest population growth between censuses, followed by Ramallo, Campana, Zárate, and Baradero, all in Buenos Aires, and the department of San Lorenzo in Santa Fe.

The rural population[3] was 5.1% of the total for the Delta matrix, less than the figure for the whole country, which was at 10.6%. Nevertheless, in some departments – mainly in Entre Ríos and some in Buenos Aires – the share of the rural population was much higher, especially in Islas de Ibicuy, where it reached almost 67% of the population, and in Diamante, where it was nearly 29%.

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1 The most traditional definition of the Paraná Delta area is that proposed by Malvárez (1997), according to whom the area extends over 17,500 km^2 and includes the department of Constitución (Santa Fe province), but does not include the departments of Paraná (Entre Ríos province) or La Capital (Santa Fe province).

2 In Buenos Aires province, these territorial divisions are called 'districts', whereas in Entre Ríos and Santa Fe, they are referred to as 'departments'. Both terms will be used indistinctly throughout the rest of this study.

3 As classified by INDEC (National Institute of Statistics and Censuses), the rural population is that which is grouped in districts of less than 2,000 inhabitants and scattered through the countryside. This data corresponds to 2001, since the specific information on urban and rural populations from the 2010 Census is not available yet.

Table 6.- Total Population, intercensal growth, population density, and rural population share for the Delta matrix.

Province	Department/ District	Population		Population Density (people/km²)	% Rural Pop. (2001)
		2010	Intercensal growth (2001–2010)		
Buenos Aires	Baradero	32,761	10.8%	20.6	15.8%
	Campana	94,461	12.9%	99.0	4.2%
	Escobar	213,619	19.9%	703.3	2.8%
	Ramallo	33,042	13.2%	34.7	13.9%
	San Fernando	163,240	8.0%	186.1	2.0%
	San Nicolás	145,857	5.8%	223.6	1.8%
	San Pedro	59,036	6.9%	44.7	14.7%
	Tigre	376,381	25.0%	1.236.7	1.7%
	Zárate	114,269	12.8%	96.1	6.1%
Entre Ríos	Diamante	46,361	5.1%	16.7	28.6%
	Gualeguay	51,883	7.8%	7.2	17.1%
	Gualeguaychú	109,461	8.0%	15.4	12.7%
	Islas de Ibicuy	12,077	5.0%	2.7	66.8%
	Paraná	339,930	6.4%	68.3	7.4%
	Victoria	35,767	4.9%	5.2	18.4%
Santa Fe	La Capital	525,093	7.3%	171.9	5.0%
	Rosario	1,193,605	6.4%	631.5	2.3%
	San Jerónimo	80,840	4.6%	18.9	9.7%
	San Lorenzo	157,255	10.7%	84.2	3.7%
Delta Matrix		**3,784,938**	**9.5%**	**72.0**	**5.1%**
Country Aggregate		**40,117,096**	**10.6%**	**10.7**	**10.6%**

Source: INDEC (2001 and 2010).

The land covered by these 19 districts totals 52,572 km^2 and the population density is 72 people/km^2, significantly greater than the average for the entire country (10.7 people/km^2). Population density is high in the districts of Tigre, Escobar and Rosario, whereas it is low in Islas de Ibicuy and Victoria.

As regards the population that inhabits the Delta itself, available data is incomplete and out of date. Population censuses do not usually distinguish between those living on islands and on the mainland, for which reason it is sometimes necessary to resort to estimates.

Historical data reveals that there was considerable emigration from the area between the 1940s and 1990s. Estimates show that, around 1940, the population of the Delta totalled 25,000 inhabitants, decreasing to 22,126 in 1960, and plunging to 12,000 in 1970 (Taller Ecologista 2010b, based on Galafassi 2005). The 2001 Census[4] data indicates that the population then increased once more, reaching approximately 24,000 inhabitants (Table 7), with very low population density (1.5 people/km^2).

The most populated area within the region is the Lower Delta. The number of inhabitants there went down from 20,000 in 1940 to 14,712 in 1960. By 1980 the population had shrunk to 12,220, and in 1991 there were 9,333 inhabitants (Taller Ecologista 2010b, based on Galafassi 2005). Population density dropped from 5.2 to 3.3 people/km^2 between 1960 and 1991, while in 2001, according to the latest data available, the population was at approximately 11,000 people with a population density of 4 people/km^2.

[4] Population data by district from the 2010 Census has not been released yet, which makes it impossible to estimate the current population of this area.

Table 7.-	Population inhabiting the Paraná Delta region, by district for 2001.		
Province	**Department / District**	**Island population**	
Buenos Aires	Baradero	163	*
	Campana	1,221	*
	Escobar	510	*
	Ramallo	48	*
	San Fernando	3,067	*
	San Nicolás	22	*
	San Pedro	42	*
	Tigre	5,034	*
	Zárate	402	*
	Sub-total	**10,509**	
Entre Ríos	Diamante	n/d	
	Gualeguay	n/d	
	Gualeguaychú	n/d	
	Islas de Ibicuy	11,498	*
	Paraná	n/d	
	Victoria	1,007	***
	Sub-total	**12,505**	a
Santa Fe	Rosario	65	**
	San Jerónimo	14	**
	San Lorenzo	18	**
	La Capital	253	**
	Sub-total	**350**	
Paraná Delta		**24,318**	

n.a.: not-avlable

a. According to the Environmental Baseline study carried out by PIECAS-DP (Environmental and Sustainable Development Secretariat 2011), based on data from the Entre Ríos Statistics and Censuses Directorate, 13,459 residents live on islands of the Delta within Entre Ríos.

Sources: * INDEC (2001); ** Environmental and Sustainable Development Secretariat (2011); *** Taller Ecologista (2010b).

Gross Geographic Product

The most comprehensive statistical instrument for measuring economic activity is Gross Geographic Product (GGP), which offers a systematic and detailed description of the economy as a whole and of its components. However, GGP measurements are not usually carried out at district level[5], let alone in even greater detail. Likewise, statistics by district do not allow the distinguishing features of the Delta area to be appreciated in comparison with the mainland. As such, GGP data is presented at province level only, that is to say, at the general level described above.

In 2009, the Gross Geographic Product – in Argentine pesos (ARS) – of the three provinces involved totalled ARS 157,673 million (at constant 1993 prices), equal to 44.3% of Argentina's Gross Domestic Product (GDP) (Table 8). The most important sector was the manufacturing industry (23.1% of the product of the three provinces taken together), followed by real estate and business services (16.5%), transport services (15%), and commerce (13.1%).

Main economic activities in the Paraná Delta

This section presents a brief description of the main economic activities in the Paraná Delta, including – in most cases – data that will then be useful for the valuation process.

Data corresponding to the Delta itself was used whenever available. When this data was lacking, the closest possible estimates for the region of study were made. Otherwise, the Delta matrix and general scales defined at the beginning of this chapter were used, and any limitations to these calculations were indicated. Annual information for 2007–2011 is provided. The absence of data for any given year has been pointed out in the relevant section.

Apiculture

Apiculture is one of the most important activities in the Paraná Delta and it is carried out almost everywhere in the region. Geographically speaking, it coexists with other production activities, and takes place on both domestic and commercial scales. One of its main advantages is that it uses the native flora as its input[6], and thus has no negative impact on the natural environment.

Compared to surrounding regions, which are characterized by large areas of monocultures, the varied flora of the Delta region favours apicultural production, giving rise to high yields of quality products (Basilio *et al.* 2010). The islands are considered one of the most productive apicultural regions in Argentina, boasting averages of 50–80 kg/hive/year, compared with those of the mainland, which are near 20–30 kg/hive/year. Nevertheless, productivity varies according to environmental conditions, particularly water levels (Taller Ecologista 2010a).

5 The only exception is Buenos Aires province, which provides GGP data by district. Appendix I includes GGP data corresponding to those Buenos Aires districts that make up the Delta matrix.

6 In the Middle Delta, output is almost entirely obtained from native wild plants. In the Lower Delta, however, apiculture relies on species that have been introduced for afforestation purposes and invasive exotic species (Taller Ecologista 2010a).

Table 8.- GGP by province, in millions of ARS, according to activity sector for 2009. Producer prices, at constant 1993 prices.

Activity sector	Buenos Aires*	Entre Ríos**	Santa Fe***	Total[a]
Goods-producing sectors	**45,458**	**2,360**	**8,626**	**56,444**
Agriculture, hunting and forestry	3,864	658	2,374	6,896
Fishing	125	1	7	133
Mining and quarrying	99	26	5	130
Manufacturing	31,009	882	4,577	36,468
Electricity, gas, and water supply	2,859	235	895	3,989
Construction	7,502	558	768	8,828
Service sectors	**76,831**	**5,432**	**18,966**	**101,229**
Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods	14,574	1,575	4,475	20,624
Hotels and restaurants	2,383	103	223	2,709
Transport, storage, and communications	20,880	673	2,079	23,633
Financial intermediation	2,703	260	1,054	4,017
Real estate, renting and business activities	17,617	806	7,589	26,012
Public administration and defence	4,327	687	242	5,256
Education, health and social work	7,312	950	2,405	10,667
Other community, social and personal service activities and private households with employed persons	7,035	378	898	8,311
Total	**122,289**	**7,792**	**27,592**	**157,673**

a. This total has been calculated in order to make a rough estimate of each sector's share in the regional GGP. Due to differences in the calculation method used by each province, the total for the region cannot be calculated by adding up the total for each province.

Sources: * Buenos Aires Statistics Directorate, www.ec.gba.gov.ar; ** Entre Ríos Statistics and Censuses Directorate, www.entrerios.gov.ar; *** Santa Fe Statistics and Censuses Institute, www.santafe.gov.ar.

Apiculture comes into conflict with cattle raising, since cows tend to destroy many components of bee flora by eating or trampling plants. Another adverse factor is fire, which is used in the area as a cattle herding tool, destroying not only plants but hives, too (Quintana and Bó 2010a).

As is the case in the rest of Argentina, honey production in the islands is highly informal and somewhat disorganized (Taller Ecologista 2010a). This might be one of the reasons which made it impossible to obtain specific information on apicultural production in the Paraná Delta. Therefore, the information presented below corresponds first to the Delta matrix and then to a more general scale (the whole country and by province).

The districts that make up the Delta matrix encompass approximately 256,000 hives and slightly more than 1,800 producers[7] (Table 9); that is, 6.4% of the hives and 5.5% of the producers in the whole country. Table 9 also includes honey production data for the 2009/2010 harvest in the districts of Entre Ríos province, which are the only ones for which detailed information was obtained.

Argentina is one of the top five producers of honey in the world. Nevertheless, output has dropped over the last few years, shrinking from an average 84,000 tonnes per year in 2000–2008 to an average 60,000 tonnes per year in 2009–2010 (Blengino 2012)[8].

Nearly all of Argentina's apiculture output (honey and beeswax) is exported. In 2011, exports – in US dollars (USD) – reached USD 226.3 million (Table 10). The main export product is bulk honey, although other by-products, such as beeswax, packaged honey, propolis, and live bees are also exported.

More than 56% of honey producers and almost 70% of hives are concentrated in the provinces of Buenos Aires, Entre Ríos, and Santa Fe (Table 11). Furthermore, they account for 66% of the national output[9] (Bedascarrasbure 2009) and 71% of exports.

7 Estimates were based on data from different producer registries (national and by province).

8 It is estimated that honey output for 2012 will reach 60,000 tonnes, rather less than in 2011, when it totalled 80,000 tonnes (Boyadjián 2012).

9 Approximately 50% of total output is concentrated in Buenos Aires province, whereas Santa Fe and Entre Ríos each contribute around 8% of the national total.

Table 9.-	Number of hives and producers and honey output (in kg), by department for the Delta matrix.		
Department / District	**No. of hives**	**No. of producers**	**Output (kg)**
Buenos Aires[a]*	25,181	252	na.
Entre Ríos**			
Diamante	10,753	62	96,595
Gualeguay	16,637	76	20,649
Gualeguaychú	57,914	138	22,823
Islas de Ibicuy	9,737	56	685,204
Paraná	57,559	326	686,708
Victoria	27,253	126	304,563
Santa Fe***			
La Capital	12,928	301	n.a.
Rosario	11,487	299	n.a.
San Jerónimo	18,362	129	n.a.
San Lorenzo	8,553	70	n.a.
Delta matrix total	**256,364**	**1,835**	**-**

LETyE

n.a.: not available

a. This value includes data for the nine districts that this study considers make up the Buenos Aires Delta matrix and for Pilar district. It is not possible to break this data down by district.

Sources: * Buenos Aires Ministry of Agriculture. Regional apiculture committees. 2009. www.maa.gba.gov.ar; ** Apiculture Department, Entre Ríos Dairy and Farming Directorate. Output data for 2009/2010 harvest. Entre Ríos Environmental Secretariat, www.entrerios.gov.ar; *** Santa Fe Ministry of Production. Apicultural production chain. 2008. www.santafe.gov.ar.

Table 10.-	Argentine honey output and exports in 2007–2011.					
		2007	**2008**	**2009**	**2010**	**2011**
Output						
Natural honey	tonnes	81,000	72,000	62,000	59,000	80,000
Argentine exports						
Natural honey	thousands of USD	134,152	181,005	160,291	173,217	223,448
	tonnes	79,861	69,113	57,969	57,250	72,356
Beeswax	miles de US$	3,290	3,207	2,735	3,149	2,915
	tonnes	822	726	594	652	572
Exportaciones provinciales (miel natural y cera de abejas)						
Buenos Aires	thousands of USD	66,183	88,657	78,457	84,884	108,904
	tonnes	38,808	33,593	28,169	27,853	35,072
Entre Ríos	thousands of USD	11,365	15,227	13,476	14,579	18,708
	tonnes	6,667	5,771	4,839	4,785	6,026
Santa Fe	thousands of USD	20,258	27,177	24,054	26,018	33,417
	tonnes	11,916	10,314	8,649	8,550	10,774

Source: INDEC www.indec.com.ar and Ministry of Agriculture, Livestock, and Fishing, www.minagri.gob.ar.

Table 11.-	Distribution of hives and producers by province in 2008.				
Province	**No. of hives**	**%**	**No. of producers**	**%**	**Hives / producer**
Buenos Aires	1,652,400	41.4	10,200	30.8	162
Entre Ríos	690,930	17.3	4,265	12.9	162
Santa Fe	433,160	10.9	4,165	12.6	104
Rest	1,214,865	30.4	14,471	43.7	84
Country Aggregate	**3,991,355**	**100.0**	**33,101**	**100.0**	**121**

Source: National Registry of Apicultural Producers (Renapa), www.minagri.gov.ar.

Organic honey output

In 2011, some 345 organic honey producers and almost 31,600 organic hives were registered at the national level. Exports reached 886 tonnes of honey that year, accounting for 1.2% of total honey exports. Between 2007 and 2011, organic honey production went through a process of fragmentation in which organic producer numbers increased whilst the number of hives per beekeeper and export levels dropped (Ramírez 2012). The provinces with the greatest focus on organic apiculture were Entre Ríos, Santa Fe, and Chaco, which together accounted for nearly half of the organic hives that have been tracked over the last five years. Córdoba and Buenos Aires provinces ranked immediately behind them:

Argentine apicultural sector (Period 2007–2011)					
	2007	**2008**	**2009**	**2010**	**2011**
Exports (in tonnes)					
Total país	1,040	1,298	833	1,058	886
Exports (in tonnes)					
Buenos Aires	6,573	3,903	4,056	3,481	3,278
Entre Ríos	8,872	12,304	15,370	5,818	5,905
Santa Fe	7,715	9,451	8,346	3,735	4,745
Rest	17,142	26,312	29,830	21,881	17,660
Country total	**40,302**	**51,970**	**57,602**	**34,915**	**31,588**

Source: SENASA based on data provided by certification agencies, www.senasa.gov.ar

The Paraná Delta has a lot of potential for developing organic production because agrochemicals are not used on crops in the region and there are no large roads or motorways in the area (Basilio *et al.* 2010). In 2000, the INTA gathered a group of producers from Victoria to produce certified organic honey through a program called '*Cambio Rural*' (rural change). Trade in transitional honey began in 2002, followed by that of certified organic honey (monofloral from dotted knotweed) in 2003, when exports to Canada, the United Kingdom, and France reached 140,000 kg. Although this experience was positive, the relationship built with exporters was not strong enough, since certified organic production requires a high degree of formality and the authentication of every step of the production process. Moreover, current laws and regulations on organic production lay down that private certification agencies should be involved, which entails a considerable increase in costs, especially for small producers (Taller Ecologista 2010a).

Fishing

More than 200 species of fish have been identified in the Paraná Delta. The region is held in esteem for its supply of large migratory species that are valuable for exporters, fishmongers, and restaurants, and for the varied recreational fishing opportunities it offers all year round (Minotti 2010).

Fishing in the Delta involves different practices: small-scale and subsistence fishing on the part of islanders, commercial or industrial fishing, and recreational or sport fishing.

Small-scale fishing

Small-scale fishing is one of the most traditional activities in the region and is the main source of income for some islanders (Baigún and Minotti 2010). Catch is sold to middlemen who visit the islands, or directly to fishmongers and restaurants on the mainland. The most sought-after species are migratory. Likewise, opposite Martin García Island there are medium-sized fishing boats equipped with a hold, which supply restaurants located in Greater Buenos Aires.

Industrial fishing

Nearly all industrial fishing in the area is for export purposes and is almost exclusively based on streaked prochilod (*Prochilodus lineatus*) (Baigún and Minotti 2010). Fishers usually work full-time using boats and nets of their own, or provided by processing plants or middlemen. The fish catch is picked up by middlemen, who transport it to processing plants. There are several fish-landing and supervision ports; those managing the largest volumes are in Diamante and Victoria, in Entre Ríos, and in Gaboto and Rosario, in Santa Fe province.

Although the available data on river fish catch in the Paraná Delta is insufficient, total exports (in tonnes) of freshwater fish will be used as a rough estimate of fish catch for industrial fishing in the three provinces involved, since most of the catch in the region is exported.

Between 1994 and 2002, records showed that freshwater fish exports soared from around 3,000 tonnes to more than 20,000 tonnes per year, of which around 80%, on average, were of streaked prochilod (Taller Ecologista 2010a). Nearly 90% of total exports were from companies based in Santa Fe and Entre Ríos.

Small-scale fisher in Ramallo, Buenos Aires province.

Claudio Baigún

Between 2003 and 2006, average streaked prochilod exports rose to 30,000 tonnes. As from 2007, volumes of trade in fish have ranged between 10,000 and 20,000 tonnes per year.

In general, fish catch in the Paraná River was stable between the 1970s and the 1990s[10]. Nevertheless, in the last few years, the setting-up of fish processing plants[11] has created greater, steady demand, which has led to a change in catch habits (Baigún 2010). From early 2000, streaked prochilod export catch volumes went up, 88% of which was to satisfy foreign demand.

Preliminary technical studies assessing streaked prochilod fisheries in the Middle and Lower Paraná, carried out as from 2005, found a decrease in the average size of caught pieces, which would indicate that populations of this species are being overfished (Taller Ecologista 2010a). Within this context, the provinces of Entre Ríos and Santa Fe and the former Argentine Agriculture, Livestock, and Fishing Secretariat established a set of regulations, such as the establishment of export quotas, with the aim of limiting catch volumes[12].

In 2011, Argentine exports of freshwater fish exceeded USD 20.1 million (17,166 tonnes), all of which originated in the provinces of Buenos Aires, Entre Ríos, and Santa Fe (Table 12). Streaked prochilod exports accounted for over 90% of the total, although other species, such as *Leporinus* spp. and trahira (*Hoplias malabaricus*), were also exported, though in smaller volumes. Almost all exports corresponded to frozen fish; exports of fresh or chilled fish were very limited.

Although the exact number of fishers working in the Delta region is uncertain, it is estimated that in 2007, there were about 3,040 fishers in Santa Fe, of whom 2,700 were within the geographic area where streaked prochilod is caught. Of these, about 1,600 are thought to be full-time fishers devoted only to streaked prochilod fishing to supply fish processing plants that export their produce[13]. In Entre Ríos, there were around 1,200 fishers working from the banks of the Paraná River[14] (Espinach Ros and Sánchez 2007). Regarding Buenos Aires province, it is estimated that that there are between 200 and 250 fishers in Ramallo, Baradero, and San Pedro (Baigún pers. comm.).

Table 12.- Argentine exports of freshwater fish (fresh, chilled, or frozen)[1] in 2007–2011.

Species	2007	2008	2009	2010	2011
in thousands of USD					
Streaked prochilod	10,988	9,943	12,023	13,443	17,194
Trahira	1,075	66	132	679	1,891
Leporinus spp.	207	28	407	0	1,044
Total	**12,270**	**10,037**	**12,562**	**14,122**	**20,129**
in tonnes					
Streaked prochilod	14,731	12,281	14,637	13,941	15,193
Trahira	1,264	51	123	308	1,265
Leporinus spp.	193	21	264	0	658
Total	**16,188**	**12,353**	**15,024**	**14,249**	**17,1116**

a. All Argentine exports (100%) correspond to the provinces of Buenos Aires, Entre Ríos, and Santa Fe, and over 90% of exports originated in the latter two. *Source:* INDEC www.indec.com.ar

10 These figures correspond to the entire Paraná River so their scope is therefore greater than the area of study. However, they are a useful approximation of the fishing situation in the Delta.

11 From the district of San Javier, Santa Fe province, to the Delta region of Entre Ríos and Buenos Aires, there are 14 major fish processing plants that buy an estimated volume of between 60,000 and 80,000 tonnes of streaked prochilod for export per year (Peteán and Cappato 2006).

12 For example, the streaked prochilod export quota for the last four-month period of 2011 was set at 6,600 tonnes. Buenos Aires province was allocated an export quota of 1,000 tonnes, while Santa Fe and Entre Ríos were allocated 2,800 tonnes each (Ministerial Decision 581/2011, Ministry of Agriculture, Livestock, and Fishing).

13 In 2010, the Santa Fe Ministry of Production granted 3,016 fish trading licenses (to small-scale fishers), of which 1,226 corresponded to the districts that make up the Delta matrix.

14 See footnote 11..

Recreational fishing

Recreational fishing takes place from both the river bank and boats, and usually also targets migratory species. Despite the importance of this activity, particularly in the Lower Delta, there is little information on numbers of fishers[15] or the volumes of fish that are caught or returned (Baigún and Minotti 2010). Nevertheless, it would be extremely important to keep records of this activity, since it has grown significantly over the last few years and contributes to the regional economy.

Finally, the catching of small fish for bait, fishkeeping, and exports of ornamental species are of proven economic importance in the region. Nevertheless, export volume data is only approximate, in that it is generally presented by group of species without indicating the region or district where they were caught (Baigún and Minotti 2010).

Hunting

The hunting of wild animals is a traditional activity in the Delta. It is usually carried out for commercial purposes or by the local people for their own subsistence (Taller Ecologista 2010a). Wildlife is also a key factor in ecotourism and recreational activities in the region, such as recreational hunting and birdwatching. The most sought-after species for hunters are the capybara, the coypu, the iguana, the viscacha, the rhea, the common tegu, and several types of ducks.

Commercial hunting

In the Delta, commercial hunting mainly takes place on a very small scale and focuses on the coypu or nutria[16]. To a much lesser extent, common tegu skins are also traded, as occasionally are the skins of capybaras and neotropical river otters (Taller Ecologista 2010a).

The coypu and the common tegu are the only two species for which there are authorized commercial hunting seasons in Entre Ríos province[17]. Buenos Aires province establishes a coypu hunting quota of 300,000 specimens[18], whereas Santa Fe province sets that quota at 150,000[19]. In turn, the commercial hunting of capybara is prohibited in the three provinces that comprise our area of study.

Coypu

During the hunting season (June–September), many islanders hunt coypus to sell their skins – nearly all of which are exported – and make use of their meat for either their own consumption or by selling it locally. Skins are sold to middlemen, intermediaries who periodically visit the islands, and who then do business with the relevant industries and exporters associations (Taller Ecologista 2010a).

There are three major stockpiling centres in the Delta region (Diamante and Victoria, Gualeguay, and Islas de Ibicuy), which in 1998 recorded the catch of nearly 500,000 specimens (Quintana and Bó 2010b). Demand has fallen since then.

Furthermore, both provincial and national regulatory agencies in charge of wildlife protection took precautionary measures by drastically reducing hunting quotas, which brought about a significant drop in the number of specimens caught, from 250,000 in 2005 and 2006 to less than 7,000 in 2009 (Table 13). Nevertheless, in 2011 this figure went up again, exceeding 58,000 specimens[20].

As for coypu exports, there is available data only at the national level. Table 14 shows that skin exports totalled around USD 2 million in 2007, 2008, and 2011 (between 17 and 22 tonnes), but decreased to less than half of that value in 2009 and 2010[21].

Common tegu

Common tegus are caught between December and March, when these animals are more active. It is worth noting that, although tegus are hunted in the Delta, this species is not exclusive of the region but widely spread in other environments as well.

In Entre Ríos province, there are two major stockpiling centres in the districts of Paraná and Gualeguaychú, but

[15] It is estimated that there are around 4 million sport fishers in Argentina (AICACYP 2010). In turn, according to data provided by the Agrifood Control Directorate General of the Entre Ríos Ministry of Production, this province granted 6,012 annual recreational fishing licenses and 7,827 temporary licenses during 2012 (up to mid-November).

[16] The Middle Delta, particularly the region comprising the islands belonging to the district of Victoria is – together with the districts of General Lavalle and General Madariaga, in Buenos Aires province – one of the two most important coypu-producing regions in Argentina, both because of the number of animals caught and the number of people employed in this activity (Taller Ecologista 2010a).

[17] Entre Ríos Province Law No. 4,841 and amendments.

[18] Ministerial Order No. 61/2011 of the Buenos Aires Ministry of Agricultural Affairs.

[19] Resolution No 54/2011 of the Santa Fe Ministry of Water, Public Utilities, and the Environment.

[20] According to partial information for 2012 provided by the Agrifood Control Directorate General of the Entre Ríos Ministry of Production, the number of coypus caught is thought to have increased by 67%.

[21] The annual export quota for coypu was fixed at 2,500,000 finished tanned hides and skins (Environmental and Sustainable Development Secretariat, Resolution 444/2012)...

they are outside the Delta (Taller Ecologista 2010a). Tegu skin extraction in this province totalled around 12,000 units between 2005 and 2007, falling by half in 2008 (Table 13). In 2009, it reached 8,500 units, but it soon fell significantly – only 200 specimens were caught in 2011[22],[23].

Capybara

The commercial hunting of capybara used to be an important activity in the Delta, but at present it is prohibited in the three provinces that make up our area of study. Nevertheless, subsistence hunting of this species is common among inhabitants of the Delta, who eat its meat and sell the hides and skins.

Argentina is the main consumer of capybara skins for leather goods – 98% of the output is intended for the domestic market – and it is also the largest global exporter of this product. Unlike other Latin American countries, such as Venezuela, Colombia, and Brazil, where the capybara industry is focused mainly on trade in meat, in Argentina leather is the main product[24].

Between 1940 and 2005, Argentine exports reached an average of around 110,000 hunted animals per year, most of which ended up in Italy (Ministry of Agriculture, Livestock, and Fishing 2013). In 2009, capybara hide and skin exports exceeded USD 100,000 (8 tonnes), but no exports have been recorded in the last two years (Table 14).

Table 13.- Number of specimens of coypu (by stockpiling centre) and common tegu caught in 2007–2011. Coypu data corresponds to the Paraná Delta region, while that for the common tegu corresponds to the district of Victoria and Entre Ríos province.

	2007	2008	2009	2010	2011
Coypu					
Diamante and Victoria*	37,984	39,250	6,160	4,000	17,087
Gualeguay	21,170	31,800	640	800	21,724
Islas de Ibicuy**	9,900	5,800	0	2,900	19,500
Total	**69,054**	**76,850**	**6,800**	**7,700**	**58,311**
Common tegu					
Victoria	1,100	300	2,000	500	0
Entre Ríos province* **	**12,600**	**6,700**	**8,500**	**1,800**	**200**

* Islands belonging to the districts of Diamante and Victoria.
** Department of Islas de Ibicuy and surrounding area.
*** In addition to the traditional coypu-producing departments, this also includes those of Nogoyá, Paraná, La Paz, and Federal.
Source: Quintana and Bó (2010b); Taller Ecologista (2010a), and Bó (pers. comm.), based on data provided by the Sustainable Management Directorate and the Entre Ríos Agrifood Control Directorate General, www.entrerios.gov.ar.

Table 14.- Argentine exports of capybara and coypu hides and skins in 2007–2011.

Item		2007	2008	2009	2010	2011
Raw capybara hides and skins	thousands of USD	92	39	108	0	0
	tonnes	9	3	8	0	0
Whole coypu hides and skins, raw or tanned	thousands of USD	2,140	2,019	698	872	1,795
	tonnes	22	19	6	9	17

Source: INDEC www.indec.com.ar

22 According to data provided by the Agrifood Control Directorate General of the Entre Ríos Ministry of Production for 2012 (data available up to November), tegu skin extraction is thought to have increased by 50%.

23 The breakdown of data on Argentine exports of tegu is not enough. The Environmental and Sustainable Development Secretariat has established an annual export quota of 1,000,000 hides and skins (Environmental and Sustainable Development Secretariat, Resolution 11/2011).

24 Venezuela is the main consumer of capybara meat. It is traditionally eaten there over Easter, and certified meat is very expensive (USD 20/kg.) (Ministry of Agriculture, Livestock, and Fishing 2011).. .

Other types of hunting

In the Delta, there are numerous species which are hunted for subsistence purposes, although at different rates (Taller Ecologista 2010a). Notable mammal species in this sense include the capybara and the coypu. Among reptiles, the common tegu and two species of aquatic turtle are also important. Common tegu and capybara fat is also used for several medicinal purposes. Creole frogs are also eaten, and occasionally caught for sale. Likewise, out of the 76 aquatic bird species present in the Paraná Delta region, it is estimated that 22 are prey to subsistence hunting, and 18 to both subsistence and recreational hunting (Bó *et al.* 2002).

Those involved in recreational hunting are typically people who live in large urban centres on the Paraná River near the Delta region. Several provincial laws regulate this activity. The species authorized for small game hunting in the three provinces in question include partridges, hares, and several species of ducks and birds[25] (Environmental and Sustainable Development Secretariat 2011). Nevertheless, there are only a few sites where recreational small game hunting is authorized within the Delta. As for big game, Entre Ríos province only allows that related to exotic species, such as buffalo, *Axis* deer, red deer, wild boar, and sable antelope[26]. Buenos Aires allows *Axis* deer, antelope, fallow deer, red deer, wild goat, and wild boar hunting.

One major problem has to do with visits from poachers from nearby large urban centres, who practise target shooting, mainly aiming at capybaras, ducks and coots of any species, birds of prey, herons, and storks, among others. It is also worth mentioning what is known as 'hunting tourism', which has been booming over the last few years and which consists of packages offered by travel agencies mainly to foreign tourists in order to hunt certain species of ducks and doves (Taller Ecologista 2010a).

Forestry

Native forests cover only 4% of the Paraná Delta land area (73,549 hectares). Nevertheless, they boast a great variety of species (Enrique *et al.* 2010). These trees provide shelter for cattle and have been greatly exploited for firewood.

The Paraná Delta is the most important region in Argentina in terms of poplar and willow cultivation. The predominant production system is afforestation using *Salicaceae*[27]. This activity, which employs around 400 forest producers (Signorelli 2012), is mainly carried out in the Lower Delta in Buenos Aires province and, to a lesser extent, on the islands of the Delta in Entre Ríos province.

Based on data provided by the Map of Forest Plantations (MPF) for the Delta, created by the Geographic Information Systems (GIS) and Forest Inventory area of the Forestry Directorate of the Ministry of Agriculture, Livestock, and Fishing (MAGyP), the Paraná Delta region has been found to contain approximately 83,000 hectares planted with *Salicaceae*, 75% of which is thought to be under management[28] (Signorelli and Gaute 2012).

In the Buenos Aires part of the Delta, there are slightly more than 60,000 afforested hectares, and the most densely planted are on the islands of San Fernando and Campana (Table 15). In turn, in the Entre Ríos part of the Delta, there are almost 23,300 afforested hectares. Of the total afforested land area in the Delta, 83% corresponds to willows and the rest to poplars. The Delta region belonging to Santa Fe province does not contribute in terms of afforestation.

There are different afforestation promotion programmes in the Delta, including: i) at the national level, Law No. 26432/08, which extends and modifies the regime established by Law No. 25080/98 (Investments in Cultivated Forests Law); ii) Buenos Aires Province Law No. 12662/01 (Afforestation Incentives Law) and the issuing of Forest Certifications (required to claim for real estate tax exemptions); iii) the Santa Fe Forestry Plan established by the Santa Fe Province Law No. 11111 (30/11/93).

Since 2003, more than ARS 20 million in non-reimbursable financial aid has been granted in the Delta region as part of National Law No. 25080, distributed among more than 500 initiatives that together represent more than 17,000 hectares planted with poplars and willows. Almost ARS 3 million had been paid out by August 2012 (Signorelli 2012).

Salicaceae timber can be used for firewood, posts and stakes, and can be milled (to make chipboards or pulp for different types of paper), sawn (to make pallets, beams, crates, furniture, etc.), and peeled (for the manufacture of matches, toothpicks, ice-cream sticks, etc.). It is estimated that 83% of the annual consumption of *Salicaceae* is for mills (boards and paper industries) and the remaining 17% for mechanical industries (log peeling and sawmills) (Borodowski 2006).

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[25] A large number of the 19 species of aquatic birds targeted by recreational hunting in the Delta are thought to be victims of target shooting practice, mainly by hunters who are not local residents, since the recreational hunting of only three species of duck is authorized (Fulvous whistling duck, Rosy-bill pochard, and Brazilian duck) and only in the districts of Diamante and Victoria (Bó *et al.* 2002).

[26] According to data provided by the Agrifood Control Directorate General of the Entre Ríos Ministry of Production, in 2012 (up to mid-November), 461 annual recreational small game permits, 288 annual recreational big game permits, and 3,518 temporary recreational hunting permits were granted to non-residents.

[27] It is the largest land area planted with *Salicaceae* in the world (Kandus 1997).

[28] The remaining 25% represent abandoned plantations or those that are difficult to reach and thus to manage..

Table 15.-	Afforested land area in hectares in the Buenos Aires and Entre Ríos Delta in 2008 and 2009.			
Province	**Department / District**	**Species**		**Total**
		Poplar	**Willow**	
Buenos Aires	Baradero	-	219	219
	Campana	8,243	11,792	20,035
	Escobar	220	2,689	2,909
	San Fernando	5,061	22,252	27,313
	Tigre	279	2,824	3,103
	Zárate	134	6,380	6,514
Buenos Aires total		**13,937**	**46,156**	**60,093**
Entre Ríos	Islas de Ibicuy	572	22,707	23,279
Delta total		**14,509**	**68,863**	**83,372**

Source: Signorelli and Gaute (2012) based on MFP/GIS (Ministry of Agriculture, Livestock, and Fishing www.minagri.gob.ar)

Table 16.-	Paraná Delta: Raw material used by forestry industries, by place of origin of logs and species, over 2007–2010*, in tonnes			
Species	**Logs** (tonnes)			
	2007	2008	2009	2010
a. Raw material used in the production of chipboards				
Buenos Aires Delta	**14,370**	**165,432**	**23,265**	**0**
Poplar	382	16,815	0	0
Willow	13,988	148,617	23,265	0
Entre Ríos Delta**	**2,531**	**3,898**	**6,100**	**22,896**
Poplar	0	561	163	2,094
Willow	2,531	3,337	5,937	20,802
Total	**16,901**	**169,330**	**29,365**	**22,896**
Poplar	382	17,376	163	2,094
Willow	16,519	151,954	29,202	20,802
b. Raw material used in the production of cellulose and paper				
Delta bonaerense	**280,874**	**242,930**	**254,618**	**232,568**
Poplar	108,071	47,305	75,134	113,443
Willow	172,803	195,625	179,484	119,125
c. Total				
Buenos Aires Delta	**295,244**	**408,362**	**277,883**	**232,568**
Poplar	108,453	64,120	75,134	113,443
Willow	186,791	344,242	202,749	119,125
Entre Ríos Delta*	**2,531**	**3,898**	**6,100**	**22,896**
Poplar	0	561	163	2,094
Willow	2,531	3,337	5,937	20,802
Total	**297,775**	**412,260**	**283,983**	**255,464**
Poplar	108,453	64,681	75,297	115,537
Willow	189,322	347,579	208,686	139,927

* There is no data available for 2011.
** Data for years 2008–2010 corresponds to the total for Entre Ríos province (see footnote 46).

Source: Forestry Directorate, Ministry of Agriculture, Livestock, and Fishing, www.minagri.gob.ar

María Luisa Bolkovic

Forestry in the Buenos Aires delta.

Based on statistics on the forestry industry's use of raw materials by species and place of origin of the logs, it can be observed that over 2007–2010[29] between 255,500 and 412,300 tonnes of *Salicaceae* grown in the Delta were used[30] in the manufacture of chipboards and paper, the latter being the largest consumer of logs (Table 16).

There are no large basic industries on the islands of the Delta, although several small sawmills have been set up in recent years (Borodowski 2006). Most timber is supplied to industrial facilities located on the banks of the Paraná River, from San Fernando and Tigre to Ramallo, and to industries based near the cities of Buenos Aires, Morón, Avellaneda, Quilmes, and Bernal. In the Delta area of influence, there are around 40 sawmills, four log peeling plants, one chipboard factory, and one newsprint factory. Timber is transported mainly by river from the islands of the Delta to the ports of Tigre, San Fernando, Escobar, Campana, Zárate, and San Pedro. Land transport takes it from these ports to the different industries.

Regarding the size of forests, more than 90% of regional producers have small sites (less than 200 hectares) and use 78% of the land for forestry, 18% for wicker, and 4% for fruit trees (Borodowski and Suárez 2005). Most timber (80%) is sold as stumpage (standing timber) and the rest is sold once harvested. Medium-sized producers (forests ranging between 200 and 1,000 hectares) account for 6.3% of all producers. Land use breaks down as follows: 90% is used for forestry and 10% for cattle raising. Medium-sized producers sell 10% of their output as standing timber and the remaining 90% as harvest timber. Furthermore, most of the major producers (forests exceeding 1,000 hectares) are industrial companies from the timber sector. They devote 95% of their land to forestry and 5% to cattle raising. These major producers sell 60% of their forest output with value added and 40% simply as harvest timber.

[29] There is no data available for 2011. Information on raw materials used by forestry industries is based on an annual survey of timber and paper industries which includes the following forestry products: blockboards, fibreboards, chipboards, preservative treatment of posts and wood in general, cellulose and paper mills, and laminated timber for other uses (Forestry Industries, Ministry of Agriculture, Livestock, and Fishing, several years).

[30] In the case of the Delta region within Entre Ríos province, detailed data is available only for 2007; for the remaining years, data corresponds to the whole province. Nevertheless, according to 2007 data, the Delta region accounts for 91% of the *Salicaceae* wood felled in Entre Ríos. Likewise, the data provided by the Map of Forest Plantations in the Delta indicates that 97% of the land area planted with poplars and willows in Entre Ríos province is located in the Delta region. Therefore, the figure for the whole province is considered to be a good estimate of that corresponding to the Delta..

Cattle raising

In the Middle and Upper Delta, cattle raising is one of the main economic activities, and its importance has grown particularly in recent decades. In the Lower Delta, livestock is raised on a smaller scale and occupies the same land as *Salicaceae* plantations[31].

The pasture of the Paraná Delta is a natural source of fodder for both wild animals and cattle. In fact, this pasture constitutes the main source of fodder for the different meat-producing cattle raising systems throughout the region (Rossi 2010).

The region was traditionally characterized by what is known as 'island cattle raising', an extensive and markedly seasonal approach: cattle were moved to be fattened on native vegetation during the warmer months and then moved back in autumn. Generally speaking, such cattle operations had no clear physical boundaries – these were imposed by geographical features – and producers took no special care of their land (Taller Ecologista 2010a).

In last the two decades, the expansion of soy production and the growing 'agriculturization' process in the Pampas region has led to great changes in the use of land for cattle raising throughout the country. The complementary dynamics between agriculture and cattle raising that characterized the farming sector during the last century have given way to a process of competition in which the agricultural frontier has been pushed back. Livestock has thus been displaced from the Pampas region towards 'marginal areas' that are less suitable for agriculture. This phenomenon has gone hand-in-hand with changes in production methods, namely the expansion of the feedlot system (Taller Ecologista 2010a). The islands of the Paraná Delta have been one of the regions to which livestock have been displaced from the Pampas.

In addition, other factors have favoured the increasing use of island land for cattle raising, among them the construction of the Rosario-Victoria bridge – which lowered livestock transport costs – and the public land lease policy implemented by Entre Ríos province (Donadille *et al.* 2010).

There has been a shift from extensive seasonal livestock farming to a more permanent and intensive system in the region, brought about by the high natural productivity of riverine wetlands in the Delta, along with a cycle of low water levels. Consequently, cattle numbers increased tenfold (from 160,000 to 1,500,000) between 1997 and 2007 – when the largest figure for recent years was recorded – leading to impacts such as overgrazing, land degradation, and possible biological and chemical pollution of waters (Quintana and Bó 2010a). In some cases, cattle raising also altered the local hydrological regime due to the construction of dams or the obstruction of waterways with embankments to ease the flow of water and prevent it from flooding grazing land.

Rubén D. Quintana

Cattle raising on islands in the department of Victoria, Entre Ríos province.

31 The land area considered to have silvopasture potential in the Lower Delta covers around 48,000 hectares and is home to 26,000 head of cattle (Dupertis 2010).

The increase in cattle numbers in the department of Victoria is an example of the expansion of livestock farming on the islands of the Delta: between 2002 and 2009, the numbers of livestock kept on the islands shot up by more than 400% (from 45,000 to 235,000 head). Likewise, in the aforementioned period, the share of livestock kept on the islands in relation to the department's total livestock increased from around 30% to more than 80% (Taller Ecologista 2010a).

From the point of view of productivity, the islands offer abundant high-quality natural resources (grazing and water), which makes it possible for the whole cattle production cycle to take place there. Their natural isolation and weather conditions, which are tempered by the effect of the river, enable the production of much higher quality meat than that produced on the mainland. During periods when water levels are low, cattle raising is particularly productive and profitable: the animals feed on natural pasture and costs are relatively low (Taller Ecologista 2010a).

Table 17 shows data for the three provinces and the Delta matrix as a whole. According to the number of cattle vaccinated per year over the last five years, there were between 1,979,000 and 2,648,000 head of cattle in the Delta matrix, between 7% and 9% of the figure recorded at province level. More than 70% correspond to Entre Ríos province.

Since there are no systematic statistics on how many head of cattle are kept on the islands of the Delta, and taking into account the fact that Entre Ríos has significantly more cattle than the other provinces in the region, the data for this province was taken as an estimate for the region as a whole. This calculation contemplated data that indicates that around 20% of the livestock in Entre Ríos correspond to the Delta region (Montesino pers. comm., Quintana pers. comm.). However, other estimates indicate that in 2012 there were 595,000 head of cattle in the part of the Delta within Entre Ríos province (Churruarin pers. comm.)[32].

Table 17.- Head of cattle vaccinated in 2007–2011. The data reflects that more animals were vaccinated during the two annual campaigns.

	2007	2008	2009	2010	2011
General scale (provinces)					
Buenos Aires	22,437,723	21,233,452	18,868,812	17,999,945	18,776,324
Entre Ríos	4,814,005	4,782,448	4,625,750	4,142,105	4,297,723
Santa Fe	7,759,248	7,587,520	7,073,620	6,437,003	6,391,253
Total	**35,010,976**	**33,603,420**	**30,568,182**	**28,579,053**	**29,465,300**
Delta matrix (districts / departments)					
Buenos Aires	243,557	232,925	284,389	214,389	203,599
Entre Ríos	1,714,977	1,812,931	1,879,573	1,350,240	1,589,196
Santa Fe	479,981	463,867	484,313	414,251	408,342
Total	**2,438,515**	**2,509,723**	**2,648,275**	**1,978,880**	**2,201,137**
Paraná Delta					
Entre Ríos*	962,801	956,490	925,150	828,421	859,545
Buenos Aires	n.a.	n.a.	n.a.	n.a.	n.a.
Santa Fe	n.a.	n.a.	n.a.	n.a.	n.a.

n.a.: not available

* Corresponds to 20% of the total head of cattle in Entre Ríos province.

Source: own elaboration based on SENASA, www.senasa.gov.ar

[32] If the calculation is based on 20% of all cattle vaccinated in Entre Ríos province during the anti-foot-and-mouth campaign carried out in the first half of 2012, the figure obtained is slightly over half a million head.

Water uffalo

In 2000, a FONTAR (Argentine Technological Fund) project called 'Adaptation of the water buffalo to the Paraná Delta, Entre Ríos province' was implemented in order to prove the feasibility of water buffalo (*Bubalus bubalis* spp.) rebreeding for meat production in the Paraná Delta. This was the first systematic experiment with buffalo in the region, and it emerged as a sustainable alternative to extensive agriculture and cattle raising.

In order to promote this activity, form groups of producers, and coordinate joint actions, the Paraná Delta Group of Buffalo Breeders was formed in 2002, and the Commission of Buffalo Farmers of the Rural Society of Islas de Ibicuy was created in 2003.

Water buffalo meat is lean, exotic, extremely tasty, and healthy, as it has low cholesterol and fat content and is rich in iron and proteins. It has great export potential as a healthy product obtained by means of an environmentally friendly grazing system, a requirement currently reinforced by the United Nations Food and Agriculture Organization (FAO) and by the European Union. Furthermore, its profitability is greater than that of cattle, which require a longer wintering period and entail higher fixed and financial costs.

The total number of buffalo in Argentina exceeds 100,000 head[b], of which around 6,400 are in the Delta. The meat produced in the section of the Delta within Entre Ríos province has been on the market since 2003 and exported to the EU (mainly to Germany) since 2006. It is also traded domestically, but to a much lesser extent. Moreover, deli meats and leather are also traded. At present, nearly 1,000 head are slaughtered per year (which represents sales of approximately ARS 2 million) and annual buffalo meat exports have reached around 20 tonnes (Cadoppi pers. comm.). It is worth noting that, since 2010, Argentina has been granted a Hilton quota to export 200 tonnes of buffalo meat to the EU, a benefit that only Australia also enjoys (Groba 2012).

a. Based on National Agency for Scientific and Technological Promotion (2006).
b. Argentine Association of Buffalo Breeders. http://www.bufalos.org.ar/difusion.php

Recreation and tourism

The Delta boasts many areas that are ideal for recreational and tourist activities thanks to its biodiversity and varied landscapes.

Tourist activities mainly take place in three areas: the river banks on the mainland, the islands, and the waterways. Some of the main activities that take place here are recreational hunting and fishing, water sports, beach- and resort-based tourism, and ecotourism – flora and fauna observation, photographic safaris, hiking. There also some areas where culinary tourism and shopping (for regional crafts) prevail, such as at the Puerto de Frutos market in Tigre (Madanes and Faggi 2010). There are inns and hotels in a variety of towns near the river which can provide accommodation for tourists demanding top-quality services.

Some of the more remarkable places have been protected as National Parks or World Heritage Sites and generate income at the local and national level. The most outstanding are the Pre-Delta National Park (Diamante), the Otamendi Strict Natural Reserve (Campana), and the Paraná Delta Biosphere Reserve (San Fernando), apart from other protected areas[33]. On average, over the last four years, the Pre-Delta National Park welcomed more than 32,000 visitors per year, whereas the Otamendi Strict Natural Reserve was visited by nearly 14,000 people (Table 18).

It should be borne in mind that both recreation and tourism can be important components of sustainable wetland management (Stolk *et al.* 2006). For example, the local population can derive employment and possible long-term income from working as tour guides or selling food or crafts. Nevertheless, these activities depend on a suitable infrastructure and must be carefully managed. Mismanagement can cause damage to the very local resources on which they are based. Moreover, there is a risk of ignoring those communities that are not directly involved in the local tourism business and disregarding their opinion on matters that affect them.

Within the Buenos Aires section of the Delta, tourism and recreational services are concentrated in the First Section of Islands, where there are several water sports clubs, boat storage facilities, small hotels, rental cabins, small farms and restaurants, fishing and motorboating facilities, as well as recreational areas and food shops. Likewise, the islands of Tigre district present the highest density of holiday homes and recreational facilities (PROSAP 2011).

33 In October 2010 the Santa Fe Islands National Park was created, but it has no visitor infrastructure yet.

Table 18.-	Visitors to protected areas located in the Paraná Delta in 2007–2010*.				
Protected area	**2007**	**2008**	**2009**	**2010**	**Promedio**
Pre-Delta NP	-	5.151	67.075	25.000	32.409
Otamendi SNR	12.077	14.267	16.770	14.434	14.387
Total	**12.077**	**19.418**	**83.845**	**39.434**	**38.694**

* There is no data available for 2011.
Source: Ministry of Tourism, Statistical Yearbook 2010.

In the city of Tigre, there are approximately 2,000 tourist beds available, with an average hotel occupancy of 24% in recent years, whereas on the islands there are nearly 8,200 beds available and hotel occupancy in the last two years reached 50% (Castro pers. comm.). In the last five years, this district welcomed almost 4.4 million tourists per year on average. Most visited the area's main attractions: the Puerto de Frutos market (33.3%), the casino (26.9%), and the Parque de la Costa theme park (22.8%). Only 13.6% of these tourists visited the Delta. In addition, nearly 9% of tourists used motorboat services and a similar percentage went on excursions, whereas 2.3% ate at bars and restaurants in the Delta. Furthermore, around 90% of visitors[34] were day-trippers, whereas the average length of stay of the rest was three days (Bisogno 2005).

San Fernando concentrates lots of recreational and tourism activities[35], many of them related to the Biosphere Reserve. Other districts, such as Escobar or Campana, have less tourism infrastructure (PROSAP 2011).

In the Middle Delta, San Pedro is one of the most active tourist destinations having welcomed approximately 50,000 tourists on average between 2008 and 2010, slightly more than 30% of whom were day-trippers. Almost half of overnight visitors stayed at hotels, 26% at campsites, 16% at holiday bungalows and inns, and 11% at rental homes (Ojeda pers. comm.).

In the Entre Ríos section of the Delta, day trips or longer visits to traditional country houses or ranches (*estancias*) are noteworthy, especially in the districts of Diamante, Victoria, Gualeguay, and Gualeguaychú (Environmental and Sustainable Development Secretariat 2011).

Data provided by the Local Tourism Information System (SILOINTUR for its acronym in Spanish) belonging to the Municipality of Diamante Tourism Directorate[36] indicates that more than 5,000 people arrived in Diamante for Easter 2012 – including overnight visitors and day trippers – entailing an average hotel occupancy rate of 98% and an average length of stay of 2.5 nights. During the same period in 2010, Diamante had welcomed 3,500 tourists, whereas in 2006, the number of visitors had been 2,147 people, which indicates that tourism has been growing in this region.

Other activities

Local residents take advantage of the high productivity of rushes, harvesting them regularly to make baskets, blinds, and other handicrafts which are then sold, together with other wickerwork products, in the port of Tigre (Vicari 2010). By way of example, in January 2005, the port of Tigre received eight tonnes of wicker products valued at ARS 12,000 and nine tonnes of rush, valued at ARS 18,000 to be sold at the Puerto de Frutos market (Bisogno 2005).

Almost all of Argentina's wicker production is concentrated in the Buenos Aires section of the Delta, which contains 98% of the planted land area. At present, there are slightly more than 200 hectares cultivated, out of the 100,000 potential hectares in the Delta (PROSAP 2011). In general, wicker is grown as a complementary enterprise on willow and poplar plantations, although it can be the main crop on small estates[37]. It is a labour-intensive low-tech activity (Environmental and Sustainable Development Secretariat 2011). The supply chain includes a cooperative of producers ('Los Mimbreros', a group of 150 growers and 70 craftsmen), local stockpilers, and small companies producing handicrafts and furniture, based near or along the river, and which may have their own plantations (Donadille *et al.* 2010).

Studies carried out on the Lower Delta region show that there are uses for more than half of the native and introduced plant species in the area, at least potentially.

34 According to the World Tourism Organization, a *visitor* is a traveller taking a trip to a main destination outside his/her usual environment, for less than a year, for any main purpose (business, leisure or other personal purpose) other than to be employed by a resident entity in the country or place visited. A visitor is classified as a *tourist* if his/her visit includes an overnight stay.

35 In the region, a total of 15 lodgings and recreational facilities have been identified (Kalesnik and Kandel 2004).

36 www.turismodiamante.gov.ar

37 The average size of plantations owned by small producers is 2.5 to 3 hectares.

Most of these have medicinal uses (78%), followed by those that are edible (19%), or can be used as fodder (14%) (Kalesnik 2010). Some species are also used in the manufacture of domestic utensils or the construction of thatched roofs and barbecue areas, while others have a technological application (tannins, resins, artificial colours, fibres).

The foraging of plants for domestic use is a long-standing activity in the region. It is part of a wider, though highly informal, foraging network, which includes trading and exchanging plant species with other regions of the country (Taller Ecologista 2010a). For example, near Puerto Gaboto, in Santa Fe province, this activity is carried out by people living on islands or along the river banks (between 80 and 100 people), while stockpilers are small companies that sell the produce to herbalists, laboratories, and beverage manufacturers. There are three stockpilers in the region.

The two extractive activities carried out in the wetlands are sand mining from waterway beds and, to a lesser extent, clay mining on the islands. Most sand and clay goes to the construction industry; there are numerous companies in the region that carry out this activity (Taller Ecologista 2010a). According to data from the Mining Directorate General of the Entre Ríos Ministry of Production, in 2009 there were 13 sand mining companies recorded in the Entre Ríos region of the Delta and 92 km of river were under concession.

As for fruit growing, frequent floods have provoked a decline in this activity, which was much more prominent in the past. At present, it is mainly focused on citrus fruit production, especially in Buenos Aires province. Output is mostly oranges and lemons and, to a lesser extent, tangerines and grapefruit used in artisanal jam-making, candied fruit for cake-making, and essence extraction (Environmental and Sustainable Development Secretariat 2011).

Other economic activities that take place in the Delta are those related to construction and real estate services.

Water buffalo (*Bubalus bubalis* sp.).

Claudio Baigún

The case of gated communities in the Delta

The lack of awareness of the importance of wetland preservation has led to substantial changes in these ecosystems, such as drainage and filling, the construction of embankments and dams, and the diversion of waterways with the aim of gaining land for roads, urban developments, and other economic activities like farming, forestry, and tourism (Turner *et al.* 2000). This process has also taken place in the Paraná Delta, where real estate projects are on the rise (Kandus and Minotti 2010).

In the last 30 years, the proximity of the Paraná Delta to densely populated areas concentrating intense economic activity, such as the city of Buenos Aires and Greater Buenos Aires, has led to an increasing demand for land for the development of gated communities in this region. Gated communities are promoted as places with better quality of life and greater contact with nature, among other benefits, but their development is based on turning the wetland into a terrestrial system where houses can be built, which disturbs the wetland's normal functions and affects its goods and service output (Fabricante *at al.* 2012).

Fabricante *et al.* (2012) surveyed built and planned gated communities on the islands of the Paraná Delta and on the floodplains of the system's tributary streams and rivers[a]. Out of the 229 gated communities surveyed in the study, 10% are located in the Paraná Delta region, of which 19 are in Buenos Aires province, particularly near the delta front in the district of Tigre, while other five are in Entre Ríos, in the districts of Victoria and Villa Paranacito. Most gated communities (90%) are located on the mainland around the Delta, mainly on the plains of the Pinazo-Burgueño-Escobar streams and the Luján River[b]. The increase in the urbanization rate of the Paraná Delta mainly began in the 2000s. In contrast, in mainland areas this process began in the 1980s.

As a preliminary approach to this subject and with the aim of assessing the extent to which the value of ecosystem services has been taken into account by these urban developments, the districts surveyed by Fabricante *et al.* (2012) have been studied so as to determine prices of land in gated communities. This assessment has made it possible to identify trends and average values per square metre of land in the district of Tigre.

In general, it can be observed that urbanization processes are linked to local economic factors and infrastructure development that facilitates access and connection to the city of Buenos Aires. The district of Tigre, in particular, boasts a significantly developed commercial, education, and service infrastructure. This is the reason why, in general, Tigre has recorded the highest prices of land in gated communities in the entire Greater Buenos Aires area (Reporte Inmobiliario 2010).

In this respect, land prices vary considerably (Reporte Inmobiliario 2009). Disparities among land prices in different gated communities depend, mainly, on the degree of urban development, the type of commercialized real estate product, the location, and the terms of housing construction and possession. Land prices also differ within a gated community, according to whether the plot has a central or peripheral location and whether it has pleasant views. It was thus observed that waterfront plots of land – overlooking lakes or the Luján River channel and, in certain cases, golf courses – are usually more expensive per square metre than those without such views.

The average price of land in gated communities in July 2012 reached USD 108/m^2 for peripheral plots and USD 155/m^2 for central plots. Prices varied considerably between USD 40/m^2 and USD 400/m^2 (Reporte Inmobiliario 2012), and tended to rise for both central and peripheral plots of land[c]:

Average price of land in USD/m^2 in gated communities in the district of Tigre				
Location	**July 2009**	**July 2010**	**July 2011**	**July 2012**
Central	134	138	146	155
Peripheral	86	97	100	108

Source: www.reporteinmobiliario.com

It can be concluded *prima facie* that environmental factors have an impact on land prices in the gated communities surveyed, reflected in higher prices of plots with pleasant views (overlooking lakes or offering private moorings on the Luján River), although these are not the only determining factors. There are other non-environmental factors involved, such ease of access, commercial and service infrastructure availability, and distinguishing characteristics of real estate projects, which also have an impact on land prices per square metre.

To a certain extent, higher prices reveal willingness to pay for the environmental factors that these plots offer, such as closer contact with nature, better air quality, and lower noise levels than in the city.

This would thus imply a partial internalization of wetland services, as reflected in the price differential that the buyer pays to the seller of land according to its location. Nevertheless, nothing indicates that these prices take into account the negative externalities of urbanization processes on wetlands (due to permanent land conversion and its subsequent effects on hydrological dynamics) (Fabricante *et al.* 2012).

Paradoxically, it is a fact that while these development projects damage the wetland by their very nature, at the same time they need to preserve the environment to maintain the attraction of the urbanization, particularly as regards water quality (Turner *et al.* 2000). It is for this reason that both developers and residents of such urbanizations are interested in minimizing the negative impact of their activity on the wetland.

The lack of internalization of the impact of economic activities on the environment in general, and on wetlands in particular, is closely related to the fact that natural resources are public goods, which results, on the one hand, in no charges being made for the use of ecosystems' environmental services and, on the other, in no fines or financial compensation being claimed for the negative effects of the different economic activities carried out in them. Were these two elements included in land prices, they would increase them and subsequently have an impact on the development of urbanization projects and of other economic activities, either in terms of their volume, extension, or care for the environment.

Land-use planning is usually employed to determine the location of different economic activities. This is why there is a strong need for adequate planning, taking into account all the factors involved in the urbanization process as well as the development of clear management rules, with the aim of minimizing the loss of ecosystem goods and services offered by the region's wetlands (Fabricante *et al.* 2012).

a. Most of the urbanizations surveyed by Fabricante *et al.* (2012) correspond to gated communities, followed by waterside developments, smaller residential developments and megaurbanizations.

b. To a lesser extent, gated communities are located on the plains of the Reconquista River and the Arroyo de la Cruz, and on the Paraná River banks in Zárate-Campana, among other areas.

c. The survey carried out by *Reporte Inmobiliario* includes regions or areas containing recently developed or developing gated community or country club projects that currently offer land for sale. Therefore, it does not consider long-standing or fully consolidated projects due to their shortage of land for sale.

APPENDIX OF ILLUSTRATIONS

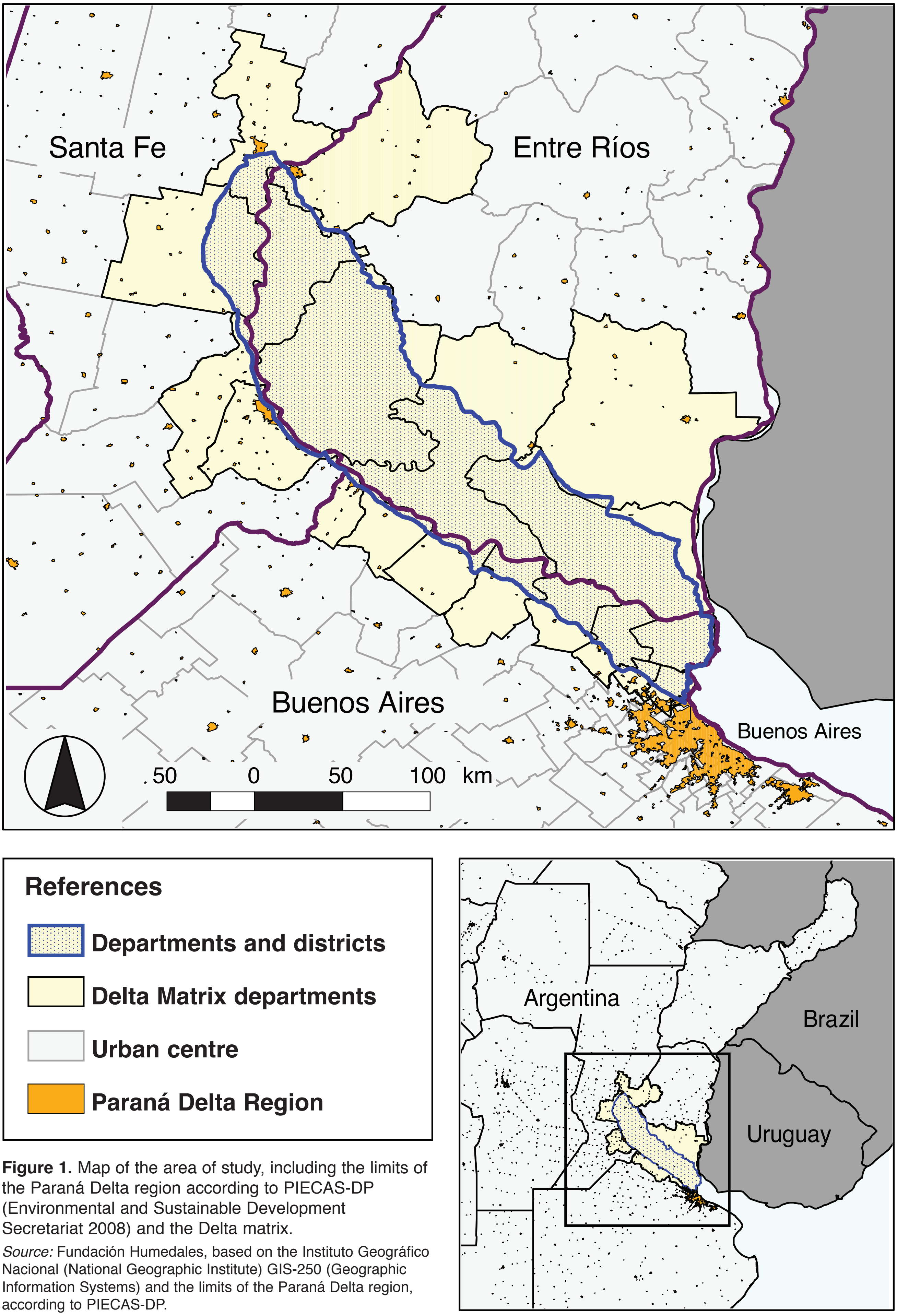

Figure 1. Map of the area of study, including the limits of the Paraná Delta region according to PIECAS-DP (Environmental and Sustainable Development Secretariat 2008) and the Delta matrix.

Source: Fundación Humedales, based on the Instituto Geográfico Nacional (National Geographic Institute) GIS-250 (Geographic Information Systems) and the limits of the Paraná Delta region, according to PIECAS-DP.

Rubén D. Quintana
Claudio Baigún
Carmen Penedo
Rubén D. Quintana
Rubén D. Quintana

A) Cattle raising on an island of the Delta; B) Water buffalo in Ramallo, Buenos Aires province; C) Kayak and rowing in Tigre, Buenos Aires province; D) Recreational fishing near Rosario, Santa Fe province; E) Growth of urbanization and urban infrastructure in wetlands in Entre Ríos province.

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F) Recently felled trees in the Alto Paraná company, Campana, Buenos Aires province; G) Small-scale fisher casting his net in Ramallo, Buenos Aires province; H) Sale of wicker products at Tigre's Puerto de Frutos market, Buenos Aires province; I) Wetlands buffer the effects of floods.

Priscilla Minotti

Claudio Baigún

Rubén D. Quintana

LETyE

J) Typical jetty at a holiday house in Tigre, Buenos Aires province; K) Freshly caught streaked prochilod (*Prochilodus lineatus*); L) Islander cleaning nutria leather; M) View of beehives in the Upper Delta.

CHAPTER FOUR

Valuation of the region's main economic activities

This chapter is devoted to estimating the value of the main economic activities carried out in the Delta: apiculture, hunting, fishing, forestry, cattle raising, and tourism. Other activities which are not as relevant as those mentioned above have been excluded from the calculation – namely, rush, wicker and plant harvesting for domestic use; mining; fruit growing; and real estate and construction activities – mainly due to the lack of available data on which to base estimates.

Unless otherwise stated, the market price method will be used to estimate the value of the abovementioned activities, based on data on output or commercialized volumes and product prices. Only the value of final goods will be estimated, and not that of inputs or raw materials. Therefore, estimates will not determine the intermediate consumption or value added for each activity, but will rather focus exclusively on the gross value of production (GVP) of each[1].

Whenever possible, estimates were calculated for the period 2007–2011 so as to minimize chances of over- or under-estimation due to temporary factors which could bias results if data for a single year were employed. Whenever data was lacking for a certain year within the abovementioned period, the approximation used for the calculation is indicated.

Finally, it is worth noting that this valuation only included those activities that are carried out within the limits of the Delta, which mostly correspond to the primary sector. Subsequent processing activities, which are mainly carried out outside the area of study, were not taken into account. For example, in the case of livestock farming, only the value of cattle on the hoof was considered, but not that slaughtered in meat processing plants; in the case of forestry, the value of timber sold to manufacturers or sawmills was calculated, but not the value of timber by-products.

The Pre-Delta National Park, in Entre Ríos province, welcomed more than 32,000 visitors per year on average over the last four years.

Jorgelina Oddi

[1] Intermediate consumption includes all outlays made to acquire raw materials, inputs, and other goods and services consumed during the production process. Value added is the additional value acquired by goods when transformed during the production process.

Value by activity

Apiculture

The method used to estimate the value of honey output varied from province to province, depending on available information, due to the scarceness of data at the district or provincial levels. In the case of Entre Ríos, output data at province and district levels was available only for the 2009/2010 season. For Santa Fe, there was data on the number of hives per department and average yield per hive for 2008. In the case of Buenos Aires, there was data on the number of hives per district for 2009 (Table 9).

Therefore, apicultural production was estimated at the level of the districts comprising the Delta matrix, as follows:

i. Entre Ríos: The province's share in Argentina's 2009 output was calculated based on output data for the 2009/2010 season released by the Apiculture Department of the Entre Ríos Dairy and Farming Directorate (13%). The province's output for the rest of the period under study was estimated on the assumption that this share is constant. In turn, assuming that each department's 2009 share in the total output for the province has remained constant over the years, output per department was estimated for the period 2007–2011.

ii. Santa Fe: The province's 2008 output was estimated by multiplying the number of hives recorded that year by a yield of 20 kg/hive (Santa Fe Ministry of Production[2]). The province's share in the national output was thus calculated (12%). Based on the assumption that this share has remained constant throughout the years in question, the province's output was estimated for the entire period under study. In order to estimate output per department, the 2008 output was estimated based on the number of hives recorded in each department and the average yield for the province, and then each department's share in the total output for the province was assumed to have remained constant for the remaining years in question.

iii. Buenos Aires: The output of the Delta matrix districts was estimated in two stages: first, the province's 2009 output was estimated on the basis of its share in the national output (50%, according to Bedascarrasbure 2009), and the output for the remaining years in the period was then calculated on the assumption that this share has remained constant. Second, the 2009 output of the departments that make up the Delta was estimated on the basis of the share of hives in the province's total for that year (1.9% according to data from regional apiculture committees of the Buenos Aires Ministry of Agricultural Affairs). Finally, on the assumption that this share has remained constant throughout the years, the output of the Delta matrix departments was estimated for the entire period under study.

Thus, according to these estimates, the 2007–2011 honey output in the Delta region and surrounding areas was between 3,200 and 4,400 tonnes per year.

The average price paid to producers for export honey was obtained from the Buenos Aires Corn Exchange[3].

By multiplying output volumes by the price paid to producers, a GVP in Argentine pesos (ARS) was obtained that ranges between ARS 18.3 million and ARS 39.4 million, with the average for the period under study being ARS 27.8 million.

It is worth noting that this method may be overestimating the value of this activity because it is based on data for the Delta matrix and not for the region.

Fishing

Since subsistence fishing is highly informal, there is no data on this activity for the Paraná Delta. It therefore had to be excluded from the valuation. Nevertheless, it is worth noting that this type of fishing is a deep-rooted practice in the region and is the way that most inhabitants of the Delta earn their livings. Nor was it possible to value recreational and ornamental fishing due to the scarcity of data available. As such, only commercial fishing was valued.

There are no specific statistics on freshwater fish catch in the Paraná Delta. However, since most Argentine exports of streaked prochilod originate in the Delta, freshwater fish export volumes (in tonnes) originating in the three provinces in question were used as a proxy variable for catch volumes (Table 12).

Although the use of data for the province as a whole and not exclusively for the Delta may mean catch volumes are being overestimated, it is worth emphasizing that streaked prochilod fishing figures for the provinces of Entre Ríos and Buenos Aires correspond almost entirely to the Delta. In this sense, according to data from the Agrifood Control Directorate General of the Entre Ríos Ministry of Production for 2012[4], more than 90% of streaked prochilod and other freshwater fish caught in Entre Ríos province corresponds to the departments of Victoria and Islas de Ibicuy, both in the Delta region.

[2] Apicultural production chain 2008, www.santafe.gov.ar.

[3] The price used corresponds to the annual average of the mean monthly export price for extra white honey FOB Buenos Aires (in barrels, in ARS/kg).

[4] Data up to mid-November.

Table 19.-	Argentine Exports of streaked prochilod, trahira (*Hoplias malabaricus*), and *Leporinus spp.* by province, in tonnes, in 2007–2011.				
Province	**2007**	**2008**	**2009**	**2010**	**2011**
Buenos Aires	939	287	596	769	1,023
Entre Ríos	9,031	6,503	8,531	9,197	10,337
Santa Fe	6,218	5,564	5,896	4,284	5,756
Total	**16,188**	**12,353**	**15,023**	**14,249**	**17,116**

Source: INDEC (www.indec.com.ar).

On the other hand, data on fishing recorded in controlled ports by the Santa Fe Ministry of Production was used in order to better estimate catch volumes corresponding to the area of the Delta within Santa Fe province. Based on this analysis, it was estimated that half of exports originating in the province come from ports located in the Paraná Delta (Table 19).

With regard to prices paid to fishers, there is data available only for 2012 and for two species, streaked prochilod and trahira (Baigún pers. comm.), which account for over 94% of total freshwater fish exports from the three provinces during 2007–2011. Likewise, in 2010–2012, benchmark prices were established for streaked prochilod fishing in Santa Fe province and Victoria. The average between benchmark prices in these two jurisdictions was used for the valuation.

Due to this scarcity of price data, the GVP of commercial streaked prochilod fishing was only estimated for 2010 and 2011; and in the case of trahira, for 2011 (using 2012 prices), obtaining an average value of ARS 26.6 million, with a maximum of ARS 35.4 million and a minimum of ARS 17.7 million.

Hunting

Subsistence and recreational hunting could not be included in the estimate due to lack of data. Therefore, only the value of commercial hunting was included in this study. It is worth noting that the calculation excluded capybara hunting, since the commercial hunting of this species is banned in the provinces of Buenos Aires, Entre Ríos, and Santa Fe.

The estimate of the GVP of commercial hunting in the period under study was based on the number of coypus caught in the Delta, the number of common tegus caught in Entre Ríos province (Table 13), and annual average prices paid for coypu hides and skins and tegu leather (Bó pers. comm.).

The average GVP thus obtained was ARS 676,000, ranging from a maximum value of ARS 1.45 million to a minimum of ARS 123,000.

Forestry

Based on statistics on raw material used in the forest industry concerning species and place of origin of tree trunks and published in the document entitled '*Industrias Forestales*' (forest industries) by the Ministry of Agriculture, Livestock, and Fishing (several years), it was estimated that between 17,000 and 169,000 tonnes of *Salicaceae* originating in the Delta region were used[5] by the chipboard industry over 2007–2010[6], whereas cellulose and paper mills used between 233,000 and 281,000 tonnes (see Table 16)[7].

Yearly price data by industry, species, and region was obtained from '*Precios Forestales*' (forest prices) published by the Ministry of Agriculture, Livestock, and Fishing (several years). The GVP thus obtained ranged between a maximum of ARS 41.1 million and a minimum of ARS 20.6 million, with an average value of ARS 33.4 million.

Cattle raising

As was explained in the section on cattle raising in Chapter Three, and since there is no specific data on numbers of head of cattle in the Paraná Delta for the period under study, 20% of the livestock of Entre Ríos province was taken as a rough estimate of that number (Table 17). It should be taken into account that this number may underestimate actual cattle numbers in the Delta since it does not include those from the provinces of Buenos Aires and Santa Fe. Nevertheless, more than 70% of all bovine livestock in the Delta matrix correspond to Entre Ríos province. Hence, the figure used could be taken as a minimum rough estimate of the total number of head of bovine livestock in the Delta.

5 See footnote 30 of Chapter 3.

6 This data is not available for 2011.

7 Data on raw material used by the forest industry includes the following forest products: blockboards, fibreboards, chipboards, wood and post preservative treatment, cellulose and paper mills, and laminated timber for other uses; therefore, the GVP may be an underestimate, since there is no data on mechanical timber industries (log peeling and sawmills).

The GVP for this activity was obtained by multiplying the head of cattle recorded for each year of the period under study by the average weight per head, so as to obtain the bovine stock weight in kilograms, which was then multiplied by the price per kilo live weight for bullocks. Both prices and weights per head of cattle were obtained from the Ministry of Agriculture, Livestock, and Fishing (2012).

Estimates of the production value for this activity range from ARS 556.4 million to ARS 1,595 million, with an average of ARS 912 million.

Estimates of buffalo cattle raising were not included in the GVP because not enough data was available for the calculation to be made.

Recreation and tourism

Tourism is an activity that is very hard to value as it cannot be considered to be a single economic activity, but is rather one that encompasses a wide range of production sectors and services. Some of these products and services can be deemed specific to tourism, such as travel agencies and accommodation, while others are partially related, such as bars and restaurants, transport services, hire car agencies, commerce, and cultural and leisure services.

Furthermore, the distinguishing characteristics of the Delta also make valuation difficult for different reasons, namely: i) the area of study is not a unit, since it includes parts of 19 departments, belonging to three different provinces; ii) in many of these departments, tourism is not necessarily related to the Delta – for example, in several districts of Entre Ríos, tourism may be focused more on seeing carnivals or enjoying thermal springs; in Tigre, many visitors only go to the Parque de la Costa theme park or to the casino; while in San Pedro fruit farms may be the purpose of their visit.

Therefore, placing a value on these activities would require large quantities of information which is not always available. When such data can be found, it comes from different sources that are not always compatible, which makes it very difficult to piece the puzzle together.

The expenditure approach is an alternative method for obtaining a rough estimate of the economic value of tourism-related activities in the region. It consists of estimating expenditures incurred by tourists. The method thus measures the economic value of tourism-related activities from the demand side. Based on the number of visitors and their average length of stay, together with their average daily expenditure, the importance of tourism in the region can be estimated.

According to the Household Travel and Tourism Survey (EVyTH) carried out in 2006, of the total number of leisure trips made within Argentina[8], nearly 2.2 million corresponded to visits to natural attractions – mainly national parks and natural reserves, 687,000 to hunting or fishing activities, and slightly more than 500,000 to rural tourism activities[9] (National Directorate for Tourism Development 2009 and 2010). Moreover, it was estimated that 38,040 travellers stayed at farms or on rural estates.

Residents of Argentina visiting natural attractions spent an average ARS 1,741 per person and stayed an average 8.1 nights. With regard to rural tourism, the expenditure recorded per person was ARS 1,526 and the average length of stay was 5.5 nights[10] (National Directorate for Tourism Development 2009 and 2010).

Taking into account the number of visitors to Delta region national parks and reserves (the Pre-Delta National Park and Otamendi Natural Reserve) over the last five years (Table 18),[11] and assuming that the expenditure per person remained constant throughout that period of time, total expenditure on natural tourist attractions in the period under study averaged ARS 67.4 million, ranging between a maximum of ARS 146 million and a minimum of ARS 21 million.

Nor is there any precise information as to the number of tourists who took part in rural tourism activities in the Delta, which made it impossible to place a value on this activity.

The estimate of the direct use value of tourism-related activities contained herein may underestimate the actual value of said activities in the region due to the scarcity of data and the difficulty of carrying out the calculation.

Value of economic activities

The value obtained by adding up the GVP of the different activities ranges between a minimum of ARS 634 million and a maximum of ARS 1,858 million, with an average value of ARS 1,067 million for the period under study, equal to ARS 472.80/hectare (Table 20). Cattle raising accounts for 85% of this value, while

8 A ‘tourism trip’ is defined as a trip taken by at least one family member outside their usual environment, for less than a year.

9 Rural tourism activities are understood to include the following: ecotourism, cultural tourism, crossings, fluvial and maritime voyages in rural settings, horse riding and equestrian sports, daytrips, hiking and walks, flora and fauna observation, nature appreciation, production and sale of handicrafts, ethnocultural activities, regional rural food consumption, and photographic safaris.

10 Estimates of accommodation in farms or on rural estates only serve as an approximation of the actual volume of rural tourism, since daytrips to these types of facilities are commonplace.

11 This number of visitors should be considered a minimum, since there are other protected areas in the region for which no such data is available.

Table 20.-	Estimates of minimum, average, and maximum values by activity, in thousands of Argentine pesos.		
Activity	**GVP**		
	Max.	**Min.**	**Average**
a. Apiculture	39.398	18.277	27.814
b. Fishing	35.436	17.699	26.568
c. Hunting	1.450	123	676
d. Forestry	41.098	20.585	33.384
e. Cattle raising	1.595.203	556.420	912.177
f. Tourism	145.974	21.026	67.365
Total GVP *	**1.858.560**	**634.130**	**1.067.984**
GVP ARS/ha	**822,8**	**280,8**	**472,8**
Excluding cattle raising			
Total GVP	**263.357**	**77.710**	**155.808**
GVP ARS/ha	**116,6**	**34,4**	**69,0**

* Sum of the value of each activity.

Source: Own elaboration.

tourism represents 6.3% of it, but the abovementioned possibility of underestimating the latter activity should be taken into account. If cattle are excluded from the calculation on the grounds that this activity – depending on how it is managed – may come into conflict with the preservation of the Delta, the average value drops to ARS 155 million, equal to ARS 69/hectare.

Appendix II presents detailed data on value estimates for each economic activity included in this study.

The GVP in constant US dollars (USD) at 2003 prices, considering the purchasing power parity exchange rate[12] ranges between USD 186.90 per hectare and USD 372.40 per hectare (see Appendix III).

[12] A purchasing power parity (PPP) index was used for this calculation (World Bank 2012b).

CHAPTER FIVE

Valuation of ecosystem goods and services using meta-analysis functions

In this chapter, the set of ecosystem goods and services provided by the Paraná Delta is valued using the benefit transfer method by applying different meta-analysis functions.

Valuation of services involved the indirect use value, the direct use value, and the existence value. Services that have an indirect use value include flood control and storm buffering, water quality improvement and habitat enhancement; those that add to the direct use value include water quantity, fishing, hunting, birdwatching, recreational and leisure activities, landscape appreciation (aesthetics), and harvesting of natural raw materials and fuel wood; while those that have to do with the existence value include conservation of biodiversity.

Due to the limited available time and resources for carrying out a primary site-specific valuation of each wetland service under study, we have employed a benefit transfer method. Of the benefit transfer methods available, we have chosen to use a meta-analysis function transfer, which has proven to be a very accurate way of estimating this transfer (see Chapter Two).

It was not possible to estimate carbon sequestration services since these have not been valued in any of the case-studies considered by the different meta-analysis models reviewed herein (Woodward and Wui 2001, Brander *et al.* 2006, Ghermandi *et al.* 2009 and Brander *et al.* 2012). Nevertheless, a first approach to this value appears in the box at the end of Chapter Six.

The lack of proper understanding of the role of a natural resource and its value has been pointed to as one of the reasons for damage to wetlands.

Rubén D. Quintana

Different approaches to the valuation of the Paraná Delta ecosystem services

Three different meta-analysis functions have been used to estimate the value of the Paraná Delta ecosystem services. The first assumes that the wetland's value is a function of the characteristics of wetlands in general and of the methodologies used to estimate the value of these ecosystems, whereas the other two functions introduce socio-economic variables that enrich the analysis.

The first function used corresponds to the model developed by Woodward and Wui (2001), which constitutes one of the first approaches to the estimation of meta-analysis functions for the economic valuation of wetland services. Subsequent studies and analyses have been based on this model, introducing additional variables, since the former did not include the characteristics of the population living near the wetland, a variable which is expected to have an impact on the valuation of these ecosystems.

Therefore, in order to include socio-economic characteristics in the estimation of the value of the Paraná Delta ecosystem services, we reviewed several studies that employ meta-analysis to measure an increasing number of variables involved in wetland valuation. The most relevant studies reviewed were Brander *et al*. (2006), Ghermandi *et al*. (2007), Ghermandi *et al*. (2008), Ghermandi *et al*. (2009), Brander *et al*. (2010), Brouwer *et al*. (2010) and Brander *et al*. (2012).

Of the literature chosen for review, we focused on the studies carried out by Ghermandi *et al.* (2009) and Brander *et al.* (2012) because they include socioeconomic variables, such as population in the vicinity of the wetland and GGP, in addition to other characteristics which make them an interesting tool through which to estimate the value of ecosystem services provided by the Paraná Delta.

The study carried out by Ghermandi *et al.* (2009) was chosen because: i) it includes a wide range of wetland valuation studies carried out on different sites worldwide – although some regions, among them South America, were sub-represented to a certain extent given the relatively limited availability of primary valuation studies undertaken, and ii) the estimation used in the study includes an indicator of human pressure on wetlands. Since the size of the population living in the vicinity of the Paraná Delta and their economic activities are significant, the inclusion of this indicator made the abovementioned study particularly interesting.

In turn, the inclusion of the study conducted by Brander *et al.* (2012) was based on two questions: i) it uses specific data on temperate climate zone wetlands, of which the Paraná Delta is one (Quintana and Bó 2010a) and ii) it puts forward a methodology for estimating the welfare effects of ecosystem change on a larger geographical scale – *i.e.*, at the national or regional level. Furthermore, it presents an outline for comparing the effects of climate change in different scenarios, which could be an interesting line of research for future studies of the Paraná Delta.

It is worth highlighting that Brander *et al.* (2012) point out that 'a common limitation of meta-analyses is to capture differences in the quality and quantity of the ecosystem services under consideration.' The quality of ecosystem goods and services is not taken into account at all when meta-analyses are applied. 'To incorporate ecosystem quality in the value transfer process would require the definition and inclusion of quality variables in both the valuation data underlying the meta-analysis and in the data on ecosystem networks to which the values are transferred. In the case of wetlands, several methods are available for assessing their ecological integrity… [but] they rely on biological, physical and chemical measurements which are not available for most of the study and policy wetland sites [to which the meta-analysis function is transferred]' (Brander *et al.* 2012).

It is for this reason that some methods, such as that developed by Ghermandi *et al.* (2009), use an estimate of the anthropogenic pressure exerted on the surroundings of the wetland as a *proxy* or substitute variable for its ecological status, assuming that the latter greatly depends on the pressure exerted by human activities.

Application of the analysis carried out by Woodward and Wui (2001)

As part of our first approach to the estimation of the value of the Paraná Delta ecosystem services, we took into account the values obtained by Woodward and Wui (2001), who analysed 39 studies from which they obtained 65 observations of wetland values[1].

Model and data used

The econometric model of Woodward and Wui (2001) is based on the hypothesis that measured wetland value per acre (y) is a function of the size in acres of the wetland (x_a), the services it provides (x_s), the methodology used (x_m), other variables describing the study – *e.g.*, year of publication and location (x_0), and a constant term.

The estimated model is:

$$\ln(y) = a + b_a \ln(x_a) + b'_s x_s + b'_m x_m + b'_o x_o$$

where *a* is the constant term and *b* are the estimated coefficients on the respective explanatory variables.

1 This study was also used as an input for the analysis of the indirect use value undertaken by Costanza (2005) for the Middle Paraná.

In order to use this equation to estimate the transfer of benefits, the coefficients of the estimated function must be adjusted by multiplying them by values that reflect the characteristics of the study site. Adjusted coefficients are then added so as to obtain the value of the dependent variable, in this case, the value per acre of wetland in 1990 US dollars.

In this first approach to the estimation of the value of the Paraná Delta ecosystem services, we use the coefficients calculated in model C developed by Woodward and Wui (2001), in which it is assumed that the value of a wetland is a function of: i) the physical characteristics of the wetland systems, ii) the methods used to measure the value of these ecosystems, and iii) the quality of the studies considered.

Table 20 shows the function used, the adjustments made (column 2), and the resulting value (column 3). The value of the set of ecosystem services provided by the Paraná Delta is thus obtained.

As Woodward and Wui (2001) explain, 'the coefficients on the wetland service variables [column 1] are estimates of the extent to which the presence of each service changes the value per acre [of the wetland]. A very small coefficient does not mean that a service has no value, but that the value of wetlands that provide that service is very close to the average value for all wetlands [analysed in the model].' Likewise, a negative coefficient – *e.g.,* on the birdhunt and amenity variable – indicates that the presence of that service reduces the value of the wetland relative to the average value of the wetlands analysed, whereas a positive coefficient – *e.g.,* on the birdwatch variable – means that the presence of that service increases the wetland's value. The negative value referring to the wetland size proves that, in the wetlands evaluated, an increase in this size pushes down the value per acre – decreasing returns to scale[2], but by a very small proportion.

In this model, the only specific data on the Paraná Delta introduced into the estimation is the surface area of the wetland. To this end, a surface area of 22,587 km^2 was used, based on the calculation considered in PIECAS-DP (Environmental and Sustainable Development Secretariat 2008). Said area equals 5,581,369 acres[3]. In the case of the variable corresponding to year of publication, the adjustment is made by multiplying this by the average value of the years used in the equation estimated by Woodward and Wui (2001). In the same way, the valuation methods – *e.g.,* hedonic pricing, net factor income, etc. – are weighted by the respective averages obtained in that study, following the guidelines put forward by Rosenberg and Loomis (2003), Rosenberg and Stanley (2006), Loomis and Richardson (2008), and Brander *et al.* (2012)[4].

Since the Paraná Delta is not a coastal wetland, the impact of this variable on the estimation is cancelled out by multiplying its coefficient by 0. In the same way, certain other variables are cancelled out because they refer to aspects of the quality of primary studies which were not relevant to this benefit transfer process, namely data, theory, metrics, and publication of results. The producer's surplus variable is also multiplied by 0 because we are not aiming to calculate only this type of value.

With regard to ecosystem services, they are all weighted by 1 because they are provided by the Paraná Delta. It is worth noting that the Delta provides improvements to the provision of ecosystem services related to commercial fishing which are not reflected in the price of fish[5]. Therefore, the corresponding variable is weighted by 1 so as to supplement the estimate obtained in the section on the valuation of fishing using the market price method.

Results

The results of this first approach indicate an average per acre value of the Paraná Delta wetland of approximately USD 83, equal to USD 206 per hectare (both measured in 1990 USD)[6] (Table 21) and which, converted into 2003 US dollars, give an average value of USD 269/ha[7].

Value of the Paraná Delta per acre, based on model C of Woodward and Wui (2001):

$$y = e^{4,423} = 83.38 \text{ (1990) USD / acre}$$
$$206.05 \text{ (1990) USD / hectare}$$

[2] This means that the value of adding one additional hectare to a large wetland is lower than the value of adding one additional hectare to a small wetland.

[3] 1 km^2 = 247.105381 international acres.

[4] The meta-analysis function thus estimates the value resulting from the average valuation method used in the studies on which the calculations of Woodward and Wui (2001) were based.

[5] Said improvements include, for example, flood pulses in the wetland's floodplains that favour the farming of different fish species. These fishing-related ecosystem services are valued by means of stated preference methods – for example, using the contingent valuation method.

[6] 1 hectare = 2.47105381 international acres.

[7] It was necessary to convert 1990 USD into 2003 USD in order to compare the value per hectare obtained using this model with the results obtained by means of the models used by Ghermandi *et al.* (2009) and Brander *et al.* (2012), who measure the value per hectare in 2003 USD. In order to do this, the GDP implicit deflator was used (World Bank 2012a)..

Table 21.- Value per acre of the Paraná Delta derived from the ecosystem services provided by this wetland, based on Woodward and Wui (2001).

Group		Variable	Coefficients (1)	Adjustment value (2)	Contribution to ln of per-acre value (3) = (1) x (2)
		Constant: a **	7.872	1	7.872
		Year of publication	0.016	14.908	0.239
Characteristics of the wetland		Size of the wetland in acres (ln) **	-0.286	15.535	-4.443
(X_a / X_S)	Tipo de humedal	Coastal wetland	-0.117	0	0
	Servicios ecosistémicos	Flood control	0.678	1	0.678
		Water quality	0.737	1	0.737
		Water quantity	-0.452	1	-0.452
		Small-scale fishing	0.582	1	0.582
		Commercial fishing services	1.360	1	1.360
		Birdhunt **	-1.055	1	-1.055
		Birdwatch **	1.804	1	1.804
		Recreation **	-4.303	1	-4.303
		Habitat	0.427	1	0.427
		Storm buffering	0.173	1	0.173
Characteristics of the studies		Publication of results	-0.154	0	0.000
		Data	0	0	0.000
(X_O / X_M)		Theory	-1.045	0	0.000
		Metrics **	-3.186	0	0.000
		Producer surplus **	-3.140	0	0.000
		Hedonic pricing **	5.043	0.031	0.156
		Net factor income	0.273	0.246	0.067
		Replacement cost **	2.232	0.277	0.618
		Travel cost	-0.341	0.108	-0.037
		Total (ln of per-acre value)			**4.423**

** The coefficient is statistically significant at the 5% level.
R^2 = 0.582

Application of the analysis carried out by Ghermandi *et al.* (2009)

Model and data used

The analysis conducted by Ghermandi *et al.* (2009) relied on the conceptual and empirical bases of previous meta-analyses on wetland valuation – *e.g.*, Woodward and Wui (2001) and Brander *et al.* (2006) – and extended these by including other explanatory variables, such as the presence of substitute sites and the anthropogenic pressure exerted on the wetlands in question, which were chosen with the aim of obtaining an explanation for the differences observed between wetland valuations, from a more economic perspective. Moreover, the meta-analysis performed by Ghermandi *et al.* (2009) introduced the original dataset developed by Brander *et al.* (2006), which consists of 215 observations of wetland values obtained from 80 studies, and substantially enhanced said data by means of more recent studies, thus obtaining a comprehensive dataset that includes 418 observations of wetland values derived from 170 studies on 186 wetlands worldwide[8].

The resulting meta-analysis model is as follows:

$$\ln(y) = a + b_S X_{Si} + b_W X_{Wi} + b_C X_{Ci} + u_i$$

where the dependent variable (ln (y)) is the natural logarithm of the wetland value expressed in 2003 USD per hectare per year, a is a constant term, b_S, b_W, b_C are the coefficients of the explanatory variables and u is an error term that is assumed to be normally distributed and with a mean value of zero.'

Explanatory variables are grouped into three categories that correspond to: i) the characteristics of the primary studies (X_S), ii) the characteristics of the wetland being valued (X_W), and iii) the socioeconomic and geographical context of the wetland under study (X_C).

The characteristics of the primary study (X_S) accounted for in this model include the valuation method used, the year of publication, and a dummy that allows marginal values to be distinguished from average values.

The variable corresponding to year of publication is adjusted by multiplying it by the average value of the years of publication for the studies considered in the equation estimated by Ghermandi *et al.*(2009), in much the same way as this variable was weighted in the equation proposed by Woodward and Wui (2001). In turn, following the guidelines set out by Brander *et al.* (2010) and Brander *et al.* (2012), the dummy variable that distinguishes between marginal and average values is set to 0, since in the case of the Delta, the average values per year per wetland hectare are estimated, but not the value of a marginal change in the surface area of the Delta, which would be estimated using marginal values.

The characteristics of the wetland site being valued (X_W) include the size and type of the wetland, the ecosystem services it provides[9], and the level of pressure exerted on it by human activities.

Data on the surface area of the Paraná Delta has been introduced into the estimation in hectares (22,587 km^2= 2,258,700 hectares).

The classification of wetland systems adopted by Ghermandi *et al.* (2009) corresponds to the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin *et al.* 1979), to which these authors added a sixth category, which identifies human-made wetlands. According to Ghermandi *et al.* (2009), 'since wetland ecosystems may include areas with different characteristics, the same observation may be classified under two or more wetland systems.' The Paraná Delta – which has a mixed hydrologic regime – is defined as a wetland with riverine characteristics, a significant component of palustrine characteristics, and estuarine dynamics (Bó pers. comm.). Therefore, the variables relative to type of wetland corresponding to riverine, palustrine, and estuarine types were set to 1, and the others, to 0.

In turn, all ecosystem services were set to 1, as in the application of the model developed by Woodward and Wui (2001).

The pressure that human activities exert on a wetland may affect its ecological status and the level of provision of ecosystem goods and services. According to Ghermandi *et al.* (2009):

> since direct observations of the ecological status are lacking for most of the wetlands in the dataset, an index was constructed that accounts for the degree

8 The largest number of observations is from North America (132), but significant numbers come from Asia (106), Europe (93), and Africa (53). South America (22), and Australia (16) are somewhat underrepresented. In the dataset used by Ghermandi *et al.* (2009), 'the geographical distribution of wetlands is skewed towards sites located at temperate Northern latitudes and in the equatorial region. Despite such a geographical bias, which reflects the availability of natural resource valuation studies, the database is considerably less biased towards North American wetlands than those used in previous meta-analyses of wetland values. This reflects a substantial shift in the geographical distribution of wetland studies in recent years from North American sites towards European, Asiatic and African wetlands.'

9 The ecosystem services considered by Ghermandi *et al.* (2009) are based on the classification proposed in the Millennium Ecosystem Assessment. The largest number of observations included in this meta-analysis relates to cultural services (264 observations) and provisioning services (257 observations), while relatively less information is available for regulating services (105 observations) and support services (45 observations). The authors stressed that it was not possible to include valuations relative to climate regulation, among other variables.

> of anthropogenic pressure exerted and may be interpreted as a broad, landscape assessment of a wetland's ecological conditions. […] The index takes into account three criteria: i) the presence of alterations in the natural hydrologic regime of the wetland as induced, for instance, by the construction of dikes to regulate the water level in the wetland, ii) whether the wetland is located in an urban or rural setting, and iii) the site's protection status, (viz, Ramsar site, national park, nature reserve or not protected). Each criterion is evaluated as a binary variable: controlled/natural hydrology, urban/rural setting, protected/not protected and the [resulting] index consists of a categorical predictor with four levels of pressure. The lowest level of pressure […] identifies wetland sites with natural hydrology, located in a rural setting and protected. At the other end of the range, 'high pressure' identifies unprotected wetlands with controlled hydrology that are located in an urban environment. The categories 'medium-low' and 'medium-high' pressure identify intermediate states.

Given the characteristics of the Paraná Delta matrix, the level of human pressure that was weighted in the application of the meta-regression analysis corresponds to a medium-high level of human pressure, due to: i) the presence of dikes and embankments for farming or urban-planning projects, and of large infrastructure works that affect the Delta's hydrologic regime (Blanco and Méndez 2010) but not to a great extent, ii) the presence of large urban centres on the periphery, and iii) the fact that it is mostly an unprotected site.

The three variables that account for the socioeconomic and geographical context (X_C) included in this meta-regression model are: gross domestic product (GDP) per capita, number of inhabitants surrounding the wetland, and total area of the wetland under study. These characteristics are expected to significantly influence valuation estimates, since environmental valuation studies carried out at different geographical sites and involving populations with different socioeconomic characteristics and consumer preferences typically produce different outcomes.

The values of real GDP per capita used in the meta-regression model by Ghermandi *et al.* (2009) are measured in 2003 USD. 'The total population and abundance of wetland ecosystems in the surroundings of the valued wetland are assessed in a radius of 50 km around the geographic center of the wetland applying GIS techniques.' (Ghermandi *et al.* 2009). Therefore, in order to introduce specific data on the Paraná Delta into this model, it was necessary to estimate the per capita gross geographic product (GGP) and the population and abundance of wetlands within a radius of 50 km.

The calculation of the per capita gross geographic product was based on data for the nine districts of Buenos Aires province that are part of the Delta matrix together with GGP data for Santa Fe and Entre Ríos provinces, since the breakdown of data by district is not available for these two provinces (Table 22). GGP data correspond to GGP expressed in current prices of 2003, the year considered in the study by Ghermandi *et al.* (2009).

Tabla 22- Estimate of the Paraná Delta GGP for 2003. Producer prices, at current prices, in Argentine pesos.

Province	Estimated GGP
Buenos Aires (nine districts only)*	11,644,339,442
Santa Fe	30,347,937,878
Entre Ríos	8,234,987,970

* Districts of Baradero, Campana, Escobar, Ramallo, San Fernando, San Nicolás, San Pedro, Tigre, and Zárate.

Source: Buenos Aires, Entre Ríos, and Santa Fe Statistics.

Using population data for 2010, the average GGP per capita obtained for the Paraná Delta matrix totalled ARS 8,536.35, equal to 2003 USD 7,525.72 considering the purchasing power parity exchange rate[10], which is one of the adjustments suggested by Ready and Navrud (2006) for international benefit transfer (see Chapter Two).

Regarding the population living in the vicinity of the wetland, Ghermandi *et al.* (2009) consider this to entail anyone living within a 50 km radius of the wetland centre. Given the size of the Paraná Delta, a relatively accurate first approximation for this indicator was reached by considering the population of the districts and departments included in the Delta matrix as representative of the population living in the Delta itself plus that based along its banks.

As a result, the calculation of the Paraná Delta population was based on population data for the districts of Buenos Aires province and the departments of Santa Fe and Entre Ríos provinces that make up the Delta matrix (Table 6), which in 2010 added up to 3,784,938 people.

It is worth noting that, in our opinion, it would have been more appropriate to use more accurate data on the population that is directly connected to the wetland. For example, an additional 10 km-wide strip along the edge of the region could have been used for this indicator, on the assumption that the population living within this distance regularly interacts with the Delta. Unfortunately, since 2010 population data have not yet been broken down by sub-district, the population data available for carrying out that calculation were not consistent with the

[10] A purchasing power parity (PPP) index was used to make this calculation (World Bank 2012b).

rest of the population data used in this study. Consequently, the calculation of the benefit transfer was based on the Delta matrix population data.

With regard to estimates of the abundance of wetlands within a 50 km radius, which seek to assess possible substitution effects for some of the wetland services of the Paraná Delta, although there are some other wetlands in nearby regions, the quantity and quality of the services that these provide are considered to fall short of substituting the services provided by the Delta[11]. Therefore, the effect of this variable in the estimate is cancelled by multiplying its coefficient by 0.

Table 23 shows the function used, the adjustments made (column 2), and the resulting value (column 3). This estimate of the value of the Paraná Delta ecosystem services was based on the coefficients calculated in model B by Ghermandi *et al.* (2009)[12]. The coefficients on water quality improvement, recreational activities – recreation, leisure, and aesthetic activities – and on provision of natural habitat and biodiversity indicate that wetlands providing these services are valued higher than the average for the wetlands analysed, whereas services related to provision of fuel wood and recreational hunting and fishing reduce the wetland value in relation to this average value. The coefficient corresponding to wetland size indicates decreasing returns to scale. Likewise, the value of the wetland can be seen to be directly related to the size of the population living in the surroundings of the wetland and to the GGP per capita (income effect).

Ghermandi *et al.* (2009) argue that:

> the coefficients for the environmental pressure variables are all positive and increase with pressure, indicating that a high pressure of human activities on the wetland produces high values. This may be linked to an improved level of provision of specific services and the intensity of use of wetlands. […] Furthermore, wetlands surrounded by densely populated areas and with unrestricted access – thus with high environmental pressure according to the index proposed in the study – are likely to be relatively easily accessible for the enjoyment of their recreational functions. High anthropogenic pressure on a wetland, however, raises questions about the sustainability of values. Regrettably, this issue cannot be addressed with the snapshots of values inferred from the valuation studies [considered within the framework of this meta-analysis].

Results

This second approximation yields an average value per hectare of the Paraná Delta wetland of approximately (2003) USD 1,169 (Table 23). The difference in the order of magnitude between this and the value estimated using the function outlined by Woodward and Wui (2001), equal to (2003) USD 269 per hectare, is mainly due to the introduction of variables relative to the socioeconomic context inherent to the Paraná Delta matrix, namely the GGP per capita and population in the vicinity of the wetland discussed above.

Paraná Delta per-hectare value based on model B by Ghermandi *et al.* (2009):

$$y = e^{7,064} = 1,169.05 \text{ (2003) USD / hectare}$$

[11] In relation to the abundance of wetlands in the Delta region, Bó (pers. comm.) made a distinction between **a proper** wetland region, such as the Paraná Delta, and a region **containing** wetlands, such as some areas near the Delta, including parts of the Pampas Region surrounding the Delta in the southeast of Santa Fe province, north of Buenos Aires province, and centre of Entre Ríos province. All these are relatively high regions alternating with depressions and valleys drained by rivers, most of which flow into the Paraná River. This is the case of the Gualeguay River alluvial valley (which lies relatively close to the city of Gualeguay, in Entre Ríos province) and of the riverside lowlands that constitute a geographic transition towards the islands of the Delta, particularly in the north of the districts of San Pedro, Zárate, Campana, and Escobar, in Buenos Aires province. Some of the latter have wetland environments that are relatively similar to those of the islands of the Delta and mainland regions. Likewise, they provide ecosystem services that are very important, but cannot replace those provided by the Delta in terms of quality or quantity.

[12] In model B, the dummy variables identifying valuation methods used in primary studies were dropped from the regression since they were found to be statistically insignificant. According to Ghermandi *et al.* (2009), 'the low significance of the coefficients on valuation methods suggests that methodological heterogeneity in the primary studies does not influence the regression results in any substantial sense.'

Table 23.- Value per hectare of the Paraná Delta derived from the ecosystem services provided by this wetland, based on Ghermandi *et al.* (2009).

Group		Variable	Coefficients (1)	Adjustment value (2)	Contribution to ln of per-hectare value (3) = (1) x (2)
		Constant: a	-0,681	1	-0,681
		Year of publication **	-0,041	21,770	-0,893
		Marginal **	0,713	0	0,000
Characteristics of the wetland (X_W)		Wetland size in hectares (ln) ***	-0,234	14,630	-3,423
	Wetland type	Estuarine	0,270	1	0,270
		Marine ***	0,754	0	0,000
		Riverine	0,380	1	0,380
		Palustrine *	-0,480	1	-0,480
		Lacustrine	0,332	0	0,000
		Constructed **	1,023	0	0,000
	Ecosystem services	Flood control and storm buffering	0,432	1	0,432
		Water quality improvement **	0,727	1	0,727
		Water quantity	-0,099	1	-0,099
		Commercial fishing and hunting	0,266	1	0,266
		Recreational hunting ***	-1,007	1	-1,007
		Recreational fishing	-0,082	1	-0,082
		Harvesting of natural materials	-0,202	1	-0,202
		Fuel wood **	-0,968	1	-0,968
		Recreation **	0,670	1	0,670
		Amenity and aesthetics	0,529	1	0,529
		Natural habitat and biodiversity ***	1,143	1	1,143
	Human activities	Medium-low human pressure **	0,572	0	0,000
		Medium-high human pressure ***	1,243	1	1,243
		High human pressure ***	1,992	0	0,000
Socio-economic and geographical context (X_C)		GGP per capita (PPP) (ln) ***	0,358	8,926	3,196
		Inhabitants in 50 km radius (ln) ***	0,399	15,147	6,043
		Wetland abundance (ln)	-0,058	0	0,000
		Total (ln of per-hectare value)			**7,064**

* The coefficient is statistically significant at the 10% level.
** The coefficient is statistically significant at the 5% level.
*** The coefficient is statistically significant at the 1% level.
R^2 = 0.47 (R^2 adjusted = 0.44).

Application of the analysis carried out by Brander et al. (2012)

Finally, a third estimate of the use value of ecosystem services provided by the Paraná Delta was made using the meta-analysis study performed by Brander *et al.* (2012), which employs specific data on temperate climate zone wetlands, as is the case with the Paraná Delta (Quintana and Bó 2010a).

Model and data used

The dataset used by Brander *et al.* (2012) to estimate the meta-analysis wetland value function contains 222 observations of wetland values for temperate climate zone wetlands only. These data were taken from 120 primary valuation studies, mainly from the United States and Europe.

The meta-analysis regression model is the same as that used by Ghermandi *et al.* (2009):

$$\ln(y) = a + b_S X_{Si} + b_W X_{Wi} + b_C X_{Ci} + u_i$$

where the dependent variable (ln (y)) is the natural logarithm of the wetland value standardized to 2003 USD per hectare per year, and the explanatory variables are grouped into three categories that correspond to: i) the characteristics of the primary studies (X_S), ii) the characteristics of the valued wetland (X_W) and iii) the socioeconomic and geographical context of the wetland being studied (X_C).

The signs of the coefficients are similar to those in the model developed by Ghermandi *et al.* (2009), which were discussed in the previous section.

In order to apply this meta-analysis function to the valuation of the Paraná Delta, the study methodologies – *e.g.*, contingent valuation, hedonic pricing, etc. – are weighted by the respective averages obtained in the equation. The variable distinguishing between marginal and average values is set to 0 because, as in the previous case, average wetland values per hectare are being estimated rather than the marginal value of an additional hectare of Delta.

Brander *et al.* (2012) characterize the different wetland types using the European Environment Agency (EEA) classification of ecosystem types. According to this classification, the type that is most representative of the characteristics of the Paraná Delta is marshes (or *inland marshes*)[13].

The remaining variables, which account for ecosystem services and the socioeconomic and geographical context, were weighted in the same way as in the estimate based on the model developed by Ghermandi *et al.* (2009).

Results

This third approximation yields an average value per hectare of the Paraná Delta wetland of approximately (2003) USD 1,277 (Table 24).

> Paraná Delta per-hectare value based on the model developed by Brander et al. (2012):
>
> $y = e^{7,152}$ = 1,276.98 (2003) USD / hectare

Table 24.- Value per hectare of the Paraná Delta derived from the ecosystem services provided by this wetland, based on Brander *et al.* (2012).

Group	Variable	Coefficients	Adjustment value	Contribution to ln of per-hectare value
		(1)	(2)	(3) = (1) x (2)
	Constant: a	-0.970	1	-0.97
Characteristics of studies (X_S)	Contingent valuation	0.317	0.269	0.085
	Experimentation	-0.524	0.031	-0.016
	Hedonic pricing **	-2.328	0.022	-0.051
	Travel cost	-0.705	0.170	-0.120
	Replacement Cost	-0.383	0.206	-0.079
	Net factor income	-0.125	0.143	-0.018
	Production function	-0.091	0.058	-0.005
	Market prices	-0.215	0.161	-0.035
	Opportunity cost	-1.164	0.040	-0.047
	Marginal valuation *	0.828	0	0.000

[13] The comments made by Bó (pers. comm.) were taken into account to make this choice.

Group		Variable	Coefficients	Adjustment value	Contribution to ln of per-hectare value
Characteristics of the wetland (X_W)		Wetland size in hectares (ln) ***	-0.218	14.630	-3.189
	Wetland type *	Marsh	-0.211	1	-0.211
		Peatbogs ***	-2.266	0	0.000
		Salt marshes *	0.073	0	0.000
		Intertidal mudflats	-0.239	0	0.000
	Ecosystem services	Flood control and storm buffering	0.626	1	0.626
		Water quality improvement	0.514	1	0.514
		Water quantity	-0.106	1	-0.106
		Commercial fishing and hunting	0.042	1	0.042
		Recreational hunting ***	-1.355	1	-1.355
		Recreational fishing	-0.119	1	-0.119
		Harvesting of natural materials	-0.153	1	-0.153
		Fuel wood	-0.959	1	-0.959
		Recreation	0.218	1	0.218
		Amenity and aesthetics	0.432	1	0.432
		Natural habitat and biodiversity **	1.211	1	1.211
Socio-economic and geographical context (X_C)		GGP per capita (PPP) (ln) ***	0.430	8.926	3.838
		Population in 50 km radius (ln) ***	0.503	15.147	7.619
		Wetland abundance (ln)	-0.125	0	0.000
		Total (ln of the per-hectare value)			**7.152**

* The coefficient is statistically significant at the 10% level.
** The coefficient is statistically significant at the 5% level.
*** The coefficient is statistically significant at the 1% level.
**** The binary variable 'saline wetlands' has been dropped from the regression due to the method used to estimate the econometric model.

R^2 adjusted = 0.36R^2 ajustado = 0,36

Discussion

The result of the estimate of the average value of the ecosystem services provided by the Paraná Delta using the function outlined by Ghermandi *et al.* (2009) is an intermediate value lying between those obtained using the function of Woodward and Wui (2001) and that of Brander *et al.* (2012) (Table 25).

It is worth emphasizing that, unlike the model developed by Woodward and Wui (2001), the models presented by Ghermandi *et al.* (2009) and Brander *et al.* (2012) allow the introduction of variables that account for the socioeconomic context inherent to the Paraná Delta matrix. Another point in favour of these studies is that they either include a wider and more up-to-date range of wetland valuation studies carried out in different regions worldwide, or use specific data on temperate climate zone wetlands. As such, the results obtained using the latter two meta-analysis functions would be more representative of the average per-hectare value for the Paraná Delta.

This allows us to conclude that the average value of the ecosystem services provided by the Paraná Delta considered herein would range between 1,169 USD/hectare/year and 1,277 USD/hectare/year.

Table 25.- Value of the Paraná Delta ecosystem services according to the meta-analysis function used, in 2003 USD per hectare/year.

Woodward and Wui (2001)	Ghermandi *et al.* (2009)	Brander *et al.* (2012)
269 USD/ha/yr	1,169 USD/ha/yr	1,277 USD/ha/yr

CHAPTER SIX

The total economic value of the Paraná Delta

On the basis of the value of the economic activities estimated in Chapter Four and of the value of ecosystem goods and services estimated in Chapter Five, the total economic value of the Paraná Delta can be estimated. The resulting value is presented in 2003 US dollars (USD) per hectare per year. By combining the minimum and maximum values obtained in each estimate, the result is a value ranging from USD 1,356 /ha/year and USD 1,649 /ha/year (liv).

Table 26.- Total economic value of the Paraná Delta in 2003 USD per hectare per year.

Value	Maximum	Minimum
Value of economic activities	372	187
Value of ecosystem goods and services	1,277	1,169
Total economic value	**1,649**	**1,356**

Source: Own elaboration based on Appendix III and Table 25.

These values may be interpreted as the average value of the services provided by a wetland over a year. This is the value of the average annual opportunity cost if the decision is made not to preserve a hectare of wetland[1]. This does not mean that the value of each hectare of the Delta is somewhere between these values, as this estimate was obtained as an average, such that the value of each hectare may vary depending on the specific characteristics of the area in question.

These values are somewhere within the range of maximum and minimum average values estimated in studies that reviewed different wetland valuation studies ranging from a minimum of USD 929 (Randall *et al.* 2008) to a maximum of USD 3,240 (Brander *et al.* 2006) (Table 27).

Table 27.- Value in average USD/ha of a wetland. The table presents the average for the values of the studies reviewed in each research study. In Randall *et al.* (2008), it corresponds to the average of the estimate made through benefit transfer.

Study	Value	Base year	Value in USD at 2003 prices*
Schuyt and Brander (2004)	3.000	2000	3.184
Brander *et al.* (2006)	2.800	1995	3.240
Randall *et al.* (2008)	1.048	2007	929

* Adjusted by GDP implicit deflator (World Bank 2012a).
Source: Own elaboration.

In this study it was not possible to value the carbon storage (or sequestration) service provided by the Paraná Delta due to: i) the lack of information on the amount of carbon sequestered by the different types of

The Paraná Delta also provides benefits such as climate regulation and flood control.

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[1] The opportunity cost is the value of the alternative that is discarded. In this case, the alternative would be not to preserve the wetland.

plants in the Delta, which results from the lack of specific studies on that issue; and ii) the fact that this service has not been valued in the case studies considered in the meta-analyses carried out by Woodward and Wui (2001), Ghermandi *et al.* (2009), and Brander *et al.* (2012), among others. Notwithstanding this, a rough estimate was made possible by taking into account the carbon accumulation rate in the *cortadera* marshlands of the Lower Delta (see the box). For this reason, this value cannot be added to the total economic value per hectare estimated in this study.

Carbon storage in the *cortadera* marshlands of the Lower Paraná Delta

Wetlands are ecosystems that are capable of storing carbon because of the water they contain: waterlogged areas have lower oxygen levels, which means that organic matter decomposes more slowly than on dry land. Net Primary Productivity (NPP) is a secondary indicator of the carbon accumulation rate. While the amount of organic matter that is decomposed must be taken into account, in the case of wetlands the decomposition rate is very low. In a study carried out on the marshlands containing *Scirpus giganteus* bulrushes in the Lower Delta, Pratolongo (2003) reports an aerial NPP of 1,866.09 ± 258.55 g/m^2/year or 18.66 tonnes/ha/year.

The area occupied by *cortadera* marshes (*Scirpus giganteus* marshes) accounts for around 25% of the Lower Delta area (which extends over 759,845 ha) (Kandus *et al*. 2006), thus constituting the largest natural environment in the ecosystem. This percentage accounts for a total of approximately 189,961 ha of marshlands, which have an annual NPP of around 3,544,676 tonne/year.

In order to value the amount of carbon stored in monetary terms, as suggested by Turner *et al*. (2008), this study has used the avoided cost method, which is based on the damage that is avoided by that carbon not being released into the atmosphere. The marginal cost of the damage caused by carbon dioxide is taken as the per tonne carbon value; this cost is also known as the social cost of carbon, defined as the net present value of the incremental damage caused by a marginal increase in carbon dioxide emissions (Tol 2009).

The value was taken from Tol (2009), who finds, after reviewing and conducting a statistical adjustment of 232 estimates of the social cost of carbon, that the average for these studies is USD 151/tonne of carbon and the mode – the most frequent value or the value that is most repeated in the range of data – is USD 41/tonne of carbon, in 1995 USD[a].

In 2003 USD, which is the unit of measurement used in the valuation of the economic activities and the ecosystem goods and services selected, the average is USD 174/tonne and the mode is USD 47/tonne[b].

Thus, carbon storage in the marshlands of the Lower Delta is avoiding a social cost ranging from USD 885 /ha/ year to USD 3,260 /ha/year.

a. This value is very different from the price of greenhouse gas emission allowances, which varies with changes on both the supply and demand sides. The main market for emission allowances is that of the European Union, where prices have proved to be very volatile. For example, in 2008 said price was at about USD 29/tonne, whereas in December 2012 it stood at USD 8/tonne.

b. For the conversion into 2003 UD dollars, the United States GDP implicit deflator was used (World Bank 2012a).

CHAPTER SEVEN

Conclusions and recommendations

This study has demonstrated the importance of knowing the value of a natural resource to decision-making processes, particularly those related to the conservation and preservation of this resource and to the economic activities that affect it. Inadequate understanding of the role of a natural resource such as the wetland system of the Paraná Delta and the value derived from it has been identified by various authors as one of the reasons these wetlands are being damaged.

With regard to economic activities, the valuation task is relatively simple as long as data is available on the characteristics of the relevant goods and services, the supply of these, and the prices paid for them. However, the quality and quantity of this information is not always sufficient for the necessary calculations to be made.

These problems are even greater for ecosystem goods and services, which are generally non-market goods. In this case, the scale of the goods and services provided by the wetland over a certain period of time is based on estimates, and the values of these were obtained using a range of methods that attempt to estimate the intensity of people's preferences for these goods and services, as revealed by their behaviour or their answers to surveys, or by alternative means.

This valuation is more complex in the case of an ecosystem because of the multiple services it provides, the interrelationships between its components, and the uncertainty about the effects of human intervention on it.

The Paraná Delta provides multiple services and supplies a wide range of goods to those who live in or near it or who visit it frequently. However, the Delta also provides benefits for people who are not usually directly involved with it, as is the case with services such as climate regulation, flood control and storm buffering, the provision of habitat for wild flora and fauna, and the conservation of biodiversity.

Due to its size, the Paraná Delta includes areas with different supplies of ecological goods and services (ecological units). This enables a range of productive activities to be carried out in the region (Kandus and Minotti 2010). This makes the valuation process more

This valuation provides useful data for decision making on the management of the Paraná Delta wetland, but it is also necessary to have mechanisms that foster conservation of the area and the continued provision of wetland goods and services.

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complex than that of smaller, less diverse wetlands, which are generally the object of study of most of the articles in which such estimates are made.

Any valuation relies on a prior assessment of the goods and services the area provides. This study has compiled and summarized the information available on the main economic activities that take place in the Paraná Delta, such as apiculture, fishing, hunting, forestry, cattle raising, and recreation and tourism. In some cases, the existing data was supplemented by interviews with, or surveys of, the people who undertake these activities and the experts that study them.

In spite of this, a thorough characterization and valuation of the activities in question was prevented by the incomplete and biased nature of the data that it was possible to gather. Most of these activities were valued using the total income method, which consists of multiplying the quantity produced or extracted by the unit price of a product or service.

With regard to the ecosystem goods and services provided by the Delta, the benefit transfer method was used, which is based on estimates that have been made for other wetlands in order to obtain the value of the wetland in question. This procedure requires less time and resources than other more complex ones and is recommended for obtaining an initial approximation of the value of a resource, on the basis of which the appropriateness of an original valuation can then be assessed. Of the different benefit transfer options available, a meta-analytic regression function transfer was chosen, as this has been shown to provide better estimates than alternative methods.

The value that was estimated for the selected economic activities ranged from a minimum of USD 187/ha/year to a maximum of USD 372/ha/year. More than 80% of this value corresponds to cattle raising. In turn, the values obtained for the ecosystem goods and services provided by the Paraná Delta ranged from a minimum of USD 1,169/ha/year to a maximum of USD 1,277/ha/year. The sum of these two sets of values is the total economic value of these wetlands, which lies between USD 1,356/ha/year and USD 1,649/ha/year. This is an initial approximation of the value of the Paraná Delta and constitutes the main original contribution of this work.

These results reflect the average value of a set of economic activities and environmental goods and services provided by a single hectare of the Paraná Delta. Certain observations should be made regarding this. First, this calculation does not reveal the value of the modification of the study area through the loss or gain of a hectare of wetland, which is known as the marginal value and which may be higher or lower than the average value depending on the ecological and socio-economic characteristics of the area in which the hectare in question is located. Second, given the heterogeneity and size of the Delta, this average value for the region as a whole is likely to differ from the average per-hectare value within each of the ecological units the Delta is made up of. Third, this type of estimate is suitable for obtaining an initial approximation of the order or magnitude of the value in question, which makes it useful for decision-making regarding natural resource management policy, notably for land-use planning. However, it does not contribute to calculating the value of environmental damage such as the loss of a hectare of Delta due to an accident or an economic activity being undertaken that is incompatible with its conservation. This would require a site-specific valuation.

In terms of the recommendations arising from this study, given the importance of the goods and services of the Paraná Delta, it should be borne in mind that the information provided by this valuation is useful for decision-making on wetland management, but that it alone is not enough to ensure wetland conservation. Achieving this would require mechanisms that provide incentives to preserve these areas and maintain their supply of goods and services. This is what is known as internalization of externalities, but in more recent literature is referred to as capturing ecosystem benefits (Fisher *et al.* 2008).

There are both positive and negative externalities for the Paraná Delta. The positive externalities include those services that benefit people and those arising from the actions of those carrying out their activities sustainably, thus favouring the conservation of the wetland. The negative externalities are actions that damage the wetland.

To ensure that people continue to benefit from the positive externalities the wetland provides, policy measures related to natural resource management are needed, including regulatory and economic instruments, and appropriate institutional frameworks (OECD 1999, Fisher *et al.* 2008). The most commonly used regulatory instruments include: (i) land-use planning norms, which aim to keep economic activities within those areas that have the least effect on wetland goods and services; and (ii) permits and licenses to undertake certain activities, such as hunting and fishing permits, the objective of which is to prevent the activity from affecting the sustainability of the resource. These rules are supplemented by regulations on how such activities should be carried out – namely which technologies and production processes are permitted or prohibited – and by others on pollutant emissions, and the treatment and disposal of waste.

The economic instruments used for the care of ecosystems include: (i) taxes to discourage potentially harmful actions and encourage the adoption of technologies that are consistent with caring for the environment, and (ii) subsidies to support activities being carried out in a way that is compatible with resource conservation. This is the case for tax reduction, free technical assistance to producers on how to make their activity sustainable, and preferential loans for those who adopt technologies and processes that are compatible with care for the environment. Another economic instrument is the use of environmental standards as a requisite for receiving direct subsidies and preferential loans for any economic activity.

There are also other instruments through which the state may play an active role or participate by establishing the regulatory framework for the operation. One such instrument that has been developed recently is payment for environmental services, a system through which the beneficiary of the service pays the supplier for the service they have received, which is an incentive for the conservation of a resource that provides services that are not otherwise paid for (Pagiola and Platais 2002). These payments can be agreed upon voluntarily by the supplier and the beneficiary or granted by the state to those who perform actions that care for certain resources. In both cases, the valuation of the service and the cost of its provision is a necessary condition for determining the amount of such payment, even if the payment does not match the full value the service represents for the beneficiary. In Argentina, the most relevant example is set out in National Law 26.331, 'Minimum standards for the environmental protection of native forests', of 2007, which establishes monetary compensation for land-owners in exchange for the conservation of native forests (Gobbi 2011, Quispe Merovich and Lottici 2011).

Another instrument for internalizing the benefits of wetland conservation is payment for carbon sequestration, which arises in the context of measures against climate change. In this case, any conservation tasks that serve to sequester atmospheric carbon dioxide or to prevent stored carbon from being released into the atmosphere can take advantage of certain schemes that have been internationally regulated as part of the negotiations at the United Nations Framework Convention on Climate Change. These schemes are the Clean Development Mechanism (CDM) and the financial compensations discussed in the context of the proposals for Reducing Emissions from Deforestation and Forest Degradation (REDD) and Enhancing Carbon Storage Capacity (REDD+). For this reason, it is of use to know the quantity and value of the carbon sequestered, an issue that was partially tackled in this study for the marshlands of the Lower Delta, taking into account the social cost of the carbon sequestered rather than its market price. A specific study estimating the carbon sequestered by the different types of Delta vegetation and analysing the extent to which they would benefit from the above-mentioned mechanisms would be of interest.

An additional way for people to benefit from taking care of the wetland, one that is also voluntary, is for producers of goods that were processed in the Delta to be able to charge a higher selling price for their products because of this care for the environment. In this case, consumers would need to value this type of action and be willing to pay a higher price in comparison with similar products that do not offer this associated positive externality. This would be particularly appropriate for exports of products from the Paraná Delta to developed countries.

One shared difficulty faced by these payment and compensation mechanisms relates to the existing institutional framework, particularly with regard to the definition of who owns the resource that provides the environmental services. This leads to the problem of the definition of the right of ownership of the resources and the incentives for nature conservation that a suitable definition might bring. Other problems are the difficulty in accurately measuring the services provided, being able to directly connect payment with the behaviour of the owner of the resource providing the service, and such payments being acceptable to society (Fisher *et al.* 2008).

The valuation process carried out for this study has also revealed the shortage of the data that would be necessary to be able to value the services provided by the Delta more precisely. This is the cause of the 'information failure' mentioned at the start of this study, which is that those who make resource management decisions do not possess all the relevant information.

To correct this 'failure' it would be necessary, in the first place, to undertake a systematic survey of the available information on the production and subsistence activities that take place in the Delta, so as to reach a better understanding of them and estimate their value more rigorously. In particular, the statistical surveys carried out by government agencies would need to distinguish how much of each activity corresponds to the islands that form part of the Delta, which is not common practice. It is important to recognize these information gaps in the different jurisdictions of the Delta to encourage the collection of this type of data.

On the other hand, in relation to ecosystem services, valuing the services of each ecological unit of the Delta would provide a more complete picture, as it is very likely that value per hectare differs according to which unit the land belongs to. The data necessary to calculate the value of the carbon sequestered in the Delta is also lacking. This could be useful for gauging the payments that could be received in return for such services, amongst other objectives. Likewise, this type of valuation can be used to estimate the value of the impact that global climate change would have on the region, as has been recently calculated for other wetlands (Brander *et al.* 2012).

In conclusion, all of these issues relating to the valuation and use of this information contribute to the debate between the various stakeholders in the Paraná Delta, be they direct or indirect users of its goods and services, and whether or not they carry out activities that may be incompatible with care for the region, are interested in its conservation *per se,* or are in charge of the design and implementation of policy measures that are instrumental to the care of the Delta and of sectoral policies relating to the economic activities that take place there.

APPENDIX I

GGP per district of Buenos Aires province, by economic activity sector for 2003*. Producer prices in thousands of Argentine pesos (ARS), at current prices.

Activity sector	Baradero	Campana	Escobar	Ramallo	San Fernando	San Nicolás	San Pedro	Tigre	Zárate	Total
Goods-producing sectors	**161,279**	**1,483,114**	**1,075,456**	**266,232**	**1,007,615**	**567,724**	**175,617**	**1,288,891**	**994,907**	**7,020,834**
Agriculture, cattle raising, hunting, and forestry	96,763	14,098	3,516	91,977	4,954	68,832	109,626	798	56,317	446,881
Fishing	53	68	53	83	75	135	233	105	71	874
Mining and quarrying	548	5,946	1,196	0	0	493	254	377	431	9,244
Manufacturing industry	47,032	1,391,917	871,649	155,119	927,793	323,187	26,653	1,031,862	804,151	5,579,364
Electricity, gas, and water supply	6,063	20,177	38,457	7,155	34,038	106,019	21,845	79,349	74,021	387,125
Construction	10,821	50,908	160,585	11,897	40,755	69,059	17,006	176,399	59,916	597,346
Service sectors	**144,750**	**464,427**	**716,558**	**137,982**	**648,653**	**671,713**	**239,732**	**1,219,620**	**380,070**	**4,623,505**
Wholesale and retail trade and repairs	24,503	90,729	139,347	24,681	132,979	130,326	38,000	225,061	56,516	862,141
Hotels and restaurants	4,288	5,776	48,626	6,766	15,035	19,836	7,675	56,311	7,957	172,271
Transport, storage, and communications	35,549	138,022	155,549	30,063	126,094	130,419	59,766	269,668	93,552	1,038,681
Financial intermediation	7,799	16,074	27,580	7,241	18,571	31,984	11,845	36,890	18,761	176,746
Real estate, rental, and business services	36,332	99,696	204,741	34,385	168,543	157,021	66,284	334,799	109,584	1,211,385
Public sector and defence	3,930	27,974	13,880	4,457	16,046	50,646	7,420	43,665	16,505	184,523
Education	15,270	33,493	40,968	7,963	48,214	55,785	16,283	92,217	28,275	338,470
Health care and social services	9,748	17,918	22,908	13,583	28,053	49,251	15,743	31,439	22,029	210,672
Other community, social, and personal services	5,084	28,232	43,086	5,999	74,110	34,217	11,854	90,696	22,309	315,587
Domestic service	2,246	6,513	19,873	2,843	21,008	12,226	4,864	38,874	4,584	113,030
Total	**306,028**	**1,947,541**	**1,792,014**	**404,213**	**1,656,268**	**1,239,438**	**415,349**	**2,508,511**	**1,374,977**	**11,644,339**

* Last available year for data broken down by district.
Source: Buenos Aires Statistics Directorate

APPENDIX II

Estimate of the value of productive activities carried out in the Paraná Delta.

Activity		2007	2008	2009	2010	2011	Maximum	Minimum	Average
a. Apiculture									
Production (tonnes)		4,409	3,919	3,375	3,211	4,354	4,409	3,211	3,853
Average price (ARS/kg)		4.1	6.7	7.8	9.1	9.0	9.1	4.1	7.3
Value (in ARS)		**18,277,047**	**26,066,999**	**26,222,792**	**29,105,193**	**39,398,237**	**39,398,237**	**18,277,047**	**27,814,054**
b. Pesca									
Exports (tonnes)	Streaked prochilod	11,853	9,501	11,722	11,799	12,611	12,611	9,501	11,497
	Trahira	1,048	50	101	308	1,023	1,048	50	506
	Leporinus spp.	179	21	252	0	605	605	0	211
Average price (ARS/kg)	Streaked prochilod	n/a	n/a	n/a	1.5	2.6	2.6	1.5	2.0
	Trahira	n/a	n/a	n/a	n/a	3.0	3.0	3.0	3.0
	Other	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Value (in ARS)		**n/a**	**n/a**	**n/a**	**17,699,097**	**35,435,940**	**35,435,940**	**17,699,097**	**26,567,519**
c. Hunting									
Animals caught (qty.)	Coypu	69,054	76,850	6,800	7,700	58,311	76,850	6,800	43,743
	Common tegu	12,600	6,700	8,500	1,800	200	12,600	200	5,960
Prices (ARS/hide)	Coypu	21	8	7	13	17	21	7	13
	Common tegu	n/a	10	10	12	12	12	10	11
Value (in ARS)		**1,450,134**	**681,800**	**132,600**	**122,778**	**993,687**	**1,450,134**	**122,778**	**676,200**
d. Forestry									
Raw material used in production (tonnes)	***1. Chipboard***								
	Poplar	382	17,376	163	2,094	n/a	17,376	163	5,004
	Willow	16,519	151,954	29,202	20,802	n/a	151,954	16,519	54,619
	Total	**16,901**	**169,330**	**29,365**	**22,896**	**n/a**	**169,330**	**16,901**	**59,623**
	2. Pulp and paper								
	Poplar	108,071	47,305	75,134	113,443	n/a	113,443	47,305	85,988
	Willow	172,803	195,625	179,484	119,125	n/a	195,625	119,125	166,759
	Total	**280,874**	**242,930**	**254,618**	**232,568**	**n/a**	**280,874**	**232,568**	**252,748**

Activity		2007	2008	2009	2010	2011		Maximum	Minimum	Average
Average forestry prices (ARS/tonne)	***1. Chipboard***									
	Poplar	58	91	94	119	175		175	58	107
	Willow	58	91	94	119	175		175	58	107
	2. Pulp and paper									
	Poplar	70	93	120	165	213		213	70	132
	Willow	70	102	114	165	200		200	70	130
Valor (en $)		**20,585,263**	**39,653,828**	**32,199,999**	**41,098,344**	**n/d**		**41,098,344**	**20,585,263**	**33,384,358**
e. Cattle raising										
Cattle (head)		962,801	956,490	925,150	828,421	859,545		962,801	828,421	906,481
Average weight (kg per head of cattle)		218	212	210	221	230		230	210	218
Cattle (kg)		209,890,618	202,775,795	194,281,500	183,081,041	197,695,258		209,890,618	183,081,041	197,544,842
Price (ARS/kg live weight)		2.7	2.9	3.2	6.5	8.1		8.1	2.7	4.7
Value (in ARS)		**556,420,028**	**597,783,044**	**620,535,111**	**1,190,942,172**	**1,595,203,037**		**1,595,203,037**	**556,420,028**	**912,176,678**
f. Tourism										
Visitors to National Parks (qty.)		12,077	19,418	83,845	39,434	n/d		83,845	12,077	38,694
Average expenditure per person (ARS)		1,741	1,741	1,741	1,741	n/d		1,741	1,741	1,741
Value (in ARS)		**21,026,057**	**33,806,738**	**145,974,145**	**68,654,594**	**n/d**		**145,974,145**	**21,026,057**	**67,365,384**
Total Direct Use Value										
In ARS		**617,758,530**	**697,992,408**	**825,064,647**	**1,347,622,178**	**1,671,030,901**		**1,671,030,901**	**617,758,530**	**1,031,893,733**
In ARS/ha.		273.5	309.0	365.3	596.6	739.8		739.8	273.5	456.9

n/a = not available

The direct use value of the Paraná Delta in ARS/ha was calculated on the basis of a surface area of 2,258,700 hectares.

Note: There may be discrepancies in activity values due to rounding up or down of figures. For further information regarding calculation details, please contact the authors.

APPENDIX III

Estimate of direct use value by activity. Maximum, minimum, and average values in constant USD at 2003 prices

Activity	Max	Min	Average
a. Apiculture	17,167,183	14,246,015	15,762,876
b. Fishing	15,440,673	8,983,754	12,212,213
c. Hunting	1,130,305	62,320	430,476
d. Forestry	26,084,237	16,045,150	20,499,996
e. Cattle raising	695,085,494	366,343,008	498,570,327
f. Tourism	86,178,214	16,388,726	39,913,211
Total	**841,086,105**	**422,068,973**	**587,389,099**
GVP USD/ha	**372.4**	**186.9**	**260.1**

Note: Values in Argentine pesos (ARS) were transformed into values in constant USD at 2003 prices. This was done using the purchasing power parity (PPP) index (World Bank 2012b) and the GDP implicit price index (World Bank 2012a)

Source: Own elaboration based on Table 20.

CHAPTER EIGHT

References and interviews with experts

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Mission:

To sustain and restore wetlands, their resources and biodiversity.

When analysing social phenomena from an economic standpoint, resource allocation decisions are one of the aspects that are taken into account. In order to make these, decision makers consider different indicators, such as resource prices. Indicating the value of a resource in monetary terms can help care for it by explicitly establishing the cost of carrying out activities which are incompatible with the conservation or preservation of said resource. The economic valuation of natural ecosystem resources can influence policy decision-making, despite the difficulties inherent in this valuation process. It has been said that one of the reasons for the damage caused to wetlands is that there is no price on many of their functions, which therefore have no economic value for decision makers.

This study presents an estimate of the economic value of the economic activities taking place in the Paraná Delta and of the ecosystem goods and services this wetland provides, in order to create a resource to inform public decisions about the use of the Delta, as such decisions often tend not to take environmental effects fully into account.

For further information
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