HOUSTON ADVANCED RESEARCH CENTER

Final Report to the

Texas Coastal Management Program
GLO contract no. 03-020

The Economic Value of Water for Ecosystem Preservation: Ecotourism in the Texas Lower Rio Grande Valley

Mitchell Mathis, Ph.D.
Principal Investigator

with assistance from
Daniel Matisoff and Travis Pritchett

Houston Advanced Research Center
4800 Research Forest Drive
The Woodlands, Texas 77381

June 2004

HOUSTON ADVANCED RESEARCH CENTER

This report was funded in part by a grant from the National Oceanic and Atmospheric Administration. The views expressed herein are those of the author and do not necessarily reflect the views of NOAA or any of its sub-agencies. Additional funding was provided by a grant from the Houston Endowment

The Economic Value of Water for Ecosystem Preservation: Ecotourism in the Texas Lower Rio Grande Valley

Executive Summary

Introduction

The Texas Lower Rio Grande Valley ("the Valley") is located at the southern tip of Texas, where biological communities from the desert, coastal, temperate, sub-tropical and tropical zones all come together. Thus, the Valley is home to more species of plants and animals than virtually anywhere else in North America. Over 400 species of birds can be found in the region, along with rare animals such as the ocelot and the jaguarundi (small North American cat species), and a variety of butterflies.

This unique multitude of wildlife attracts thousands of bird, butterfly and nature enthusiasts to the Valley, bringing millions of dollars each year to the region. As a result, "ecotourism" is becoming an important part of the local economy.

Ironically, while ecotourism is growing, the Valley's fragile ecosystem is facing unprecedented pressure from other economic activities. One of the key pressures concerns water. As agricultural production, industry and a rapidly growing urban population use all but a trickle of the Rio Grande (the region's only major source of fresh water), the water needs of the ecosystem are rarely considered and this fragile natural asset is deteriorating. One of the main obstacles to more widespread recognition of the ecosystem's water needs is that the economic value of using water to sustain the Valley's ecosystem has never been quantified. Without "economic representation" of this value, it is difficult for water managers, planners, and users to consider the ecosystem, along with agriculture, industry, and municipalities, when making water use decisions.

The purpose of the research presented in this report is to shed new light on the value of water to sustain the ecosystem in the Valley, focusing on the economic contributions water makes to the burgeoning ecotourism sector. While tourism economics provides insight into the nature of the tourism production function and product, and existing agricultural economics literature provides some insight into approaches that might be applied to the valuation of water as an input to the production of ecotourism goods, new methodologies must be developed in order to rigorously examine the value of water derived from ecotourism activities.

The approaches developed for this project represent a first step toward this objective. We explore in detail the connection between ecotourism activities and the economic value of water to sustain the ecosystem. To do so we have drawn on a variety of threads within the fabric of economic theory, and have examined how water used to sustain the ecosystem generates economic value through the consumption and production of ecotourism.

Background

"Nature-based tourism" and "nature-tourism" are often used interchangeably to refer to the same activity that we refer to throughout this report as "ecotourism." While a variety of definitions exist for ecotourism, the International Ecotourism Society defines ecotourism as "responsible travel to natural areas that conserves the environment and sustains the well-being of local people." Currently, ecotourism represents between 5% and 10% of the global travel market, but it is currently one of the most popular and fastest growing tourism markets. Growth rates for ecotourism are estimated to range between 10% and 30% annually compared to 4% for tourism throughout the world. The Valley's ecotourism sector appears to be following a similar trend.

Ecotourism in the Valley focuses primarily on birding, but also accommodates butterfly, dragonfly and other wildlife and outdoors enthusiasts. The Valley, often considered the number two birding site in North America, has recorded almost 500 bird species, drawing thousands of people and millions of dollars into the region. Its remarkable biodiversity and role as a major stopover on one of North America's migratory flight paths, have led to the development of a burgeoning ecotourism sector and an international reputation as a top birding spot. A variety of wildlife preserves and refuges have been established to protect remaining fragments of the Valley's diversity of ecosystems. These protected areas are valuable natural assets upon which the region's ecotourism activities are based.

As with the tourism industry in general, the ecotourism industry is a "composite industry" composed of a variety of other sectors that includes travel, lodging, restaurant, tour guide operations, public agencies, and non-profit organizations. In the Valley, restaurants, bed and breakfasts, ranches, and tour operators, as well as local, state, and federal agencies, and non-profit organizations contribute to various aspects of ecotourism. However, because definitions differ about what constitutes the "ecotourism industry," and because ecotourism is comprised of elements of other sectors such as the travel, hotel, and restaurant industries (which also serve with non-ecotourist clients), obtaining accurate economic data specifically regarding ecotourism presents a formidable challenge. Nonetheless, recent efforts suggest that ecotourism in the Valley has a significant economic impact in the region. For example, birdwatchers at the Santa Ana National Wildlife Reserve, Laguna Atascosa National Wildlife Reserve, and Sabal Palm Audubon Sanctuary alone are estimated to annually bring more $59 million in direct expenditures to the Valley economy. Farm earnings in the region, by comparison, accounted for $105.9 million in 1994. The various birding festivals held in the Valley are estimated to bring more than a million dollars to the region each year.

Results

As mentioned above, our objective was to examine the value of water to sustain the ecosystem in the Valley, focusing on the role of water in supporting ecotourism activities. Our analysis was based on the familiar economic framework in which economic value can be generated from the activities of both consumers and producers.

To investigate the value of water in ecotourism production, we gathered data regarding the firms' costs associated with guided ecotourism excursions as well as the prices charged. From this data, a representative cost profile was developed for a one-day excursion, which was then used to analyze the net revenue generated by the excursion. The per-trip net revenue was found to be $30, or roughly a ten percent "return" on costs. This net revenue was interpreted as the per-trip economic value of (i.e. the firm's willingness to pay for) the natural asset as an input to the "production" of the excursion. Based on a simplified representation of the "production" of the natural asset in which land and water are the only inputs, the value of water to sustain the ecosystem was taken to be some portion of the value of the natural asset (the ecosystem). However, due to the need for information regarding the biological and physical relationship between water and the ecosystem that was beyond the scope of the project, it was not possible to estimate this proportion. Consequently, a range of estimated values that might be attributable to water used to sustain the natural asset was suggested. This range was $3 to $27 per one-day excursion. Drawing upon observations regarding water and land used in agriculture, we speculate that the value of water to sustain the ecosystem as characterized here would be unlikely to lie at either extreme of the estimated range.

Given the complexity of ecotourism production, the lack of crucial economic and ecological information, and the simplifying assumptions needed to carry out the analysis, these values should be viewed as "first pass" approximations rather than precise estimates. Furthermore, the focus of the estimation of economic value attributable to water as an input to ecotourism production was quite narrow, considering only the simplest of ecotourism goods offered by an owner-operated ecotourism firm. Thus it did not incorporate the benefits that might accrue to restaurants, hotels, and other firms that might also contribute goods to, and benefit from, the ecotourists visit. Consequently, these benefits, though important, remained outside of the analysis and are not included in the estimate of the value to firms of water used to sustain the ecosystem.

For our examination of ecotourists' (i.e. consumers') activities, we used the notion of "willingness to pay" as the basis of economic value. To gather information regarding consumers' willingness to pay for ecotourism services in the Valley, we conducted a mail survey of nearly 300 attendees of the 10th Annual Rio Grande Valley Birding Festival, held in Harlingen, Texas in November 2003. The purpose of our birder survey was to gain a greater understanding of the economic value generated through the consumers' enjoyment of ecotourism. In addition to demographic and general festival activity questions, we included travel-cost questions designed to gather data regarding how much people spent to attending the festival, as well as a question designed to elicit information regarding attendees "willingness-to-pay" specifically for water to sustain the ecosystem in the Valley. Respondents returned 202 useable surveys, for a response rate of 68 percent.

Based on the results of the survey, travel expenditures ranged from $ zero to $8,300, and the average expenditure per person was approximately, $1,100. These expenditures reflect a "lower bound" benchmark of willingness to pay to for the experience of observing birds in their natural habitat, or, more generally, to experience nature. In other words, consumers demonstrated a willingness to pay that is *at least* equal to the expenditures they actually made. Our working hypothesis is that some portion of the consumer's willingness to pay can be assigned to the value of water used to sustain the ecosystem. However, from the travel cost data generated by the survey alone, it is not possible to assess water's role in the consumer's willingness to pay values based on travel expenditures.

Thus, as a first step towards isolating festival attendees' willingness to pay specifically for water to sustain the ecosystem, the survey included a contingent valuation question in which respondents were asked to directly state their willingness to pay for "the minimum amount of water [the ecosystem] needs to remain healthy." The annual amounts range from $ zero to $600, with an average of $38. This is almost 3.5% of the average expenditures incurred by festival attendees. However, it is not possible within the scope of this research to determine the relationship of the willingness to pay value attached to environmental flows to the overall willingness to pay to experience nature, as represented by travel expenditures. In particular, it not possible to ascertain whether the value derived from the contingent valuation question is "in addition to" or "part of" the more general ecotourism value reflected in the travel cost analysis.

For the sake of illustration, consider the possibility that, based on the above results, approximately 3% of direct expenditures associated with ecotourism in the Valley can be attached to water as its value in sustaining the ecosystem. If we use as a rough estimate of total annual direct expenditures the $59 million figure arrived at by Eubanks et al. (1995) discussed earlier in this report, the annual economic value for water to sustain the ecosystem embedded in this expression of consumer willingness to pay for ecotourism could be in the neighborhood of $1.7 million per year.

Alternatively, we could also suppose that the results of the contingent valuation question are "in addition to" the willingness to pay to observe birds in their natural habitat, and that they are generalizable to all ecotourists who visit the Valley each year. If the number of annual ecotourists to the Valley is roughly 150,000 and they are willing to pay on average $38 each for water to sustain the ecosystem, this amounts to a value for environmental flows of approximately $5.7 million per year.

We emphasize that the above discussion of the survey results as they pertain to broader implications regarding economic value associated with water to sustain the ecosystem in the Valley are purely illustrative. Whether or not they are "in the ballpark" remains a matter of further research.

Concluding Observations

While the research presented here focuses on the value of water to sustain the ecosystem generated through ecotourism activities, two additional major sources from which the economic value of environmental flows derives are (1) the non-market value of myriad ecosystem services and (2) non-use values.

As the many beneficial functions provided by the ecosystem become better understood, and as the benefits the ecosystem bestows upon humans become more widely appreciated, significant research attention has begun to focus on the economic value associated with ecosystem services. Although there is often considerable debate about the methods used and the validity of the values derived, there is little doubt that the economic value of ecosystem services, though un-priced, is enormous. Because most ecosystems require water to remain healthy, the value they generate through their many beneficial services is partially attributable to the water needed to sustain them.

A second additional source of economic value for water to sustain the ecosystem is the non-market value derived from satisfaction the individual receives from knowing that a given natural asset exists, and/or will continue to exist, without actually experiencing them at that moment. These non-use values can be divided into "existence," "bequest," and "option" values. Option values are motivated by the desire to preserve the option of the individual to enjoy the environmental benefit at some point in the future, even though the individual may not currently be doing so. Bequest values reflect the desire to leave an environmental legacy, i.e. to preserve the option for others in the current and/or future generations to enjoy a given environmental benefit. Finally, existence value is based on the satisfaction derived from simply from knowing that a given element of nature exists. For any or all of these reasons, many individuals may be willing to pay to ensure that sufficient water is used to sustain the ecosystem in the Lower Rio Grande Valley (and elsewhere), even if they do not expect to travel to the region to experience the benefits. As noted in the report, the scant research in this area suggests that non-use values for environmental flows may be quite large.

Thus, the economic value of water derived from the production or consumption of ecotourism goods reflects only part of the value of water used to sustain the ecosystem. Moreover, the value of water derived from ecotourism my be just "the tip of the iceberg" in that it is likely to be relatively small compared to non-use values and values derived from ecosystem services. Nonetheless, because ecotourism generates real dollars and real jobs, the water used to sustain the natural assets upon which ecotourism depends has a tangible impact on the regional economy of the Lower Rio Grande Valley.

Table of Contents

Ecotourism in the Texas Lower Rio Grande Valley

1. Introduction

Located on the southernmost portion of the Texas coastal region, the Lower Rio Grande Valley (the Valley) – comprised by Cameron, Willacy, Hidalgo and Starr counties – lies in one of the most ecologically complex and biodiverse regions in all of North America. As more and more people become aware of the ecological treasures that exist there, ecotourism in the Valley has developed into a rapidly growing sector of the regional economy. Ironically, while ecotourism is growing, the Valley's fragile ecosystem is facing unprecedented pressure from other economic activities. One of the key pressures concerns water. As agricultural production, industry and a rapidly growing urban population use all but a trickle of the Rio Grande (the region's only major source of fresh water), the water needs of the ecosystem are rarely considered and this fragile natural asset is deteriorating. One of the main obstacles to more widespread recognition of the ecosystem's water needs is that the economic value of using water to sustain the Valley's ecosystem has never been quantified. Without "economic representation" of this value, it is difficult for water managers, planners, and users to consider the ecosystem, along with agriculture, industry, and municipalities, when making water use decisions.

A detailed understanding of the Valley's ecotourism sector, as well as the role of water plays in supporting this ecotourism, can help establish the ecosystem as an economically important user of Rio Grande water. Without sufficient water, the ecosystem will likely continue to decline, fewer mammals, birds and butterflies will be found, possibly leading to fewer visitations by ecotourists to the Valley. Thus the purpose of the research presented in this report is to shed new light on the value of water to sustain the ecosystem, focusing on the economic contributions water makes to the ecotourism sector.

The report is organized into seven sections. The next section, Section 2, provides a broad characterization of the ecosystem in the Lower Rio Grande Valley. In keeping with the economic focus of the research, this remarkably complex and diverse ecosystem is often referred to in subsequent sections as a “natural asset” or ecological asset”, which serves as the foundation upon which ecotourism activities are based. Thus, this section is intended to provide the reader with a more detailed flavor of what is subsumed under these somewhat abstract and sterile economic terms.

Section 3 provides an overview of ecotourism in the Valley. The section begins with a brief discussion of what ecotourism is, and then grounds the analysis of ecotourism, as a general concept, in economic theory. The section concludes with an in-depth characterization of ecotourism in the Valley, placing it within the larger context of the state and local economy.

Section 4 presents an overview of economic value, the economic value of water, (particularly the value of water used to sustain the ecosystem), and some of the methods used to estimate this value. This section considers the source of value from the perspective of both the firm and the consumer, setting theoretical framework for the next two sections.

Section 5 examines the value of water to sustain the ecosystem from the firm’s perspective, looking specifically at water’s role in the production of ecotourism. The section begins with a review of the relatively scant literature regarding ecotourism production. While this literature has not examined the value, or even the role, of water in ecotourism production, insight can be gained from the extensive literature in agricultural economics regarding the value of water used to produce crops. Thus, this section also included a review of methods used to estimate the value of water used in agricultural production. Next, a more detailed characterization of the ecotourism firm is developed in terms of simple production and cost functions. Finally, an analysis of net benefits generated by guided ecotourism excursions is undertaken.

Section 6 presents an analysis of the economic value water to sustain the ecosystem from the consumers' side, based primarily on an in-depth survey of birding enthusiasts who attended the Rio Grande Valley Birding Festival held in November of 2003. Using the information generated by the survey, the analysis explores the ecotourists' willingness to pay using two different approaches.

Section 7 concludes with some final observations and remarks.

This research was made possible by grants from the Texas Coastal Management Program (Grant Cycle 7) and the Houston Endowment, Inc.

2. A Characterization of the Ecosystem in the Lower Rio Grande Valley

Serving as a basis for the ecotourism in the Lower Rio Grande Valley, the unique ecosystem that exists in the region is an economically valuable asset. The diverse biotic communities that make up the ecosystem of the Lower Rio Grande Valley support a wide variety of plant and animal life. The multitudes of rare and endangered species and especially birds that make their habitat within the ecosystem attract thousands of eco-tourists to the region each year. The in-stream flows of the Rio Grande are crucially important in supporting this habitat. Additionally, these in-stream freshwater flows sustain the estuary at the mouth of the Rio Grande and help sustain commercial and recreational fishing in this part of the Gulf of Mexico.

This section of the report seeks to provide a broad characterization of the terrestrial ecosystems of the Lower Rio Grande Valley. It relies heavily on the work of Jahrsdoerfer and Leslie (1988), which to date remains the most authoritative description of the Tamaulipan Brushland of the Lower Rio Grande Valley. A brief description of the riverine ecosystem is also included, which draws primarily on Edward and Contreras-Balderas (1991, 1999).

2.1. Tamaulipan Brushland: Terrestrial Ecosystems of the Lower Rio Grande Valley

The Lower Rio Grande Valley, a fertile plain located in south Texas and Northeast Mexico, is home to a unique ecosystem known as the Tamaulipan brushland. Blair (1950) characterized this biotic province based on topographic features including climate, vegetation types, and terrestrial vertebrates (excluding birds). Tamaulipan brushland is part of the south Texas plain that lies south of the Balcones fault line, extending south to the Rio Grande River and east to the Gulf of Mexico. The Tamaulipan brushland covers about 19.7 million acres (8 million ha) (Lonard 1985). The area that is significant for this study is the Matamoran district, named by Blair for the city located across the Rio Grande from Brownsville, Texas, Matamoras, Mexico. The Matamoran district is comprised of four counties: Cameron, Hidalgo, Starr, and Willacy. This unique ecosystem is found nowhere else in the United States and is home to a diverse group of flora and fauna, many of which are only found in this region.

The Matamoran district is semi-arid and subtropical, receiving irregular rainfall. Among the four counties, the average temperature in January is 10 degrees C (50 degrees F) and in July average temperatures are 36 degrees C (96 degrees F). Annual average rainfall across the four counties is 38-76 cm (15-30 in). With such little annual average precipitation, a large majority of each month's rainfall could occur during one storm. This unpredictable pattern requires drought resistant vegetation to combat the high temperatures and irregular rainfall.

The physical features of each county vary depending on the proximity of the Gulf of Mexico or the Rio Grande River. Cameron County, which has one border created by the Rio Grande River and another provided by the Gulf of Mexico, is flat with 90% clay or loam soil composition, 3% sand, and the remainder characterized as other. Willacy County, which is directly north of Cameron County and shares a border with the Gulf of Mexico, is flat but sloping to Laguna Madre. Its soil is 73% clay-loamy, 16% sandy, and the remaining 11% is comprised of other types of soil. Moving inland, Hidalgo County is flat in the southern part of the county but fades into rolling hills as it extends north of the Rio Grande River. The soil composition of this county is 60% clay, 22% sandy, and 12% clay-loamy. Starr County, the westernmost region of the Matamoran District, is characterized by rolling hills comprised of 76% loamy soil, 5% sandy soil, and 19% a combination of loam or clay.

The bulk of the vegetation in the Matamoran District is comprised of thorny brush, with relatively few species accounting for the majority of plants. Estimates of the number of native woody species in the Lower Rio Grande Valley range from 170-265 total species. The most prevalent species include: mesquite (*Prosopis glandulosa*), granjeno (*Celtis pallida*), guayacan (*Porliera angustifolia*), cenizo (*Leusophyllum frutescens*), white brush (*Aloysia gratissima*), prickley pear (*Opuntia lindheimeri*), tasajillo (*Opuntina leptocaulis*), and various species of *Condalia*, *Castela*, *Acacia*, and *Mimosa*.

The brushland can be divided into two different classifications: mesquital and chaparral (Crosswhite 1980). Mesquital grasslands are characterized by bosque of large trees with an under story of native grasslands. The chaparral regions consist of impenetrable, stiff, usually evergreen bush. The plant communities are characterized by mixtures of plants found in deserts to the west, coastal regions of the Gulf Coast, temperate zones to the north, and tropical or subtropical regions to the south. Moving north or south, away from the Rio

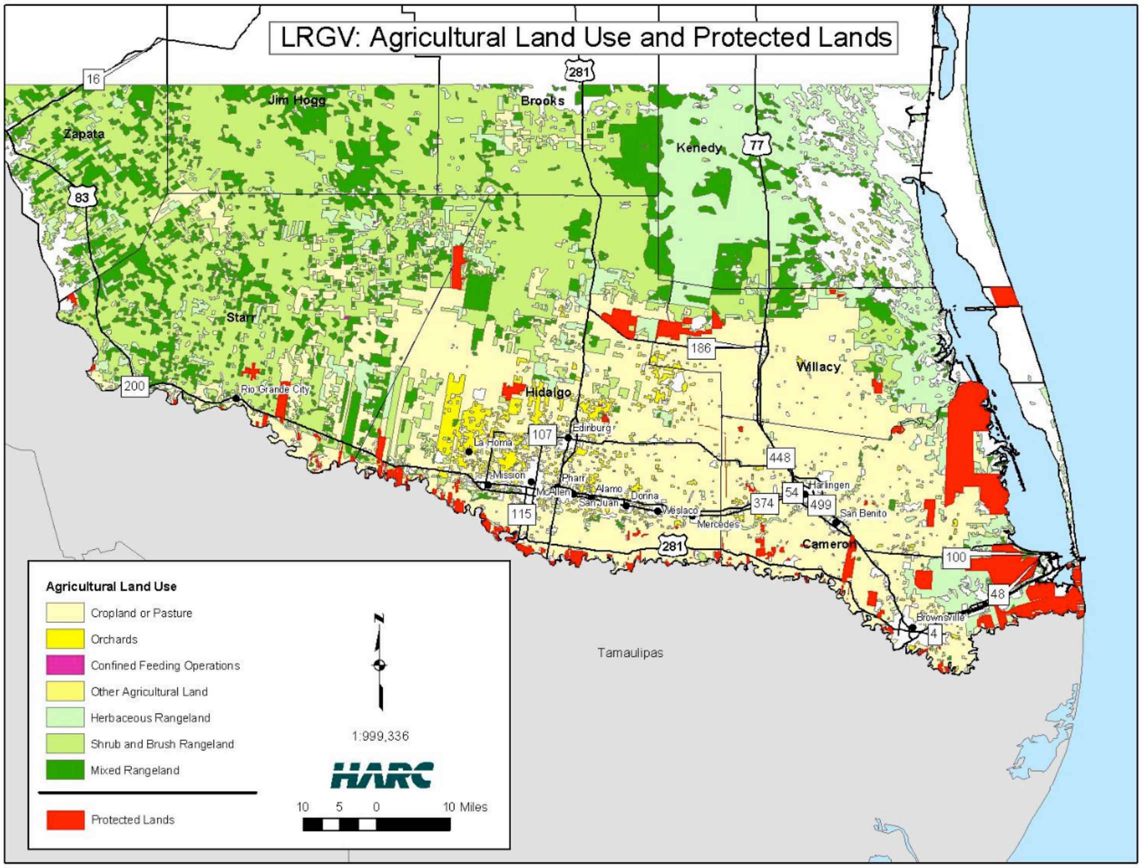
Grande River, plants show a greater adaptation to drier conditions. The dense cover provided by many of these species supplies food, nesting sites, and cover for many of the unique animals in the region. This neo-tropical region, characterized by dense, thorny brush, is the northern limit of the range for many mammals, snakes, lizards, salamanders, and a few species of fish.

The province is home to a diverse group of fauna. By 1988, nearly 700 species of vertebrates had been documented in this study area with 86 vertebrate species listed as Threatened, Endangered, or potential targets for immediate protection by some governmental organization. The biodiversity in the region is demonstrated by the greater than 900 species of beetles identified in one Audubon Sanctuary. Thirty-five percent of the Texas ondonates are accounted for in these four counties. An estimated 300 species of butterflies have been recorded in the region, with new species being discovered frequently. Forty percent of the snake fauna, 33 species, have been identified in the four county region. As of 1998, 485 bird species had been recorded in the Lower Rio Grande Valley. The special habitats provided by the Tamaulipan biotic province supports small groups of subspecies found nowhere else in the United States such as the Texas red-shouldered hawk *(Buteo lineatus texanus),* Zapata Carolina wren (*Ferminia cerverai*), and the Brownsville Common Yellowthroat (*Geothlyptus trichas inseperati*). Many other bird and fish species, including the fat snook (*Centropomus parallelus*), reach the northern limits of their range in the Lower Rio Grande Valley. The 83 species of mammals that occur in this region include not only terrestrial mammals, but also marine mammals in the adjacent Rio Grande estuary. The rare felids, the ocelot (*Felis pardalis*) and the jaguarundi (*Felis Yagouaroundi*), also make their home in the dense brush along the coastline and the Rio Grande River.

2.1.1. History

Prior to European colonization, human disturbance to the delta was minimal. Most Native Americans lived in small bands on the coastline and in the river bottoms. In the 1700's, riparian areas and draws contained mesquite stands as tall as 21 meters, with native grass under stories (Thornton 1977). As Europeans began introducing cattle and ranching, heavy grazing decimated much of the grass, which was replaced with cacti, brush, and stunted mesquite. After the Mexican War in 1848, free-range cattle ranching began to have

Figure 2.1. Land Use in the Lower Rio Grande Valley



significant effect on the brushland and inevitably the wildlife diversity. In the early 1900's, agriculture began blossoming and by the 1930's large scale farming was commonplace. The rich delta soil, sub-tropical climate, and long growing season make the region home to some of the most productive farmland in the United States.

Originally, land clearing and irrigation was done by hand and presented no significant impact on the native plant communities. However, improved techniques developed in the 1930's significantly increased pressure on the region. As more land was cleared for crops, greater pressure was put on the water supply and improved irrigation techniques began to modify the Rio Grande landscape. This change would have direct and indirect effects on the process of natural flooding; a necessary process to maintain the natural conditions in sub-tropical, floodplain forests. Along with land-clearing and redistribution of water came the increased use of pesticides and herbicides to clear land and protect crops. The agricultural expansion lead to increased human populations and urban developments. Urban development resulted in the introduction of a variety of industries and associated infrastructure. Since 1920, human impacts resulting from brush clearing, pesticide and herbicide use, and irrigation have been severe. As of 1988, 95% of the native brushland on the Lower Rio Grande Valley had been converted to agricultural or urban use (see Figure 2.1). In 1999, estimates of riparian vegetation cleared on the United States side of the Rio Grande increased to 99% (Fermata 1999). The original 40,000 acres (16,200 ha) of Sabal Palm Forest have been reduced to approximately 40 acres. Brush clearing in the South Texas region has been compared to the clearing of the rain forest in Latin America. Most remaining tracts of undeveloped land are small and fragmented, leaving only isolated wildlife habitats.

2.1.2. Biotic Communities

The Matamoran district is composed of 11 uniquely identified biotic communities as identified by the United States Fish and Wildlife Service (Jahrsdoerfer and Leslie 1998). Each community is recognized for its unique contributions to the Tamaulipan district.

2.1.2.1 Chihuahan Thorn Forest

The Chihuahuan Thorn Forest, also known as the Falcon Woodland, is the desert shrub community that follows the Rio Grande below the Falcon Reservoir. This riparian zone is an ecotone, a transitional area between two adjacent ecosystems, with the desert scrub on one side and the river on the other. The riparian zone is home to black willow (*Salix nigra*), Montezuma baldcypress (*Taxodium mucronatum*), texas ebony (*Ebenopsis ebano*), and mesquite. The upland portion of the region contains sotol (*Dasylirion texanum*), catclaw mimos (*Mimosa biuncifera*), and blackbrush acacia (*Acacia rigidula*). Fauna unique to this thorn forest include: the brown jay (*Psilorhinus morio*), the green kingfisher (*Chloroceryle Americana*), the ringed kingfisher (*Ceryle torquata*), the belted kingfisher (*Ceryle alcyon*), and the ferruginous pygmy owl (*Glacidium brasilianum*).

2.1.2.2 Upper Valley Forest

The Upper Valley Forest consists of small-forested valleys along the Rio Grande between Falcon and Mission, Texas. The predominate woody species, mesquite and granjeno, provide important fall roosting areas for white winged doves as well as suitable habitat for many other species.

2.1.2.3 Barretal Region

The thicket, or Barretal, region is characterized by narrow band of gravel and caliche, impermeable formations of calcium carbonate ridges. This thicket is the only place in the United States where the native citrus tree, *Heletta parvifolia* occurs as a thicket. The region is also home to brush species such as the chaparro prieto, Tamaulipan Palo Verde (*Cercidium macrum*), chaparro amargosa, and junco (*Koeberlinia spinosa*). Other species making the thicket their home include: the elf owl (*Micrathene whitneyi*), the reticulate collared lizard (*Crotaphytus reticulates*), and the Mexican burrowing toad (*Rhynophrynus dorsalis*).

2.1.2.4 Upland Thorn Scrub

The Upland Thorn Scrub, surrounding the Rio Grande delta and the valleys within the Tamaulipan Biotic Province, is the most common habitat type. The *anacahuita* and *cenizo* are the common woody species. The tracts in close proximity to the Rio Grande provide wildland corridors that connect the uplands and the riparian habitats. The thornscrub is used by raptors such as the Swainson's hawk (*Buteo swainsoni*) and the broad-winged hawk (*Buteo platypterus*) as they migrate through the Lower Rio Grande Valley.

2.1.2.5 Mid-Valley Ripirian Woodland

The Mid-Valley Riparian woodland is a bottomland hardwood site. The dense tall canopy forest characteristic of this community is made up of cedar elm, Berlandier ash (*Fraxinus berlandieriana*), sugar hackberry (*Celtis laevigata*), along with mesquite and granjeno. Many rare birds such as the oriole (*Icterus spp*), chachalacas (*Ortalis vetual*), and green jays *(Cyanocorax yncas*) are observed in great densities. This community also contains resacas, which provide a unique aquatic ecosystem. Resacas are former channels of the Rio Grande and now serve as closed aquatic systems, only collecting water during flood conditions.

2.1.2.6 Sabal Palm Forest

The Sabal Palm Forest is located in the southmost bend of the Rio Grande. Palm dominated tracts are all that remain of the former 40,000 acre (16,200 ha) palm community that once existed. The current 3,500 acre (1,418 ha) palm tracts are represented by Mexican palmettos (*Sabal mexicana*) but include a mixture of tepeguaje (*Leucaena pulverulenta*), anacua, and Texas ebony. Ocelots, jaguarundis, lesser yellow bats (*Lasiurus ega*), hooded orioles (*Icterus cucullatus*), speckled racer (*Drymodius margaritiferus*), and northern cat-eyed snake (*Leptodeira septentrionalis*) have been observed in this community.

2.1.2.7 Clay Loma and Wind Tidal Flats

The Clay Loma and Wind Tidal flats form a miniature eco-system of wooded islands and tidal flats that are inundated by water from the Gulf Coast. Lomas form from particles originally deposited by the Rio Grande that are blown off the tidal flats when they are dry or barren. Dunes, normally covered by woody vegetation, are also formed from wind blown particles. Rain and flooding will erode the outer edges of the lomas and the process begins afresh. The lomas are home to vegetation such as the Texas ebony and fiddlewood (*Citharezylum brachyanthum*). Borricha (*Borrichia frutescens*) and salicornia (*Salicornia spp*) dominate the flats while the South Bay is home to the black mangrove (*Avicennia nitida*). The community is represented by vertebrates such as the Texas tortoise (*Gopherus berlandieri*), long billed curlews (*Numerius americanus*), and the hypersaline-tolerant Gulf oyster (*Ostrea equestris*).

2.1.2.8 Mid-delta Thorn Forest

The Mid-delta Thorn Forest was once a vast thicket of mesquite and granjeno mixed among Texas ebony, anacua (*Ehretia anacua*), and brazil (*Condalia hookeri*). Less than 5% of the original acreage still exist in the form of fencerows, highway right-of-ways, canals, and ditch banks. Very few small remnant tracts (<40 ha [<100 acres]) of this tightly interwoven canopy of shrubs still exist. Historically, the Mid-delta Thorn Forest was a nesting ground for the white-winged dove.

2.1.2.9 Ramaderos

The Ramaderos biotic province consist of dense brush, often characteristic of the upland areas in the Lower Rio Grande Valley, located along isolated riparian strips of land. Granjeno, huisache *(Acacia farnesiana),* retama (*Parkinsonia aculeata L.*), brazil, mesquite, and other woody species found in Ramaderos habitats can withstand the periodic flooding that is characteristic of this riparian land. Check dams in arroyos can prevent water and nutrients from reaching the Ramaderos and therefore reduce the height and density of the plant species. This riparian land not only provides important nesting and feeding grounds for numerous species, but also creates a travel corridor along the Rio Grande. The white winged dove, plain chachalaca, white tailed deer (Odocoileus virginianus), Harris hawk (Parabuteo unicinctus), reticulate-collared lizard, and northern cat-eye snake are all common wildlife within the Ramaderos region. In 1984, it was estimated that 35,000 acres (14,175 ha) of Ramaderos remain, with the majority of them in Starr County (Collins 1985).

2.1.2.10 Woodland Potholes and Basins

The Woodland Potholes and Basins biotic province consist of hypersaline salt lakes such as La Sal Vieja that are created by an inflow from underground salt springs. The lakes are surrounded by brushlands that include many small freshwater wetlands or potholes. Some of these wetlands are resacas while others occupy shallow basins. During wet seasons these wetlands are very productive, serving as greentree reservoirs for wintering waterfowl. Potholes are islands of wildlife habitat in an extensively cultivated region and are valuable to resident and migratory wildlife (Martin and Hehnke 1981; Guthery and Bryant 1982). The inland pothole wetlands are important for waterfowl production and over wintering, flood control, ground water recharge, and water pollution abatement (Spiller and French 1986).

2.1.2.11 Coastal Brushland Potholes

The Coastal Brushland Potholes range from freshwater ponds to brackish pools and saline estuaries. The saline influence and proximity to the Gulf of Mexico results in varied vegetation. This microclimate is more stable than the other regions, producing more days of cloud cover, more precipitation, and fewer temperature extremes. In some areas, moving sand dunes influence topography by burying the edge of the forest on the leading edge and uncovering vegetation on the trailing edge. Moving sand dunes can also create depressions that become wetlands and receive heavy use by waterfowl. The Coastal Brushland is also a prime habitat for the endangered ocelot and jaguarundi.

2.1.3. Keystone Species

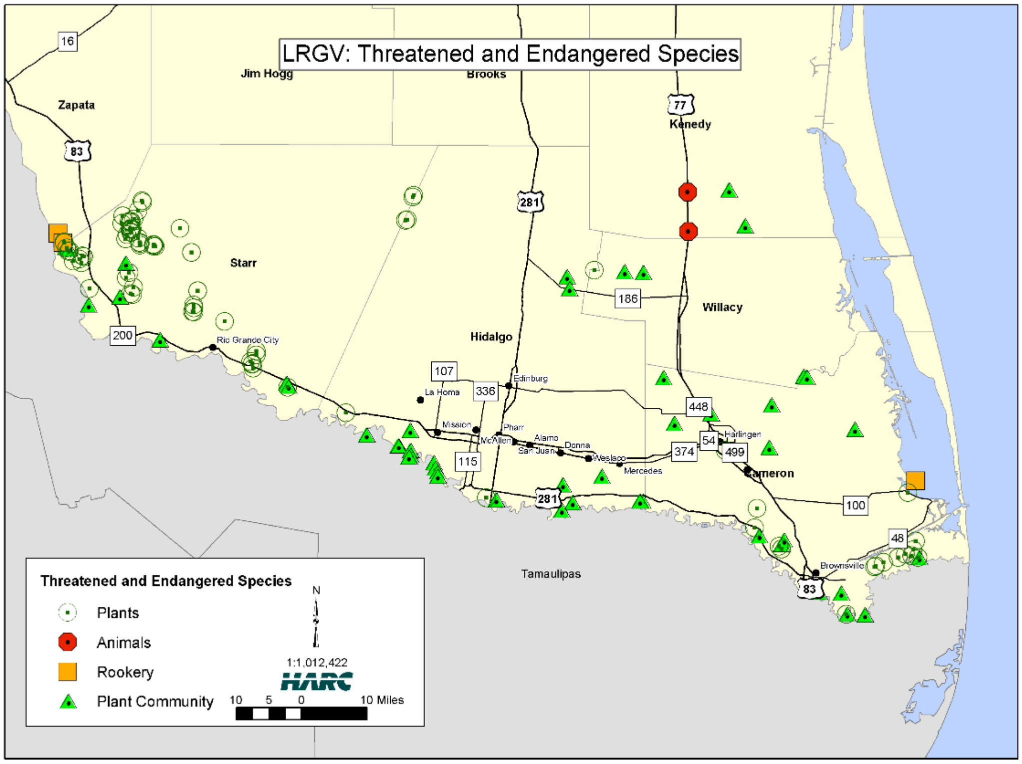
Robert Paine (1969) described a keystone species as one whose impact on its community or ecosystem is larger or greater than would be expected from its relative abundance or biomass. According to Paine, two parameters qualify keystone species. First, their presence must be crucial in maintaining the organization and diversity in their community. Second, the species, relative to the rest of the community, must be of exceptional importance. The loss of such species can have cascading effects on the remaining species within an ecosystem. Many times keystone species are predators that are high on the food chain and sparsely populated making them prone to extinction. Losing one keystone predator species can lead to significant changes in population sizes of other species. However, in most cases, groups of keystone or functional species, rather than individual keystone species, are responsible for engendering dramatic changes in the structure and function of a biological community (World Resources Institute, 2003).

Many of the keystone species in the Lower Rio Grande Valley have been lost to extirpation, extinction or near extinction. The habitat is so fragmented that it has become less volatile as biodiversity has slowly been pared away (J. Lester, personal communication, 2003).

2.1.4. Threatened and Endangered Species of the Lower Rio Grande Valley

The diverse habitat of the Lower Rio Grande Valley is home to a variety of unique species. Unique habitats such as the Tamaulipan floodplain forest support many species at the northern limit of their home range. About 700 vertebrate species have been found in the Matamoran District of the Lower Rio Grande Valley (Jahrsdoerfer and Leslie 1988). Of these, 86 are considered endangered, threatened, or placed on a watch list by the U.S. Department of the Interior, the State of Texas, or the Texas Organization of Endangered Species. In 1973, the Texas legislature authorized the Texas Parks and Wildlife Department (TPWD) to establish a list of endangered or threatened species. Endangered species are defined as those species that the Executive Director of the TPWD has named as being "threatened with statewide extinction". Threatened species are those species that the TPWD has determined, are likely to become endangered in the future. In 1988, similar legislation

Figure 2.2. Sightings of Threatened and Endangered Species in the Lower Rio Grande Valley



was passed, authorizing the establishment of a list of threatened and endangered plants. The TPWD prohibits the taking, possession, transportation, or sale of any animal species designated by the state as endangered or threatened. Additionally, some species that are listed by the TPWD as threatened or endangered are likewise recognized by federal regulations and receive additional protection from the U.S. Fish and Wildlife Service.

Willacy and Cameron Counties are home to five species of sea turtles, including the green sea turtle (*Chelonia mydas*), listed as endangered, threatened, or both. Several bird species, including the mountain plover (*Charadrius montanus*), piping plover (*Charadrius melodus*), and northern aplomado falcon (*Falco femoralis septentrionalis*) are characterized as endangered in Willacy, Hidalgo, and Cameron counties. Two felids found only in this region, the ocelot (*Leopardus pardalis*) and the jaguarundi (*Herpailurus yagouaroundi*), are endangered in all four counties. Plants such as the south Texas ambrosia (*Ambrosia cheiranthifolis*), star cactus (*Astrophytum asterias*), Texas ayenia (*Ayenia limitaris*), and ashy dogweed (*Thymophylla tephroleuca*) are all listed as endangered by the TPWD and/or the U.S. Department of the Interior.

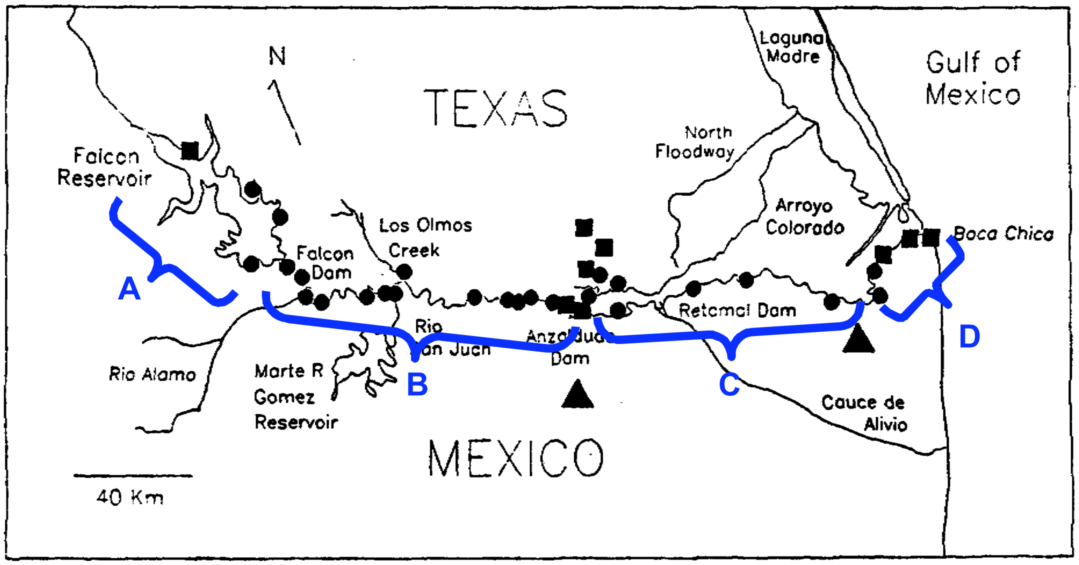
The loss of habitat and the reduction of quality in the habitat that remains are the primary reasons for the declining populations of most of these species (TPWD, 2003). The prevention of naturally occurring fires, agriculture, urban development, and heavy machinery all contributed to the loss of native species and the degradation of habitat. To preserve crucial habitat, public and private organizations have set up wildlife refuges and conservancies. The Santa Ana Refuge, Lower Rio Grande Refuge, and Laguna Atascosa Refuge are all part of the U.S. Refuge System sponsored by the Department of the Interior. A number of state, county, and city protected areas have also been established, and other privately held lands have been designated as wildlife management areas and sanctuaries. Many of these protected areas are described in greater detail in the next section.

2.2. Riverine Ecosystem of the Lower Rio Grande Valley

The riparian district of the Lower Rio Grande Valley begins with the Falcon Reservoir in Starr County and extends along the Rio Grande River to the Boca Chica in Cameron County. Two tributaries, the Rio Alamo and Rio San Juan, enter from the Mexican side of the border and one tributary, Los Olmos Creek, enters from South Texas. Three dams restrict the flow of the Rio Grande in this region; Falcon Dam below falcon reservoir, Anzalduas Dam further down stream, and finally Retamal Dam.

During the last 150 years, four fish collection studies have been conducted on this region. During the 1850's, John H. Clark took limited fish samples from Boca Chica to Brownsville as part of a Texas Mexico Border Survey (reported in Baird and Girard, 1853; and Girard, 1856). In 1953, Trevino Robinson (1956, 1959) sampled fish in the Lower Rio Grande. His collection efforts coincided with the closure of the Falcon Dam. Twenty years later, Rodriguez-Olmos (1976) completed similar collections in the areas below the Falcon Reservoir. Most recently, Edwards and Contreras-Balderas (1991) began systematically sampling the abundance of fishes in this region. Beginning in 1981 and continuing to 1991, Edwards and Contreras-Balderas sampled fish fauna to assess the status, ecological

Figure 2.3. Fish Sampling Locations and River Segments, Edward and Contreras-Balderas (1991)



Source: adapted from Edwards and Contreras-Balderas (1991)

relationships, and factors influencing fish abundance in this portion of the Rio Grande River, and to confirm changes in abundance and composition.

For analysis purposes, Edwards and Contreras-Balderas (1991, 1999) arbitrarily divided the river into four equidistant regions. Region A is the Falcon Reservoir. Region B begins below the Falcon Dam and extends downstream to the Anzalduas Dam in Hidalgo County. The third segment, region C, begins below the Anzalduas Dam and flows downstream to a point east of Brownsville. Region D begins where region C ended and follows the Rio Grande to Boca Chica. Based on an analysis of the previous fish collections, Edwards and Contreras-Balderas determined that there appeared to be two different ecological faunas in the Lower Rio Grande River. The past 150 years of collections revealed an upstream fauna, primarily in regions A, B, and C and a downstream fauna of fish in Region D. The historical collections found 114 species of fish in these four regions. Edwards and Contreras-Balderas found samples of 104 of those species. Of the 104 species taken, each was classified as freshwater fauna, estuarine, or marine fauna. It should be noted that comparing historical data dating back 150 years is problematic due to differences across the years in such areas as the number of collections, location of sampling stations, collection methods, and the differing collection efficiencies of personnel. Edwards and Contreras-Balderas tried to minimize these variations by using similar sampling stations as well as similar seine nets used in previous collections.

2.2.1. Upstream

The upstream fauna is comprised of mostly freshwater species such as cyprinids (carps and minnows) and centrarchids with a few estuarine or brackish species present. Edwards and Contreras-Balderas found that about 20 species inhabit all four regions of the Lower Rio Grande River including: *Dorosoma cepedianum, Dorosoma petenense, Astyanax mexicanus, Cyprinus carpio, Notropis jemezanus, Notropis orca, Hybognathus amarus, Macrhybopsis aestivalis, Carpiodes carpio, Ictalus furcatus,* and *Gambusia affinis*.

Fourteen species are considered common to all three of the upstream segments. They include the Atractosteus spatula, Lepisosteus osseus, Pimephales vigilax, nortopis amabilis, Notropis braytoni, Cyprinella lutrensis, Ictalurus punctatus, Micropterus salmoides, Lepomis fulosus, Lepomis cyanellus, Lepomis macrochirus, Pomoxis annularis, Cichlasoma cyanoguttatum, and Tilapia aurea. Three species were only found in Segment B; Lepisosteus oculatus, Notropis buchanani, and Moxostoma congestum. Carassius auratus and Selene vomer were only found in segment C, with Awaous tajasica appearing very rarely only in this segment as well. Additionally, a few species were found only in segment A, the Falcon Reservoir. These species are Notemigonus crysoleucas, Lepomis megalotis, and Lepomis auritus. Morone crysops and Lepomis microlophus were only found in segments A and B. Hybrids of L. Microlophus and L. Macrochirus were also observed in Falcon Reservoir on two separate occasions. Based on actual numbers, D. cepedianum, D. petenense, C. lutrensis, P. vigilax, S. marina, F. grandis, P. latipinna, P. Formosa, G. affinis, M. beryllina, L. macrochirus, C. cyanoguttatum, and T. aurea dominate the upstream fauna.

2.2.2. Downstream

Originally, the downstream fish assemblage was comprised of more upstream species such as cyprinids *M. aestivalis, H. amarus, N. jemezanus, A. mexicanus*, and *C. carpio* along with several brackish species such as poeciliids and cyrinodontids, as well as marine species such as sciaenids, gobiids, gerreids, and other traditionally coastal species. A surprisingly large number of marine species have been observed in segment D. Of these marine species, large numbers are juveniles suggesting that the downstream portion of the Lower Rio Grande River could be an important nursery ground or spawning region for many marine species. However, a few species that were once found in this region were rarely collected, or not collected at all in the most recent surveys. These species include: *A. mexicanus, C. carpio, P. Formosa, G. affinas,* and *Dormitator maculates*.

Coastal species such as *Agonostomus monticolas, Gobiomorus dormitory*, and *Gobiosoma bosc* have been observed as far upstream as segment B. *G. dormitory* has been frequently documented in sport fishing catches of segments B and C (Contreras-Balderas 1972). Evidence of *G. bosc* at a number of sites in segment C in 1981 and 1989 could represent the natural upstream extension of the coastal populations. Based on the findings of Edwards and Contreras-Balderas, the two distinct fish faunas still exist although the boundaries of the two are beginning to blend together.

Although there has been no observable general decline of some species (M. aestivalis, H. amarus, N. jemezanus, N. orca, and I. furcatus) in the Lower Rio Grande River, some species (Notropis buchanani, N. amabilis, M. congestum, Aplodinotus grunniens, and M. cephalus) appear in lesser abundances or not at all. The gar populations (A. spatula, L. oculatus, and L. osseus) have also experienced some decline in the upstream segments, quite possibly due to the competition from large populations of needlefish (S. marina). Likewise M. cephalus may be experiencing declines due to the competition of the large populations of A. monticola.

Other species such as *Pimephales bigilax, S. marina, F. grandis, C. variegates, A. monticola*, and *T. aurea* have experienced increases in relative abundance. Due to the rare capture and/or documentation of the needlefish (*S. marina*) and mountain mullet (*A. monticola*), it is unclear as to whether they were a part of the original downstream fauna. Currently they are both common members of the Lower Rio Grande fish fauna.

Except during periods of heavy runoff, the latest collection periods of Edwards and Contreras-Balderas yielded upstream waters of .5 ppt salinity. The elevated salinity in the upstream waters could account for the increase in abundance of traditionally downstream species occurring in upstream waters. This change in environmental conditions would be conducive to successful colonization by estuarine and coastal species (Edwards and Contreras-Balderas 1991).

Prior to 1972, blue tilapia (*T. aurea*) was only captured north of the Falcon Dam. However, recent collection comparisons have revealed a significant increase in abundance in upstream regions. During recent collections, Edwards and Contreras-Balderas found *T. aurea* to be the dominant species in segments B and C. The species seems to be increasing in abundance despite massive reduction in numbers during a winter die offs in 1983 and 1987 (Edwards, per obs). This is probably due to the species adaptability; *T. aurea* is able to successfully colonize general habitats and also has very generalized food habits.

2.2.3. Rio Grande Estuary

In contrast to most other major Texas rivers, the Rio Grande does not flow into a bay; instead, it flows directly into the Gulf of Mexico. The mouth of the Rio Grande forms a variable estuary depending on the amount of inflow from the river and the amplitude of tides of the Gulf of Mexico. Due to variability of tides and inflows from the river, the estuary is highly variable and less predictable. Very little is known about the ecology of this system. The Texas Parks and Wildlife Department has been working to characterize the fish populations of the estuary. However, this work remains unpublished (Blankinship per communication).

Although the Rio Grande has no direct inflows into the Laguna Madres, indirect interactions of freshwater inflows from the Rio Grande may occur, but are poorly understood.

3. Overview of Ecotourism in the Lower Rio Grande Valley

3.1. Overview of Ecotourism

In December, 1998, the United Nations declared 2002 the "International Year of Ecotourism," in accordance with the UN environment and development agenda to encourage efforts by governments, international and regional organizations, and non-governmental organizations to promote development and protect the environment. Although ecotourism represents only a small portion (5% to 10%) of the global travel market, it is currently one of the fastest growing tourism markets. Vincent and Thompson (2002) estimate that growth rates for ecotourism range between 10% and 30% annually, compared to 4% for tourism in general.

Birding and other forms of ecotourism and outdoor recreation are extremely popular with Americans and are becoming increasingly widespread. The National Survey on Recreation and the Environment, conducted by the U.S. Forest Service, reported that 33% of Americans participated in birding one or more times in the previous twelve months. They also noted that the percentage of the population that participates in birding has increased from 12% in 1982-83 to 33% in 2000-2001 (U.S. Forest Service, 2001). The U.S. Fish and Wildlife Service and U.S. Bureau of the Census (1997) also conducted a survey detailing expenditures and popularity of several wildlife related activities. The survey found that 31% of Americans and 25% of Texans are annually involved with wildlife-watching.

"Nature-based tourism" and "nature-tourism" are often used interchangeably to refer to the same activity that we refer to throughout this report as "ecotourism," although a variety of definitions exist for ecotourism. The International Ecotourism Society defines ecotourism as "responsible travel to natural areas that conserves the environment and sustains the well-being of local people." McNeely et al (1992) define it as "tourism that involves traveling to relatively undisturbed natural areas with the specific object of studying, admiring, and enjoying the scenery and its wild plants and animals, as well as any existing cultural aspects (both past and present) found in those areas." Sirakaya, Sasidharan, and Sonmez (1999) note that ecotourism is a form of tourist activity and development that produces a minimal negative impact on the host environment; an evolving commitment to environmental protection and conservation of resources; the generation of financial resources to support and sustain ecological and socio-cultural resources; and an active involvement and cooperation of local residents, as well as tourists. in enhancing environmental, economic, and social benefits to the host community. No attempt is made here to distinguish between or reconcile these different definitions, and the term "ecotourism" is used simply because it is less awkward than the term "nature-based tourism."

Although tourism can be based on natural attractions, it is not necessarily ecologically or socially sustainable. Sustainable tourism is therefore distinct from ecotourism: not all sustainable tourism is ecotourism, nor is all ecotourism sustainable. Sustainable tourism, based on the concept of sustainable development, is concerned with the social, economic and environmental impacts of tourism activities, be they ecologically based or otherwise. Within the concept of sustainable tourism, much discussion exists pertaining to tourism management techniques to achieve sustainability. By monitoring damage to the natural environment, paying attention to the location's carrying capacity, and overall minimizing negative impacts and maximizing positive ecological, sociocultural and economic impacts, ecotourism can be sustainable. Indeed, the Quebec Declaration on Ecotourism (United Nations Environmental Programme, 2002) "embraces the principles of sustainable tourism... and the following principles which distinguish it from the wider concept of sustainable tourism:

- Contributes actively to the conservation of natural and cultural heritage,
- Includes local and indigenous communities in its planning, development and operation, contributing to their well-being,
- Interprets the natural and cultural heritage of the destination to visitors,
- Lends itself better to independent travelers, as well as to organized tours for small size groups." [1]

[1] In the framework of the UN International Year of Ecotourism, 2002, under the aegis of the United Nations Environment Programme (UNEP) and the World Tourism Organization (WTO), over one thousand participants coming from 132 countries, from the public, private and non-governmental sectors met at the World Ecotourism Summit, hosted in Quebec City, Canada, by Tourisme Quebec and the Canadian Tourism Commission, between 19 and 22 May 2002. The Quebec Declaration on Ecotourism was one of the outcomes of this event.

Thus, while not all definitions of ecotourism require sustainability, ecotourism can clearly fit within the concept of sustainable tourism, providing a framework by which those promoting tourism and those promoting nature conservation can work towards similar objectives.[2]

3.2. Some Economic Insights regarding Ecotourism

Following the above discussion of tourism, this section draws from micro-economic theory to explore specific aspects of ecotourism.[3] Despite the focus is on ecotourism, much of the analysis applies to the broader context of tourism in general, and we have relied substantially on insights drawn from Gray's (1982) reflection on the usefulness of economics as a tool in understanding tourism. Of particular interest in this analysis are asset theory and the theory of public goods, as well as trade theory.

3.2.1. Asset Theory and the Use of Natural Assets in Ecotourism

In the economic analysis of natural resources, various elements of nature, such as land, fish, or forests have long been viewed as assets, which generate a return when used to produce a market good such as corn, harvested fish, or timber. More recently, economists have expanded the notion of natural assets by recognizing that nature also generates a "return" by providing a wide variety of economically valuable public "services" (e.g. carbon sequestration, reduction of air an water pollution, biodiversity, recreation and aesthetic beauty, to name but only a few), without being harvested or otherwise undergoing appropriation for use in the production of market goods. By definition, ecotourism requires the existence of a unique "natural asset" to which visitors are willing to travel to experience, such as well preserved, habitat, biodiversity, rare species of flora and fauna, and the like. Viewing nature (or elements of it) as a valuable asset that attracts visitors who wish to experiences some unique set of attributes clearly distinguishes its role as a crucial "input" to the production of ecotourism. It also reveals a fundamental economic rational for ensuring

[2] For a detailed discussion on this issue see the Commission for Environmental Cooperation, "Sustainable Tourism in Natural Areas (99.01.05) The Development of Sustainable Tourism in North America: Background, Issues, and Opportunities," Discussion Paper, prepared for A Dialogue on Sustainable Tourism in Natural Areas in North America, 27-28 May 1999, Playa del Carmen, Mexico.
[3] Tisdell (2001) provides a comprehensive review of macroeconomic analysis of tourism within the context of sustainable tourism, environmental impacts, and developing countries.

that such natural assets are preserved, maintained, and even increased, both in terms of quality and quantity.

Many natural assets exhibit characteristics that create the potential for firms to capture returns that exceed “normal” returns.[4] More technically, these “extra” returns are known by economists as “Ricardian rent,” which is defined as the returns to a production input or asset that exceed the opportunity cost of the use of that input or asset. Typically, these assets are characterized by fixed, or nearly fixed, (inelastic) supplies, and little availability of substitutes. The potential for such natural assets to generate Ricardian rent attracts firms seeking to capture this rent by utilizing the asset as an input to some production process. The example used by Ricardo (1821) is the landowner’s use of land, along with labor and capital, as an input to agricultural production. Harvesting (including mining) is also a common means by which firms seek to generate rent from natural assets. Two well-known examples of harvesting activity are the fishery and forestry. In the fishery, labor, capital and wild fish are inputs to the production of harvested fish. Similarly, in forestry, labor, capital and standing trees are inputs to the production of timber. However, an import difference between the fishery and forestry exists: in the case of forestry, the natural asset is stationary, exists on land, and can be owned; in the case of the fishery, the natural asset swims free in the ocean, and is difficult if not impossible to own.

3.2.2. The Role of Subtractability and Excludability

From the above discussion it is clear that ecotourism firms can potentially capture Ricardian rent by utilizing the natural asset as part of a ecotourism production process. As will be explored further below, the ability of the firm to appropriate (i.e. claim and/or establish ownership of) the natural asset can play a role in determining how this process is undertaken.

At this point it is useful to recall two characteristics that play a fundamental role in economic analysis of natural resources: subtractability and excludability. Subtractability

[4] Note that the use of term “firm” here, and throughout the report, is drawn from economic theory, and thus refers in a generalized way to *any* organization that engages in the production of goods and services. In economic theory firms typically are assumed to make decisions that will maximize profit (or minimize costs).

Figure 3.1. Typology of Economic Goods Based on Excludability and Subtractability.

		Subtractability	
		Low	High
Exludability	Difficult	I Public Goods	II Open-Access Resources
	Easy	III Toll Goods	IV Private Goods

refers to the degree to which the consumption of a good by one individual reduces the amount of that good available for others to consume. Excludability refers to the extent to which one individual can prevent others from appropriating or consuming the good. Each of these characteristics represents a spectrum within which economic goods fall, and together they provide a framework by which goods can be categorized according to where along these continua they lie. This framework is depicted in Figure 3.1.

Standard private goods, which are by far the category of goods with which we are most thoroughly familiar (e.g. food, clothing, houses, computers) are both highly subtractable and highly excludable. Assuming rule of law prevails, the purchaser of a pint of ice cream is recognized as the owner, who can exclude others from appropriating and consuming the ice cream.[5] The pint of ice cream is perfectly subtractable in that once the consumer eats it, there is one less pint available for her or anyone else to consume thereafter.

Private goods are so commonplace that the characteristics of excludability and subtractability are often taken for granted. However, as illustrated in Figure 3.1, three other classes of goods exist in which one or both of the excludability and subtractability characteristics do *not* hold. It is these classes of goods – rather than the more familiar private goods – that are important to the economic analysis of the role of natural assets in ecotourism.

---

[5] Closely associated with excludability is the enforceable right of ownership. In the absence of rule of law to enforce ownership rights, exclusion from many goods can still be achieved through personal vigilance and enforcement, in which case "possession is nine-tenths of the law."

Of particular interest is the characteristic of *non*-subtractability. Recall that a non-subtractable good is one in which consumption by one individual does *not* reduce the amount of the good available for another individual to consume.[6] Consider, for example, the use of a natural asset to generate a scenic view of nature. Assuming no congestion, the "consumption" of the view by one person does not reduce the amount of scenic view available for the next person to enjoy. This characteristic of non-subtractable consumption is present in many of the natural assets that serve as the basis for ecotourism. Rather than consuming a harvested physical commodity, such a fish or timber, that reduces the amount of the resource available to the next consumer, ecotourists consume an experience that depends on a non-subtractable service, such as aesthetic beauty, provided by the natural asset.

Thus, many if not most natural assets are not inherently non-subtractable; this characteristic depends upon the way the asset is used. For example, while the use of a forested mountainside for ecotourism is non-subtractable, the use of the same mountainside to generate lumber is highly subtractable. Whether or not most natural assets are non-subtractable is fundamentally a consequence of human choice.

The non-subtractable characteristic of the natural asset used in ecotourism, together with the degree of excludability that is possible, positions the asset as either a club good or a public good, as indicated in Figure 3.1. The difficulty or ease of excludability suggests distinct approaches by which natural the asset might be incorporated into the production of ecotourism.

Consider first the instance when excludability of the natural asset is high, that is, when the natural asset is a club good (quadrant III in Figure 3.1).[7] Because of the natural asset's characteristics as a club good, it is relatively easy to limit or exclude others from enjoying the benefits of the natural asset, while enjoyment of the benefits by one person does not prevent use by others. The ability to exclude use can be translated into the ability of the owner to charge a fee to, i.e. extract rent from, ecotourists willing to pay to experience the natural asset. Club goods can be provided through markets as well as by the government.

[6] Non-subtractability is also referred to more technically by economists as "non-rivalry of consumption" or "indivisibility of benefits."
[7] This type of good is also referred to alternatively as a toll good, and is a subclass of impure public goods, also known as near-public goods, and quasi-public goods. For an extensive theoretical analysis of club goods, see Cornes and Sandler (1996).

Private nature parks, and to a certain extent public nature parks, can be viewed as club goods. It is typical for private nature parks to contain relatively small-scale, specific natural features such as a cave, a rock formation, or an endangered species, while public parks are often much larger, both in geographical scale and natural assets they contain. Of course, the management approaches, and the purpose and determination of the fee are quite different between public and private parks. As public entities, the objective of public nature parks are often much larger, geographically, and, so they do not fully exploit the opportunity to generate Ricardian rent, even though it might be possible to do so. Generally, the objective of the entry fee for public parks (which) is to offset some (but not all) of the costs of operation. In contrast, the objective of a private park, as with any firm, is to generate revenue that exceeds the cost of operation, that is, profits. Thus the private park could be expected to pursue strategies to provide ecotourists with the benefits of the natural asset in ways that generate as large a Ricardian rent as possible.

Consider now the case when the natural asset used in ecotourism *is not* appropriable. Referring again to Figure 3.1, the non-excludability of the asset, combined with its non-subractable aspect establishes it as a public good (quadrant I). Oft-cited examples of public goods include lighthouses, national defense, environmental quality, and fireworks displays or other scenic views. Many elements of public parks can also be classified as pubic goods. As with club goods, the enjoyment of the benefits of public goods does not reduce the amount of benefits available for other to enjoy. However, because the consumption of public goods is not excludable, they be neither appropriated nor owned. Consequently, and in contrast to club goods, firms cannot profitably provide public goods through the market because it is not possible to exclude nonpaying individuals from consuming the good. Perhaps the most perplexing insight (for non-economists) yielded by the theory of public goods it that, even if it were possible for firms to charge a price for public goods, the economically efficient price for the befits of a public good is zero, since the opportunity cost for additional consumers is zero.

The unique characteristics of public goods thus preclude direct generation of Ricardian rent through the process of ecotourism production, as described above in the case of a club good. However, a natural asset that is a public good might be used to *indirectly* generate rent in ecotourism production through a rather different process. In this process, the natural asset serves simply to attract ecotourists to a particular location. Once visitors, thus attracted, travel to a given geographical location to enjoy attributes of the natural asset, they also consume other services such as hotels, transportation, restaurants, and guides that are part of the composite production of ecotourism. In this sense, the natural asset provides "visitor attraction" as an input to the production processes of many firms involved in the components of ecotourism. Moreover, the asset provides this highly valuable service at no charge to the firms involved.

It is important to note that once ecotourists have traveled to their tourism destination, they are temporarily "captive" by the constraints of time and space. The fact that consumers do not have the option to overcome these constraints by instantaneously traveling somewhere else creates opportunities for hotels, restaurants, and other firms to add a premium to the price of whatever service they provide.[8] This premium can be viewed as rent, above and beyond covering the costs of production. Anecdotal evidence suggests that this dynamic could be at work in many tourist locations. However, if other firms enter the market seeking to capture rent by providing similar services, the standard textbook scenario of competitive markets may unfold in the usual way: increased competition will introduce downward pressure on prices, eventually reducing and even eliminating the premium firms could charge under less competitive circumstances.

3.2.3. Preservation and Maintenance of the Natural Asset: A Public Good

The theory of public goods suggests that for a number of reasons including the "free rider" problem, markets fail to provide the level of a public good that yields the maximum well being to society. A free rider benefits from a good without paying for the supply of the good, a phenomenon that is directly related to the inability to exclude consumption by non-paying individuals. Because other consumers can benefit without paying from a public good purchased by the initial consumer, incentive is diminished to pay for the good to begin with. With a large number of free riders, voluntary payments, whether they occur through markets or individual donations, typically do not result in sufficient revenue to provide the optimal level of the public good. Consequently, economic theory typically prescribes that public

[8] The constraints of time and space, and their role in restricting consumer choice, can be viewed as bestowing a temporary element of market power to firms, thus enabling firms to manipulate prices upward.

goods must be provided and maintained by government, and paid for through the assessment of taxes.

Within this discussion of the provision of public goods, natural assets are somewhat different from standard public goods in that they are provided by forces other than those of humankind, and at no cost. No matter how much government or private revenue is generated, it is typically not possible for any human organization to create a mountain range, a beautiful climate, or a species. However, given that a natural asset already exists, the "service" of preserving and maintaining the natural asset is itself a public good, much like national defense, and is subject to the challenges of sufficient provision just described. Establishing and operating nature parks and other protected areas to preserve and maintain natural assets is thus a public good that is distinct yet inseparable from the natural asset.

Through the processes described above, the tourism industry can derive great benefit from natural assets, thus the providers of tourism goods and services have an evident interest in preserving the asset(s) upon which their operation is based. However, these same firms may also be subject to a form of the free rider problem regarding the preservation and maintenance of the natural asset upon which they depend. If left as a voluntary decision by each firm, the incentive to free ride could result in the under-provision of preservation and maintenance, resulting in the deterioration of the natural asset. The collective outcome of the firms' decisions is to the detriment of all firms, even if it is in each and every firm's best interest to optimally maintain the asset.

Finally, while firms engaged in the production of ecotourism have a relatively well-defined interest in maintaining the natural asset because of the benefits they receives, ecotourists also receive direct benefits provide by the natural asset (see discussion of consumer and producer surplus in subsequent sections). If individuals indirectly derive satisfaction in simply knowing that natural asset exists and will be continue to exist through preservation and maintenance efforts, then benefits of the asset extend well beyond ecotourists and ecotourism firms to a much larger population. Yet, for direct and indirect consumers, as with ecotourism firms, the incentives to contribute to the preservation of the asset are countered by the incentives to free ride.

3.2.4. Open Access and Carrying Capacity

Cornes and Sandler (1996) convincingly demonstrate that *pure* public goods, that is, goods that are perfectly non-excludable and perfectly non-subtractable, are quite rare. In this sense most natural assets that serve as the basis for ecotourism are not pure public goods for at least two reasons: crowding effects that reduce the level of enjoyment yielded by the ecotourism experience, and (2) the physical degradation of the resource due to the impacts of contact with ecotourists that exceed the natural asset's ability to absorb these impacts. Both of these impacts reflect costs that arise from overuse, and reflect the imperfectly non-subtractable nature of natural assets used in ecotourism, particularly if the carrying capacity for ecotourism is surpassed.

The more subtractable the natural asset used in ecotourism, the closer it is to an open access resource (quadrant II in Figure 1). Because of their non-excludable but subtractable nature, open access resources are subject to inefficient overuse, which if extreme can completely destroy the resource. This phenomenon, popularized by Hardin (1968) as the "tragedy of the commons," has been observed in a wide range of natural assets including pastures, forests, fish, and aquifers.

However, many natural assets exhibit a degree of excludability. The ability to exclude, even if far from perfect, may provide means by which access to the natural asset can be limited or regulated, thus mitigating the costs of crowding effects and degradation from overuse. This suggests a possible relationship between excludability and subtractability when considering natural assets that serve as the basis for ecotourism: the lower the degree of excludability, the higher is the subtractability due to such factors as crowding effects and physical degradation.

3.2.5. Ecotourism and Trade Theory

A defining feature of ecotourism is the existence of geographic variations in the endowment of natural assets that embody unique attributes that are sufficiently desirable to induce the consumer to travel to experience them. A second defining feature is the immobility of these natural assets, compared to the relative mobility of other factors of production (e.g. man-made capital, labor), and consumers. The notion of trade is useful in examining implications of these two features. The common conceptualization of trade involves an economic transaction in which a good is exchanged, and often suggests the transportation of the good across a certain distance. International or interstate trade implies that the transaction involves movement across political boundaries. Trade in services, rather than goods, also occurs, thought it is less intuitive. Trade in services is somewhat distinct from the trade of goods in that the producer must travel to the consumer, or *vise versa*, in order for the service to be provided. As an example, consider for a moment international consulting services. For "trade" in consulting services to occur, the consultant must travel to the client, or the client must travel to the consultant. Although an account's ledger book might treat both of these cases identically as "exporting" a consulting services product, in fact, the latter case is actually an example of "importing" a consumer of the consulting services. This latter case provides a parallel for ecotourism. Given the immobility of a natural asset that provides the basis for the production of ecotourism, the only way for the eco-tourist to consume the product is to travel to the site of the natural asset, where "production" takes place. Thus, ecotourism is characterized by the "importation" of eco-tourists, who bring with them the demand for the eco-tourism product, which is based upon a geographically fixed natural asset.

3.3. Ecotourism in the Texas Lower Rio Grande Valley

Located on the southernmost portion of the Texas coastal region, the Lower Rio Grande Valley (the Valley) lies in one of the most ecologically complex and biodiverse regions in all of North America. As more and more people become aware of the ecological treasures that exist there, ecotourism in the Valley has developed into a rapidly growing sector of the regional economy. Tourism is the 3rd largest industry in Texas, and ecotourism makes up a significant share of total tourism in the state. Texas is the number one bird-watching state/province in North America, and the Valley is often considered the number two bird-watching destination in North America. The four counties of the Valley – Hidalgo, Starr, Willacy, and Cameron (see Figure 1) – together have recorded almost 500 bird species – more than all but four states.

Ironically, while ecotourism is growing, the Valley's fragile ecosystem is facing unprecedented pressure from other economic activities. One of the key pressures is water. As agricultural production, industry, and a rapidly growing urban population use all but a trickle of the Rio Grande (the region's only major source of fresh water), the water needs of the ecosystem are rarely considered and this fragile natural asset is deteriorating. An important obstacle to more widespread recognition of the ecosystem's water needs is that the economic value of using water to sustain the Valley's ecosystem has never been quantified. Without "economic representation" of this value, it is difficult for water managers, planners, and users to consider the ecosystem, along with agriculture, industry, and municipalities, when making water use decisions.

A detailed understanding of the Valley's ecotourism sector and the role water plays in supporting it can help establish the ecosystem as an economically important user of Rio Grande water. Without sufficient water, the region's ecosystem will continue to decline, with potentially detrimental effects on the ecotourism industry.

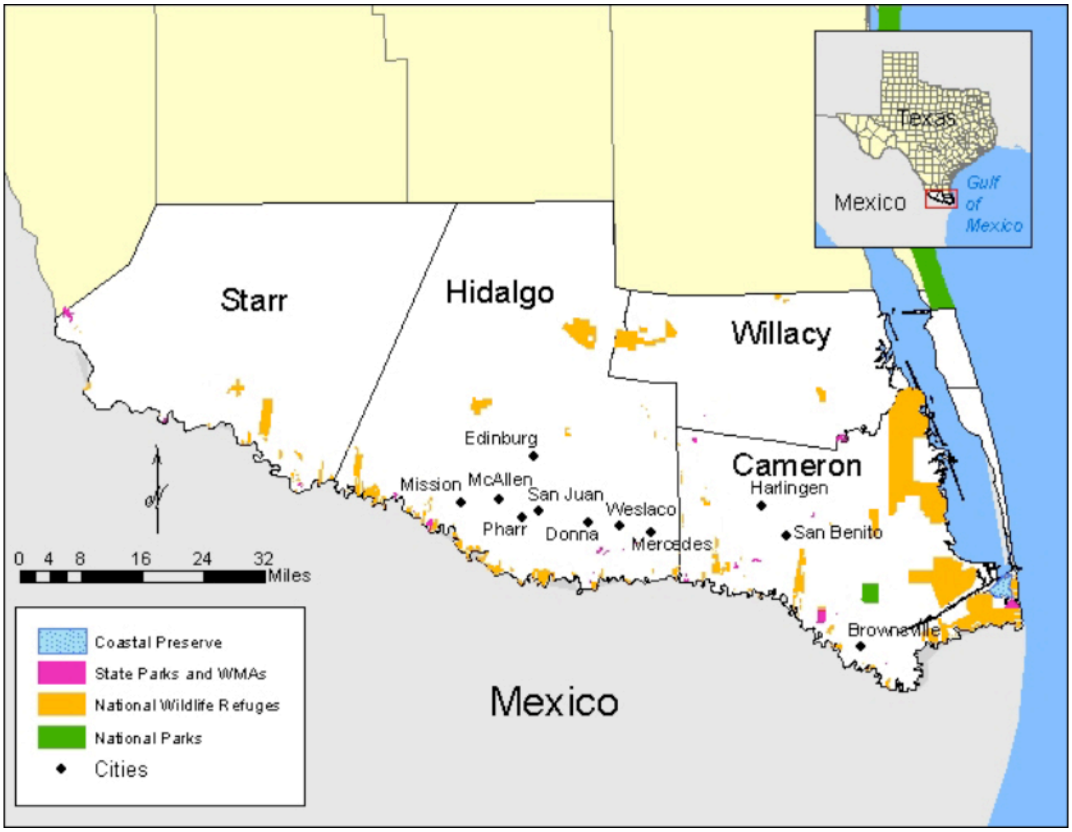
Known internationally as a destination for ecotourism, Texas hosts more than 75% of the bird species in the country. Texas is often characterized as having 3 of the top 12 birding "hot spots" in North America, and is the number one bird watching destination in the U.S. It also has 5,500 plant species, of which arguably 425 occur only in Texas, and 1,100 vertebrate species, of which 60 appear nowhere else in the world (Audubon Texas 2001a).

Within Texas, the Lower Rio Grande Valley is one of the most biodiverse areas in all of North America.[9] The region is home to a unique ecosystem known as the Tamaulipan brushland. Cameron, Hidalgo, Starr, and Willacy counties all lie in the Matamoran district, which is composed of 11 uniquely identified biotic communities, as characterized by the U.S. Fish and Wildlife Service (Jahrsdoefer and Leslie 1989). Each of these biotic communities, ranging from the coastal brushland potholes to the Chihuahuan thorn forest, contributes a unique variety of habitats to support a wide diversity of plant and animal life, as demonstrated by the sheer numbers of species found in the region. It is a major crossroads for migratory birds, and is an important transition region between temperate and tropical zones.

Ecotourism in the Valley focuses primarily on birding, but also accommodates butterfly, dragonfly and other wildlife and outdoors enthusiasts. Due to the diversity of birds

[9] For a comprehensive overview of the ecosystem in the Lower Rio Grande Valley, see "A Characterization of Multiple Ecosystems of the Lower Rio Grande Valley," Valuing Nature in Texas Working Paper VNT-02-03, Houston Advanced Research Center, or Jahrsdoerfer and Leslie (1988). See also Fermata Inc.'s website, <http://www.fermatainc.com/nat_riogrande.html>.

Figure 3.2. Public Protected Areas of the Lower Rio Grande Valley



in Texas, birders flock to the state, making it the most visited state for birding. The Valley, often considered the number two birding site in North America, draws thousands of people and millions of dollars into the region. The Valley's remarkable biodiversity and its role as a major stopover on one of North America's migratory flight paths, have led to the development of a burgeoning ecotourism sector.

3.3.1. Protected Areas of the Lower Rio Grande Valley: Valuable Natural Assets

A variety of wildlife preserves and refuges have been established to protect remaining fragments of the Valley's diversity of ecosystems (See Figure 3.2). These protected areas are valuable natural assets upon which the region's ecotourism activities are based. Details about the acreages of these protected areas are presented in Table 3.1.

Established in 1943 for the protection of migratory birds, the Santa Ana National Wildlife Refuge encompasses a 2,088 acre tract in an important ecological crossroads along the banks of the Rio Grande where subtropical climate, gulf coast, great plains, and

Table 3.1. Public Birding/Ecotourism Sites in the LRGV

Site	Size (Ac)
Santa Ana NWR	2,088
Laguna Atascosa NWR	45,000
Sabal Palm Audubon Sanctuary	535
Lower Rio Grande Valley NWR*	90,000
Las Palomas WMA	3,311
Bentsen Rio Grande SP	760
Chihuahua Woods Nature Preserve	349
Boca Chica SP	1,055
McAllen Nature Park	15
Harlingen Bird Sanctuary	40
Hugh Ramsey Nature Park	50
Anzalduas County Park	96
Total	**143,299**

*Founded in 1979, the Lower Rio Grande National Wildlife Refuge is still in its acquisition phase. While it currently contains 90,000 acres, it will eventually contain 132,500 acres along the last 275 miles of the Rio Grande as it flows into the Gulf. Some 40,000 acres of tracts are currently open, free of charge to the public.

Chihuahuan desert meet. Located in the Rio Grande floodplain, the Santa Ana Refuge provides habitat for more endangered and threatened species than any other refuge in the U.S. Refuge System (Jahrsdoerfer and Leslie 1988). This sanctuary provides undisturbed habitat for endangered felids, nearly 400 species of birds, 33 species of mammals, 50 species of reptiles and amphibians, 200 species of butterflies (about one-half of all butterfly species found in the United States), and more than 450 plant species (Handbook of Texas online). Santa Ana is also an important nesting site for whistling ducks (*Dendrocygna autumnalis*), altamira orioles (*Icterus gularis*), and the migrant broad-winged hawk (*Buteo platypterus*). A 68 acre (27.8 ha) Texas Ebony Natural Area within the refuge has been set aside for research and educational purposes.

Before dams and flood control structures significantly reduced the flow of the Rio Grande, periodic floods cut shifting channels into the delta, creating crescent-shaped oxbow lakes, referred to as 'resacas.' Santa Ana's management program attempts to imitate the historical flooding of the Rio Grande, maintaining the bottomland hardwood forest and providing crucial nesting and feeding habitat for birds, watering holes for animals, and a refuge system for amphibians, reptiles, crustaceans and insects. However, even when technically feasible, this goal faces significant challenges in the larger political, social and economic context of water use in the region (U.S. Fish and Wildlife Service, 2001b). Established in 1946, the Laguna Atascosa NWR is the largest single protected area of natural habitat left in the Lower Rio Grande Valley.[10] Its 45,000 acres encompass a unique blending of temperate, subtropical, coastal, and desert habitats. The refuge is comprised of approximately 50% wetlands (9,720 ha [24,000 acres]), 28% coastal prairie (5,670 ha [14,000 acres]), 17% brushland (3,280 ha [8,100 acres]), 3% grasslands (607 ha [1,500 acres]), and 2% cropland (405 ha [1,000 acres]) (Jahrsdoerfer and Leslie, 1988). Many native plants and wildlife typical of northern Mexico are found at the northernmost edge of their range. The refuge is the also the southernmost waterfowl sanctuary in the Central Flyway and hosts roughly 65,000 wintering ducks each year, as well as other waterfowl such as sandhill cranes. Over 350 species of birds, 30 species of mammals, and 30 species of reptiles and amphibians have been observed in the refuge. Due to the general semi-arid climate of the region, 95% of the American alligators (*Alligator mississippiensis*) in the Lower Rio Grande Valley are concentrated in this refuge.

The Sabal Palm Audubon Center and Sanctuary, located near Brownsville on the banks of the Rio Grande, preserves a 527-acre portion of remaining sabal palm forest. Prior to development and flood control efforts, sabal palms grew profusely along the edge of the Rio Grande in small stands or groves extending approximately 80 miles upstream from the Gulf of Mexico. Although little of it remains, this forest ecosystem is one of the most beautiful and critical ecosystems of south Texas and northern Mexico (Audubon Texas, 2001b).

Comprising more than one hundred separate land tracts that lie between Falcon Dam and the Gulf of Mexico, the Lower Rio Grande Valley National Wildlife Refuge (LRGV NWR) creates a patchwork of protected areas along the last 275 river miles of the Rio Grande. Established in 1979, the LRGV NWR compliments an existing wildlife corridor of lands managed for the benefit of wildlife by the Texas Parks and Wildlife Department, National

[10] While the Lower Rio Grande Valley NWR has more acreage than Laguna Atascosa, its acreage is divided among many tracts.

Audubon Society, The Nature Conservancy, private landowners, and the Santa Ana andLaguna Atascosa NWRs. The LRGV NWR land tracts currently total more than 90,000 acres. Through the purchasing of properties and conservation easements, LRGV NWR expects to eventually encompass 132,500 acres in the lower four counties of the Valley. Because it has land tracts that lie across virtually the entire geography of the Valley, the LRGV NWR is one of the most biologically diverse NWRs in the continental United States, containing representations of 11 distinct biotic communities that are host or home to 1,100 types of plants, 700 vertebrate species (including 484 bird species) and more than 300 species of butterflies (U.S. Fish and Wildlife Service, 2001a).

The Las Palomas Wildlife Management Area consists of 3,311 acres of land spread amongst 18 units in Cameron, Hidalgo, and Presido counties of the Lower Rio Grande Valley. This land was purchased to preserve native brush nesting habitat, as well as farmland and wetlands for white-winged doves. Managed by Texas Parks and Wildlife, the tracts range in size from two acres to 604 acres (Texas Parks and Wildlife Department, 2003b).

Along the Rio Grande River, Bentsen-Rio Grande Valley State Park is located 5 miles southwest of Mission, in Hidalgo County. The original 587.7 acres of subtropical resaca woodlands and brushland of thicket-forming thorny shrubs and small trees were acquired from private owners in 1944. The park recently acquired additional land to increase its size to 760 acres. This park is one of the best places in the United States to observe subtropical birds and wildlife that are more commonly found in Mexico. Birds from both the eastern and western United States are also found in the area; and during spring migration, the park is especially interesting to birders. Unusual birds include: paraque, groove-billed ani, green kingfisher, blue bunting, black-bellied whistling duck, clay-colored robin, rose-throated becard, tropical parula and masked tityra. Together with other protected areas along the Rio Grande, the park is also one of the last natural refuges in Texas for cats such as the ocelot and jaguarundi (Texas Parks and Wildlife Department, Publication Date Unknown-a).

The Chihuahua Woods Nature Preserve, managed by the Nature Conservancy and located in Hidalgo county, is a small private preserve (349 acres) with a unique ecosystem containing an expansive variety of trees, shrubs and thickets. The preserve is home to many species native to the Valley, and its plant life provides a range of seasonal foods and cover for wildlife. Additionally, many cacti still survive in the thorny scrubland.(The Nature Conservancy, 2003).

Boca Chica State Park, containing approximately 1055 acres in the Boca Chica sub delta of the Rio Grande River, in southeastern Cameron County, was acquired and opened in May 1994 in order to protect its native vegetation, fauna, and geological structures in a natural state. One of the major sections, the Barnes Tract, includes the Mesa de Gavilan (a flat upland about 5 feet above sea level), the south shore of South Bay, the west shore of Boca Chica Bay, and the flat, sandy, northern end of Boca Chica Island. It consists of low, shrubby, salt-tolerant vegetation with grasses and herbs interspersed. Trecul's yuccas and Nopal prickly pears rise above this low vegetation on higher elevations. On Boca Chica Island, the Barnes Tract consists of low, newly-forming sand dunes with their anchoring vegetation amidst bare sand flats. A variety of endangered and rare birds can be seen on almost every visit, including brown Pelicans, reddish egrets, roseate spoonbills, osprey, white-tailed kites, Aplomado falcons, snowy plovers, least and sooty terns, black skimmers, Chihuahua ravens, and Cassin's, Botteri's, and seaside sparrows. Many marine shellfish and finfish rely on South Bay as an important hypersaline nursery area. The area serves as a major winter ground for endangered peregrine falcons and piping plovers. The park is managed by Bentsen-Rio Grande State Park (Texas Parks and Wildlife Department, Publication Date Unknown-b).

Because it is a flyway between North and South America, migratory birds essentially become “bottlenecked” in the Valley as they make their migrations. The Santa Ana National Wildlife Refuge, Bentsen-Rio Grande State Park, and Sabal Palm Grove, among others, are part of the Great Texas Coastal Birding Trail (GTCBT) that helps attract ecotourism. The Great Texas Coastal Birding Trail winds through 43 Texas counties, encompassing the entire Texas coastal region. Completed in April 2000, the Trail features 308 distinct wildlife-viewing sites (Texas Parks and Wildlife Service, 2003a). In addition to the GTCBT, the World Birding Center is an ambitious project to further elevate recreational birding as an outdoor activity and pastime. Stretching from Roma to South Padre Island the World Birding Center creates an opportunity to introduce visitors to several hundred species of birds found in six differing biotic communities. The concept of a birding center, originally envisioned by the Texas Parks & Wildlife Department, is now a partnership between nine local municipalities and U.S. Fish and Wildlife Service, and Texas Parks & Wildlife. Three sites, Bentsen-Rio Grande, Resaca de la Palma and Estero Llano Grande are state parks which have partnered with Mission, Brownsville, and Weslaco respectively. The remaining sites are operated by the local communities of McAllen, Hidalgo, Edinburg, Harlingen, South Padre Island and Roma, the last of which is in partnership with U.S. Fish & Wildlife Service. These sites collectively will fulfill the mission of the World Birding Center which states, "The World Birding Center, a Texas Parks and Wildlife partnership project, will work to significantly increase the appreciation, understanding and conservation of birds, wildlife, habitat and Texas' natural heritage for current and future generations through education, community involvement and sustainable nature tourism" (World Birding Center, Publication Date Unknown).

In addition to the various protected areas just described, well-preserved habitat also exists on private land, most notably on many of the large ranches that dominate South Texas. The Fennessey ranch, just outside of the study area, boasts over 750,000 acres of land, of which 4,000 are wetlands. The King Ranch contains 700,000 acres of pristine land, adjacent to its other ranching and commercial operations. The Kenedy Ranch possesses over 400,000 acres of land. A small but growing number of ranches offer birding and other ecotourism activities that depend on their vast tracts of native habitat. These are discussed in greater detail below. As interest in nature tourism grows, and local communities look for ways to diversify their economies, ecotourism may provide an alternative means of generating income from the land. In a state that is 94% privately owned, the wildlife resources of Texas are entrusted to the stewardship of private landowners. Many landowners in Texas already derive substantial income from the wildlife-associated recreation of hunters and anglers.

3.3.2. The Multiple Nature Tourism Services in the LRGV

Throughout the Lower Rio Grande Valley, many bed and breakfasts, ranches, hotels, tour operators and restaurants derive much of their business from ecotourists. Some bed and breakfasts cater specifically to ecotourists and wildlife enthusiasts, advertising birding, butterfly watching, and fishing. Some bed and breakfasts, such as the Brown Pelican Inn and The Inn at Chachalaca Bend, cater to birders and offer birding packages with boat tours and photo safaris. The Inn at Chachalaca Bend even includes birding checklists for their property. The Brown Pelican Inn's birding package for 4 nights is $500 plus tour costs. Their package includes time for visits to the state parks and wilderness preserves in the surrounding area, making those public goods an input into their product. In addition to bed and breakfasts, numerous hotels, RV parks, nature tours, private zoos, and optical equipment stores advertise their role in the ecotourism industry and proximity to the birding industry.

As noted above, private ranches have begun to capitalize on the ecotourism industry as well. The Kenedy, King, and Fennessey ranches are among those that offer ecotourism passes for birding, hunting, hiking, and wildlife viewing. The Fennessey Ranch, for example, is part of a 750,000 acre private land empire that has remained in the same family for many decades. It includes over 4,000 acres of wetlands, meadows, and natural lakes, and over nine miles of mission river frontage. They offer bird lists, hawk watches, hummingbird hayrides, hiking, birding, hunting, and boating passes. During migration seasons, they employ professionals to guide tours for birds and butterflies. Photo safaris are marketed as well. In addition to their private lands, they advertise that they are only one hour from the Aransas NWR, King Port, Corpus Christi, and Port Aransas.

The King Ranch, between Corpus Christi and Brownsville, encompasses 825,000 acres, of which 700,000 are advertised as pristine habitat for birders and hunters. Tours for birdwatchers range from a $23.50 half-day tour where 50 different species of birds can be viewed to $150 for private full-day tours where over 60 different species can be expected to be seen, including many endangered and rare species. Additionally, the ranch offers a plethora of other nature tours to see native plants, dragonflies, butterflies, and rare species such as the bobcat and the javelina (King Ranch, 2003).

Many private ranches in South Texas are connected through the South Texas Heritage Trail. Ranches on this trail that conduct ecotourism tours include the B Bar B Ranch, Cozad Ranch, El Canelo Ranch, Knoll Farms, La Copita Ranch, La Mariposa Ranch, La Mota Ranch, Lomitas Ranch, Lobo Creek Ranch, Martin Refuge, Margo Ranch, Rancho San Buenaventura, and the Santa Maria Ranch. Of these, the El Canelo Ranch, Margo Ranch, Martin Refuge, Lomitas Ranch, and Cozad Ranch are located in the LRGV. The El Canelo Ranch, for example, offers tours and overnight stays on its property, with the opportunity to view many of the 300 species of birds that have been sighted there (El Canelo Ranch, 2000).

Several organized annual events in the Valley attract large numbers of ecotourists into the region. The Texas Tropics Nature Festival, held in McAllen during March, allows people to explore the area that functions as an important migratory route for birds and butterflies. The October Texas Butterfly Festival in Mission celebrates the Valley's nearly 300 species of butterflies. Wild in Willacy takes place in November and seeks to "Have a 'wild' time in the wild outdoors in Willacy County" (Hunter, 2000). The largest of these festivals, the Rio Grande Birding Festival in Harlingen, in November, annually attracts 2,000 birders to the region.

3.3.3. Economic Impact of Ecotourism in the LRGV

Expenditures and economic impacts from ecotourism are notoriously difficult to characterize. Definitions differ about what constitutes the "ecotourism industry," and because ecotourism is comprised of elements of other sectors such as the travel, hotel, and restaurant industries, obtaining accurate economic data regarding ecotourism (and tourism in general) presents a challenge. However, by any account, the ecotourism industry in Texas is enormous. The Texas Comptroller's office estimates that the industry contributed approximately $25.4 billion to the $39.9 billion tourism industry in the state. By comparison, the Texas gross state product (GSP) totaled $807.4 billion in 2002 (Strayhorn, 2002a). Thus, nature based tourism is arguably one of the largest industries in Texas. Nature based tourism is estimated to have increased by 63% from 1980 to 1990, and is the fastest growing sector of the travel industry. It generates $1 billion in state taxes, $739 million in local taxes, and $1.4 billion of economic activity (Audubon Texas, 2001a).

The unique ecological assets of the Texas Lower Rio Grande Valley have made ecotourism an increasingly important component of the region's economy. Comprised of the four southernmost counties in Texas – Cameron, Hidalgo, Willacy and Starr –the Valley is one of the poorest, though fastest growing regions in the United States, historically ranking among the very worst in the U.S. in terms of unemployment rates, income, and poverty rates. Average per capita personal income for 2001 in 2001 dollars ranged from a meager $9,769 in Starr County to $15,334 in Cameron County, compared with a per capita personal income of $28,472 for Texas and $30,511 for the nation. Total income per county in 2001 ranged from $537 million in Starr County to $5.3 billion in Cameron County to $8.2 billion in Hidalgo

Table 3.2. Personal Income and Production Earnings by County, 2001 ($000)

□	Cameron	Hidalgo	Starr	Willacy	Total
Per Capita Personal Income	15,334	13,788	9,769	12,760	
Total Personal Income [a]	5,283,442	8,169,870	537,137	253,484	14,243,933
Non-farm Personal Income	5,246,957	8,093,164	525,960	255,290	14,121,371
□	99.3%	99.1%	97.9%	100.7%	99.1%
Farm Earnings	36,485	76,706	11,177	-1,806	122,562
□	0.7%	0.9%	2.1%	-0.7%	0.9%
Dividends, Interest and Rent	775,057	1,061,418	52,749	32,951	1,922,175
□	14.7%	13.0%	9.8%	13.0%	13.5%
Transfer Payments	1,352,068	2,073,001	214,945	96,475	3,736,489
□	25.6%	25.4%	40.0%	38.1%	26.2%
Total Travel Spending [b]	485,387	704,690	18,386	13,468	1,221,931
□	9.2%	8.6%	3.4%	5.3%	8.6%
Production Earnings [c]	3,366,168	5,341,861	276,409	97,024	9,081,462
Farm Earnings	36,485	76,706	11,177	-1,806	122,562
□	1.1%	1.4%	4.0%	-1.9%	1.3%
Non-farm Earnings	3,329,683	5,265,155	265,232	98,830	8,958,900
□	98.9%	98.6%	96.0%	101.9%	98.7%
Manufacturing	341,041	300,049	2,229	1,067	644,386
□	10.1%	5.6%	0.8%	1.1%	7.1%
Retail Trade	301,060	587,902	35,219	10,928	935,109
□	8.9%	11.0%	12.7%	11.3%	10.3%
Health Care [d]	549,438	91,090	–	9,049	649,577
□	16.3%	1.7%	□	9.3%	7.2%
Government	939,080	1,468,716	136,472	39,546	2,583,814
□	27.9%	27.5%	49.4%	40.8%	28.5%
Total Travel Spending [b]	485,387	704,690	18,386	13,468	1,221,931
□	14.4%	13.2%	6.7%	13.9%	13.5%

Sources: U.S. Bureau of Economic Analysis (2001) and Office of the Governor, Economic Development and Tourism(2001)

[a] Percentages are based on contribution to total personal income.

[b] Total Travel Spending is derived from the Texas Department of Economic Development, 2001 and does not refer to any single industry or sector. It is possible that there is some overlap with the other listed categories, though we believe such an overlap is small, if one exists at all.

[c] "Production Earnings" excludes income derived from transfer payments and interest, dividends, and rent. Percentages reflect the particular sector's contribution to production earnings, rather than total personal income.

[d] The health care data for Starr county was undisclosed by the U.S. Bureau of Economic Analysis due to privacy issues. Thus, total health care data excludes Starr county.

County. The Valley's four counties yielded a total gross regional product of $14.2 billion in 2001. Over 19,000 people were employed in the tourism industry, which contributed $1.2 billion in travel spending receipts (U.S Bureau of Economic Analysis, 2001). Basic figures regarding personal income and production earning in the Valley are summarized in Table 3.2. In the larger, thirteen-county region South Texas Border Region, as noted by the Texas state comptroller's office, tourism was the fourth largest industry by employment, behind government, health services, and wholesale and retail trade (Strayhorn, 2002b). Moreover, tourism between 1994 and 2001 grew at an average annual rate of 4.9%, in terms of total spending, making it one of the fastest growing industries in the region (Office of the Governor, Economic Development and Tourism, 2001).

While irrigated agriculture played a historically significant role in shaping the Valley's economy and culture, agriculture today contributes less that 1% of total personal income in most counties (U.S. Bureau of Economic Analysis. 2003).[11] Manufacturing also remains a small sector.[12] In contrast, services represent a major and expanding job source. In the Valley, services sector jobs have increased in the 1990s at an annual rate of 6.2 percent and now account for over 22 percent of all non-farm jobs (Schmandt et al., 2000). Most of that growth has come in health services and in services that may also be related to tourism, i.e., recreation and entertainment. The annual presence of more than 125,000 Winter Texans – typically retirees from the northern U.S. who spend part or all of the winter in Texas – creates significant additional demand for goods and especially services.[13]

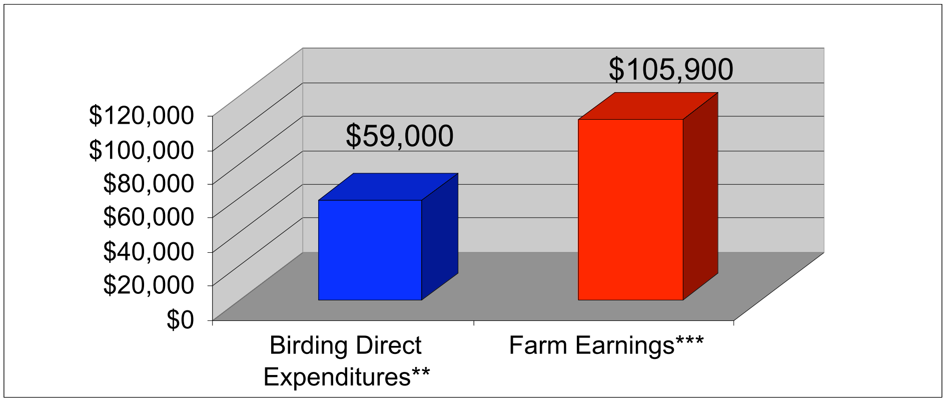
The wildlife refuges and birding festivals that take place in the Lower Rio Grande Valley have significant economic impacts on the regional economy. In the Valley, ecotourism reportedly generates between $100 million and $170 million annually and

[11] 2001 Farm earnings for Cameron, Hidalgo, Willacy, and Starr counties totaled $36.5, $76.7, -$1.8 and $11.7 million, respectively.

[12] Cameron County derives about 6.4 percent of its earnings from manufacturing while neighboring Hidalgo County generates 3.7 percent from this source. In the remaining counties in the region, manufacturing accounts for a very small share of total earnings.

[13] See Vincent et al., (2003) for a detailed description of Winter Texans and other winter visitors to the Texas Rio Grande Valley. An estimated 40-50% of the Winter Texans visit wildlife reserves during their stay. Mexican residents who travel to the Valley represent an increasing source of income for the region's economy. While these visitors frequently travel to Texas primarily to shop and to visit Fiesta Texas and Sea World, many of also take time to visit some of the wildlife refuges in the area (Vincent, 2004)

Figure 3.3. Birding revenue from 3 major sites vs. farm earnings in the Lower Rio Grande Valley* (1994, $000)



* The LRGV is defined here as Cameron, Hidalgo, Willacy, and Starr counties.
**Birding impact was drawn from Eubanks et al. (1995), and refers only to the direct expenditures in the Valley from birders visiting Santa Ana NWR, Laguana Atascosa NWR, and the Sabal Palm Audubon Center and Sactuary.
*** Farm Earnings consists of proprietor's net farm income, the wages of hired farm labor, the pay-in-kind of hired farm labor, and the salaries of officers of corporate farms.

employs several thousand people (Chapa, 2004). In the feasibility study for the World Birding Center, it was determined that a greater percentage of the local population would be willing to pay entrance fees for the World Birding Center than for the planned Dallas Cowboys training camp (Youth, 2001).

Eubanks and Stoll (1999) compared the economic impact between attendees to the Rio Grande Valley Birding Festival and those who participated in the Great Texas Coastal Birding Trail (GTCBT). While attendees to the Rio Grande Valley Birding Festival tend to be committed birders, those who traveled the GTCBT tended to be more casual birders who consider birding as one of many outdoor hobbies. Birders who attend the four-day Rio Grande Valley Birding Festival in Harlingen spend, on average, $1,352.86 each year for their trips to the festival and the GTCBT. This direct expenditure translates into a Total Gross Output (TGO) of $2,705.72 annually, per visitor to the festival, for a total economic impact of$1.5 million.[14] In contrast, more casual birders – those who travel the GTCBT, spend $2,452.18 directly along the GTCBT, for a TGO of $4,904.36 per traveler.

[14] Eubanks, Kerlinger, and Payne 1995 in Avitourism and American Birding Association, "The Growth of Birding and an Economic Value of Birders: Part 10: A Texas Perspective," <http://americanbirding.org/programs/consecond10.htm>, 2003. Accessed 11 Jun 2003.

Table 3.3. Three Major Economically Significant Birding Sites in the LRGV

Site (Annual)	**Visitors**	**Economic Impact**
Santa Ana NWR	100,000	$34,500,000
Laguna Atascosa NWR	48,000	$20,000,000
Sabal Palm Audubon Center and Sanctuary	8,850	$8,000,000

Source: Eubankset al. (1995), based on survey data

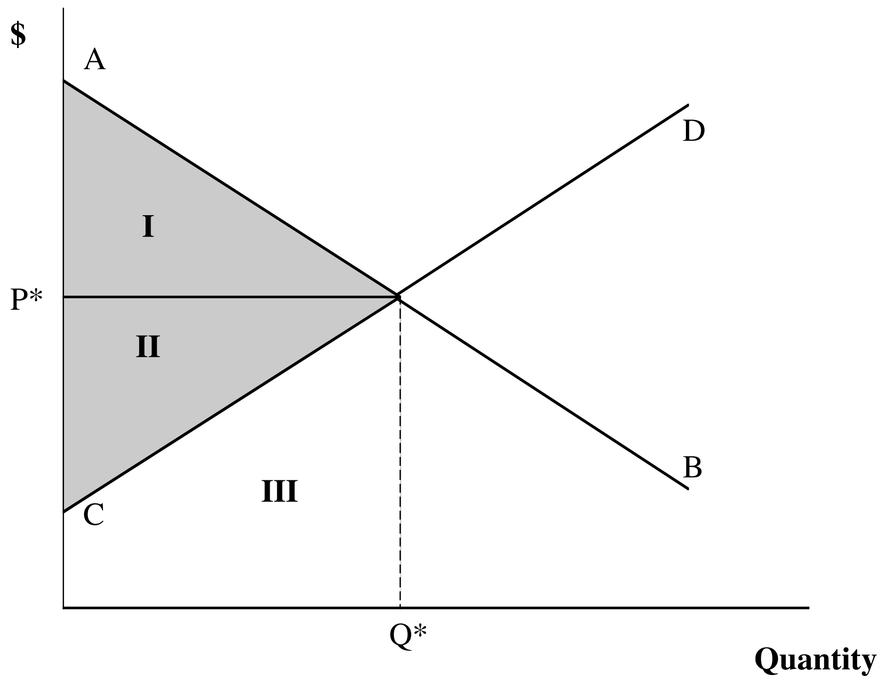
Eubanks et al. (1995) estimate that birdwatchers at the Santa Ana National Wildlife Refuge, Laguna Atascosa National Wildlife Refuge, and Sabal Palm Audubon Sanctuary contribute more than an estimated $59 million in annual direct expenditures to the LRGV economy. By comparison (see Figure 3.3), farm earnings in the region accounted for $105.9 million in 1994 (Schmandt et al. 2000). Based on 100,000 visitors per year, the Santa Ana National Wildlife Reserve generates an estimated $14 million in local direct expenditures and has an economic impact of $34.5 million. Laguna Atascosa attracts around 48,000 birders yearly for approximately $5.6 million in local expenditures and a $20 million impact. The Sabal Palm Grove Sanctuary attracts 8,850 visitors for roughly $6.9 million and an additional $1.1 million in the surrounding area. These estimates are summarized in Table 3.3.

Direct expenditures measure the amount of money spent by a tourist getting to, from, and while visiting a site. However, when the regional or national income changes by a greater amount than the original injection to the economy, this is called the multiplier effect. Applying a conservative multiplier of two to the $59 million in direct expenditures described above would translate into an economic impact of $118 million. However, it is important to note that this is only a partial estimate for ecotourism impact from the Valley; these three sites only account for34% of the total public land that attracts birders and nature enthusiasts. Moreover, this estimate does not include impacts from other ecotourism activities such as backpacking, butterfly watching, or adventure sports. Thus, the total economic impact of all nature tourism activities would be expected to be greater than $118 million. Unfortunately, the economic impacts of the other major ecotourism sites in the LRGV have not yet been measured.

4. Economic Value

Before moving forward, it is useful to discuss what is meant by the term "economic value." This section provides an overview of the basic concepts and theoretical framework associated with economic value, as well as a general discussion of related issues as applied to the context of water.

Figure 4.1. Framework of Economic Value



4.1. Basic Economic Framework

Economic theory contains a number of concepts pertaining to value. Some of the most fundamental of these notions are represented in Figure 4.1 above, which presents a simple depiction of a "market" in which the consumer and the producer interact to generate a price, P* , and quantity, Q* . This familiar graph contains a variety of important information regarding economic value, derived from certain characteristics of consumers and producers, and the relationship of these characteristics with the market.

4.1.1. Marginal Costs and Marginal Willingness to Pay

Consider first line segment AB, which maps out the consumer's "marginal willingness to pay" for each successive unit of the good in question to form the "demand curve." Its downward slope reflects "decreasing marginal utility" – the notion that the value to the consumer of each successive unit of the good decreases the more units of the good the individual obtains. This line is also often referred to as the "marginal benefits" curve.

Turning now to the producer (the firm), consider line segment CD. This line represents the firm's "marginal costs" – the costs associated with producing each successive unit of the good. The marginal cost curve's upward slope reflects the idea that firms will utilize "low hanging fruit" first, and as more units of the good are produced, accessing "fruit higher in the tree" increases the cost of production. The marginal cost curve is also the foundation of the familiar "supply" curve.

4.1.2. Market Price

When the consumer and producer come together with "mutual coincidence of wants" to form a market, the consumer will accept a price no higher than his willingness to pay, and producers will accept a price no lower than her cost of production (willingness to sell). The market price P* occurs at the number of units Q* where the marginal benefits (willingness to pay) to the consumer equal the marginal costs to the producer. In other words, price simultaneously matches the consumer's willingness to pay and the producer's willingness to sell, thus "clearing the market" – at (P*, Q*) there is no gap between marginal willingness to pay, marginal costs, and the market price. No trades for additional units of the good will occur because the price exceeds the consumer's willingness to pay, and falls below the producer's marginal cost. It is important to recognize that the market price P* reflects *only* the value of the last unit, Q* , exchanged in the market, and this value is identical for both the consumer and the producer.

Because the market price increases or decreases according to changes is supply and demand – for example, a decrease in supply or increase in demand will both lead to a higher price – price is often relied upon as an indicator of economic scarcity. The scarcer is the good, the higher is the price, and visa versa.

4.1.3. Economic Surplus

For each unit exchanged in the market previous to Q*, a gap exists between the consumer's willingness to pay, the producer's marginal costs of production, and the market price at which those units were exchanged. The difference between the consumer's marginal willingness to pay curve and the producer's marginal cost curve for each successive unit of the good is referred to marginal surplus (or marginal net benefits). This marginal surplus is divided between the consumer and the producer. For each unit, the consumer surplus is the amount by which his willingness to pay exceeds the market price, while the producer surplus is the amount by which the market price exceeds the marginal cost. Total consumer surplus is found by summing up the marginal consumer surplus for each unit of the good up to Q*, and is represented in Figure 4.1 by shaded triangle I. Similarly total producer surplus is represented by shaded triangle II. Total surplus is the combination of both consumer and producer surplus, represented by both shaded triangles, and can be viewed as the total net benefits to society achieved by the production and consumption, sale and purchase, of Q* quantity of the good. In the standard neo-classical economic model presented here, it is total surplus that is typically used as the definition of economic value. Total benefits, i.e. economic value, are maximized at the point where marginal benefits (willingness to pay) are equal to marginal costs, and the market outcome is said to be "efficient" because no further trade can be made that increases these total benefits. The maximization of total benefits is one of the fundamental objectives of the economic decision-making process.

Observe that economic value, defined as total surplus, is not the same as market value. Market value is simply the producer's revenue – the number of units sold, Q*, multiplied by the price, P*. While market value includes the producer surplus, represented in Figure 4.1 by triangle II, it also includes the cost of producing Q*, represented by area III. Moreover, it does *not* include any surplus that accrued to the consumer (triangle I).

4.1.4. Economic Value vs. Economic Impact

Finally, it is important to distinguish between economic value, as described above, and "economic impact." Economic impact is a broad concept often used to understand the "pros" and "cons" of changes associated with implementing a project or policy, in terms of the economic system that is affected. Analysis of economic impact can include economic value, but economic impact is *not* the same as economic value. It typically includes estimates of "direct" effects (e.g. changes in direct revenues and income, changes in the number of jobs) and may also include estimates of secondary effects that result as direct effects work their way through the economic system. For example, a policy or project that yields direct negative impacts on the local fishing industry may also yield negative secondary impacts on the coastal community that provides the fishing industry with a variety of goods and services. When considering increases or decreases in income/revenue, a "multiplier" is often used to capture some of these secondary effects. Occasionally, efforts to analyze economic impact also include estimates of "intangible" economic values, in terms of losses or gains associated with ecological benefits, or social considerations.

In general, the economic impacts of a given change make some people better off and others worse off, and these losses and gains are not distributed equally across neighborhoods, cities, counties, regions and states. It is therefore important to examine *where* the economic impacts of a project or policy occur. Although economic theory can contribute extensive insights regarding efficiency and the objective of maximizing total benefits, it provides relatively little guidance as to whether one distribution of losses and gains is better than another.

4.2. Economic Value and Water[15]

Having completed the brief general overview of economic value, the discussion now turns to some important issues regarding economic value and water.

Economic value for water is important in at least two fundamental aspects of decision-making:

(1) how to allocate water in a way the generates the most total benefits, and

(2) how to account for changes in economic value due to the changes in water allocation associated with implementing a particular project or policy.

It is important to recognize that water is unique among natural resources in the wide variety uses in which it can be employed. The uses are typically divided into four broad categories:

---

[15] Much of this section is based on Mathis (1999, Ch. 4).

municipal, industrial, and agricultural, together representing human use, and environmental, often referred to as environmental flows. This categorization is becomes more complex when instream uses such navigation and hydro-power generation are also included. A more detailed discussion of instream flows follows below. Complexities of categorization not withstanding, the optimal use of the water is achieved by allocated the amount of water resources across its various uses in a way that maximizes the total benefits. Thus, the economic value associated with each is use is important to achieving the objective of optimal water allocation.[16]

While optimal allocation of water is a key objective of economic decision-making, it is not the criteria by which water is typically allocated. The allocation of water is based on a complex system of water law. Water is often allocated, in the form of water permits, on a first-come-first served basis. Moreover, different water uses often receive different status according to the water laws in place. For example municipal use may receive special priority over other uses, and environmental uses may not even be recognized as legitimate in the water code.

The economic value of water may also be important in the assessment of the costs and benefits of implementing a particular project or policy that will result in a change from the *ex ante* allocation of water. This is especially germane to the ecological impacts due to changes in environmental flows.

4.2.1. Cost, Price and Value

Perhaps the biggest challenge to understanding the economic value of water is that the price actually paid rarely reflects the water's economic value. In most cases the price is determined by the cost of providing the water, and often no price for exists at all, as is the cast with instream flows, including environmental flows.

Although nature provides raw water free of charge, the timing, location and quantity of naturally occurring water supplies seldom correspond with patterns of human use. Costs arise when the natural temporal and spatial distribution of water is modified to match human demand more closely. Resources are required to capture, store, transport and treat (if

[16] It may appear that instream water is provided by nature in a fixed amount at no cost, but the cost of instream water to individuals appears as the sacrifice of benefits from off-stream uses to leave the optimal amount of water in the stream. Recalling Samuelson (1954, 1955), the optimal level of instream water is the amount at which the sum of each indivual's willingness to pay for an additional unit equals the marginal cost.

necessary) the supply of water supplied by nature. In some cases, the production of delivered water is carried out by the water users themselves (or associations of users), particularly in the agricultural sector. In most other cases the production of delivered water is carried out by public or quasi-public entities. To avoid monopolistic behavior, public water utilities are generally limited by their charter to charging consumers a price that is sufficient only to cover production costs. In either case, cost water use faced by individual agents is, at best, based on the cost of producing delivered water rather than the water's scarcity value, which is typically much higher.

In addition, government subsidies on the construction of large reservoirs and delivery infrastructure projects are common, serving to increase the gap between water's scarcity value and its price. Wahl (1989) provides a detailed account of the subsidies to construction costs on U.S. Bureau of Reclamation water infrastructure projects. In some cases in California the subsidy on irrigation infrastructure has surpassed 90%. Burness et al. (1980) examines 49 U.S. Bureau of Reclamation's projects and finds that while the average proportion of the total cost of these projects allocated to irrigation was 70%, the average actually paid by farmers amounted to only 30%. A study of irrigation in Mexico and the United States estimates that Bureau of Reclamations farmers in the U.S. pay on average only 39% of scarcity value for irrigation water, while their counterparts in Mexico pay a mere 4% (Cummings and Nercissiantz, 1992).

Thus, in the vast majority of cases, the price paid for water is only a fraction of its scarcity value and provides very little information about the waters true economic value.[17] After decades of intensive research to derive estimates of the economic value of water, the value of water used in agricultural, industrial and municipal contexts is relatively well understood. Yet for many other uses of water, and environmental flows in particular, estimating the economic value is more difficult and remains poorly understood.

[17] The result can be tremendous inefficiency with regard to the use of water. This inefficiency is exacerbated if no price exists at all. In theory, this inefficiency can be remedied if the price of water accounts for all private and social values associated with water's various uses. In this situation, the market price would motivate choices that lead to the optimal use of water, in which water is allocated and used in a way that yield the most benefits to society.

4.2.2. Economic Value of Instream Flows

Instream flows is a general term that comprises a variety of uses for water that is left in the stream channel (or other water body), rather than diverted for use "off-stream." These uses include fish and wildlife population maintenance, outdoor recreation activities, navigation, hydroelectric generation, waste assimilation (sometimes termed water quality), conveyance to downstream points of diversion, ecosystem maintenance, and the provision of aesthetic beauty (U.S. Water Resources Council, 1978).[18] Thus, ecosystem sustenance, is but one of many uses of instream water. The absence of prices for instream water has led to significant efforts to estimate the value of water for instream uses using non-market valuation approaches – typically travel cost or contingent valuation methods. Most of these studies consider either recreational uses, such as fishing or rafting, or non-use values.

Fishing and rafting are the recreation activities that are most often studied. A recent study of the recreation benefits of instream flow in Montana's Big Hole and Bitterroot Rivers, for example, estimates marginal recreational value ranging from $10 to $25 per acre foot at 100 cfs decreasing to $0 as stream flow increased to 2000 cfs (Duffield et al, 1992). Daubert and Young (1979) estimate marginal instream benefits from recreation during low flows on Colorado's Cache la Poudre River at $17 per Mm^3 for fishing and $12 per Mm^3 for shoreline recreation (also falling to zero as stream flow increased). Another study of Colorado rivers finds that optimal stream flow for recreation to be 35% of the maximum, and estimates the value of an additional Mm^3 beyond the 35% stream flow at $17 for fishing, $4 for kayaking, and $3 for rafting (Walsh et al., 1980, cited in Colby, 1990). Research on instream recreation in northern Utah finds that the marginal value of water is zero until stream flow drops below 50%, and increases to a maximum of $65 per Mm^3, when flow diminished to 20-25% (Amirfathi et al., 1984, cited in Colby, 1990).

In contrast to recreational value, non-use value for in-stream water involves the willingness to pay to maintain the river habitat, without actually physically enjoying any of its attributes.[19] Because non-use values do not involve an actual visit to the site, travel cost

[18] See also Colby (1990, 1989b), MacDonell et. al, (1989), Gibbons (1986).
[19] Non-use value for water can be further categorized into option, bequest, and existence values (Colby, 1990). Option values are the willingness to pay to preserve a river habitat so that the individual has can enjoy it in the future; bequest values are similar, but are associated with the enjoyment of the preserved river habitat by future

valuation methods cannot be used, leaving contingent valuation as the only available valuation tool. Due to the methodological difficulties of estimating non-use values for instream water, few such studies have been undertaken.[20] However, the scant existing literature suggests that non-use values can be large, especially for unique recreation cites or for the preservation of endangered species (Walsh et al., 1984). In Wyoming, Colorado and Alaska, non-use values have been estimated at $40 to $80 per non-use household per year (Greenley et al., 1982; Madariago and McConnell, 1987). Another study finds evidence that non-use values of instream water are substantially greater than use values (Schulze et al., 1983). A study of California's Mono Lake estimates that non-use values accounted for more than 80% of the total willingness to pay to preserve the lake's level (Loomis, 1987).

Berrens et al. (2000) conducted a contingent valuation study investigating the non-market benefits of protecting minimum instream flows in four New Mexico Rivers, the Gila, Pecos, San Juan, and the Middle Rio Grande. They used a telephone survey with a dichotomous choice elicitation method based on a voluntary contribution to a trust fund established to pay for the provision of minimum instream flows. The willingness to pay to protect minimum in-stream flows in all four New Mexico rivers together was $73.99, while mean willingness to pay to protect minimum instream flows in the Middle Rio Grande alone was $57.04.[21]

Frederick et al. (1997) recently compiled and analyzed nearly 500 estimates of water values. Nearly 80 percent of these estimates were for recreation/fish and wildlife habit maintenance, and irrigation. Table 4.1 summarizes some of the results of this analysis and provides a rough comparison of values across various instream and withdrawal uses. Although methods for estimating these values varied tremendously, and may result in marginal, average or total values, it is clear that, despite Frederick et al.'s (1997) comparison of "apples and oranges," values associated with recreation and habitat maintenance can be significant. However, non-use values for instream water are difficult to translate into marginal values that permit comparison with the marginal values for other uses for instream

generations; existence value derives from benefits generating simply by the knowledge that a river habitat will be preserved.

[20] Virtually all of these use some version of the contingent valuation method.

[21] The median willingness to pay values were between $20-30 and $40-50 respectively.

Table 4.1. Summary of U.S. Water Value Estimates by Use ($/Acre-foot)

Use	Average	Median	Minimum	Maximum	No. of Values
Instream					
Recreation/Fish and Wildlife Habitat Maintenance	48	5	0	2,642	211
Waste Disposal	3	1	0	12	23
Navigation	146	10	0	483	7
Hydropower	25	21	1	113	57
Withdrawal					
Irrigation	75	40	0	1,228	177
Industrial Processing	282	132	28	802	7
Domestic	194	97	37	573	6

Source: Frederick et al.(1997)

water. Given this difficulty, marginal values for instream water in recreational uses provide a lower bound for the actual total benefits generated by maintaining instream flows (Colby, 1990).

Finally, it is worth noting that instream flows in general, and environmental flows in particular, exhibits characteristics that typically place them in the category of "public good" as described in Section 3 (recall Figure 3.1). This presents an additional layer of complexity when considering optimal allocation of water, and the mechanisms by which that allocation might be achieved (see e.g. Colby 1989a).[22]

[22] In particular, the public good character of intream water poses challenges to market based allocation approaches. It is well established that when the provision of a public good is left to market decisions, the good may be under-supplied due to the free-rider problem. An additional complication follows from the non-subtractible aspect of instream flow; once this flow has been provided, the optimal charge to additional users is zero, a situation for which the market is not ideally suited.

5. Ecotourism Production

This section undertakes an examination of the value of water to sustain the ecosystem, focusing only on the firm. Specifically, it will look at the value of water in its role in the production of ecotourism. The section begins with a review of the relatively scant literature regarding ecotourism production. While the ecotourism literature provides important insights to our analysis, it has not examined the value, or even the role, of water in ecotourism production. However, drawing on the parallel between using water to sustain the ecosystem (essentially "irrigating the ecosystem) and water's use to produce crops, insight can be gained from the extensive literature in agricultural economics regarding the value of water in agricultural production. Thus, this section also reviews the methods most commonly used in agricultural economics to estimate the water's value as a production input. Following these overviews, a more detailed characterization of the ecotourism firm is developed in terms of simple production and cost functions. Finally, an analysis of net benefits generated by guided ecotourism excursions is undertaken.

5.1. Literature regarding Ecotourism Production

Tourism is based on the existence of relatively immobile manmade or natural attributes, to which individuals are willing to travel to enjoy. The willingness to travel derives from being able to experience something better or different at the tourism site than is possible at one's home location. Tourism can thus be based on a wide variety of geographically specific resources that include resorts, casinos, entertainment, culture, *ambiance*, historical landmarks and architecture, climate, scenic beauty, and natural wonders.

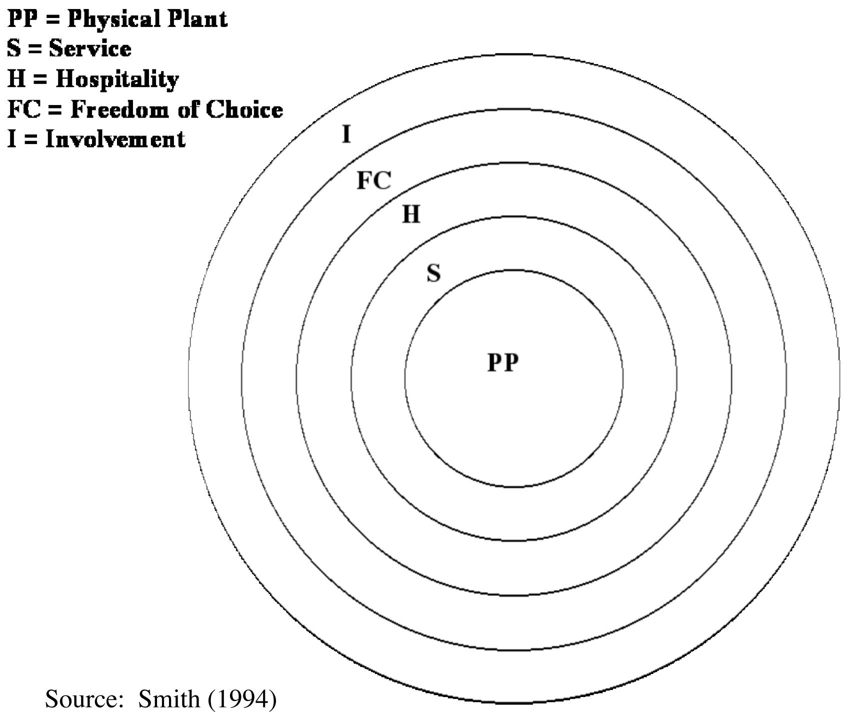
Consumers of tourism, i.e. tourists, are relatively easy to identify as those who travel away from their local surroundings to experience attributes associated with other geographies. However, tourism industry, of which nature-based tourism obviously is a subset, is deceptively complex. Smith (1994, 367) observes that the tourism industry "is the constellation of businesses, public agencies, and non-profit organizations that create products to facilitate travel and activity for people away from their home environment." To make matters even more complex, many of the services and infrastructure used to provide the tourism product are also used in non-tourism activities. For example, the hospitality industry plays a large role in the supply of tourism, but hotels and restaurants are used for many other purposes other than tourism. Because a composite of industries and organizations contribute infrastructure, goods and services to the tourism industry, and because many of these same goods and services are also used by non-tourists, no widely agreed upon definition of the tourism industry exists. Indeed, Tucker and Sundberg (1988, 145) argue that, because there is no single production process, no homogeneous product, and no locationally confined market (tourists are inherently mobile), tourism is not truly an industry, at least in the conventional sense.[23] However, as Tisdell (2001) points out, the difficulty of defining the boundaries of the industry is not unique to tourism, and, to one degree or another, is common phenomenon.

The vast majority of the literature in which economics is applied to the tourism phenomenon focuses on the demand for various components or aspects of the tourism experience. As discussed earlier, demand is derived from the consumer (i.e. tourist) side of the market. Relatively little research examines tourism *production,* and even less looks specifically at the *production of ecotourism*.

As alluded to above, the tourism product is remarkably complex. It can be defined more as a service than a good. Smith (1994) examines the production process and inputs of the tourism industry in detail. The "generic product" of the tourism industry, he argues, is essentially an experience. The tourism industry aggregates five elements: the "physical plant" includes the natural resource, and tourism infrastructure; the service includes the design and provision of the physical plant and performance of specific tasks to meet the needs of tourists; hospitality encompasses the attitude in which service is performed; freedom of choice refers to the necessity that the traveler has some acceptable range of options in order for the experience to be satisfactory; and involvement is regarded as the active engagement of the consumer in the delivery of services. The physical plant also refers to conditions of the physical environment such as weather, water quality, crowding, and the condition of tourism infrastructure, including the hotel and building conditions. The physical plant provides the natural and cultural resources on which any form of tourism is based. Their physical design has a major impact on the consumer's experience. The generic production begins with raw

[23] For the same reason, obtaining detailed and accurate economic data regarding tourism activities is quite difficult.

Figure 5.1. Layers of Ecotourism Production



Source: Smith (1994)

inputs, progresses through intermediate inputs and outputs, to final outputs, that is the tourist's experience. The conceptual model he proposes places the physical plant at the center of increasingly widening concentric circles (see Figure 5.1).

Smith's (1994) conceptualization of tourism yields a useful framework for understanding the production process. The production of tourism begins with the primary inputs of resources, raw materials and other components to create the facilities and equipment needed by the tourism industry. These inputs also include the attraction that draws tourists to the site. These facilities are then converted through additional processing into intermediate inputs or tourism facilities such as national parks, museums, galleries, historic sites, restaurants and hotels. The intermediate inputs are further refined through managerial expertise, technical services, scheduling, and packaging into intermediate outputs such as performances, meals, events, souvenirs, and other services. When tourists consume these products and services, the final output – intangible but highly valued experiences – is created. Smith (1994) outlines how these elements are incorporated through a synergistic interaction

Figure 5.2. The Tourism Production Process

Primary Inputs (Resources) ⇨	**Intermediate Inputs (Facilities)** ⇨	**Intermediate Outputs (Services)** ⇨	**Final Outputs (Experiences)**
Land	Parks	Park Interpretation	Recreation
Labor	Resorts	Guide Services	Social Contacts
Water	Transportation Modes	Cultural Performances	Education
Agricultural Produce	Museums	Souvenirs	Relaxation
Fuel	Craft Shops	Conventions	Memories
Building Materials	Convention Centers	Performances	Business Contacts
Capital	Hotels	Accommodations	
	Restaurants	Meals and Drinks	
	Rental Car Fleets	Festivals & Events	

Source: Smith (1994)

among all the components to create the tourism product. Tourism, he notes, is more than just the sum of its parts, or inputs, it is how these inputs interact with each other to create the experience of tourism for the traveler.

Given the complex nature of the tourism product it is not surprising that tour operators represent a substantial part of the tourism industry.[24] Tour operators "bundle" the multiple inputs of tourism and supply a "package" service that is the tourism product. A tour package is thus the combination of components of a vacation that are sold to the consumer as a single product. Tour packages vary in their components, but generally include airfare, hotel, and some meals. In addition to providing a single aggregated tourism product, tourism packages are consumed solely by tourists for leisure purposes, and can therefore be useful in separating business travelers from leisure travelers (see Figure 5.2). This model is particularly applicable to ecotourism, where a key component of the physical plant is a natural asset, or combination of natural assets.

Tisdell (2001) assesses the economics of ecotourism and investment in the ecotourism industry. He presents a checklist of factors that affect the ecotourism potential – or demand in

[24] In 1978, more than 40% of U.S. residents traveling overseas purchased a package tour (Sheldon, 2001).

an area. These include: proximity of the area to an international airport or tourist center and ease of access, special wildlife attractions and successful viewing possibilities, proximity to features of interest, proximity to the areas of tourist interest, cultural attractions, variety of recreational opportunities, uniqueness of the area, attractiveness of the area, and standard of food and accommodation available

While the other inputs as well as the production process are important to ecotourism, the primary concern for this literature review is the role of water in production. While Smith (1994) and Tisdell (2001) describe an intricate model for inputs and a complex production process leads owards their output as a service, there is a direct link between the input supply of water and the final ecotourism output, making it possible explore that relationship further.

Acharya (1998) describes the environment as an input in a production function. She postures that the value of an environmental resource can be determined when the output of the production function is measurable:

$$Y=f(x_1, \ldots, x_k, q)$$

where Y is the measurable output, $x_1, \ldots x_k$ are inputs of goods and services and q is the input of the un-priced environmental resource, then the economic value of a small change in the resource supply (holding all other prices constant) is the value of the production change that will accompany the change in the resource availability. This welfare change is the sum of the consumer and producer surplus measures. However, if the production units (i.e. firms) are small relative to the market for the final output, and they are essentially price takers, it can be assumed that product and variable input prices will remain fixed after a change in the environmental resource, q. In this case, the benefits of a change in q will accrue to the producers. This scenario relates well to an ecotourism scenario where inputs other than water can be held constant.

The above production function can be further generalized to:

$$y = f(x, q).$$

Additionally, suppose that resources, s , must be expended to sustain/preserve the natural asset q. The production function can now be written as

$$y = f(x, q, s).$$

If we explore a simple positive relationship between s and q (the more q, the more s, noting that "more" can include quality as well as quantity) then we could re-write the production function as $y = f\,(\,x\,,\, q(s)\,)$, and we could even specify a simple linear relationship: $q = \square\, s$. Thus, with some adaptation, this general approach appears to be applicable to the case of ecotourism production.

5.2. Agricultural Economics Literature

Continuing the discussion of the production of ecotourism, agricultural production exhibits a number of similar characteristics that might illuminate our exploration. As with ecotourism, agricultural production requires a variety of inputs in the areas of natural resources, labor, and capital, which are organized through production techniques. Martin Upton (1976) discusses the input output relationships of agricultural production. While he notes that there are a plethora of inputs and that many cannot be controlled, and that the precise level of output cannot be controlled due to the unpredictability of some factors such as weather, pests, and diseases, it is possible to study the response of a single variable input, which he calls the factor-product relationship.

Assuming that all resources except one are fixed, the factor-product relationship may be expressed in terms of total product, average product, marginal product or elasticity of response. By summing the marginal increases from additional input, the total product can be determined. The total product curve, shown by the varying inputs on total, average, and marginal products, 'the response curve' can be derived. While Upton develops methods for dealing with multiple-factor inputs, he does not focus on water as an input.

Gollehon and Quinby (2000) studied the direct relationship between irrigation and economic activity in the American West. As an input, they found that irrigation accounts for 72% of the value of crops sold from about 27% of the harvested cropland in the West. They found that in accomplishing these higher sales, irrigated agriculture accounts for three-quarters of the water withdrawn and most of the water use (not counting in-stream uses) in the West. While noting that it is not possible to view the total crop production for a farm (because much of the production is used as inputs into other parts of the farm) they looked at crop sales, and the difference in crop sales between irrigated and non-irrigated areas to determine the value of irrigation. One drawback to their study is that while they demonstrate that irrigation plays an important role in the Western economy, they do not ever value irrigation independently. Additionally, because the crops are not constant between irrigated and non-irrigated land, it is difficult to determine the true input value of water in the high worth of sales of crops.

Quantitative integrated assessment methods (e.g. Antle and Capalbo, 2001) have been used to determine agricultural production models through a class of empirical economic production models called econometric process models. Site specific data are used to estimate econometric production models, and these data and models are incorporated into a simulation model that represents the decision-making process of the farmer as a sequence of discrete and continuous land-use and input-use decisions. This econometric process has the ability to handle a multitude of fixed, variable, and biophysical characteristics of a site. However, it requires measurable data on many variables and it needs to be tailored to every site. It is designed for agricultural economics and the production function of an agricultural good and may not be adaptable to other industries.

Hellegers et al. (2001) conducted as study that valued water and nature monetarily, and compared the value of nature to other uses, including agriculture. Developing a model that studied the trade-offs between agriculture and the environment, they dealt with water levels and how these affect agricultural/economic production. By maximizing the agricultural production value and the value of nature, the socially optimal, rather than the privately optimal groundwater level can be obtained. Further, the study notes that other variables, such as fertilizer and sowing costs can be held constant regardless of what the groundwater level is. This study exhibits potential applicability to the analysis of environmental flows and ecotourism production. Variables such as hotel and labor costs could be held constant regardless of the in-stream flows, and ecosystem maintenance and other uses for the water such as agricultural production work in a trade-off scenario much as they do in the Netherlands.

Several methods exist for isolating the value of water in agriculture. Gibbons (1986) discusses various methods for placing a value on water used for irrigation. The two primary methods are crop-water production function analysis and farm crop budget analysis. Crop-water production function analysis uses data collected from controlled experiments to calculate the marginal physical productivity of water for each acre-inch of water used for irrigation. Multiplying the marginal physical product of water and the crop price yields the marginal value of water.

Farm crop budget analysis can be used to value irrigation water when the actual physical productivity of water cannot be measured. This method uses representative farm crop budgets to estimate the maximum revenue share of the water input. The on-site value of water is equal to the total crop revenue less the non-water input costs. By further subtracting water procurement costs, the in-stream water values can be calculated (Gibbons, 1986).

A variation on crop budget analysis uses linear programming to calculate irrigation water values. Linear programming techniques can be used to calculate a water demand schedule for a representative farm. The linear programming objective is to maximize net returns for a farm of a particular size subject to various economic and physical constraints. A series of linear programming solutions for a range of water costs, holding all other constraints constant, results in average water values by crop. This set of solutions is the farm's water demand schedule (Gibbons, 1986).

Linear programming has been applied to the estimation of the demand function of water for some time now. Applications of this technique include, Hartman (1960), Moore and Trimble (1963), Johnson (1966), Miller (1966), Stults (1966), McGuire and Brown (1967), Gisser (1970), Craddock (1971), Lacewell, Sprott, and Beattie (1974), Condra, Lacewell, Sprott, and Adams (1975), Whillitt, Hathorn, and Robertson (1975), Shulstad, Cross, and May (1982) and more recently Tisdell (1996).

Craddock (1971) discussed three different types of linear programming models that have been used to study irrigation, the ordinary linear programming model, a recursive model, and a multi-period linear programming model. The ordinary linear programming model is a single period model used for finding the equilibrium solution. This model is rather limited in that is specific to a particular point in time with no indication of how a farm should transition from the present state to the new equilibrium. Furthermore, the results may be inconsistent with a dynamic transition process.

Recursive models are able to overcome some of the limitations of the non-dynamic ordinary linear programming model. The recursive model formulates activities and constraints for a single period in time as is done in the ordinary model. The model specified and coefficients estimated, for each period between the initial situation and some future point in time. The solution for a given matrix determines some of the constraint levels for the model depicting the succeeding time period. Recursive models allow for the inclusion of flexibility constraints that bound the levels of certain activities that are acceptable in the solution. The inclusion of these constraints allows the model to derive a solution that more closely approximates expected behavior (Craddock, 1971).

A final type of model is the multi-period linear programming model often referred to as dynamic programming. This model is formulated so that separate activities and constraints are included for each period in the same matrix implying that there will be a two-way dependence between different periods. This technique differs from the recursive model, which only allows future periods to depend on the current period. The two-way dependence implies that the entire planning horizon is solved simultaneously (Craddock, 1971).

Actually estimating irrigation water demand involves separating the cost of irrigation water from other variable costs for each irrigated crop activity in the linear programming matrix. One activity for buying irrigation water is included in the matrix for each time period. In the ordinary linear programming model, the price of irrigation water for the water buying activity over the entire range of possible prices can be parametrically varied. In the recursive and multi-period models, the direct parameterization of the water buying activity is not possible, so the demand curve can be approximated by successively solving the models for alternative water prices (Craddock, 1971).

Gisser (1970) used a linear programming model to estimate the agricultural demand function for imported water in the Pecos River basin. The critical assumptions of the model were that the agricultural process could be divided into separate independent activities, constant returns to scale and fixed input proportions characterize each production activity, and fractions of activities could be used. The model was set up to maximize the following objective function,

$$Z = \sum_{ijk\ln} \pi_{ijk\ln} \cdot X_{ijk\ln} + \sum_{ijk\ln} \left(\pi_{ijkl2n} - P \cdot I_{ijkl2n} \right) X_{ijkl2n}$$

where Z is total profits, _ is profit per activity, X is acreage, P is price per acre-foot of imported water delivered to the farm, I is irrigation intensity. The subscripts are i the type of crop, j is the soil type, k is salinity, l is irrigation intensity, m is the source of water, and n is the irrigation technique. The maximization is subject to a series of local salinity constraints, legal constraints imposed on the use of water, an acreage constraint, a constraint on the percentage of acreage devoted to vegetables, and a constraint on the percentage of acreage devoted to cotton.

The data used included estimates of agricultural activities in the Pecos basin. These estimates showed the net returns to land and management for various crops grown on two different types of land, four different levels of irrigation intensity, and eight degrees of salinity. Data on costs of various inputs per acre under various irrigation techniques was also collected. With this information, a demand curve for imported water was calculated (Gisser, 1970).

Various studies have estimated the value of water used in irrigation, and a few have compared the value of water in different uses, e.g., irrigation, municipal, industrial and recreational uses (e.g., Gibbons 1986; Colby 1989). For crop irrigation, the most commonly used methodology for estimating the value of water in agricultural use is the farm crop budget analysis (Gibbons 1986). Total revenues generated by irrigated crop production, less all non-water production costs, represent the maximum amount a producer would be willing to pay for water (and just break even). This maximum amount divided by the volume of water used represents the maximum average willingness to pay. The marginal willingness to pay for an additional unit of water is represented by the total revenues minus all non-water production costs generated by applying that additional unit of water to the crop. Estimates of the value of water used in crop irrigation are influenced by various factors, including crop prices. Often, values of irrigation water reported are on-site, and do not include the total costs of supplying water to the farm, e.g., the costs of reservoirs and diversion canals.

Values reported in the literature vary considerably. Gibbons (1986) reviewed a number of U.S. studies and converted per acre-foot values to 1980 dollars to facilitate comparison. Per acre- foot values of water in wheat production ranged from $US18 to $US59; alfalfa from $US20 to $US25; potatoes from $US185 to $US698; and citrus from $US95 to

$US1,087. In a recent study of irrigation in southern Alberta, Adamowicz and Horbulyk (1996) reported per acre-foot values of water in pasture, forage and cereal crops of $10 to $68, and $100 to $350 for specialty crops. Expressed in dollars per cubic meter, a value of $100 per acre-foot converts to $.08 per m3. For processing tomatoes in Ontario, one of the highest value crops in the Province, Tan (1990) calculated an average increase in yield due to irrigation of 11 tonnes per hectare ($1,430/ha increase in gross income) for the years 1985-1988. Not surprising, the largest increase in yield, 21.6 tonnes/ha ($2,813/ha increase in gross income), occurred during the drought year of 1988. Note that data on production costs and the amount of irrigation water applied would be required to calculate a value of irrigation water comparable to the estimates reported above for the United States and Alberta.

Several studies have made comparisons of water values across uses. Gibbons (1986) suggested that when water is in short supply, the marginal value in municipal use would be greater than the value of water in any other use. Colby (1989) concluded that the value of in-stream uses, including recreation, may be comparable to, or greater than many off-stream uses, such as irrigation.

5.3. Overview of the Productivity (Net Factor Income) Method[25]

The productivity method, also referred to as the net factor income or derived value method, is similar to the farm crop budget model discussed above, but is more generalized for use in a variety of contexts. It is best utilized to estimate the economic value of ecosystem products or services that are used, along with other inputs, to produce a commercially marketed good, as is the case with the production of ecotourism goods.

To apply the productivity method, data must ideally be collected regarding how changes in the quantity or quality of the natural resource affect such factors as costs of production for the final good, supply and demand for the final good, and supply and demand for other factors of production. This information is used to link the effects of changes in the quantity or quality of the resource to changes in consumer surplus and/or producer surplus, and thus to estimate the economic benefits. Both consumer and producer surplus may come into play. If the quality or price to consumers of the final good changes, there will be changes

[25] This summary is based on King and Mazzotta (2002).

in consumer surplus; if productivity or production cost changes, there will be changes in producer surplus.

The advantages of using the productivity method are that, in general, the methodology is relatively straightforward, and data requirements are less demanding and the relevant data may be readily available. However, as with all non-market valuation techniques, the productivity method faces several methodological limitations and challenges. The method is limited to valuing those resources that can be used as inputs in production of marketed goods. It is also important to keep in mind that, not all benefits of the natural resource or ecosystem will be related to the production of marketed goods, thus, the inferred value of that ecosystem may understate its full value to society. If the changes in the natural resource affect the market price of the final good, or the prices of any other production inputs, the method becomes much more complicated and difficult to apply. Finally, in terms of information needs, the greatest challenge pertains to the scientific relationships between actions to improve quality or quantity of the resource and the actual outcomes of those actions. In some cases, these relationships may not be well known or understood.

A recent study used this approach to estimate the value of wetlands in the Peconic Estuary, Long Island, New York (Opaluch, 1999). Peconic Estuary includes many productive wetlands of different types, including eelgrass, saltmarsh, and intertidal mudflats. Development and resulting water quality degradation have reduced the quantity of these wetlands. The Peconic Estuary Program, which is part of the National Estuary Program, was considering various management actions for the Estuary and surrounding land areas. to assess some of the values that may result from these management actions, a productivity study for wetlands was conducted.

For the analysis, it was assumed that wetlands provide both food chain and habitat support for crabs, scallops, clams, birds, and waterfowl. The analysis required that the productivity of different wetlands types in terms of food chain production be estimated and linked to production of the different species of fish. The expected yields of fish and birds per acre of habitat were then estimated. The quantities of expected fish and bird production were valued using commercial values for the fish, viewing values for birds, and hunting values for waterfowl.

The study yielded estimates that an acre of eelgrass wetland is worth $1065 per year, an acre of saltmarsh is worth $338 per year, and an acre of intertidal mudflat is worth $68 per year, in terms of increased productivity of crabs, scallops, clams, birds, and waterfowl. However, as the study points out, these values do not capture the full value of the wetlands, because they *only* address values in production of commercially and recreationally valuable species, thus excluding other ecosystem services, such as erosion and storm protection or aesthetics.

5.4. Water as an Input to Ecotourism Production

Overall, there has been very little qualitative research completed concerning the production of ecotourism and there has been even less quantitative work done that incorporates input factors and ecotourism. While previous work in the field provides some general insight as to the factors that should be considered when thinking about ecotourism, and agricultural economics provides a basis for some quantitative work in the field, the research in this field has been sparse, vague, and has lacked organizational structure.

This section builds on concepts and approaches discussed in the previous sections to develop a simple framework with which to explore the value of water as an input to ecotourism production. This framework consists of a highly stylized representation of a small competitive "ecotourism" firm. To facilitate this representation, it is useful to begin by conceptualizing this firm as a private ecotourism ranch, in which the natural asset that is of interest to the ecotourist lies on a land parcel owned by the firm (recall the discussion in Section 3 of the ways ecotourism firms might derive economic rent from natural assets). Further, assume that this single ecotourism firm provides a "package" experience, that is, it provides all services (lodging, food, guide, etc) needed by the ecotourist. The firm uses land, water, and a number of other natural inputs (un-priced ecosystem services) such as sunlight, to "produce" or perhaps more accurately in this case, maintain, the natural asset (the ecosystem) that attracts ecotourists. As we undertake our examination of the Lower Rio Grande Valley we will, for the sake of simplicity, take this natural asset to be bird habitat together with birds that inhabit it. To further simplify the analysis, we will assume that this habitat takes the form of a wetlands. In addition, the firm uses a variety other traditional inputs, broadly referred to here as labor and capital, to produce the services included in the ecotourism experience they provide.

Thus the simple characterization of the ecotourism firm developed here can be presented in terms of two functions. The first describes the provision/maintenance of the ecosystem. Conceptually, this is a production function in which the firm uses water and acreage to produce an intermediate input, i.e. birding habitat, which is in turn used as an input to providing the final good, the ecotourism experience. The second function is the firm's production function related to producing the ecotourism experience, reflecting the specific characteristics of the ecotourism firm described briefly above. Each of these functions will be discussed below.

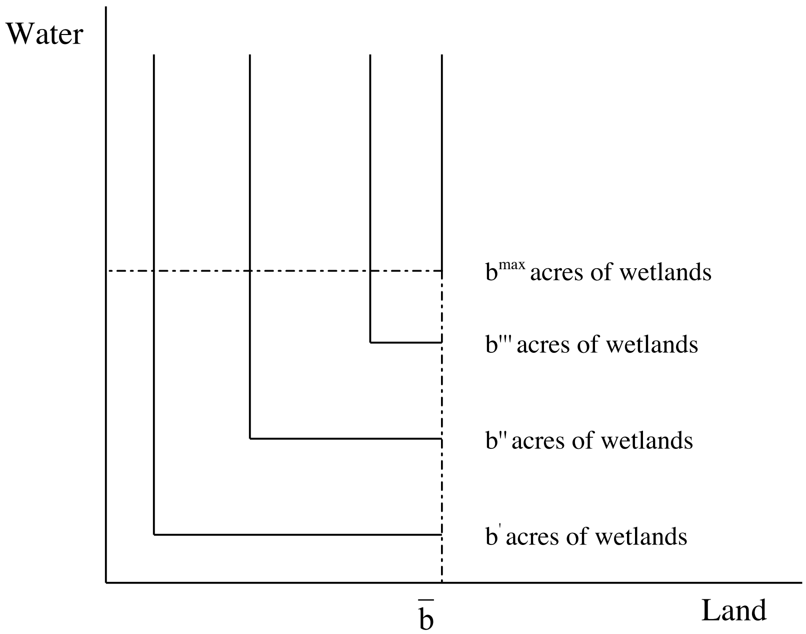
5.4.1. Ecological Production: Wetlands as an Intermediate Good

Consider, the production/maintenance of the ecosystem that exists on the land owned by ecotourism firm. Suppose that the land owned by the firm is comprised $\bar{t}$ total acres, of which $\bar{b}$ acres posses the requisite characteristic to make them suitable to be maintained as wetlands. While historically these $\bar{b}$ acres of wetland were provided water by periodic floods, today, unless the firm uses water withdrawals from the river to maintain them as wetlands they will eventually transform into an ecosystem adapted for dryer conditions. Consequently, the diversity and number of bird species that can be observed on the land is reduced, as is the attractiveness of the natural asset to ecotourists, thus also reducing its value as an input to the production of ecotourism. In the crudest sense, two inputs are needed to maintain the welands: land, b, and water, a.[26] While this level of abstraction obscures the multiple complexities associated with living organisms and natural systems it allows the ecological production function to be written as follows:

$$\textit{Amount of wetlands ecosystem} = g(a, b)$$

[26] A third input would, of course be labor, and a fourth set of inputs could include sunlight, nutrients, soil structure are also necessary, but are characterized broadly as ecosystem services available at no cost to the firm.

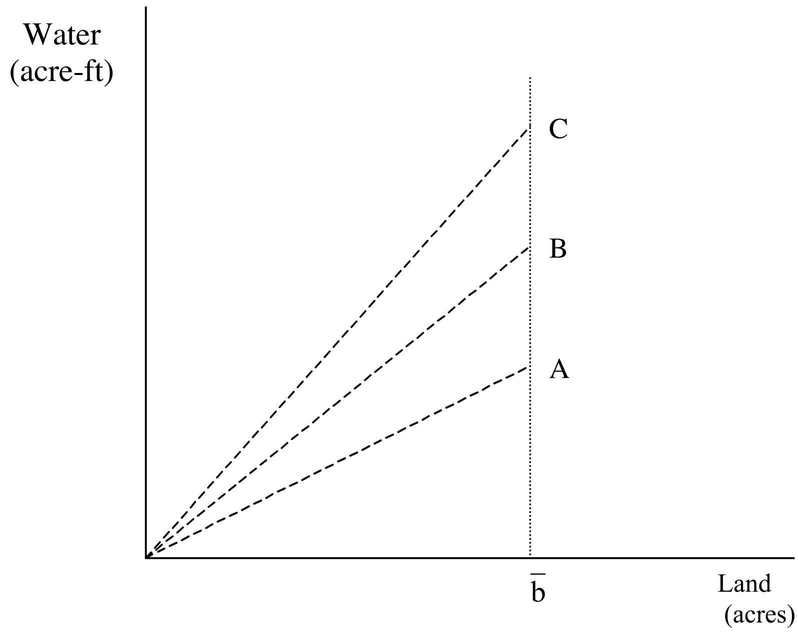
Figure 5.3. A Simple Fixed-Factor Wetlands Production Relationship



Here, "amount" is defined in terms of acres.[27] Assume that in the short run the maximum acreage available to be maintained as wetlands is fixed at $\bar{b}$ and water, a , is variable. Further, assume that a certain amount of water is required to sustain each acre of wetlands. Although a constraint on maximum the possible acres of wetlands exists, determined by $\bar{b}$,until the firm reaches that limit it can choose the amount of acreage available for wetland to combine with water to produce wetlands (see Figure 5.3). Of course, a similar constraint on the maximum amount of water available to apply to the land, due to the quantity limitations of a water permit, for example, would likewise constrain the production of wetland. As characterized here, the two inputs to wetland production exhibit a "fixed factor" relationship, in which one acre of wetland can be produced only by combining one unit of land with one unit of water in a "fixed proportion." This means that additional wetlands cannot be created by adding only more water or only more land. Figure 5.3 illustrates this relationship.

[27] More complex ecological models could be explored, in which the "output" might be defined in terms of biomass, for example, but such an undertaking lies well outside the scope of this project.

Figure 5.4. Proportional Relationship of Water to Land in the Production of Bird Habitat



Assuming that the number of acres of bird habitat equals the acres of land upon which the habitat exists, the production relationship between water and land can be re-interpreted as a function that describes a proportional (linear) relationship of water to land in the production of bird habitat. Examples of three such possible relationships are illustrated in Figure 5.4. In fact, the relationship between these two elements of wetlands production/maintenance is not sufficiently well understood to be estimated in a quantifiable way.

5.4.2. Ecotoursim Production

Consider now the characterization of ecotourism production. This production depends fundamentally on the existence of the natural asset of sufficient interest to attract ecotourists – in this case (for simplicity), healthy wetland habitat and the large number of different bird species that inhabit it. As outlined above, the firm uses land and water to maintain/provide this natural asset (an intermediate good), which enters the ecotourism production function as an input. Together with the natural asset, the firm uses a variety other traditional inputs, generally falling under the broad categories of labor and capital, to produce the ecotourism good they provide. Thus, in this simplified characterization, the general form production function can be written as follows:

$$x = f(k, l, g[a, b])$$

where k is capital, l is labor, and $g(\bullet)$ is the amount of ecosystem, which (as describe above), is dependent on the amount of land, b, and water, a.

The production function relates the firm's output, in this case the ecotourism good, to the various inputs used to produce it. The quantity of output sold, together with the sales price, yields the firm's revenue; the inputs, together with their associated prices, constitute production costs. The revenue and costs of a firm's operation are linked to each other through the familiar profit function:

$$\pi = px - c$$

where x is the quantity of the ecotourism good produced, and p is its sales price. The quantity the good, multiplied by the price, i.e. px, is the gross revenue earned by the firm. The cost function c reflects the costs associated with all production inputs, that is, the sum of the products of the quantity of each input used, and it's corresponding price. The difference between gross revenue and costs is referred to as profit, π, or more generally, net benefit.

Following standard economic theory, the objective of the firm is to choose the amounts of inputs (or conversely the level of output) that minimize costs(maximize profits). Because land is treated as fixed in the short run, the short run choice variables available to the firm are k, l, and a. The corresponding cost function c can be written as

$$c = w_k k + w_l l + \overline{w}_a a + w_t t$$

Here, w_k is the market price for capital, w_l is the reservation wage for labor, established in an alternative market, and $\overline{w}_a$ is the price paid for water. To more closely resemble reality, assume the price for water is not a market price, but rather, is fixed based upon some set of minimal costs associated with diverting the "wetlands" water from its source and directing it to the land parcel in question. Although the amount of land is not a choice variable in these short run analysis, we have nonetheless included the cost of land, expressed in terms of "rent," w_t , associated with land t upon which the wetland acres b exist. It is worth noting that the rent for land may or may not incorporate the potential benefits to be derived from the ecosystem that exists upon a given parcel. Thus w_t may or may not reflect the value of the ecosystem as the basis for ecotourism.

Solving the maximization problem for the choice variables k , l , and w is relatively straightforward and will not be undertaken here. Instead, this analysis seeks to develop a stylized, but more detailed, characterization of the costs and revenues of the ecotourism firm.

5.5. Analysis of Ecotourism Guide Operators

With the above characterization of the ecotourism firm and methodological techniques discussed earlier in mind, let us consider how these ideas might be applied within the context of seeking a value for water to sustain the ecosystem through its role as an input to the production of ecotourism in the Lower Rio Grande Valley. Given the complexity of ecotourism production and the challenges of obtaining detailed data, we attempt to pursue this analysis by applying a simplified approach to the context of the simplest possible ecotourism firm.

The approach we employ is the "net revenue" analysis (see e.g. Whittington et al. 1994, p.113) to yield an estimate of net benefits that accrue to the ecotourism firm. This approach is conceptually related to the net factor income and farm budget model approaches described earlier, though it is much simpler. The basic premise of the net revenue approach is that net benefits can be calculated as simply gross revenue less costs:

$$\text{Net Benefits} = \text{Gross Revenue} - \text{Costs} .$$

The parallel with the firm's profit function discussed above is obvious, and also recalls the discussion of producer surplus in Section 4.

Importantly, the data requirements of this approach are less demanding than the productivity method. Nonetheless, obtaining necessary information regarding costs is often difficult and costly. For example, due to insufficient cost data and project limitations that precluded the formal surveying needed to obtain this information, Whittington et al. (1994)

assume, based on information gathered in informal interviews, that net revenue is simply a percent (10-20%) of gross revenues, bypassing an analysis of costs altogether.

In terms of ecotourism production, one of the simplest forms the ecotourism good can take is a guided eco-excursion to a public protected area, such as the Bentsen-Rio Grande Valley State Park or Santa Ana National Wildlife Refuge. This places the possession and production/maintenance of the natural asset (i.e. birds and their habitat), outside the ecotourism firm and in the hands of a public agency. Consequently, the ecotourism firm does not make decisions about, or incur costs from, the provision or maintenance of the natural asset, as in the characterization above, but simply takes it as a fixed input to the production of the ecotourism good. Thus,

$$x = f(k, l, \bar{g})$$

In this simplest case, access to the natural asset is obtained through the payment of a minimal park entrance fee. The simplified cost function can then be written as:

$$c = w_k k + w_l l \ ,$$

where the costs of the firm are associated only with the capital and labor involved in producing an ecotourism excursion. As already noted, the costs of land and water needed to produce the intermediate good, i.e. birding habitat, are external to the firm.[28]

The ecotourism good is further simplified if the excursion is only for a single day. This eliminates lodging requirements and associated costs, and greatly reduces meal requirements as well. It is the most basic of ecotourism goods, consisting of a guide, transportation to and from the natural asset, (perhaps) snacks and printed material, and a desired natural asset that is accessible at a negligible cost. Distilling the ecotourism good down to this simple form offers two advantages: (1) allows the benefits of the natural asset to enter into the analysis essentially as pure benefits, and (2) it reduces data requirements.

Table 5.1. Stylized Costs and Revenue Profile of a One-Day Ecotourism Excursion

[28] Note that this characterization of ecotourism production relates directly to the discussion in Section 3 regarding how rent might be generated from a natural asset that takes the form of a public protected while the characterization of ecotourism production outlined at the beginning of this section is parallels the discussion in Section 3 of rent generated by a natural asset that is a privately owned as part of a nature park.

Costs ($)	
Vehicle Costs and Maintenance	38
Fuel	17
Lodging	n/a
Snacks and Beverages	24
Insurance	n/a
Other Supplies[a]	22
Other Operating Expenses[b]	39
Wage ($20 per hour)	160
Total Costs	**300**
Gross Revenue ($55 per person)	**330**
Net Revenue	**30**

Systematically compiled firm level data regarding guided ecotours, was essentially non-existent, and yet this information was important to understanding our research questions. As a first step to filling this gap in information, we conducted a series of in depth interviews with key informants regarding ecotourism guide operations in the Valley. These interviews followed a guided, open-ended question format (see e.g. McCracken, 1988) designed to elicit information about the price and costs of guided eco-tours, to be subsequently used in the net revenue analysis. Interestingly, none of the guide operations we contacted rely exclusively on tours to the natural areas of the Valley for revenue/income; instead they either provide tours to other natural areas in Texas besides the Valley, or the revenue from guide operation is supplemented by other economic activities.

With the information gathered from these interviews, we developed a stylized revenue and cost profile of a one-day (8 hour) guided ecotourism excursion in the Valley (see Table 5.1). Because most of the guide operations we contacted offered one-day packages, this provided an opportunity to standardize to some extent the ecotourism good being analyzed (the unit of analysis), while accounting for the fact that the annual revenue generated by ecotourism excursions in the Valley represented different portions of total annual revenue across these firms, greatly complicating comparability in terms of *annual* revenues and costs.

The cost profile for the one-day ecotour was built around an excursion with the following characteristics:

- 6 paying ecotourists, one guide (8 hours labor), one vehicle
- 100 miles driven, vehicle receives 10 MPG
- Snack and beverages included, meals not included, no lodging necessary
- Firms organized as limited liability partnerships, liability insurance costs assumed to be negligible

Based on an excursion with these characteristics, the stylized ecotourism firm's cost profile was determined as follows:

Vehicle costs and maintenance were calculated on a per mile rate of $0.38/mile. This rate was based on $2,000 maintenance every 20,000 miles, and a linear depreciation over five years of the initial $25,000 value of the vehicle.

Fuel cost were calculated based on a 100 mile trip at 10 MPG, assuming a fuel price of $1.70/gallon.

Snacks and beverages were calculated at $4/person, for six people.

Other supplies include per-person costs of photocopies materials, other incidental supplies, and $10 in entry fees to public protected areas (assuming fee is per vehicle rather than per person).

Other operating costs include advertising, phone, electricity, other utilities, office space, and other general expenses associated with the cost of doing business. These were calculated as a rate (percentage) applied to all other costs. This rate was assumed to be 15%.

Wages were assumed to be $20/hour, which is the equivalent of $41,600 annually, working full-time.

Gross revenue was determined by multiplying the $55 per/person excursion cost by the number of ecotourists on the trip. Based on this profile, the net revenue to the ecotourism firm for a one-day excursion is $30, or roughly ten percent of costs.

Before examining the implications of the net revenue generated by the one-day ecotousism excursion, further explanation of the hourly wage used to develop the cost profile is warranted. Characterizing the cost of labor is more complex that it may first appear. In many small, owner-operated businesses, wages are often determined by the amount of revenue that remains after all non-labor costs have been accounted for. Even if the owner pays herself a "salary," it is typically closely related to the remaining amount of revenue from which it is drawn. Thus, during an off period for the firm, the wage actually earned may be small, or, for a short period, even zero. It is within this context that the notion of a "reservation wage" becomes important. The reservation wage is simply the wage that the individual could earn working in alternative industry or sector. Economic theory asserts that if the wage the individual earns in the ecotourism sector is significantly less that the reservation wage, then the individual has strong incentive to switch to the alternative sector in which the reservation wage can be earned.[29] The reservation wage represents the opportunity cost of labor used as an input to produce the ecotourism good. If revenue is such that what remains after paying non-labor costs results in the owner-operator receiving an effective wage below the reservation wage, this can be viewed as not fully covering the "true" cost of labor, as measured by opportunity cost. Conceptually, in this case the firm is operating "at a loss" even though the owner-operator receives some compensation for her labor (albeit less than the reservation wage). It is important to recognize that this basic version of the story does not account for less tangible benefits associated with operating ecotourism excursions, such a working in the outdoors, experiencing nature, etc. Such benefits might keep the individual from leaving the ecotourism sector, even if the wage received is significantly less than the reservations wage.

The reservation wage is also useful in evaluating producer surplus. Recalling Figure 4.1. in Section 4, producer surplus is the revenue the firm receives, less the costs of

[29] Viewed in a slightly different way, in the case where the firm brings in revenues that allow labor to be compensated at exactly the reservation wage, the individual would be indifferent between working in one industry or the other.

production. This, of course, is virtually the same as our definition of net revenue above. Using the reservation wage to determine the cost of labor as a production input allows the separation of producer surplus from the "market value" of labor in the case when the ecotourism firm brings in revenues that not only exceed non-labor costs, but also the costs based on the reservation wage. Even if the owner-operator takes as salary all remaining revenue after paying non-labor costs, the "surplus" component of that salary – $30 for a one-day excursion in the case of the ecotourism firm – would be the amount remaining after accounting for the cost of labor based on the reservation wage.

Thus, in the ecotourism firm's cost profile, the $20/hour wage used to calculate labor costs is an estimate of the reservation wage, rather than a characterization of wages actually paid.

5.5.1. Net Benefits to Firm Generated By Ecotourism Excursion

Given that the surplus generated with each one-day ecotourism excursion is $30, economic theory presumes that the ecotourism firm would be willing to pay up to $30 per excursion for the natural asset with which her ecotourist clients interact, in this case, birding habitat and the birds that populate it. This "willingness to pay" can therefore be interpreted as the economic value of the natural asset to the firm.

At this point it is useful to recall the notion of a "public good," discussed earlier in Section 3. As presented here, the natural asset exhibits certain characteristics that are associated with public goods. Of particular relevance is the "non-subtractable" nature of its consumption, i.e. the use of the natural asset by one individual does not reduce the amount available for another individual to use. This characteristic is also referred to as "indivisibility of benefits," which has a further implication – unlike private goods such as pints of ice cream, public goods must be provided to all consumers in the same amount. For example, national defense, which is as close to a pure public good as may exist, is supplied to every citizen in the same amount. Moreover, even though each citizen may value national defense differently, once it is provided, they cannot choose to consume more or less it even if they want to. Transportation infrastructure represents a less pure form of public good, (sometimes referred to as "quasi-public goods"), but exhibits similar indivisibility of benefits: the infrastructure that has been provided is available at the same quantity (and quality) for everyone use.[30] Protected natural areas are much like transportation infrastructure in that a certain quantity and quality of protected acreage exist, and the same number of acres available to anyone who wants to derive benefits from them.

As already discussed, the ecotourism firm takes the amount of natural asset as given in its production of the ecotourism good. It is important to note, then, that the firm's per-trip willingness to pay, derived above, is for quantity and quality of the natural asset currently provided. Thus the economic value of the natural asset derived from the net benefits of a one-day ecotourism excursion is for the *total* "given" amount of natural asset, rather than per acre, or for a marginal change in acreage. We emphasize that no presumption is made here whether or not the natural asset is provided at the optimal level (and quality).

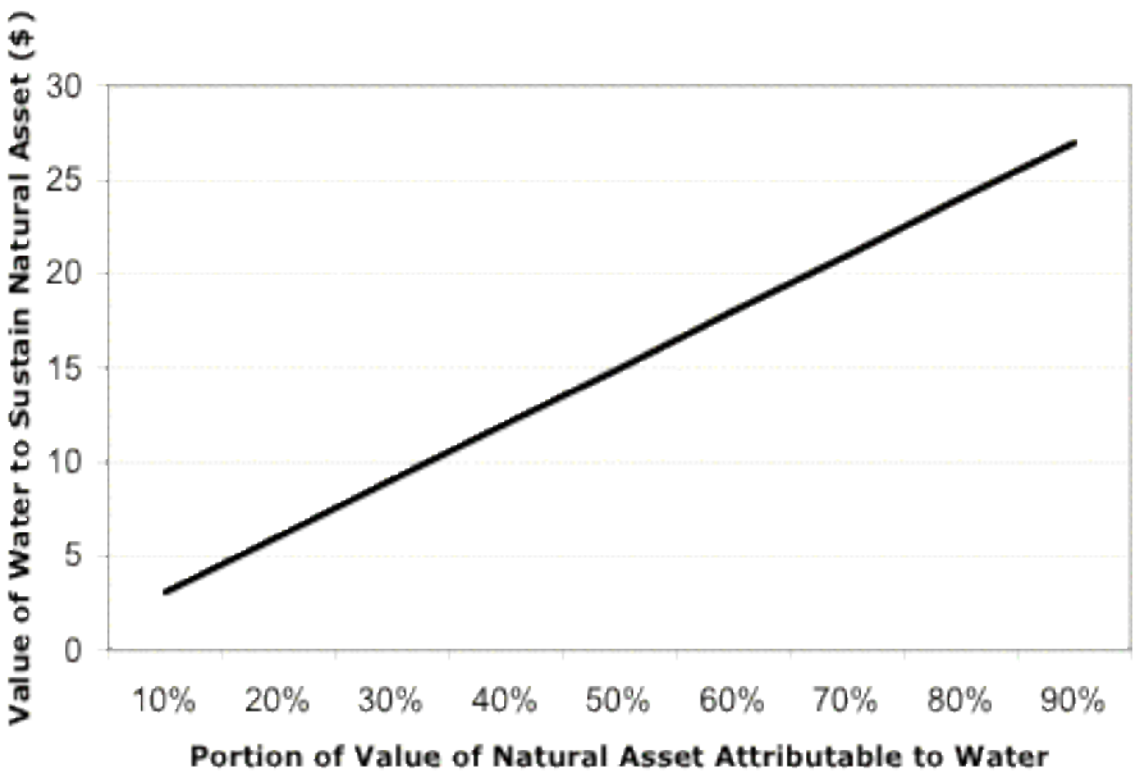
5.5.2. The Value of Water to Sustain the Ecosystem

The final step in deriving an estimation of the economic value of water to the firm in sustaining/providing the natural asset is to extract this value from the more general value attached to the natural asset. This requires at least a rudimentary understanding of how the two are related. Perhaps the simplest approach is to use a basic proportion rule that describes the portion of the value of the natural asset attributable to the water used to sustain it. However, without further research regarding the biological and physical relationships between water and the ecosystem, it is impossible to estimate even this basic percentage. Thus, we can only suggest a range of values that might be attributable to water in sustaining the natural asset. This range is presented in Figure 5.5.

Two observations are worth considering, and suggest that the value of water to sustain the ecosystem derived from the value of the natural asset is unlikely to lie either extreme on the continuum of possible values. First, in agricultural production, the difference in the value of land with and without access to water for irrigation is well established. Indeed, this Difference allows a relatively straightforward technique to be used to estimate the value of the water used for irrigation. However, it also demonstrates that land has value, though less of it,

[30] When the number of consumers using the infrastructure at the time surpasses a certain threshold (capacity), congestion occurs. Thereafter, each additional consumer reduces the amount of good available to the next.

Figure 5.5. Range of Possible "Per-Trip" Values Attached to Water so Sustain the Ecosystem, Based on a One-Day Excursion



without water. In other words, the value of the land is not determined entirely by the value of the water. This suggests that it is extremely unlikely that value of the natural asset sustained by water is 100 percent attributable to the water itself.

Second, recalling the work by Golleron and Quinby (2000) reviewed earlier in this section, water may contribute as much as seventy percent of the value of agricultural products. This suggests that it is also extremely unlikely that the value to the firm of water used to sustain the natural asset is negligible.

Finally, we note that that water to sustain ecosystem is a public good. Moreover, in its use to preserve/maintain the ecosystem if much closer to a pure public good than the natural asset it sustains, closely resembling the example of national defense used earlier.

6. Consumer Willingness to Pay

This section of the report turns from an analysis of the ecotourism firm to an analysis of the economic value of water to sustain the ecosystem derived from the consumers participation in the ecotourism activities. It is based on a detailed survey of attendees of the 10th Annual Rio Grande Birding Festival, which took place in McAllen, Texas, November 2003. The survey incorporated questions that allowed two different techniques to be used to pursue the value of water to sustain the ecosystem from different approaches. Both of these approaches provide new information regarding the ecotourists' (the consumers') "willingness to pay."

6.1. Description of Survey of Attendees of the Lower Rio Grande Birding Festival

In a 1999 feasibility study for the World Birding Center, Fermata, Inc., led by Ted Eubanks and John Stoll completed two surveys of birders in the Valley. They surveyed attendees of the RGVB Festival and travelers along the central portion of the Great Texas Coastal Birding Trail with respect to their motivations, satisfaction levels, demands and desires, and expenditures related to birding along the Texas coast and in the LRGV. With the results of this survey, Eubanks and Stoll were able to generate a profile concerning "traditional socio-demographic characteristics, as well as motivations, degrees of commitment, satisfaction levels, trip expenditures, and willingness-to-pay for above trip expenditures." The second objective of these studies was to gauge interest and support for continued production of Birding Trail Maps and the proposed World Birding Center.

To maintain consistency with information gathered in the Eubanks and Stoll survey that has already been collected, our survey carefully parallels many of the questions in their survey. These intentional similarities allow the results of the two surveys to be compared, and analyses to be carried out regarding possible trends.

The objectives of our survey were somewhat different than the objectives of the Eubanks and Stoll survey. While the Eubanks survey focuses primarily on demand for various services associated with the Great Texas Coastal Birding Trail and the proposed World Birding Center, our survey focuses more on the spending patterns of those who visited the LRGV Birding Festival. In order to gain further insight with respect to people's willingness to pay for ecotourism services in the Valley, we used several different types of questions throughout the survey. We included both travel-cost questions, measuring how much people spent traveling to and attending the festival and we sought to generate a non-use value for instream flows for ecosystem sustainability in the Valley by asking a CV question.

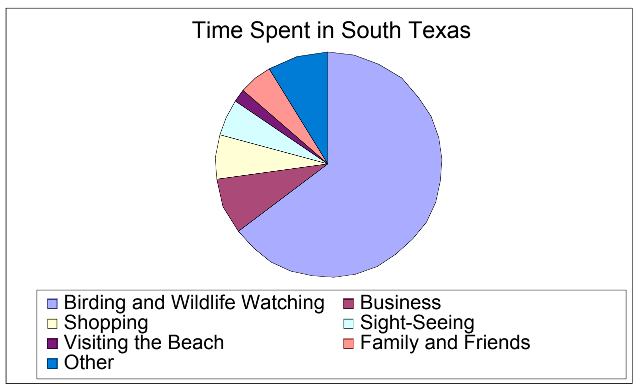
The purpose of our birder survey was to attempt to gain a greater understanding of the demographics and spending patterns of the birding community, in order to be able to characterize their typical behavior and impact on the economy of the LRGV. In addition, we included a question designed to elicit information regarding the "willingness-to-pay" value of water to sustain the ecosystem in the Valley. To accomplish these objectives, we began with a demographic section of the survey, in order to understand who the typical birders and attendees to this festival were, as well as information such as their spending constraints based on their income. Additionally, by obtaining zip code information, we were able to better determine how far attendees traveled in order to reach Harlingen for the birding festival. The second section focused on birding, concentrating on which characteristics of the birding experience appeal most to birders. The travel section attempted to discern the transportation and lodging impacts of birders by asking how long they stayed, how they traveled, and how much of a factor birding was in their decision to attend. This section also contained the travel cost portion, asking respondents to detail their total expenditures for several categories. The activities section focused on a variety of miscellaneous questions evaluating how respondents spent their time in the Valley. The final question – a contingent valuation question that was attached separately – looked at the value of water to sustain the ecosystem in the Valley.

Again, to maintain consistency with the previous work by Eubanks and Stoll (1999), our method of administering the survey closely followed the method employed in their study, which was a modification of the Salant and Dillman (1994) protocol involving four separate mailings. The mailing list of festival registrants was obtained from the Harlingen Area Chamber of Commerce, which had served as the event coordinator. The list contained what were ascertained to be 297 usable addresses. The initial mailing was undertaken in mid February, 2004, and consisted of a postcard that was mailed to the 297 addresses, informing the recipients that they would soon receive a survey packet and encouraging their participation in the study.[31] Several days later, we mailed out the survey packet, which included the survey itself, and two letters of introduction. One letter was from us, explaining who we are, the purpose of the survey, and the deadline for responses (March 25, 2004). The other letter was from Father Thomas Pincelli, a well-respected birder and president of the Birding Festival, in which he encouraged the festival attendee to participate in survey. Approximately two weeks after mailing the survey packet we sent out a second postcard, which thanked those who had already responded for their participation and encouraged those who had not yet responded to do so, reminding them of the upcoming March 25 deadline. After roughly two more weeks, we then sent out the final mailing to those on the mailing list who had not yet responded another copy of the survey; and extended the March 25 deadline by several weeks to April 15 to encourage additional respondents to participate. In total, we received 202 responses, for a response rate of 68%. Two surveys were returned blank, and one survey was returned due to a bad address. In addition, five completed surveys were returned significantly past the extended deadline and were not included in the survey results.

Using Microsoft Access, we compiled the surveys into a database that consisted of 202 observations and 72 variables. Data input was carried out by using a customized on-screen data entry form that mimicked the format of the survey. In general, responses were entered as each attendee had listed them on the survey. For most questions, if the format was multiple choice, or a checkbox answer, the data entry was very straight forward. If it was a free response question and there was a value entered, that data was entered as the respondent had listed it. If the survey answers were left blank, then we entered that as a no response. Frequently, we realized that a blank response to a question probably indicated a 0, but unless the attendee specifically entered a 0, we did not enter it as such. Additionally, certain questions only required checking a box for yes. For these questions, there is no way to distinguish between a 'no' and a non-response.[32] We were only able to count 'yes' responses – and give a percentage of people who visited a certain location, or used a certain type of transportation. For certain questions, such as zip code, if the zip code was left blank, but the

31 For this postcard, as well as the other letters and a copy of the survey, please see the appendix.
32 We believe the distinction between true "zero" responses and non-responses could be improved by instructing respondents on free response questions to enter 0 if they mean 0, and leave blank or put a dash for a non-response. On multiple-choice questions, a "zero" checkbox would help determine the difference between a non-response and a true zero.

city and state were filled in, then we filled in the zip code to complete the dataset. Using ArcGIS, we were able to create an additional variable, determining the distance traveled to the event, by using a function that allows the analyst to put two zip codes into the system, and it outputs the "as the crow flies" distance between them. Using a script that automatically repeated this function, we calculated the distance from all zip codes in the database to Harlingen, Texas. Frequently, attendees would note that they purchased their plane ticket with frequent flyer mileage. The economic value of frequent flyer miles to the traveler is generally 1 to 9 cents per mile, (airline corporations generally value them at 1.7 cents in revenue per mile); nevertheless, we did not change any values for transportation expenditures.[33] Additionally, it is noteworthy that for questions such as #27, where respondents were asked to estimate their percentage of time at each of a variety of activities, totals did not necessarily add up to 100%. Such inconsistencies are not unusual, but should be accounted for. On question #27, the total amount of the mean time spent in each activity added up to 107.5%, so we proportionally scaled down the percentage in each activity so that the total equals 100%, as illustrated with the pie chart below, which represents the relative time spent in each activity. Finally, due to the nature of the how the addresses were collected, many respondents were members of larger travel parties and of households with multiple attendees. It is often unclear to what extent responses were given for an individual household as opposed as for a larger group. Additionally, certain questions were targeted towards one individual – such as Male or Female, when it is clear that the respondent gave answers for his or her household. While data were collected on some of these difficulties, by asking how many households were represented in the travel party, and most



33Webflyer. "Pressroom." http://www.webflyer.com/company/press_room/facts_and_stats/frequent_flyer_facts.php . Last update unknown. Visited 20 May, 2004.; in the future, there should be a separate column for how many frequent flyer miles did the respondent used to reach this destination.

parties were only represented by one household – there were some travel parties with as many as six households represented.

6.2. Summary of Analysis

Analysis included three components: demographics, travel expenditures, and the willingness to pay for water to sustain the ecosystem. For each question, a different number of observations are usable for analysis due to response rates. In the results section of the appendix, each question notes how many responses were usable for each question. The demographics section contained the first 9 questions, with responses ranging from 189 to 202 per question. Questions 10-32 dealt with travel expenditures and trip characteristics. These questions had between 151 and 202 responses. We were also able to divide local attendees vs. non-local attendees for many of the questions as we felt that it would assist understanding the data.[34] The CV question received 106 usable responses. Interestingly, we received comments on the returned survey for this part, explaining that the respondent wasn't sure, did not really understand the question, or providing some sort of political commentary on the water situation in the Valley, without actually responding to the question. Overall, with the many parts to different questions, we compiled 79 different variables that could be used in analysis.

In our study, we looked to determine the value of water in the Valley for ecosystem sustainability. In general, economic valuation looks to determine what people are willing to pay for a certain good or service. Of the variety of economic valuation techniques available, we felt that travel-cost and contingent valuation were the most useful techniques for this purpose.

Contingent valuation (CV) values public goods through survey questions that elicit a population's preferences.[35] Contingent valuation is the only economic method for measuring non-use values. By presenting a sample population with hypothetical markets, preferences can be determined by asking its willingness to pay to purchase or restore that good, or its

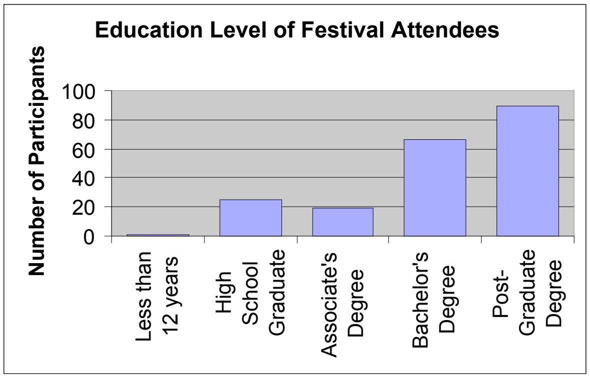
[34] Local attendees were defined as those who indicated in their survey responses that they live in one of the four counties that comprise the Valley – Cameron, Willacy, Hidalgo, and Starr.
[35] This approach has also been known as: the survey method, the interview method, the direct interview method, the direct questioning method, the hypothetical demand curve estimation method, the difference mapping method, and the preference elicitation method.

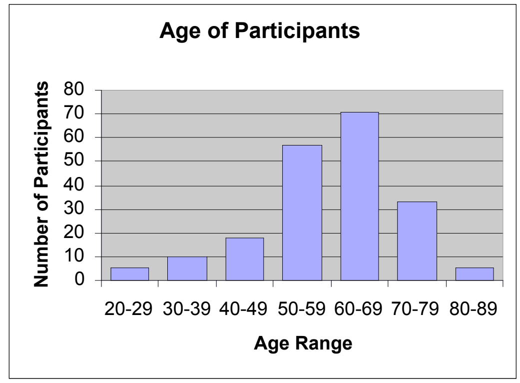
willingness to accept to no longer be able to purchase or fully utilize that good. Therefore, these "willingness to pay" and "willingness to accept" values are *contingent* upon the interviewer's description of the hypothetical market.

Because CV asks consumers to directly state their values rather than inferring values from actual market behavior, controversy about its accuracy arises. However, CV is not the only empirical method that uses data from surveys and many large data sets used by economists consist of survey data (i.e. census surveys, consumer expenditure surveys). CV surveys differ from traditional data surveys because the respondents make a hypothetical value trade-off rather than simply report their own characteristics or purchases. This hypothetical characteristic of CV introduces unique challenges because respondents may not correctly understand the good or service being valued, they may not be able to accurately estimate their willingness to pay in monetary terms, or their response may be skewed based on the hypothetical description of the given good.

Under proper conditions, many economists believe that CV is as accurate as other methods, without having to make many of the theoretical assumptions of consumer behavior that market-based models do. In Mitchell and Carson (1989), the standard reference on contingent valuation, the authors argue, "contingent valuation represents the most promising approach yet developed for determining the public's willingness to pay for public goods".

The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent their willingness-to-pay for access to the site. Thus, peoples' minimum value of the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples' willingness to pay for a marketed good based on the quantity purchased at different prices. When environmental amenities are primarily used for recreational purposes, it is possible to use the travel cost method to estimate the economic use value of those environmental amenities. Three observations form the basis for the travel cost method. First, the cost of using a recreation site is not limited to the price of admission; the monetary and time costs of traveling to the site must also be included. Second, different costs of using a recreation site apply to people living different distances form the site. Finally, assuming that the value that people place on a site





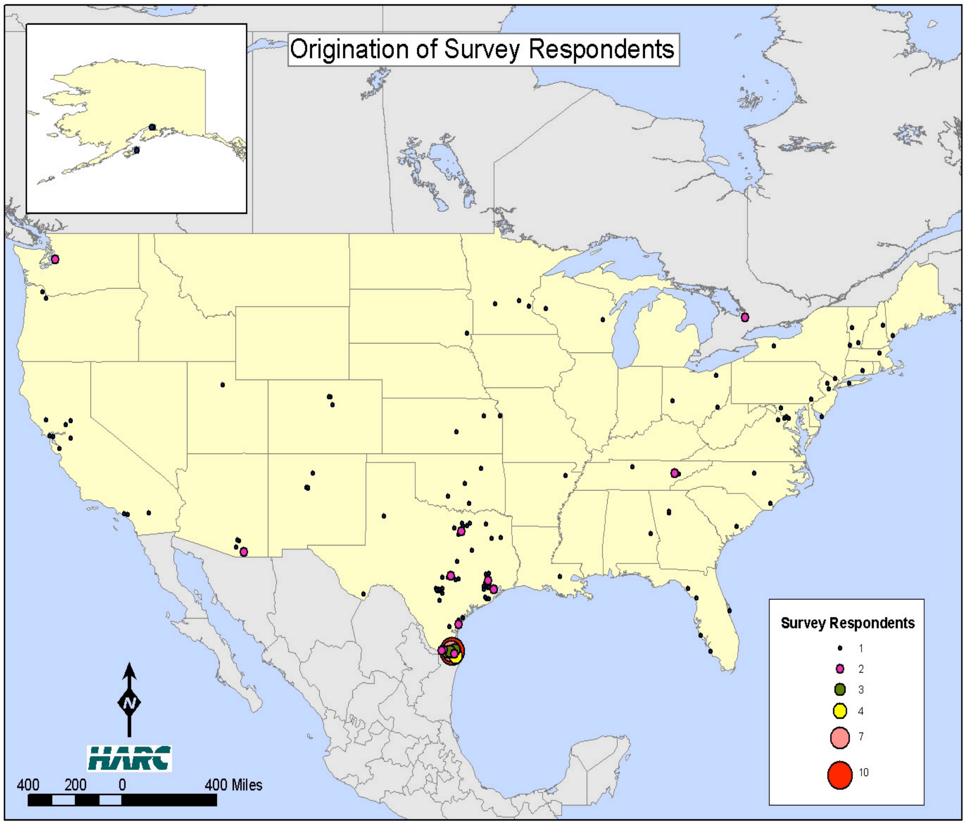
does not systematically vary with travel distance, it is possible to use travel cost as a proxy for price and derive a demand curve for the recreation site (Lesser *et al*., 1997).

Like the contingent valuation method, the travel cost method utilizes surveys to collect data. Individuals may be asked about the distance they traveled, the expenses they incurred traveling, the length of their trip, how much time they spent at the site, other places they visited on the same trip, the quality of their recreational experience at the site, their perceptions of the site's environmental quality, possible substitute sites, characteristics of the site and substitute sites, and demographic information. While the travel cost method is similar to contingent valuation in the use of survey techniques, it differs in that the travel cost method uses revealed preferences. Individuals' actual behavior and choices reveal the value they place on the environmental amenity. Because the travel cost method uses revealed preferences to measure actual use values, it is relatively uncontroversial, particularly when compared to contingent valuation techniques (King & Mazzotta, 2002).

6.3. Summary of Results

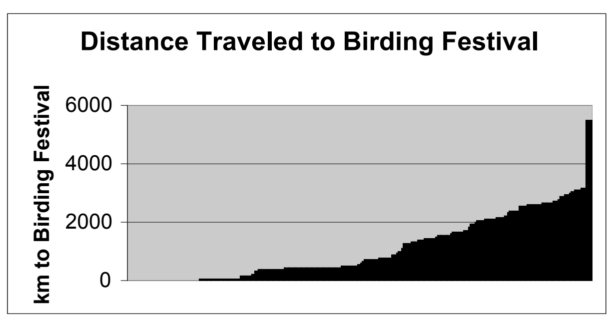
The typical attendee to the 2003 Rio Grande Valley Birding Festival was generally in his or her 50's or 60's, white, and upper-middle class. While more females than males filled out the survey, this may have been more of a function of who filled the surveys out – as many groups of two were clearly couples. The population was overwhelmingly white, with a small number of Hispanics. More than half the participants were retired – though many others took vacation time from work to attend, averaging about 26 hours for those who took time off. Most participants live in couple households – with the range spanning from 1 to 7 people in the household. The attendees are well educated, with 77.5% having obtained at least a

Figure 6.1. Survey Respondents' Points of Origin



bachelor's degree. Nearly 75% live in suburbs or cities – with much of the remainder living in rural, non-farm areas. Many attendees were from Texas, with the Valley, Houston, and Austin being three of the most common locations of origin; however, a variety of states were represented, with a mean distance traveled of 1,135 km. Figure 6.1. provides a map illustrating the survey respondents' points of origin. 83.5% of survey respondents indicated that they traveled out of town to reach Harlingen.

The attendees are avid birders, leaving their home an average of 26 times per year to enjoy wildlife. Most birders belong to a few environmental conservation organizations. Additionally, their trip to the Valley was focused primarily on this festival, with only 9% indicating that the festival was incidental to their plans. They stayed about a week



each, spending about 5 days of that birding. Only about a third of the respondents traveled elsewhere other than the Valley during this trip. About a third of the participants used air transportation and a rented automobile. Most of the rest relied on an owned automobile, and several relied on a charter bus. Most travel parties consisted of 2 people, from one household, however, parties reached as large as 11 people, with as many as six households. Generally, most attendees participated in birding.[36]

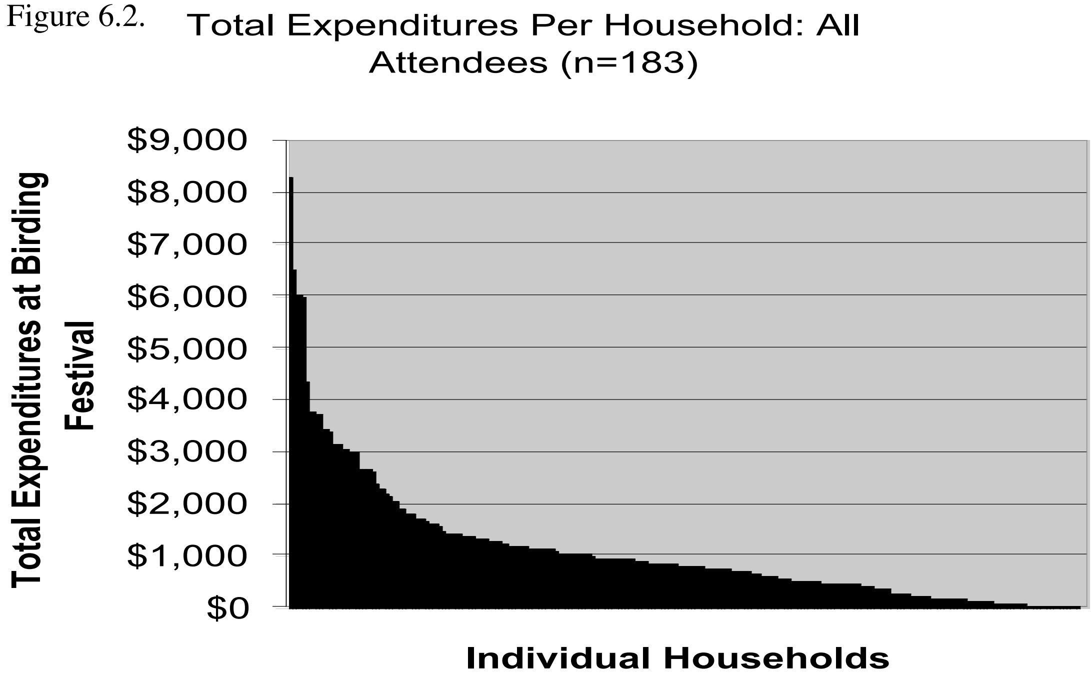
Birders enjoy being outside, experiencing nature, improve their birding skills, and attempting to view bird species they have never seen before. They are also interested in other wildlife, get away for a vacation, and see a wide variety of bird species; however, these goals seemed secondary in nature. Also of secondary nature, birders enjoyed a social aspect to their travel, enjoying the family recreation, friendships, and sharing experiences with other birders. Most birders did not consider being alone or gaining the respect of other birders to be of high importance. While at the festival, they spent the majority of their time birding, but also participated in shopping, visiting the beach, business, sightseeing, and seeing family and friends. More than half of respondents visited Bentsen Rio Grande State Park and Laguna Atascosa NWR. Nearly half also visited Santa Ana NWR, Sabal Palm Audubon Sanctuary, and South Padre Island. Other destinations were less popular. Most visitors did not cross the border to bird. Many of these attendees have attended this festival in the past, yet have not attended other festivals in the Valley. Over 70% plan on attending next year's festival.

While we were able to collect detailed data concerning the spending patterns of the attendees to the festival, it is important to note that we do not know to what extent people answered per person vs. per group for their expenditures. At review of the data suggests that most respondents answered for their household. Thus, with the average travel party being two people, most answers probably represent a couple.

Overall, the typical attendee spent $1,102 per person traveling to and attending the festival. The aggregation of respondents' travel spending is presented in Figure 6.2. Breaking down the spending patterns, it is helpful to examine local, versus non-local

[36] These questions that determined group size, etc – should, in the future, be asked before the spending questions, and geared to standardize how respondents answer expenditure questions. For example, respondents should all answer per household, but it is not clear that this is what occurred. By asking the questions prior to asking about spending receipts, the respondents will think about how they spent their money.

Figure 6.2.



attendees separately, as these two groups of birders have different spending patterns and habits. The non-local contingent of attendees comprised 83.5% of the sample.

On average, non-local attendees spent $1,305 each. The aggregation of non-local respondents' travel spending is presented in Figure 6.3. The typical festival attendee probably spent somewhat less, as several high spenders and attendees from great distances raised the mean. At the festival, out of town birders spent an average of $313 on transportation, $334 on lodging, $203 on food, and $196 on birding tours. Nearly all of these average figures are slightly above the median spending by the non-local attendee. Most attendees did not buy birding equipment at this festival, however, due to several large purchases, the mean purchase worked out to $272. Miscellaneous expenditures for out of town guests averaged $60 per respondent.

Local attendees spent an average of $325 per person and spent less, on average, in every category. The aggregation of local respondents' travel spending is presented in Figure 6.4. Local attendees spent about $11 each on transportation, $4 on lodging, and $21 on food. Most local attendees spent significantly less than these figures, as several larger spenders raised the mean. For example, the typical local attendee did not spend anything on housing,

Figure 6.3

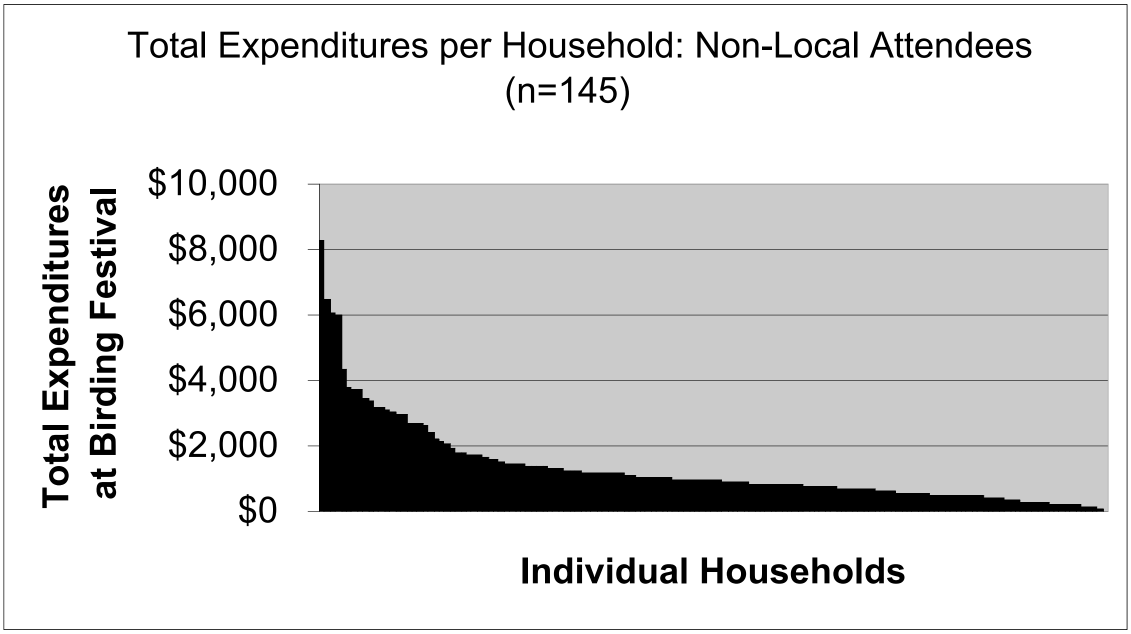


Figure 6.4

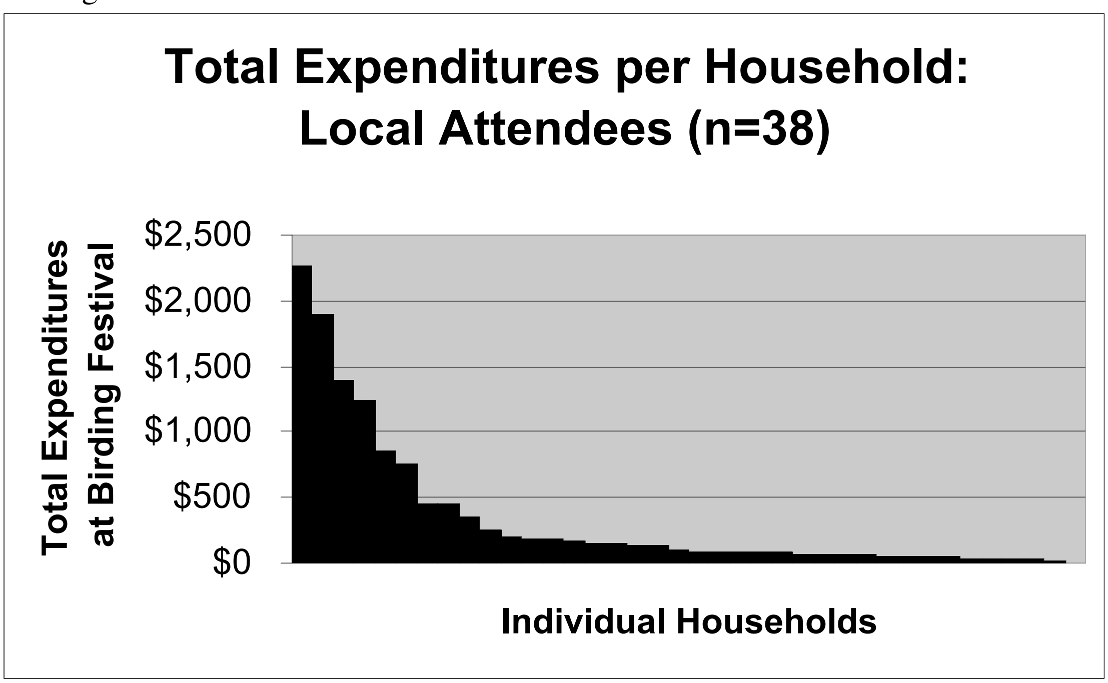
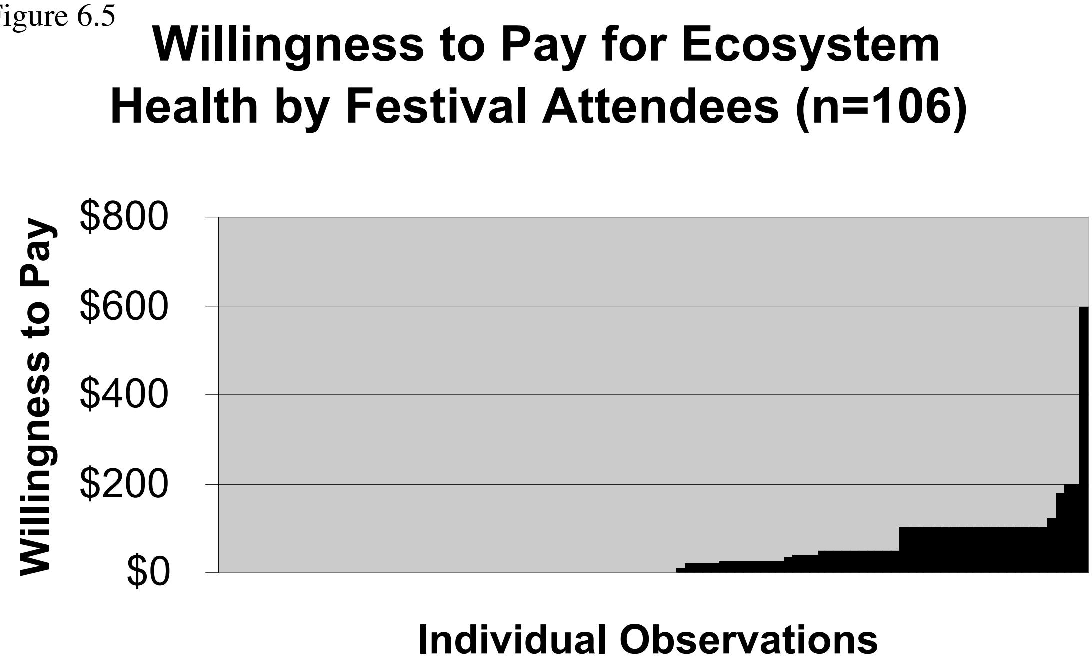


Figure 6.5



the median amount spent on transportation was $5, and the median amount spent on food was $10. Local attendees also spent significantly less on birding tours, equipment, and miscellaneous, averaging $124, $190, and $31 per respondent, respectively. Once again, these average expenditures were significantly higher than the median local attendee's expenditures.

In response to the CV question, a large number of respondents were either not willing to donate money to purchase water for ecosystem preservation or did not complete this section of the survey. The maximum willingness to pay was $600, and the mean for all attendees was $38.53. Non-local attendees were willing to pay an average of $7 more for water for the ecosystem than local attendees. The aggregation of survey respondents' willingness to pay values is shown in Figure 6.5.

One of the objectives of the our survey was to provide updated information comparable to that generated by Eubanks and Stoll (1999) to build a more complete understanding of the attendees of the RGVB Festival. Comparing the two survey, Eubanks and Stoll had slightly more responses – 225 as opposed to 202. The overall demographic profile was very similar. Women slightly outnumbered men in their survey, as well as ours. Most attendees were white, in the 50-70 age range, well-educated, and upper-middle class. About half attendees were retired. Reinforcing the similarity between the samples, the birding motivation chart appears very similar, with attendees reporting very similar reasons they enjoy birding. The one major difference was that in our survey, we had a larger percentage of local attendees that may lead to slightly different results due to a large percentage of people who did not need to travel to reach the Festival. The inclusion of local attendees to the survey may lower some of the expenditures in areas such as food, lodging, and transportation. Additionally, while the Eubanks and Stoll survey asked about replacement cost for birding equipment elsewhere in the survey, we asked about birding equipment bought during this trip, leading to a slightly different total calculation. Even with these differences, however, the spending similarities are remarkable. If one were to count only non-local attendees from our survey, travel and lodging expenditures will have increased, slightly, and food will was identical. This difference can be attributed to just a few observations, such as travelers from Alaska whose travel expenditures were extraordinarily high. Overall, there was a slight increase in travel expenditures for the out of town traveler – from $969 to $1,305; however, excluding the $272 in equipment expenditures, out of town travelers demonstrate only a negligible increase of expenditures of $64 which can be attributed to inflation and higher travel costs. The total expenditures per attendee, excluding equipment costs, and including local attendees was $912, appropriately slightly less than the Eubanks and Stoll result of $969.

6.4. Detailed Survey Results

Each of the survey questions, along with basic statistical information follows below.

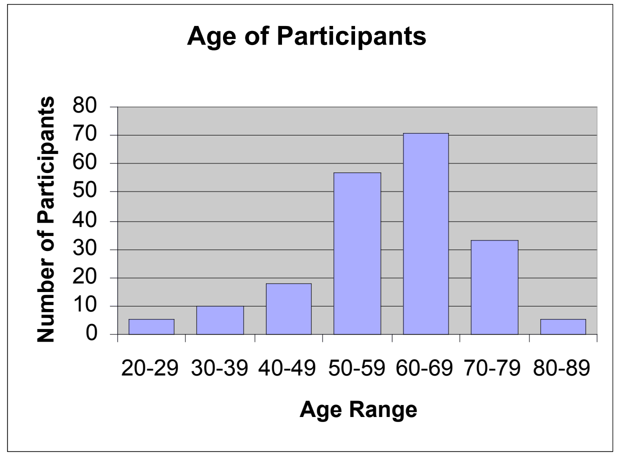
6.4.1. Demographic Information

1. Gender n=201

43.3% Male 56.7% Female

2. What is your age? n=199

Range	Percentage
20-29	2.0%
30-39	5.0%
40-49	9.0%
50-59	28.6%
60-69	35.7%
70-79	16.6%
80-89	2.5%



3. Are you retired?
n=202

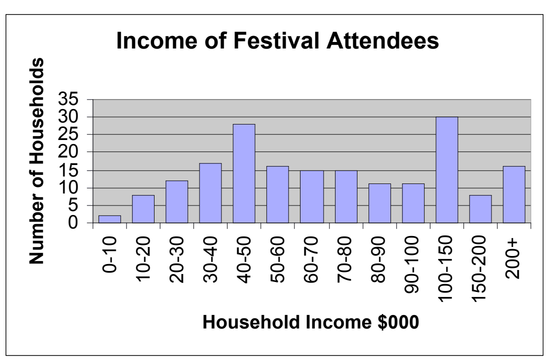
56% Yes 44% No

4. How many people live in your household, including yourself? n=200

Mean = 2.01; Median = 2; Range = 1:7

5. What is your approximate annual *household* income, from all sources, before taxes?
n=189

A. Less than $10,000 1.1%
B. $10,000 – $19,999 4.2%
C. $20,000 – $29,999 6.3%
D. $30,000 – $39,999 9.0%
E. $40,000 – $49,999 14.8%
F. $50,000 – $59,999 8.5%
G. $60,000 – $69,999 7.9%
H. $70,000 – $79,999 7.9%
I. $80,000 – $89,999 5.8%
J. $90,000 – $99,999 5.8%
K. $100,000 – $149,999 15.9%
L. $150,000 – $199,999 4.2%
M. $200,000 or more 8.5%

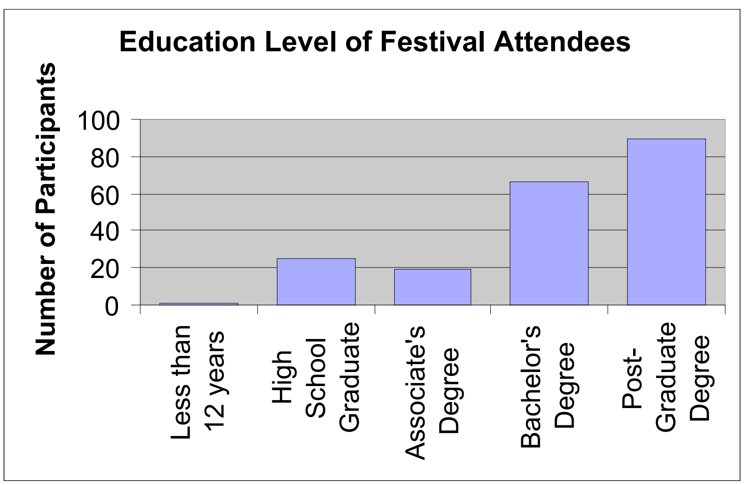


6. What is your ethnicity? n=200

A.	African-American	0%
B.	Caucasian	93.5%
C.	Asian	1%
D.	Hispanic	3%
E.	Native American	0.5%
F.	Other	2%

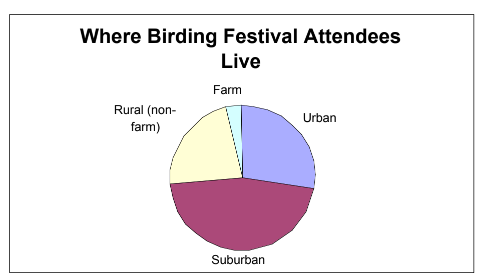
7. Which of the following best describes your education level? n=200

A.	Less than 12 years	.5%
B.	High school graduate	12.5%
C.	Associates degree	9.5%
D.	Bachelor's degree	33%
E.	Post-graduate degree	44.5%



8. Which of the following best describes where you live? n=201

A.	Urban	27.9%
B.	Suburban	45.3%
C.	Rural (non-farm)	23.4%
D.	Rural (farm)	3.5%



9. In which city, state or country do you live? If you do not live in a city or town, in what county do you live? What is the nearest city or town? Finally, what is your zip code?

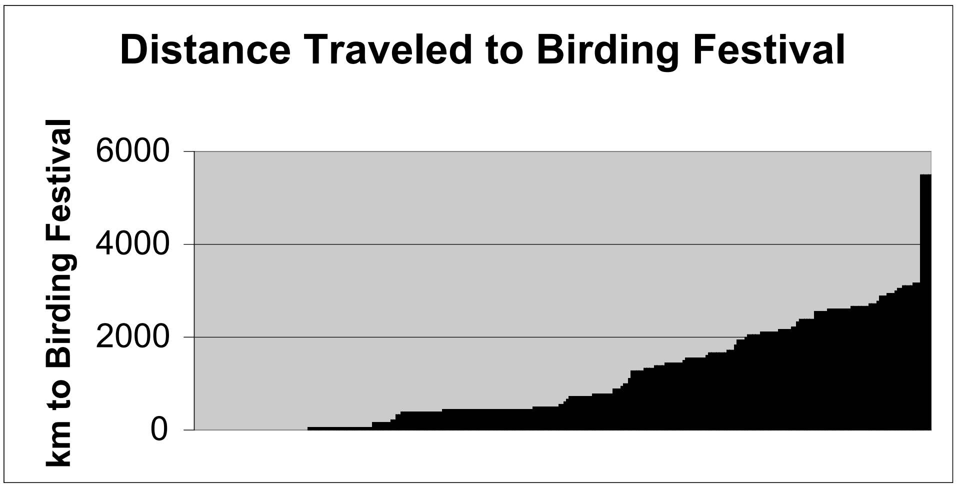
City (or Nearest City) ______________________________

County ______________________________

State or Country ______________________________

Zip Code ______________________________

Distance Traveled n=202
Mean = 1,135.35 km; Median = 513; Mode = 0; Range = 0:5509



6.4.2. Birding Preferences and Participation

10. Below is a list of reasons why people participate in bird watching. On a scale of 1 to 5, where 1 is "not at all important" and 5 is "extremely important" please state the number that indicates how important each item is to you as a reason for birding.

n=195-200

Reason	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
To enjoy the sights, smells, sounds of nature	0.0%	0.0%	5.0%	37.2%	57.8%
To be outdoors	0.0%	0.5%	6.5%	39.7%	53.3%
To see bird species that I have not seen before	0.5%	5.0%	21.0%	30.5%	43.0%
To see other wildlife, besides birds	0.5%	6.5%	35.5%	36%	21.5%
To improve my birding skills and abilities	0.5%	6.0%	21.6%	36.2%	35.7%
To see as many bird species as possible	4.5%	11.5%	35.5%	23.0%	25.5%
To get away from the demands of life	5.6%	14.7%	27.9%	26.4%	25.4%
For family recreation	20.5%	16.9%	27.7%	25.1%	9.7%
To be with friends	12.1%	20.7%	34.8%	22.7%	9.6%
To share experiences with other birding enthusiasts	5.1%	15.2%	34.8%	32.3%	12.6%
To do something creative	17.2%	21.2%	26.8%	22.7%	12.1%
To be alone	45.5%	24.2%	19.7%	7.1%	3.5%
To gain the respect of other birders	58.4%	25.4%	11.7%	2.5%	2.0%

11. Are you a member of any local, state, national or international environmental conservation organization? n=198

76.3% Yes 23.7% No

12. (If yes), how many do you belong to? n=149

Mean = 3.57; Median = 3; Range = 1:20

6.4.3. Travel

13. Was it necessary for you to travel out of town to attend the LRGV Birding Festival? n=200

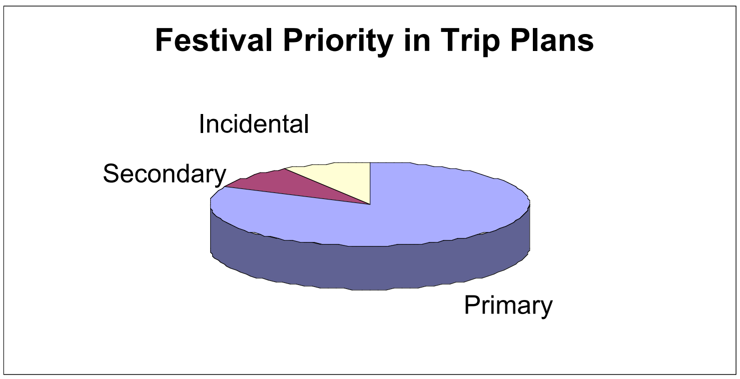
83.5% Yes 16.5% No

14. In the past 12 months, how many trips away from home (more than one mile from your primary residence) did you make for the purpose of observing, feeding or photographing wildlife? n=197

Mean = 26.6; Median = 10; Range = 0:250

15. How important was birding and wildlife watching as a motivation for making your trip to Harlingen? n=194

82.0% Primary
9.3% Secondary
8.8% Incidental



16. How many days and nights did you spend in the Lower Rio Grande Valley for this trip? n=163; n=155

Days: Mean = 7.1; Median = 8; Range = 0:90
Nights: Mean = 6.9; Median = 5; Range = 0:90

17. Of the total days involved in your trip to Harlingen in November, how many days did you spend birding or watching other wildlife? n=180

Mean = 5.17; Median = 4; Range = 0:55

18. Did your trip involve visits to other destinations besides the Valley? n=186

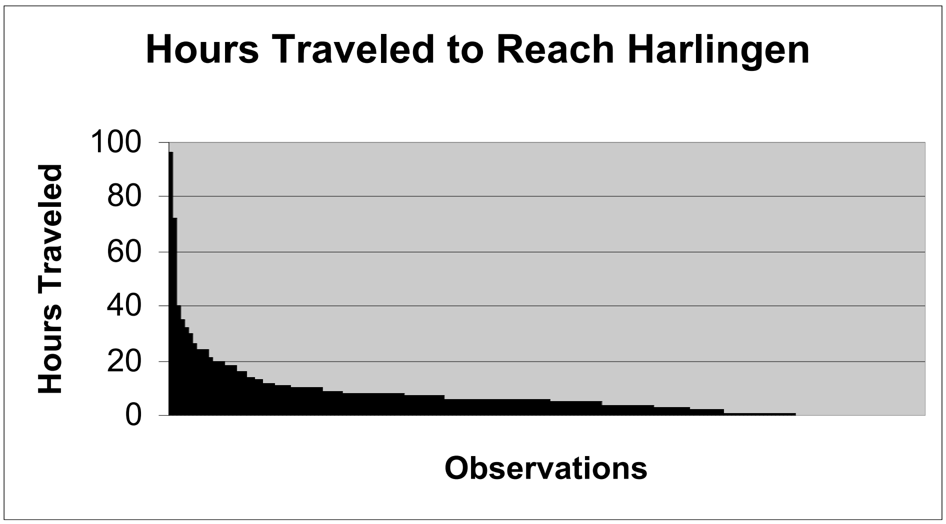
31.1% Yes 58.9% No

19. What kinds of transportation did your trip involve? n=202

55.0% Automobile (owned)
32.7% Automobile (rented)
6.4% Camper/RV
9.9% Charter Bus
0.5% Public Bus
34.7% Air
4.5% Other

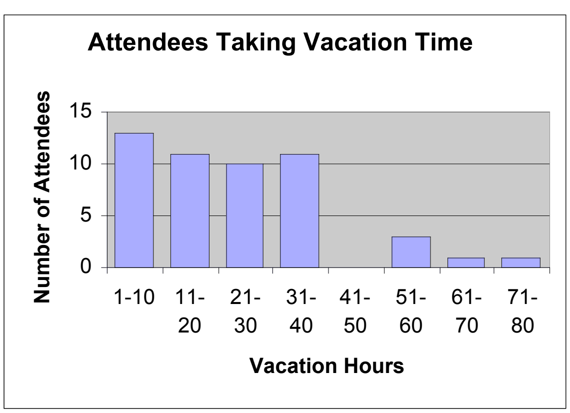
20. Approximately how many hours did you travel (one way) to reach Harlingen? n=187

Mean = 7.24 hours; Median = 5; Range = 0:96



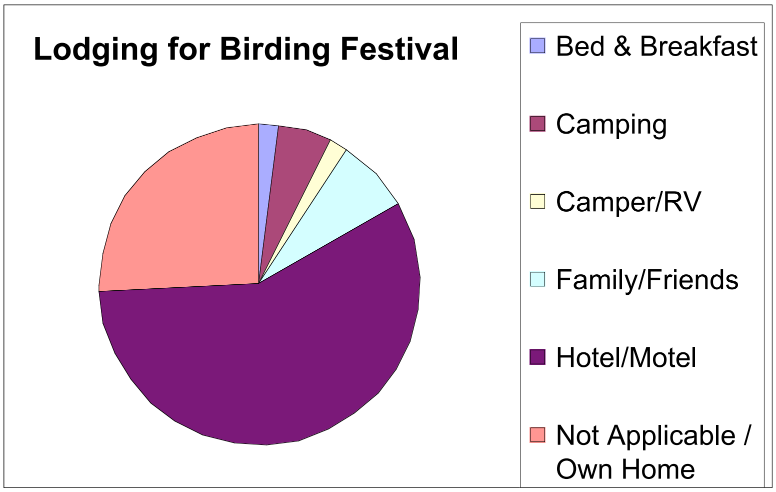
21. Did you take off of work in order to attend the Birding Festival? If yes, how many hours did you take off? n=195

27.7% Yes; Mean = 25.8 hours; Median = 24; Range = 3:80
73.3% No



22. What was you primary form of lodging? n=197

2.0% Bed & Breakfast
5.6% Camping
1.5% Camper/RV
7.6% Family/Friends
57.4% Hotel/Motel
25.9% Not Applicable / Own Home



23. On this trip to the Valley, how much did you spend on each of the following?

Transportation (n=175) Mean = $254.09; Median = $125; Mode = $0; Range = $0:$5,000

Transportation for local attendees (n=34)Mean = $11.32; Median = $5; Mode = $0; Range = $0:$50

Transportation for non-local attendees (n=141) Mean = $312.63; Median = $200; Mode = $200; Range = $0:$5,000

Lodging (n=171) Mean = $274.27; Median = $200; Mode = $0; Range = $0:$3,400

Lodging for local attendees (n=31) Mean = $3.87; Median = $0; Mode = $0; Range = $0:$60

Lodging for non-local attendees (n=140) Mean = $334.14; Median = $250; Mode = $0; Range = $0:$3,400

Food (n=176) Mean = $168.19; Median = $100; Mode = $100; Range = $0:$2,500

Food for local attendees (n=34) Mean = $20.85; Median = $10; Mode = $0; Range = $0:$100

Food for non-local attendees (n=142) Mean = $203.46; Median = $125; Mode = $100; Range = $0:$2,500

Birding Tours (n=178) Mean = $181.78; Median = $150; Mode = $0; Range = $0:$2,302

Birding Tours for local attendees (n = 35); Mean = $123.93; Median = $55; Mode = $0; Range = $0:$1,250

Birding Tours for non-local attendees (n=143); Mean = $195.94; Median = $150; Mode = $150; Range = $0:$2,302

Birding and Wildlife Viewing Equipment (n=157) Mean = $255.46; Median = $0; Mode = $0; Range = $0:$5,000

Birding and Wildlife Equipment for local attendees (n= 31) Mean = $189.84; Median = $0; Mode = $0; Range = $0:$2,000

Birding and Wildlife Equipment for non-local attendees (n=126) Mean = $271.60; Median = $0; Mode = $0; Range = $0:$5,000

Other (n=151) Mean = $54.26; Median = $0; Mode = $0; Range = $0:$500

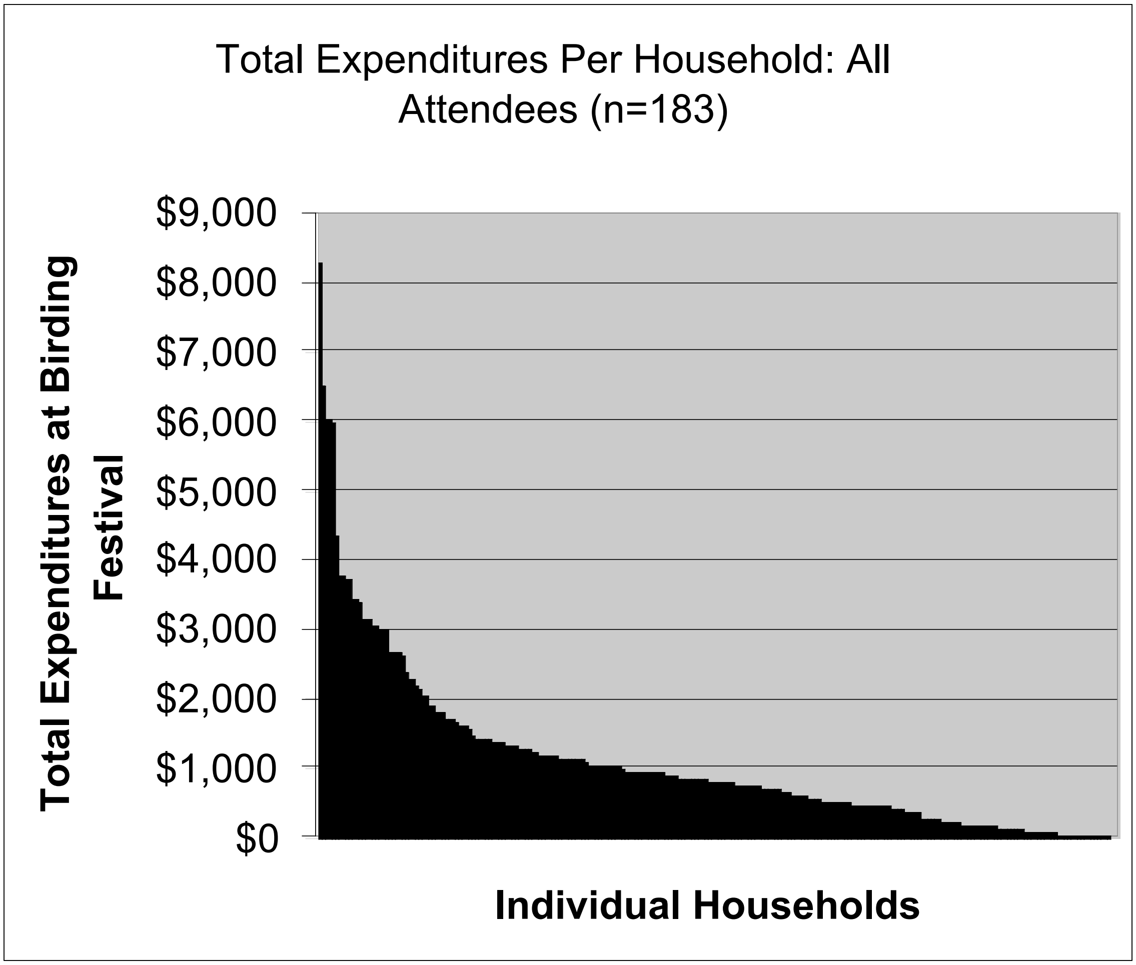
Other – local attendees (n = 30) Mean = $31.33; Median = $0; Mode = $0; Range = $0:$300

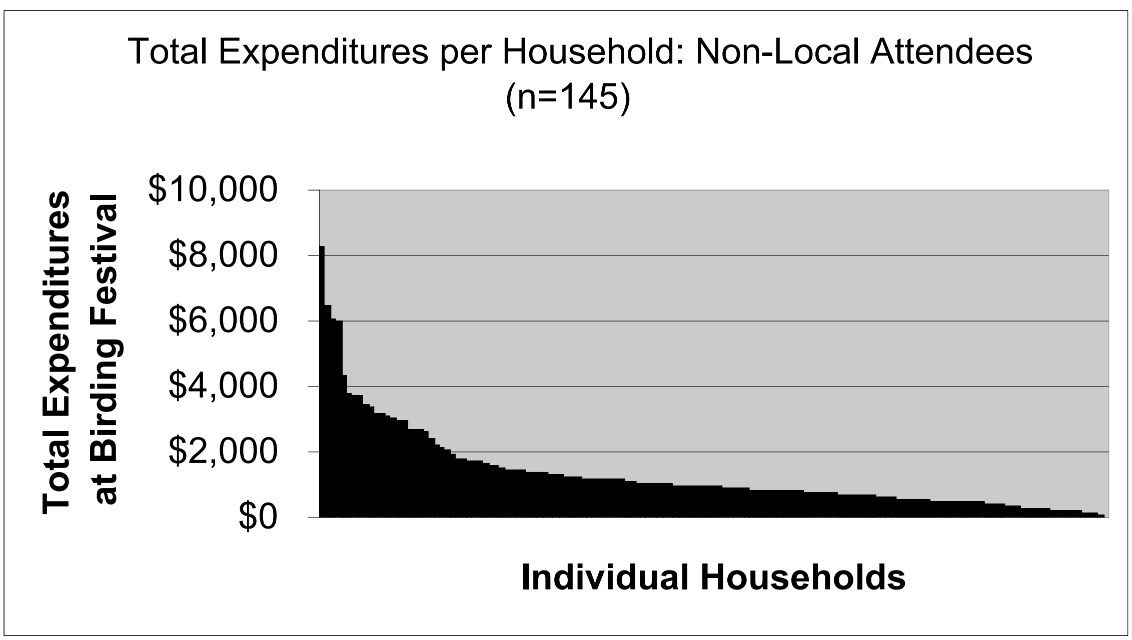
Other – non-local attendees (n=121) Mean = $59.94; Median = $0; Mode = $0; Range = $0:$500

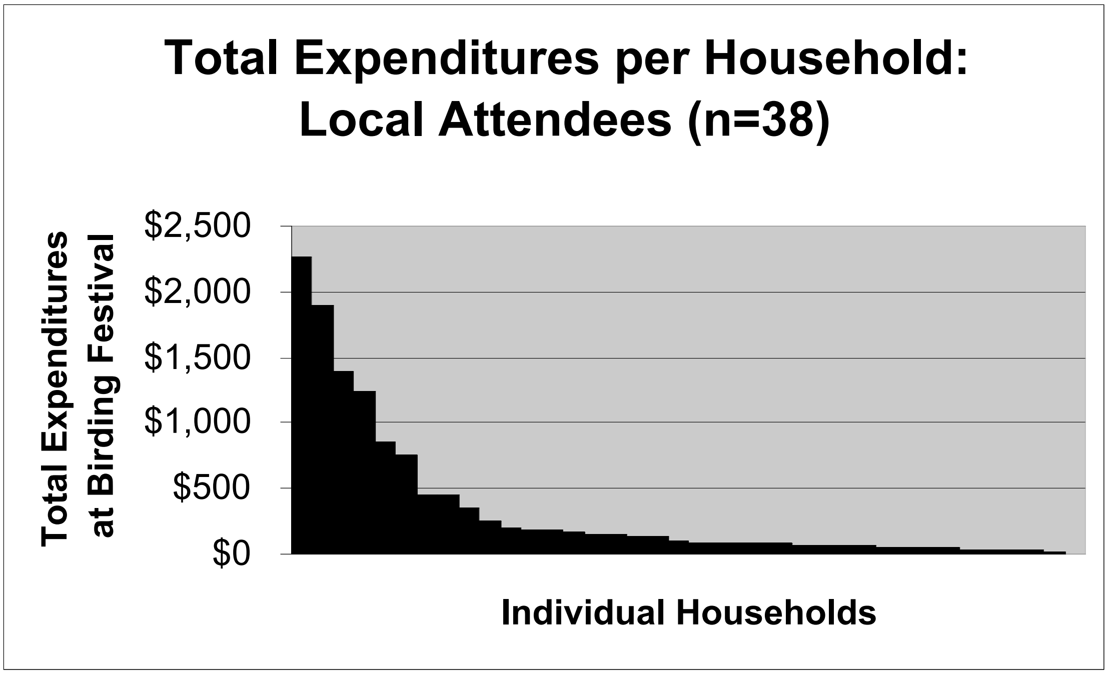
Total (n=183) Mean = $1,102; Median = $800; Range = $0:$8,300

Total – local attendees (n=38) Mean = $325.70; Median = $100; Range = $0:$2,270

Total – non-local attendees (n=145) Mean = $1,305.16; Median = $950; Range = $30:$8,300


Total Expenditures Per Household: All Attendees (n=183)
Total Expenditures at Birding Festival
$9,000
$8,000
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
Individual Households


Total Expenditures per Household: Non-Local Attendees (n=145)
Total Expenditures at Birding Festival
$10,000
$8,000
$6,000
$4,000
$2,000
$0
Individual Households



24. How many people, including yourself, were in your travel party? n=195

Mean = 2.1; Mean = 2; Mode = 2; Range = 1:11

25. How many households were represented in your travel party? n=191

Mean = 1.5; Median = 1; Mode = 1; Range = 1:6

26. Within your travel party, how many people (including yourself) watched birds or other wildlife? n=189

Mean = 2.0; Median = 2; Mode = 2; Range = 0:11

6.4.4. Trip Activities

27. Approximately what percentage of your time (other than sleeping and eating) did you spend on the following activities while in Harlingen for the Birding festival ?

Mean = 69.5% Birding/wildlife watching n=182

Mean = 8.7% Business n=138

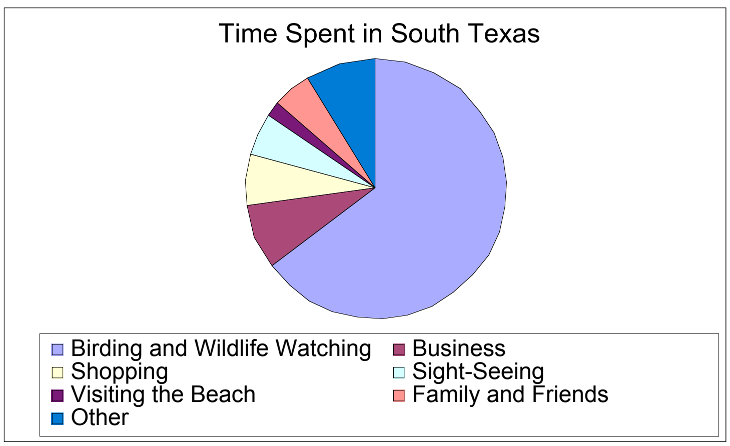
Mean = 6.9% Shopping n=153

Mean = 5.7% Sight-seeing n=147

Mean = 2.2% Visit beach/ocean n=143

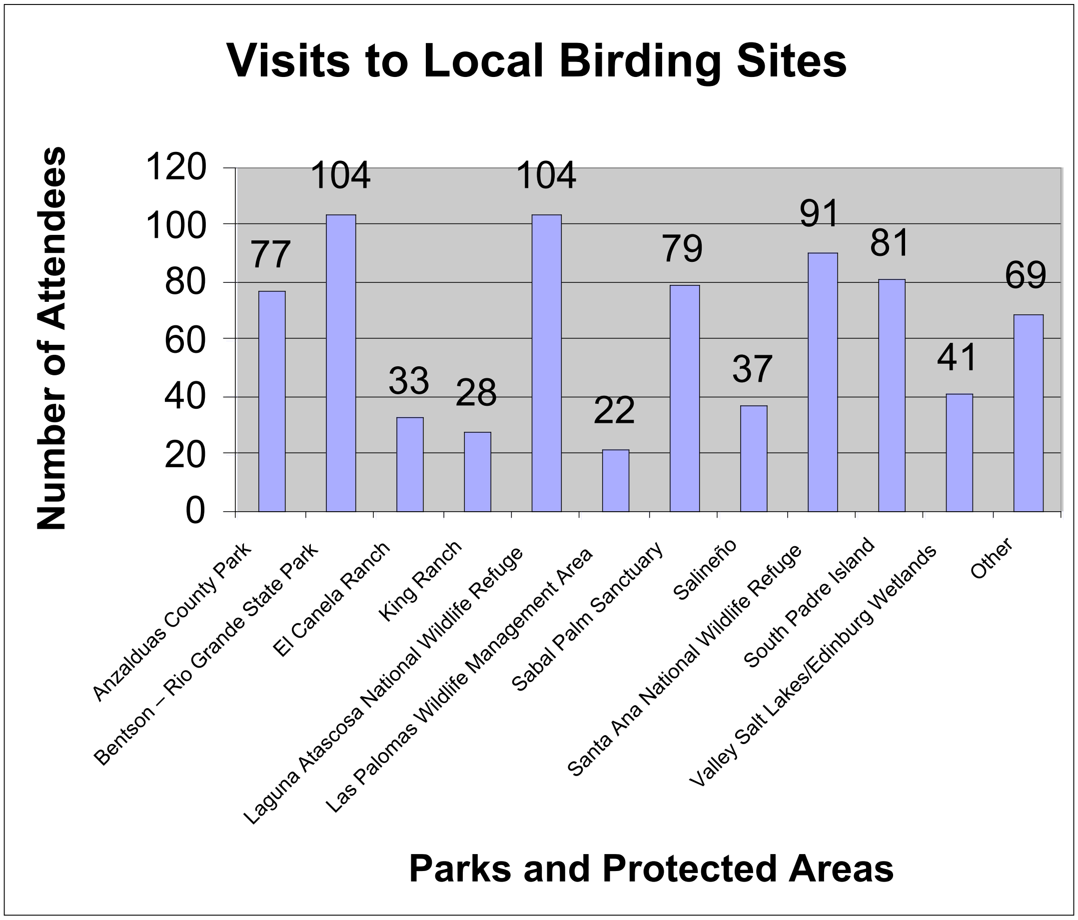
Mean = 5.2% Visit family or friends n=144

Mean = 9.3% Other (please describe) ___________________________________



28. Which birding sites did you visit during your trip?

38.1% Anzalduas County Park
51.5% Bentsen – Rio Grande State Park
16.3% El Canela Ranch
22.3% King Ranch
51.5% Laguna Atascosa National Wildlife Refuge
10.9% Las Palomas Wildlife Management Area
39.1% Sabal Palm Sanctuary
18.3% Salineño
45.0% Santa Ana National Wildlife Refuge
40.1% South Padre Island
20.3% Valley Salt Lakes/Edinburg Wetlands
38.1% Other ____________________________________



29. During your trip to the Birding Festival, did you visit Mexico to watch birds or other wildlife? n=200

6.5% Yes 93.5% No

30. Have you attended the Rio Grande Valley Birding Festival before? n=201

62.7% Yes 37.3% No

31. Have you attended other wildlife festivals in the Valley? n=201

27.9% Yes 72.1% No

32. Do you plan to attend the Rio Grande Valley Birding Festival next year? n=185

71.9% Yes 28.1% No

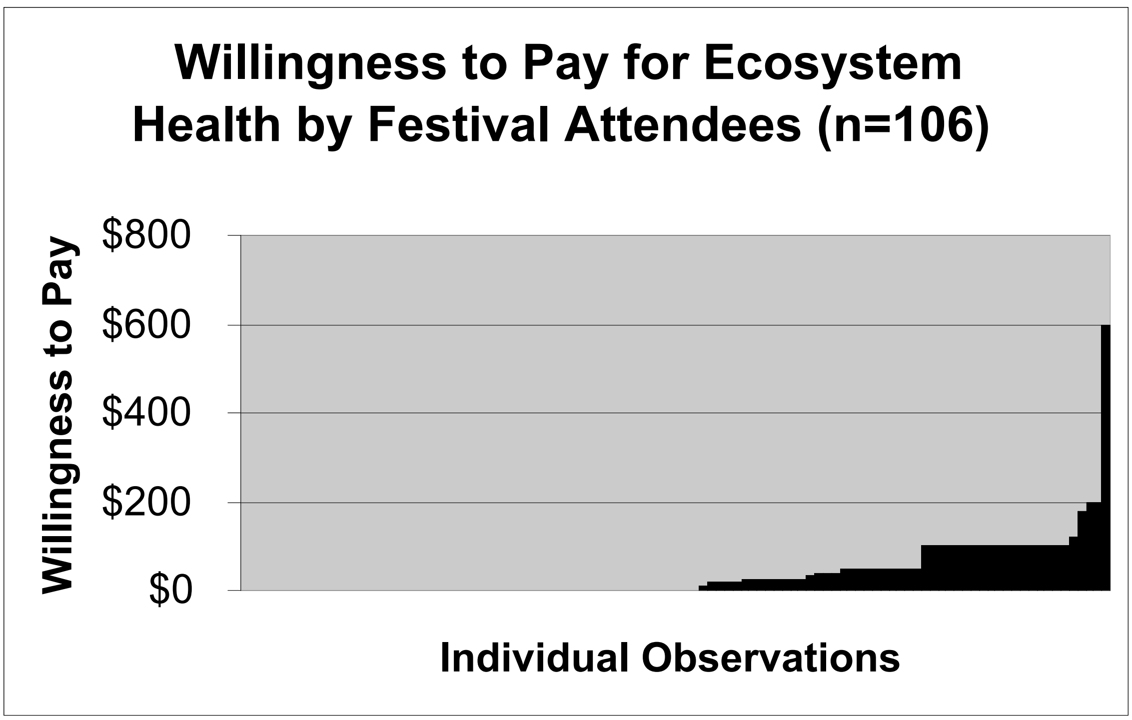
6.4.5. Respondents Willingness to Pay for Water to Sustain the Ecosystem

33. Contingent Valuation Question n=106

Mean = $38.53; Median = $0; Mode = $0; Range = $0:$600

CV question: Local attendees (n=24) Mean = $32.92; Median = $0; Mode = $0; Range = $0:$120

CV question: non-local attendees (n=82) Mean = $39.71; Median = $0; Mode = $0; Range = $0:$600



7. Conclusion

The Texas Lower Rio Grande Valley is endowed with unique natural assets that attract a growing number of ecotourists each year, and serve as inputs to the production of ecotourism goods and its related services such as lodging and dining. Despite difficulties in measuring ecotourism activities and their economic impact, the sparse research to date suggests that nature tourism plays a small but important role in the Lower Rio Grande Valley economy. If ecotourism in the Valley follows general trends for ecotourism globally, the sector will likely continue to grow.

Even as the Valley's ecotourism sector gains momentum, the fragile and diverse habitats that characterize the region, the very natural assets that draw ecotourists, are experiencing increasing pressure from human development. Obtaining resources to sufficiently preserve these natural assets presents a formidable challenge. Beyond financial resources, an adequate amount of water is required to sustain the ecosystem. Yet as domestic, industrial and agricultural users compete for water in the face of persistent scarcity, the ecosystem's water needs are overlooked.

Understanding the economic value of water in the production of ecotourism can help to establish the economic rationale for using scarce water to preserve and maintain the Valley's ecosystems. While tourism economics provides insight into the nature of the tourism production function and product, and existing agricultural economics literature provides some insight into approaches that might be applied to the valuation of water as an input to the production of ecotourism goods, new methodologies must be developed in order to rigorously examine the value of water derived from ecotourism activities.

The approaches developed here represent a first step toward this objective. We have explored in detail the connection between ecotourism activities and the economic value of water to sustain the ecosystem. To do so we have drawn on a variety of threads within the fabric of economic theory, and have examined how water used to sustain the ecosystem generates economic value through the consumption and production of ecotourism.

7.1. Value Derived from the Production of Ecotourism

To investigate the value of water in ecotourism production, we gathered data regarding the firms' costs associated with guided ecotourism excursions as well as the prices charged. From this data, a representative cost profile was developed for a one-day excursion, which was then used to analyze the net revenue generated by the excursion. The per-trip net revenue was found to be $30, or roughly a ten percent "return" on costs. This net revenue was interpreted as the per-trip economic value of (i.e. the firm's willingness to pay for) the natural asset as an input to the "production" of the excursion. Based on a simplified representation of the "production" of the natural asset in which land and water are the only inputs, the value of water to sustain the ecosystem was taken to be some portion of the value of the natural asset (the ecosystem). However, due to the need for information regarding the biological and physical relationship between water and the ecosystem that was beyond the scope of the project, it was not possible to estimate this proportion. Consequently, a range of estimated values that *might* be attributable to water used to sustain the natural asset was suggested. This range was $3 to $27 per one-day excursion. Drawing upon observations regarding water and land used in agriculture, we speculate that the value of water to sustain the ecosystem as characterized here would be unlikely to lie at either extreme of the estimated range.

Given the complexity of ecotourism production, the lack of crucial economic and ecological information, and the simplifying assumptions needed to carry out the analysis, these values should be viewed as "first pass" approximations rather than precise estimates. Furthermore, the focus of the estimation of economic value attributable to water as an input to ecotourism production was quite narrow, considering only the simplest of ecotourism goods offered by an owner-operated ecotourism firm. Thus it did not incorporate the benefits that might accrue to restaurants, hotels, and other firms that might also contribute goods to, and benefit from, the ecotourists visit. Consequently, these benefits, though important, remained outside of the analysis and are not included in the estimate of the value to firms of water used to sustain the ecosystem.

7.2. Value Derived from the Consumption of Ecotourism

To gather information regarding consumers' willingness to pay for ecotourism services in the Valley, we conducted a mail survey of nearly 300 attendees of the 10th Annual

Rio Grande Valley Birding Festival, held in Harlingen, Texas in November 2003. The purpose of our birder survey was to gain a greater understanding of the economic value generated through the consumers' enjoyment of ecotourism. In addition to demographic and general festival activity questions, we included travel-cost questions designed to gather data regarding how much people spent to attending the festival, as well as a question designed to elicit information regarding attendees "willingness-to-pay" specifically for water to sustain the ecosystem in the Valley. Respondents returned 202 useable surveys, for a response rate of 68 percent.

Based on the results of the survey, travel expenditures ranged from $ zero to $8,300, and the average expenditure per person was approximately, $1,100. These expenditures reflect a "lower bound" benchmark of willingness to pay to for the experience of observing birds in their natural habitat, or, more generally, to experience nature. In other words, consumers demonstrated a willingness to pay that is *at least* equal to the expenditures they actually made. Our working hypothesis is that some portion of the consumer's willingness to pay can be assigned to the value of water used to sustain the ecosystem. However, from the travel cost data generated by the survey alone, it is not possible to assess water's role in the consumer's willingness to pay values based on travel expenditures.

Thus, as a first step towards isolating festival attendees' willingness to pay specifically for water to sustain the ecosystem, the survey included a contingent valuation question in which respondents were asked to directly state their willingness to pay for "the minimum amount of water [the ecosystem] needs to remain healthy." The annual amounts range from $ zero to $600, with an average of $38. This is almost 3.5% of the average expenditures incurred by festival attendees. However, it is not possible within the scope of this research to determine the relationship of the willingness to pay value attached to environmental flows to the overall willingness to pay to experience nature, as represented by travel expenditures. In particular, it not possible to ascertain whether the value derived from the contingent valuation question is "in addition to" or "part of" the more general ecotourism value reflected in the travel cost analysis.

For the sake of illustration, consider the possibility that, based on the above results, approximately 3% of direct expenditures associated with ecotourism in the Valley can be attached to water as its value in sustaining the ecosystem. If we use as a rough estimate of total annual direct expenditures the $59 million figure arrived at by Eubanks et al. (1995) discussed earlier in this report, the annual economic value for water to sustain the ecosystem embedded in this expression of consumer willingness to pay for ecotourism could be in the neighborhood of $1.7 million per year.

Alternatively, we could also suppose that the results of the contingent valuation question are "in addition to" the willingness to pay to observe birds in their natural habitat, and that they are generalizable to all ecotourists who visit the Valley each year. If the number of annual ecotourists to the Valley is roughly 150,000 and they are willing to pay on average $38 each for water to sustain the ecosystem, this amounts to a value for environmental flows of approximately $5.7 million per year.[37]

We emphasize that the above discussion of the survey results as they pertain to broader implications regarding economic value associated with water to sustain the ecosystem in the Valley are purely illustrative. Whether or not they are "in the ballpark" remains a matter of further research.

7.3. Final Observations and Remarks

While the research presented here focuses on the value of water to sustain the ecosystem generated through ecotourism activities, two additional major sources from which the economic value of environmental flows derives are (1) the non-market value of myriad ecosystem services and (2) non-use values.

As the many beneficial functions provided by the ecosystem become better understood, and as the benefits the ecosystem bestows upon humans become more widely appreciated, significant research attention has begun to focus on the economic value associated with ecosystem services (see e.g. Costanza et al., 1999; Daily, 1997). Although there is often considerable debate about the methods used and the validity of the values derived, there is little doubt that the economic value of ecosystem services, though un-priced, is enormous. Because most ecosystems require water to remain healthy, the value they

[37] Eubanks et al. (1995) based their estimates of direct expenditures on a total of 156,850 visitors to Santa Ana National Wildlife Refuge, Laguna Atascosa National Wildlife Refuge, and Sabal Palm Audubon Sanctuary.

generate through their many beneficial services is partially attributable to the water needed to sustain them.

A second additional source of economic value for water to sustain the ecosystem is the non-market value derived from satisfaction the individual receives from knowing that a given natural asset exists, and/or will continue to exist, without actually experiencing them at that moment. These non-use values can be divided into "existence," "bequest," and "option" values. Option values are motivated by the desire to preserve the option of the individual to enjoy the environmental benefit at some point in the future, even though the individual may not currently be doing so. Bequest values reflect the desire to leave an environmental legacy, i.e. to preserve the option for others in the current and/or future generations to enjoy a given environmental benefit. Finally, existence value is based on the satisfaction derived from simply from knowing that a given element of nature exists. For any or all of these reasons, many individuals may be willing to pay to ensure that sufficient water is used to sustain the ecosystem in the Lower Rio Grande Valley (and elsewhere), even if they do not expect to travel to the region to experience the benefits. As noted in the report, the scant research in this area suggests that non-use values for environmental flows may be quite large.

Thus, the economic value of water derived from the production or consumption of ecotourism goods reflects only *part* of the value of water used to sustain the ecosystem. Moreover, the value of water derived from ecotourism may be just "the tip of the iceberg" in that it is likely to be relatively small compared to non-use values and values derived from ecosystem services. Nonetheless, because ecotourism generates real dollars and real jobs, the water used to sustain the natural assets upon which ecotourism depends has a tangible impact on the regional economy of the Lower Rio Grande Valley.

We believe the research presented in this report demonstrates (1) the usefulness of applying economic theory and methodologies to the question of allocating water to sustain the ecosystem, and (2) that real economic value is attached to water used to sustain the ecosystem, derived from the ecotourism activities of both consumers and producers.

As is often the case in research, when pursuing the answer to existing questions an even greater number of new questions are discovered. Such was the case for project discussed here. We hope that this effort serves to stimulate further research and discussion regarding the importance of reflecting environmental needs in water management and water policy decisions.

8. References

Acharya, Gayatri. 1998. "Valuing the Environment as an Input: The Production Function Approach," in M. Acutt and P. Mason, eds., *Environmental Valuation, Economic Policy and Sustainability: Recent Advances in Environmental Economics* , pp. 63-78 , Edward Elgar, Cheltenham, U.K.

Adamowicz W.L., and T.M. Horbulyk. 1996. "The Role of Economic Instruments to Resolve Water Quantity Problems." *Canadian Journal of Agricultural Economics.* 44(4): 337-344.

American Birding Association. 2003. "The Growth of Birding and an Economic Value of Birders: Part 10: A Texas Perspective." <http://americanbirding.org/programs/consecond10.htm>. Accessed 11 Jun 2003.

Amirfathi, P.; Narayanan, R.; and Larson, D. 1984. A Methodology for Estimating Instream Flow Uses for Recreation. Logan, Utah: Water Research Laboratory, Utah State University.

Antle, John M. and Susan M. Capalbo. "Econometric-Process Models for Integrated Assessment of Agricultural Production Systems." American Journal of Agricultural Economics. 83(2) (May 2001): 389-401.

Audubon Texas. 2001a. "Nature Tourism in Texas, an Economic Treasure." <http://tx.audubon.org/tourism.html>. Accessed 11 Jun 2003.

Audubon Texas. 2001b. "Sabal Palm Audubon Center and Sanctuary." <www.audubon.org/local/sanctuary/sabal/>. Accessed 29 Oct 2003..

Baird, S. F., and C. Girard. 1853. Descriptions of new species of fishes collected by Mr. John H. Clark, on the United States and Mexican Boundary Survey, under Lt. Col. Jas. D. Graham. *Proc. Acad. Nat. Sci., Philadelphia*, 6: 387-390.

Berrens, R.P., Bohara, A.K., Silva, C.L., Brookshire, D., and McKee, M. (2000). 'Contingent Values for New Mexico Instream Flows: With Tests of Scope, Group-Size reminder and Temporal Reliability'. *Journal of Environmental Management*, 58: 73-90.

Blair, W.F. 1950. The biotic provinces of Texas. *Texas Journal of Science* 2(1):93-117.

Burness, et al. 1980. "United States Reclamation Policy and Indian Water Rights," *Natural Resources Journal*, vol. 20: 807-834.

Chapa, Sergio. 2004. "Water key to Valley eco-tourism." *Valley Morning Star*. January 29, 2004, A1.

Cobly, Bonnie. 1989b. "Estimating the Value of Water in Alternative Uses," *Natural Resources Journal*, vol. 28: 511-527.

Colby, Bonnie. 1989a. "The Economic Value of Instream Flows – Can Instream Values Compete in the Market for Water Rights?" in L. MacDonnell, ed., *Instream Flow Protection: Law and Policy*. Boulder: University of Colorado Press.

Colby, Bonnie. 1990. "Enhancing Instream Flow Benefits in an Era of Water Marketing," *Water Resources Research*, vol. 26: 1113

Collins, K. 1984. *Status and management of native south Texas brushland*. U.S. Fish and Wildlife Service. Corpus Christi, Texas. 18 pp.

Commission for Environmental Cooperation. 1999. "Sustainable Tourism in Natural Areas. (99.01.05) The Development of Sustainable Tourism in North America: Background, Issues, and Opportunities." Discussion Paper: prepared for 'A Dialogue on Sustainable Tourism in Natural Areas in North America,' 27-28 May 1999, Playa del Carmen, Mexico.

Condra, G.D., Lacewell, R.D., Sprott, J.M., and B.M. Adams. .1975. "A Model for Estimating Demand for Irrigation Water on the Texas High Plains," Texas Water Resource Institute Technical Report no. 68. College Station, Texas A&M University

Cornes, R. and Sandler, T. 1996. *The Theory of Externalities, Public Goods and Club Goods*, 2nd ed. Cambridge, Cambridge University Press.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Bruello, R.G. Raskin, P. Sutton, M. van den Velt. 1997. "The Value of the World's Ecosystem Services and Natural Capital." *Nature* 287: 253-260.

Craddock, W. J. 1971. "Linear Programming Models for Determining Irrigation Demand for Water," Canadian Journal of Agricultural Economics. Vol. 19 (3). pp. 84-92.

Crosswhite, F.S 1980. *Dry country plants of the south Texas plans*. Desert Plants 2:141-179.

Cummings, Ronald G. and Nercissiantz, Vahram. 1992. "The Use of Water Pricing as a Means for Enhancing Water Use Efficiency in Irrigation: Case Studies in Mexico and the United States," *Natural Resources Journal*, vol. 32: 731-755.

Daily, Gretchen. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C.

Daubert, J. T. and Young, R. A. 1981. "Recreational Demands for Maintaining Instream Flows: A Contingent Valuation Approach," *American Journal of Agricultural Economics*, vol. 63: 666-676.

Duffield, J.; Neher, C; and Brown, T. 1992. Recreation Benefits of Instream Flow: Application to Montana's Big Hole and Bitter Root Rivers," *Water Resources Research*, vol. 28: 2169-2181.

Edwards, R.J., and S. Contreras-Balderas. 1999. "Ecological Conditions in the Lower Rio Grande/Río Bravo Basin." Houston Advanced Research Center Working Paper Series, Water and Sustainable Development in the Binational Lower Rio Grande/Río Bravo Basin. Houston Advanced Research Center, The Woodlands, Texas.

Edwards, R.J., S. Contreras-Balderas. 1991. *Historical changes in the ichtyofauna of the Lower Rio Grande (Rio Brave del Norte), Texas and Mexico*. Texas Parks and Wildlife Department. Austin, Texas.

El Canelo Ranch. 2000. "Birding at El Canelo Ranch. <http://www.elcaneloranch.com/birding.html> Accessed 25 September 2003.

Eubanks, Ted and Stoll, John R. 1999. "Avitourism in Texas: Two Studies of Birders in Texas and Their Potential Support for the Proposed World Birding Center." Texas Parks and Wildlife Department Contract #44467, Austin, Texas.

Eubanks, Ted; Kerlinger, Paul; and Payne, R.H. 1995. "Nature tourism in the Lone Star State: A report from the State Task Force on Texas Nature Tourism." Presented at the White House Conference on Tourism, October 30-31. 1995.

Gibbons, Diana C. 1986. *The Economic Value of Water*. Washington, DC: Resources for the Future (distributed by Johns Hopkins University Press, Washington D.C.).

Girard, C. 1856. Researches upon the cyprinoid fishes inhabiting the fresh waters of the United States of America west of the Mississippi Valley, from specimens in the Museum of the Smithsonian Institution. Proc. Acad. Nat. Sci., Philadelphia, 8: 165-218.

Gisser, Micha. 1970. "Linear Programming Models for Estimating the Agricultural Demand Function for Imported Water in the Pecos River Basin," *Water Resources Research*. Vol. 6 (4). pp. 1025-32.

Gollehon, Noel and Quinby, William. 2000. "Irrigation in the American West: Area, Water and Economic Activity." *Water Resources Development*. v16, n2 187-195.

Gray, H.P. 1982. "The Contributions of Economics to Tourism." *Annals of Tourism Research*. v.9: 105-25.

Greenly, D.; Walsh, R.; and Young, R. 1982. *Economic Benefits of Improved Water Quality*. Boulder: Westview Press.

Guthery, F.S., and F.A. Stormer. 1984. *Managing playas for wildlife in the southern high plains of Texas*. Texas Tech University Management Note 4. pp 6.

Hardin, G. 1968. "The Tragedy of the Commons," *Science*, v. 162: 1243-48.

Hartman, L.M. 1960. "Marginal Values of Irrigation Water," *Colo. Agr. Exp. Sta. Tech. Bull.* (70). Fort Collins.

Hellegers, P. J. G. J.; K. Oltmer, E.C. van Ierland, and L.C. van Staalduinen. 2001. "An Economic Analysis of Shallow Groundwater Management for Nature Conservation and Agricultural Production." Journal of Environmental Planning and Management. 44(4) 545-559.

Hunter, Brett. 2000. "The Rio Grande Valley Birding and Butterfly Guide." Harlingen, TX, publisher unknown.

Jahrsdoerfer, Sonja and Leslie, David. 1988. *Tamaulipan Brushland of the Lower Rio Grande Valley of South Texas: Description, Human Impacts, and Management Options*. Biological Report 88, no. 36, U.S. Fish and Wildlife Service, Washington, D.C.

Johnson, R. L. 1966. "An investigation of methods for estimating marginal values of irrigation water." Master's Thesis. Utah State University, Logan.

King Ranch. 2003. "Nature Tours." <http://www.king-ranch.com/visit.htm>. Accessed 25 September 2003.

King, D. and Mazzotta, M., "Travel Cost Method." <http://www.ecosystemvaluation.org/travel_costs.htm>September 4, 2002.

Lacewell, R.D., Sprott, J.M., and B.R. Beattie. 1974. 'Value of Irrigation Water with Alternative Input Prices, Product Prices, and Yield Levels: Texas High Plains and Lower Rio Grande Valley,' Texas Water Resource Institute Technical Report no. 58. College Station, Texas A&M University.

Lesser, Jonathan A., Daniel E. Dodds, and Richard O. Zerbe. 1997. "Measuring Environmental Costs and Benefits," chapter 11 in *Environmental Economics and Policy* New York: Addison Wesley, pp. 265-314.

Lonard, R.I., J.H. Everitt, F.W. Judd, and N.A. Browne. 1985. Woody plants of the lower Rio Grande Valley, Texas. University of Texas, Austin, Texas.

Loomis, J. 1987. "The Economic Value of Instream Flow: Methodology and Benefit Estimates for Optimal Flows," *Journal of Environmental Management*, vol. 24: 169-179.

MacDonnell, Lawrence J.; Rice, Teresa A.; and Shupe, Steven J.. 1989, eds. *Instream Flow Protection in the West*. Boulder:

Madariago, B. and McConnell, K. 1987. "Exploring Existence Value," *Water Resources Research*, vol. 23: 936-942.

Martin, C.O., and M.F. Hehnke. 1981. South Texas Potholes – their status and value as wildlife habitat. *Wetlands* 1:19-46.

Mathis, Mitchell. 1999. Policy Design in an Imperfect World: Essay on the Management and Use of Open Access Renewable Natural Resources. Doctoral dissertation, Department of Economics, University of Texas at Austin.

McCracken, Grant. 1988. *The Long Interview*. Sage Publications. Newbury Park, California

McGuire, C.B., G.M. Brown Jr. .1967. "A socially optimum water pricing policy for a public water agency." Water Resources Research. Vol. 3 (1). pp. 33-43.

McNeely, J.A.; Thorsell, J.W.; and Ceballos-Lascurain, H. 1992. *Guidelines: Development of National Parks and Protected Areas for Tourism*. World Tourism Organization, Madrid, and United Nations Environment Program, Paris: 7-8.

Miller, T.A. 1966. "Sufficient conditions for exact aggregation in linear programming models, Agricultural Economics Research." Bull. Agr. Econ. 85. Corvallis.

Mitchell, Robert and Richard Carson. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington D.C., Resources For the Future.

Moore, C.V., and R.H. Trimble. 1968. "Economics of on-farm irrigation water availability and costs, and related farm adjustments, vol. 2 Farm Size in Relation to Resource Use, Earnings and Adjustments on the San Joaquin Valley Eastside." Rep. 263. California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics, Berkeley.

Office of the Governor, Economic Development and Tourism. 2001. "Texas Travel Spending Comparison. <http://www.travel.state.tx.us/tspend.asp>. Last update unknown. Accessed 17 Feb 2004.

Opaluch, James J. 1999. "Environmental Economics in Estuary Management: The Peconic Estuary Program," in Coastlines, online newsletter, <http://www.epa.gov/owow/estuaries/coastlines/aug99/envrEcon.html>, accessed January 23, 2004.

Paine, Robert. "A Note on Trophic Complexity and Species Diversity. *American Naturalist* v.100 :91–93.

Ricardo, David, 1821 *On the Principles of Political Economy and Taxation*, 3rd ed., from *The Works and Correspondence of David Ricardo*, edited by Piero Sraffa with the collaboration of M. H. Dobb, (Cambridge: Cambridge University Press), 1951.

Rodríguez-Olmos, G. R. 1976. Cambios en la composición de especies de peces en comunidades del bajo Río Bravo, México-Estados Unidos. Unpubl. M.S. thesis, Univ. Autónoma Nuevo León, Monterrey, México.

Salant, P. and D. Dillman. 1994. *How to Conduct Your Own Survey*. John Wiley and Sons, Inc. New York.

Samuelson, Paul A. 1954. "The Pure Theory of Public Expenditure." *Review of Economics and Statistics*, v. 36: 387-389.

Samuelson, Paul A. 1955. "A Diagrammatic Exposition Exposition of a Theory of Public Expenditure." *Review of Economics and Statistics*, v. 37: 350-356.

Schmandt, J.; Aguilar-Barajas, I.; Mathis, M.; Armstrong, N.; Chapa-Aleman, L.; Contreras-Balderas, S; Edwards, R.; Hazleton, J.; Navar-Chaidez, J.; Vogel-Martinez, E.; and Ward, G. 2000. Water and Sustainable Development in the Binational Lower Rio Grande/Rio Bravo Basin. Final Report to EPA/NSF Water and Watersheds Grant Program, Grant No. R 824799-01-0, Houston Advanced Research Center, The Woodlands, Texas.

Schulze, W.; Brookshire, D.; Walther, E.; MacFarland, K.; Thayer, M.; Whitworth, R.; Ben –David, S.; Malm, W.; and Molenar, J. 1983. "The Economic Benefits of Preserving Visibility in the National Parklands of the Southwest," *Natural Resource Journal*, vol. 23: 149-163.

Sheldon, Pauline. 2001. "The Tour Operator Industry: An Analysis." in C. Tisdell, ed *The Economics of Tourism*, Vol. I,., Northampton, MA: Elgar Reference Collection,

Shulstad, R.N., E.D. Cross, R.D. May. 1982. "The Estimated Value of Irrigation Water in Arkansas." Arkansas Farm Research. vol. 27, no. 6.

Smith, Stephen L. J. 1994. "The Tourism Product." in The Economics of Tourism, Vol. I, Tisdell ed. Northampton, MA: Elgar Reference Collection, 2001.

Spiller, S.F., and J.D. French. 1986. The value and status of inland pothole wetlands in the Lower Rio Grande Valley, Texas. U.S. Fish Wildlife. Corpus Christi, Texas. 18 pp.

Strayhorn, Carole Keeton, Texas Comptroller of Public Accounts. 2002a. "Window on Texas Government. Texas Regional Trends and Outlook: South Texas Border Region." <http://www.cpa.state.tx.us/ecodata/regional/stxborder/outlook.html>. June 2002. Accessed 11 Jun 2003.

Strayhorn, Carole Keeton. Texas Comptroller of Public Accounts. 2002b. Texas Business and Industry Data Center. "Texas Gross State Product Detail: Calendar Years 1970-2026." <http://www.bidc.state.tx.us/cpa/2.xls>. Fall, 2002. Accessed 11 Jun 2003.

Stults, H.M. 1968. "Predicting farmer response to a falling water table: An Arizona case study," in Proceedings of a conference on Water Resources and Economic Development of the West, *Rep. 15*, Committee on the Economics of Water Resources Development of the Western Agricultural Economics Research Council, Las Vegas, Nevada.

Syrakaya, Ercan; Sasidharan, V.; and Sonmez, Sevil. 1999. "Redefining Ecotourism: The Need for a Supply-Side View." *Journal of Travel Research*, v. 38(2): 168-172.

Tan, C.S. 1990. "Irrigation Scheduling for Tomatoes: a Water Budget Approach." Report to the Ministry of Agriculture and Food, Ontario Canada.

Texas Parks and Wildlife Department. 2003a. "Great Texas Wildlife Trails: Coastal Birding Trail." <http://www.tpwd.state.tx.us/birdingtrails/coastal_trail/> March 2003. Accessed 11 Jun 2003.

Texas Parks and Wildlife Department. 2003b. "Las Palomas Wildlife Management Area, Lower Rio Grande Valley Units." <http://www.tpwd.state.tx.us/wma/find_a_wma/list/?id=47 >. February, 2003. Accessed 29 Oct 2003.

Texas Parks and Wildlife Department. Publication Date Unknown-a. "State Parks and Historic Sites: Bentsen Rio Grande State Park." <http://www.tpwd.state.tx.us/park/bentsen/>. Accessed 29 Oct 2003.

Texas Parks and Wildlife Department. Publication Date Unknown-b. "State Parks and Historic Sites: Boca Chica State Park." <http://www.tpwd.state.tx.us/park/boca/>. Last update unknown. Accessed 29 Oct 2003.

Texas Parks and Wildlife Website. 2003. http://www.tpwd.state.tx.us/. Accessed on March 30, 2003.

The Nature Conservancy. "Chihuahua Woods Nature Preserve." 2003. <http://nature.org/wherewework/northamerica/states/texas/preserves/art6023.html>. October 2003 Accessed 29 October 2004.

Thornton, O.W., Jr. 1977. The impact of man upon herpetological communities in the Lower Rio Grande Valley, Texas. M.S. Thesis. Texas A&M University. College Station Texas.

Tisdell, C.lem. 2001. "Introduction: Basic Economics of tourism: An overview mainly of Volume I," in *The Economics of Tourism*, Vol. I. Tisdell ed. Northampton, MA: Elgar Reference Collection, 2001.

Tisdell, Clem ed. 2001. *The Economics of Tourism*, Vol. I. Tisdell ed. Northampton, MA: Elgar Reference Collection. ., Tisdell, J. G. 1996. "The Price of Irrigation Water." Economic Analysis and Policy. vol. 26 (1). pp. 95-104.

Treviño-Robinson, D. 1955. The ichthyofauna of the lower Rio Grande river, from the mouth of the Pecos to the Gulf of Mexico. Unpubl. M.S. thesis. Univ. Texas, Austin.

Treviño-Robinson, D. 1959. The ichthyofauna of the lower Rio Grande, Texas and Mexico. *Copeia*, 1959: 255-256.

Tucker, Ken. and Sundberg, Mark. 1988. *International Trade in Services*. London:Routledge

U.S. Bureau of Economic Analysis. 2003. "Local Area Personal Income 2001." <http://www.bea.gov/bea/regional/reis/action.cfm > May 2003. Accessed Feb 17 2004.

U.S. Fish and Wildlife Service and U.S. Bureau of the Census. 1997. "1996 National survey of fishing, hunting, and wildlife-associated recreation." <http://www.census.gov/prod/3/97pubs/fhw96nat.pdf >. November, 1997. Accessed 17 Feb 2004.

U.S. Fish and Wildlife Service. 2001a. "Lower Rio Grande Valley National Wildlife Refuge." <http://southwest.fws.gov/refuges/texas/lrgv.html>. December, 2001. Accessed 29 Oct 2003.

U.S. Fish and Wildlife Service. 2001b. "Santa Ana National Wildlife Refuge." <http://southwest.fws.gov/refuges/texas/santana.html>. December, 2001. Accessed 29 Oct 2003.

U.S. Fish and Wildlife Service. 2002. "Laguna Atascosa National Wildlife Refuge." <http://southwest.fws.gov/refuges/texas/laguna.html>. April, 2002. Accessed 29 Oct 2003.

U.S. Forest Service. National survey on recreation and the environment. Publication Date Unknown. <http://www.srs.fs.usda.gov/trends/Nsre/nsre2.html > Accessed 17 Feb 2004.

U.S. Water Resources Council. 1978. *The Nation's Water Resource 1975-2000.* Washington, D.C.: U.S. Government Printing Office.

United Nations Environmental Programme (UNEP). 2002. "International Year of Ecotourism." <http://www.uneptie.org/pc/tourism/ecotourism/iye.htm>. Accessed Feb 18, 2004

Upton, Martin. Agricultural Production Economics and Resource Use. Oxford, England: Oxford University Press, 1976.

Valley Land Fund. Publication Date Unknown. "Conservation." < http://www.valleylandfund.com/conservation.html >. Accessed 5 Sept 2003.

Vincent, Vern and Thompson, William. 2002. "Assessing Community Support and Sustainability for Ecotourism and Development." *Journal of Travel Research*. v. 41: 153-160.

Vincent, Vern. 2004. Personal Communication. Center for Tourism Research, College of Business Administration, University of Texas – Pan American, Edinburg, Texas.

Vincent, Vern; Thompson, William; Williamson, Mark. 2003. "2002-03 Rio Grande Winter Visitor Survey." Center for Tourism Research, College of Business Administration, University of Texas – Pan American, Edinburg, Texas.

Wahl, Richard. 1989. *Markets for Federal Water: Subsidies, Property Rights and the Bureau of Reclamation*. Washington, D.C.: Resources for the Future.

Walsh, R.; Ericson, R.; Arosteguyl, D; and Hansen, M. 1980. "An Empirical Application of a Model for Estimating the Recreation Value of Instream Flow." Colorado Water Resources Research Institute Completion Report No. 101, Fort Collins: Colorado State University.

Walsh, R.; Loomis, J.; and Gilman 1984. "Valuing Option, Existence and Bequest Demand for Wilderness," *Land Economics*, vol. 60: 14-29.

Webflyer. "Pressroom." http://www.webflyer.com/company/press_room/facts_and_stats/frequent_flyer_facts.php . Last update unknown. Visited 20 May, 2004.

Whittington, D., G. Cassidy, D. Amaral, E. McClelland, H. Wang, C. Poulos. 1994. "The Economic Value of Improving the Environmental Quality of Galveston Bay." Publication GBNEP-38, Galveston Bay National Estuary Program.

Willit, G.S., Hathorn, S., C.E. Robertson. 1975. 'The Economic Value of Water Used to Irrigate Field Crops in Central and Southern Arizona,' Department of Agricultural Economics Report no. 9. Tucson, University of Arizona.

World Birding Center. Publication Date Unknown. "Site Overview." <http://www.worldbirdingcenter.org/worldbirdingcenter/sites/index.phtml>. Accessed 11 Jun 2003.

World Resources Institute Website. 2003. http://www.wri.org/wri/biodiv/cascade.html. Biodiversity Loss: Cascade Effects. Accessed on March 30, 2003.

Youth, Howard. 2001. "Cashing in on Conservation," National Wildlife Federation. <http://www.nwf.org/nationalwildlife/article.cfm?articleID=402&issueID=37>. September 2001. Accessed March 30, 2004.

9. Appendices

Appendix 1: Postcard sent out before survey

Dear Sir or Madam:

On behalf of the Harlingen Chamber of Commerce, thank you for attending the Tenth Annual Rio Grande Valley Birding Festival in Harlingen, November 5-9, 2003. We hope you enjoyed your stay in south Texas!

Within the next several days you will receive a “follow-up survey” packet. The packet will contain a questionnaire that will ask you about your trip to Harlingen and your participation in the birding festival. All of the information you provide, as well as your name and mailing address, will remain confidential. The survey packet will also include a letter of introduction from the president of the Rio Grande Birding Festival, Thomas Pincelli, as well as an addressed and postmarked envelope with which to return the completed questionnaire. Your participation in the survey will help provide up-to-date information about birding activities in the Rio Grande Valley, and will be greatly appreciated.

We would like to thank you in advance for your cooperation with our research.

Appendix 2: Letters Accompanying the Survey

Dear Sir or Madam:

We are a Texas not-for-profit research organization working with the Harlingen Chamber of Commerce to conduct a detailed study of nature tourism in the Texas Rio Grande Valley.

Enclosed is a survey packet that contains a questionnaire about your recent participation in the Tenth Annual Rio Grande Valley Birding Festival in Harlingen, November 5-9, 2003. The survey packet also includes a letter of introduction from the president of the Rio Grande Birding Festival, Thomas Pincelli, as well as an addressed and postmarked envelope with which to return the completed questionnaire.

The questionnaire contains 32 short questions related to the Birding Festival, as well as a separate single question about water in the Texas Rio Grande Valley. These questions should take around fifteen minutes to complete. Your responses will be completely confidential and you will not be identified with your answers. By completing and returning the enclosed survey, you will help provide improved and up-to-date understanding of birding activities in the Rio Grande Valley. For your responses to be included as part of the study, we must receive the completed questionnaire by March 25, 2004.

On behalf of the Harlingen Chamber of Commerce, we would like to thank you again for attending the Rio Grande Valley Birding Festival, and for your participation in this important research.

HARC
HOUSTON ADVANCED RESEARCH CENTER

RIO GRANDE VALLEY
TROPICAL BIRDS OF THE BORDER
BIRDING FESTIVAL

February 16, 2004

Dear Colleague:

Thank you so much for joining us at the Rio Grande Valley Birding Festival this past fall. We hope that you agree the Rio Grande Valley is a haven for birds and birders alike!

The Houston Advanced Research Center is conducting a survey on ecotourism and its economic impact on a community. We are asking that you take a few minutes to complete the enclosed survey. It is quite lengthy and the questions are somewhat personal, including questions on the amount of money you have spent or currently spend on birding activities. All of the data, including your name and mailing address, will remain confidential. We hope that your response will help to raise awareness of the importance of birding and the conservation of bird habitat to our area.

Thank you for your assistance. We look forward to seeing you at this year's Festival!

Warm regards,

Fr. Tom Pincelli

Rev. Thomas L. Pincelli
RGV Birding Festival President

TLP/tb
enclosure

Appendix 3: Survey Instrument

Survey
Nature Tourism in the Lower Rio Grande Valley

Instructions
Please take a few minutes to fill out the survey below, answering all questions as accurately as possible. For multiple-choice answers, please circle the appropriate response or check the appropriate box. For other questions, please write your response in the space provided. If you are not sure of an exact value for certain expenditures, please approximate your response to the best of your ability. If you are a permanent or seasonal resident of the Valley, please interpret questions pertaining to "this trip" as your visit to the LRGV Birding Festival in November and answer to the best of your ability.

Your participation is greatly appreciated.

Demographic Information

1. Gender

   Male Female

2. What is your age? ____________________

3. Are you retired?

   Yes No

4. How many people live in your household, including yourself? ________________

5. What is your approximate annual *household* income, from all sources, before taxes?

N.	Less than $10,000	U.	$70,000 – $79,999
O.	$10,000 – $19,999	V.	$80,000 – $89,999
P.	$20,000 – $29,999	W.	$90,000 – $99,999
Q.	$30,000 – $39,999	X.	$100,000 – $149,999
R.	$40,000 – $49,999	Y.	$150,000 – $199,999
S.	$50,000 – $59,999	Z.	$200,000 or more
T.	$60,000 – $69,999		

6. What is your ethnicity?

   G. African-American
   H. Caucasian
   I. Asian
   J. Hispanic
   K. Native American
   L. Other ______________________________

7. Which of the following best describes your education level?

   F. Less than 12 years
   G. High school graduate
   H. Associates degree
   I. Bachelor's degree
   J. Post-graduate degree

8. Which of the following best describes where you live?

   E. Urban
   F. Suburban
   G. Rural (non-farm)
   H. Rural (farm)

9. In which city, state or country do you live? If you do not live in a city or town, in what county do you live? What is the nearest city or town? Finally, what is your zip code?

City (or Nearest City) ______________________________

County ______________________________

State or Country ______________________________

Zip Code ______________________________

Birding

10. Below is a list of reasons why people participate in bird watching. On a scale of 1 to 5, where 1 is "not at all important" and 5 is "extremely important" please state the number that indicates how important each item is to you as a reason for birding.

Reason	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
To enjoy the sights, smells, sounds of nature	1	2	3	4	5
To be outdoors	1	2	3	4	5
To see bird species that I have not seen before	1	2	3	4	5
To see other wildlife, besides birds	1	2	3	4	5
To improve my birding skills and abilities	1	2	3	4	5
To see as many bird species as possible	1	2	3	4	5
To get away from the demands of life	1	2	3	4	5
For family recreation	1	2	3	4	5
To be with friends	1	2	3	4	5
To share experiences with other birding enthusiasts	1	2	3	4	5
To do something creative	1	2	3	4	5
To be alone	1	2	3	4	5
To gain the respect of other birders	1	2	3	4	5

11. Are you a member of any local, state, national or international environmental conservation organization?

Yes No

12. (If yes), how many do you belong to?

____

Travel

13. Was it necessary for you to travel out of town to attend the LRGV Birding Festival?

Yes No

14. In the past 12 months, how many trips away from home (more than one mile from your primary residence) did you make for the purpose of observing, feeding or photographing wildlife?

____

15. How important was birding and wildlife watching as a motivation for making your trip to Harlingen?

- ❑ Primary
- ❑ Secondary
- ❑ Incidental

16. How many days and nights did you spend in the Lower Rio Grande Valley for this trip?

Days ____________________ Nights ____________________

17. Of the total days involved in your trip to Harlingen in November, how many days did you spend birding or watching other wildlife?

____

18. Did your trip involve visits to other destinations besides the Valley?

Yes No

19. What kinds of transportation did your trip involve?
- ❑ Automobile (owned)
- ❑ Automobile (rented)
- ❑ Camper/RV
- ❑ Charter Bus
- ❑ Public Bus
- ❑ Air
- ❑ Other ______________________

20. Approximately how many hours did you travel (one way) to reach Harlingen?

__________________ hours

21. Did you take off of work in order to attend the Birding Festival? If yes, how many hours did you take off?

Yes ______ hours No

22. What was you primary form of lodging?

- ❑ Bed & Breakfast
- ❑ Camping
- ❑ Camper/RV
- ❑ Family/Friends
- ❑ Hotel/Motel
- ❑ Not Applicable / Own Home

23. On this trip to the Valley, how much did you spend on each of the following?

Transportation	$___________________________
Lodging	$___________________________
Food	$___________________________
Birding Tours	$___________________________
Birding and Wildlife Viewing Equipment	$___________________________
Other	$___________________________

24. How many people, including yourself, were in your travel party?

____

25. How many households were represented in your travel party?

____

26. Within your travel party, how many people (including yourself) watched birds or other wildlife?

____

Activities

27. Approximately what percentage of your time (other than sleeping and eating) did you spend on the following activities while in Harlingen for the Birding festival ?

__________% Birding/wildlife watching

__________% Business

__________% Shopping

__________% Sight-seeing

__________% Visit beach/ocean

__________% Visit family or friends

__________% Other (please describe) ____________________________________

28. Which birding sites did you visit during your trip?

- ❑ Anzalduas County Park
- ❑ Bentson – Rio Grande State Park
- ❑ El Canela Ranch
- ❑ King Ranch
- ❑ Laguna Atascosa National Wildlife Refuge

- ❑ Las Palomas Wildlife Management Area
- ❑ Sabal Palm Sanctuary
- ❑ Salineño
- ❑ Santa Ana National Wildlife Refuge
- ❑ South Padre Island
- ❑ Valley Salt Lakes/Edinburg Wetlands
- ❑ Other ____________________________________

29. During your trip to the Birding Festival, did you visit Mexico to watch birds or other wildlife?

Yes No

30. Have you attended the Rio Grande Valley Birding Festival before?

Yes No

31. Have you attended other wildlife festivals in the Valley?

Yes No

32. Do you plan to attend the Rio Grande Valley Birding Festival next year?

Yes No

Contingent Valuation Question

Water in the Lower Rio Grande Valley

We would like to ask you a question about the water needs of the environment in the Rio Grande Texas Valley. In a moment, you will be asked about the dollar value you place on ensuring minimum water for the Valley's ecosystem. There are no right or wrong answers.

As you may know, the Lower Rio Grande Valley is a semi-arid region which relies almost entirely on the Rio Grande for water. Humans and nature compete for scarce water. Currently, agriculture uses roughly 85% of the water taken from the Lower Rio Grande, with urban areas using the rest.

For many rivers in Texas, the Texas Parks and Wildlife Department has developed estimates of the minimum annual amounts of water needed by ecosystems to remain healthy. For the last 10 years, the annual amount of Rio Grande Water available for the ecosystem in the Valley has ranged from 70% to as low as 40% of the minimum water requirements estimated by the Texas Parks and Wildlife Department.

Texas is developing a program that allows individuals to contribute to a Valley "Water Trust Fund" that is used to buy or lease water from willing water permits owners in the Valley to ensure that the environment receives the minimum amount of Rio Ground water it needs to remain healthy. Purchasing water for the environment means less is available for agricultural, industrial and municipals uses, and may cause local water bills to increase slightly.

How much would your household be willing to donate next year to the Valley Water Trust Fund, to help ensure the environment receives the minimum amount of water it needs to remain healthy?

Please write your response in the space below. Before you give your answer, keep in mind your household budget, and that the money contributed to the water fund can be used to buy other household goods and services.

$ ______________________________

Appendix 4: Follow up postcard

Dear Birding Festival Participant:

Thank you for participating in our birding survey regarding the 2003 Rio Grande Birding Festival. By completing and returning the survey, you have helped provide improved and up-to-date understanding of birding activities in the Rio Grande Valley. Your time and interest are greatly appreciated. If you have not yet returned the survey, we'd like to remind you that for your responses to be included as part of the study, we must receive the completed questionnaire by **March 25, 2004**.

We would like to thank you once again for your cooperation with our research.

Appendix 5: Final Letter

Dear Sir or Madam:

We are a Texas not-for-profit research organization working with the Harlingen Chamber of Commerce to conduct a detailed study of nature tourism in the Texas Rio Grande Valley. Last month you should have received a survey packet that contained a questionnaire about your recent participation in the Tenth Annual Rio Grande Valley Birding Festival in Harlingen, November 5-9, 2003.

We know that your time is valuable, and would like to provide you with a final opportunity to have your responses included as part of the study. If you have not already done so, please take a few moments to complete and return the survey. By participating in this research, you will be providing vital information that can greatly improve understanding of birding activities in the Rio Grande Valley.

For your convenience, we have enclosed a new copy of the survey questionnaire and an addressed and postmarked return envelope. The questionnaire contains 32 short questions related to the Birding Festival, as well as a separate single question about water in the Texas Rio Grande Valley. These questions should take around fifteen minutes to complete. The information you provide will be completely confidential and you will not be identified with your answers.

Your response is important to us. To ensure that you have every opportunity to participate in the study we have extended the deadline to receive the completed questionnaire to **April 15, 2004**.

On behalf of the Harlingen Chamber of Commerce, we would like to thank you again for attending the Rio Grande Valley Birding Festival, and for your participation in this important research.