

The Economic Value of Gray Whales to Local Communities:
A Case Study of the Whale Watching Industry
in Two Communities in Baja, Mexico

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ABSTRACT

Worldwide, whale watching is a growing business for coastal communities but over-exploitation of the environment, particularly in developing countries, is still a common problem for which tourism does not provide a simple solution. The situation demands economic conservation measures that provide incentives for local people to act as stewards of the environment. This study investigates the economic value of gray whales (*Eschrichtius robustus*) in two communities in Baja, Mexico. I develop a cost benefit framework for estimating the amount of economic rent that gray whales generate for local communities and offer cost effective strategies to maximize this rent, accounting for distributional effects of income to stakeholders. Results show that the rent currently captured by local communities is significant but not maximized. Moreover, analysing the current permit structure, which serves to limit whale watching capacity, reveals that the call for more permits and/or larger boats is unjustified.

Keywords: economic rent, multi-objective management, producer surplus, whale watching, gray whale

DEDICATION

To the children of Bahia Magdalena – may this research in some way help them to establish a life around the natural wonders for which they will be stewards.



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CHAPTER 1 INTRODUCTION

1.1 Overview

The loss of biodiversity is one of the most striking problems of our time. Many scientists agree that biodiversity is not only essential for the earth's ecosystems but also crucial for our own existence (Gowdy 1997). Biodiversity conservation is a world-wide issue especially prevalent in resource based communities of developing countries where family survival depends on the availability of common pool resources. Unfortunately, the abundance of wildlife is often viewed as a "barrel without a bottom" making over-exploitation a common issue. One way of dealing with the problem is to investigate what strategies and incentive structures would convince people to sustainably use their natural resources (Wunder 2000).

Nature-based tourism is often advocated as a conservation strategy for developing countries as it gives local people motivation to protect the wildlife and ecosystems that attract visitors, while benefiting the community (Gössling 1999). This economic incentive is crucial for achieving economic development and nature conservation, especially in areas where no environmental regulation and enforcement occurs (Wunder 2000). But as long as protected areas do not allow local people access, eco-tourism will not provide a long-term strategy to promote sustainable community development and ensure a long-term flow of benefits from conservation (Bookbinder et al. 1998).

In this context, Mexico provides an interesting case study since it is one of the world's richest countries in terms of its biodiversity and also rapidly developing in many of its hinterland regions. Therefore, finding long-term community development strategies

is essential for preserving biodiversity values on the local, national, and international scale. The “Baja born” eastern North Pacific gray whale (*Eschrichtius robustus*) is among Mexico’s charismatic wildlife species. Gray whales migrate annually from their feeding grounds in the Arctic Ocean to their breeding sites in bays off the west coast of Baja, where they stay from January until March. Along their migratory route, the whales have become an icon for coastal communities in Mexico, Canada, and the United States, that seek alternative income through nature-based tourism (Hoyt 2001). Whether or not the whales will keep coming back to whale watching destinations along the Pacific West Coast depends on successful conservation efforts in Baja’s breeding lagoons (Figure 1-1).

This study will focus on the Bahia Magdalena lagoon complex which is the southern most breeding lagoon of the eastern North Pacific stock of gray whales (Figure 1-1 and Figure 3-1). Among other breeding sites on the west coast of the Baja Peninsula, Bahia Magdalena in particular was subject to extensive commercial whaling in the mid 1800’s and again in the 20th century (Dedina 2000; Le Boeuf 1999). Due to their protective waters, these bays are nursing habitat for the gray whales.¹ However, lagoons leave the whales very vulnerable to human exploitation, which decimated the stock from ca. 20,000 animals to only 4,400 in 1875 (Dedina 2000). The U.S. Navy was permitted to use parts of Bahia Magdalena for bombing exercises in the 1890s. Subsequently, the population plummeted to an all time low of 3000 animals in the early 1950s (Dedina 2000).

In 1933, Mexico signed the first worldwide whale conservation regulation, the Geneva Convention for the Regulation of Whaling of 1931, and in 1949 joined the

¹ The term bay and lagoon is used synonymously meaning the breeding lagoons of the gray whale.

International Whaling Commission (IWC). In 1946, Mexico ratified protective legislation prohibiting the harvest of gray whales off its coast and signed the first conservation agreement that ended the era of commercial whaling in Mexico.² In 1971, Mexico was first in declaring a sanctuary for whales. Over the 1970s and 1980s Mexico was one of the first countries in the world to set aside several marine protected areas in the lagoons of Ojo de Liebre and Guerrero Negro, and later San Ignacio. Together with adjoining terrestrial areas, these lagoons form the Vizcaino Biosphere Reserve (established in 1988), which the UN declared a World Natural Heritage Site in 1993 (Dedina 2000).

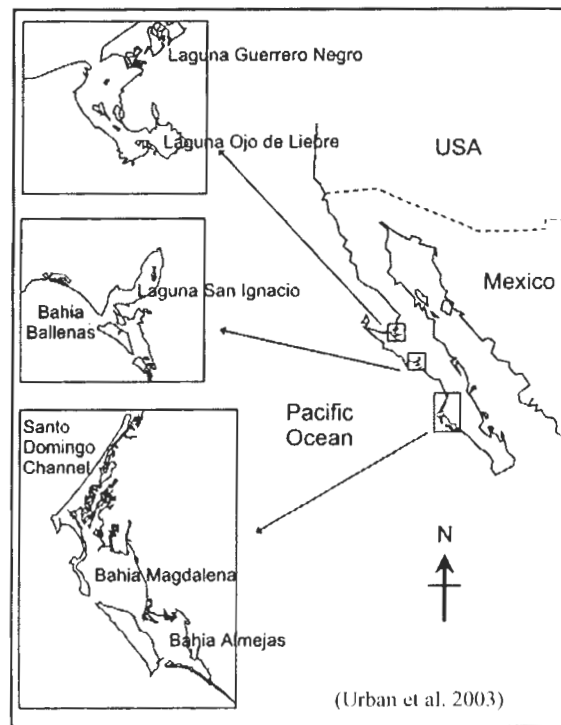


Figure 1-1 Baja Peninsula with breeding lagoons

² Also, over-harvesting of the whale stock and the collapse of the market for whale oil made the industry unprofitable (Dedina 2000).

1.2 Specific problem statement

The Bahia Magdalena lagoon complex does not contain any protected areas, even though it harbours the third largest congregation of gray whales (Urban et al. 2003). Despite growing income from tourism, the richness and diversity of local fisheries remains the backbone of the economy of Bahia Magdalena and draws a large influx of migrant workers. The exploitative pressure on marine resources caused by outside *permisionarios* remains largely unregulated due to the centralized government system ill-suited to deal with problems in hinterland regions.³ As a result, many shellfish species have not recovered within the last 20 years and other fisheries are declining (Young 1999). While local fisheries are dwindling, new alternatives in tourism are on the horizon but rarely offer solutions. During the two-month-long whale watching season, a number of local fishermen convert their fishing boats into tour vessels to take visitors whale watching. While few visitors spend time in the local communities beyond what's required for whale watching, a growing number of shops, hotels, and restaurants are trying to keep visitors in town longer (García Martínez 2006).

Communities in Bahia Magdalena are facing several challenges including declines in local resources, increased tourism causing cultural change, and the seasonal influx of migrant workers. Conflict over resource allocation and the lack of trust between people arriving from different parts of the country often inhibit local collaboration that could be an important part of a solution (Young 1999). Even though local participation is difficult to achieve, and might not guarantee the success of conservation efforts, the

³ *Permisionarios* are economically and politically powerful large-scale permit-holder-entrepreneurs that mainly reside outside of the Bahia Magdalena region. *Permisionarios* employ migrant workers to exploit shellfish resources that are not exclusively fished by locals (Young 1999).

economic valuation of wildlife can be an important bridge between people divided by conflict but with common long-term goals.

1.3 Research objectives

This study serves as the economic corner stone of a three year long research project investigating the prospects of community-based management. In particular, I estimate the financial contribution of whales to the communities of Bahia Magdalena and offer solutions for maximizing this benefit. In addition, the analysis focuses on who gains and who loses from whale watching in Bahia Magdalena.

The specific objectives of this research are to:

- examine the environmental factors influencing local whale abundance;
- describe local whale watching activity in each community;
- analyse the cost structure and organization of the whale watching industry in two communities;
- estimate the economic contribution (economic rent) attributable to the gray whales;
- investigate the distribution of rent among business owners, workers, and government; and
- recommend strategies for maximizing these economic benefits to the community.

CHAPTER 2 LITERATURE REVIEW

2.1 Economic valuation of wildlife

As the encroachment of humans on nature continues, society seeks ways to assess the trade-offs involved in its development actions. The demand for estimating the value of environmental assets is growing as they become more scarce (Smith 1993).

Quantifying the economic value of nature has been a part of social and economic research since the late 1970s and 1980s and serves as a tool for better decision making (Bockstael and McConnell 1981). The methodology focuses mainly on the demand side, such as the travel cost method or contingent valuation techniques, but also takes supply side approaches based on production theory (Barbier 1994; Ellis and Fisher 1987; Freeman and Harrington 1990).

Studies devoted to estimating recreational demand and the willingness of consumers to pay for wildlife viewing are numerous (Maille and Mendelsohn 1993; Moran 1994; Barnes 1996; Navrud and Mungatana 1994; Naidoo and Adamowicz 2005). The studies show that non-consumptive wildlife values are substantial and call for strategies to conserve this value. Barnes (2001) investigates the contribution of wildlife to national income in Botswana and finds that wildlife viewing provides higher economic returns compared to safari-hunting. Maille and Mendelsohn (1993) estimate the value tourists associate with visiting a nature reserve in Madagascar at US\$ 276 to US\$ 360 per visitor and year. Navrud and Mungatana (1994) measure the recreational value of a national park in Kenya at 7.5 to 15 million US\$ per year; while Moran (1994) quantifies the annual consumer surplus of protected areas in Kenya at US\$ 450 million per year.

Recently, discrete choice methods improved and extended the contingent valuation method as shown by Naidoo and Adamowicz (2005), who examine the contribution of biodiversity to tourists' willingness to visit a forest reserve in Uganda. The authors derive people's relative preferences in viewing a diversity of bird species and estimate the demand for nature based tourism in this context. Results show that as the number of bird species rises visitors are more willing to visit the area (Naidoo and Adamowicz 2005). However, the reliability of the contingent valuation method has been widely debated. For example, concerns for potential bias arise from the hypothetical nature of the methodology (Mitchell and Carson 1989), or relate to strategic incentives, the bidding approach to questioning, and other methodological issues (Smith 1993).

Even though studies measuring consumer surplus offer first insights about the value consumers associate with observing wildlife, they fail to provide a complete value picture that incorporates consumer and producer values. The usefulness of many valuation studies has been weakened by a failure to properly frame the specific policy questions that they are meant to answer (Pagiola, von Ritter, and Bishop 2004). A question of utmost importance for the success of conservation efforts is whether local stakeholders benefit or lose from conservation (Martinez-Alier 2001). Local participation is essential for successful policy implementation, particularly in rural areas of developing countries where economic interests and conservation often conflict (Young 1999). Illustrating the financial value of local wildlife resources to local communities is crucial for achieving conservation. Since locals are in many cases the suppliers (producers) of wildlife viewing tours, the analysis requires an estimation of producer surplus.

Studies investigating the value of wildlife to producers are rare, underlining the fact that research has given less attention to values at the local level.

2.2 Economic studies concerning whales

There have been a number of economic studies on whales, mainly using bioeconomic models to find optimal management solutions associated with harvest and non-consumptive use (Conrad 1989; Horan and Shortle 1999; Kuronuma and Tisdell 1994). Conrad's (1989) harvest model for bowhead whales estimates the net benefits derived from whales as the sum of consumptive and non-consumptive use values assuming alternative rates of discount and different levels of conservation.⁴ Kuronuma and Tisdell (1994) and Horan and Shortle (1999) develop extensions to Conrad's (1989) framework applying it to assess harvest regulations for minke whales in Antarctica. The authors conclude that the moratorium on minke whales is not economically efficient unless the species has substantial non-consumptive values (Kuronuma and Tisdell 1994). Horan and Shortle's (1999) model is spatially explicit and accounts for uncertainty in the levels of the multiple stocks of minke whales. The authors conclude that the moratorium is efficient as long as existence values are included, since these raise the opportunity cost of harvesting.

Adding to the debate over consumptive and non-consumptive use values, Bulte and van Kooten (1999) as well as Horan and Shortle (1999), offer an interesting view on the costs of preventing wildlife species from going extinct. The authors argue that the economically efficient preservation of charismatic species depends on the marginal value

⁴ Economists refer to whales as being a *mixed good* because consumptive and non-consumptive use values exist.

of the species. Estimating marginal values allows for the distinction between the benefit to society from preventing a species from going extinct and preserving a species above minimum viable population numbers.⁵ Under varying assumptions on discount rates and the inclusion of non-market values, extinction and preservation can both be optimal from an economic perspective (Bulte and van Kooten 1999; Horan and Shortle 1999). In terms of implementing successful conservation policies, the calculation of marginal value is crucial in order to understand how net benefits change under changing environmental conditions (Bulte and van Kooten 1999; Loomis and Larson 1994; Pagiola, von Ritter, and Bishop 2004).

Studies addressing the non-consumptive use value of cetaceans are often found in the tourism and recreation literature and less so in the bioeconomic genre. Marine mammals such as dolphins and gray whales are a magnet for tourists in coastal communities worldwide. The tremendous increase in whale watching activity since the early 1990s is evidence of increasing non-use value (Hoyt 2001). This “new consumption of the animal performance” serves as an argument against whaling and for the conservation of the species (Cloke and Perkins 2005). Critics of a ban on whaling argue that harvesting whales is culturally important to indigenous people and should be part of a development strategy for aboriginal communities (Moyle and Evans 2006). Moyle and Evans (2006) also criticise past socio-economic studies such as Hoyt’s (2001), who illustrates conservation value equal to gross revenues thus not accounting for the costs associated with providing whale viewing services or other dimensions of the whale watching experience.

⁵ Charismatic wildlife refers to animals that have widespread popular appeal such as the panda bear, wolf, whale, or elephant.

Few socio-economic studies exist on measuring welfare effects of whales, and focus mainly on estimates of consumer welfare, ignoring the value to producers entirely. Day (1987) quantifies the non-consumptive use value of whales to whale-watchers in Massachusetts, USA, and crosschecks estimates from a contingent valuation survey with calculations using the travel cost technique. The first contingent valuation survey eliciting values for eastern Pacific gray whales was conducted by Hageman (1985). In a survey of California households, the author estimates the mean annual willingness to pay (WTP) for gray whale conservation to be US\$ 26.98 per year (Hageman 1985).

Chien (1994) and Loomis and Larson (1994) conduct two additional valuation surveys on gray whales and find similar results. In addition, results from these studies indicate diminishing marginal WTP in relation to increasing whale abundance. *Users* are willing to pay US\$ 10.89 for a 50% increase in the population of eastern Pacific gray whales, whereas for a 100% increase they are willing to pay less than double that, US\$ 14.52.⁶ Further findings also suggest that increases in the population of whales will make *non-users* more likely to become whale watchers. As would be expected, there is higher WTP for *users* compared to *non-users*.

Utilizing data by Loomis and Larson (1994), Larson and Shaikh (2003) estimated the demand for gray whales and calculated consumer surplus for three whale-watching sites on the California Coast. WTP estimates range from US\$ 79 to US\$ 360 per person depending on trip length and location (Larson and Shaikh 2003). Besides the deficiencies and strengths of studies discussed above, the work by Foucat and Alvarado (1998) represents the only attempt to value benefits of gray whales to local communities in Baja.

⁶ Users are defined as people who whale watch.

However, the authors estimate the benefits communities derive from gray whales based on aggregate revenue information which is inconsistent with economic theory because it ignores the costs associated with viewing whales.

Summarizing, preceding studies indicate that there is significant non-use value associated with the eastern North Pacific stock of gray whales. Due to the one sided consumer approach to valuation, however, the above mentioned studies provide an incomplete value picture because they ignore the value to producers at the local level. Studies that attempt to estimate local benefits are not in compliance with economic theory which calls for a more thorough micro-economic analysis as suggested by this study.

2.3 Valuing the environment to producers

Economic rent theory provides a framework for estimating net social returns from natural resources. The concept of economic rent was first introduced by one of the most influential classical economists, David Ricardo (1817). The classical school of economics employs three factors of production, land, labour, and capital, each earning a distinct type of income: rent, wages, and interest. In economic terms, rent accrues to the owner of the land in excess of the cost of keeping the land in its current use. Note, the latter definition emphasizes the owner's trade-offs involving utilizing the land in its current use, by accounting for the income that the land could have earned in its second best use (opportunity cost of land). In the context of natural resources, economic rent is defined as the surplus remaining "after revenues from natural resources have been disbursed to pay all costs of production – including a return on investment, or 'normal profit', equivalent

to what could be earned in the next best use of the capital” (Gunton and Richards 1987, p.xxxi). More generally, Anderson (1985) defines rent as the difference between the social value of an economic activity and the social cost attributable to that activity.⁷ Gunton and Richards (1987) call economic rent the most appropriate measure for estimating the contribution of natural resources to human welfare.

Ricardo (1817) defines two concepts surrounding resource rent: *scarcity rent*, which exists in situations where the resource is scarce, and *differential rent* which is rent received through resources of differing quality.⁸ Other conceptually different categories of rent include *monopoly rent*, *user cost rent*, and *windfall rent* (Gunton and Richards 1987). *Scarcity rent* arises in situations when resources are limited in supply. On a per unit basis, scarcity rent is equal to the difference between the product price and the marginal production cost. *Differential rent*, often calculated in the mining sector, for example, is defined as the difference in cost between one mine just covering the cost of labour and capital (marginal mine) and another mine generating a surplus above the costs of production (intra-marginal mine) (Gunton 2004). Intra-marginal mines can occur in situations when higher quality ore, cheaper transportation, or easier extraction exists. *Monopoly rent* arises when producers exercise market power to curtail supply in order to raise the price and generate rent. *User cost rent* is generated when current resource prices increase due to people’s anticipation of resource exhaustion. *Windfall rent* originates in cases of inelastic supply where an unanticipated increase in demand raises price in the short run and causes above-normal returns to producers. An additional complication related to windfall rent is the concept of *quasi-rent*, which is defined as the income

⁷ Social cost accounts for the opportunity costs associated with utilizing all factors of production.

⁸ Differential rent is sometimes also called Ricardian rent.

earned by a fixed input and therefore equal to the opportunity cost of capital investment. In other words, quasi-rent occurs through the distinction of short run costs, as the sum of variable and operating costs, and long run costs, which include capital costs since capital is variable in the long run (Gunton and Richards 1987, p.33-34).

Economic rent analysis is widely applied to quantify the benefits to society from developing a resource and to find ways to compensate the resource owners (the public) in the form of taxes (Anderson 1985). For the economic analysis of non-renewable resources, rent theory is employed to measure resource scarcity of minerals (Halvorsen and Smith 1984), to develop optimal depletion rules of mineral deposits (Frechette 1999; Gunton 2004), and to formulate efficient tax policy for mining (Sunnevag 2002; Gunton 2004). In the renewable resource sector rent analysis is utilized to analyse rent dissipation (Walker, Gardner, and Ostrom 1989) and the effectiveness of fishing fleet rationalization programs (Schwindt, Vining, and Globerman 2000), or to estimate the social welfare impacts of changes in fisheries management (Holland 2000). In tourism, Davis and Gartside (2001) estimate the welfare impacts of changes in management of a marine reserve applying rent theory. Grafton, Lynch and Nelson (1998) compare Ricardian rent in the forest product industry for different forest sites, where one site is more productive and therefore yields more timber for the same amount of capital and labour, resulting in higher Ricardian rent. The authors calculate Ricardian rent as the sum of the value of outputs minus the sum of variable input cost, and the revenue forgone if the fixed factor would have been employed in the next best alternative activity. The more productive the fixed factor (higher quality) the greater differential rent (Grafton, Lynch, and Nelson 1998).

Summarizing, the above mentioned studies illustrate the wide applicability of rent analysis to investigate effective taxation, changes in management policies, and industry efficiency with the latter constituting the main goal of traditional rent analysis. Besides the overarching aim to maximize rents, however, a more novel approach to the analysis incorporates considerations of equity as being the distribution of income to all claimants of economic rent.

2.4 Addressing issues of equity and distribution

Increasingly, conservation and development strategies centre around local communities due to their direct linkage and dependence on natural resources (Pagiola, von Ritter, and Bishop 2004). However, besides calculating the magnitude of local welfare, the question of who gains and who loses from utilizing the environment is a growing consideration of effective policy development, particularly in developing countries (Charles 1988; Martinez-Alier 2001). Issues of equality are intensified in the context of common pool resources such as fisheries, where a wide range of stakeholder interests can create conflict and add complexity to finding effective management schemes. Fisheries are commonly known for having a variety of management objectives including social considerations such as maintaining the resource, economic performance, and equity (Charles 1988).

The question remains whether fisheries management should focus on maximizing resource rents, be concerned with equity, or whether both goals are obtainable. Bromley and Bishop (1977) argue that social welfare considerations need to be “based on both efficiency and equity” (p. 299). This multi-objective view constitutes a paradigm shift

away from the traditional single-objective of rent maximization. But Hannesson (1981) warns that there is no “best world” and that multi-objective management is associated with trade-offs between objectives.

Research on wealth distribution often employs the Lorenz curve which graphically illustrates the distribution of income in society (Lorenz 1905). Extending this framework, the Gini index quantifies inequality by determining a ratio based on graphical areas measured under the Lorenz diagram. An index of zero is attributable to perfect equality while an index of 100 is associated with perfect inequality (Gini 1921).⁹

Studies on the distribution of rent in fisheries are quite numerous (Griffin, Lacewell, and Nichols 1976; Huq and Huq 1985; Toufique 2000). Griffin, Lacewell, and Nichols (1976) analyse the distribution of net social returns in the Gulf of Mexico shrimp fishery and find that crew members’ share of rent is less affected by changes in product price than the share going to vessel owners. However, if crew and vessel owners split some of the costs, which is common in fisheries, rent accruing to crew-members becomes more sensitive to changes in product price. Huq and Huq (1985) apply the Lorenz curve and calculate Gini indexes to compare income distribution across different regions in Bangladesh. Toufique (2000) investigates the distribution of rent in the inland fisheries of Bangladesh, and concludes that fishers receive large amounts of rent but ownership and access rights are important factors determining the amount of rent received by individual fishers. Also the distribution of rent is more egalitarian, the better the fishing grounds are, suggesting that heterogeneity between fishing grounds plays a role in the distribution of rent (Toufique 2000).

⁹ Mexico’s Gini-index is equal to 49.5 compared to Sweden’s 25 and Bolivia’s 60 (United Nations 2006).

Other methodologies to describe the distribution of income can be found in the project valuation and cost benefit literature. For example, Curry and Weiss (2000, p. 265) discuss income distribution effects of a telecommunications project to different stakeholders such as project owners, workers, lenders, government, and telephone users. Their approach is based on estimating income flows from financial statements and analysing income transfers between stakeholders. The advantage of Curry and Weiss's (2000) approach lies in the ease of discounted present values tracing the distributional effects of the project. In particular, the annual income flows of the project are capitalized into a net present value that is used to analyse the distribution of income over the life of the project, instead of comparing income effects year by year (Curry and Weiss 2000). Critical to note, however, is that the approach becomes inaccurate when financial and economic prices change over time, in which case the conversion factor is not constant (Curry and Weiss 2000, p. 266).¹⁰

¹⁰ For cases where a project's outputs and inputs are tradable, financial prices need to be converted into economic prices. Economic prices take into account the effects trade has on supply and demand of the project's inputs and outputs, by employing a conversion factor (Curry and Weiss 2000, p. 71).

CHAPTER 3 ECONOMIC AND ECOLOGICAL LINKAGES

3.1 Total abundance

The eastern North Pacific stock of gray whales (*Eschrichtius robustus*), also called the California stock, is the largest of the two populations of gray whales still in existence today.¹¹ Besides the smaller western population inhabiting the coast of Korea and hunted to almost extinction, the eastern stock is healthy and totalled approximately 22,000 animals in 1995 (Hobbs et al. 2004). The population has recovered in recent years from two periods of exploitation in the mid 1800s and mid 1900s, when numbers reached all time lows of 4,400 and 2,894 animals, respectively (Dedina 2000). Recent estimates of the stock size before the 1800s range between 13,000 and 20,000 animals (Witting 2003). Even though gray whales have a low population growth rate of about 2.5 percent and a long gestation period of 13 months, the population has recovered and doubled in size since 1972, in part due to conservation measures taken by the International Whaling Commission (Buckland and Breiwick 2002).

However, further growth of the eastern North Pacific stock is already affected by changes occurring in their primary food source (Le Boeuf et al. 2001). Recent studies on nutritive conditions in gray whales reveal under nourishment and low recruitment (Moore et al. 2001; Le Boeuf et al. 2001; Perryman and Lynn 2002). Gray whales feed on amphipods, which are suspension feeders that live in mud and sand on the ocean floor primarily in the Chirikov Basin, a marine area located between the Bering and Chukchi Seas. The shallow waters of the Chirikov Basin produce approximately 70 percent of the

¹¹ Sub-fossil records, dated A.D. 500, indicate that historically the gray whale also inhabited the Atlantic (Rice and Wolman 1971).

world's biomass of amphipods. Research shows a decline in the amphipod population in this area, possibly due to increased predation pressure caused by the doubling of the eastern North Pacific gray whale stock since the 1970s (Le Boeuf 1999). The decline of amphipods is also seen as an indicator that gray whales are reaching carrying capacity (Le Boeuf 1999). Other propagates of this starvation hypothesis think that the major threat to the eastern North Pacific stock of gray whales is the decline of its prey rather than the change in environmental conditions in the breeding lagoons (Urban et al. 2003).

Besides environmental factors influencing stock size, some small scale harvesting by aboriginal groups is taking place. In 2004 the International Whaling Commission (IWC) set the total catch limit for the eastern North Pacific stock of gray whales to a total of 620 whales between 2003 and 2007 with a maximum of 140 in any one year (IWC 2004). These whales can only be taken by native peoples whose traditional, aboriginal, and subsistence needs have been recognised, such as Natives of Alaska and Chukotka (Siberia) (IWC 2004).

3.2 Variation in abundance

Every fall, gray whales are displaced from their Arctic feeding grounds by the approaching sea ice and their inability to break through the ice for respiration (Rugh, Shelden, and Schulman-Janiger 2001). Once their urge to migrate overrules their drive to continue feeding, the whales travel between 8000km and 10000km from the Arctic Ocean to lagoons of the Baja Peninsula (Figure 1-1). From December until March, the warm and shallow waters of the lagoons are nurseries, reproduction areas, and locations where the whales can conserve energy during times when their Arctic feeding area is

covered by sea ice (Rugh, Shelden, and Schulman-Janiger 2001).¹² Perryman et al. (2002) finds evidence that the longer the primary feeding area remains ice-free the higher the calf production in the following year.

The whales take approximately two months southbound, and three months for their northbound journey, which constitutes the longest migration of any mammal (Rugh, Shelden, and Schulman-Janiger 2001). Feeding during migration is uncommon since the whales' food source is mainly located in the Arctic Ocean (Mate, Lagerquist, and Urban R. 2003). The resulting six months long energy deficit causes the whales to be more slender in shape on their northbound migration compared to the southbound journey (Perryman and Lynn 2002). During southern migration, northern lagoons are subsequently filled earlier due to the closer geographic distance from Arctic feeding areas. Consequently, whales reside longer in northern bays than in the lagoons to the South (Rugh, Shelden, and Schulman-Janiger 2001). However, the shape of the annual temporal distribution is believed to be similar across all lagoons following a normal distribution (Gard 1978; Rice et al. 1981).

Research on the distribution and relative abundance of gray whales at their overwintering sites indicates that most whales concentrate near the mouth of the breeding lagoons at the beginning and end of season. During the peak, whales distribute more evenly, also occupying central and upper parts of the lagoons (Gardner and Chavez-Rosales 2000). Researchers categorize whales visiting the breeding lagoons into two groups that show slightly different temporal distribution patterns. Cow-calf pairs are first in entering the lagoons whereas single adults, juveniles, and non-parturient females

¹² Since food is restricted during winter, the whales need to conserve their fat reserves which is more efficiently done in warmer water.

constitute the second group and follow later. The latter group displaces the mothers and calves from the lagoon entrance to more protected nursing areas inside the lagoon which results in longer residence times for cow-calf-pairs (Gardner and Chavez-Rosales 2000; Norris et al. 1983). Urban et al. (2003) estimate the average residence time for single whales in Ojo de Liebre to be 13 days whereas mother-calf-pairs stay up to 22 days. This seasonal pattern causes whales to persist at the lagoon entrance throughout the season, whereas areas located further inland are more likely to be occupied during peak season (Rice and Wolman 1971; Norris et al. 1983; Jones, Swartz, and Leatherwood 1984).

Determining the time when whale numbers peak in the lagoon is complicated by the fact that southbound and northbound migrations somewhat overlap when the last southbound migrants meet the first northbound whales (Rice et al. 1981). Also, the date at which whale numbers peak differs among single whales and cow-calf-pairs. For example, in Laguna Ojo de Liebre, the northern most breeding site, the number of adult gray whales is highest between February 1st and 18th whereas the number of cow – calf – pairs reaches its peak between February 12th and 15th (Rice et al. 1981). Moreover, whale numbers generally peak later in southern bays than in northern breeding sites (Pérez-Cortés, Urban, and Loreto 2004; Rice et al. 1981). In the southern most breeding area of Bahia Magdalena, Pérez-Cortés (2004) observes a maximum combined count of single whales and cow-calf-pairs between February 14th and February 27th. Migratory timings have not significantly changed since the 1970s (Rugh, Shelden, and Schulman-Janiger 2001).

Besides the seasonal fluctuations caused by migration and breeding activity, historical surveys indicate that many of the lagoons are subject to year by year variations

in the abundance of whales (Pérez-Cortés, Maravilla, and Loreto 2000; Urban et al. 2003). Annual fluctuations in abundance can be caused by climatic events or environmental disturbances such as changes in tides. For example, the El Niño event in 1998 caused a large reduction in the relative abundance of gray whales in Bahía Magdalena (Gardner and Chavez-Rosales 2000). Instead, the missing proportion was observed in San Ignacio and Ojo de Liebre, two breeding areas to the North of Bahía Magdalena that were not as affected by the increase in water temperature (Pérez-Cortés, Maravilla, and Loreto 2000).

Besides climate impacts, other environmental influences can change relative abundance in the breeding lagoons. For example, tidal activity and ocean current can transport large amounts of sand to and from lagoon entrances inhibiting whales from entering the protected lagoon areas (Norris et al. 1983; Pérez-Cortés, Maravilla, and Loreto 2000; Urban et al. 2003). Le Boeuf (1999) and Pérez-Cortés (2004) indicate that such clogging of lagoon entrances causes the number of whales to fluctuate unpredictably. The phenomenon causes temporary abandonment and occurs particularly in the Santo Domingo Channel which constitutes the northern part of the Bahía Magdalena lagoon complex. Other examples of temporary abandonment were found in Guerrero Negro but researchers are divided over what causes the temporary displacement of whales there. Gard (1974) relates evidence of increased boat traffic through shipping of salt occurring between 1957 and 1967 to an abandonment of Guerrero Negro as nursing area during that time. Others believe that the change in location of the salt shipment facility no longer required dredging of the lagoon entrance leaving the entry channel impassable for ships and whales alike. The lagoon no longer serves as an

important breeding and nursing area (Pérez-Cortés, Maravilla, and Loreto 2000; Urban et al. 2003).

3.3 Habitat utilization

Less than one third of the eastern population of gray whales visits the breeding lagoons in Baja; the remainder spreads along the coast from Alaska to California (Dedina 2000; Pérez-Cortés, Maravilla, and Loreto 2000). At present, not all lagoons are equally important for calf production and population numbers have varied over the last 150 years due to exploitation in bays where commercial whalers had easy access to the breeding locations. Since pregnant female gray whales return to their natal lagoons for calving, hunting in a particular lagoon can have detrimental long-term effects on a lagoon's future population (Goerlitz et al. 2003). Today, Laguna Ojo de Liebre is the most important breeding lagoon with 53 percent of all calves born, followed by Laguna San Ignacio (11%), Laguna Guerrero Negro (9%), Estero Soledad (12%) and the main part of Bahía Magdalena (5%) (Rice et al. 1981).¹³ Recent research on gray whales using photo-identification studies and recent genetic testing suggests that individuals return to the same lagoons year after year to mate and nurse their young (Goerlitz et al. 2003).

However as discussed above, changing environmental conditions such as climatic changes and tidal current seem to influence this site-fidelity. The observed behaviour shows that pregnant gray whales might not strictly choose their place of birth for calving over any other breeding ground. Instead site preference and relative abundance are dependent on changing environmental conditions which might force whales to abandon

¹³ Estero Soledad comprises the northern part of the Bahía Magdalena complex and is also called Santo Domingo Channel. The estero is located near the town of Puerto Adolfo López Mateos, one of the study sites of this project. The entrance to the estero is called the Boca de Soledad.

one breeding site and colonize another. This type of behaviour is commonly known to occur among metapopulations (Hanski and Gilbin 1991). In ecology, the theory of metapopulations suggests that populations live in a patchy environment characterized by extinction and recolonization of vacant habitat patches (Hanski and Gilbin 1991).

3.4 Human impact on gray whales

Research on human activities threatening gray whales focuses mainly on short-term reactions to human impacts, rather than investigating long-term consequences (Moore and Clarke 2002). Impacts range from coastal and offshore development to whale watching and commercial fishing. The level of disturbance caused by coastal development seems to increase the likelihood of gray whales abandoning their breeding lagoons (Findley and Vidal 2002; Gard 1974; Reeves 1977). A prime example for the loss of valuable breeding habitat is San Diego Bay. Before the 1950s the bay was heavily populated by the gray whale but the enormous coastal development caused the whales to abandon the area (Reeves 1977). Another example of human activity displacing whales from their nursing areas is Guerrero Negro as I mentioned in the previous section (Gard 1974). In addition to the currently used breeding lagoons on the west coast of the Baja peninsula, there were two more calving sites on the Northwest coast of mainland Mexico (western coast of Gulf of California) where a small number of gray whales congregated until the mid 1980s. Findley and Vidal (2002) believe that the whales left these breeding areas because of increased disturbances through coastal development.

Breeding cow-calf pairs are especially affected by development occurring in the inner areas of the lagoons because during gestation the pairs utilize shallow areas closer

to shore more frequently than solitary adults, breeding pairs, and juveniles who swim outside the lagoon (Ollervides and Pérez-Cortés 2000). Coastal development could cause mothers and calves to abandon the protected waters of the inner lagoon areas and force them to move offshore where the survival of calves would be more uncertain due to higher predation of killer whales (*Orcinus orca*) and more turbulent ocean conditions (Pérez-Cortés 2005).

Offshore oil and gas development, large commercial vessel traffic, or aircraft can negatively affect gray whales particularly in the way they communicate (Moore and Clarke 2002). Gray whales use underwater vocalization, which may be disturbed by underwater noise from seismic activity or engine noise from boats or airplanes. Moore and Clark (2002) mention, that eastern North Pacific gray whales may be stressed by increased noise levels near shipping lanes or ports, particularly apparent in the Southern California Bight. Also, common fisheries related whale deaths occur when whales get entangled in fishing gear or collide with fishing vessels. In British Columbia for example, 27 percent of all gray whale fatalities are related to fishing activity (Baird et al. 2002).

Whale watching can also negatively affect gray whales in their nursing areas as well as on their migration path (Duffus 1996; Ollervides and Pérez-Cortés 2000; Heckel et al. 2001). Depending on the angle and speed of an approaching vessel, gray whales change their swim velocity and swim behaviour, which is believed to increase their energy consumption (Heckel et al. 2001). In particular small boats such as the ones used for fishing and whale watching in the breeding lagoons can severely harass whales (Norris et al. 1983). Since annual reproduction occurs in the specific nursing area, any detrimental effects from whale watching in these locations can impinge on a year's

production of calves and jeopardize the status of the stock (IWC 2000). Gray whales are most vulnerable in their breeding grounds where they congregate more densely than in any other parts of their migration (Heckel et al. 2001). However, most researchers do not consider whale watching activities to be solely responsible for variations in the whale abundance and habitat utilization (Ollervides and Pérez-Cortés 2000; Pérez-Cortés, Maravilla, and Loreto 2000). More likely, the variation in the number of whales visiting the lagoon annually is related to changes in the environment such as climatic or physiologic effects, as discussed in the previous section.

3.5 Local resource conditions

The Bahia Magdalena lagoon complex consists of an extensive array of narrow mangrove channels and wide open waterways that are subdivided into three regions: the northern, middle and southern region (Figure 3-1) (Rice et al. 1981).¹⁴ Even though the three regions are connected by water ways navigable by humans, the whales cannot pass through the narrow channel, called Curva del Diablo (Devil's Bend). Curva del Diablo connects the northern region with the middle section of the bay. This natural border creates two separate local subpopulations, one in the north utilizing the Santo Domingo Channel and the other in the middle and southern part utilizing the main part of Bahia Magdalena and Bahia Almejas (only partly shown in Figure 3-1), respectively (Pérez-Cortés, Maravilla, and Loreto 2000).

¹⁴ Similar to all calving lagoons on the west coast of Baja, Bahia Magdalena was formed by the subsiding coastal plain millions of years ago, allowing sea water to break the coastal dunes and flood parts of the deserted hinterland. Tidal action dredged parts of the very shallow lagoons to form channels that now reach maximum depths of 15 to 20 meters, deep enough for whales to pass (Rice et al. 1981).

Whales are spotted most frequently in the two dark areas indicated on Figure 3-1 (Dedina 2000; Norris et al. 1983; Pérez-Cortés 2005; Rice et al. 1981). In the northern region, whale watching activities are based in the small fishing town of Puerto Adolfo López Mateos (PALM), whereas tour boats operating in the middle part of the lagoon complex embark from the largest fishing town in the area, Puerto San Carlos (PSC) (Figure 3-1). No whale watching is allowed in the southern section of the lagoon complex. For the remainder of this report I will refer to the northern location as PALM or the Santo Domingo Channel and refer to the middle part of the lagoon complex as PSC or simply Bahia Magdalena. I call the whole region consisting of northern, middle, and southern parts, the *Bahia Magdalena lagoon complex*.

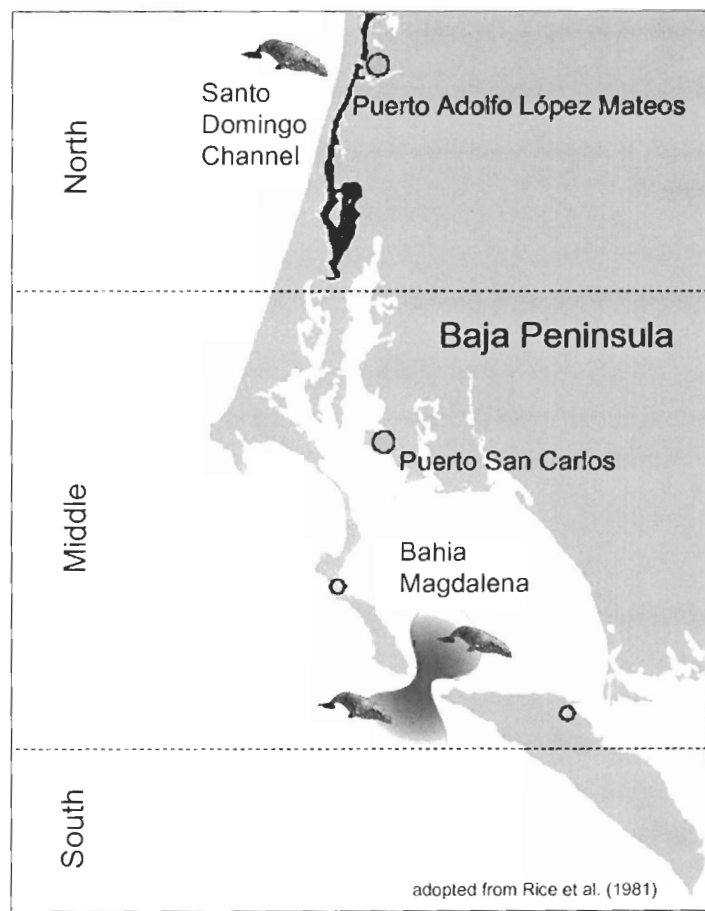


Figure 3-1 Regions of the Bahia Magdalena lagoon complex

Approximately ten percent of the breeding population of gray whales frequent the Bahia Magdalena lagoon complex. Two thirds visit the northern part of the lagoon complex, whereas the remainder congregates in the middle and southern sections (Le Boeuf 1999; Rice et al. 1981; Pérez-Cortés, Urban, and Loreto 2004). The first whales arrive in early January and leave by the end of March (Pérez-Cortés 2005; Rice et al. 1981). In 1980, maximum counts for each part of the lagoon complex were observed between Feb 7th – Feb 10th (Rice et al. 1981).

The whales utilize the region differently, where the Santo Domingo Channel constitutes one of the most productive breeding sites with 12 percent of all calves born to the eastern North Pacific stock, Bahia Magdalena attracts more solitary whales for mating and congregating (Rice et al. 1981; Pérez-Cortés, Urban, and Loreto 2004). While, the lagoon in PALM harbours predominantly nursing mothers and their calves (83 percent), 89 percent of all whales observed out of PSC are single whales (Le Boeuf 1999).

The observed pattern of habitat utilization with only a few cow-calf-pairs visiting Bahia Magdalena did not always occur. Le Boeuf (1999) states that Bahia Magdalena once was a more important breeding site during pre-exploitation times. Considering the fact that mothers are more likely to return to their natal lagoons than to other breeding sites, the reason for the lack of mother-calf-pairs in PSC relates to extensive past commercial whaling for which Bahia Magdalena was very suitable (Le Boeuf 1999).¹⁵

Summarizing, Bahia Magdalena provides an interesting case study because the Bay seems to be a marginal breeding area at the southern end of the migratory path that

¹⁵ Large vessels are able to easily navigate through the entrance to Bahia Magdalena which created particular incentives for commercial whaling.

has unused capacity. From an economic perspective, the increase in population of gray whales expanding the use of this area could more than in other lagoons affect economic benefits to whale watching operators.

3.6 Local whale watching

Prior to 1994 the market for whale watching in Baja was dominated by U.S. based companies who offered boat tours to many breeding lagoons including the Bahia Magdalena lagoon complex. It was not until the early 1990s that local fishermen began seeking alternative income from tourism as a result of declining fisheries (Dedina 2000). After disputes between foreign operators and an ever increasing fleet of local fishermen offering whale watching tours, the Mexican government granted an exclusive right to local operators in 1994. Federal authorities demanded the formation of cooperatives for whale watching and issued a fixed number of permits (Dedina 2000).

The permits were available at no cost but required operators to pass an examination on whale watching guidelines that dictate “self enforcement among operators” (Government of Mexico 1998; Pérez-Cortés 2005; Spalding 2002). Operating permits are location-specific to whale watching areas, non-transferable, and non-tradable. However, permits are often shared within families, and cooperatives tend to reassign or share permits with new members who buy in. In the past, the industry was managed by the federal agency for agriculture, rural development, and fisheries SAGARPA (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación), who recently transferred responsibilities to the federal department of environment and natural resources SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales).

The whale watching season is governed by the arrival of whales in January and usually lasts from mid January to the end of March, totalling 44 days in 2005 (Gonzalez Agundez 2006). Until the first whales arrive, the coastal communities of the region are mainly occupied with fishing for shrimp, one of the most profitable fisheries in the region. As soon as the whales arrive, shrimp fishing is restricted to areas not occupied by whales to avoid conflicts and entanglement of the whales with fishing gear (Pérez-Cortés 2005). Then, fishermen in possession of a whale watching permit convert their typical Mexican fishing boat, called panga, to suit whale watching activities.¹⁶ The fishermen install cushions and flooring and paint the inside and outside of the boat to provide an appealing look.

Pangas are open skiffs, five to seven meters in length and built from fibreglass. These small fishing boats seat six passengers and the pangero comfortably. Most boats run on a sixty-five horsepower two-stroke outboard engine, which is frequently used by fishermen in the region. Even though there are no regulations in place that govern the size of boats and engines the industry shows almost homogeneous types of engines and boats.

The interviews with pangeros focused on fuel consumption and how it might vary throughout the year depending on whale abundance, engine type, and length of trip. Fuel consumption in both towns is considerably lower during times when maximum numbers of whales are observed in the bay compared to the beginning of whale season when operators must drive all the way to the mouth of the lagoon to see whales (Figure 3-2). Clearly, boats in PSC are more efficiently run which is partly explained by the differing engine technologies used in each community. In PSC, 40-percent of the engines used for

¹⁶ Fishermen only switch once from fishing to whale watching and therefore won't engage in both activities at the same time should they decide to offer whale watching tours.

whale watching are fuel efficient four-stroke engines, whereas operators in PALM exclusively use less efficient two-stroke engines.

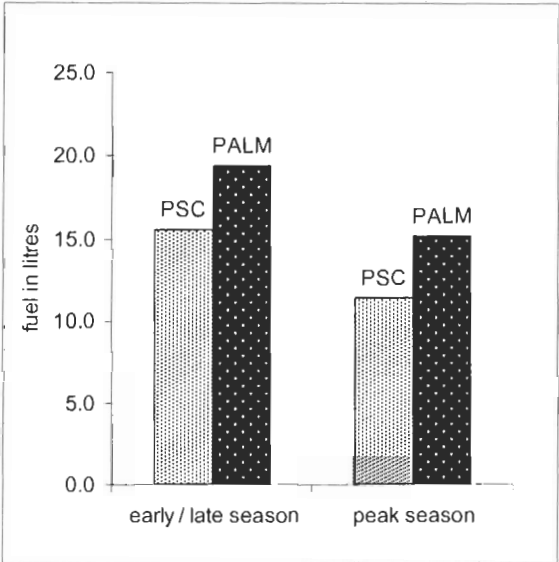


Figure 3-2 Average per hour fuel consumption dependent on whale abundance

It is interesting to note that all whale watching operators based in Puerto San Carlos that don't fish during the rest of the year use more fuel efficient four-stroke engines. Table 3-1 shows that fuel consumption in litres per trip varies by trip length and engine type in each community. Longer trips use relatively less fuel per boat hour, particularly with four-stroke engines.

Table 3-1 Annual average fuel consumption in litres per trip

location	engine type	trip length				
		1h	2h	3h	4h	5h
PSC	2-stroke		37.00	49.00	54.00	60.00
PSC	4-stroke		34.50	32.81	41.25	43.75
PALM	2-stroke	22.17	31.53	41.00		

Whale watching is limited to approximately six hours per day, constrained by weather and ocean conditions. High winds can prohibit whale watching activities occurring in the afternoon, especially in the early season (Gonzalez Agundez 2006). After the whale watching season is over, most operators begin fishing clams and lobster as well as other species found outside the lagoon (Pérez-Cortés 2005).

In the following sections I will first describe whale watching activities in the Santo Domingo Channel and then explain operations in Bahía Magdalena, since resource conditions and industry structure are somewhat different in the two communities.

3.6.1 Puerto Adolfo López Mateos

In the northern part of the bay, the Santo Domingo Channel is a one to two kilometre wide water body created by sand dunes that protect the lagoon from the Pacific Ocean (Figure 3-1). The dunes are broken up in several locations creating openings to the Pacific of which one, the Boca de Soledad, is the only channel barely deep enough for whales to enter the lagoon. Once gray whales pass this sand corridor, they occupy the deeper parts of the inner lagoon where some courting and mating occurs predominately near the mouth and nursing mothers recede to the inner parts of the lagoon (Norris et al. 1983)¹⁷. Overall, the whales occupy an area approximately 32km² in size. Maximum whale counts can reach up to 200 which translates into 6.25 whales per square kilometre (Pérez-Cortés, Urban, and Loreto 2004; Rice et al. 1981). However, the number of whales returning to the lagoon is uncertain due to sand-blockages at the mouth, where current and tides transport sand into the main access channel at the Boca de Soledad.

¹⁷ Courting and mating behaviour is not limited to the breeding lagoons and occurs throughout the migratory path (Norris et al. 1983).

Occasionally, these habitat changes hinder whales from entering the lagoon and cause year by year fluctuations in the number of whales returning to the estuary (Norris et al. 1983; Pérez-Cortés, Maravilla, and Loreto 2000; Urban et al. 2003).¹⁸

The first-time-visitor to Puerto Adolfo López Mateos will have an easy time finding the local whale watching businesses due to the well marked directions throughout town. After travelling about one kilometre from the town's plaza visitors reach the facilities on the eastern shore of the Santo Domingo Channel. Visitors arriving by plane to go whale watching use the town's airstrip near the embarkment point. Small restaurants and souvenir shops established themselves near the tourism dock and the tourist police keeps an eye on organized parking, businesses, and visitors alike. Plans are under way to build more restaurants and tourism facilities, which would offer year-round activities such as turtle and bird watching, surfing and sports fishing to keep visitors in town for longer.

Often, whale watchers can readily observe whales in close vicinity of the tourist pier. The dock holds approximately sixty boats that are ready to transport visitors to their *once-in-a-life-time* encounters with gray whales. The walk-in whale observer can choose among four businesses, located next to each other. The operations are run very efficiently with pangeros (Spanish for boat driver) already waiting at the dock to take visitors on tours. Several dock hands provide a helping hand when visitors embark the skiffs from the docking facility.

¹⁸ For example, in 1998 the maximum whale count was only 31 whales which indicates high variation in whale abundance considering maximum counts of 200 (Pérez-Cortés, Maravilla, and Loreto 2000).

Boat trips last between one and three hours with first whales being sighted within minutes of departure. The boat tour focuses on the calm waters inside the lagoon and avoids the outer parts on the Pacific Ocean due to the dangerous mouth of the lagoon at the Boca de Soledad. During the tour, visitors observe whales in very close proximity displaying different behaviours such as courting, mating, nursing, or spy hopping. Due to the narrow area of the lagoon in which the whales are constrained, individual whales are easily observed for extended periods of time. However, the geographical setting also leads to some crowding of tour boats in areas of intense whale activity.

Operations in PALM show a high degree of cooperation and partnership among participants in the industry. The whale watching industry consists of two large cooperatives and two small sole proprietors that together hold a total of twenty seven whale-watch-permits (Table 3–2). The two cooperatives are run similarly and each have twenty five to thirty members and hold between ten and thirteen permits. Most members of the cooperative are long time residents that predominately fish during the rest of the year.¹⁹ Besides sharing whale watching permits, members contribute half of their revenue to the cooperative to cover costs for lobbying, marketing, office expenses, and whale watching equipment.²⁰ Pangeros are hired at a local wage of Pesos 70 per boat hour.

¹⁹Income from fishing amounts to approximately 80 percent of total annual income where the remainder is attributable to whale watching.

²⁰ In the next chapter I will provide a more detailed account of these costs and how the benefits from whale watching are distributed among the community.

Table 3–2 Distribution of whale watching permits by location and organization

	PSC		PALM	
	<i>operators</i>	<i>permits</i>	<i>operators</i>	<i>permits</i>
local				
<i>not organized</i>	3	14	4	4
<i>organized in union/coop</i>	11	21	55	23
<i>sub-total</i>	14	35	59	27
non-local				
<i>not organized</i>	2	4	--	--
total	16	39	59	27

PALM has a well-established client base mainly through pre-arranged package tours by travel agencies that amounts to 54 percent of total business (Table 3–3). The second strongest clientele comes through walk-in whale watchers (35 percent), followed by cruise ship business (8 percent) and independently organized bus groups (3 percent). Prices per boat hour differ somewhat among operators and depending on client groups range from Pesos 600 to Pesos 650 per boat hour (Table 3–3). For PALM walk-in customers and travel agencies constitute the main market. Since business from cruise ships and bus groups tends to be less important, I ignore prices charged to these groups for reasons of simplicity and lack of data. I normalize the percentages for walk-in clients and agency customers and calculate an average price per boat hour for each community. According to this framework, the price per boat hour of whale watching equals Pesos 620 in PALM. I also calculate the per-person-price according to the average number of seats per boat occupied during the 2005 season, based on visitation rates and trips outlined in a report by SEMARNAT (2005) (Table 3–3).

Table 3–3 Price discrimination depending on client group

(in 2006 Mexican Pesos)	<i>PSC</i>	<i>PALM</i>
walk-in		
<i>proportion</i>	57%	35%
<i>price</i>	600	650
group/bus		
<i>proportion</i>	10%	3%
<i>price</i>	n/a	n/a
cruise-ship		
<i>proportion</i>	0%	8%
<i>price</i>	n/a	n/a
agency		
<i>proportion</i>	33%	54%
<i>price</i>	550	600
price per boat hour ^a	582	620
price per person ^b	140	116
Notes:		
a) weighted price		
b) assumes 4.16 (5.33) seats per boat occupied in PSC (PALM). see: SEMARNAT (2005)		

Locals also receive business through an American based company that runs weekly cruise ship excursions entering the Santo Domingo Channel from the south through Bahia Magdalena.²¹ The company, who is also known as a world leader in geography, cartography, and exploration and known for its large and internationally known publication, hires local guide services to gain access to whale watching rights. Commonly, cruise ship passengers do not visit the town of PALM. During interviews with local operators, respondents report that especially on weekends, the whale watching fleet is reaching capacity and cooperatives are seeking to buy larger boats to accommodate this peak demand.

²¹ In personal interviews, local fishermen criticised the cruise ship for damages to the benthic environment in the narrow mangrove channel at Curva del Diablo.

3.6.2 Puerto San Carlos

Bahia Magdalena forms the middle and largest part of the Bahia Magdalena lagoon complex, extending thirty one kilometres North-South and twenty two kilometres East-West (Rice et al. 1981). Two mountainous islands, Isla Magdalena and Isla Margarita, protect the bay from the Pacific Ocean and form a five kilometre wide access channel used by whales and large vessels alike to enter the lagoon (Dedina 2000).²² The whales occupy an area that is approximately 560 km² in size (Rice et al. 1981). Historic maximum whale counts range between 90 in 1997 (Pérez-Cortés, Urban, and Loreto 2004) and 110 in 1980 (Rice et al. 1981) which relates to a maximum whale density in the occupied surface area between 0.16 and 0.2 whales per square kilometre. This density is low compared to the density of 6.25 whales per square kilometre observed in PALM. Even though there are generally fewer whales visiting Bahia Magdalena, the returns are a bit more certain than in PALM. Tidal currents at the mouth of the bay do not contribute to sand blockages as observed in PALM due to the ten meter deep entrance channel that is protected by shoals extending from each island.

Before entering the town of PSC the visitor will be surprised by the lush mangroves that are pleasing to the eye after driving through the Baja California desert. Puerto San Carlos sits on a sand spit on the northern shore of Bahia Magdalena where the turquoise of the ocean is framed by the green of the mangroves and the beige of the rugged mountains seen in the distance. The remoteness and natural beauty of the surrounding environment, the sand roads, and rustic character of the town create an atmosphere of a frontier town.

²² Once per week, a large oil tanker enters the bay and docks in the port of PSC to supply bunker oil for generating electricity in the nearby power plant.

Visitors on their first trip to PSC will find it difficult and somewhat cumbersome to whale watch. The businesses are located throughout town and each operator has his own signage. There is also no common location where whale tour businesses sell whale watching trips, as in PALM. Local tour guides commonly receive business by flagging down costumers that are driving through town.

After initial contact with customers, operators load their boats on trailers, from their home or office location across town, to a common launching beach that serves as a natural launching site for all operators. Besides the logistics of the operations being quite cumbersome for clients and operators alike, this natural embarkment point is affected by tidal changes that make launching a difficult and laborious task.

Most whales are seen closer to the mouth of the bay which is approximately twenty kilometres distant from the town of PSC (Figure 3-1). The vast and extensive area of the bay turns boat trips into two to five hour long wilderness experiences, that are occasionally constrained by weather and water conditions (Gonzalez Agundez 2006).

Compared to their northern competitors, whale watching in PSC is less organized and participants cooperate less, showing more tension and competition. The industry is comprised of three sole proprietors that together hold a total of thirteen permits (Table 3-2). Additional twenty one permits are held by a union which can be characterized as a joint venture between its members. It is interesting to note that there is less cooperation in between members of the union in PSC than observed in cooperatives in PALM. For example, the eleven members of the union in PSC each hold two permits that they generally do not share among members, revenues and costs are also not shared.

Cooperation exists in the form of occasionally allotting excess clientele to other members.

Similar to cooperatives in PALM, union members in PSC are fishers during the remainder of the year. However, the three sole proprietors specialize in year-round nature based tourism and offer natural history tours, wildlife viewing, kayaking, surfing and sports fishing. Interviews with operators reveal that union members and the three sole proprietors are in fierce competition and rarely cooperate to share clients or to lobby the government for their cause. Central docking and business facilities, comparable to the ones found in PALM, are being built and should considerably improve the dangerous and inconvenient embarkment situation.²³ Pangeros earn Pesos 100 per hour which reflects the higher risks involved in taking out visitors in the vast and sometimes rough waters of Bahia Magdalena, compared to PALM (Pesos 70 per hour).

PSC's client base is less established and mainly involves walk-in customers (57 percent). Only 33 percent of the operators' business comes from travel agencies and 10 percent through individually organized groups (bus tours) (Table 3-3). Local operators do not receive any business through cruise ships but occasionally are hired to transport clients for two, non-local, whale watching companies based in the state's capital, La Paz. Both of these companies own two whale watching permits each, and offer multi-day whale watching, where clients stay in remote whale watching and nature camps in the Bahia Magdalena area (Table 3-2).

Similar to PALM, I observe some price discrimination in PSC, where the price per boat hour varies somewhat among operators and ranges between Pesos 550 and Pesos

²³ The construction of docking facilities in PSC is being stalled due to regulatory issues.

600 depending on the client group (Table 3–3). Since business focuses on walk-in customers and package tours (travel agency), the weighted average price per boat hour is equal to Pesos 582 in PSC (Table 3–3).

CHAPTER 4 ECONOMIC RENT ANALYSIS OF WHALE- TOURISM

4.1 Overview

In this section I develop a framework for evaluating the financial contribution of gray whales to economic welfare in PALM and PSC. Economic rent is the most appropriate measure of this contribution because it calculates the surplus remaining after revenues have been used to pay all costs of production including a return on investment, or “normal profit” (Gunton and Richards 1987).²⁴ Normal profit is equal to what could have been earned in the next best use of the capital (opportunity cost of capital). A key distinction between this type of economic analysis and a financial analysis is that it reflects the social opportunity costs associated with utilizing the project’s factors of production (Curry and Weiss 2000, p. 38). In the case of whale watching in Bahia Magdalena, any surplus above and beyond this opportunity cost is equal to rent that is attributable to the gray whales visiting the bay, the resource conditions and site specific characteristics of each location, and the organization of the industry, just to name a few fixed factors of production.²⁵

The method of estimating rent is conceptually straightforward but entails some practical hurdles, one of which is the proper calculation of the opportunity cost of capital (Lyon 1990; Schwindt, Vining, and Globberman 2000; Gunton and Richards 1987; Gunton 2004). Cost-benefit theory requires that costs accruing as investments be

²⁴ Normal profits are part of total costs and therefore not part of surplus rent.

²⁵ The environment and site specific characteristics are considered fixed factors of production, but other unknown characteristics can play a role in the generation of rent.

converted into the stream of costs and benefits that would have resulted if the investments had not taken place (Schwindt, Vining, and Gliberman 2000).

Costs and benefits that arise in different years cannot be valued equally across the years of a project because we associate higher value to benefits that occur sooner rather than later.²⁶ Discounting helps to account for this time value of money, which is different depending on society's perspective or the view of an individual decision maker. While society's goal is to allocate resources efficiently, an individual perspective focuses on the decisions surrounding income. In the former case, the discount rate accounts for the social opportunity cost of using up society's capital resources for the project, which then accounts for the cost of not using the capital in its next best use. In the latter case, the theoretic basis for the discount rate is that it accounts for people's time value of money, as reflecting the opportunity cost of deferring consumption.

Since this study is a social analysis I focus on social discount rates and ignore private discount rates. Economists apply two distinct approaches to the social discount rates. The consumption discount rate (formerly called the time preference rate) reflects the social time preference and allocation of resources to society. It is often assumed to be proxied by the yield on government bonds. In contrast, the production discount rate reflects returns on the next best investment opportunity and is proxied by the marginal rate of return on capital (MOC). The latter is always higher than the consumption discount rate and emulates the risk involved in market investments (Curry and Weiss 2000, p.38). For the purpose of this analysis, I use the MOC because the project uses private capital even though the analysis focuses on social outcomes. The implications of a

²⁶ No discounting would assume that beneficiaries are indifferent between costs and benefits in year one and costs and benefits in year 30.

higher discount rate are two fold: first, it reduces rent and second it stifles investment in whale watching. Also, in the tradition of Pearce and Markandya (1987) I do not adjust the MOC to account for externalities.²⁷ Taxes are considered only in financial analysis, but since this is an economic analysis that investigates the benefits to different stakeholders including the government, taxes are benefits that are accounted for in this analysis.

Much uncertainty surrounds the cost of capital in developing countries where the availability of credit can be limited (Block and Vaaler 2004). The marginal opportunity cost of capital needs to be higher than the risk free rate to reflect a realistic level of risk associated with private investments, such as for whale watching operations. For Mexico, the long term risk free interest rate is between 7 and 8 percent (OECD 2006). Gonzalez-Ramirez (2003) used a private discount rate of 10 percent for a cost benefit study of Mexican bean farming. Thus, for the base case of this analysis I assume the real before tax opportunity cost of capital to be 12 percent and check for sensitivity between 2 and 20 percent.^{28,29} Employing a high rate for this project constitutes a conservative measure and accounts for some of the uncertainties (Gollier 2002).

Another concern associated with the analysis relates to uncertainties inherent in fluctuations in the business cycle and the resulting volatility in annual rent not captured. The potential issue with my analysis is that it bases projections on a single year's data.³⁰

²⁷ Externalities in the whale watching industry could be the human impact on whales or the environmental cost of pollution from boat motors. In a regular Cost Benefit Analysis, these externalities would be accounted for in terms of the MOC, which adjusts benefits and costs accordingly to include these externalities. Since the latter is not the intent of this study the discount rate is not adjusted for externalities.

²⁸ The high value of 20 percent was used because operators' normal borrowing rate with local banks is as high as 45 percent (García Martínez 2006). Also Young (1999) reports on fishermen having difficulties to obtain loans.

²⁹ I use real discount rates which adjust nominal (monetary) rates for inflation effects.

³⁰ It is uncertain whether the 2005 business year, on which calculations in this analysis are based, was a good or a bad year.

This approach is justifiable since the general assumption is that high returns above the long run opportunity cost of capital will compensate for low returns during weak markets. However, Gunton (1987) notes that high returns could also be misinterpreted as rents instead of compensation and therefore skew the value picture. While economists normally base their projections on an average historic profit (Gunton and Richards 1987; Schwindt, Vining, and Globerman 2000), a better method is to simulate fluctuating returns for the forecast to account for market uncertainty (Morgan and Henrion 1990).

Market imperfections are a third potential issue because the estimation assumes well functioning markets (Gunton 2004). For whale watching in Bahia Magdalena it is reasonable to assume that buyers and sellers do not hold enough market power to affect the price for whale watching tours. On the producer side, 14 communities engage in whale watching in Mexico, of which two are located in the Bahia Magdalena lagoon complex (Hoyt 2001). There are two non-local and 73 local participants operating in the area. Of the 73 local operators, 66 organized themselves into cooperatives, and five work as sole proprietors, suggesting that none of the operators alone can control the market and affect the price. On the consumer side, the Mexican share of the world-wide market amounts to one percent equalling approximately 100,000 visitors annually (Hoyt 2001). Due to the small and remote nature of the industry and the far distance to the U.S. border, I assume that there are no distortions in the local economy. It is reasonable to assume that purchases of whale watching inputs have no impact on input prices and that there are no

subsidies.³¹ Therefore, economic prices can be set equal to financial prices (Curry and Weiss 2000).

The fourth problem concerns efficient management of the industry and whether or not the industry maximizes rent. Even though the industry is managed in a limited entry system, this does not prevent capital stuffing and rent seeking as observed by Johnson and Libecap (1982) in the case of limited entry fisheries. Gunton and Richards (1987) find that particularly in resource industries, rents allow firms to stay competitive while engaging in non-profit-maximizing behaviour that dissipates part of the rent. Such behaviour can be found in developing surplus capacity for example, a common problem in resource industries (Gunton and Richards 1987, p. 26).

Other market imperfections relate to externalities such as the possible losses incurred by fishermen whose fishing activity is restricted once the whales enter the bay (Pérez-Cortés 2005). While I ignore the loss to fishermen in this empirical analysis, it would be possible to develop a conceptual model of financial trade-offs involved in whale watching for the community as a whole. Other externalities not accounted for in this analysis include the possible displacement of whales due to boat traffic (discussed in section 3.4) and environmental costs such as water pollution caused by marine engines.

4.2 A model of economic rent

For each community, I assume that the goal of economic activity is to maximize net income resulting from the production of whale watching trips over time. In order to account for the time value of money, rent is traditionally estimated in the form of

³¹ A fuel and engine subsidy exists but can only be requested during the fishing season and not while operating as whale watching guides (García Martínez 2006).

aggregate rent, the sum of discounted annual net income streams. In this context, annual net income is equal to the annual revenue minus the annual costs, including capital costs.³² The aggregate rent is equal to the net present value of the resource and is stated formally as:

$$\Pi_{NPV} = \sum_{t=0}^T \frac{R(t) - C(t)}{[1 + r]^t}, \quad (4.1)$$

where, Π , is the net present value of economic rent, $R(t)$ is the annual revenue earned by the industry, $C(t)$ is the annual aggregate total cost of production (including capital), r is the *pre tax* marginal opportunity cost of capital, and t is the year. I set the discount period, T , at 30 years. All benefit and cost flows are assumed to occur at the end of each period and are projected over the time horizon of the project. In addition, I provide an estimate of the “levelized” annual benefit flow equal to the amortized present value which in mathematical form is calculated as:³³

$$\Pi_{\text{levelized}} = \Pi_{NPV} \cdot \frac{r}{1 - (1 + r)^{-T}}. \quad (4.2)$$

In the following sections I follow the approach by Gunton (1987) and Schwindt et al. (2000) who present the contribution of natural resources to economic welfare in the form of net present value associated with a projection of expected income streams generated by the resource in the future. The analysis is comprised of two parts, first I

³² Normal return to capital (also called “normal profit” or a “return on investment”) is equal to what could have been earned in the next best alternative use of the capital.

³³ Note, the levelized value shows the amortized annual benefit *flow* as opposed to the NPV, which illustrates the present (or say capitalized) value of the resource and thus constitutes a *stock* (Silberberg 1990, p. 224). Levelized values are the annual constant flows that constitute the NPV.

estimate the aggregate rent generated through whale watching, and second I calculate the distribution of rent as it accrues to operators, labour, and government.

I collected cost data for the industry through semi-structured interviews with twenty-five operators conducted between February 22nd and March 8th 2006, and analyzed the revenue and cost structure of the industry based on the approach taken by Curry and Weiss (2000, p. 25). I also used annual business reports submitted in 2005 to SEMARNAT (SEMARNAT 2005). One serious limitation arises from the lack of historical data, which prevented the analysis from accounting for temporal variation in the data (Morgan and Henrion 1990). Often the availability of data is limited in developing countries and requires extensive data collection by the researcher who is constrained by the study's budget and time frame. Further data on historical business activity and macro economic parameters, combined with a Monte Carlo simulation, could improve the value estimates of this study.

4.3 Industry revenue and costs

Assuming an inelastic demand curve, each community captures total benefits from whale watching equal to industry revenue, formally stated as:

$$\begin{aligned}
 R(t) &= p[y(t)] \cdot y(t), \\
 \text{where: } y(t) &= g(t) \cdot l, \\
 g(t) &= \frac{v(t)}{s} \quad \text{for} \quad g(t) \leq \frac{h}{l} \cdot n \cdot j, \quad (4.3)
 \end{aligned}$$

where $p[y(t)]$ is a downward sloping inverse demand function, where p is the price per boat hour, and $y(t)$ is the number of boat hours supplied by the industry. The latter is equal to the product of total annual trips supplied, $g(t)$, and the average trip length in

hours, l .^{34,35} I calculate the number of trips by dividing annual visitor numbers, $v(t)$, by the number of seats occupied per trip, s .³⁶ Note, h is the maximum hours of operations per day, and $g(t)$, cannot exceed the maximum possible number of annual trips which is equal to the product of the number of trips per permit per day, h/l , the number of permits, n , and the season's length in days, j .

Larson and Shaikh (2003) estimate the elasticity of whale watching demand in Monterey Bay to be minus 0.5571.^{37,38} Since, Monterey Bay is frequented by the North East Pacific stock of gray whales and observation activity tends to be similar there, I use their estimate to represent changes in visitation responding to changes in the price per boat hour.³⁹ World wide whale watching demand has grown on average between 10 and 13.6 percent annually between 1991 and 1998 (Hoyt 2001). For the base line case in this analysis I assume the demand for whale watching will grow 10 percent annually, an assumption consistent with reports of historic business activity collected through the semi-structured interviews.

³⁴ Consumer surplus occurs but accrues to outsiders, in this case whale watching clients residing in other parts of Mexico or foreign countries. Since clients are non-local, I ignore consumer surplus for this analysis.

³⁵ Average trip length, l , is 3.0 hours in PSC and 2.12 hours in PALM (SEMARNAT 2005).

³⁶ The number of seats occupied, is based on visitation data provided by SEMARNAT (2005).

³⁷ Since the actual whale watching demand in Bahia Magdalena is unknown I relied on estimates of elasticity calculated by Larson and Shaikh (2003). Moreover, I assume a downward sloping demand curve where the number of annual visitors depends on visitation growth, η , and the elasticity of demand \mathcal{E} . For further sensitivity analysis I use the following statement to calculate the annual visitor numbers:

$$v(t) = v(t-1) \cdot \left(1 + \mathcal{E} \frac{\Delta p}{p}\right) \cdot (1 + \eta).$$

³⁸ Note, inelastic demand is indicated by $|\mathcal{E}| < 1$.

³⁹ Operations in Monterey Bay use boats to take out visitors to watch whales where trips last three hours (<http://www.montereybaywhalewatch.com/trips.htm>).

For each of the two towns, I express the annual aggregate industry cost $C(t)$, as the sum of annual operating costs, $OC(t)$, annual capital charges, $K(t)$, and annual fixed cost, F :

$$C(t) = OC(t) + K(t)_{\text{levelized}} + F. \quad (4.4)$$

In addition, I assume $OC(t) = C_F(t) + C_{oL}(t)$ with C_F representing total annual fuel cost, and C_{oL} being the opportunity cost of labour.⁴⁰

4.3.1 Operating costs

Industry fuel cost is based on the different trip-lengths and engine types (two-stroke vs. four-stroke) as observed in personal interviews with pangeros in PALM and PSC, and equal to:

$$C_F(t) = \sum_i^m \sum_k^n \sum_j^z g_i \cdot a_{ik} \cdot f_{kj} \cdot [p^{\text{fuel}} + \varphi_j p^{\text{oil}}], \quad (4.5)$$

where m is the number of individual operators, i ; n is the number of trip types, k ; and z is the number of individual engine types, j . The number of trips per operator is represented by g_i , a_{ik} is the proportion of trips by operator and trip type, and f_{kj} is the volume of fuel used per trip dependent on the engine type (Table 3–1). The expression in square brackets is equal to the unit price for fuel, which is the sum of the per-litre-price of fuel p^{fuel} , and the value of oil-additive, where φ_j is the proportion of oil-gas-mixture per engine type,

⁴⁰ Capital charges include investment costs and costs for working capital as outlined in Curry and Weiss (2000, p. 21). Note, capital charges are equal to the amortized value of the sum of all capital used over the time horizon of the project.

and p^{oil} the per-litre-price of oil-additive. Note, the engine is running constantly during a trip, therefore a one hour trip results in the engine running for one hour.

Labour costs are valued at their opportunity cost which in reality is unknown and subject to further assumptions (Griffin, Lacewell, and Nichols 1976). Since, most pangeros work as fishermen during the rest of the year, the opportunity cost would be what the average skilled pangeros could earn as an average skilled fishermen. However, the calculation of an hourly wage for fishermen is difficult because their income is proportional to the value of the catch, which varies across fisheries. In addition, working days are longer in the fishing industry than they are in the tourism industry. I use the minimum wage of Pesos 47 per hour to estimate the opportunity cost of labour and will analyze the sensitivity of this assumption below.⁴¹ The minimum wage approach will potentially overstate the calculation of rent since pangeros have certain skills like boat handling and a general knowledge of navigating the ocean, that would put them in higher income brackets. I calculate the opportunity cost of labour as:

$$C_{ol}(t) = \sum_{i=1}^m w_{\min} [y_i + \gamma g_i], \quad (4.6)$$

where w_{\min} is the minimum wage, γ is a factor reflecting the hours of boat cleaning per trip (20 min per trip), and y_i is the sum of annual boat hours supplied by the individual operator. Since actual wages paid to pangeros are substantially higher than the minimum wage (Pesos 100 per hour in PSC, Pesos 70 per hour in PALM), the difference is equal to the surplus labour receives as part of the rent from whales.

⁴¹ One could argue that the opportunity cost of labour is higher in PSC than in PALM. The reason being that pangeros operating in Bahia Magdalena require more “ocean” skills due to the wilderness setting of the bay and the associated risks.

4.3.2 Capital charges

I calculate annual capital charges as the amortized NPV of the sum of initial capital investment, $K(0)$, and capital investments that replace the assets once they reach their life, $K(t)$ (Curry and Weiss 2000, p. 28). The levelized annual capital charge is equal to:

$$K(t)_{\text{levelized}} = K_{PV} \cdot \frac{r}{1 - (1+r)^{-T}}$$

$$\text{where: } K_{PV} = K(0) + \sum_{t=0}^T \frac{K(t)}{[1+r]^t}, \quad (4.7)$$

where $K(t)$ is the ongoing capital replacement which varies according to a schedule. Capital charges are adjusted for the share in use of each asset for whale watching, for example the boat is used for fishing and whale watching.⁴² Interviews with operators revealed that there are no salvage values associated with each asset. Note, the value of the whale watching permit is not part of capital costs because it is not a resource that is used up while engaging in whale watching. If this value would be included it would mean “double-counting” the value of the resource (Schwindt, Vining, and Gliberman 2000).⁴³

4.3.3 Fixed cost

Fixed costs for the industry include the lease of office buildings, office expenses, wages paid to office workers, travel, advertising, insurance, the cost of preparing the fishing boat for whale watching (switching cost), boat and motor repair, boat

⁴² $K(t) = \sum_{i=1}^m \sum_{j=1}^s \phi_j p_j A_j(t)$, where s is the number of different types of assets, j is the individual asset, and ϕ represents the proportion of annual use of the asset for whale watching. Further, p_j exhibits the initial purchase price of the asset and $A(t)$ illustrates the replacement schedule of asset j .

⁴³ The permit value is representative of the future cash flows generated by the resource.

transportation costs, and the water access fee. I express fixed cost for the industry, F , as the sum of each individual operator's fixed costs, F_i :

$$F = \sum_{i=1}^m F_i. \quad (4.8)$$

With estimates of all the components of total cost that are accounted for in this study, I can calculate total cost as the sum of opportunity costs associated with the utilization of all factors of production accounted in this analysis. I calculate the present value of total cost as follows:

$$C_{PV} = \sum_{t=0}^T \frac{C(t)}{(1+r)^t}, \quad (4.9)$$

with the levelized cost being equal to:

$$C_{\text{levelized}} = C_{PV} \cdot \frac{r}{1 - (1+r)^{-T}} \quad (4.10)$$

4.4 Rent

Following the model of rent outlined in (4.1), I express the distribution of rent as the sum of rent to labour, Π_{labour} , rent to operators, $\Pi_{\text{operators}}$, and rent to the government, Π_{gov} , or:

$$\Pi = \Pi_{\text{labour}} + \Pi_{\text{operators}} + \Pi_{\text{gov}} \quad (4.11)$$

Generally, the distribution of economic rent among labour, operators, and government is complicated by taxes and other transfers like non-wage benefits to labour, permit fees, licenses or other similar charges. The treatment of taxes is different in efficiency analysis

than in distribution analysis.⁴⁴ While taxes are ignored in the former they are explicitly taken into account in the distribution analysis since government is considered a stakeholder. It is important to note that even though taxes are included in the distribution analysis, they do not affect the overall efficiency result, meaning they do not affect the total amount of rent generated (Curry and Weiss 2000, p. 266). Gunton and Richards (1987) mention that it is possible that rents support non-wage benefits such as job security or unemployment insurance, which is not the case in Bahia Magdalena. The main transfer payments are taxes that amount to 28 percent of net income and apply to labour and operators equally.⁴⁵

I will calculate the post-tax-rent accruing to labour and business owners, before estimating the total amount of taxes from rent. The NPV of rent appropriated by labour is equal to:

$$\Pi_{\text{labour}} = \sum_{t=0}^T \frac{[C_L(t) - C_{ol}(t)] \cdot [1 - \tau]}{(1+r)^t}$$

where: $C_L(t) = \sum_{i=1}^m w_d y_i + w_c \gamma g_i$, (4.12)

where C_L is the actual labour cost, w_d is the driver's wage and w_c , the wage for cleaning boats. Since, labour receives income over and above its opportunity cost, the extra income (pre tax) includes unappropriated rent of which labour will keep a share equal to $[1 - \tau]$, where τ is the marginal income-tax rate.

⁴⁴ Efficiency analysis solely focuses on the maximization of rent whereas the goal in distribution analysis is to show who benefits from the resource by how much.

⁴⁵ Operators pay a seasonal water access fee (permisio nautico) of Pesos 1000 per boat to the Capitan de Puerto, the harbour master, who belongs to a federal agency. The permisio nautico is solely used to maintain buoys, lights, and other boat traffic related services. Therefore, the fee is part of government costs related to servicing the whale watching industry and not part of rent.

For the calculation of rent accruing to operators, I first consider that taxes are not part of the analysis. Thus, the calculation of rent (pre tax) to operators is equal to the total rent minus the rent (pre tax) that goes to labour. Operators will pay taxes on this remaining “pre tax amount” and keep a share equal to $[1 - \tau]$. I express the post tax rent accruing to operators as follows:

$$\Pi_{\text{operators}} = \sum_{t=0}^T \frac{[\Pi(t) - [C_L(t) - C_{oL}(t)]] \cdot [1 - \tau]}{[1 + r]^t}$$

where: $\Pi(t) = R(t) - C(t)$.

(4.13)

Rent appropriated by government is the sum of not appropriated rent by labour and operators, or put differently, the tax share of total resource rents generated. In present value terms I state this as:

$$\Pi_{\text{gov}} = \sum_{t=0}^T \frac{\Pi(t) \cdot \tau}{[1 + r]^t}$$
(4.14)

The above model summarizes the calculations undertaken for estimating resource rent generated through whale watching and its distribution to stakeholders. In the next chapter I parameterize the model and present the results of my calculations and sensitivity analysis.

CHAPTER 5 RESULTS AND DISCUSSION

5.1 Parameter assumptions

The calculations of rent are based on the parameter assumptions summarized for the base case scenario as follows (Table 5–1).

Table 5–1 Parameter assumptions for base case scenario

	<i>PSC</i>	<i>PALM</i>	<i>source</i>	
varying parameters				
<i>r</i>	discount rate	12%	12%	OECD (2006)
<i>p</i>	price per boat hour of whale watching in Pesos	582	620	personal interviews
<i>w_{min}</i>	hourly minimum wage in Pesos	47	47	García Martínez (2006)
<i>s_{max}</i>	seats per boat available	6	6	personal interviews
<i>s</i>	average seats per boat occupied in 2005	4.16	5.33	SEMARNAT (2005)
<i>η</i>	visitor growth per year	10%	10%	Hoyt (2001)
<i>ε</i>	elasticity of demand	-0.5571	-0.5571	Larson and Shaikh (2003)
fixed parameters				
<i>p_o</i>	price of oil mixture in Pesos per litre	30	30	personal interviews
<i>p_f</i>	price of fuel in Pesos per litre	6.25	6.25	personal interviews
<i>w_d</i>	hourly panguero wage in Pesos	100	70	personal interviews
<i>w_c</i>	hourly wage for boat cleaning in Pesos	60	60	personal interviews
<i>γ</i>	factor for boat cleaning (0.3/trip)	0.3	0.3	personal interviews
<i>τ</i>	income tax	28%	28%	García Martínez (2006)
<i>φ</i>	gas-oil-mixture	1/50	1/50	personal interviews
<i>h</i>	daily hours of operations	6	6	Gonzalez Agundez (2005)
<i>j</i>	season length in 2005 in days	44	44	Gonzalez Agundez (2005)
<i>v(0)</i>	visitors in 2005 (excl. outsiders' business)	3384	9317	SEMARNAT (2005)
<i>g(0)</i>	trips in 2005 (excl. outsiders' business)	813	1748	SEMARNAT (2005)
<i>Φ</i>	proportional use of asset for whale watching	20%	20%	personal interviews
<i>l</i>	average length per trip in hours	3.0	2.1	SEMARNAT (2005)
<i>f</i>	average fuel consumption per boat hour in litres	93.6	105.6	personal interviews

According to equation (4.5) and respective parameters stated in Table 5–1, annual fuel costs in 2006 amount to Pesos 228,443 in PSC and Pesos 391,131 in PALM (Table 5–2).⁴⁶ I calculate labour cost, C_l , utilizing equation (4.12), which equals Pesos 258,719

⁴⁶ For the calculations of rent, the amount of fuel cost observed in interviews in 2006 was proxied to business activity in 2005 due to a lack of data.

in PSC and Pesos 300,633 in PALM (Table 5–2). Fixed costs, F , are Pesos 449,765 in PSC and Pesos 551,295 in PALM (equation (4.8)). PALM has higher fixed costs because of the larger scale of operations and the higher stock of capital (59 boats in PALM vs. 35 boats in PSC). Table 5–2 shows the initial price of each asset, p_j , and the respective reinvestment schedule, $A(t)$. Taking the proportional use of the fishing boat for whale watching into account, the initial capital stock $K(0)$, amounts to Pesos 888,629 in PSC and Pesos 1,106,685 in PALM (equation (4.7)). The higher $K(0)$ in PALM is a result of almost double the amount of boats used in PALM compared to PSC.

Table 5–2 Industry cost structure based on interview data

(in 2006 Mexican Pesos)	asset life	PSC	PALM		total PSC	total PALM
Operating costs						
$[C_F]$ fuel cost					228,443	391,131
$[C_L]$ labour cost					258,582	290,718
OC					487,025	681,849
Fixed costs						
rent for office					7,200	7,200
motor and boat repair		8,000	8,000	per boat	56,000	94,400
office expenses		770	770	per operator	10,778	45,422
office workers		273	542	per operator	3,818	32,000
travel		4,786	2,076	per operator	67,000	122,500
advertising		5,893	192	per operator	82,500	11,323
insurance		1,113	521	per boat	38,950	30,721
switching cost		2,521	2,521	per boat	88,229	148,729
boat transport		1,723	0	per boat	60,289	0
water access fee		1,000	1,000	per boat	35,000	59,000
F					449,765	551,295
Initial Capital						
vehicles	5	50,000	0	per operator	140,000	55,000
trailers	3	7,857	0	per boat	55,000	0
boats	30	42,000	42,000	per boat	294,000	495,600
motors	5	40,455	40,455	per boat	283,182	477,364
life jackets	3	2,180	2,180	per permit	76,300	58,860
radios, first aid, etc.	4	1,147	736	per permit	40,147	19,861
K(0)					888,629	1,106,685

It is interesting to note that PSC spends seven times more in advertising: Pesos 82,500 compared to Pesos 11,323 in PALM. PSC's advertising expense is higher because of the lack of cooperation in between operators, but also due to the fact that PALM is well known for its superb whale watching whereas PSC is just starting to become a whale watching destination. While whale watching operations in PALM started more than 30 years ago, most tour companies in PSC have only been in business for 15 years. Also, the lack of docking facilities in PSC force operators to transport their boats between their business location and the embarkment point for each trip. This creates transportation costs for PSC that are non-existent in PALM. Finally, the vast and extensive area of Bahia Magdalena translates into higher insurance costs and higher expenses for safety equipment in PSC (Table 5-2). Note, the longer distance to see whales and the rougher ocean conditions in PSC could possible result in higher fuel consumption, would PSC exclusively use two-stroke engines. Since operators in PSC use fuel efficient four-stroke engines, fuel consumption in PSC is lower than in PALM (Figure 3-2). Note, *switching cost* refers to the annual one-time cost of preparing the panga for whale watching activity (Table 5-2).

Besides information on costs and revenues the interviews with operators and pangeros revealed aspects of training and safety in the whale watching fleet. Just under one half of operators found it difficult to find skilled pangeros for guiding whale watching tours (45 percent), which suggests that the true opportunity cost of labour is higher than the minimum wage as assumed in the base line scenario. Three quarters of the responding boat drivers receive safety training in some form for conducting whale watching tours, but a majority of the respondents (87 percent) identify that additional

training is needed. More than half of them want to speak better English (60 percent), improve their knowledge of whale ecology (10 percent), advance their skills in repairing motors (9 percent) and better their first aid and safety training (8 percent). Almost all of the interviewees (96 percent) provide a safety briefing for customers before embarking. The formal education level among operators and pangeros ranges widely between none and sixteen years of formal education.

5.2 Rent and its distribution effects

All calculations in this section are summarized in Table 5–3 and based on the base-line scenario consisting of parameter values mentioned in Table 5–1.⁴⁷ I calculated all present values according to equation (4.1) with levelized values based on equation (4.2). For convenience to the reader, I will refer to levelized values since these annual benefit and cost flows are easier to grasp than the concept of NPV. Whenever, NPV is used I will specifically refer to it as NPV.

Recalling equation (4.3), revenue is equal to Pesos 2,917,554 in PSC and Pesos 3,604,509 in PALM (Table 5–3). Utilizing equation (4.10), total cost amounts to Pesos 1,401,975 in PSC and 1,719,764 in PALM, which is 48 percent of total whale watching revenue in both communities. Operating costs in PSC total Pesos 728,623 (25% of revenue) and in PALM Pesos 925,947 (26% of revenue). Levelized fixed cost is Pesos 449,765 (15% of revenue) and Pesos 619,735 (17% of revenue) in PALM. Capital charges amount to Pesos 223,587 in PSC and Pesos 242,521 in PALM annually, equal to 8 percent and 7 percent of revenue respectively. Summarizing, the cost structure in both

⁴⁷ For detailed calculation tables see: [http://www.crosscountryalaska.com/Toby/thesis/BCA\(Jan-12\).xls](http://www.crosscountryalaska.com/Toby/thesis/BCA(Jan-12).xls) and open spreadsheets: “CBA-PSC and CBA-PALM.”

communities is almost identical, amounting to approximately 50 percent of revenue with the main part attributable to operating costs followed by fixed costs (Figure 5-1). Capital intensity is low in this industry, with capital charges being the smallest share of total cost.

Table 5–3 Costs and resource rents for whale watching fleets in PSC and PALM

<i>(in 2006 Mexican Pesos)</i>	<i>Puerto San Carlos</i>			<i>Puerto Adolfo Lopez Mateos</i>		
	<i>NPV</i>	<i>levelized</i>	<i>% of revenue</i>	<i>NPV</i>	<i>levelized</i>	<i>% of revenue</i>
Revenue	23,501,437	2,917,554		29,034,984	3,604,509	
Total Cost	11,293,168	1,401,975	48%	13,853,012	1,719,764	48%
<i>Operating costs</i>	5,869,191	728,623	25%	7,458,673	925,947	26%
<i>fuel</i>	3,781,550	469,455		4,945,968	614,011	
<i>labour</i>	2,087,641	259,167		2,512,705	311,936	
<i>Fixed costs</i>	3,622,939	449,765	15%	4,992,080	619,735	17%
<i>Capital charges</i>	1,801,038	223,587	8%	1,953,555	242,521	7%
Rent	12,208,269	1,515,579	52%	15,181,972	1,884,746	52%
<i>labour</i>	1,578,709	195,987	13 % of rent	837,583	103,981	6 % of rent
<i>operators</i>	7,211,244	895,230	59 % of rent	10,093,437	1,253,036	66 % of rent
<i>government</i>	3,418,315	424,362	28 % of rent	4,250,952	527,729	28 % of rent
Rent per permit	348,808	43,302		562,295	69,805	
Rent per operator	515,089	63,945		171,075	21,238	

Utilizing equation (4.1) and the amortization formula in equation (4.2), the levelized rent in PSC is equal to Pesos 1,516,579 (52% of revenue). In PALM annual rent amounts to Pesos 1,884,746 (52% of revenue), illustrating that rent in both communities amounts to the same proportion of revenue, with more rent accruing to PALM in absolute value terms (Figure 5-2). The reason for the latter can be found in complementarity effects that arise when the environmental good influences the quality of a related marketed good (Freeman 2003). Freeman (2003) states that the environment enhances the enjoyment consumers derive from purchasing a marketed good.⁴⁸ For example, an increase in the number of whales returning to a bay will increase the quantity demanded

⁴⁸ The environment is a weak complement rather than a complement because other factors such as the better knowledge of tour guides for example, could result in higher demand as well.

for whale-watching at a given price. Thus, higher rent in PALM is associated with the higher whale density and therefore higher quality of the whale watching experience in PALM.

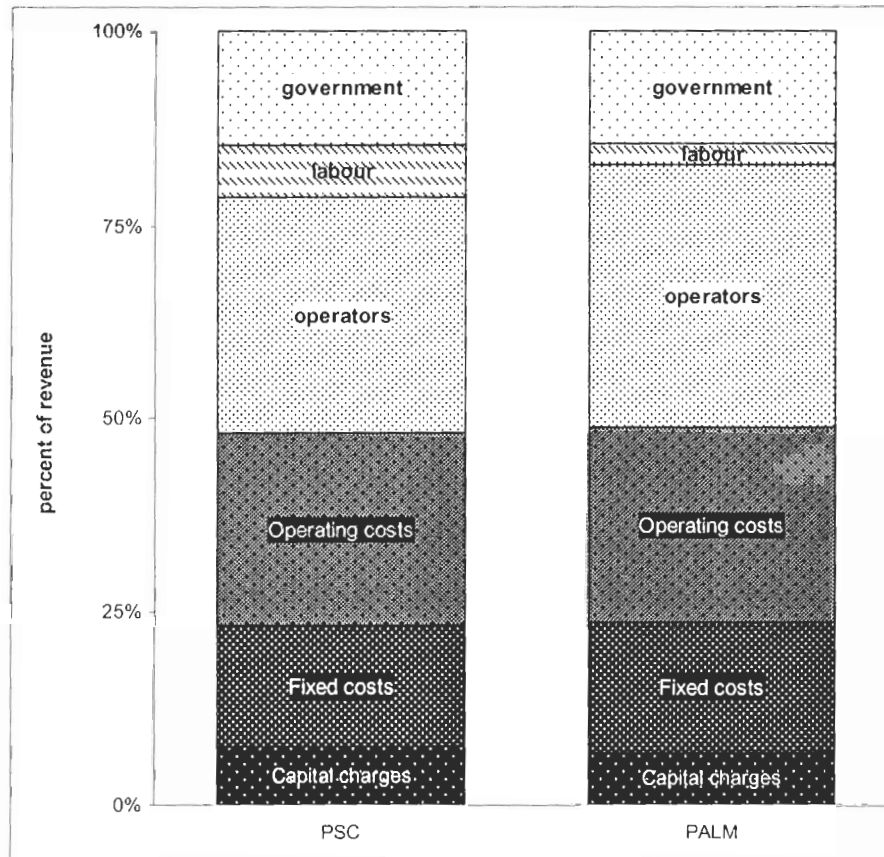


Figure 5-1 Cost structure and rent distribution as a percentage of revenue

The distribution of resource rent among stakeholders follows equation (4.11). Rent accruing to labour (equation (4.12)) is equal to Pesos 195,987 in PSC, and amounts to 13 percent of total rent generated. In contrast, the share of rent that goes to labour in PALM is much smaller in relative and absolute terms, equalling 6 percent of rent and Pesos 103,981, which is due to the lower pangero wage in PALM. The smaller labour share in PALM leaves operators with a much larger portion of rent (66 percent of rent), equalling Pesos 1,253,036, compared to PSC (59 percent of rent) and Pesos 895,230.

Using equation (4.14), rent accruing to government measures to Pesos 424,362 in PSC and Pesos 527,729 in PALM, where the proportion of total rent is equal to the tax rate of 28 percent (Table 5-3).^{49,50}

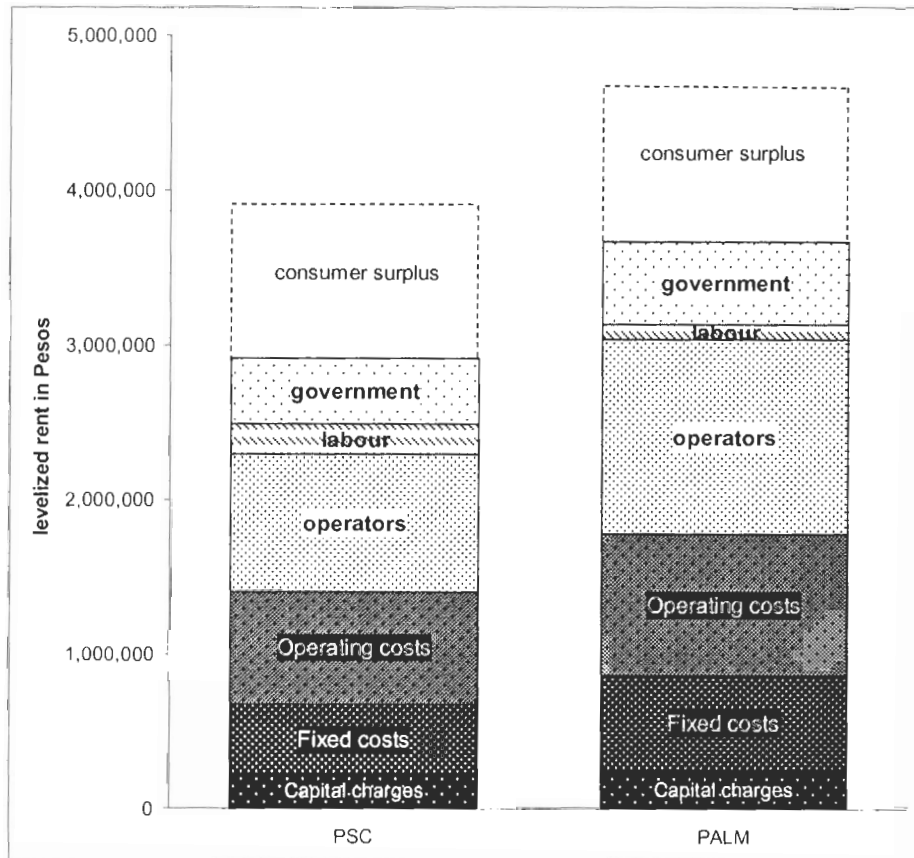


Figure 5-2 Annual levelized cost structure and rent distribution in Pesos

Interesting to note is the amount of rent generated by each permit and how it differs depending on location (Figure 5-3). In PSC, the higher number of permits and the lower amount of total rent generated results in Pesos 43,302 per permit annually. In

⁴⁹ Government share is equal to the additional tax collected by government over and above the opportunity cost of labour and capital (which includes 28% taxes that are considered “normal taxes”, payments for government services). Thus, the calculation of rent to government takes into account a *pre tax* opportunity cost of capital introduced in equation (4.1).

⁵⁰ I did not include lenders as beneficiaries as suggested by Curry and Weiss (2000, p. 277) because evidence shows that operators have difficulties financing through banks (García Martínez 2006; Young 1999).

PALM the rent per permit is equal to Pesos 69,805, which could indicate that a portion of rent is related to the restriction of permits and creates scarcity rent that is traceable to the whales visiting Bahia Magdalena.⁵¹

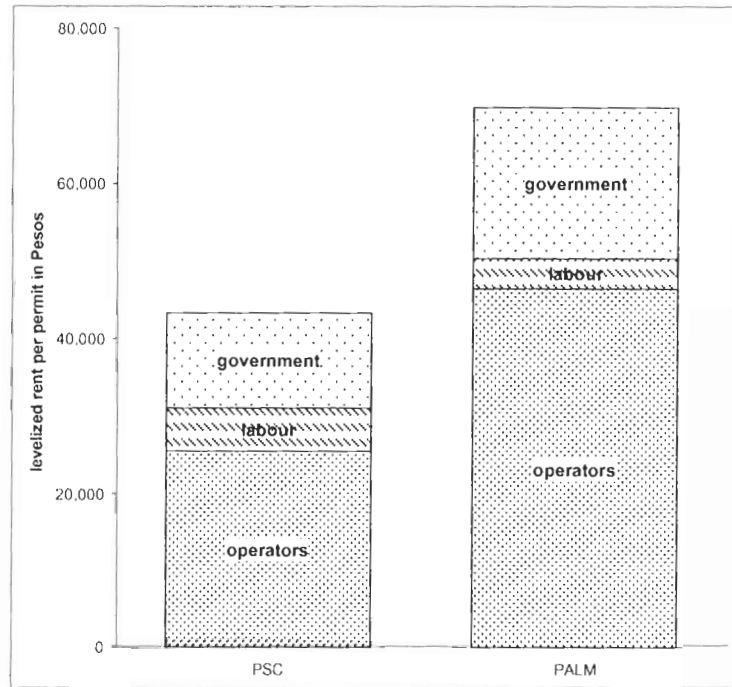


Figure 5-3 Annual rent per permit and location

Note, the resource values calculated above are equal to benefits from whale watching as they accrue in the two communities. This approach consequently ignores additional value gained by other interest groups not included in this study, and likely underestimates the total economic value of the resource. From the producer side, the approach excludes rents generated by whale watching businesses based in La Paz. On the consumer side, the framework fails to account for substantial consumer surplus arising from direct use value to subsistence hunters in the Siberian Arctic (IWC 2004), for

⁵¹ An additional interesting consideration arises when we investigate the rent accrued per operator. In this context, the per operator rent in PALM is smaller compared to PSC, Pesos 63,945 per operator in PSC versus Pesos 21,238 per operator in PALM (Table 5-3, Figure 5-3).

example. Also, there exist significant non-use value and existence value associated with the preservation of the whales for communities and whale observers world wide, as preceding research indicates. Thus, the dotted boxes in Figure 5-2 conceptually indicate additional value in form of consumer surplus occurring elsewhere. However, since the study's "accounting stance" is the communities of the Bahia Magdalena lagoon complex, I ignore values accruing elsewhere even though they are significant and would be required for the completion of the value picture (Whittington and Mac Rae 1986).⁵²

Another theoretic complexity surrounds the question whether the values estimated in this study can be associated with the whales directly and be considered a biodiversity value. Estimates of rent generated in the whale watching industry cannot fully be attributed to the whales. Instead, the rent generated is also due to locational advantages of PALM versus PSC, and due to the experience as a whole. In economic terms, the value of whales is different from the rent generated because the calculated rent does not account for species substitution or complementary effect. In order to explicitly take these effects into account and estimate the value of a whale, a marginal valuation exercise investigating how profitability of the industry changes when the number of whales changes, is required. Complementarity and substitution effects relate to the central question whether or not whale watchers travel to the breeding grounds to watch whales or to also watch other wildlife and enjoy the environment as a whole. Thus, it is essential to estimate how much the additional whale contributes to consumers' WTP.

In addition, Hoehn and Loomis (1993) caution that the aggregate value of a group of species (whales and dolphins for example), might be different from the sum of values

⁵² Consumer surplus in the community is likely to be small due to the mainly international and national clientele, and consequently omitted for the purpose of this study.

associated with individual species, thus adding to the complexity of estimating the value of biodiversity. The notion of biodiversity value extends beyond the market mechanism and therefore can have different meanings, depending on our perspective. Empirical literature fails to apply economic valuation to the entire range of ecosystem benefits. Available estimates provide a very incomplete perspective and at best offer a lower bound to the unknown value of biodiversity (Nunes and van den Bergh 2001). In order to emphasize the point of significant consumer surplus and the likely understated value of the resource, I conceptually added consumer surplus to Figure 5-2.

The application of the above calculated aggregate value for policy design and evaluation is limited because it does not account for the consequences of changes in whale abundance over time. Knowing the capitalized total value of the resource is simply not enough. Instead, information about how the flow of benefits changes when environmental conditions or policies change is much more applicable for developing effective conservation policies (Pagiola, von Ritter, and Bishop 2004). The latter context requires a marginal valuation exercise, calculating the marginal value of a whale to the community, and thus forms a possible extension to this study.

5.3 Sensitivity analysis

In this section I investigate how rent and its distribution changes under varying assumptions surrounding the minimum wage, the opportunity cost of capital, the price per boat hour, the growth in demand, and the elasticity in demand. Even though this approach does not account for the uncertainties by using a simulation, it outlines the possible

effects of changes in the base line assumptions. Due to their large size, sensitivity tables are placed in an Appendix.

The sensitivity of resource rents to minimum wage assumptions varies slightly in the two communities (Table 5–4). Increasing the opportunity cost of labour from Pesos 47 to Pesos 60, decreases annual resource rents in PSC by Pesos 71,684 and 4.7 percent and in PALM by Pesos 86,281 and 4.5 percent. The share of total resource rent that goes to labour is slightly more affected by minimum wage assumptions in PALM, where a minimum wage of Pesos 60 would decrease labour’s share by four percentage points, whereas in PSC the higher wage would dampen labour’s portion of total rent by three percent (Table 5–4). Labour share in PALM is more sensitive to minimum wage assumptions due to the already low wages that result in a much lower share of rents accruing to labour.

Table 5–4 Sensitivity of annual resource rents to minimum wage assumption

<i>PSC</i>	<i>min. wage</i>	<i>levelized rent</i>	<i>labour share</i>	<i>PALM</i>	<i>min. wage</i>	<i>levelized rent</i>	<i>labour share</i>
	47	\$1,515,579	13%		47	\$1,884,746	6%
	50	\$1,499,037	12%		50	\$1,864,835	5%
	55	\$1,471,466	11%		55	\$1,831,650	4%
	60	\$1,443,895	10%		60	\$1,798,465	2%

The sensitivity of rent to assumptions surrounding the discount rate are analyzed next. As expected, increasing the *pre tax* marginal opportunity cost of capital decreases the net present value of the resource, holding price constant (Appendix 1 A and Appendix 3 A). Taking the NPV of rent for PALM, Figure 5-4 demonstrates the rent decreasing effect of a rising opportunity cost of capital, where the bold curve for PALM represents NPV for PALM at a discount rate of 12 percent, whereas the dashed lines exemplify NPV for PALM at discount rates of 8 and 10 percent, respectively. For comparison, rent

accrued in PSC at 12 percent discount is shown by the lower bold curve in Figure 5-4. The higher the discount rate the lower the NPV trajectory.

Besides the effect the opportunity cost of capital has on rent, Figure 5-4 also shows the effect of a downward sloping demand curve. A price increase decreases the amount of whale watching trips demanded, however, depending on the elasticity of demand, a price increase does not necessarily cause an initial decline in net social returns. Increases in the price per whale watching hour will cause rent to first rise to a maximum and then decline as the additional price increase restricts demand beyond the optimal price that is maximizing rent. Beyond the optimal price, marginal net gains from marginal increases in price will be smaller than the marginal losses from a restriction in demand caused by the rise in price. Thus Figure 5-4 shows rent following a parabolic trajectory across the price-axis.

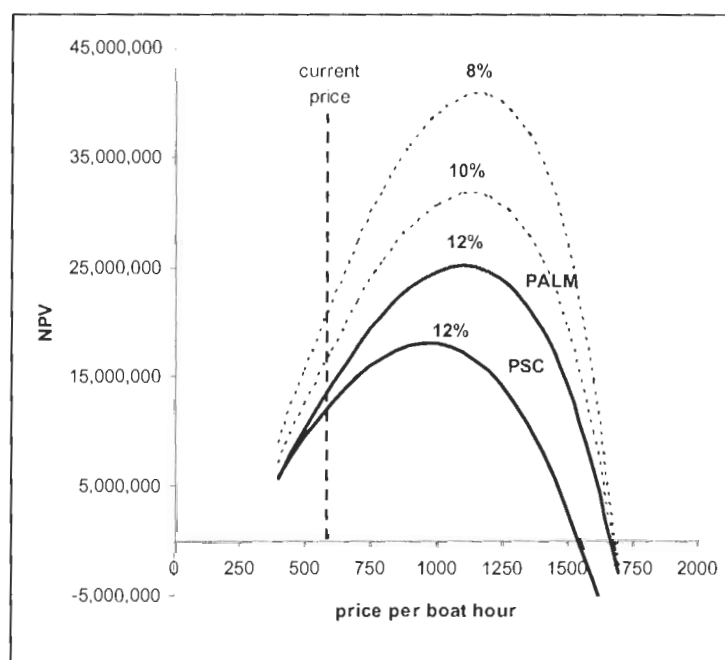


Figure 5-4 Sensitivity of NPV to changes in price and discount rate

Also, the opportunity cost of capital assumptions affect the optimal price at which rent is maximized in each community. Assuming a discount rate of 18 percent, rent in PSC is maximized at approximately Pesos 900 per boat hour, whereas at 2 percent, rent is maximized at Pesos 1100 per boat hour. Even at a marginal borrowing rate of 45%, rent is maximized at Pesos 900 per boat hour in PSC and Pesos 1000 in PALM (Appendix 1). For PALM the respective discount scenarios relate to optimal prices of Pesos 1000 and Pesos 1300. While this result shows that the optimal price is higher in PALM than in PSC, it also suggests that resource rent is more sensitive to discount assumptions in PALM (Appendix 3 A). Again, these results assume that the demand elasticity is equal to that found in Monterey Bay.

The sensitivity of resource rents to assumptions surrounding the elasticity of demand show that the more elastic demand the lower the optimal price per boat hour that maximizes rent. Larson and Shaikh's (2003) analysis of elasticities in three whale watching destinations off the Pacific coast in California reveal, that Monterey Bay has the most elastic demand (-0.5571), while the two other study sites (Point Reyes and Half Moon Bay) show considerable more inelastic demand (-0.1193 and -0.1009 respectively). I use the elasticity of demand for Monterey Bay as the base line assumption. Calculations outlined in Appendix 4 and Appendix 5 show that elasticities between minus 1 and minus 0.6 are associated with optimal prices ranging between Pesos 700 and Pesos 900 for PSC and Pesos 800 to Pesos 1100 for PALM. Thus, the recommended optimal price per boat hour of Pesos 900 in PSC and Pesos 1000 in PALM is justified. Figure 5-5 supports this result for PSC. It is interesting to note that the current price of Pesos 600 is not sensitive

to changes in elasticity and becomes the optimal price once the elasticity exceeds minus 0.8.

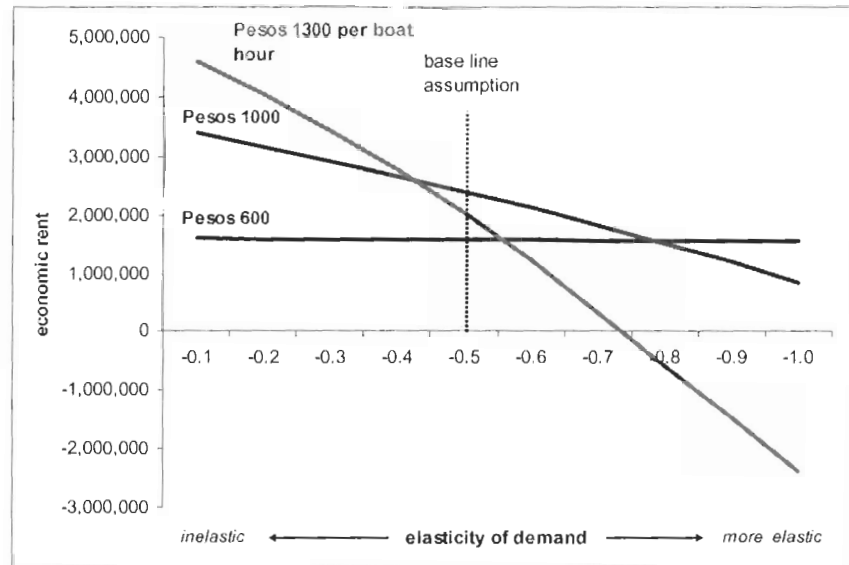


Figure 5-5 Sensitivity of economic rent to elasticity of demand in PSC

In summary, rent calculations in both communities are highly sensitive to assumptions surrounding the opportunity cost of capital and elasticity of demand. In addition, the analysis shows that both communities currently charge less than the optimal price for whale watching trips assuming the demand observed by Larson and Shaikh (2003) in Monterey Bay is comparable to demand in the Bahia Magdalena region.

I now investigate how the growth in demand alters resource rents and its distribution and how this differs with changes in the price per boat hour. For PSC, Figure 5-6 illustrates that increasing annual growth will increase resource rents to the community. But this increase will differ depending on the price charged per boat hour. For a price of Pesos 1000, rent is maximized throughout the assumed range of growth assumptions. For growth rates between 1 percent and 10 percent, a price of Pesos 600 is

superior to a price of Pesos 1300. For growth beyond 10 percent, the higher price of Pesos 1300 will increase rent more than a price per boat hour of Pesos 600.

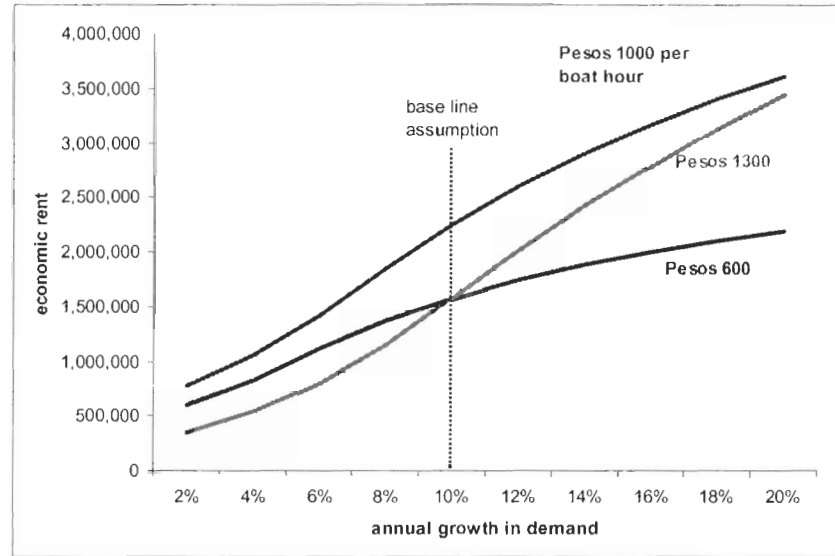


Figure 5-6 Sensitivity of rent to annual growth in demand in PSC

Appendix 1 B and Appendix 3 B show the effect of higher annual growth in demand on rent, where increasing growth raises rent and the optimal price per boat hour that maximizes rent for each growth scenario (shown in bold frames). As we might expect, the effect of growth on rent counteracts to the effect of the *pre tax* marginal opportunity cost of capital. Recommending a more efficient pricing policy requires both factors to be taken into account. For each community, I investigate the price under which resource rents are maximized depending on varying discount rates (Appendix 1 A and Appendix 3 A) and growth assumptions (Appendix 1 B and Appendix 3 B). In this context, I observe the maximum NPVs between an hourly boat price of Pesos 900 and Pesos 1100 in PSC, and Pesos 900 and Pesos 1300 in PALM. For the base-line scenario, a price increase to Pesos 1000 per boat hour would increase annual resource rents in PSC

by Pesos 671,958 or 43 percent of current resource rents and in PALM by Pesos 1,342,743 or 75 percent.

However, changes in the discount rate and changes in price affect stakeholders differently. Taking the case of PSC as an example calculations from Appendix 2 A, B, and C are visualized in Figure 5-7 which demonstrates that operators (dotted parabola) will benefit or gain the most, followed by government (solid parabola) and workers (line). Recall, for price increases up to the optimal price per boat hour business owners and government will gain the most, whereas workers will lose. For prices beyond the optimal price per boat hour, operators will lose most, followed by government, and workers who will lose the least. Figure 5-7 shows the above described effects to each stakeholder group, keeping other assumptions constant. Note that price increases will always lower rent accruing to labour (Figure 5-7, Appendix 2).⁵³

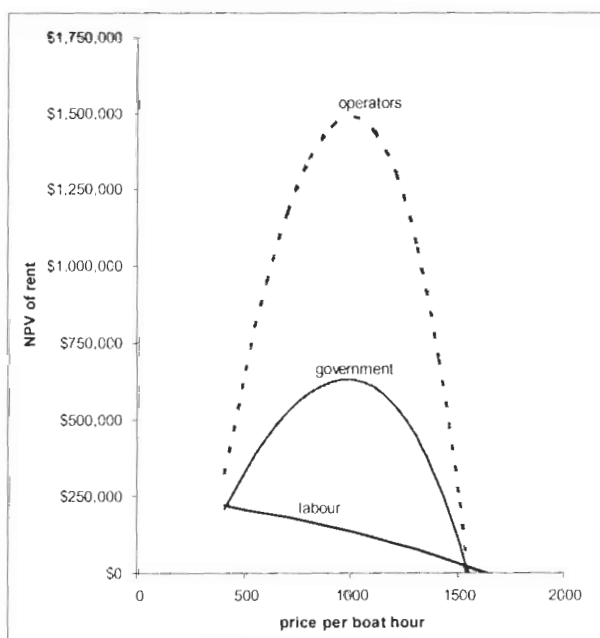


Figure 5-7 Resource rents accrued by different stakeholders

⁵³ Rent accruing to operators is most sensitive to changes in price per boat hour (curve is steepest compared to other), followed by government (curve is less steep), and workers (flattest trajectory).

Rent accruing to operators and labour as a share of total rent varies depending on discount and growth assumptions. In the case of PSC, rent accrued by operators decreases with an increasing marginal cost of capital and increases with rising growth in demand (Appendix 6). For PALM the above described effect seems to be weaker (Appendix 7).

5.4 Capacity considerations

During interviews with operators in PSC and PALM, many respondents identified that they would like more permits for the industry. While section 3.4 of this study supports the claim that an increase in permits could have a negative effect on gray whales, this section will investigate whether or not the request for more permits would be beneficial. Other options for maximizing rent may be more economically and environmentally sound than an increase in permits. Often, producers forget that more permits also mean more capital and ultimately higher costs, which could jeopardize profitability (Gunton and Richards 1987). The call for more permits was especially strong in PSC, where the industry already owns more permits (35) than in PALM (27). In the following section I calculate the remaining years for which the whale watching industry in each community has excess capacity. The model used for the calculation assumes a fixed number of permits, constant demand throughout each season but increasing demand over the projected 30 year time horizon. The assumption of constant seasonal demand is somewhat arbitrary since there is peak demand namely on weekends. Consequently, this approach inflates the results causing the calculations to overstate the number of years remaining until capacity is reached. However, the analysis still provides insight, should operators decide to implement peak-pricing, in which case peak-demand could be re-allocated to weekdays when the fleet has unused excess capacity.

Figure 5-8 summarizes the calculations outlined in Appendix 8 and Appendix 9 for three price scenarios in PSC and the current price scenario in PALM. The graph shows the estimated time in years from now, when operators are expected to hit full capacity depending on varying annual growth rates in demand. Capacity is reached earlier the higher the growth in demand and the lower the price per boat hour. Raising the price will result in capacity being reached later due to dampened demand. Under baseline assumptions (current price of Pesos 600 and 10 percent growth), operators in PSC will be operating at full capacity in 16 years. This result means that whale watching is not operating at full capacity right now and suggests that a call for more permits is not justified. On the other hand, operations in PALM are much closer to full capacity, as the black dotted line in Figure 5-8 shows. Industry in PALM will reach the capacity limit in an estimated time of eight years from now. However, since this result ignores peak demand it could be that PALM already operates at full capacity, particularly on weekends. Respondents in PALM raised concerns about not having enough capacity on weekends already. However, in case PALM decides to raise the price per boat hour to Pesos 1,100, this would lengthen the time under which the industry could operate at the current capacity to 14 years from now.

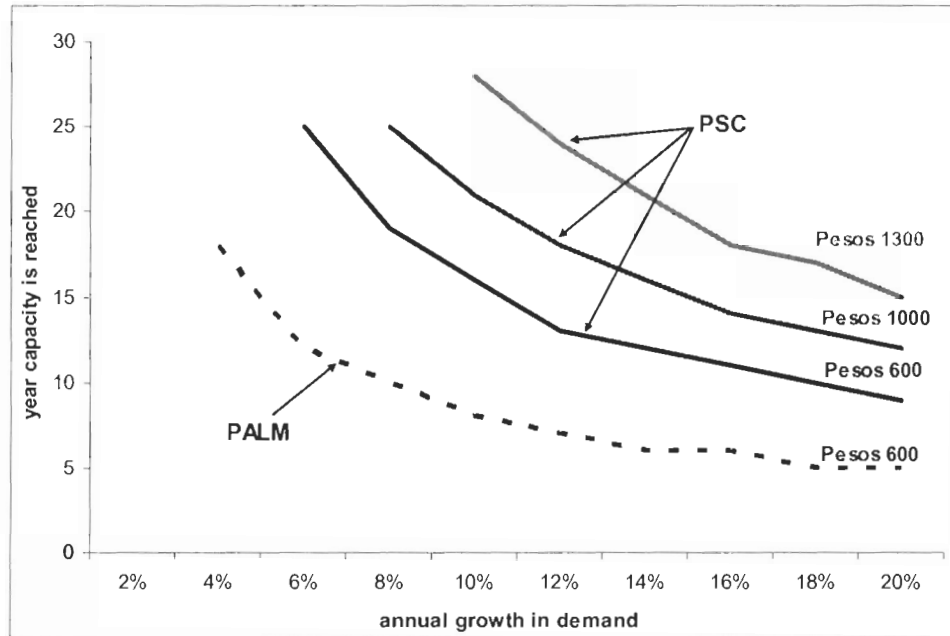


Figure 5-8 Industry capacity under varying growth assumptions

Interviewees in PALM also consider buying larger boats to accommodate peak demand. Should the whale watching industry in PALM decide to buy larger boats, one result could be decreased rents in the short run due to high capital investment and operating costs as well as unused excess capacity in off-peak periods. As Gunton (1987) indicates, “a way to reduce costs of production is to prevent over capacity and therefore rent dissipation.”

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

Unlike any of the preceding economic studies the approach taken in this project estimates the net benefits from whale watching to local communities. Thus, the analysis fills an important gap for completing the “value picture” of the eastern North Pacific stock of gray whales and provides information to the whale watching industry for efficient decision making at the local level. The main objective of this study was to assess the cost and revenue structure of the whale watching industry in the Bahia Magdalena lagoon complex in order to estimate the amount of economic rent generated by the whales in the lagoon. In addition, it offers alternative strategies for maximizing this rent and considering distributional income effects and uncertainty surrounding parameter assumptions of growth and opportunity costs. Finally, depending on growth assumptions associated with demand I tried to answer how long the current capacity of the industry will be sufficient for serving an increasing number of visitors. I also suggested strategies for managing peak demand.

The findings of this study indicate that both communities have a similar cost structure in relation to revenues and in absolute terms PALM generates 25 percent more revenue than PSC. Differences in costs arise from the higher amount of capital used in PALM. Also, fuel consumption in PALM is somewhat higher on a per hourly basis due to the use of less efficient engines. However, transportation costs in PSC are much higher due to the lack of docking facilities, such as those that exist in PALM. Finally, PSC shows significantly higher advertising expenses that could be reduced through better cooperation among operators.

Annual net benefits differ in both communities, where economic rent amounts to Pesos 1,515,579 in PSC and Pesos 1,884,746 in PALM which is equal to 52 percent of total revenue. However, the distribution of rent is different among stakeholders in the two communities, particularly with respect to workers. The benefits labour receives in PSC are double the amount of rent accrued by workers in PALM. The relative share of rent to labour in PSC amounts to 16 percent and only 6 percent in PALM. Since the government's share is equal to the income tax rate of 28 percent, consequently, the relative share to operators is smaller (59 percent) in PSC than it is in PALM (66 percent). However, considering the large number of permit holders in PALM, rent to operators on a per operator basis is much smaller in PALM.

Optimal rent accumulation is not realized at current price levels. Accounting for the effects of varying assumptions associated with capital costs, growth, and demand elasticities, rent is maximized at about Pesos 1000 per boat hour in PALM and Pesos 900 in PSC. However, increasing the price to Pesos 1000 in PALM and Pesos 900 in PSC will decrease the rent accruing to labour by 22 percent and possibly lead to a loss in jobs. Although this study assumes that demand in the Bahia Magdalena region is comparable to demand in Monterey Bay, the result is stable for inelastic demand smaller than minus 0.8. Thus, the results show that due to the currently lower than optimal price charged, some of the rent that *could* be generated goes to consumers instead of being collected by the community.

Also, capacity considerations indicate that at the current price, the PALM fleet is closer to reaching its capacity than whale watching operations in PSC. In sum, whale watching has significant positive impact on the welfare of PSC and PALM and can

further be maximized if the following strategies are implemented. Resource rents in both communities are below the maximum possible. One solution, advocated by the operators, is to increase the number of permits in PSC or to invest in larger boats in PALM. However, this study shows that operators should instead raise the price to maximize rents and to dampen peak demand. Raising the price on weekends could provide a good strategy for dealing with limited weekend capacity and in addition could raise net social returns. Another option for the whale watching industry is to charge different visitor groups differently according to their average income. This would mean that Mexicans would be charged less than visitors originating from the United States and Canada for example. A two-tier pricing system is common in many protected areas in developing countries and allows operators to extract more rent (Alpizar 2006).⁵⁴

Additional suggestions for PSC relate to advertising expenses which form a large part of fixed costs in PSC. PSC would benefit if operators would share advertising costs and decide on a common marketing strategy. For example, PSC could focus their advertising on offering whale watching trips with a wilderness experience that is very different from the somewhat crowded setting in PALM. This strategy is already being used by eco-tourism businesses based in La Paz that operate in Bahia Magdalena and take advantage of the unique wilderness setting Bahia Magdalena offers. These companies operate nature camps that offer packaged tours including whale watching, kayaking, camping, and natural history tours. This product differentiation strategy could justify even higher prices and attract a very different clientele; wealthy international nature enthusiasts.

⁵⁴ A two-tier pricing system would have to account for different elasticities of demand associated with different visitor groups. For example, Mexican low income families might be more price sensitive than affluent singles originating from the United States.

My project has indicated that whale watching in the Bahia Magdalena lagoon complex has significant value to local communities. Such information can help government to formulate and implement more effective policies focusing on a multi-objective approach to the management of marine resources. For the communities of PSC and PALM, the results presented herein could enable them to make better and more informed decisions to increase the profitability of their enterprises and to improve the wellbeing of their communities. Moreover, the results can contribute to a more sustainable future in which upcoming generations can continue to enjoy the natural wonders surrounding Bahia Magdalena.

APPENDICES

Appendix 1 Sensitivity analysis showing NPV of resource rents in PSC

discount	price per boat hour													
	\$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00
2%	\$27,337,609	\$41,751,313	\$54,897,586	\$66,536,731	\$76,376,189	\$84,063,287	\$89,010,302	\$90,525,306	\$87,366,540	\$77,710,010	\$57,799,952	\$29,375,884	(\$4,088,105)	(\$4,592,015)
4%	\$19,382,210	\$29,743,883	\$39,047,306	\$47,116,350	\$53,741,869	\$58,678,804	\$61,529,905	\$61,847,338	\$58,855,363	\$51,478,989	\$37,624,772	\$18,397,416	(\$4,239,175)	(\$30,285,002)
6%	\$14,059,089	\$21,722,200	\$28,492,964	\$34,241,247	\$38,816,673	\$42,047,957	\$43,664,888	\$43,375,928	\$40,693,320	\$34,980,037	\$25,061,701	\$11,641,213	(\$4,158,885)	(\$22,338,593)
8%	\$10,413,980	\$16,236,338	\$21,299,632	\$25,506,602	\$28,748,532	\$30,905,033	\$31,791,193	\$31,216,206	\$28,871,565	\$24,378,040	\$17,073,284	\$7,405,888	(\$3,975,651)	(\$17,071,332)
10%	\$7,859,621	\$12,398,456	\$16,284,614	\$19,445,933	\$21,803,402	\$23,271,953	\$23,035,021	\$21,007,856	\$17,416,261	\$12,743,945	\$8,442,882	\$2,943,629	(\$3,756,318)	(\$13,486,065)
12%	\$6,031,680	\$9,654,101	\$12,710,810	\$15,147,667	\$16,906,962	\$17,928,280	\$18,123,566	\$17,409,895	\$15,661,921	\$12,743,945	\$8,442,882	\$2,943,629	(\$3,530,707)	(\$10,980,124)
14%	\$4,696,079	\$7,650,248	\$10,109,948	\$12,034,370	\$13,381,157	\$14,107,198	\$14,151,238	\$13,458,308	\$11,947,939	\$9,538,779	\$6,109,636	\$1,780,033	(\$3,317,260)	(\$9,182,242)
16%	\$3,701,064	\$6,157,804	\$8,178,887	\$9,733,413	\$10,790,152	\$11,318,197	\$11,274,737	\$10,623,196	\$9,311,739	\$7,291,617	\$4,493,943	\$996,367	(\$3,121,371)	(\$7,859,270)
18%	\$2,946,140	\$5,025,310	\$6,717,738	\$7,999,924	\$8,848,740	\$9,241,933	\$9,149,443	\$8,546,869	\$7,400,717	\$5,681,848	\$3,351,229	\$458,566	(\$2,844,824)	(\$6,861,940)
20%	\$2,363,537	\$4,150,805	\$5,592,309	\$6,670,103	\$7,366,985	\$7,666,869	\$7,548,557	\$6,995,735	\$5,986,711	\$4,504,157	\$2,526,097	\$85,815	(\$2,787,158)	(\$5,062,821)
45%	\$26,210	\$608,034	\$1,058,070	\$1,375,485	\$1,559,711	\$1,610,393	\$1,527,186	\$1,310,026	\$958,868	\$473,818	(\$145,017)	(\$897,370)	(\$1,783,124)	(\$2,802,279)

growth	price per boat hour													
	\$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00
2%	\$1,429,441	\$3,342,639	\$4,817,052	\$5,852,680	\$6,449,522	\$6,607,579	\$6,326,851	\$5,607,337	\$4,449,038	\$2,851,955	\$816,085	(\$1,658,569)	(\$4,572,009)	(\$7,924,233)
4%	\$2,706,968	\$4,976,800	\$6,726,054	\$7,954,730	\$8,662,828	\$8,850,348	\$8,517,290	\$7,663,654	\$6,289,440	\$4,394,648	\$1,979,278	(\$956,670)	(\$4,413,196)	(\$8,390,299)
6%	\$4,068,393	\$6,841,356	\$9,034,652	\$10,616,389	\$11,556,888	\$11,827,428	\$11,424,907	\$10,393,235	\$8,732,413	\$6,442,439	\$3,523,315	(\$24,960)	(\$4,202,385)	(\$9,008,951)
8%	\$5,165,006	\$8,398,154	\$11,049,818	\$13,079,645	\$14,432,632	\$15,068,594	\$14,919,924	\$13,927,199	\$12,021,742	\$9,200,963	\$5,603,245	\$1,230,122	(\$3,918,408)	(\$9,842,344)
10%	\$6,031,680	\$9,654,101	\$12,710,810	\$15,147,667	\$16,906,962	\$17,928,280	\$18,123,566	\$17,409,895	\$15,661,921	\$12,743,945	\$8,442,882	\$2,943,629	(\$3,530,707)	(\$10,980,124)
12%	\$6,722,625	\$10,671,111	\$14,071,883	\$16,869,394	\$19,004,978	\$20,403,260	\$20,947,911	\$20,551,207	\$19,048,958	\$16,257,668	\$11,843,409	\$5,310,966	(\$2,995,058)	(\$12,552,053)
14%	\$7,290,683	\$11,490,439	\$15,165,875	\$18,313,560	\$20,784,563	\$22,518,903	\$23,417,698	\$23,331,318	\$22,138,518	\$19,532,006	\$15,145,117	\$8,262,758	(\$2,247,435)	(\$14,746,119)
16%	\$7,751,246	\$12,175,435	\$16,134,205	\$19,514,776	\$22,268,281	\$24,315,178	\$25,535,069	\$25,785,358	\$24,900,348	\$22,523,398	\$18,260,007	\$11,206,448	(\$1,194,945)	(\$17,834,645)
18%	\$8,140,222	\$12,751,605	\$16,922,246	\$20,543,228	\$23,554,755	\$25,891,236	\$27,417,292	\$27,964,940	\$27,332,973	\$25,266,099	\$21,163,725	\$14,053,942	\$296,998	(\$2,213,224)
20%	\$8,452,251	\$13,258,633	\$17,563,308	\$21,451,147	\$24,667,161	\$27,250,157	\$28,057,269	\$28,901,448	\$28,543,049	\$27,716,773	\$23,846,059	\$16,778,341	\$2,216,900	(\$28,453,316)

Note: Bold numbers mark base line scenario. Bolded frames indicate maximum NPVs for each scenario.

Appendix 2 Sensitivity analysis showing levelized resource rents accruing to different stakeholders in PSC

A		Operators													
discount	price per boat hour	\$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00
		\$596,346	\$1,068,428	\$1,500,798	\$1,885,947	\$2,214,686	\$2,475,918	\$2,661,357	\$2,719,304	\$2,641,085	\$2,359,759	\$1,758,428	\$868,642	(\$143,167)	(\$1,337,000)
2%	\$538,538	\$979,624	\$1,377,664	\$1,725,493	\$2,014,581	\$2,234,916	\$2,370,464	\$2,402,988	\$2,301,150	\$2,021,402	\$1,479,239	\$717,197	(\$186,796)	(\$1,232,745)	
4%	\$460,664	\$891,954	\$1,257,543	\$1,570,764	\$1,823,893	\$2,008,114	\$2,109,701	\$2,113,702	\$1,995,320	\$1,722,067	\$1,234,299	\$566,104	(\$226,561)	(\$1,143,697)	
6%	\$424,379	\$807,899	\$1,143,751	\$1,425,861	\$1,647,384	\$1,800,723	\$1,874,371	\$1,856,329	\$1,727,383	\$1,463,828	\$1,024,460	\$435,939	(\$262,212)	(\$1,069,991)	
10%	\$370,858	\$729,138	\$1,038,411	\$1,293,251	\$1,487,697	\$1,615,322	\$1,666,647	\$1,497,416	\$1,245,276	\$847,874	\$325,642	(\$293,871)	(\$1,010,865)		
12%	\$320,795	\$656,570	\$942,544	\$1,173,938	\$1,345,644	\$1,452,303	\$1,486,221	\$1,440,068	\$1,302,879	\$1,062,730	\$701,011	\$233,132	(\$321,904)	(\$964,095)	
14%	\$274,478	\$590,466	\$856,299	\$1,067,820	\$1,220,705	\$1,310,539	\$1,331,152	\$1,276,932	\$1,139,763	\$911,389	\$579,600	\$155,868	(\$346,795)	(\$928,391)	
16%	\$231,896	\$530,656	\$779,243	\$974,080	\$1,111,540	\$1,188,024	\$1,198,631	\$1,139,110	\$1,003,517	\$786,216	\$479,314	\$91,270	(\$369,059)	(\$901,672)	
18%	\$192,859	\$476,702	\$710,606	\$891,514	\$1,016,408	\$1,082,377	\$1,085,557	\$1,022,758	\$889,664	\$682,483	\$396,185	\$36,960	(\$399,180)	(\$882,236)	
20%	\$157,061	\$428,032	\$649,469	\$818,778	\$933,463	\$991,183	\$988,911	\$924,271	\$794,154	\$596,044	\$326,786	(\$9,113)	(\$407,584)	(\$868,625)	

B		Labour													
discount	price per boat hour	\$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00
		\$282,502	\$273,791	\$264,046	\$253,072	\$240,651	\$226,544	\$210,141	\$190,899	\$167,570	\$138,458	\$99,721	\$55,732	\$11,743	(\$32,246)
2%	\$268,492	\$258,842	\$248,175	\$236,322	\$223,105	\$208,332	\$191,498	\$172,191	\$149,450	\$122,063	\$87,369	\$48,829	\$10,289	(\$28,251)	
4%	\$254,728	\$244,274	\$232,844	\$220,300	\$206,499	\$191,297	\$174,288	\$155,171	\$133,234	\$107,641	\$76,609	\$42,815	\$9,021	(\$24,772)	
6%	\$241,617	\$230,508	\$218,483	\$205,433	\$191,250	\$175,831	\$158,859	\$140,126	\$119,119	\$95,288	\$67,474	\$37,710	\$7,946	(\$21,818)	
10%	\$229,436	\$217,820	\$205,359	\$191,972	\$177,583	\$162,122	\$145,348	\$127,128	\$107,102	\$84,926	\$59,674	\$33,462	\$7,051	(\$19,361)	
12%	\$218,337	\$206,347	\$193,592	\$180,073	\$165,558	\$150,189	\$133,724	\$116,089	\$97,037	\$76,368	\$53,643	\$29,980	\$6,317	(\$17,346)	
14%	\$208,364	\$196,117	\$183,186	\$169,530	\$155,119	\$139,935	\$123,850	\$106,824	\$88,700	\$69,369	\$48,581	\$27,151	\$5,721	(\$15,709)	
16%	\$199,490	\$187,083	\$174,069	\$160,424	\$146,135	\$131,199	\$115,526	\$99,105	\$81,838	\$63,678	\$44,489	\$24,864	\$5,239	(\$14,386)	
18%	\$191,643	\$179,152	\$166,128	\$152,559	\$138,443	\$123,790	\$108,539	\$92,697	\$76,206	\$59,056	\$41,185	\$23,018	\$4,850	(\$13,318)	
20%	\$184,728	\$172,212	\$159,231	\$145,781	\$131,871	\$117,517	\$102,680	\$87,377	\$71,580	\$55,298	\$36,511	\$21,523	\$4,535	(\$12,453)	

C		Government													
discount	price per boat hour	\$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00
		\$341,774	\$521,974	\$686,328	\$831,841	\$954,853	\$1,050,957	\$1,112,605	\$1,131,745	\$1,092,255	\$971,529	\$722,614	\$367,257	(\$51,109)	(\$532,484)
2%	\$313,845	\$481,626	\$632,271	\$762,928	\$870,211	\$950,152	\$996,319	\$1,001,459	\$953,071	\$833,570	\$609,236	\$297,899	(\$68,643)	(\$490,388)	
4%	\$285,986	\$441,866	\$579,595	\$696,525	\$789,597	\$855,327	\$888,218	\$882,340	\$827,771	\$711,553	\$509,797	\$236,802	(\$84,599)	(\$454,405)	
6%	\$258,998	\$403,825	\$529,758	\$634,392	\$715,024	\$768,660	\$790,700	\$776,400	\$718,084	\$606,323	\$424,641	\$184,197	(\$98,881)	(\$424,493)	
10%	\$233,448	\$368,261	\$483,689	\$577,587	\$647,609	\$691,228	\$704,664	\$684,191	\$623,979	\$517,301	\$353,013	\$139,652	(\$111,541)	(\$400,566)	
12%	\$209,663	\$335,579	\$441,831	\$526,536	\$587,690	\$623,191	\$629,979	\$605,172	\$544,412	\$442,982	\$293,476	\$102,321	(\$122,728)	(\$381,672)	
14%	\$187,772	\$305,894	\$404,244	\$481,192	\$535,043	\$564,073	\$565,834	\$538,127	\$477,736	\$381,406	\$244,292	\$71,174	(\$132,540)	(\$367,150)	
16%	\$167,762	\$279,121	\$370,733	\$441,196	\$489,096	\$513,031	\$511,061	\$481,528	\$422,082	\$330,514	\$203,701	\$45,163	(\$141,485)	(\$356,245)	
18%	\$149,528	\$255,055	\$340,952	\$406,028	\$449,109	\$469,065	\$464,371	\$433,788	\$375,616	\$288,377	\$170,088	\$23,325	(\$149,462)	(\$348,271)	
20%	\$132,918	\$233,428	\$314,494	\$375,106	\$414,296	\$431,161	\$424,508	\$393,419	\$336,674	\$253,300	\$142,060	\$4,826	(\$156,741)	(\$342,641)	

Appendix 3 Sensitivity analysis showing NPV of resource rents in PALM

discount	price per boat hour \$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00	\$1,800.00
2%	\$20,217,430	\$34,557,627	\$48,245,404	\$61,113,793	\$72,956,054	\$83,520,179	\$92,390,536	\$99,165,263	\$103,112,042	\$103,261,602	\$97,822,207	\$83,990,190	\$52,519,336	\$1,959,969	(\$55,782,022)
4%	\$15,067,819	\$25,861,705	\$36,058,414	\$45,515,585	\$54,061,098	\$61,490,521	\$67,475,438	\$71,712,124	\$73,660,554	\$72,639,126	\$67,441,638	\$56,050,314	\$33,790,926	(\$409,771)	(\$39,469,127)
6%	\$11,522,103	\$19,885,688	\$27,700,884	\$34,845,985	\$41,177,159	\$46,528,126	\$50,638,424	\$53,277,890	\$54,046,800	\$52,464,350	\$47,715,464	\$38,525,415	\$22,167,662	(\$1,704,058)	(\$28,967,069)
8%	\$9,014,485	\$15,667,637	\$21,815,636	\$27,354,085	\$32,162,537	\$36,105,330	\$38,975,097	\$40,597,068	\$40,674,353	\$38,866,924	\$34,622,299	\$27,133,669	\$14,806,608	(\$2,389,292)	(\$22,028,095)
10%	\$7,194,883	\$12,613,100	\$17,564,599	\$21,959,612	\$25,697,009	\$28,665,602	\$30,698,963	\$31,667,114	\$31,345,803	\$29,495,111	\$25,739,664	\$19,568,563	\$10,048,867	(\$2,728,548)	(\$17,321,163)
12%	\$5,842,052	\$10,346,827	\$14,419,162	\$17,981,666	\$20,949,160	\$23,230,364	\$24,692,844	\$25,235,207	\$24,692,200	\$22,892,885	\$19,581,824	\$14,435,881	\$6,910,155	(\$2,871,653)	(\$14,043,094)
14%	\$4,813,190	\$8,626,890	\$12,038,812	\$14,982,071	\$17,384,730	\$19,171,660	\$20,236,523	\$20,501,961	\$19,844,217	\$18,141,958	\$15,221,252	\$10,878,390	\$4,796,683	(\$2,904,609)	(\$11,699,968)
16%	\$4,014,184	\$7,294,024	\$10,199,596	\$12,672,950	\$14,653,186	\$16,078,311	\$16,862,711	\$16,947,332	\$16,239,307	\$14,652,544	\$12,068,667	\$8,360,029	\$3,344,264	(\$2,877,057)	(\$9,982,198)
18%	\$3,381,730	\$6,241,213	\$8,751,180	\$10,861,305	\$12,519,905	\$13,675,708	\$14,259,610	\$14,226,529	\$13,506,662	\$12,039,014	\$9,743,162	\$6,539,899	\$2,325,824	(\$2,617,729)	(\$8,681,991)
20%	\$2,872,385	\$5,395,099	\$7,590,628	\$9,415,168	\$10,824,756	\$11,776,894	\$12,215,670	\$12,106,690	\$11,397,424	\$10,044,777	\$7,994,295	\$5,197,570	\$1,587,439	(\$2,743,218)	(\$7,700,522)
45%	\$414,475	\$1,348,852	\$2,114,222	\$2,701,485	\$3,103,808	\$3,316,530	\$3,335,128	\$3,159,130	\$2,767,357	\$2,220,222	\$1,458,324	(\$502,979)	(\$644,523)	(\$1,982,772)	(\$3,511,138)

growth	price per boat hour \$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00	\$1,800.00
2%	\$3,617,093	\$6,738,447	\$9,217,308	\$11,088,842	\$12,295,043	\$12,895,910	\$12,871,445	\$12,221,647	\$10,946,515	\$9,046,051	\$6,520,254	\$3,369,123	(\$407,340)	(\$4,809,136)	(\$9,836,266)
4%	\$4,659,773	\$8,353,057	\$11,422,497	\$13,813,127	\$15,475,727	\$16,365,185	\$16,443,459	\$15,697,801	\$14,178,976	\$11,924,251	\$8,927,627	\$5,189,103	(\$708,690)	(\$4,513,643)	(\$10,477,866)
6%	\$5,239,175	\$9,311,766	\$12,838,650	\$15,730,218	\$17,928,075	\$19,344,247	\$19,907,249	\$19,544,750	\$18,170,652	\$15,708,925	\$12,123,206	\$7,604,969	(\$2,190,099)	(\$4,121,401)	(\$11,329,534)
8%	\$5,596,564	\$9,927,263	\$13,768,014	\$17,042,319	\$19,672,979	\$21,557,860	\$22,611,244	\$22,708,173	\$21,740,902	\$19,558,029	\$16,001,506	\$10,855,124	(\$4,185,679)	(\$3,593,023)	(\$12,476,793)
10%	\$5,842,052	\$10,346,827	\$14,419,162	\$17,981,666	\$20,949,160	\$23,230,364	\$24,692,844	\$25,235,207	\$24,692,200	\$22,892,885	\$19,581,824	\$14,435,881	\$6,910,155	(\$2,871,653)	(\$14,043,094)
12%	\$6,009,291	\$10,655,571	\$14,896,718	\$18,679,609	\$21,915,478	\$24,502,271	\$26,326,458	\$27,264,623	\$27,132,672	\$25,733,179	\$22,743,569	\$17,760,105	\$10,007,063	(\$1,875,025)	(\$16,207,057)
14%	\$6,132,919	\$10,882,482	\$15,274,421	\$19,218,812	\$22,670,198	\$25,523,154	\$27,652,458	\$28,914,658	\$29,149,393	\$28,131,612	\$25,508,845	\$20,787,351	\$12,990,266	(\$5483,951)	(\$19,227,474)
16%	\$6,238,756	\$11,059,382	\$15,553,839	\$19,670,983	\$23,271,860	\$26,332,095	\$28,722,826	\$30,287,733	\$30,842,827	\$30,177,968	\$27,899,761	\$23,496,160	\$15,785,696	\$1,424,134	(\$23,479,504)
18%	\$6,322,604	\$11,201,215	\$15,797,843	\$19,994,699	\$23,807,183	\$27,010,211	\$29,598,587	\$31,419,932	\$32,275,366	\$31,927,082	\$30,006,172	\$25,894,788	\$18,381,660	\$3,467,073	(\$29,506,910)
20%	\$6,375,808	\$11,346,360	\$15,970,358	\$20,329,868	\$24,174,150	\$27,589,071	\$30,389,509	\$32,394,351	\$33,504,677	\$33,458,978	\$31,850,878	\$28,059,878	\$20,766,063	\$5,504,352	(\$38,097,203)

Appendix 4 Sensitivity analysis showing levelized resource rents in PSC depending on elasticity of demand

elasticity	price per boat hour \$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00
-0.1	\$630,702	\$1,121,384	\$1,601,017	\$2,067,083	\$2,520,826	\$2,962,245	\$3,391,340	\$3,808,112	\$4,209,746	\$4,597,510	\$4,972,240	\$5,333,939	\$5,682,604	\$6,013,066
-0.2	\$656,987	\$1,138,254	\$1,595,974	\$2,026,754	\$2,432,868	\$2,811,878	\$3,162,326	\$3,496,288	\$3,777,182	\$4,040,648	\$4,289,043	\$4,467,719	\$4,628,729	\$4,757,651
-0.3	\$683,871	\$1,155,124	\$1,590,931	\$1,986,426	\$2,342,367	\$2,665,498	\$2,922,641	\$3,143,662	\$3,315,502	\$3,432,489	\$3,494,312	\$3,497,304	\$3,437,535	\$3,311,359
-0.4	\$709,235	\$1,171,993	\$1,585,888	\$1,946,097	\$2,249,369	\$2,492,561	\$2,671,169	\$2,780,351	\$2,815,014	\$2,766,740	\$2,633,249	\$2,401,749	\$2,063,078	\$1,603,453
-0.5	\$734,416	\$1,188,863	\$1,580,846	\$1,904,839	\$2,154,832	\$2,324,434	\$2,406,972	\$2,394,125	\$2,274,868	\$2,037,082	\$1,664,212	\$1,136,886	\$480,326	(\$284,877)
-0.6	\$759,598	\$1,205,733	\$1,575,803	\$1,862,190	\$1,957,387	\$1,968,883	\$1,835,125	\$1,535,174	\$1,035,454	\$322,682	(\$545,221)	(\$1,565,226)	(\$2,737,330)	(\$4,061,535)
-0.7	\$784,112	\$1,222,491	\$1,570,760	\$1,819,541	\$1,776,892	\$1,554,538	\$1,194,156	\$527,685	\$330,376	(\$578,014)	(\$1,660,233)	(\$2,916,281)	(\$4,346,158)	(\$5,949,865)
-0.8	\$807,659	\$1,238,292	\$1,565,718	\$1,776,892	\$1,854,538	\$1,779,941	\$1,524,742	\$1,053,459	(\$377,734)	(\$1,478,710)	(\$2,775,245)	(\$4,267,337)	(\$5,954,987)	(\$7,838,194)
-0.9	\$831,005	\$1,254,092	\$1,560,675	\$1,733,480	\$1,749,339	\$1,582,741	\$1,194,156	\$527,685	(\$9,567)	(\$2,379,407)	(\$3,890,256)	(\$5,618,392)	(\$7,563,815)	(\$9,726,524)
-1.0	\$854,452	\$1,269,893	\$1,555,632	\$1,688,552	\$1,641,696	\$1,376,799	\$840,859	(\$9,567)	(\$1,085,843)	(\$2,379,407)	(\$3,890,256)	(\$5,618,392)	(\$7,563,815)	(\$9,726,524)

Appendix 5 Sensitivity analysis showing levelized resource rents in PALM depending on elasticity of demand

elasticity	price per boat hour \$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00
-0.1	\$628,996	\$1,205,064	\$1,772,344	\$2,330,732	\$2,876,678	\$3,412,668	\$3,938,704	\$4,454,785	\$4,960,911	\$5,454,031	\$5,932,868	\$6,400,602	\$6,857,235	\$7,302,767
-0.2	\$652,266	\$1,223,029	\$1,776,217	\$2,309,200	\$2,819,272	\$3,309,433	\$3,773,581	\$4,212,411	\$4,627,832	\$5,009,296	\$5,366,305	\$5,686,957	\$5,978,236	\$6,230,940
-0.3	\$673,757	\$1,240,995	\$1,780,090	\$2,287,668	\$2,761,865	\$3,197,423	\$3,596,220	\$3,945,847	\$4,250,705	\$4,505,866	\$4,702,114	\$4,837,770	\$4,908,308	\$4,907,527
-0.4	\$693,880	\$1,258,960	\$1,783,963	\$2,266,136	\$2,701,277	\$3,082,298	\$3,400,899	\$3,653,108	\$3,831,202	\$3,927,030	\$3,928,148	\$3,825,820	\$3,606,858	\$3,254,560
-0.5	\$714,003	\$1,275,622	\$1,787,836	\$2,244,605	\$2,637,259	\$2,956,306	\$3,191,608	\$3,332,437	\$3,359,603	\$3,263,823	\$3,021,449	\$2,608,708	\$1,989,650	\$1,111,734
-0.6	\$732,512	\$1,291,156	\$1,791,709	\$2,223,073	\$2,573,242	\$2,826,206	\$2,966,646	\$2,976,070	\$2,830,797	\$2,501,632	\$1,945,421	\$1,101,670	(\$79,987)	(\$1,451,771)
-0.7	\$749,430	\$1,306,693	\$1,795,582	\$2,201,641	\$2,504,874	\$2,687,936	\$2,724,557	\$2,587,358	\$2,235,117	\$1,612,590	\$627,763	(\$10,781)	(\$2,266,091)	(\$4,038,166)
-0.8	\$766,348	\$1,322,229	\$1,799,455	\$2,179,803	\$2,434,364	\$2,540,723	\$2,464,125	\$2,156,916	\$1,554,384	\$548,163	(\$870,659)	(\$2,537,561)	(\$4,452,196)	(\$6,614,561)
-0.9	\$782,823	\$1,337,764	\$1,803,328	\$2,155,791	\$2,363,126	\$2,386,365	\$2,181,092	\$1,678,018	\$766,732	(\$652,519)	(\$2,369,081)	(\$4,364,341)	(\$6,638,299)	(\$9,190,956)
-1.0	\$796,479	\$1,353,300	\$1,807,201	\$2,131,780	\$2,206,238	\$2,223,579	\$1,876,184	\$1,143,346	(\$149,261)	(\$1,853,549)	(\$3,867,502)	(\$6,191,120)	(\$8,824,403)	(\$11,767,351)

Appendix 6 Share of rent to operators (A) and labour (B) under varying discount and growth assumptions in PSC

A - operators		B - labour													
discount	growth rate	discount						growth rate							
		2%	4%	6%	8%	10%	12%	14%	2%	4%	6%	8%	10%	12%	14%
2%	0.56	0.59	0.60	0.60	0.60	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
4%	0.55	0.58	0.60	0.60	0.60	0.60	0.60	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
6%	0.55	0.58	0.59	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
8%	0.54	0.57	0.59	0.59	0.59	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
10%	0.53	0.56	0.58	0.59	0.59	0.59	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
12%	0.52	0.56	0.57	0.58	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
14%	0.51	0.54	0.56	0.57	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
16%	0.50	0.53	0.55	0.57	0.57	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
18%	0.49	0.52	0.54	0.56	0.56	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
20%	0.49	0.52	0.54	0.56	0.56	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57

Note: Decimals illustrate the share of total rent accrued by stakeholder group, where total rent is equal to 1.

Appendix 7 Share of rent to operators (A) and labour (B) under varying discount and growth assumptions in PALM

A - operators		B - labour													
discount	growth rate	discount						growth rate							
		2%	4%	6%	8%	10%	12%	14%	2%	4%	6%	8%	10%	12%	14%
2%	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
4%	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
6%	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
8%	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
10%	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
12%	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
14%	0.65	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
16%	0.65	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
18%	0.65	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
20%	0.65	0.65	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66

Appendix 8 Estimated years in which capacity is reached in PSC

growth	price per boat hour																
	\$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00			
2%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6%	22	23	25	26	28	-	-	-	-	-	-	-	-	-	-	-	-
8%	17	18	19	20	22	24	25	28	30	-	-	-	-	-	-	-	-
10%	14	15	16	17	18	19	21	23	25	28	-	-	-	-	-	-	-
12%	12	13	13	14	15	16	18	19	21	24	27	-	-	-	-	-	-
14%	10	11	12	13	13	14	16	17	18	21	23	28	-	-	-	-	-
16%	9	10	11	11	12	13	14	15	17	18	21	25	-	-	-	-	-
18%	9	9	10	10	11	12	13	14	15	17	19	22	-	-	-	-	-
20%	8	8	9	9	10	11	12	13	14	15	17	20	29	-	-	-	-

Note: Cells marked with "-" indicate years greater than 30.

Appendix 9 Estimated years in which capacity is reached in PALM

growth	price per boat hour																
	\$400.00	\$500.00	\$600.00	\$700.00	\$800.00	\$900.00	\$1,000.00	\$1,100.00	\$1,200.00	\$1,300.00	\$1,400.00	\$1,500.00	\$1,600.00	\$1,700.00			
2%	25	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4%	14	16	18	20	23	26	29	-	-	-	-	-	-	-	-	-	-
6%	10	11	12	14	16	18	20	22	25	29	-	-	-	-	-	-	-
8%	8	9	10	11	12	14	15	17	20	22	26	30	-	-	-	-	-
10%	6	7	8	9	10	11	13	14	16	18	21	25	-	-	-	-	-
12%	6	6	7	8	9	10	11	12	14	16	18	21	26	-	-	-	-
14%	5	6	6	7	8	9	10	11	12	14	16	18	23	-	-	-	-
16%	5	5	6	6	7	8	9	10	11	12	14	16	20	30	-	-	-
18%	4	5	5	6	7	7	8	9	10	11	13	15	18	27	-	-	-
20%	4	5	5	6	6	7	7	8	9	10	12	14	17	24	-	-	-

Note: Cells marked with "-" indicate years greater than 30.

Appendix 10 Questionnaire for interviewing whale watching business owners

Name of business:	
Name of respondent:	
Location:	Date:
Interviewer(s):	

Preamble

My name is Tobias Schwoerer and I am working on a three-year research project involving UABCS in La Paz, Simon Fraser University in Vancouver and SFS in Puerto San Carlos. The study is examining the economic benefits of whale watching to the community of P.S.C. (P.L.M.) and prospects for expansion of *ecoturismo* in Bahia Magdalena. I am fortunate to have Citlally help me translate the questions for me. I can assure you that the information you provide will be kept strictly confidential and we will share the results of the study with you, if you are interested. If you have any concerns about the study, contact:

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Are you willing to participate in our study and be interviewed? Yes ___ No ___

Part A. Background and General Information

A.1 We would like to start by learning a little about you.

- a) For how many years have you lived in P.S.C. (P.L.M.)?
- b) If not all your life, then where did you come from?
- c) How old are you?
- d) How many years of formal schooling have you completed?

A.2 We are interested in some general information about your whale watching business.

- e) Who owns your business? If not you, what is your role in the business?
- f) In case of private ownership, what percentage of your business is locally owned? (how measured?)
- g) How long has the business been active in whale watching?
- h) How many trips/clients/boat-hours did your whale watching business provide in each of the last 3 years? [CHOOSE AT LEAST ONE]

Activity	2003	2004	2005
trips			
clients			
boat-hours			

- A.3 We are interested in learning about your whale-watching permit(s).
- Who holds the whale-watching permit that you use? Is this a private enterprise, co-operative or union (or other?)?
 - How long have you or they held this permit?
 - How many flags come with the permit?
 - How is it determined who uses the flags on a given day?
 - Are the flags ever rented or sold, temporarily or permanently? If so, how is this done?
 - Do you think there should be more permits and/or flags for whale watching? Please elaborate (e.g. more flags/same no. of permits or vice-versa)? Do you wish to obtain more flags?
- A.4 If relevant, please tell us about the co-operative or union holding the permit.
- When and why was it formed?
 - How many members does it have? Has this been constant over time?
 - Where do the members/executive reside?
 - What other activities is it involved in besides whale watching?
 - How does the co-operative or union make a decision?
 - Is it required that boat operators use co-operative members as crews, drivers, etc.?
- A.5 We would like to learn about the boats you are using for whale watching.
- Do you use these boats for other purposes? What (e.g. fishing)?
 - What proportion of their use is for whale watching (e.g. 25%)?
 - What is the capacity of your whale watching boats (no. of clients) and motors (hp)?
 - How many 2-stroke and 4-stroke engines (*dos/cuatro tiempos*) do you have?
 - Have you heard of the SEMARNAT program that assists owners with switching to a 4-stroke engine? Have you participated? Why or why not?

Part B. Revenues and Costs

- B.1 We would like to learn about your pricing system
- What types of clients do you serve and how important is each type?
 - Do you charge different prices during the season or for groups/elderly/students? If so, what?
 - If you offer package tours for tourism agencies or cruise ships coming to the Bay from outside of Bahia Magdalena, can you explain how this works? What is the price for these package tours?
- B.2 Can you tell us about the employees in your whale watching business?

	SALARIES			Place of origin (no. of employees)		Comments
	wage (\$/unit)	length of employment (units/yr)	total salary (\$/yr)	Local	Non-local	
manager						
<i>pangeros</i>						
office worker						
maintenance workers						
Other						

B.3 In addition to fuel, what are the main costs for your whale watching business?

Item	Quantity Required/ Used	Cost (CHOOSE ONE TYPE)			Where purchased normally?
		purchase (\$)	item life (years)	annual cost (\$/yr)	
rent for land/buildings					
advertising					
insurance					
vehicles & trailers					
boats					
motors					
life jackets					
radios, first aid kits, etc.					
boat/motor maintenance					
taxes, licenses, other fees					
other					

B.4 (If co-operative or union) After you deduct your own costs, how are the remaining revenues shared or allocated? What share of revenues is provided to the co-op or union to cover its costs?

B.5 We would like to get an understanding of the relationship between the number of whales in the Bay and some of your costs associated with taking people out to watch whales. Taking the whale-watching trips you offer, what percentage does

each type of trip represent of the total number of trips and how much fuel is used on each type of trip. Please answer for the early/late seasons when there are fewer whales and the peak season, when there are more whales [USE TABLE]

Trip Length	Early/Late Season		Mid/Peak Season	
	% share	fuel (l/trip)	% share	fuel (l/trip)
hours				
hours				
hours				
Other?				
Total	100%		100%	

Part C. Other Activities and Concerns

C.1 We would like to know about other tourism related activities that your business is involved in?

What activities besides whale watching does your business offer to tourists? If any, please specify. What are your rates for these services?

C.2 We are interested in learning about training and safety issues related to your whale watching and other ecoturismo activities?

- d) Is it difficult for your business to find skilled *pangeros*?
- e) What are the minimum skills you require when hiring a *pangero*?
- f) Do your boat drivers receive any training? If yes, what type of training and from whom?
- g) Do you believe your *pangeros* should receive additional training? If so, what?
- h) Do you provide safety training to your *pangeros*?
- i) Do you or your *pangeros* provide a safety briefing to clients before the trip?

C.3 Finally, we would like to hear about your concerns and future plans for the business.

- a) Is there any resentment towards the whales in the Bay and whale watching or conflicts with other users of the Bay? Please elaborate.
- b) Are you familiar with the whale-watching guidelines developed by the government?
- c) Do you witness incidences of non-compliance with the whale watching guidelines among some *pangeros*? If so, what percentage of the drivers?
- d) What is your opinion on how the government manages whale watching overall? What else could they do to assist you?
- e) What do you believe are the future prospects for whale watching and *ecoturismo* in Bahia Magdalena?
- f) What are the main challenges and opportunities you see for your business?

g) What are your plans for the business in the future?

Thanks you for your help!

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