Citizens' Attitudes to Re-Establish a Permanent Water Flow for the Colorado River Delta, North Western Mexico

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Ecosystem services and goods are non-market values that are increasingly being accounted through contingent valuation methods and more specifically by studying people's willingness-to-pay for them. Large ecosystem restoration is an area that benefits from economic valuation because placing a monetary value proves that restoration efforts are justified to preserve resources for future generations, wanted by a community, and even a profitable investment of public funds. However, what determines that a community supports and understands restoration efforts is linked to their social, economic, cultural, and geographic reality. In this study I adopted the idea of willingness-to-pay to examine people's attitudes towards river flow restoration efforts in the Colorado River Delta. The Colorado River Delta is a resilient ecosystem that has endured severe river flow depravation for more than 70 years now; yet, this ecosystem still provides many environmental services and goods and its restoration is well justified for that. This research mainly reveals that the Colorado River Delta is still an undervalued ecosystem despite its resiliency and the many regional benefits it still provides. This study has two research questions. Fist, I determined what factors influence Mexicali's willingness-to-pay. Second, I compared willingness-to-pay attitudes between the cities of Mexicali and San Luis Rio Colorado (SLRC); two neighboring Mexican cities of different size and economic structure but of similar social, ecologic and geographical conditions. The instrument to collect field data was a survey that posed a realistic river flow restoration scenario at a range of prices from 10 to 90 pesos in order to test people's willingness-to-pay; a total of 564 surveys were delivered face to face in Mexicali. Subsequently, I compared Mexicali survey results with a previous SLRC survey. Descriptive statistics, non-parametric analysis, and qualitative analysis were the main instruments to arrive to my conclusions. Within Mexicali, I found that parenthood and the perception of received benefits from the river were the most significant factors that determined people's willingness-to-pay. Migration was also a salient socio-demographic factor that probably has an influence on people's attitudes towards river flow restoration. When making comparisons between cities I found that SLRC is more willing to pay than Mexicali, which confirmed my hypothesis that environmental awareness influences willingness-to-pay in each city given that SLRC is a true river city while Mexicali is 64 km away from the river. Pricing was also influential in both cities. People's exposure to the river varied from one city to the other –SLRC people have more interactions with the river than people from Mexicali do, thus matching again the difference in willingness-to-pay attitudes of each city. Although income, education, frequency of visits, and awareness of dry river conditions were expected to have a clear connection to willingness-to-pay within Mexicali, I found only a marginal statistical relationship that was very close to be significant. This was due to the fact that I analyzed the dependency of those variables for all prices and not at a specific price range where the actual average willingness-to-pay resides. Finding that average and then analyzing the relationships again should clarify this issue. What motivates people to pay was related to resource conservation and the recognition of the river's ecological importance. What motivates people to not pay relates to negative attitudes such as incredulity and lack of trust in Mexican institutions. My main recommendations are to raise local environmental awareness of river issues with environmental education, to address local negative attitudes towards river restoration, and to explore the analysis of these data with other approaches such as socio-psychological models.

Acknowledgements

There are many people who helped this thesis become possible. I want to thank you all even if you do not find your names in the list below. I extend my recognition and sincere gratitude to the following people and institutions:

Dedication

My thesis is dedicated to the Colorado River Delta, and to the people and organisms that live there, depend on it, and care for it. My work is also dedicated to all those researchers, environmental activists, and organizations that have not given up in their long journey to understand and protect this vast and stoic ecosystem. The determination of these people and the Delta itself has been exemplar to me, thanks to all of you for leading me in this journey.

"Esta lucha es para todos…"

Elvira Arellano, activista y migrante en lucha, 2007.

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Frequent Acronyms

AGEB – Area Geoestadistica Basica (Basic Geostatistic Area)

CILA – Comison Internacional de Limites de Aguas, Mexico

CONAGUA – Comision Nacional del Agua (National Waters Commission)

CONANP – Comision Nacional de Areas Naturales Protegidas (National Commission for Natural Protected Areas, Mexico)

CONEPO – Consejo Estatal de Poblacion, Baja California (Population State Council)

df – Degrees of freedom

EVRI – Environmental Valuation Reference Inventory

GNP – Gross National Product

IBWC – International Boundary and Water Commission, U.S.

INE – Instituto Nacional de Ecologia (National Institute of Ecology, Mexico)

INEGI – Instituto Nacional de Estadistica, Geografia e Informatica (National Institute of Statistics, Geography and Informatics, Mexico)

MODE – Wellton-Mohawk Main Outlet Drain Extension Canal

NGO(s) – Non-Governmental Organizations

ppm – parts per million, salinity measure (1/1,000,000)

ppt – parts per thousand, salinity measure (1/1,000)

RC/ CR – Rio Colorado

RH/ HR – Rio Hardy

SEMARNAT – Secretaria del Medio Ambiente y Recursos Naturales (Environment and Natural Resource Secretariat, Mexico)

SER – Society for Ecological Restoration

SLRC – San Luis Rio Colorado

SPSS – Statistical Package for the Social Sciences

TFDD – Transboundary Freshwater Dispute Database by the Department of Geosciences of Oregon State University

WTP – Willingness-to-Pay

1 INTRODUCTION

1.1 Context of the Study

Ecosystem services are non-market values whose importance society has just begun to recognize, especially after events such as hurricane Katrina, in 2005. The immediate devastation of Katrina is perhaps one of the best cost-benefit examples ever given by nature. Were decades of development and economic accomplishments worth the multidimensional costs of Katrina, roughly estimated in 1,836 lives and $156 U.S. billion (Burton and Hicks, 2005); or are Katrina's immediate and long-term losses higher than the benefits extracted? These types of questions are slowly emerging to shed some light on how society has undervalued ecosystem services over time. Answering this type of questions is both a challenge and a necessity. This study looks at the Colorado River delta, a case study where environmental services at the end of the river were also never taken into consideration before damming the river, and where remnant environmental services are still undervalued. Restoring damaged ecosystems is an alternative to conserve species, ecosystem functions, and biodiversity as a whole. However, the ecological restoration of large ecosystems is a major task and it can only be successful with citizen support and participation. This thesis is about assessing citizens' attitudes towards restoring a permanent river flow in the Colorado River delta; their attitudes directly relate to the level at which they value a restored ecosystem service.

Documents and citizens' collective memory recognize that the Colorado River delta, including the Upper Gulf of California, was once one of the world's greatest desert estuaries. During most of the twentieth century, water diversions and dams prevented the Colorado River from reaching the sea. For decades, the generalized thought was that the Colorado River delta's ecosystems had been condemned to collapse. Although the delta's original abundance of water and wildlife will be remembered mostly through pictures, documents, and stories, recently the delta has also shown unpredicted signs of recovery. Despite all odds, years ago the delta made a meaningful comeback as a result of unusual wet years during the period 1980-1993, which saw El Niño events and the filling of major structures upstream (Pitt, 2001). A decade of incidental flows triggered the delta's ecosystem resilience, a slow process witnessed by local communities and a few researchers from both sides of the border. After damming the river and during dry years, agricultural waste flows have been the only fresh water source maintaining what is left of the Colorado River delta (Glenn, 1998; Luecke, *et al.,* 1999). Luecke *et al.* (1999) describe today's delta as "a remnant of small wetlands and brackish

mudflats" covering about 60,000 Ha, an area that equals 8% of its original surface (Glenn *et al.,* 1999).

According to many authors (Glenn*,* 1998; Luecke *et al.*, 1999; Pitt, 2001; Zamora-Arroyo *et al.*, 2005), the Colorado River delta in Mexico merits conservation due to the value of its remaining habitat and wildlife resources. Progress to restore and conserve the remaining Colorado River delta is just beginning. Two recent milestones have shown some changing views on water use and users (Hyun, 2005). In 2000, the first diplomatic agreement towards recognizing the Colorado River delta's water needs was signed under the name of Minute 306. This milestone proves that the delta's environmental agenda is gaining importance, but it will take a while before these changing views translate into legislation and action. Minute 306 did not grant water for environmental purposes in the delta; it only recognized that the two countries cooperate in studies, with an aim to conserve the delta's environmental assets (Pitt, 2001). Prompted by Minute 306, in 2002, many scientists, NGOs, and land managers gathered at a binational meeting to produce a document titled "Conservation Priorities in the Colorado River Delta" (Zamora-Arroyo *et al*., 2005). Although this document cannot be considered a restoration or conservation plan *per se*, it constitutes an important step in organizing knowledge and experts in the region. Conservation Priorities is the first collective transboundary document that visualizes a direction for conservation and restoration efforts in the Colorado River delta. Among many recommendations, evaluating the economic costs and benefits of restoration is one of the research needs identified in that document.

The Society for Ecological Restoration (SER) International defines ecological restoration as "an international activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability. Frequently, the ecosystem that requires restoration has been degraded, damaged, transformed or entirely destroyed as the direct or indirect result of human activities." Ehrenfeld (2000) recognizes three common levels of goals in the fields of conservation and restoration: species, ecosystems, and environmental services, each level with varying strengths and weaknesses. One of the advantages of using environmental services as a goal for restoration is its obvious human interest that generates economic and political support. Given that the Colorado River is subjected to greater institutional control than perhaps any other river in the world (Cohen, 2002), it seems logical to strengthen an economic approach in the restoration efforts of the delta, aiming to convince and gain support from citizens and decision makers in both nations.
In Conservation Priorities (Zamora-Arroyo *et al.*, 2005), most restoration research has already tackled restoration work by focusing on species and ecosystems. An ecosystem service approach has just

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begun to be examined through studies of economic valuation of ecosystem services. The National Institute of Ecology (INE, Mexico) recently finished an economic valuation of the in-stream flows in the Colorado River delta. In San Luis Rio Colorado (SLRC), Sonora, INE used a contingent valuation method to determine the non-use value of restoring a constant river flow. With this study INE concluded that the Mexican government should invest in restoration efforts, given that restoring the river will also derive modest economic benefits to the region (Sanjurjo and Carrillo, 2006a). Gathering more information about citizens' levels of interest on flow restoration, in large cities such as Mexicali, will contribute to further justify a federal restoration plan for the delta.

Willingness-to-pay surveys are common tools used for the economic valuation of ecosystem services and goods that are not part of the world's markets (Carson, 2000). Estimating people's willingness-to-pay to conserve or restore the environment is useful for planning, policymaking, taxation, and resource conservation. Understanding why people is in favor or opposed to restore an ecosystem service can be approached using socio-psychological models which basically evaluate the systems of beliefs, motivations and behaviors that characterize a group of people. In this study I specifically look at the motivations behind willingness-to-pay to restore a river flow.

1.2   Research Questions and Objectives

This study seeks to answer two main research questions:

1.   What factors influence the attitudes of Mexicali citizens towards re-establishing a permanent water flow for the Colorado River?

2.   Is there a difference in people's attitudes towards re-establishing a permanent water flow in the Colorado River, between the cities of Mexicali and SLRC, Mexico?

The main research hypothesis is:

Hypothesis: Mexicali and SLRC have different willingness-to-pay attitudes due to differences in levels of environmental awareness in each city.

In order to answer these research questions and test my hypothesis, this study had three specific objectives: 1) to survey Mexicali and gather evidence of citizens' attitudes towards the potential restoration of a permanent water flow for the Colorado River; 2) to compare results between Mexicali and SLRC surveys, in order to identify patterns and differences in levels of citizens' interests to

support river flow restoration in each city: 3) to collect high-quality information that can be transferred to INE for its econometric analysis. Expanding our understanding of the economic costs and benefits of restoration will contribute to design an integral restoration plan for the Colorado delta.

1.3 Study Area

In a broad context, the remaining Colorado River delta scattered between the municipalities of Mexicali and SLRC, Mexico, was the general geographic unit for this study (Figure 1.1). However, this case study focused most of its fieldwork (survey) exclusively on the city of Mexicali, which is the capital of the State of Baja California, Mexico (Figure 3.1).
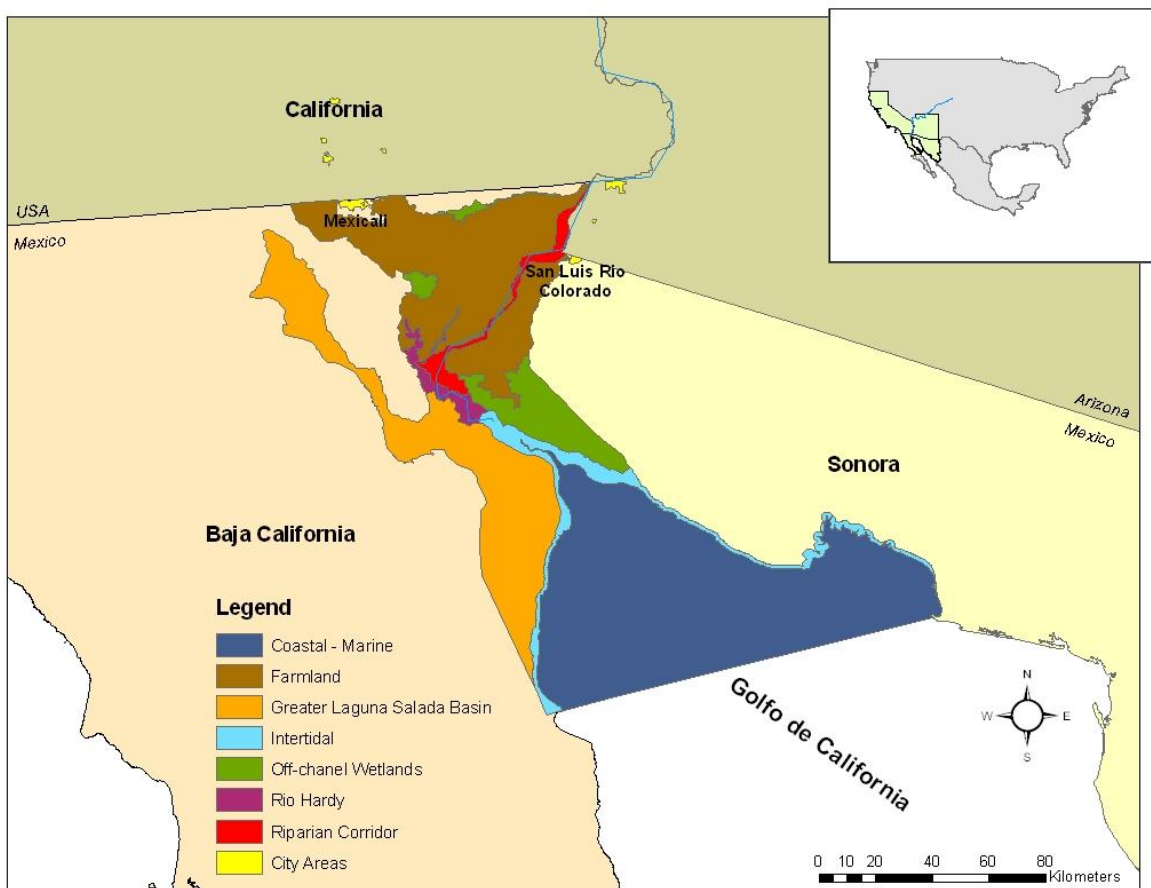
Figure 1.1. Study area delimiting the ecological zones currently identified in the Colorado River Delta (adapted from Zamora-Arroyo *et al*., 2005).

1.4 Methodology

This study mostly uses a case study approach to achieve its goals. Two specific tools for data collection and analysis were used: a field survey in Mexicali, and cross tabulation analysis (Pearson's Chi-square). The results of the Mexicali survey are the prime material for most of our analysis and they are presented in the descriptive statistics (Section 4.1). The cross tabulation analysis is used to assess dependency across Mexicali variables. The Chi-square test for independence focuses on testing if there is a difference in willingness-to-pay between Mexicali and SLRC. Other tools to collect complementary data included direct observation, and secondary sources such as the SLRC survey results (2005), academic reports, and government records.

1.5 Thesis Organization

This thesis has been divided into six chapters, two Appendixes, and a bibliography. This introductory chapter presents the problem statement, purpose, research questions, and hypothesis underpinning the study, as well as a general explanation of the methodology and the structure of the document. Chapter 2 delves into a broader background explanation of the Colorado River Delta environmental issues and it explains the conceptual framework of this study. To explain the theoretical context of the study I examine how citizens' attitudes to support ecological restoration can be assessed with willingness-to-pay surveys. Chapter 3 provides a detailed explanation of the methodology followed during this study. Chapter 4 contains the study's results divided in three main blocks: Mexicali survey descriptive statistics; cross tabulation analysis of relevant Mexicali variables; and a comparison of willingness-to-pay distributions of Mexicali and SLRC (Chi-square test for independence). Graphical and numeric evidence to discuss and answer the two initial research questions is provided during this chapter. Chapter 5 discusses the main findings of this study. Chapter 6 presents conclusions and recommendations for the direction of future research. Finally, Appendix A and B provide Mexicali and SLRC supporting materials, respectively.

2   CONTEXT AND CONCEPTUAL FRAMEWORK

2.1   Research Context of the Colorado River Delta

According to Sykes (1937), the first records of explorations conducted in the Colorado River delta took place in 1539 by Francisco de Ulloa, a captain in the service of Hernan Cortes. Despite those first attempts, "the delta remained almost a *terra incognita* for the coming two centuries thereafter". Most of the records left by the first explorers merely contribute small glimpses of an "unattractive land, traversed by a great river that was difficult to access, surrounded by inhospitable deserts of unknown extent, and guarded from a sea approach by great and violent tides". In his physiographic study of the Colorado River delta, one of the earliest academic studies of this area, Sykes (1937) provided valuable information through 45 years of personal observations of the delta. This study was unique because it was done at a time of major environmental changes in the delta's ecosystem, and because the Colorado River delta had not been formally studied before 1937 – at that time, the Mississippi and the Fraser River deltas were the only deltas previously studied in North America. Sykes was particularly interested in the Colorado River delta because of its size, its peculiarities as a desert delta that alternately discharged its waters into land-locked basins and the sea (one of the few deltas with this characteristic in the world), and because of the magnitude and effects of tides on the deposited sediments (tides three times bigger than those of the Tigris-Euphrates in the Persian Sea, its nearest analogue). Sykes (1937) rightly predicted most of the major environmental changes that would affect the delta after the damming of the river was completed, which included changes in vegetation cover, erosion at the delta and head of the Gulf of California, elimination of flood hazards in the lower Colorado River, new hydrological conditions, landscape changes, and transboundary political tension for water resources.

According to Cohen (2002), the development of water resources has brought economic growth to entire regions, generated relatively clean power, provided regular-dependable supplies for urban, industrial and agricultural users, and allowed the settlement of new areas that otherwise, without massive hydrologic infrastructure and institutions, would have not been possible. The Colorado River has not been the exception; it has brought economic growth to most of the southwestern United States and northwestern Mexico. This area provides today a valuable example about the complexity of the interactions of human development, economic progress, water management, politics, and environmental degradation across international borders. Several authors such as Sykes (1937), Leopold (1948), Luecke *et al.* (1999), Pitt (2001), Cohen (2002), and Ward (2003) highlight that

progress had come to the Colorado River Basin at a high environmental costs: developing agricultural oases transformed the region's landscape in less than a century.

In 1981, Fradkin concluded in his book *A River No More*, that the Colorado River Delta was dead after more than 50 years of extreme fresh water depravation. However, despite all predictions the delta showed signs of recovery in response to small incidental floods during the late 1980s. According to Glenn *et al.* (1996, 2001), the delta has been partially revegetated following 20 years of unintentional water releases from the United States, which brought back native trees and other original vegetation to its riparian corridor. Similarly, Galindo-Bect *et al.* (2000) correlated peak shrimp catches of the last two decades, in the Gulf of California, with pulses of water released to the Colorado River delta. Evidence like this motivated scientists and local and international conservationist groups in 2000 to join efforts to awaken federal and binational attention: to persuade them to work together in the conservation and restoration of the remaining, but resilient Colorado River delta.

2.2   Hydrology of the Colorado River Basin

The Colorado River basin covers 655,000 km^2, from the snow-covered Rocky Mountains range in the United States to the arid salt flats of the remaining Colorado River delta in Mexico. Miller (1998) states that the Colorado River has a total length of about 2,300 km before reaching the Gulf of California in Mexico. About 98.4% of the Colorado River basin lies within the United States, and the rest (1.6%) is in Mexico (TFDD, 2002). Within the basin, the Rocky Mountains receive most of the precipitation, primarily as snow. Much of the rest of the basin is extremely arid, with less than 80 mm of annual precipitation (Harding *et al.,* 1995). Harding *et al.* (1995) report that 70% of the river's annual natural flow occurs from May through July, when the spring and summer heat melts the snow in the Rockies. Ohmart *et al.* (1998) also report that intra-annual fluctuations vary, depending on the size of the Rockies' snow pack and how quickly it melts, with peak flows in June and the lowest flows in mid-winter.

The Colorado River's hydrologic history can basically be divided in two: before and after major dam construction and water diversion projects along the river. Cohen (2002) argues that marked volume fluctuations used to characterize the Colorado, both between and within years prior to any man-made modifications of the river. The maximum reconstructed annual flow (i.e., the flow that would have occurred without dams or withdrawals) during the period of record occurred in 1983, with an estimated flow of 31 km^3; the minimum reconstructed flow occurred in 1934, with an estimated flow of 7.7 km^3. According to other researchers, the average annual flow could have varied from a

long-term mean of 16.7 km^3, based on tree-ring records (Meko *et al.,* 1995), to 18.6 km^3 for the past century of instrumental record (Owen-Joyce and Raymond, 1996).

The new hydrology of the Colorado River is strictly subjected to institutional control through nearly 50 dams (Nijhuis, 2005) and more than 80 major diversions that move water out of the Colorado River to irrigate more than 1.5 million Ha and serve about 30 million people in the U.S and Mexico (Pontius, 1997; Luecke *et al.*, 1999). The first diversions for agricultural purposes were in 1896, but it was not until the completion of Hoover Dam (1935) that the flow of the river was completely controlled (Glenn *et al.,* 1996; Cohen, 2002; Ward, 2003). These major dams succeeded at holding water and large amounts of sediments that used to characterize the river (from there its name "Colorado"), but by 2000, Kowalewski *et al.* reported reverse sedimentary processes in the delta, which means that the tides currently are removing more sediments than what the river discharges. Now that the Colorado River hydrology is controlled by predictable sets of releases (timed to meet city and irrigation needs, and maximize peak power generation), the river below dams rises and falls as much as 1.2 m/day (4 ft/day) (Reclamation, 1996). Also, each drop of the Colorado River water is estimated to be used an average of 17 times (Cohen, 2002), but while irrigated agriculture is the top tier user, evaporation from reservoirs is the second largest consumer in the Colorado Basin. Diversions such as the water piped to Los Angeles are the third largest withdrawal.

Although a complete hydrologic model for the delta area is in the top five research priorities (Zamora-Arroyo *et al*., 2005), some advances have been made in this respect. For instance, Glenn *et al.* (1996) list five main sources of water for the Colorado River delta. The first one is Rio Hardy, a tributary of the Colorado River, which originates from a geothermal well discharge and from agricultural return flows (Payne *et al.,* 1992). Flow volumes of this tributary are not well documented but a mean discharge of agricultural return, for 1971-1976, averaged 1.3 km^3. The second source is the Wellton-Mohawk main outlet drain extension (MODE) canal, which since 1977 has carried 1.2-1.8 km^3/year of mildly saline (3ppt) ground water from the irrigation district of Wellton-Mohawk, Arizona (Burnett *et al.*, 1993). The third source of water is the Riito Drain with approximately 0.25 km^3/year of agricultural drain water (4ppt) from the San Luis irrigation district. The fourth source comes from natural seepage, via artesian springs of groundwater onto the mudflats, though its exact volume is unknown. Estimations made by Glenn *et al.* (1996), report 0.1 km^3/year of artesian flow; this small flow is important because it provides a constant source of water in core delta areas. The last source of water is seawater from the Gulf of California. Although hypersaline (40 ppt), this source is significant because of the extreme tide ranges of the Upper Gulf, some of the highest of any coastline (Thompson, 1968).

Additionally, Cohen *et al.* (2001) calculated a preliminary water balance for the lower Colorado River main stream, Ciénega de Santa Clara, and El Indio wetlands in the delta, for the period of 1992 to1998. Among the main findings of this research was that during non-flood years, agriculture and domestic returns to the main stream contributed 180% of discharge at the International Border (at San Luis Rio Colorado, Sonora, Mex.), but that such volume may not be sufficient to meet the flood requirements demanded by native riparian species. The most consistent source of water to the delta was agricultural drainage, which provided the majority of the discharge for most of the wetlands (El Indio) and Ciénega de Santa Clara. The quality of the returned flow was assumed to be low.

2.3 Transboundary Water Management

The allocation of the Colorado River waters between Mexico and the United States lies in a complex legal framework called "The Law of the River". This law is a collection of legal documents that reflect the negotiations between both countries since the Mexico-U.S. Water Treaty of 1944. In this treaty Mexico was guaranteed an annual volume of 1.85 km^3 (plus an annual surplus), and a later amendment also prescribed a salinity range of 115 ppm ± 30 ppm U.S count (IBWC, 1973; Varady *et al.,* 2001; Cohen, 2002; Ward, 2003). The two commissions that rule international water negotiations are the International Boundary and Water Commission (IBWC) representing the United States, and the Comisión Internacional de Limites y Aguas (CILA) on behalf of Mexico.

According to Glenn *et al.* (1996), Mexico was allotted approximately 10% of the base river flow, through the Water Treaty of 1944, but left the delta with no water rights for nature's use (the remaining 90% is used by the U.S.). Nevertheless, he points to a change that took place in the early 1980s, when up stream dams reached their capacity (Lake Mead and Lake Powell, in 1979 and 1977, respectively), combined with the occurrence of a wet period (1980-1983, during El Niño events). Such a change allowed water to reach the delta, through water releases up to 10 times higher than water treaty allotments (average excess flows were 4.8 km^3/ year, or three times the treaty allotment). That amount of water represented 25% of the historic flow that reached the delta, before the dams were constructed (Glenn *et al.,* 1996). These unintended floods were responsible for the partial recovery that the delta has experienced since 1981, which demonstrated the resiliency of the delta's ecosystem and the need for restoration and conservation of this area.

An important milestone in "The Law of the River" for conservation purposes of the delta is Minute 306, signed by IBWC and CILA in 2000. Minute 306 represents the first bilateral recognition

of the ecological importance of the delta. Nevertheless, this minute falls short because it does not go beyond recognizing the need to study the delta's ecological needs. Overall, so far academics and NGOs have been the only ones to make significant contributions to move the delta's research, conservation, and restoration efforts forward.

Given the river impoundment's storage capacity and flood control capabilities, Glenn *et al.* (1996) conclude that during new wet years, excess flow could be expected to be released into the delta again (Holburt, 1982, 1984; Rhodes *et al.*, 1984). Although the storing capacity is 740 km^3, the total space needed for flood control is only 66 km^3, thus during wet years storage capacity and distribution of excess water are limited.

According to the Global International Waters Assessment (GIWA) for the Gulf of California (Arias *et al.*, 2004), there are two major problems in the legal framework that have had a considerable impact on the Colorado River delta: the Colorado River waters are over-allocated (up to 30% by some estimates), and ecosystems are not considered beneficial users of that water. The combination of these two problems means that the Colorado River delta is last in line of a valuable and over-allocated resource.

2.4   Colorado River Delta Ecology

The delta of the Colorado River was once one of the world's great desert estuaries, supporting vast riparian freshwater, brackish, and inter-tidal wetlands in the most arid portion of the Sonoran desert (McDougal, 1904; Sykes, 1937; Leopold, 1949). Today, the Colorado River delta is still considered the largest desert estuary in North America, and is comparable in size, ecological, and economic importance to the Nile, the Tigris-Euphrates, and Indus deltas (Sykes, 1937; Kowalewski *et al.,* 2000). Historically, the Colorado River delta encompassed 780,000 Ha of land near or below sea level in the United States and Mexico, including two evaporation basins, the Salton Depression (now the Salton Sea) and Laguna Salada (Sykes, 1937). After modern human settlements began and agriculture expanded (for the last 100 years), the Colorado's wetland area was reduced to less than a tenth of its former size, to approximately 60, 000 Ha (Luecke *et al.*, 1999; Pitt, 2001).

The Colorado River delta was formed by the deposition of sediments from periodic Colorado River floods that date back to the Tertiary period (beginning 65 million years ago). Its shape and up-building were influenced by three main factors: the relatively narrow space available for sub-aerial sedimentary deposition, the pre-existing topography toward and into which the river flow was directed, and major tidal forces at the head of the Gulf of California (Sykes, 1937). Tides are the most

important forces that influence the shape of the delta, which has been characterized by extensive mud flats and a diurnal tidal range that reaches 8 to 10 m (Thompson, 1968). Thompson (1968) was one of the first researchers to report environmental changes in the inter-tidal zone after the shutdown of the river and the cutoff of the sediment supply. He reported that tidal currents and waves eroded intertidal mud, resulting in the exhumation of millions of mollusk shells and making the shoreline into residual beach ridges. Subsequent studies by Kowalesky *et al.* (2000) concluded that the land area of the Colorado River delta could be expected to decrease over time, similar to the events occurring in the Nile delta (Stanley and Warne, 1993).

Early explorers reported jaguars, beavers, deer, and coyotes in addition to the legendary abundance of waterfowl, fish, and other marine and estuarine organisms (Leopold, 1948; Spamer, 1990). Early explorers also encountered the Cucapá tribe, or the "People of the River", who are descendents of the Yuman-speaking Native Americans and have inhabited the delta for nearly 1,000 years. The Cucapá used the delta floodplain extensively for harvesting Palmer's salt grass (a wild grain), and for cultivating corn, beans, and squash. Other foods included mesquite, wild boar, wild geese, ducks, doves, quail, and fish (Williams, 1983). Nowadays, the Cucapás have been reduced in number and have difficulty sustaining their traditional livelihood, which depends upon the river's flow (Ward, 2003).

In 1904, when the delta's channels were still navigable, McDougal provided one of the earliest inventories of its flora. McDougal described the delta's vegetation as a gallery forest of cottonwoods (*Populus fremontii*) and willow (*Salix gooddingii*), grading at the southern end into a tidally influenced plain of salt grass (*Distichlis spicata*), and other halophytes with widely separated screw bean (*Prosopis pubescens*), honey mesquite trees (*P. glandulossa*), and saltbushes (e.g., *Artiplex lentiformis*).

By 1977, Felger's field trips reported the absence of gallery trees and their subsequent substitution for salt-tolerant vegetation; a substitution that was due to the replacement of natural flood flows by brackish irrigation return flows from 1904 to 1977 (Glenn *et al.,* 1996). Additionally, some nonnative species appeared and extended over the delta, like the shrub salt cedar (*Tamarix ramosissima*), noted already by Sykes in 1935 (Sykes, 1937).

Later on, Glenn *et al.* (1992, 1996) provided the most complete flora inventories of the contemporary delta, emphasizing wetland impacts of transboundary water management. These authors argue that 100 years of upstream water diversion has resulted in a reduced flow of water and sediments, and thus, in a loss of natural wetland habitat, and the conversion of the upper flood-plain vegetation from gallery forest to lower-growing halophytic plants.

Some endangered species present in the delta are the desert pupfish (*Cyprinodon macularis*), the Yuma clapper rail (*Rallus longirostris yumanensis*), and the southwest willow flycatcher (*Empidonax traillii extimus*). The estuarine and marine portions support two additional endangered species: the totoaba (*Totoaba macdonaldi*), and the vaquita porpoise (*Phocoena sinus*).

In 2000, Kowaleski *et al.* combined paleontological and geological data to estimate the past and current abundance of mollusks, used as a proxy to estimate the benthic productivity of the Colorado Estuary. This approach allowed researchers to make a comparison of biotic and environmental conditions before and after major human perturbations. According to their findings, the most conservative calculation indicated that during the time of natural river flow, an average population density of $50/m^2$ bivalve mollusks thrived on the delta. In contrast, in 1999-2000, the population density of the same benthic mollusks was $3/m^2$ (94% lower). Researchers concluded that such a dramatic decrease in mollusks' populations proves the severe loss of benthic productivity resulting from diversion of the river flow and the inadequacy of its partial resumption (since 1981 to the present). A notable increase in the levels of selenium and other harmful pollutants associated with the agricultural water waste (Glenn *et al.,* 1996) may have also played a negative role. Nutrient levels and phytoplankton productivity on the delta have been reported as being high (Hernandez-Ayon *et al.,* 1993), but both were presumably even higher during times of river input (Kowaleski *et al.,* 2000). According to Kowaleski *et al.,* the recent partial reestablishment of the Colorado River flow resulted in some revival of riparian habitats, which has been proclaimed a hopeful sign for a partial restoration of the delta's ecosystems (Luecke *et al.,* 1999); however, Kowaleski *et al.,* argued that they found strong evidence against a similar revival for the marine part of the estuary.

2.5   Conservation and Restoration Opportunities in the Delta

Some steps towards conserving and restoring the remnant delta's ecosystems have been slowly happening over the last decade. For instance, on June 10 of 1993, Mexico declared the delta and its surrounding marine areas as the Biosphere Reserve of the Upper Gulf of California and Colorado River Delta, a United Nations designation to protect world-class ecosystems while encouraging to continue sustainable economic activities in surrounding buffer areas (Luecke *et al.,* 1999). According to SEMARNAT (the Environment and Natural Resource Secretariat, Mexico) the Colorado River delta and Upper Gulf of California acquired a Biosphere Reserve status given that such areas are "in need of conservation and restoration", and because they are "inhabited by species that represent

national biodiversity, including those that are considered endemic, threaten, or endangered". Today, the Biosphere Reserve includes 934,756 Ha, of which 164,780 Ha (17.6%) are designated a core area, and 769,976 Ha (82.3%) are designated as a buffer zone (CONANP). The Biosphere Reserve was designated to protect an estimated 19% of the plant species found in Mexico, 22 of the 37 saltwater fish species endemic to the Gulf of California, and the desert pupfish, the only surviving native freshwater fish of the delta (Luecke *et al.,* 1999).

Soon after the Biosphere Reserve was declared, the Colorado River delta wetlands were also listed as "wetlands of international importance" under the RAMSAR Convention (1996). Perhaps the biggest contribution to the conservation and restoration of the delta has been the many years of scientific research in the area, mostly led by universities and NGOs from both sides of the border. Eventually, those who have participated in that research process collected their experiences in 2000 and delivered a document that identifies the top "Conservation Priorities" for the delta (Zamora-Arroyo *et al.*, 2005). The following paragraphs present some of the most prominent scientific research findings and recommendations to conserve and restore the delta, from many of the leading authors.

In 1996, Glenn *et al.* identified two main threats to the remnant Colorado delta's wetlands: water management decisions and flood control projects that do not treat such areas as assets to be protected. These authors also offered a valuable comparison between the ecological state of the Colorado River delta and the state of the Nile and Indus river deltas. The authors concluded that conservation challenges in the Colorado River delta are not nearly as severe as the conservation problems faced in the other two river basins. For instance, the Colorado delta's population (below 1.5 million people, INEGI, 2000) is not as large as that of the Nile or the Indus (10-15 million people in each basin). At the moment, conservation efforts in those two deltas focus on reducing the rate at which urban and agricultural land will erode within the next 50 years, rather than preserving wetlands (Stanley and Warne, 1993). The conclusion was that in the Colorado River delta, Mexico and the United States still have the opportunity to recover and maintain wetlands, but it will require active, rather than passive efforts (Fredrickson and Reid, 1990), probably by building on the status of the delta as a Mexican biosphere reserve, and on the environmental provisions of the North America Free Trade Agreement (NAFTA)(Appleton, 1994).

Glenn *et al.* (1996) also suggests two specific actions to stabilize the delta wetlands: restoration of the lower Rio Hardy wetland through implementation of a new earthen dam at the freshwater-intertidal intersection on the Colorado River channel (Payne *et al.,* 1992), and a commitment by the U.S. Department of the Interior to continue to provide Wellton-Mohawk drain water for Ciénega de Santa Clara (Glenn, 1992).

The Biosphere Reserve's office has also identified other influential factors that threaten the remnant ecosystems, which include invasive species, agricultural run-off, illegal hunting, archeological artifacts looting, solid waste accumulation, underground water depletion, lack of superficial water, and abuse and misuse of the superficial water that is currently available. Recently, the Reserve authorities have also requested that the National Waters Commission (CONAGUA) concede the ecosystem some water rights on the Colorado waters that Mexico receives from the U.S., so that in the future the delta can be legally considered a user of the same river (CONANP, 2005).

In 1999, Luecke *et al.* reported the latest scientific findings about the delta's partial recovery and made recommendations for managing the existing flows to further benefit the delta's ecosystem. According to this research team, key areas of the delta can be conserved through deliberate water management of its current flow, and without adverse effects on other Colorado Basin water users. Managing agricultural drainage, wastewater, and floodwater into the delta is their main proposal based in the modest water needs that the delta requires to sustain and rehabilitate its current protected areas (about 1% of the mean river's flow; Pitt, 2001). Luecke *et al*. also argue for a long-term vision where economical, social, and ecological values of the delta have to be recognized in future deliberations over the allocation of water surpluses and where in-stream flows may be dedicated to sustain the delta.

Pitt (2001) suggested the creation of a water market for the region in which water can be dedicated for environmental purposes by means of leasing or buying water rights from the agriculture sector. Similarly, Arias *et al.* (2004) suggested that to minimize conflict while enhancing ecological responsibility, restoration plans should include leasing water rights in Mexico and the U.S. for transfer to the delta. They also suggested the decoupling of subsidies to decrease water consumption. Carrillo-Guerrero (2002) concluded that restoration efforts could be embraced and enhanced by the participation of local communities in Mexico, either by leasing water or land rights.

According to Cohen (2002), dedicating water to the Colorado River delta will require several steps. These include: developing local capacity and linking economical development in the region to the health of the environment; developing specific policies that acknowledge the needs of water users for consistency and reliability in the system; increasing public awareness and appreciation of the delta; expanding research efforts to refine and document the delta's water needs; and increasing communication among stake holders. Cohen also argued that perhaps the greatest challenge to restore the delta will be to array real and perceived legal and institutional obstacles to dedicate some of the river flow for environmental use.

Finally, Zamora-Arroyo *et al.* (2005) concluded four main things: that sufficient scientific information already exists about the delta's ecosystems to determine priorities and begin action in conservation and restoration; that the principal threat to the delta's ecosystems is the lack of fresh

water inputs; that large-scale improvements in the ecosystem health will not be attained until the governments of the United States and Mexico make significant commitments to conserve and restore the delta; and that each of the delta's ecosystems is threatened with loss of resource value. The same document established the following recommendations: implement immediate bilateral policies to ensure no further harm to the delta's ecosystems; use Minute 306 as a platform to launch a conservation and restoration plan; implement binational collaboration either through treaty agreements, national policies or market-based mechanisms; seek funding from multilateral parties such as the Commission for Environmental Cooperation of NAFTA; include consultation to local communities before deploying any project; and support further research.

It is expected that in the future the demand for water resources and land will increase in the region, and that global warming will impact water availability. Thus, conservation and restoration efforts will have to compete with tighter human needs and come up with creative solutions to secure water for the environmental purposes of the delta.

2.6 Environmental Services and Willingness-to-Pay

Only recently have researchers begun to estimate dollar prices on environmental services, often with the intention of demonstrating how essential these services are for our economy, and for the very existence of humans. Despite criticism of assigning dollar prices to environmental services, the aim of this approach seems to offer a missing perspective on the decision-making puzzle of economic development. For instance, Costanza *et al.* (1997) provided one of the first examples of economic valuation of global ecosystem services. They estimated that the annual average global value of 17 ecosystems services was 1.8 times higher than the 1997 global GNP. Global environmental services were valued at US $33 trillion/year, *versus* the value of the 1997 global GNP of US $18 trillion/year. Two implications from this study were drawn: first, that this type of studies could help modify systems of national accounting to better reflect the value of ecosystems services and natural capital; and second, they could aid project appraisal to include ecosystem services lost during cost-benefit assessments.

Valuation of a non-market service or an endangered species is not an easy task. There is controversy of why we do it and how reliable and accurate are the current methods to achieve it (Carson *et al.*, 2001). The contingent valuation method is a popular survey-based methodology that helps to establish the dollar value of an environmental good or service (Carson, 2000). Willingness-to-pay surveys are common tools in contingent valuation methods. The idea of measuring people's

willingness-to-pay for an environmental service or good is the foundation of the contingent valuation method (Whitehead *et al.,* 1997). Willingness-to-pay is based on the theory of economic value through which our society assumes that environmental goods and services are anthropogenic and thus subjected to be paid for.

Willingness-to-pay is one of two standard procedures to measure economic value. It is an appropriate measure to use when an agent wants to acquire a good or a service. The other standard measure of economic value is willingness-to-accept and is an appropriate measure when a person with legal entitlement to a good is asked to give it up through compensation. Because we do not have legal entitlements to environmental services or goods, the appropriate measure to use here is willingness-to-pay (Carson, 2000). For this study, willingness-to-pay was appropriate because the remaining wetlands of the delta are a public good providing many environmental services, and because their restoration depends on a solid economic justification of the profitability of federal investments to purchase water for the river itself (Sanjurjo and Carrillo, 2006b). Proving that people are willing to pay to have water back in the river and that they will benefit from it could strengthen a restoration strategy for the Delta.

Typically, a willingness-to-pay survey constructs scenarios that offer possible future government actions. Survey participants are asked to state their monetary preference concerning those actions. During the survey participants are also informed of the context of those actions and their repercussion before they state their preference; the idea is that participants make an informed choice and reflect their realistic willingness-to-pay. For this study, I adopted a hypothetical water flow restoration scenario and then asked people to state what prices they preferred to pay for restoration. The final part of a contingent valuation is to analyze participants' choices in a similar manner as the choices made by consumers in a real market. A variety of econometric models exist to determine what is the maximum, minimum, and the average that people is willing-to-pay for an environmental good or service. Most models are based on linear regressions. However, to match my experience level and accomplish the purposes of this study, I decided to take a non-parametric approach to assessing people's willingness-to-pay. I used willingness-to-pay at a descriptive level to define people's attitudes and motivation towards restoration efforts in the Colorado River delta. I assumed that linking resource use and willingness-to-pay can provide a good platform to examine motivation to support restoration in the delta.

Standard features of a willingness-to-pay survey are: (1) an introductory section that gives background information about the decision to be made; (2) a description of the good under valuation; (3) an instrument to capture the participant's monetary contribution; (4) an explanation of how he or she will pay; (5) the debriefing questions of why participants responded un they way they did; (6) a

survey method to elicit respondent preferences; (7) the collection of supporting socioeconomic data form each participant. In this study, both surveys had all the above elements recommended by Carson *et al*., 2001. In addition, the Mexicali survey considered double-dichotomous choices to comply with the previous SLRC survey design but also to provide an interval of choices for participants.

2.7   Willingness-to-pay in a Latin American context

Willingness-to-pay surveys are common tools in contingent valuation methods. Contingent valuation is a relatively new approach that has developed over the last 40 years, mostly used by Federal agencies and international organizations with environmental responsibilities (Carson, 2000). Contingent valuation is growing in importance. By 2000, some 200 academic papers in many fields of study, in many places around the world, had been published (Carson, 2000). A quick search on the Environmental Valuation Reference Inventory (EVRI) yielded 1194 studies around the world, for the term "willingness-to-pay". EVRI is a large online database assembled for policy making purposes by Environment Canada, the European Union, the Environmental Protection Agencies of the U.S, Mexico and Chile, the World Bank, and the Economy and Environmental Program for South Asia. For Latin America contingent valuation is even newer; a search on EVRI yielded only 21 studies, the earliest ones from 1994 on air quality and forest value, in Chile and Mexico respectively. Other Latin American countries with this type of study include Costa Rica (4), Brazil (4), Ecuador (1), Dominican Republic (1), Uruguay (1), Haiti (1), Colombia (1), Peru (1), and Bolivia (1). Currently, EVRI has on record five contingent valuation studies in Mexico on air quality, water supply, biodiversity, and forestry. The 2005 SLRC study on which I have focused my research is not part of the EVRI database.

2.8   Importance of valuating the environment

The economic valuation of environmental services has evolved on at least three main lines of estimation: total value, passive use value, and natural resource damage (Costanza *et al.,* 1997; Carson *et al.,* 2001; Carson *et al.,* 2003). The Biodiversity in Development Project (2001) defined total value as the sum of use values (direct use of products and services), and passive use values. When an agent does not need to make use of a good to receive benefit from it (e.g., an agent benefits from the existence of glaciers in the Antarctic, even if he or she never interacts with them), that use is passive, (Carson *et al.,* 2001). Natural resource damage is a popular application of contingent valuation and large studies such as the one on the 1989 EXXON Valdez oil spill in Alaska illustrate one of the best

examples available today (Carson *et al*., 20003). During a later valuation of environmental damages, Carson *et al.* (2003) found that the 3 billion dollars (1990) paid by EXXON on oil spill response, restoration, and compensation to the state of Alaska, actually matched the lower bound estimation of 2.8 billion dollars, originally estimated with a national contingent valuation. From this experience, these authors argue that requesting restoration or compensation for damaged natural resources requires knowledge of the monetary value the public places on a resource, and therefore the utility of the contingent valuation approach.

Sanjurjo and Carrillo (2006a) gave a first estimate of the present passive use value of a constant river flow in the Colorado River Delta. The present passive use value of a constant water flow in the Delta was estimated at $38 million pesos/year (or US$3.45 million/year; at an exchange rate of 1:11 dollars to pesos, in 2006)(Carrillo and Sanjurjo, 2006a). The estimation is qualified as conservative and it only expressed the opinion of SLRC and a few other river communities. According to the authors, estimating the passive value that larger neighboring cities such as Mexicali, Yuma, or San Diego place on a constant river flow should notably increase their initial estimate. Both authors have also clarified their aim to emphasize the importance of revealing contemporary passive use value of remnant environmental services in the Delta, rather than to open the debate on transboundary environmental justice. This thesis supports the same point of view and strives to make contributions in the same direction.

2.9   Socio-psychological models and willingness-to-pay

Socio-psychological models are tools to dissect the interactions of people's decisions and opinions and public policy strategies. These types of models look at people's systems of beliefs, attitudes, motivations, and behaviors (Brunson and Shindler, 2004). Although developing this type of models can vary depending on the object and group of people under study, there are common elements to all of them. For instance, all attitudes are the result of cognitive beliefs, emotional responses and value orientations towards an object in people's lives (Bright et al., 2002; Brunson and Shindler, 2004). Relevant theories that are commonly used during social psychology studies of natural resource management and valuation are the theory of planed behavior (Pouta and Rekola, 2001) and the theory of reasoned action (Fishbein and Ajzen, 1971). Pouta and Rekola (2001) argue that using the theory of planed behavior is appropriate in natural resource valuation, given that those types of resources involve non-market benefits. The theory of planed behavior uses willingness-to-pay as a behavioral intention where participants state their support or oppositions to protect a resource at their own cost.

The theory of planed behavior basically explains how behavior relates to intended behavior and how this relates to attitudes and norms. Three types of attitudes have been already related to willingness-to-pay studies, those are: attitudes towards the public good, attitudes towards policies dealing with the public good, and attitudes towards paying for the public good (Pouta and Rekola, 2001). In this study I mostly dealt with the attitudes towards paying for a public good although not exactly following any of the above theories and mostly relaying on my own intuition.

2.10 Conceptual Framework of the Study

Figure 2.1 outlines the disciplines and methods underpinning this study. The two leading disciplines of this study are restoration ecology and economics. Those disciplines converge into a strategy to study the economic costs and benefits of restoration through an analysis of people's willingness-to-pay (attitudes). The expected contribution of this work is to record and yield more information on potential regional benefits and barriers related to restoration efforts. The methods used in the analysis of this study were fieldwork and the analysis of secondary sources. Fieldwork focused on surveying Mexicali's households, and on gathering direct observations during a three-month stay in key locations of the study area. Other tools to collect complementary data were the 2005 SLRC survey results, academic reports, and government records. The study had exploratory, descriptive, and explanatory purposes.

Restoration Ecology

Ecosystem Services

Economics

Economic Valuation Theory
(CV)

Willingness-to-Pay

Local
Relationships &
Awareness of the Colorado River

Regional Profile of Attitudes

Public Support of
Restoration

Analysis of
Restoration Benefits
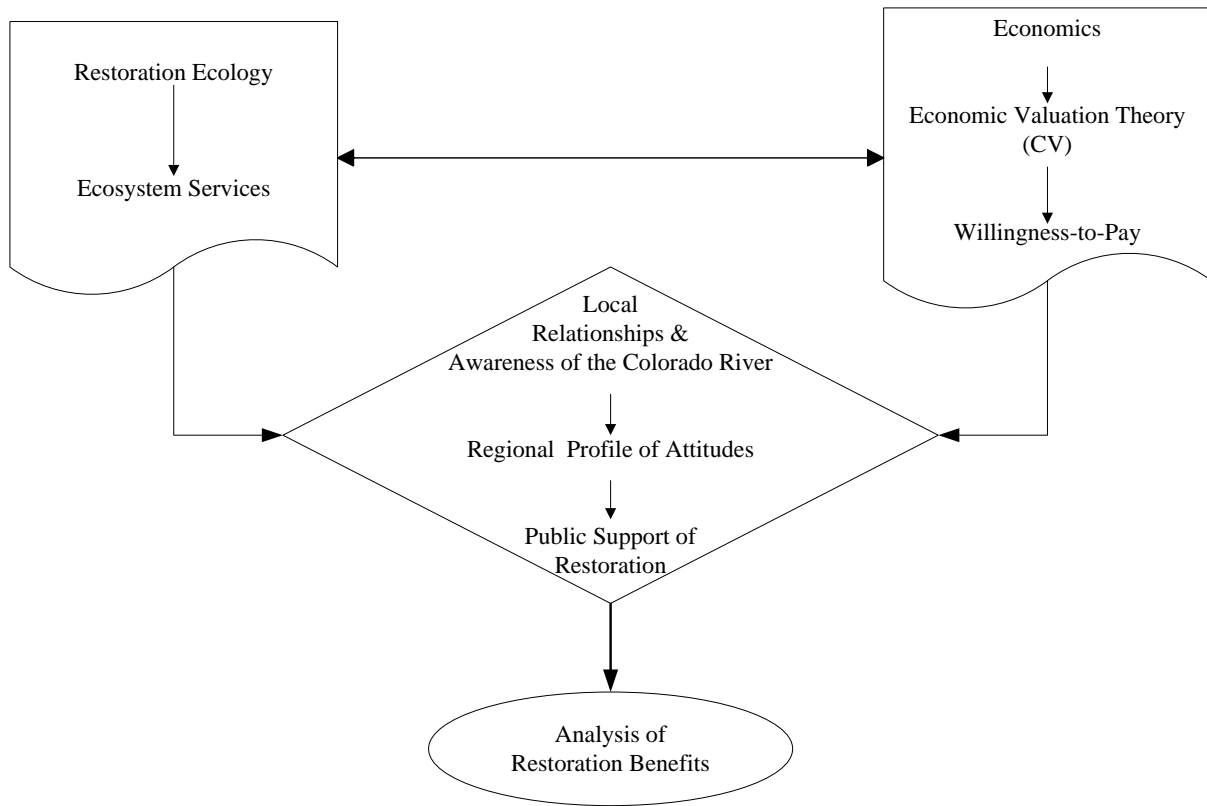
Figure 2.1. The conceptual framework of this study.

3 METHODOLOGY

3.1 Introduction

This thesis uses a case study research strategy and most of its findings were achieved through non-parametric statistic analysis of data. According to Yin (2003), a case study approach is used when there is a need to understand complex social phenomena in a contemporary domain. The case study is used in many situations to contribute towards knowledge of individual, group, organizational, social, political, economic, and related phenomena (Yin, 2003). According to Cohen (2002), the Colorado River delta provides a valuable case study for several reasons. On the one hand, the Colorado River delta offers a unique example of transboundary ecological degradation, as a direct consequence of extensive physical infrastructure and a complex legal framework. On the other hand, it also represents a valuable transboundary restoration opportunity due to the proven resilience of this ecosystem. The contingent valuation method is a survey-based economic method that focuses on asking people how much they are willing to pay for an environmental good or service. This method yields a number that represents how much that environmental good or service is valued by a specific group of people (community). In this study I used the core ideas and procedures of contingent valuation to investigate what determines people's attitudes to support a water flow restoration for the Colorado River delta.

3.2 Area of Study

First, it is worth distinguishing between the municipality of Mexicali, the city of Mexicali, and the Mexicali Valley. Basically, the last two are contained within the larger geographic and politic unit of the municipality. As a municipality, Mexicali is one of five municipalities in the state of Baja California, and it is also the state's capital (Figure 3.1). When talking about the municipality, I will refer to it as "the municipality of Mexicali," and it will include the city of Mexicali. However, for this study the survey efforts focused only on the city area to which I will refer as the "city of Mexicali" or "Mexicali." Finally, when talking about the rural area and crop production land, I will refer to it as the "Mexicali Valley" (Figure 1.1).

The city of Mexicali is bordered by California to the north, the Colorado River and Sonora to the east, the Mexicali Valley to the south, and the municipality of Tecate to the west (Figure 3.1). Mexicali is a border city located within 64 km of the Colorado River, at an elevation of 3-10 m, and with a municipal territory of 13,700 km^2. This city lies within the Sonoran Desert biome characterized

by a dry tropical climate (BW of the Köppen classification), an average precipitation of 5mm/year, and average evaporation of 170 mm/year. The temperatures range from 12°C to 49°C (Perez, 1981).

Figure 3.1. The state of Baja California with its five municipalities: Mexicali, Ensenda, Playas de Rosarito, Tijuana, and Tecate (Gobierno del Estado de Baja California, 2007).

In 2005, the city of Mexicali had a population of 653,046 people, about 74% of the population of the entire municipality (INEGI, 2006). The annual population growth for the municipality was 2% in 2005 (INEGI, 2006). In contrast, the national growth rate was 1%, in 2005, which means that the municipality of Mexicali has one of the highest population growth rates in Mexico (INEGI, 2006). According to federal and state reports, the state of Baja California has been known as a waiting area for emigrants for many decades, but in recent years the intensity of emigration has been gradually decreasing. In 2000, 12.8% of the population was classified as recent migrants ("migrantes recientes," people with less than 5 years of residency in the state), while in 2005 that proportion shrank to 8.2% (INEGI, 2006).

For many centuries, the Colorado River nurtured a vast extension of land known now as the Colorado River delta. Thanks to the deposition of layers of sediment that reach up to 2.5 km in thickness, the Mexicali Valley emerged as prime farming land extending to more than 2,000 km^2 (207,

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000 Ha) of irrigated land (Sykes, 1937; Cohen and Henges-Jeck, 2001). The Mexicali Valley is the agricultural heart of the state of Baja California and it is still responsible for some of the largest crop productions in Mexico (Sanchez-Lopez, 2000). Historically, this valley focused its production on cotton and became the leading national cotton exporter in the 1950s and 1960s (Gobierno del Estado de Baja California, 2007). Since the 1960s, the valley has diversified its production and now exports wheat, asparagus, broccoli, green onions, and radishes. Overall, crop production for internal and external markets includes about 40 commercial varieties between cereals, oilseeds, fodder, vegetables, flowers, and fruit trees (Sanchez-Lopez, 2000). In general, the valley's production is subjected to two productive cycles: spring-summer, and fall-winter. During the first cycle, cotton is the most important crop due to its value, while during the second cycle wheat is the most important crop (Gobierno del Estado de Baja California, 2007).

Gradually, Mexicali has been experiencing more economic changes thanks to the decree of a tax-free zone for imports and to the North American Free Trade Agreement (Mexicali Tourism Board, 2006). Mexicali's economy is now reoriented towards industrial activities, services, commerce, and tourism. Industrial activities for instance, are now dominated by assembly and manufacturing plants ("maquiladoras") that focus their production on electronics, textiles, cars, and trucks (Secretaria de Desarrollo Economico, Gobierno del Estado de Baja California, 2007). There are 24 large industrial zones within the municipality of Mexicali. In a national context, the state of Baja California has also one of the highest living standards in Mexico reflected by high investments in education and low unemployment rates. In 2006, Baja California's unemployment rate was 1.8% while the national rate was 4% in 2007. Both the state and municipal governments recognize that the economic life of this region is directly linked to water availability from the Colorado River.

Carrillo-Guerrero (2002) argued that community participation from private landowners could contribute to further conserve and restore the Colorado River delta. In her thesis work, Carrillo-Guerrero interviewed residents along the Colorado's riparian corridor (within the Mexicali Valley) and assessed their willingness-to-lease land and water rights under hypothetical conservation and restoration scenarios. Carrillo-Guerrero's work unveiled local interest, support, and commitment towards restoration efforts, which included retiring marginal cropland and leasing water rights. This author argued that gaining community participation is another crucial factor to overcome regional historic trends in wetland conservation. Therefore, gaining more knowledge about other rural communities or large urban centers associated with the delta will contribute towards a more integrated and inclusive restoration and conservation plan. As the state's capital and largest city in the Colorado River delta, Mexicali is an important site to study people's attitudes to support the ecological restoration of the delta.

Additionally, San Luis Rio Colorado, Sonora, was a secondary area of study that allowed me to make comparisons between a large city (Mexicali) and a small city (SLRC). Both cities are associated with the Colorado River but while SLRC has been characterized as a true river city, Mexicali is at least 64 km away from the river's influence. This variation in "distance to the river" was expected to influence people's environmental awareness and attitudes towards hypothetical water flow restoration efforts. SLRC is also a border city (Figure 1.1). In 2005, INE investigated people's willingness-to-pay in SLRC and found that people is willing-to-pay a maximum of 52 pesos/person/visit to a restored a Colorado River Delta area. During my study, I took the results of the SLRC study and made a non-parametric comparison of two things: levels of people's willingness-to-pay, and their motivation to support restoration efforts.

3.2.1 SLRC survey

This study used a previous willingness-to-pay survey from SLRC, Sonora, done by INE in 2005 (Carrillo-Guerrero, 2005). The sample size of this survey was n= 306, the error was 5%, and had a significance level of 90%. The rate of "no response" was not reported in that study. The SLRC survey had a total of 19 questions and all of them were also used in the Mexicali survey allowing me to follow the same survey design. Data collection followed a simple random sampling approach. The size of this city (145,006 people according to census of INEGI, 2000) allowed researchers to include all neighborhoods with a quota of 20 surveys from each of the 15 neighborhoods that compose this small city. Each neighborhood was delimited in a map and then systematically sampled starting from the most northwestern corner and then skipping four houses to collect the next survey.

3.3 Research Methods

3.3.1 Mexicali Survey

A survey was implemented during October of 2006 and targeted the heads of households in Mexicali. A total of 564 households were surveyed in three weeks. The unit of analysis, the household head, was considered as any adult (18 years or older) representing a family, specifically those making budget decisions or administering the resources of a home such as a mother or a father. On average, each survey took 15-25 minutes and was given in Spanish. To execute the survey, the researcher hired

the services of a market-research agency named FOCUS, a company with ample experience and headquarters in Mexicali. FOCUS provided five interviewers, one field supervisor, AGEB maps, and transportation. The researcher participated as a trainer, coordinator, and interviewer. All surveys were done face-to-face and captured on paper (Appendix A).

The survey design complied with standard contingent valuation methods building one realistic scenario with 4 price variations in the initial offer, randomly assigned to participants (Survey Type1 to 4, Appendix A). Each participant was asked to state his or her preference of price twice (double bounded dichotomous questions). With a binary survey design I investigated preferences at three levels: a baseline price or Offer1 that all participants received (20, 40, 60, 80 pesos); a higher price or Offer2 (30, 50, 70, 90 pesos); and a lower price or Offer3 (10, 30, 50, 70 pesos). Each participant was given an initial offer (Offer1), then, according to their Yes/No answer a second choice (Offer2 or Offer3). Offer2 comprised higher prices and was given only to those who already agreed to pay Offer1. Offer3, on the other hand, comprised lower prices and was given only to those who refused to pay Offer1.In other words, Offer2 tested participants' limits to pay above the initial offer, while Offer3 lowered the price seeking to shift negative responses into positive at a lower price.

3.3.1.1 Sample Size

The sample size was obtained primarily by reconstructing the standard deviation and the mean for the monthly income per household in Mexicali. To reconstruct that data I used the state of Baja California's census of population and housing CONTAR 2000, from INEGI. Precautions were taken to minimize the sampling error of the statistical estimators in accordance to our time and budget constrains. Under those considerations, the sampling size was finally established at $n=561$ households, with a margin of error (e) of 6.5%, and a confidence level of 95% (z). The final sample was rounded to $n=564$ households.

The sample was representative of the population because it was based on calculations of central income estimators (average and variance) of the population under study, which was later corroborated with state reports. The last available state report from 2003 locates Baja California's GDP at US 9,571 per person/year (Secretaria de Desarrollo Social del Estado de Baja California, 2007). This state report confirms and validates the income estimations made in this study (9,554 pesos/month of average income; 7522 deviation standard). The Statistical Consulting Service of the Statistics and Actuarial Science Department, at the University of Waterloo, provided support throughout the design and analysis of this study.

3.3.1.2 Sampling Procedure

In order to select 564 households from the city of Mexicali (Figure 3.2), I used a combination of random and systematic sampling design. First of all, I used random sampling at an AGEB (Basic Geostatistic Area) level and then systematic sampling of households within each AGEB. An immediate sampling need was to build the geographic limits of the sampling area. For that I adopted the AGEB as an intermediary area unit for this survey, aware that drawing a random sample from a city with 133,345 households would have been unviable with my resources. AGEB units are widely recognized and used for demographic and economic research by INEGI. In Mexico, one AGEB groups city blocks in sets of 50, approximately; the final area will always vary from one AGEB to the other (Figure 3.3). Based on the total number of AGEBs reported in the city of Mexicali (208), I discarded any remote AGEB (eight satellite urban areas), and those AGEBs that reported under100 households (three) during the 2000 population census (SCINCE por Colonias de Baja California, XII Censo General de Poblacion y Vivienda 2000, INEGI).

Once the survey area was delimited, a total of 47 AGEBS and 18 replacements were drawn using the random number function of Excel. An example of an AGEB's map is provided in Figure 3.3. I used similar maps for each AGEB visited during the survey. Subsequently, a quota of 12 surveys/AGEB was established based on two things: resources availability and direct recommendations from two marketing research agencies that usually implement 10 to 30 surveys/AGEB when surveying Mexican cities by AGEB.

Though this study tried to gather information from all socioeconomic levels, the highest socioeconomic levels of Mexicali were not reached. Access to households with the highest income levels of the city was not possible due to barriers to reach such strata (e.g. vigilance and security in rich neighborhoods). The original random sampling of AGEBs did include two rich neighborhoods but obtained zero response and thus I substituted them with a similar AGEB of a lower income. I believe that the data collected during this study is still representative given that the majority of the populations is medium/low class and thus very well represented in this work.
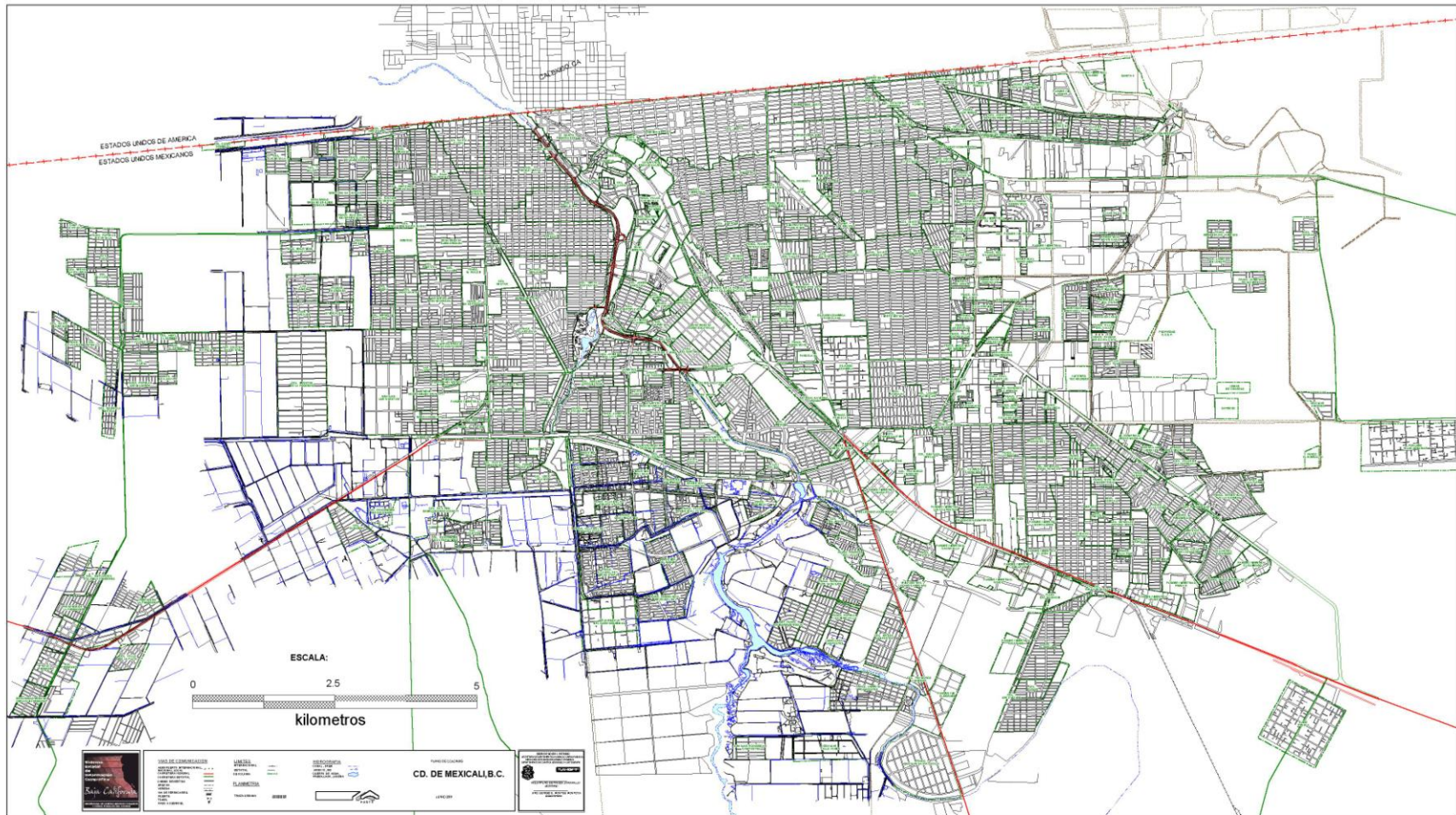
Figure 3.2. The city of Mexicali including its 208 AGEBs (Gobierno del Estado de Baja California, 2007).
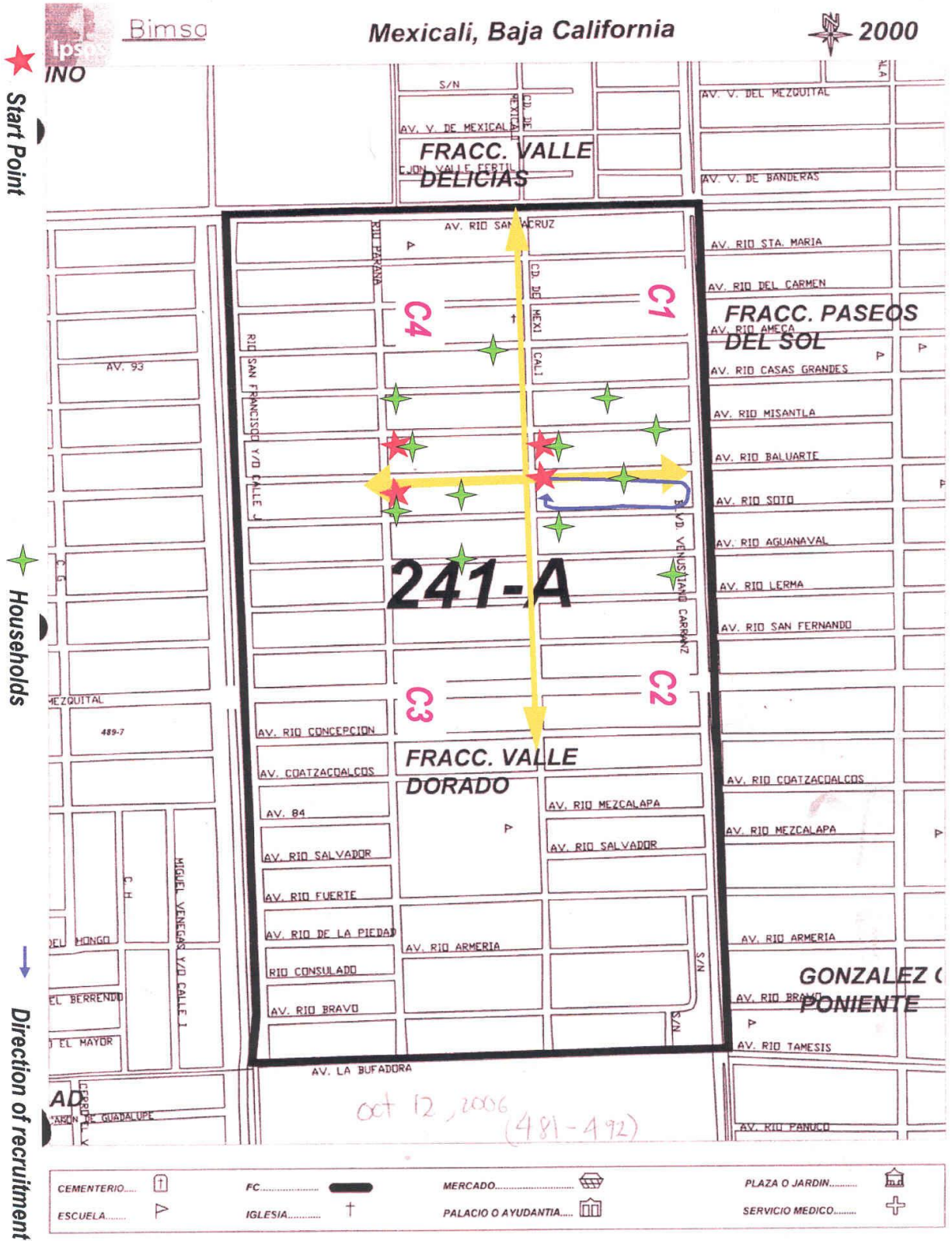
Figure 3.3. Example of an AGEB, the intermediate survey area to survey Mexicali (Bimsa-Focus, 2006). The stars indicate starting points (red) and sampled households (green).

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The procedure for the systematic sampling of each AGEB had four steps:

- Set a random start point for each AGEB, some times moving it a few blocks off to avoid industrial areas, public spaces, or abandoned property. Each starting point was always at the intersection of two streets in order to have three or four quadrants.

- Identify all quadrants and their boundaries, number them, identify the most northwestern corner of the first block of each quadrant, and assign one interviewer per quadrant.

- Interviewers started at the most northwestern corner of their first block (quadrant) and moved it in a clockwise direction until closing that block or until finishing their survey quota (three or four surveys). When response was low in a city block, interviewers continued sampling on the next block of their quadrant, always staying within the AGEB boundaries.

- Systematic household selection implied that interviewers made skips every four houses to obtain a maximum of three surveys per city block, or a maximum of two surveys per side of block (on one street).

- The refusal rate was not recorded in detail but in general it was low (once every 10 interviewed houses).

3.3.1.3 Survey Content

The purpose of the survey was to assess the level of citizens' interest in restoring a constant water flow to the Colorado River. To assess the levels of people's interest, the survey gathered information in four categories: people's interactions with the river, willingness-to-pay to re-establish a water flow, willingness-to-pay for potential recreational opportunities, and the socio-economic profile of participants.

The Mexicali's survey was adapted from Carrillo-Guerrero (2005). The original survey comprised 19 questions and was implemented in the neighboring city of SLRC, Sonora, in 2005. The modified survey for Mexicali had 29 questions including all 19 original questions from SLRC. The remaining 10 questions were added to make the new survey sensitive to Mexicali's specific circumstances. Most questions were closed ended and included numeric answers, multiple choices, and Yes or No answers. Only four questions were open ended. An example of the survey is available in Appendix A.

To comply with the original survey design, Mexicali's study also used four survey variations (Survey Type1 to 4). On a typical willingness-to-pay survey, prices are set in a way the participant can be tested for a range of prices, usually through binary choices (Carson, 2000).

Four initial prices conformed Offer1 in question 17. Questions 18 and 19 presented Offer2 and Offer3, respectively. All other questions were kept the same for all surveys. In survey Type1, participants were asked to choose from monetary values of 20 and 30 or 10 pesos. Survey Type2 participants have to state their preference at 40 and 50 or 30 pesos. Survey Type3 offered choices of 60 and 70 or 50 pesos. Survey Type4 offered choices of 80 and 90 or 70 pesos. The price range of 10 to 90 pesos was set by INE, according to the regional minimum daily wage of $48.67 pesos (INEGI, 2005). This spectrum of prices allowed participants to have choices, selecting a realistic monthly monetary contribution to restore water to the river. Appendix A contains the four surveys with their respective field materials (map and pictures). Each household was randomly assigned one survey type. The number of surveys was approximately uniform across the types. The final tally included 142 surveys of Type1, 141 surveys of Type2, 140 surveys of Type3, and 141 surveys of Type4, for 564 surveys in all.

3.3.2   Secondary Data

Secondary sources and a detailed literature review provided the conceptual framework and context for this study. The literature review covered two main categories: an overview of historic environmental issues and conservation and restoration opportunities in the Colorado River Delta; and an overview of economic valuation and willingness-to-pay methods. These subjects were looked at to demonstrate the link between people's attitudes towards restoration efforts and the economic benefits from ecosystem restoration.

Secondary data such as federal and state publications aided this study from three different angles: building the study's framework, determining a sample size, and to providing a basis for qualitative comparisons during the results' analysis. Some of the most useful secondary sources were the demographic and economic reports from INEGI. Other useful materials were academic and internal reports with the latest recommendations on how to approach conservation and restoration challenges in the delta.

3.3.3   Direct Observation

Field observations were mostly incidental and happened during a three month immersion in field work. Interacting with land managers, academics, NGOs, households, and rural communities allowed me to acquire a better understanding of restoration issues in the delta, levels of organization to push the restoration agenda, work ethics of those directly involved, citizens' attitudes, citizens' needs, and so on. I made field observations as a side record in order to understand the environmental conditions of the Colorado River Delta and how citizens' support could improve the ecological state of such ecosystem.

3.4   Analysis

Three stages of data analysis took place during this study. The first object of analysis was the Mexicali survey from which I drew a descriptive statistical report. Building a solid database in SPSS was an initial step to handle most of the subsequent analysis, although most graphs were produced in Excel. Then I identified key variables from the descriptive statistics and did a cross tabulation to reveal dependency among variables within Mexicali's boundaries. In this second stage, I also examined Mexicali and SLRC's relevant variables in order to reveal if environmental awareness and income influenced the differences in people's support for restoration. Finally, I used secondary sources such as INEGI and the Baja California Government Reports to set my findings in a regional socio-economic context.

Overall, the combination of secondary data, a solid literature review, and the analysis of field data allowed me to validate the study's findings.

3.5   Ethics

All questions used during this research were reviewed and approved by the University of Waterloo's Office of Research Ethics. Permission to participate in the anonymous survey was always verbally granted by participants; interviewers received proper training and were reminded that participants had the right to answer only the questions that they wished to do so.

4 RESULTS

The results are presented in three parts: descriptive statistics of Mexicali survey, cross-tabulation analysis of Mexicali variables, and Mexicali-SLRC analysis. The answer to the first research question relies on the findings of Section 4.1 and 4.2, while the answer to the second question is in Section 4.3. Regional and national socioeconomic information is provided with the Mexicali survey results to give the reader a context to interpret results.

4.1 Descriptive statistics of Mexicali survey

4.1.1 Participants' socioeconomic profile

The sample consisted of 40% (222) males and 60% (332) female participants. The participants' age averaged 43.6 years, while the median was 42 years (recall that the survey targeted people of 18 years or older). The number of years of residency in Mexicali or its vicinity averaged 31 years. The box plots of Figure 4.1 present a visual summary of age and years of residency. The summary includes the median, minimum, maximum, lower quartile (q1), and upper quartile (q3) for each variable.
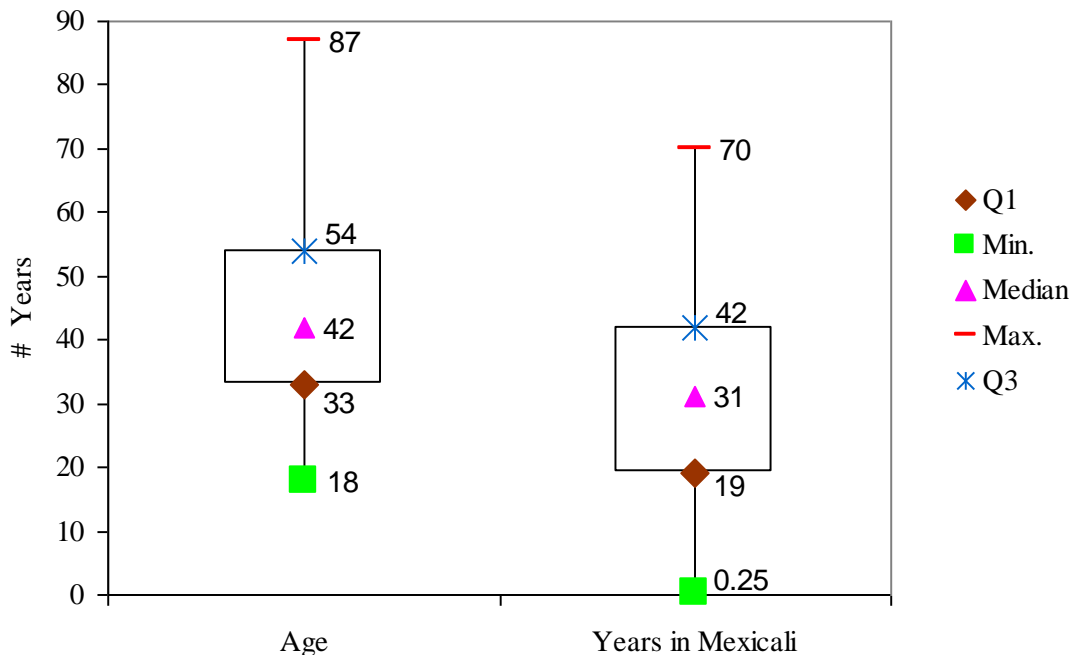
Figure 4.1. Five-number summary of participants' age and years of residency in Mexicali.

The number of years of residency in Mexicali, in general was high. The histogram of Figure 4.2 shows a higher concentration of answers in the 20-50 years range (65%), than in the 0.25-19 years range (25%), or the 51-70 years range (10%). Only 6% of the participants were recent immigrants to the state with 5 or less years of residency in the area. These findings match trends of diminishing migration to the region (INEGI, 2000 and 2006 census). In 2000, INEGI reported that 12.8% of the state's population was considered recent immigrants, by 2005 the percentage of recent immigrants diminished to 8.2%. Our findings yielded 6% of recent immigrants (in 2006), which in general correspond to the regional tendency of diminishing migration.
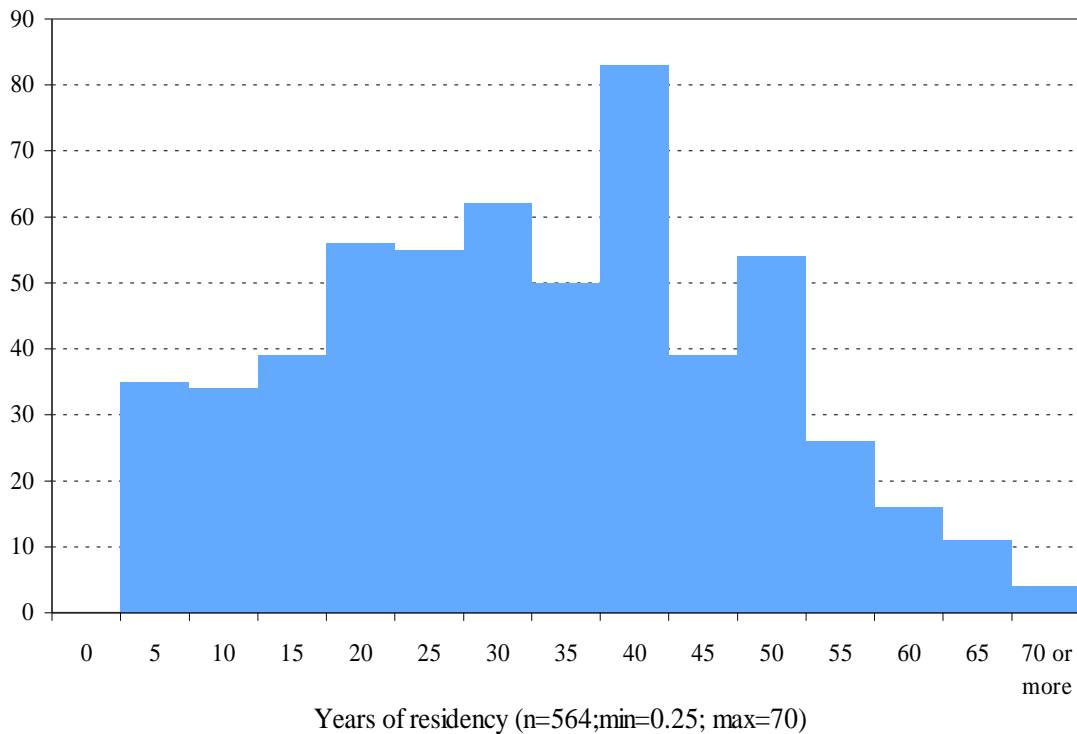
Figure 4.2. Histogram of participants' number of years living in Mexicali.

Nearly 46% of participants were born in Baja California (261), and more specifically in the municipality of Mexicali (45%). In this study I confirmed that neighboring states such as Sinaloa, Sonora, Jalisco, Michoacan, and Nayarit were the main sources of emigrants into Mexicali (35%). The rest come from other states (19%). Over time, state and federal demographic reports have discussed the migratory nature of Mexican border cities like Mexicali and Tijuana. In Baja

California, migration is the main demographic component that defines population growth. For instance, in 2006, 1 of every 2 Baja California residents was born outside the state or came from another country (CONEPO 2007). According to the state government, migrants arrive in Baja California with the intention of crossing to the United States but when their attempts fail they decide to stay and make their lives there. In 2005, Baja California reported a migratory population of 43.6%. According to INEGI (2007), there are two main reasons for migration into Baja California: finding a job, and reuniting family members.

The average number of adults/household was 2.9 and there was an average of 1.4 children/ household. The highest complete education level attained in the majority of the households was junior high with 28% (in Mexico, grades 7-9), followed by high school with 26% (grades 10-12), then elementary school with 18%(grades 1-6), then people with no education or unfinished elementary school with 14%, and finally people with a completed college degree, 12%. Only 1.1% (6) had postgraduate education. Average income per household was 8,310 pesos/month. This average represented the sum of earnings of all family members that contribute to support the economy of a single house. Figure 4.3 summarizes the statistics for this variable from which it can be observed that the median was 7,000 pesos/month, although the mode was 4,000 pesos/month. The minimum was 0 pesos and the maximum was 36,000 pesos/month.
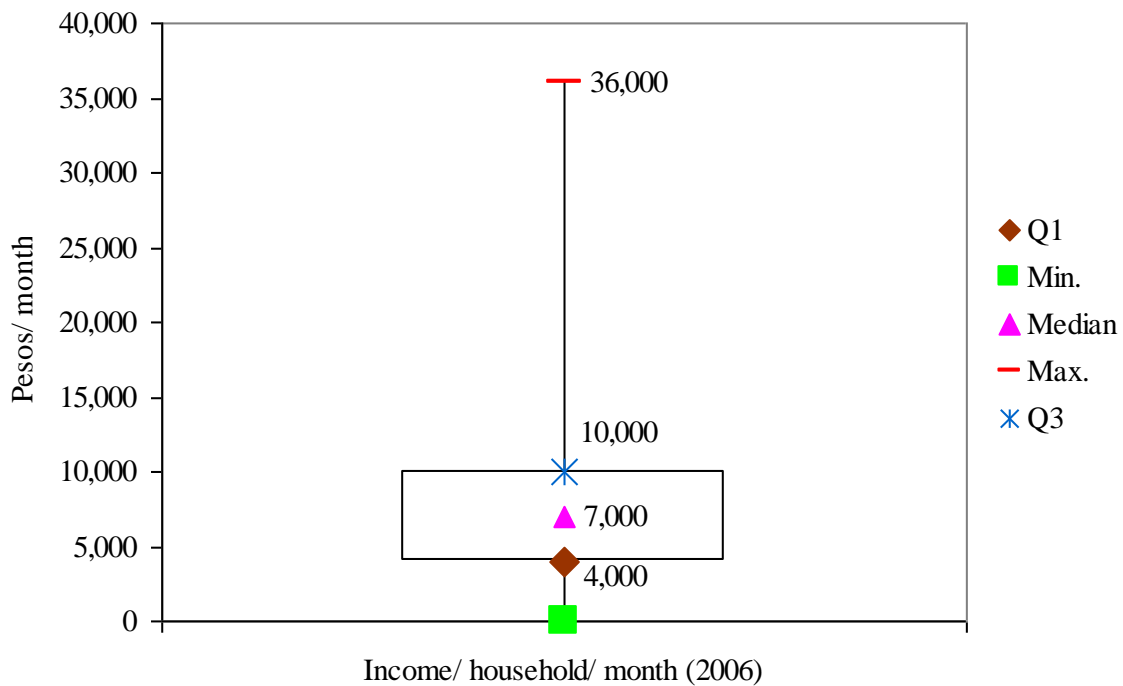
Figure 4.3. Participants' income in a five-number summary.

4.1.2 Visitor-river interactions

To determine different levels of visitor-river interactions I used several questions that differentiated levels of interactions. First, I asked whether participants ever saw or visited the Colorado or Hardy Rivers (Q2). Affirmative answers accounted for 74.3% (419) and negative answers for 25.7% (145). Participants with negative answers were excluded from other visitor-river interaction questions, and directed to another question to determine their indirect exposure to the river (Q8).

The next question (Q3) asked 416 participants (3 missing responses) to verify what sections of the river they have seen or visited with the aid of a map (Appendix A). About 84% (351) easily differentiated between the two rivers on the map. On the other hand, 16% (65) got confused between the two rivers, thus reflecting that perhaps these people has been visiting the Hardy instead of the Colorado River. Those participants who got confused were directed to Question 8.

People who correctly identified the Colorado River as the area they had previously seen or visited were classified into five categories of interactions (Q4). Out of 351 people, 62% (216) declared to have "only seen" the river but "never visited". The rest of them, 38% (131 participants), have indeed "visited" the river to varying degrees: 30% had visited "a little", and 8% had visited the river "a lot". The number of annual-river visits with specific recreational purposes of the 131 people who have visited the Colorado River averaged 0.9 visits/participant/year.

Figure 4.4 displays what sort of activities people preferred during their visits to the Colorado River (Q7). All activities were day trips and not overnight stays, except for a single case that reported camping. The most popular activity was to visit the river for a family "picnic" ("días de campo con la familia"), which represented 36% of the preferred activities. Fishing, day hikes, and swimming were the next preferred activities during river visits accounting for 17.4%, 16.5% and 15.3%, respectively. Other activities that were less frequently chosen included dirt road biking and wood gathering.
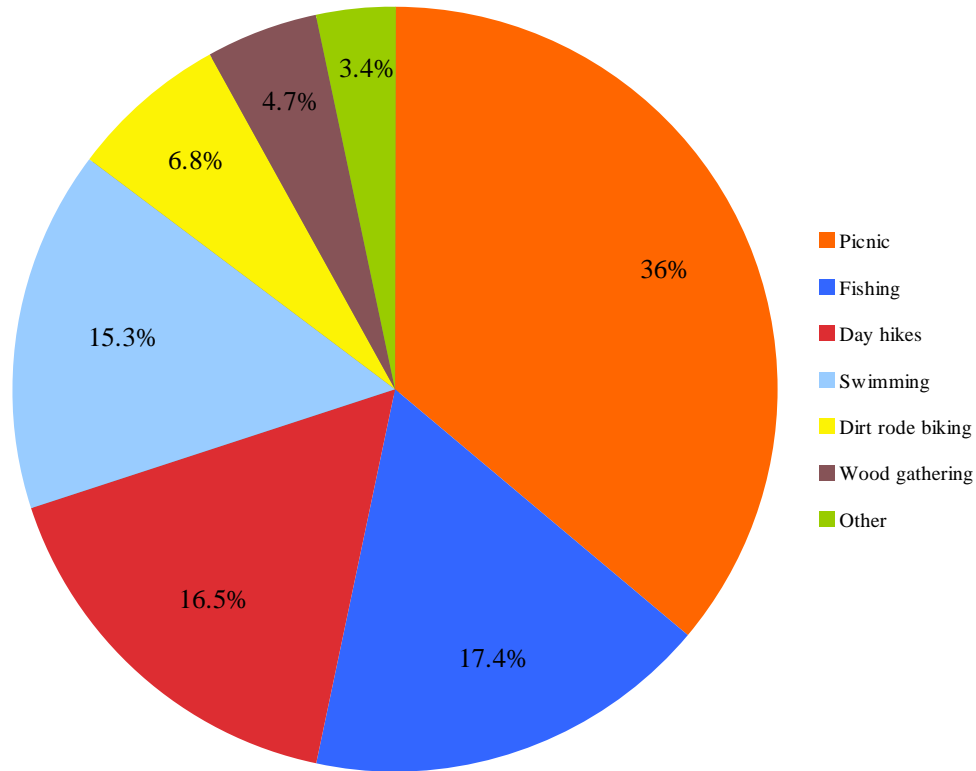
Figure 4.4. Preferred activities associated to river visits in the Colorado River (n=131).

Another strategy to measure how often people from Mexicali interact with the Colorado River was to look at how often they drive over the SLRC Bridge, a bridge connecting the states of Baja California and Sonora via the main regional highway. That specific site was selected because the tollbooths are located a few meters away from the river's course and all vehicles have to use the bridge, even when the river is now dry most of the year. These questions (Q8-Q9) included all participants (564), including those who say they "never visit/see the river," as it was a way of estimating their indirect exposure to the river. The average of SLRC Bridge crossing was 0.52 times/participant/month, which broadly means, that one person from Mexicali made one round trip (crossed twice the bridge) every four months, approximately.

The remaining questions assessed people's awareness of the river's environmental issues and their interest to protect the river in the future. First I found how many people reported ever seeing the Colorado River dry (Q10). For this variable, affirmative answers accounted for 51% (287). Other people declared to have never seen the river dry, 37% (210); while the remaining 12% (67 people) said they did not know what were the water conditions of the river. Participants reported dry river conditions in 2006, 2005, 2004, 2003, 2002, 2001, 2000, 1999, 1996, 1995,

1994, 1991, 1990, 1987, 1985, 1983, 1970, 1960 and 1953. Most of these years matched periods of dry river years reported in the literature (Glenn *et al.,* 2001; Zamora-Arroyo *et al.,* 2001).

Participants were also asked if they could recall the 1997-98 wet years (Q11), which increased the river's flow due to "El Niño" event. In this question 60% (337) of the total sample answered "Yes" while the other 40% (226) answered "No."

Subsequently, participants were provided with two statements with which they had to agree, disagree, or express their lack of awareness (Q12-Q13). In the first case, 83% (464) agreed that "when the river carries more water, environmental improvements manifest along the river's corridor". Only 5.5% (31) disagreed and the remaining 12% (67) expressed not knowing about it. The second statement was "the scarcity of river water is one of the causes why the totoaba (giant sea bass) is currently endangered". With this statement, 47% (261) of participants agreed, 9% (51) disagreed, and 44% (244) admitted to not know about the issue.

Approximately 99% (557) of participants stated they were in favor of legally protecting the Colorado River and its adjacent forests (Q14). Only 1% (6) participants responded "No" to seeking legal protection for the river.

In regards to participants' preference for a desirable constant water level in the river (Q15), the preferred river condition was an "abundant flow" with 66% (373) of preferences; the "1997-98 pictures" represented this condition. A "moderate flow" condition accounted for 33% (188) of preferences. The remaining 0.4% (2) indicated no preference for either of the water levels. A picture representing "dry-river" conditions was also showed to participants but nobody selected it. Appendix A has the pictures of the three river conditions presented to participants.

All participants were also asked if they were currently enrolled in any group advocating environmental activism as its main trait. Only 2 people (0.4%) provided an affirmative answer, which reflects citizens' lack of involvement in regional and local environmental matters.

4.1.3 Willingness-to-pay for a constant water flow

Willingness-to-pay to reinstate a constant flow to the river was addressed in Questions 17, 18, and 19. The survey had three offers but each participant received only two at the time. The mechanism to deliver offers was to first ask everyone if they were willing to pay Offer1, which included randomly assigning initial prices of either 20, 40, 60, or 80 pesos. Then, depending on their "Yes" or "No" answer, they were given a second choice (Offer2 or Offer3, respectively). On one hand, those with affirmative answers were asked if they were willing to pay a higher price

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in Offer2 (30, 50, 70 or 90 pesos). On the other hand, those with a negative answer were asked to pay a lower price instead, in Offer3 (10, 30, 50, or 70 pesos). Further methodological details can be found in Chapter 3 and Appendix A.

Tables 4.1 to 4.3 provide a qualitative willingness-to-pay baseline. In Table 4.1, I summarized participants' percentages of response to Offer1 and Offer2, simultaneously. To interpret the results presented in this table, observe that the left side columns only refer to people who responded "Yes" to Offer1 (in any of its four prices). The right side columns contain the Yes and No answers from Offer2, which quizzed participants with previous "Yes" answers to Offer1. All percentages are based on the total number of surveys applied for each price; each price was initially considered a separate case (100%).

Table 4.1. Percentage of people reflecting their willingness-to-pay to restore a constant river flow.

Offer1: "YES" (Q17)			Offer2: Yes and No (Q18)		
Price	#Surveys	#YES (%)	Price	#Yes (%)	#No (%)
$20	142	98 (69%)	$30	70 (49%)	28 (20%)
$40	141	63 (45%)	$50	47 (33%)	16 (11%)
$60	140	49 (35%)	$70	32 (23%)	17 (12%)
$80	141	42 (30%)	$90	32 (23%)	10 (7%)
	Total=564	**252 (44.7%)***		**181 (32.1%)**	**71 (12.6%)**

Following the same organization, Table 4.2 contains participants' percentages of "No" responses to Offer1, and then the Yes/No answers to Offer3.

Table 4.2. Percentage of people reflecting less willingness-to-pay to restore a constant river flow.

Offer1: "NO" (Q17)			Offer3: Yes and No (Q19)		
Price	#Surveys	#NO (%)	Price	#Yes (%)	#No (%)
$20	142	44 (31%)	$10	25 (18%)	19 (13%)
$40	141	78 (55%)	$30	17 (12%)	61 (43%)
$60	140	91 (65%)	$50[a]	16 (11%)	74 (53%)
$80	141	99 (70%)	$70	14 (10%)	85 (60%)
	Total = 564	**312 (55.3%)**		**72 (12.8%)***	**239 (42.4%)****

a:$50 pesos had 1 survey with no answer (90=91-1)

Figures 4.6 and 4.7, along with Table 4.3, can further illustrate the meaning of Tables 4.1 and 4.2. I determined how many people were in favor of supporting water flow restoration by committing to pay at least one of the offers they received. I found that 57% of people were

willing to pay at least one of the offers; the other 42% showed no commitment since they answered "No" twice (Table 4.3).

Table 4.3. Descriptive summary of willingness-to-pay.

Willingness-to-pay overall percentages	
Total Yes* (to at least one offer)	324 (57.5%)
Total No** (to both offers)	239 (42.4%)
TOTAL	563 (100%)
AVERAGE***	**42.8** pesos/household

*I added totals of "Yes" from Offer1 and Offer3.
***I made a simple calculation with Offer1 (Yes).

I also wanted to infer what was the preferred price that people was willing to pay. Figure 4.5, shows how many people initially answered "Yes" to Offer1 (left side columns), and then how many of them were willing to pay a higher price in Offer2 (right side columns). Overall, Offer1 of 20 pesos received the greatest support from participants ("Yes"= 69%; "No"=31%), and Offer1 of 80 pesos was the least supported price ("No"=70%; "Yes"=30%).
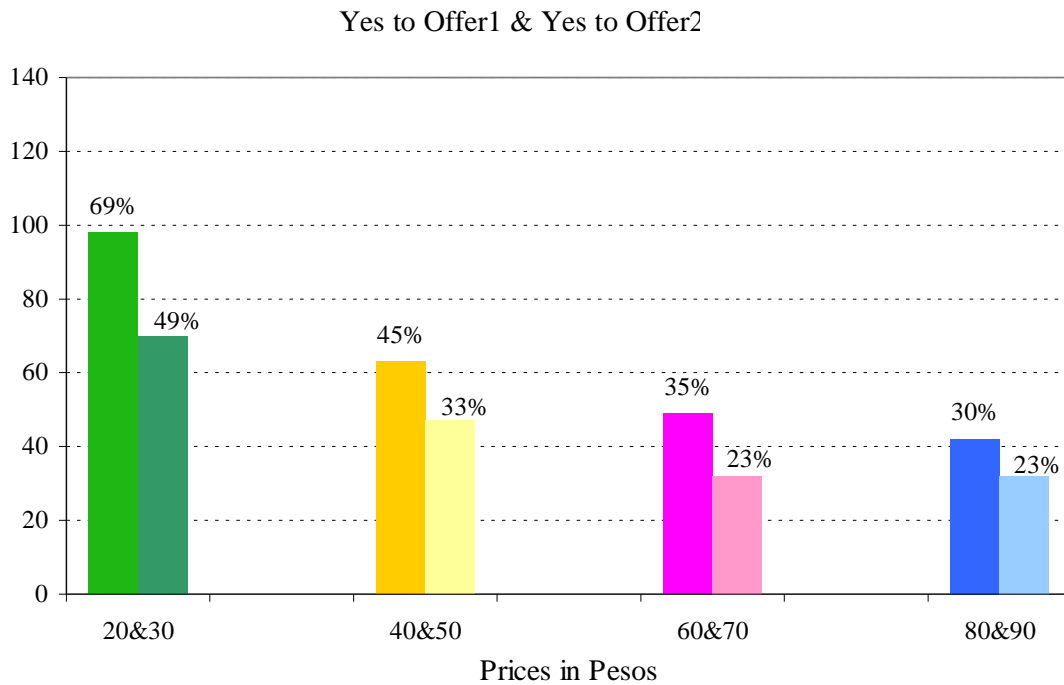
Figure 4.5. Summary of affirmative support (%Yes) to pay Offer1 and Offer2 in Mexicali.

Also, while contrasting Offer1 and Offer2 (Figure 4.5) it is evident that when prices between offers increase then support drops for all prices as well. For example, the original 69% that agreed to pay 20 pesos shrunk to 49% when participants were asked to pay 30 pesos instead. The remaining prices also lost support as prices increased between offers.

Offer3 was presented only to those participants who initially answered "No" to Offer1, in order to test their willingness-to-pay at a lower price. As can be seen in Figure 4.6 for Offer1 (left-side columns) and Offer3 (right-side columns), only the first price of Offer3 (10 pesos) gained more support than any of the other prices (30, 50 or 70 pesos). For instance, people's support shifted notably given that more than half (25 participants) of those who did not want to pay 20 pesos (44 participants) changed their opinion to pay 10 pesos/month instead. That shows that people who already answered "No" to the highest prices of Offer1, changed little their mind to commit even at lower prices (i.e. only 14 people changed their mind out of 99 who initially responded "No" to Offer1 of 80 pesos).

NO to Offer1 & Yes to Offer3

Figure 4.6. People who changed their mind and agreed to pay Offer3 (right side columns), after stating "No" support to Offer1.

Subsequently, I also investigated the reasons underlying negative responses to pay any of the given prices (Figure 4.7). More than half (62%) of those who answered "No", expressed that

either $20-10, $40-30, $60-50, or $80-70 pesos was more than they could pay per month. Other people (13%) expressed that they did not want to receive additional charges on their water bill, thus these people were classified as "not interested" in supporting any restoration that implies their monetary commitment. Another reason to not pay was that people considered that these kinds of actions were not a "citizen obligation"; these people particularly pointed out to the binational nature of the issue and called for federal (resource) intervention instead of community participation (10.4%).
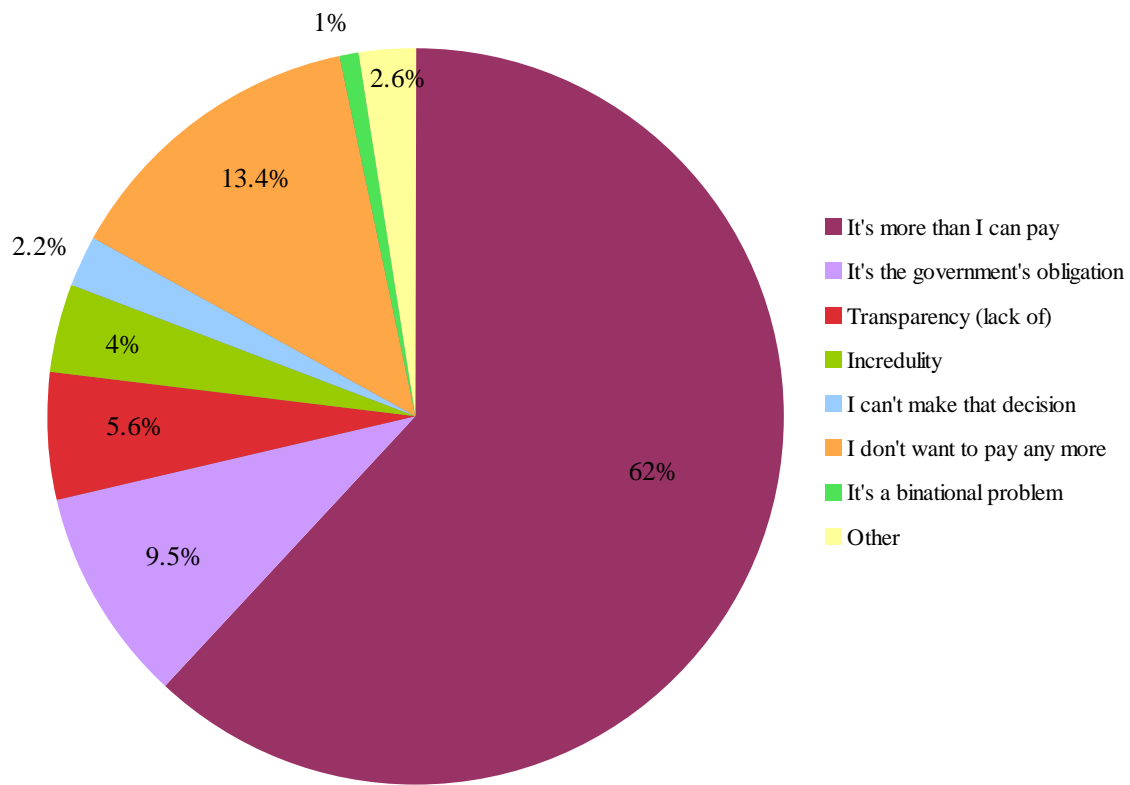
Figure 4.7. Main reasons to not pay to re-establish constant water flow.

To further inquire about the motives that persuaded participants to say "YES" to any of the given prices, the survey also asked why participants wanted to pay to reinstate a constant flow (Q20). The main reasons to pay for the river's water were, first, to conserve resources (23%); then people also recognized the river's ecological importance (17%); then its importance for future generations (16%); people were also interested in its economic potential (14%); its esthetic

contribution to the regional landscape (12%); and finally in the protection of an element that is part of their regional identity (12%).

4.1.4 Willingness-to-pay for potential recreational opportunities

(Questions 21 to 24)

This last section of questions focused on the potential for future recreational preferences and demands from participants. First, I asked if they thought they were already receiving any direct benefits from the Colorado River, in its current state (dry), at two levels: personal (or family) and regional levels.

At a personal or family level most participants expressed that the river did not benefit them at all (45%; Figure 4.8). A second group of people, 35%, thought that the river's water is directly supplying households with residential tap water. In fact, most Mexicali tap water comes from Mesa Arenosa ground-well field (Alvarez[1], 2007) and thus the Colorado benefits them through ground water recharge, in an indirect way. A third group, 10%, admitted to not know what sort of benefits they already receive from the Colorado River. Adding up these three groups, I concluded that 90% of people either has the wrong information about where their tap water is coming from, neglects the importance of the river in their lives, or ignore how the river really supports their lives overall. Other perceived personal benefits included tourism, environmental services, trees and shade, a beautiful landscape, agriculture, and reception of the city's sewage. Only 1% considered that the current state of the river ("dry") had negative impacts in their lives such as insecurity, hidden drug traffic, depressing landscapes, and the region's bad reputation. This specific answer deserves some attention because although the question did not focused on the negative impacts, 1% of participants brought it up and perhaps the question should have been expanded to gather opinions on the negative impacts of a "dry river".

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[1] Alvarez, Manuel. 2007. Personal communication from a CILA retired engineer.
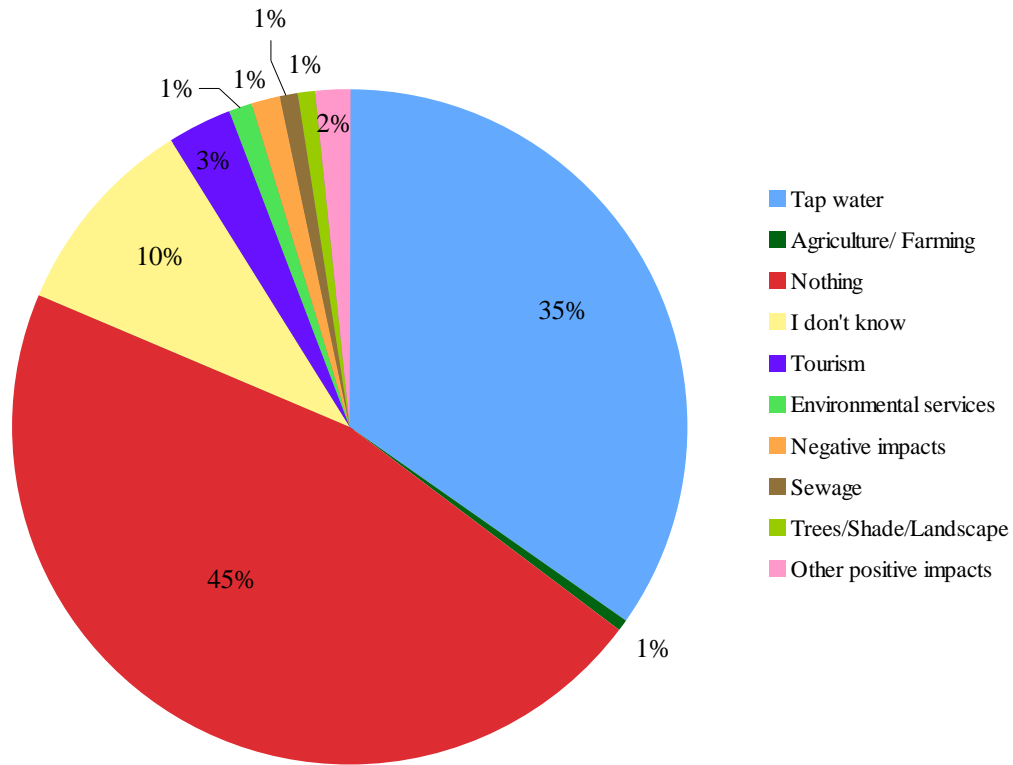
Figure 4.8. Perceived personal benefits associated to the Colorado River.

On the other hand, the perceived regional benefits indicated that 42% of people think that agriculture and farming are the main water beneficiaries in the region (Figure 4.9). This appreciation matches the hydrological reality of the Mexicali Valley. Subsequently, 33% of people either did not know how the river benefits the region or undermined its importance and declared that the river brings no benefits to the region. The remaining 25% included a wide variety of perceived regional benefits.
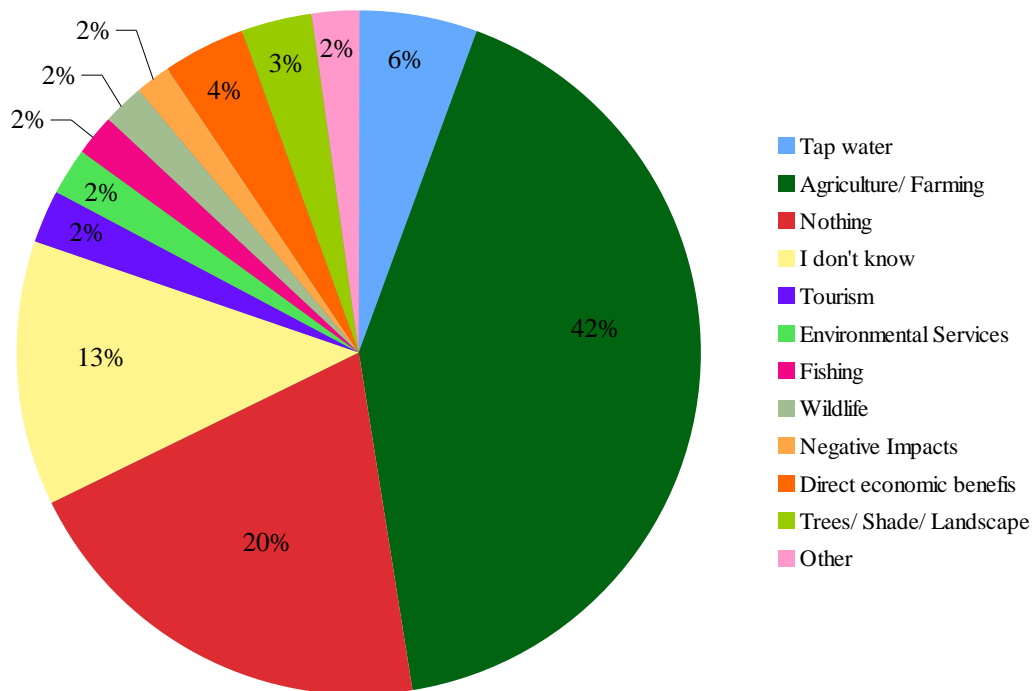
Figure 4.9. Perceived regional benefits associated to the Colorado River.

When asked if they would consider the Colorado and Hardy Rivers as future recreational options in the region (Q22), 93% said Yes and 7% said No.

In regards to participants' willingness-to-spend on a day trip to the Colorado River with their families (Q23; Figure 4.10), I found that most people preferred to spend between 50-100 pesos per person per day (44%, 246); followed by 100-200 p/p/d (29%, 163); then 200-300 p/p/d (14%); and finally >300 pesos (9%). Ranges of expenditure varied from 50 to more than 500 pesos.
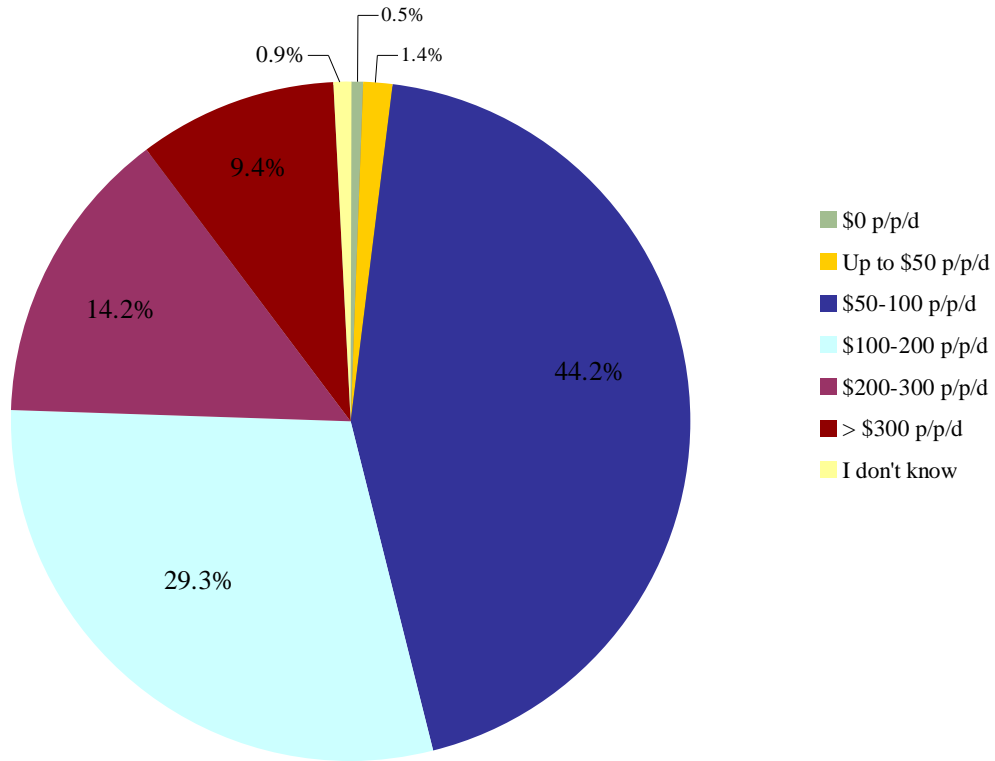
Figure 4.10. Potential visitors' ranges of expenditure for a river trip (pesos/person/day).

Finally, the survey gathered opinions about what to change in the Colorado River in order to make it more attractive to visitors and increase visits (Q24). Most people (546) provided at least one suggestion, if not more. The collection of ideas is represented in Figure 4.11. The five most outstanding suggestions were: provide infrastructure and facilities for recreation (23%), reforestation (15%), more spaces with shade (with man-made structures such as palapas, 14%), provide and maintain clean spaces (7%), as well as provide a constant and clean water flow (6%).

I don't know
More security & vigilance
Public WC
Reforestation/ healthy ecosystems
Constant water flow/ clean water
Facilities for recreation
Clean spaces & their maintenance
Shade/ Palapas
Giftshops & grocery stores
Organize activities & events
Rent of equipment
Improve vehicular access/ public transportation
Promote fishing
Control acces & regulate activities
Food services
Camping areas, bungalows, a hotel
Other facilities & actions

Figure 4.11. Collective ideas to improve the quality of their visits to the Colorado River.

4.2   Cross-tabulation analysis of Mexicali variables

To study the dependence among Mexicali variables I relied on non-parametric statistic analysis, and I cross-tabulated the variables of interest to obtain their Pearson Chi-square (χ^2) and *p-value*. I initially based variable association on suggestions made by INE, relying on their experience working with SLRC in 2005. Table 4.4 summarizes the analyses presenting Chi-square values, *p-values*, and the resulting conclusion for each association, expressed as the "Significance of the Relationship." Detailed tables of results for each variable association are in Appendix A.

The null (H_0) and alternative (H_1) hypotheses tested for each pair of associations are:
H_0: *There is no relationship between the two variables being compared*
H_1: *There is a relationship between the two variables being compared*

The analyses concentrate on testing the dependency of willingness-to-pay Offer1 against ten other relevant variables (Table 4.4). I choose Offer1 (Q17) as the only offer to test because it was the only one presented to all participants. The variables tested in association with willingness-to-pay (Q17) were: people who visit or do not visit the river; degree of people-river interactions; frequency of visits; frequency of bridge crossings; awareness of dry river conditions; advocacy for legal protection of the river; perceived personal benefits from the river; presence of children at home; level of education; and income. Additionally, I decided to complement those associations testing two other associations: "dependency of willingness-to-pay for potential services" (from Q23, not Q17) *vs.* "perception of received personal benefits from the Colorado River"; and "perception of received personal benefits" *vs. "*levels of education."

To draw conclusions on associations, researchers first have to estimate the Pearson's Chi-square statistic, compare it to critical values using the calculated degrees of freedom, *df*, and finally arrive to the *p-value*. The *p-value* is then used to decide whether or not to reject the null hypothesis (H_0). In social sciences, the null hypothesis (H_0) can be rejected when the calculated *p-value* is less than 0.05. I found that most variable associations (9) were independent (*p-value* >0.05) and that only 3 associations were actually dependent (*p-value* <0.05) (Table 4.4). The three dependent associations were between:

- Willingness-to-pay for river flow restoration and the perception of receiving personal benefits from the river ($p < 0.001$)

- Willingness-to-pay and presence of kids in a household ($p = 0.016$)

- Willingness-to-pay for potential recreational services and perceived personal benefits ($p < 0.001$).

Table 4.4. Relevant associations of variables from Mexicali survey.

Cross-tabs	Description of each association	Chi-square	*p-value*	Significance of Relationship
Q17-Q2	Willingness-to-pay *vs.* People who have seen or visited the CR or HR	1.26	0.150	NO
Q17-Q4	Willingness-to-pay *vs.* Degree of people-river interactions	8.35	0.080	NO
Q17-Q5	Willingness-to-pay *vs.* Frequency of visits/ year	5.1	0.078	NO
Q17-Q8	Willingness-to-pay *vs.* Frequency of CR crossings/ month at SLRC bridge	1.33	0.722	NO
Q17-Q10	Willingness-to-pay *vs.* Awareness of dry river conditions	5.05	0.080	NO
Q17-Q14	Willingness-to-pay *vs.* Wanting legal protection for the CR	0.32	0.570	NO
Q17- Q21a	Willingness-to-pay *vs.* Perceived personal benefits received from the CR	17	<0.001	**YES**
Q17- Q26	Willingness-to-pay *vs.* Presence of children in households	5.8	0.016	**YES**
Q17- Q27	Willingness-to-pay *vs.* Level of education	9.06	0.107	NO
Q17- Q29	Willingness-to-pay *vs.* Income	13.05	0.071	NO
Q21a-Q23	Perceived personal benefits from the CR *vs.* Willingness-to-pay for potential services (recreation)	22.2	<0.001	**YES**
Q21a-Q27	Perceived personal benefits from the CR *vs.* Level of education	9.13	0.100	NO

Within the independent associations there were also two slightly different groups, though. The first group showed a strong variable independence in five associations with *p-values* clearly above 0.05 (Appendix A- Tables 1, 4, 6, 9, and 12). The second group showed borderline *p-values* in 4 associations, by which I mean that although values were above 0.05 they were so close to 0.05 that H_0 might have been rejected if I had analyzed the data within a limited range of prices and not with all the prices at once. This specific issue is discussed in Section 5.4. The variables that showed borderline associations with willingness-to-pay were: degrees of river interactions; frequency of visits to the Colorado River; awareness of dry river conditions; and income (Appendix A- Tables 2, 3, 5, and 10).

4.3   Mexicali and SLRC analysis

Answering the second research question of this study lies within the analysis presented in this section, where common variables from the Mexicali survey are contrasted with their counterpart in SLRC. I present the comparison of both localities in two parts. First, I compare relevant variables drawn from the descriptive statistics of both surveys (Section 4.3.1). Then, I present the results of a qualitative comparison of willingness-to-pay from both locations (Section 4.3.1.).

4.3.1 San Luis Rio Colorado and Mexicali descriptive statistics

The following summary compares 14 common variables divided into three categories relevant to both localities: people-river interactions, socioeconomic profile, and willingness-to-pay to reinstate a constant water flow. I present people-river interactions first and then the socioeconomic comparison in order to build at the end a qualitative analysis of willingness-to-pay between the two localities.

4.3.1.1   People-river interactions in SLRC and Mexicali

a)   Frequency of visits to the Colorado River/year

In Mexicali, residents averaged 0.9 visits/household/year while in SLRC residents averaged 1.9 visits/household/year (Carrillo-Guerrero, 2005). This means that on average, people from SLRC visit the Colorado River twice as often as people from Mexicali.

b)   Preferred activities during river visits

In Mexicali, the top three preferred visitor activities were family trips for picnics (36%), fishing (17%), and day hikes (16%). In SLRC the top three preferred activities were family trips for picnics (21%), swimming (21%), and fishing (7%).

c)   Awareness of dry river conditions

In Mexicali, only 51% of interviewees have witnessed dry river conditions while in SLRC more people are familiar with that condition (90%). Additionally, in Mexicali 37% of participants said that they have "never seen the Colorado River dry" and another 12% said they ignore the rivers' flow conditions. Overall, these data reflect less awareness of the river's flow conditions in Mexicali than in SLRC, which is understandable due to the distance of each city to the river (SLRC is right next to the river while Mexicali is at least 65 km away).

d)   Awareness of river floods (1997-1998)

In Mexicali, only 60% of participants were aware of the 1997-1998 floods while in SLRC up to 84% confirmed to be aware of those floods. Thus, people in Mexicali are less aware of the river's flow conditions than people in SLRC. Distance to the river can again explain variations in levels of awareness of the river's conditions.

e)   Environmental improvements in the delta associated to larger river flows.

In Mexicali, 83% of people agreed that environmental improvements in the delta are associated with larger river flows. Nearly the same proportion confirmed the same in SLRC, 88%. In this question, people from both cities have similar opinions regardless of river-to-city distance.

f)   Totoaba's endangered status.

In SLRC 83% of people agreed that the endangered status of the totoaba was directly related to lower river flows. In contrast, in Mexicali only 47% agreed to the same statement, while 44% said they did "not know". This strong contrast in levels of awareness of environmental issues associated to the lack of water in the Colorado River Delta is probably a direct reflection of river-to-city distances. However, this conclusion is only tentative, as the SLRC survey did not include a " do not know" choice of answers, and thus people in SLRC did not have the opportunity to express their lack of knowledge.

g)   Legal protection for the Colorado River.

Strong majorities in both localities advocated for setting up legal protection for the Colorado River and its riparian forests: 99% in Mexicali, and 96% in SLRC.

h)   Preferred river flow condition.

The preferred flow condition for both localities was "an abundant flow", with 86% of participants' support in SLRC and 66% of support in Mexicali. The second preferred river condition was a "moderate flow" with 12% of participant's support in SLRC and 33% of in Mexicali. The same set of pictures was used in both surveys (Appendix A).

4.3.1.2 Socioeconomic profiles of SLRC and Mexicali

I drew a basic comparison of the socioeconomic profile of participants from both cities. Similar levels of female/male participation were found (60% females and 40% males in Mexicali; 63% females and 37% males in SLRC). The average age of participants was similar as well, 43 years in SLRC and 43.6 years in Mexicali.

I also found that in SLRC the length of residency was lower (24 years) that in Mexicali (31 years), which makes sense considering that Mexicali is the largest city in the region and that its growth has attracted a large number of immigrants. The average number of children/household was 2 in SLRC while in Mexicali it was lower, 1.4 children/household. The average number of adults/household was 2 in SLRC and 2.9 in Mexicali. Overall, the differences in ratio of adults and children between localities reflect again the migratory nature of Mexicali where the working force is expected to be higher than in a small city such as San Luis Rio Colorado.

Education levels in both cities were similar, junior-high is the prevalent education level in the region (32% in SLRC and 28% in Mexicali). Other relevant findings were the lack of citizens' engagement in environmental groups or activism, in both locations.

Finally, the level of annual income was also compared (Figure 4.12). It is necessary to clarify that there were some structural survey changes advised by INE, in order to improve the data for econometric purposes. In SLRC annual income was estimated by asking participants to indicate the range into which their annual income fell, while in Mexicali participants were asked

to state a precise amount of either annual or monthly income. I used income ranges for both. To make comparisons, the Mexicali annual income data were grouped into categories using the same ranges as in the SLRC study.

I found that in SLRC half of the people earned between 21,000 and 40,000 pesos/year (in 2005), while in Mexicali people have higher incomes in general. For instance, 37% of Mexicali participants earned 100,000 pesos/year or more, followed by 22% that earned between 40,000 and 60,000 pesos/year. Figure 4.12 shows comparisons of ranges of income between cities.
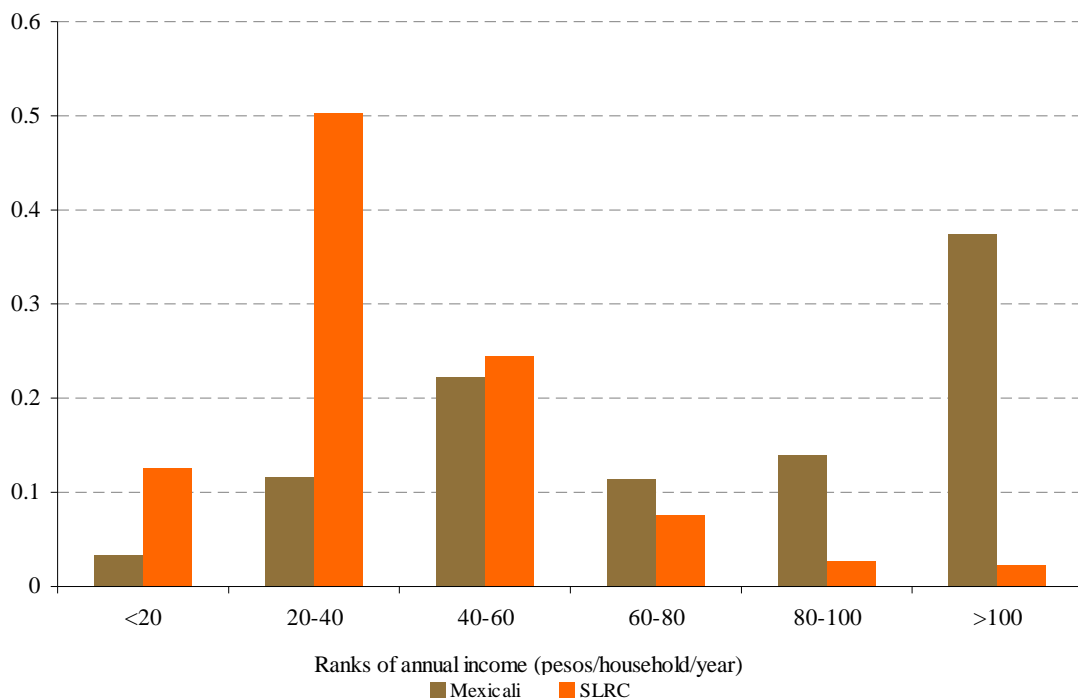
Figure 4.12. Comparison of annual ranges of income between SLRC and Mexicali (2006).

4.3.2 Chi-square test for independence of SLRC and Mexicali

In this study I also wanted to see if there was any difference in willingness-to-pay between Mexicali and SLRC, under the assumption that differences in willingness-to-pay, from one city to the other, reflect changes in people's attitudes to support restoration efforts in each site. To accomplish that goal I relied on two complementary analyses: Chi-square test for independence

and a graphic analysis of relative frequencies. Thus, I established a new set of null and alternative hypotheses:

H_0: The two locations have the same distribution
H_1: The two locations do not have the same distribution

These hypotheses are valid to compare the distribution of willingness-to-pay responses, across all offers, between the two cities (Table 4.5). I used all willingness-to-pay results from Mexicali (Tables 4.1 and 4.2) and SLRC (see table in Appendix B). After calculating the Chi-square test for independence in Excel, at a significance level of 0.05 (α), and then looking at the graphical comparisons, I concluded that there is strong evidence to say that willingness-to-pay does vary from one city to the other. The Chi-square test for independence yielded observed values much higher than the critical Chi-square value of 7.81, at 3 *df*. Thus, I rejected H_0 and accepted H_1.

Table 4.5. Mexicali and SLRC associations of willingness-to-pay.

Comparison of distributions	Chi-square test for independence	*p-value* *	*df*	Conclusion
Offer1: Mexicali *vs*. SLRC	84.25	< 0.05	3	Reject H_0
Offer2: Mexicali *vs*. SLRC	68.75	< 0.05	3	Reject H_0
Offer3: Mexicali *vs*. SLRC	36.39	< 0.05	3	Reject H_0

The critical value was 7.81 at 3 *df*; the *p-value*= $3.22e^{-8}$ which is < 0.05.

Furthermore, to complement the test for independence findings I graphically compared the relative frequencies of choices for all offers. In Figures 4.13 to 4.15, I simultaneously compared all relative frequencies from all answers to all prices in both locations, and observed that SLRC provided more affirmative answers to Offer1. That can be seen in Figure 4.13 where SLRC's Yes columns are taller for the lowest three prices, but just slightly smaller for the last price of $80 (Mexicali =0.74 *vs*. SLRC= 0.69).

Similarly, Figure 4.14 shows the same trend again where participants from SLRC gave more affirmative support to pay the lower three prices, while the last price of $90 received less support in SLRC than in Mexicali (Mexicali= 0.12 *vs*. SLRC= 0.093). Notice that Figure 4.14 refers to a new set of answers from people who already answered "Yes" to Offer1, but now tested at a higher price.
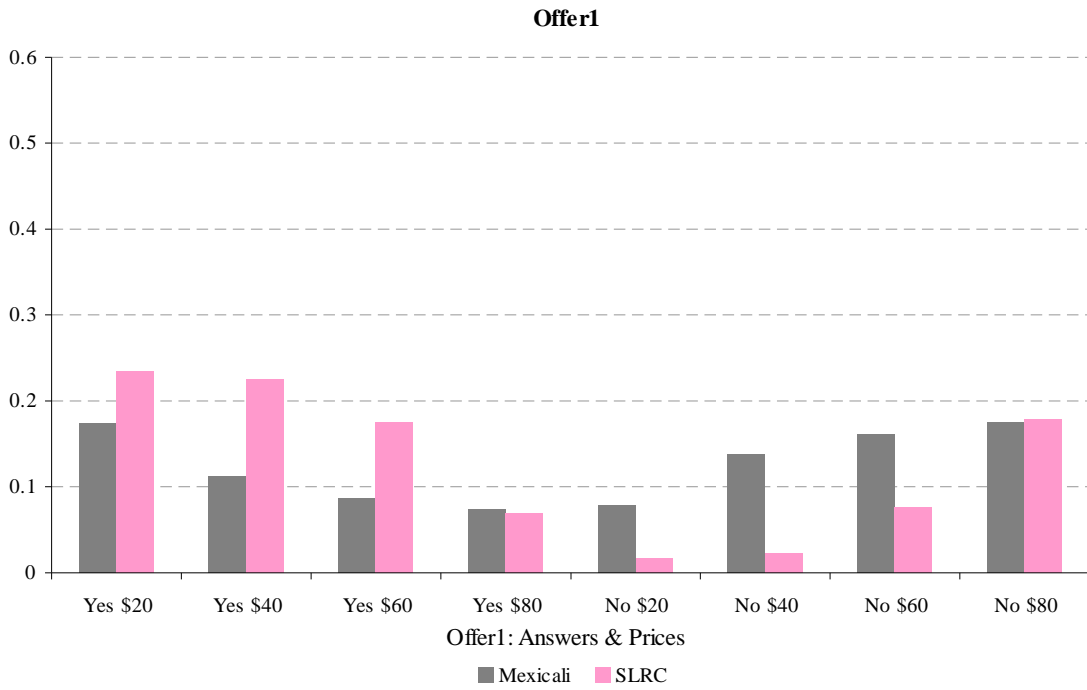
Offer1

Figure 4.13. Comparison of answers to all Offer1 prices (Mexicali, n= 563; SLRC n= 302).
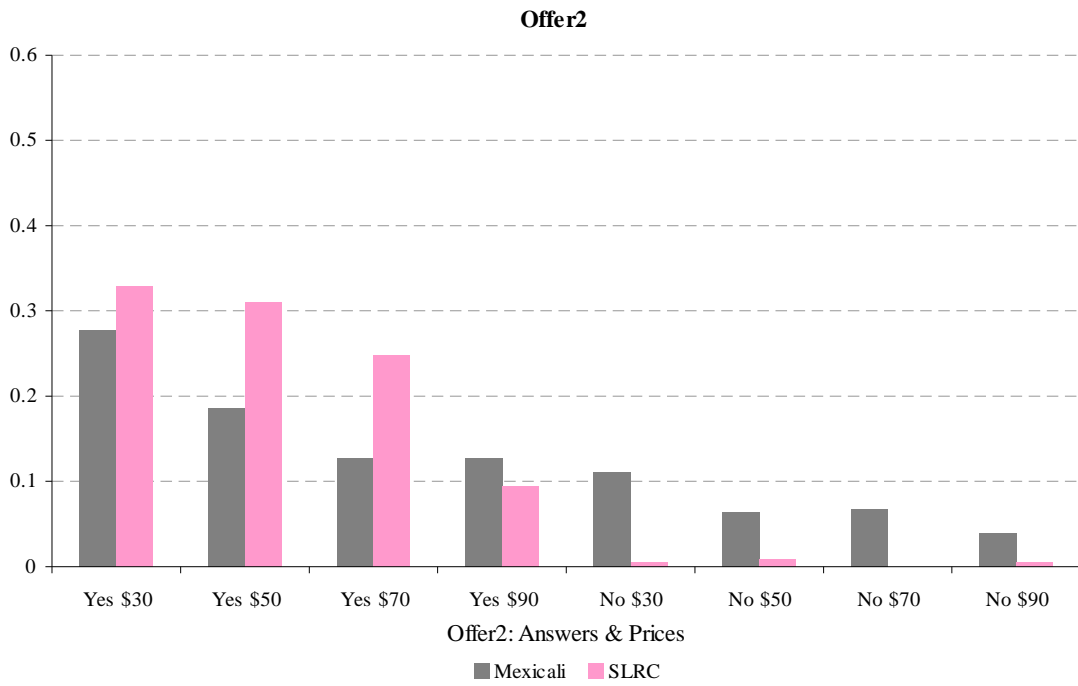
Offer2

Figure 4.14. Comparison of answers to all Offer2 prices (Mexicali n= 252; SLRC n= 213).
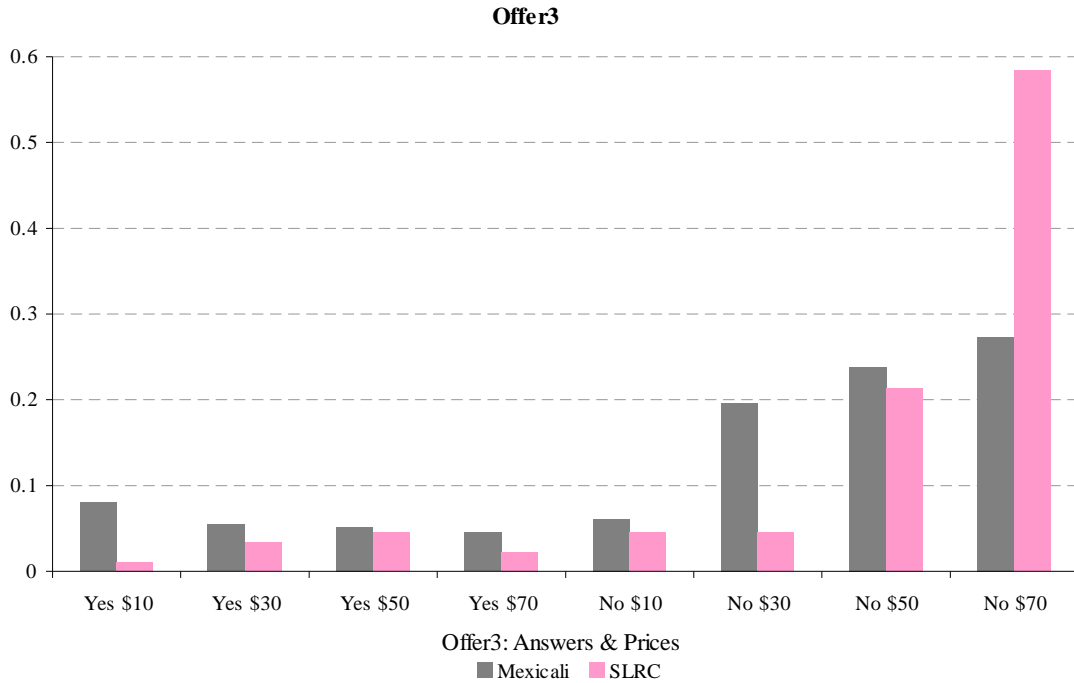
Offer3

Figure 4.15. Comparison of answers to all Offer3 prices (Mexicali n= 311; SLRC n= 89).

Figure 4.15, on the other hand shows less support from SLRC participants, however here we have to remember that this graph represents the new answer of all the people who already answered "No" to Offer1. Therefore, in this graph I basically observe that people who already answered "No" to Offer1, change their mind very little to pay even at a lower price, in both locations.

Two other important graphical trends can also be observed if we consider the influence of distance (to the river) and prices, on the decisions of people from both locations. The assumption that living close or far from the river influences participants' response is based on my observations and conclusion that people from SLRC interact more with the Colorado River (see Section 4.3.1.1). Figure 4.16 shows the combination of people's responses to the two offers of prices that they received, thus observing four possible responses for each price. The first association "yy" means that people answered yes to both offers (to an initial price and then a higher price); "yn" represents people who originally answered yes but then rejected the second offer; "ny" represents people who originally rejected the initial offer but then changed their mind with a lower price; and finally "nn" represent people who did not want to pay at all.

In SLRC more people answered "yy" for all four prices and *vice versa*, more people answered "nn" in Mexicali.

55
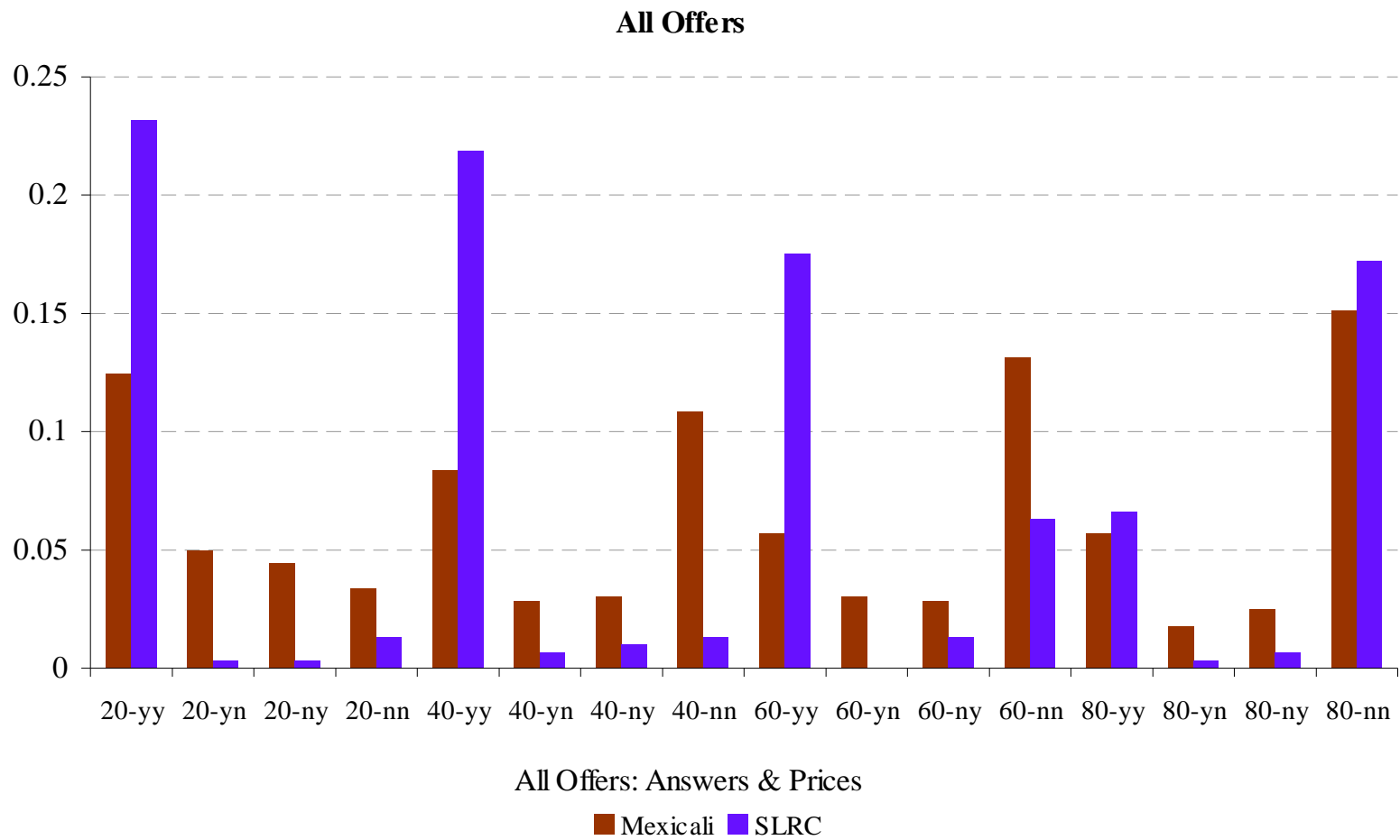
All Offers

Figure 4.16. Comparison of all answers, all prices, and all Offers, for both locations (Mexicali n=563; SLRC n=302).

More people in Mexicali are willing-to-pay only when the original price is reduced in the second offer ("ny"). These results are consistent with the suggestion that proximity of residence to the river influences people's willingness-to-pay.

In the case of the influence of price, Figure 4.16 also shows that in SLRC slightly more people reject the highest price of $80-90 pesos ("nn") than in Mexicali. This is consistent with the pattern in Figure 4.15. These patterns are consistent with the suggestion that income is an influence on willingness-to-pay.

Finally, looking across all graphs from Figure 4.15 to 4.18, we also observe that most participants from both locations preferred to pay monthly prices between 10 to 60 pesos, while at the same time strongly rejecting the highest prices of $70, $80, or $90. Taking these data into a further econometric analysis will yield a firmer approximation of how much Mexicali people are willing to pay for a constant river flow.

5 DISCUSION

The main goal of this study was to answer two research questions. The first one was to find "what factors influence the attitudes of Mexicali citizens to re-establish a permanent water flow for the Colorado River delta". The second one was to find if there is "a difference in people's willingness-to-pay between Mexicali and SLRC". Throughout the data presented in my results section and these discussions I was able to answer each question and validate my research findings.

In the past, authors such as Carson (1993) made comparisons of national willingness-to-pay estimates for water quality ($n = 813$), with similar studies at city level (Boston) or previous pilot studies at national level ($n = 773$), and with different time frameworks (1973 and 1981 *versus* 1993 estimates), arguing that with differences in sample size, methods, and time accounted for, this type of comparison is valid. At my own level of data analysis, I believe that the comparisons I make here are valid as well, given the similarities in the socio-economic profiles of these two cities, their geographical proximity, the homogeneity of both surveys and data gathering procedures, and common research themes. I use Sanjurjo and Carrillo's (2006a) estimation of 46.5 pesos/visit and 3.45 USD million/year of passive use value of a constant water flow in the Delta as reference points for my arguments.

5.1 Environmental awareness influence on willingness-to-pay differences

My initial hypotheses was that exposure to the river affects people's environmental awareness and therefore their willingness-to-pay (attitudes) for environmental services. This relationship has been noticed elsewhere. In a study conducted by Menegaki *et al.* (2007) of willingness-to-pay for recycled water in agriculture, in Crete, Greece, factors such as participant's environmental awareness, income, and pricing were influential. Similarly, Carson and Mitchell (1993) concluded that national willingness-to-pay for clean water in the U.S. was determined by the quality of the water offered, the recreational benefits associated, participants' income, and their environmental attitudes.

In the two cities that I studied I found that people's environmental awareness of river issues varies from one city to the other. For instance, in Mexicali only half of interviewees (51%) is aware of dry river conditions while in SLRC most people (90%) is aware of those conditions. When I asked if they have noticed river flooding (in 1997-1998), 60% of interviewees in Mexicali said yes *vs.* 84%

in SLRC. Similarly, when participants were asked about the relationship between the lack of normal river flow and the endanger status of the totoaba in the Upper Gulf of California, more people agreed with this statement in SLRC (83%) than in Mexicali (47%). Thus, SLRC showed more environmental awareness in regards to river issues than Mexicali. An evident explanation to this difference is the fact that SLRC is a true river city having the river at its doorstep while Mexicali is at least 60 km away from it. I argue that the fact that SLRC is more river aware than Mexicali corresponds to its higher willingness-to-pay as it is shown in Figures 4.13-4.16 in Section 4.3.2.

Subsequently, I also argue that my study reveal that river awareness is determined by people's exposure to the river. Only 25% of people in Mexicali crosses the river at least once every month, while in SLRC 84% of people do. On average, people in Mexicali cross the river 0.52 times/month while in SLRC people cross the river 3.27 times/month. Evidently, people from SLRC are more exposed to the Colorado River because they have to cross it more often than people from Mexicali do. Given that Mexicali is the capital of the state, it constitutes the largest city in the delta and many people from SLRC commute to work there daily. Those who migrate to Mexicali and stay in the city are not as exposed to the river because they only cross it twice a year (when they arrive and to go see their families in the main land), while those commuting to work from SLR have the opportunity to drive by the river very often. Thus, from these observations exposure to the river does affect people's river awareness and therefore their willingness-to-pay.

Other authors argue that socioeconomic and geographic factors influence collective attitudes towards resource management and conservation efforts. These types of parallel examples reinforce the idea that socioeconomic factors can also influence environmental awareness and general attitudes. In 2004, Brunson and Shindler argued that citizen's acceptance (attitudes) and knowledge about resource management practices vary across geographic space, time, and social affiliations. According to them, collective judgment and acceptance varies from one place to another due to local-specific social and environmental factors that affect local knowledge. On the other hand, Kideghesho *et al.,* (2007) argues that factors such as history, politics, ecology, socio-demographics, culture, and economics play a role in defining local conservation efforts in the Serengeti, Tanzania. In a Mexicali context, migration for example is the biggest influencing force that shapes citizens' environmental awareness due to a local working culture, the population's mobility and its consequent underdeveloped attachment to the region. As half of Mexicali's population is migrant, people most likely did not spend their first years in the city looking for opportunities to participate in environmental causes; instead they probably spent their time working and adjusting to the new city.

5.2 Factors influencing willingness-to-pay in Mexicali

In addition to environmental awareness, I found that parenthood and perception of received benefits from the river were significant influential factors in Mexicali's willingness-to-pay. These two factors reveal specific motives affecting willingness-to-pay. Similar relationships are reported in the literature. McConnell (1997) illustrated the importance of altruistic motives with a harbor porpoise example from New England. In his example people were asked if they were willing to pay a state tax to eliminate porpoise by-catch in gill nets. The example illustrated the importance of perceived benefits as an altruistic motivation to influence willingness-to-pay by informing only half of the sample that the harbor porpoise is rarely seen, and the other half without telling them that fact. The results of the study proved that when people do not perceive use value or a benefit from the environmental good or service in question, their willingness-to-pay declines. In that case, only when people heard that no one (other people) would benefit from protecting this animal did they show less interest in paying for its protection, which is a specific type of altruistic behavior (non-paternalistic). Similarly, Brunson and Steel (1996) argue that attitudes towards resource management are strongly associated with value orientations towards the role of humans in nature. Additionally, in Kideghesho *et al*. (2007) study in Tanzania, conservation attitudes were positive only when interests of local communities were not affected over the use of protected areas. My findings are congruent with both altruistic motives and received benefit perceptions: when Mexicali citizens perceived that the river actually benefits them, or that it could benefit them in the future (option value), or that their children and grandchildren could benefit from it latter, then they were more inclined to pay for restoration efforts.

According to many authors, studying attitudes and motives is important for understanding how the public values environmental goods (Blamey, 1988; Spash, 2000; Rosemberg et al., 2003; Milon and Scrogin, 2006). Asking participants why they preferred to pay or not pay for a given survey price is highly recommended to insure the reliability of contingent valuation estimates (Arrow *et al.,* 1993; Carson *et al.,* 2003). In accordance with that principle, I then corroborated what influenced willingness-to-pay in Mexicali, by asking participants directly why they were willing-to-pay. I found that resource conservation and the recognition of the ecologic importance of the delta ecosystems were the top two reason (40%). Chi-square analysis also showed dependency between willingness-to-pay for future options of recreation and participants' perception of river-derived benefits. Similar results were reported by Bright *et al.* (2002), who studied attitudes in Chicago towards ecological restoration in urban areas and found that positive and negative attitudes were determined by perceived

outcomes of restoration initiatives. They also concluded that positive attitudes are related to values while negative attitudes are related to emotions.

This last observation was visible in Mexicali's results when asking people about their reasons to not pay. For example, negative attitudes were evident in responses such as "it is the government's obligation, not mine", or "I do not believe that this type of programs can achieve their goals" (general incredulity), or "no, because the government is corrupted" (lack of trust in institutions). It is evident that receiving utility or a benefit from river restoration is important for Mexicali people. The three main requests for improvement of river visits were actually two in type of services (Figure 4.11) –first people requested material infrastructure improvements and maintenance ("more recreation facilities and clean areas"), then people requested specific environmental services such as "shade" (from trees and palapas) and water to swim. If investment is going to be made to improve the river's attractions, the best economic results would come from providing infrastructure, shade and water. Restoring the natural assets of the river seems to be something that people would support in the area because it will directly benefit them.

5.3   Other factors (Mexicali)

Other factors that could potentially affect willingness-to-pay in Mexicali were: frequency of visits to the river, awareness of dry river conditions, and income. These three factors were not found to be statistical significant with my analysis approach for Mexicali's variable associations, but were very close. I believe that they were not significant because when I determined the relationship of those variables with willingness-to-pay (Pearson Chi-square) I used the full pricing range from10 to 90 pesos. Instead, I should have used only the range of prices where the actual Mexicali willingness-to-pay lies (below 46 pesos/visit using the average SLRC-WTP estimated by Sanjurjo and Carrillo, 2006a) and then have tested its dependency to confirm the influence of any one of the three factors.

Commonly, income determines people's willingness-to-pay (Carson and Mitchell, 1993; Carson *et al*., 2001; Carson *et al.,* 2003; Sanjurjo and Carrillo, 2006b; Menegaki *et al.,* 2007). With a non-parametric analysis of all prices my results did not correspond to this expectation, but were very close to make the relationship of willingness-to-pay and income significant. Having the specific amount that Mexicali people is willing to pay could clarify the influence of income.

A general expectation was that our graphic results would conform to economic theory that says that "the percentage of respondents willing to pay falls as the price they are asked to pay increases" (Carson *et al.,* 2001). This was the only income influence that I fully corroborated in both cities. Other income observation that I was able to make were limited; for example, there was an obvious shift from positive to negative willingness-to-pay in SLRC in the last set of prices (80, 70, 90 pesos; Figures 4.13 to 4.15). Lower income in SLRC deterred people from expressing their willingness to pay at the highest prices surveyed; on the other hand in Mexicali, less environmental awareness influenced people's willingness-to-pay instead.

Education is often found to influence willingness-to-pay (Carrillo-Guerrero, 2005; Sanjurjo and Carrillo, 2006b). The influence of education on willingness-to-pay did not seemed to be determinant in my study. For instance, the SLRC 2005 study argued that there was a relationship between education and willingness-to-pay, however I was not able to associate those variables significantly for Mexicali. Rather than literacy, environmental education and raising awareness are likely more relevant for Mexicali. As Menegaki *et al.,* (2007) illustrate for Crete, farmers' education is not synonymous with experience in agriculture, therefore willingness-to-pay to use recycled water in Crete was not influenced by levels of education. I believe that a similar parallel applies to Mexicali citizens: environmental awareness is lacking at all education levels and it is not education *per se* that affects willingness-to-pay. In other words, the fact that a person in Mexicali has 17 years of education (completed college degree) does not outweigh environmental awareness, or that a person only knows how to write and read (unfinished elementary school) does not mean that he or she is less environmentally aware than a person with more yeas of education. If a person is exposed to the river and he or she interacts with it often, then this person is more environmentally aware regardless of his or her education level. Hours spent in a classroom can expand certain perspectives to understand society and the world we live in but they do not substitute time spent in contact with nature.

I also inferred that current access to environmental education for most citizens is absent given that 55% of Mexicali citizens either perceived that the river does not benefit them at all or ignored that the river benefits them. Another 3% of survey participants suggested deliving more river information to the general public to improve people-river interactions; and only 2 Mexicali participants recognized to participate in environmental matters associated to their academic career. Similarly, in SLRC only 8 people recognized to be currently involved in environmental matters. Thus, a conservationist or environmentalist culture is lacking in both cities.

5.4 Mexicali and SLRC differences in willingness-to-pay

People in Mexicali are less willing than people in SLRC to pay to restore water flow to the Colorado River. This conclusion directly addresses the second research question of finding differences in attitudes towards restoring a water flow between these two neighboring cities. Similar results of the relationship of attitude to willingness-to-pay have been reported elsewhere. Pouta and Rekola (2001) tested a socio-psychological model to demonstrate that people's attitudes can predict willingness-to-pay (for forest regeneration in Finland), and that people's systems of beliefs determine those attitudes. An underlining assumption of this study was that willingness-to-pay is a visible expression of positive or negative attitudes towards river flow restoration. The interpretation of results from the Chi-square tests for independence (Table 4.5) and the graphical analysis presented in Section 4.3.2, showed that willingness-to-pay response was more positive in SLRC than in Mexicali (Fig. 4.13, 4.14, 4.15), across prices. Accordingly, in Mexicali people's average willingness-to-pay is expected to be below SLRC's average of 46.5 pesos/visit, estimated by Sanjurjo and Carrillo (2006a).

Although finding the exact monetary value that Mexicali people are willing to pay is necessary to make further monetary comparisons with SLRC, I argue that attitudes and their underlying motivations did influence willingness-to-pay in each location. According to McConnell (1997) contrasting responses between what people state that they will do and what they actually do depict a motivation *vs.* behavior pattern, where motives such as altruism can play a big role in defining people's willingness-to-pay. Motives may range from a broad concern for the natural order, to a desire to save large mammals, or to altruism. Similarly, Bright *et al.* (2002) argues that attitudes towards urban ecological restoration in Chicago can be predicted from cognitive, affective, and behavioral responses to the object being evaluated. The importance of the object or situation being valuated also influences people's responses. According to these authors, cognitive components relate to perceived outcomes and people's objective knowledge of ecological restoration. The affective component represent emotional responses to ecological restoration, while behavioral components measure actions related to ecological restoration and the environment. In this study we found good examples that reflect specific attitudinal responses for each of the factors enumerated by Bright *et al.* For example, when people were asked if they would like to see legal protection for the river corridor, positive attitudes were displayed in both Mexicali and SLRC (99% and 96%, respectively), and the preferred flow condition was "an abundant flow" in both cities, which portrays people's expectations for benefits. In contrast, behavioral components were reflected when people were tested about their environmental awareness of river issues, the numbers differed from one city to the other, and when

they were asked if they belonged to any environmental organization, the prevalent response was "no" in both cities. Finally, emotional components emerged when asking people why they were not willing-to-pay to restore river flow, obtaining disbelief and lack of trust in public institutions as the main influential factors.

6 CONCLUSIONS and RECOMENDATIONS

The two research questions of this study were answered and its three specific objectives were also accomplished. Willingness-to-pay does vary between Mexicali and SLRC. People in Mexicali are generally less willing to pay for water flow restoration than people in SLRC. A non-econometric estimation averaging the number of Yes responses to Offer 1 gave me a result of 42.8 pesos per household. In Mexicali, people's average willingness-to-pay is probably below SLRC's average of 46.5 pesos/visit. Distance of each city to the Colorado River affects environmental awareness of citizens and therefore their motivation to pay for water flow restoration.

Additionally, in Mexicali willingness-to-pay is associated with parenthood and perception of received benefits from the river. I argue that citizens' perception of benefits is determined by citizens' exposure to the river because, in many senses, perceptions are an expression of a citizen's environmental awareness. Other factors that might count later, once the average willingness-to-pay for Mexicali is estimated, are income, level of people-river interactions (such as frequency of river visits), and awareness of dry river conditions. Factors such as level of education, gender, or number of people per household were not influential on willingness-to-pay.

Overall, I found that present environmental services associated to the Colorado River Delta are undervalued, and locally underappreciated. Mexicali in particular is a city that has very little contact with the Colorado River while SLRC still interacts and benefits from the remnant environmental services associated to the river, such as recreation, its landscape, and shade.

Relevant recommendations derived from this study are that environmental education must receive emphasis to improve Mexicali citizens' understanding and appreciation of ecosystem services associated with the Colorado River. Support and acceptance of future river restoration projects can be improved by raising people's environmental awareness as well.

From my observations of negative attitudes towards restoration efforts I conclude that building transparency is an area for improvement because citizen trust of government institutions is weak. In

this study, many citizen opinions reflected negative attitudes towards institutional capacity. The participation of local or national NGOs should take into account the presence of negative attitudes towards government actions and build transparent processes that involve the community. Community participation must also be enhanced and developed. Strategies that raise community awareness of local environmental issues and integrate the community to solve them could probably be of great benefit for large ecosystem restoration projects like the delta. Once again, delivering information on what is happening with the delta's restoration will be fundamental to gain support and acceptance from citizens.

Other salient factors that were not discussed here but that did call my attention during my filed research were the need to improve security to promote future recreational activities in the delta, as the region is known for drug trafficking and illegal migration trafficking as well. Efforts to promote activities in this area must consider this large external social driver that should be addressed in the long term, in order to gain community support for the area under restoration.

Potential research directions for this work will be to analyze the present results of this study within a socio-psychological model for example. As this study progressed towards its end, I realized that other research approaches exist to study people's attitudes with psychological and behavioral models; such models have allowed researchers to deliver parametric results about citizen attitudes. I believe that most of the Mexicali survey material can be used to build a psychological model, aside from the econometric models that this information can already sustain.

APPENDIX A –Mexicali (2006)

I. Mexicali survey

NOTE: A copy of SURVEY TYPE 1 is shown below, questions 1 to 29. Afterwards, surveys TYPE 2,3, and 4 only show the questions with price variations (17-19), for the sake of avoiding repetition.

SURVEY TYPE 1

Interviewer code: _____ **Colony's name:** _____

AGEB#:_____ **Survey #:** _____ **Date:** _____

Participant's gender: ☐ M ☐ F

Good morning (afternoon), we are conducting this survey in order to learn about the interest of Mexicali people on the restoration and conservation of the Colorado River Delta. The answers you provide us with will help us study how to conserve the environment and its natural resources, your answers will also help us to better understand how to restore the Delta.

This survey is part of a Master Thesis research at the University of Waterloo, Canada and results will also be useful for its sponsors: Pronatura A.C., The Sonoran Institute and The National Institute of Ecology. Your participation is voluntary, anonymous, and confidential. If you decide to participate you will be helping our project enormously. Thank you!

Survey began at: _____ **(hour)**

Section 1: Perceptions and interactions with the Colorado River

1. How long have you been living in the municipalities of Mexicali or San Luis Rio Colorado (SLRC)? _____(Years)

2. Have you ever seen or visited the Colorado or Hardy Rivers? ☐ Yes ☐ No
 (If No, go to #8)

3. Please, look at the map and point out what sections of these Rivers you have seen or visited before.

☐ a   ☐ b   ☐ a & b   ☐ Other

(If answer was "b"/"Other", then go to #8)

4. At what of the following degrees you will say that you know the Colorado River? *(Check only one of the following options)*

☐ I have seen it a few times but I have never visited the river *(go to #8)*

☐ I have seen it a few times and I have visited it a few times

☐ I have seen it many times and I have never visit the river *(go to #8)*

☐ I have seen it many times and I have visited it a few times

☐ I have seen it and visited many times

5. During the last 12 months, how many times have you visited the Colorado River for recreational purposes? (Not for work) _____ (times)

6. During the last 5 years, how many times have you visited the Colorado River for recreational purposes (2000-06)? (Not for work) _____ (times)

7. If you do/did visit the river, what type of activities you do/did when you visit the river? *(Please mark all that apply)*

○ Swimming

○ Fishing

○ Pick nick

○ Hike around the river and forest

○ Hunting

○ Dirt road motorcycling

○ Wood gathering

○ Other, which? _____

8. Approximately, how many times, per month, do you cross the bridge set before the SLRC pay-toll highway? _____ (Times/month)

9. Approximately, how many times, per year, do you cross the bridge set before the SLRC pay-toll highway? _____ (Times/year)

Please clarify the participant that "the river that goes underneath the SLRC's bridge is actually the Colorado River and that right besides it there is a concrete irrigation channel that has flowing water all year round".

10. Have you ever seen the Colorado River dry?

☐ **Yes**, when was the last time? _____ (year)

☐ **No**

☐ **I don't know**, I have never paid close attention

In 1997 and 1998 the river carried more water than in any other years, this made that the river increased its volume and size, to a size bigger than we normally see it in these days.

11. Did you see or hear about those events?

☐ Yes   ☐ No

Please say if you agree, disagree or do not know what to say about the following affirmations:

12. When the river carries larger flows of water there are environmental improvements along the river corridor (like in 1997-1998).

☐ Yes   ☐ No   ☐ I do not know

13. The scarcity of water in the Colorado river is one of the causes why the totoaba is currently endangered.

☐ Yes   ☐ No   ☐ I do not know

In your opinion,

14. Would you lake to see legal protection for the Colorado River and its willow and cotton wood forests?

☐ Yes   ☐ No

Show the participants the pictures in the following order: a dry river bed (1996), with a moderate water level (2004), and a river with abundant water (1997-98). Once they see the pictures, please ask for their preference.

15. Comparing the pictures of a normal river condition (1996), with the pictures of the restored sites produced after the larger floods of 1997-1998 and 2004, please select the set of pictures that best represent the condition in which you would prefer to see the river on a constant basis.

☐ a) 1996 picture (almost dry)

☐ b) 2004 picture (moderate volume)

☐ c) 1997-98 picture (large volumes of water)

Section 2. Willingness to Pay

For the next section it will be important that you have your water bill at hand. We will be glad to wait for you while you go and find one; it does not matter if it is not the most recent you have, it could be any water bill of this year.

16. What was the water consumption charged in your water bill?

Consumption in m^3 = _____

Consumption in $ = _____ (just monthly consumption, no late charges)

Right now there are some projects to restore a constant minimum water flow for the Colorado River, nevertheless these project need funding. In order to achieve restoration goals, many sources of funding will be required. Potential funding sources would be households of the cities that lay within the Mexican Colorado delta, like Mexicali and SLRC households. Other funding sources could be federal and International funds.

The vision for the Colorado River restoration seeks to benefit the environment, so that any water put back in the river will not be dedicated to direct human consumption or agriculture. Taking that vision in consideration, now we introduced you to different scenarios for you to choose from.

17. If you could vote for one of the following options, which one would you select?

☐ **a.** That there was a guaranteed constant river flow (at least moderate), all year around; even if I have to pay **$20 pesos** extra in each water bill.

☐ **b.** That all stay the same as today; that the river flow depends on its own sake and that my water bill is not affected with extra-charges. *(Go to # 19)*

18. If the extra charge on you receipt rose by **$30 pesos** instead of $20, would you keep your vote the same?

☐ **Yes,** I would continue voting in favor *(go to #21)*

☐ **No,** I would change my vote and vote against paying more *(Go to #21)*

19. If the water bill charges rose for only **$10 pesos** instead of $20, would you change your vote?

☐ **Yes,** I would change my vote in favor *(go to #22)*

☐ **No,** my vote would stay the same

If your answered No, why did you say No? _____ *(Go to #23)*

Now, please make note of the first three responses of the participant, when possible, classify each answer into one of the following categories. If the answer does not fit any of the categories, just write down the answer.

20. Could you please tell us, why did you answer (at least once) that you will be in favor to see a constant restored river flow in the Colorado?

☐ Recognition of its ecological importance

☐ Recognition of its esthetic values

☐ Recognition of its economic potential and values

☐ Ethical values: to improve the environment for the wellbeing of all

☐ To protect an important element of the regional identity

☐ For the future generations

☐ Other reasons; please specify: _____

21. In its current conditions, what type of services and benefits does the Colorado river already provides to: (list at least one for each)

a) you or your family?: _____

b) the region?: _____

22. Would you consider the Colorado/Hardy river as an option for recreation in the future?

☐ Yes   ☐ No

A restored river would have a great ecological and use potential. If the Colorado river was turned into a site for the recreation for the Mexicali families, then…

23. How much would you be willing to spend with your family/friends in a visit to the Colorado River? Please consider your personal expenses in food, and services like bathroom use or equipment rental. Exclude gas expenses. Expenses will be in pesos/person/day

☐ $100-$200 ☐ $200-$300 ☐ $300-$400 ☐ $400-$500

Other amount $: _____ (pesos/person/day)

24. What would you change in the river or its promotion in order for you and others to visit it more often?_____

Section 3. Personal and household information

25. Place and year of birth: _____

26. Number of people in your house: # Adults _____ # Children _____

27. What is the maximum academic grade accomplished by the head of this house (father or mother)?

☐ No studies or unfinished elementary school

☐ Completed elementary school

☐ Completed secondary school

☐ Completed high school

☐ Completed technical school

☐ Completed College

☐ Postgraduate studies

28. Do you belong to any environmentalist group?

☐ Yes, which one? _____ ☐ No

The following information is important for this study. Please take a few minutes to answer on your own. Please remember that your answer is voluntary, that it will be strictly confidential and that it will be well secured. For your safety the interviewer will give you an empty envelope, please double

check that it has no marks and once you finish fold the survey, seal the envelope and deposit it in the box we use to collect all surveys.

29. Approximately, what is the monthly total income in your household? (Please add up all the salaries of the people that live in this house and that contribute to pay for the family's expenses)

Total income of this household is = $ _____ (pesos/month)

Survey ended at: _____ (hour)

Thanks for your participation and have a nice day!

(close the envelope and deposit it in the box).

SURVEY TYPE 2

17. If you could vote for one of the following options, which one would you select?

☐ **a.** That there was a guaranteed constant river flow (at least moderate), all year around; even if I have to pay **$40 pesos** extra in each water bill.

☐ **b.** That all stay the same as today; that the river flow depends on its own sake and that my water bill is not affected with extra-charges. *(Go to # 19)*

18. If the charge on you receipt rose by **$50 pesos** instead of $40, would you keep voting the same?

☐ **Yes,** I would continue voting in favor *(Go to #21)*

☐ **No,** I would change my vote and vote against paying more *(Go to #21)*

19. If the water bill charges rose for only **$30 pesos** instead of $40, would you change your vote?

☐ **Yes,** I would change my vote in favor *(Go to #22)*

☐ **No,** my vote would stay the same

If your answered No, why did you say No? _____ *(Go to #23)*

SURVEY TYPE 3

17. If you could vote for one of the following options, which one would you select?

☐ **a.** That there was a guaranteed constant river flow (at least moderate), all year around; even if I have to pay **$60 pesos** extra in each water bill.

☐ **b.** That all stay the same as today; that the river flow depends on its own sake and that my water bill is not affected with extra-charges. *(Go to # 19)*

18. If the charge on you receipt rose by **$70 pesos** instead of $60, would you keep voting the same?

☐ **Yes,** I would continue voting in favor *(Go to #21)*

☐ **No,** I would change my vote and vote against paying more *(Go to #21)*

19. If the water bill charges rose for only **$50 pesos** instead of $60, would you change your vote?

☐ **Yes,** I would change my vote in favor *(Go to #22)*

☐ **No,** my vote would stay the same

If your answered No, why did you say No? _____ *(Go to #23)*

SURVEY TYPE 4

17. If you could vote for one of the following options, which one would you select?

☐ **a.** That there was a guaranteed constant river flow (at least moderate), all year around; even if I have to pay **$80 pesos** extra in each water bill.

☐ **b.** That all stay the same as today; that the river flow depends on its own sake and that my water bill is not affected with extra-charges. *(Go to # 19)*

18. If the charge on you receipt rose by **$90 pesos** instead of $80, would you keep voting the same?

☐ **Yes,** I would continue voting in favor *(Go to #21)*

☐ **No,** I would change my vote and vote against paying more *(Go to #21)*

19. If the water bill charges rose for only **$70 pesos** instead of $80, would you change your vote?

☐ **Yes,** I would change my vote in favor *(Go to #22)*

☐ **No,** my vote would stay the same

If your answered No, why did you say No? _____ *(Go to #23)*

II. Mexicali survey field materials: map and pictures

Map 1. Regional map presented to survey participants in Question 3. Fine details were not provided on this map in order to distinguish between visits to the Colorado River and to the Hardy River.

a) Rio Colorado sin agua (1996)

Picture 1. Question 15 of the Mexicali survey, Option "a": 1996 pictures (dry river conditions).

b) Rio Colorado con nivel moderado de agua

Picture 2. Question 15 of the Mexicali survey, Option "b": 2004 pictures (moderated river flow).

C) Rio Colorado con mucha agua (1997-98)

Picture 3. Question 15 of the Mexicali survey, Option "c": 1997-1998 pictures (abundant river flow).

III. Mexicali contingency tables and Pearson Chi-square results

Appendix A-Table 1. Contingency table of "People who have seen or visited the Colorado and Hardy Rivers *vs.* Willingness-to-pay Offer1."

Q17-Q2		Willingness-to-pay Offer1 (20,40,60,80)		
		Yes	No	Total
People who have seen or visited the CR or HR	Yes	193	226	419
	No	59	86	145
Total		252	312	564
Chi-square = 1.26		df = 1	*p-value* = **0.150**	

Appendix A-Table 2. Contingency table of "Degree of interaction *vs.* Willingness-to-pay Offer1."

Q17-Q4		Willingness-to-pay Offer1 (20,40,60,80)		
		Yes	No	Total
Degree of people-river interactions	Seen a little/Never visited	94	89	183
	Seen a little/ Visited a little	38	48	86
	Seen many times/ Never visited	9	24	33
	Seen many times/ Visited a little	10	6	16
	Seen a lot/ Visited a lot	13	15	28
Total		164	182	346
Chi-square = 8.35		df = 4	*p-value* = **0.080**	

Appendix A-Table 3. Contingency table for "Frequency of visits to the CR/year *vs.* Willingness-to-pay Offer1."

Q17-Q5		Willingness-to-pay Offer1 (20,40,60,80)		
		Yes	No	Total
Visits to the CR/year	0	39	57	96
	1	10	6	16
	2 or more	12	7	19
Total		61	70	131
Chi-square = 5.1		df = 2		*p-value = 0.078*

Appendix A-Table 4. Contingency table of "Frequency of CR crossings/ month at SLRC Bridge *vs.* Willingness-to-pay Offer1."

Q17-Q8		Willingness-to-pay Offer1 (20,40,60,80)		
		Yes	No	Total
Frequency of CR crossings/ month at SLRC Bridge	0	213	254	467
	2	24	36	60
	4	11	13	24
	10	4	8	12
Total		252	311	563
Chi-square = 1.33		df = 3		*p-value = 0.722*

Appendix A-Table 5. Contingency table of "Awareness of dry river conditions *vs.* Willingness-to-pay Offer1."

Q17-Q10		Willingness-to-pay Offer1 (20,40,60,80)		
		Yes	No	Total
Awareness of dry river conditions	Yes	125	162	287
	No	104	106	210
	I don't know	23	44	67
Total		252	312	564
Chi-square = 5.05		df = 2	*p-value* = 0.080	

Appendix A-Table 6. Contingency tables of "Support of CR's legal protection *vs.* Willingness-to-pay Offer1."

Q17-Q14		Willingness-to-pay Offer1 (20,40,60,80)		
		Yes	No	Total
Support of CR's legal protection	Yes	247	304	551
	No	2	4	6
Total		249	308	557
Chi-square= 0.32		df = 1	*p-value* = 0.570	

Appendix A-Table 7. Contingency table of "Perceived personal benefits from the CR vs. Willingness-to-pay Offer1."

Q17-Q21a		Willingness to pay Offer1 (20,40,60,80)		
		Yes	No	Total
Perceived personal benefits from the Colorado River	YES	127	104	231
	NO	123	206	329
Total		250	310	560
Chi-square = 17		df = 1	*p-value* < 0.001	

Appendix A-Table 8. Contingency table of "Presence of kids in households *vs.* Willingness-to-pay Offer1"

Q17-Q26		Willingness to pay Offer1 (20,40,60,80)		
		Yes	No	Total
Presence of kids in households	Yes	175	187	362
	No	76	125	201
	Total	251	312	563
Chi-square= 5.8		df = 1	***p-value* = 0.016**	

Appendix A-Table 9. Contingency table of "Level of education *vs.* Willingness-to-pay Offer1."

Q17-Q27		Willingness-to-pay Offer1 (20,40,60,80)		
		Yes	No	Total
Level of education * Finished	Unfinished element. school	33	47	80
	Elementary *	37	63	100
	Secondary *	77	81	158
	High School *	76	72	148
	College *	27	41	68
	Post graduate	1	5	6
	Total	251	309	560
Chi-square = 9.06		df = 5	***p-value* = 0.107**	

Appendix A-Table 10. Contingency table of "Total annual income *vs.* Willingness-to-pay Offer1".

Q17-Q29		Willingness to pay Offer1 (20,40,60,80)		
		Yes	No	Total
Ranks of total annual income/ household (in pesos)	≤ 20,000	5	13	18
	20,001- 40,000	25	38	63
	40,001- 60,000	48	73	121
	60,001- 80,000	24	38	62
	80,001- 100,000	45	31	76
	100,001-140,000	36	51	87
	140,001- 200,000	38	41	79
	Up to 432,000	20	18	38
Total		241	303	544
Chi-square = 13.05		df = 7	*p-value* = **0.071**	

Appendix A-Table 11. Contingent table of "Perceived personal benefits form the CR *vs.* Willingness-to-pay for potential services."

Q23-Q21a		Willingness-to-pay for potential services(recreation)		
		YES	NO	Total
Perceived personal benefits from the CR	≤ 50 pesos	6	10	16
	50-100 pesos	78	166	244
	100-200 pesos	87	74	161
	200-300 pesos	39	40	79
	> 300 pesos	19	33	52
Total		229	323	552
Chi-square = 22.2		df = 4	***p-value* < 0.001**	

Appendix A-Table 12. Contingency table of "Level of education *vs.* Perceived personal benefits from the CR."

Q27-Q21a		Perceived personal benefits from CR		
		YES	NO	Total
Level of education * Finished	Unfinished element. school	41	38	79
	Elementary*	36	61	97
	Secondary *	68	90	158
	High school*	62	86	148
	College*	21	47	68
	Post graduate*	1	5	6
Total		229	327	556
Chi-square = 9.13		df = 5	*p-value* = 0.100	

APPENDIX B –SLRC (2005)

I. Tables of results from the SLRC survey done by INE and PRONATURA (2005).

Appendix B-Table 1. SLRC willingness-to-pay (Carrillo-Guerrero, 2005).

Offer1: "YES" (Q12)			Offer2: Yes and No (Q13)		
Price	#Surveys	#YES (%)	Price	#Yes (%)	#No (%)
$20	76	71 (93%)	$30	70 (92%)	1 (1%)
$40	75	68 (91%)	$50	66 (88%)	2 (2.6%)
$60	76	53 (70%)	$70	53 (70%)	0
$80	75	21 (28%)	$90	20 (27%)	1 (1%)
	Total=302	**213 (70.5%)**		**209 (69.2%)**	**4 (1.3%)**

Appendix B-Table 2. SLRC willingness-to-pay (Carrillo-Guerrero, 2005).

Offer1: "NO" (Q17)			Offer3: Yes and No (Q14)		
Price	#Surveys	#NO (%)	Price	#Yes (%)	#No (%)
$20	76	5 (7%)	$10	1 (1%)	4 (5.3%)
$40	75	7 (9%)	$30	3 (4%)	4 (5.3%)
$60	76	23 (30%)	$50	4 (5%)	19 (25%)
$80	75	54 (72%)	$70	2 (2.6%)	52 (69.3%)
	Total=302	**89 (29.5%)**		**10 (3.3%)**	**79 (26.15%)**

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