A CONTINGENT VALUATION STUDY OF THE VALUE OF PROTECTING RIPARIAN HABITAT IN THE UPPER SAN PEDRO RIVER BASIN, ARIZONA

by

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DEDICATION

To Barron, the unofficial advisor I hired and fired a thousand times.

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ABSTRACT

Sustaining the riparian resources of the San Pedro Riparian National Conservation Area (SPRNCA) is a challenge, due in part to competing water demands from agricultural and urban users in the Upper San Pedro River Basin in southeastern Arizona. Policymakers attempting to balance these interests seek ways to compare competing demands, often through economic valuation. Comparing the value of water across alternative uses is complicated by the fact that some uses such as the value of preserving riparian ecosystems do not have an observable value in a traditional economic sense (i.e. market values). Using a contingent valuation methodology (CVM) this study estimates a willingness to pay (WTP) by site visitors for riparian area preseration in the SPRNCA. The WTP was estimated from the results of a questionnaire-based survey of visitors at two key visitor locations. This study confirms that respondents place substantial positive economic value on riparian area preservation.

1. Introduction

1.1 The Problem and its Context

Comparing the value of water across alternative uses is complicated by the fact that some uses do not have an observable value in a traditional economic sense (i.e. market values). When considered at a landscape scale, water has value beyond its benefits in consumptive uses. Those non-consumptive uses include, but are not limited to, the ecological integrity of the resources themselves, cultural and historical value, amenity value, bequest value, and the value of indirectly related activities (like recreation) made possible by the natural resources. Policy makers faced with the task of addressing preservation concerns while also meeting consumptive water demands have difficulty in evaluating trade-offs associated with such different needs. The challenge then becomes how to reasonably estimate the value of water in order to compare economic benefits across different uses when market and non-market values can be estimated.

Valuing consumptive demand associated with agricultural and municipal water use is commonplace in the field of economics, given the existence of market transactions and production functions that link water use to production of market outputs such as agricultural crops. While the full social value of resource use may not be represented, market values provide a fundamental base from which to evaluate the general economic trade-offs between agricultural and municipal water use. However, the value of water for non-extractive uses such as the preservation of a riparian ecosystem is more difficult to estimate. The absence of market transactions in no way makes the riparian area water

needs less economically important, but it does necessitate using alternatives to traditional market valuation.

Over the past several decades, economists have developed and refined a number of non-market environmental valuation techniques. The more common include the contingent valuation method (CVM), travel-cost, and hedonic pricing methods. While these techniques place economic values on environmental resources, fully conceptualizing and reliably measuring such resources is problematic.

The difficulty in assessing the economic value an individual derives from a natural resource is compounded by the fact that value can be subdivided into non-consumptive use values and non-use values. The non-consumptive use value is the value an individual derives directly through activities such as birdwatching or hiking. The non-consumptive non-use value takes the form of existence value (knowing the resource is maintained) or bequest value (preserving the resource for future generations). In reality, when economic values are placed on environmental resources only a narrow range of attributes of that resource can be valued with useful precision. Generally these are attributes that can be associated with the resource or an activity that can be tied to economic value in some way.

The selection of highly representative activities can provide an important avenue from which to explore the value of natural resources not captured by traditional markets. Non-market valuation techniques can provide a bridge between consumptive use assessment and corresponding non-consumptive uses. This provides a basis for comparison across competing uses, particularly where policymakers are exploring different avenues to solve complex and controversial problems.

For the past several decades, economic value has been assigned to non-consumptive uses of resources such as river systems (Wilson and Carpenter 1999). Relatively few peer-reviewed studies have been conducted assessing the economic value associated with water quantities or water levels of US rivers using the CVM (Table 1.1).

TABLE 1.1. Water level benefits in the U.S. measured with the CVM.

Study	Good(s) being valued	Sample units	Unit specific benefit (1997 U.S. dollars)
Berrens et al., 1996	Benefits of maintaining minumum flows in one New Mexico River (Middle Rio Grande) vs. all New Mecico Rivers	All households in the state of New Mexico	Middle Rio Grande River, $29 per year; all New Mexico rivers, $91 per year
Boyle et al., 1993	Policies that would result in varying increases in cubic feet per second (cfs) flow of the river for whitewater rafting	Commercail and private whitewater boaters	Commercial: @26,000 cfs. $842:@40,000 cfs $532. Private: @26,000 cgs. $691: $40,000 cfs $512
Cordell and Bergstrom, 1993	Four management programs that alter "full water levels" in four reservoirs during summer and fall.	Recreationists on four reservoirs in western North Carolina	Present $46: Scenario1. $57; Scenario 2. $72; Scenario 3 $83
Daubert and Young, 1981	Recreational benefits of instream flow at several different levels of cubic feet per second (cfs)	Recreationists using the Cache la Poudre River	@500 cfs. $53; @900 cfs. $59
Sanders et a., 1990	A special fund to be used exclusively to include 11 Colorado rivers under the protection of the Wild and Scenic Rivers Act	All households in the state of Colorado	Eleven Colorado rivers $116 per year

Adapted from: Wilson and Carpenter 1999.

The studies that are available demonstrate that respondents place substantial positive economic value on water levels associated with sustaining natural resources (Wilson and Carpenter 1999). However, the actual values reported vary widely. Wilson and Carpenter

(1999) suggest that it is plausible that at least some of this variability could be explained by differences among the surveyed populations, ecosystem types evaluated, or specific environmental scenarios considered. However, they point out that the data are just too sparse for a meaningful statistical test of such ideas. While the discipline of economics has provided an avenue to make quantitative assessments of economic values of natural resources including river ecosystems, the results can be taken as reasonable estimates but the user is cautioned to be mindful of the challenges and limitations associated with assessing such economic values.

The case of the Upper San Pedro River Basin in southeastern Arizona and the water issues associated with its riparian areas provide prime example of where quantitatively assessing the economic value of water in riparian area preservation could help inform a difficult policy making process. The effects of surface water diversions and groundwater depletion increasingly threaten the ecological integrity of the Basin. The collective problem of groundwater pumping by rapidly urbanizing areas and irrigated agriculture puts in jeopardy the integrity of the Basin's riparian areas, including the congressionally designated San Pedro Riparian National Conservation Area (SPRNCA). While vast groundwater resources underlie the Basin, they will not be sufficient to support the growing water demands across all users indefinitely. Difficult water conservation and/or allocation choices will have to be made in order to maintain the current ecological composition and function of the riparian areas. The complex relationship between the natural, social, political, economic and legal systems poses a daunting challenge to policymakers exploring avenues to solve this issue. The discipline of economics can make

an important contribution towards informing the policy decision-making process by quantifying the economic value of water across alternative uses. However, such an undertaking presents the challenge of attributing a justifiable value to different water uses.

In an effort to inform the water policy debate of the Upper San Pedro River Basin, this research focuses on estimating the value of preserving the SPRNCA. It involves a contingent valuation study undertaken in order to assess the economic value of the riparian resources in the Conservation Area from the perceptions of nature tourists visiting the Upper Basin. The analysis is based on 843 on-site respondent surveys collected at two popular destinations for nature tourists. The access points to these destinations include the San Pedro House (east of Sierra Vista and located inside the SPRNCA) and the Ramsey Canyon Preserve Visitors Center (south of Sierra Vista, outside the SPRNCA). Three fundamental questions are addressed:

1. What are the socio-demographic characteristics of nature visitors and why are they willing to contribute to the preservation of the SPRNCA?
2. What monetary value do nature tourists place on preservation of the ecological integrity of the SPRNCA?
3. What are the aggregate total benefits associated with the preservation of the SPRNCA?

1.2 The Study Area

The San Pedro River flows north from its source in northern Sonora, Mexico across approximately 300 km to its confluence with the Gila River near Winkleman, Arizona in the United States. Its watershed covers 11,620 km^2 and is split into a Lower and Upper Basin (Arias 2000; BLM 1998). The Lower Basin covers almost half the total watershed's area and is fully in the United Sates. The Upper Basin spans 1,900 km^2 in Mexico and 4,500 km^2 in the United States. The San Pedro Basin is physiographically part of the Basin and Range Province with elevations ranging from 500 m in semi-desert grassland and desert scrub to sky island highlands reaching over 2000 m covered by coniferous forest and oak woodland.

The resources of the San Pedro River have supported people from as far back as ca. 10,900 B.P. (before present), as evidenced at the Murray Springs archeological site of the Clovis Culture of Paleoindians (Haynes 2001). The Sobairpuri tribe of Pima Indians were practicing irrigated agriculture along the San Pedro when the first European settlers came to the area in the 16th Century (Finan and West 2000). Rural communities in the valley have been built around irrigated agriculture and ranching ever since.

Today, the city of Sierra Vista is the largest urban center in the Upper San Pedro River Basin, with a population growth rate that exceeds the regional average due in part to its ties to the U.S. military presence at nearby Fort Huachuca. Other growth areas include Benson, Bisbee, Huachuca City, St. David and Tombstone. Benson is the only urban center located directly on the river. It was developed as a stop site and bridge crossing for the Southern Pacific Railroad (ADWR 1991). Benson promotes itself as an

ideal retirement and tourism location and has become a bedroom community for many living and working in Sierra Vista and Tucson. Outside of these areas, the purchasing and parceling of land into "hobby farms" and "ranchettes" by people looking for open space and a more rural lifestyle has added to the demographic changes taking place in the Upper San Pedro River Basin (Finan and West 2000).

One of the main attractions of the San Pedro River Basin is its unusually high native biodiversity. The U.S. portion of the Basin has one of the highest bird diversities of areas its size in the United States (Commission of Environmental Cooperation 1999). It plays a vital role in maintaining national and transnational species diversity (Steiner et al. 2000). Between 1 and 4 million migrating songbirds use the riparian habitat annually. It is an important habitat for some rare and endangered species including the Yellow-billed Cuckoo and the Southwestern Willow Flycatcher (Commission of Environmental Cooperation 1999).

The diversity of flora and fauna in the Basin is primarily due to water resources. The San Pedro River is essentially an oasis between the Sonoran and Chihuahuan deserts and the Plains grassland that provides the most important source of ephemeral and perennial water in the region. The unusual degree of biodiversity results from the location of the San Pedro at an ecotone of three ecosystems (Steiner et al. 2000). That water not only defines the ecological composition of the area, but serves human needs as well. Unfortunately, the rate of human extraction is beginning to change the hydrologic balance in the Basin.

The regional aquifer has an estimated overall water storage of 39,349 hm^3 (millions of cubic meters) (Arias, 2000). The floodplain aquifer that serves most of the irrigation in the Basin reaches depths of 12 to 45 m, covering an area of 141.87 km^2 with a storage estimated at 0.65 hm^3. The recharge of the floodplain aquifer is supplied mainly by direct runoff and regional aquifer contribution. A cone of depression due to excessive groundwater pumping has been reported in the Sierra Vista area by several research groups (Sharma, MacNish, Maddock 2000: Vionnet and Madock 1992). Groundwater models have been developed to assess groundwater depletion and to provide that scenarios involving urban growth and irrigation can be evaluated relative to subsurface flows. Arias (2000), using the Sierra Vista sub-basin, illustrates how as population grows, the groundwater sub-basin deficit will increase (Table 1.2). This research also illustrates how the agricultural sector the historically largest user of water in the Basin has been overtaken by municipal water use. Arias (2000) highlights how as human populations grow, the groundwater sub-basin deficit increases.

The data collection points selected for contacting visitors and eliciting values for riparian preservation were the San Pedro Riparian National Conservation Area (SPRNCA) and the Ramsey Canyon Preserve, managed by the Bureau of Land Management (BLM) and the Nature Conservancy respectively (Figure 1.1). An admission fee is charged at the Nature Conservanc's Ramsey Canyon Preserve whereas access is free to the public at the SPRNCA.These sites are among the more important focal points for nature tourism and other visitation within the Upper Basin. Both are particularly attractive to birders and other nature tourists.

TABLE 1.2. Upper San Pedro River Basin water budget.

	Virgin Conditions	1990	2000	2030
Groundwater Recharge (Deep Aquifer)				
Aquifer flow from Mexico	3,000	3,000	3,000	3,000
Recharge-Huachuca Mtns.	10,580	10,580	10,580	10,580
Recharge-Mule Mtns.	5,290	5,290	5,290	5,290
Total	18,870	18,870	18,870	18,870
Groundwater Discharge (Deep Aquifer)				
Underflow at Fairbanks	-440	-440	-440	-440
Evapotranspiration	-7,900	-7,900	-7,900	-7,900
Base flow discharge	-9,530	-7,400	-7,400	-7,400
Early Wells (Bisbee)	-1,000	-1,000	-1,000	-1,000
Consumptive Uses (withdrawals---recharge)*				
Wells, Fort Huachuca**		-2,000	-2,300	-2,300
Wells, Sierra Vista		-4,100	-5,000	-9,000
Other domestic wells		-1,000	-1,000	-2,300
Agricultural irrigation		-2,800	-1,100	-1,100
Total	-18,870	-26,640	-26,140	-31,440
Groundwater Sub-Basin Deficit	0	-7,770	-7,270	-12,570

*Consumptive use estimates are based on population growth projections from 51,400 in 1990 to 73,900 in 2030 (Corell 1996).

** Current and potential recharge initiatives by Fort Huachuca and the city of Sierra Vista may lead to increased returns to the groundwater sub-basin.

Source: Arias 2000

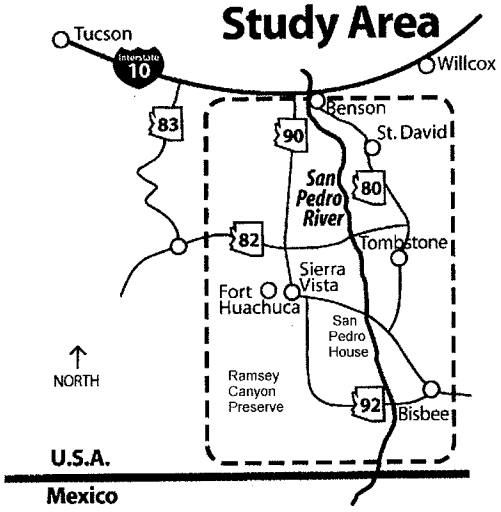


FIGURE 1.1. Location of the study area and the collection sites.

One of the primary economic measures obtained in the data collection was the respondent's willingness to pay for preservation, which was focused explicitly on the SPRNCA portion of the Upper Basin. Congressionally designated in 1988, the Conservation Area spans thirty-six miles of the river's path and covers 57,000 acres. Formerly owned by the Boquillas Land and Cattle Company, the land was sold to the Tenneco Properties who intended to develop it. The Bureau of Land Management (BLM) convinced the developer to swap the land for an area of equal acreage near Phoenix. This allowed the BLM to take possession in 1986 in order to protect and preserve it (BLM Volunteer Training Guide-San Pedro House). The Tenneco properties of 43,000 acres were merged with smaller land donations totaling 14,000 acres to create what today is called the San Pedro Riparian National Conservation Area.

The SPRNCA was established to protect floristic, aquatic, wildlife, archeological, paleontological, scientific, cultural, educational, and recreational resources of the public

lands surrounding the San Pedro River (Arizona-Idaho Conservation Act, Pub. L. No. 100-696, Title I, 102 Stat. 4571 [1988]). It serves as a migratory passage for national and trans-national birds, in addition to supporting a wide diversity of other wildlife. In 1996, the area was designated a "Globally Important Bird Area" by the American Bird Conservancy and the BLM. This was the first designation of its kind in the United States (McKnight and Deihl 1996).

2. Primary Consumptive Users of Upper San Pedro Water

Information concerning the consumptive use of water in the Upper San Pedro River Basin provides an economic context from which the value of water in riparian area preservation can be evaluated. Given inadequate water supplies to indefinitely satisfy all water users (at current levels of use) in the Upper San Pedro River Basin, the economic benefits derived from water dedicated to riparian area protection would likely be attained at some economic cost to other water use sectors. Data needed to estimate water demand by the municipal and agricultural sectors for the Upper San Pedro River Basin is not readily available and this thesis does not develop formal water demand functions for municipal and agricultural water. However, this chapter provides more general information on population totals, growth rates, water pricing and per capita consumption in key municipalities. It also reviews the agriculture sector in Cochise County and the Basin and the value of water for key crops.

2.1 Municipal Water Use

Municipal water use historically was lower than agricultural use in the Upper San Pedro River Basin. However, in recent years agricultural use has been overtaken by the municipal water use of increasing populations in more urbanized areas. The population growth trends suggest this pressure will increase in coming years, requiring a greater share of the Basins water resources, including the portion of water resources currently used by agriculture and the riparian ecosystem.

2.1.1 Municipal Population and Growth Trends

The U.S. Census and the Arizona Department of Economic Security consider Benson, Bisbee, Huachuca City, Sierra Vista, St. David, and Tombstone as Benson, St. David, Tombstone, Huachuca City and Bisbee as the municipal population centers in the Upper San Pedro River Valley (Table 2.1).

TABLE 2.1. Population projection for urban centers.

	1997	1998	1999	2000	2005	2010	2015	2020
Benson	4,234	4,269	4,300	4,329	4,429	4,472	4,478	4,499
Bisbee	4,533	6,554	6,573	6,590	6,650	6,676	6,679	6,692
Huachuca	2,006	2,027	2,046	2,065	2,152	2,229	2,298	2,362
Sierra Vista	49,950	50,681	51,401	52,129	55,840	59,740	63,585	66,991
St. David	1,804	1,836	1,866	1,896	2,045	2,193	2,334	2,461
Tombstone	1,457	1,478	1,496	1,512	1,571	1,595	1,599	1,611
Total	65,984	66,845	67,862	68,521	72,687	76,905	80,973	84,616

Source: Arizona Department of Economic Security, 1997

The majority of this population is concentrated in the city of Sierra Vista, the only urban center in the Upper Basin. Sierra Visit is located just over 30 km (19 miles) north of Mexico, almost 115 km (72 miles) southeast of Tucson, and almost 15 km (9 miles) west of the San Pedro River, adjacent to the Fort Huachuca Military Reservation. Sierra Vista accounted for 52,129 people in the year 2000, or 76% of the region's municipal population. By the year 2050, Sierra Vista will have grown to 78,687 people as projected by the Arizona Department of Economic Security (1997).

All other municipalities in the Upper San Pedro accounted for 24% of the total population in 2000. Of these, Benson and St. David are physically closest to the San Pedro and exhibit the fastest population growth rate. Benson is located downstream from Sierra Vista and the Riparian Conservation Area along the San Pedro River. From its history as a

railroad town, a copper and silver smelting and distribution hub, and agricultural center, the City of Benson and the greater Benson area has reinvented itself. The area now promotes itself as an ideal retirement and tourism location with many of the visitors owning manufactured homes. The areas has also become a bedroom community for demographic subgroups who live and work in Tucson and Sierra Vista but make their home in the Benson/St. David area. The commuters reap the benefits of a small town lifestyle while working in larger urban centers of Sierra Vista and Tucson (Finan and West 2000). Parcelization of land into "hobby farms" and "ranchettes" has also added to the influx of people to the Benson area further changing the socio-economic profile of the area.

An as yet unknown factor in Benson/St. David population growth is the impact of the 1999 opening of Kartchner Caverns State Park. Kartchner Caverns is one of the largest living wet caves in the United States. The caves could become the one of the largest tourist attraction in the State of Arizona. Current estimates suggest that the Kartchner Caverns will attract 150,000 tourists per year (Finan and West 2000). Benson has copyrighted a name "Home of Kartchner Caverns" and hotels, restaurants, and other tourist trade establishments have been built to facilitate expected tourist trade. New RV (recreational vehicle) parks and services has been planned by the city of Benson. In 1999, there were over 1,600 RV spaces in the Benson city limits and additional 500 lots in the surrounding area (Finan and West 2000).

2.1.2 Water Providers and Per Capita Consumption Rates

The major municipal water providers in the Sierra Vista area include the Bella Vista Water Company, Pueblo del Sol Water Company, Arizona Water Company, Cloud 9 Water Company and Sierra Vista Municipal Water Supply Company (ADWR 1991). The average amount of water consumed in Sierra Vista is estimated at 153 gallons per capita per day (gpcd) (Bauer 2001). The City ranks among the lowest gpcd user across other Southwestern cities (Table 2.2).

TABLE 2.2. Average water consumed by southwestern cities.

City	Water Consumed by All Users (gpcd)
Apache Junction	140
Avondale	152
Sierra Vista	153
Los Angeles	155
El Paso	163
San Diego	170
Phoenix	199
Albuquerque	204
Tucson	208
Denver	219
Gilbert	224
Bullhead City	238
Prescott	250
Lake Havasu	262
Casa Grande	313

Source: Bauer 2001

There are three main residential water providers in the Benson sub-basin: Benson Municipal Utility Department, St. David Water Association and Pomerene Domestic Water Users Association. The Benson Municipal Utility Department, regulated by the City Council, is the largest provider (Finan and West 2000). The two other providers, St. David Water association and Pomerene Domestic Water, are non-municipal providers, and

are regulated by the Arizona Cooperation Commission. The average amount of water consumed in the Benson sub-basin is estimated at 168 gpcd (Finan and West 2000).

Based on 2000 population figures and an average daily per capita water use rate of 160 gallons (for both Sierra Vista and Benson), the municipal sector uses 4 billion gallons of water per year (12,278 acre-feet).

2.2 Agricultural Water Use

Agriculture has historically been the largest water user in the Upper San Pedro Basin. In the past two decades there has been a decline in total available agricultural land (13,000 acres in the 1980s to approximately 6,000 acres in the 1990s). Active production on these acres fell even more dramatically (8,400 acres in the 1980s to less than 1,000 acres in the 1990s) (ADWR 1991; Dunn and Clark 1997). The change in land under production has had a major impact on agricultural water use. Though the sector has been surpassed by the urban sector as the major consumptive water use, it continues to be viewed by many as the sector where water conservation and reallocation efforts could be directed in order to protect the unique riparian resources of the basin.

2.2.1 Agricultural Conditions at the County Level

Most agricultural data is reported by county rather than by watershed. To better understand the role of agriculture in the Upper San Pedro River Valley, it is useful to assess corresponding county data. The San Pedro River Basin lies primarily in Cochise County in the southeastern corner of Arizona. Cochise County is approximately 80 miles square and contains 4,003,840 acres and has a population of 126,300 inhabitants (Arizona

Department of Economic Security, 2001). The majority of the population (including Sierra Vista) is in the southern part of the county. The remaining areas are sparsely populated (Dunn and Clark 1997). A variety of field crops are grown in the county, including cotton, corn, alfalfa, lettuce and chile. Vegetable, fruit and nut crops have become increasingly important since the 1990's, with Cochise County now widely known for its apples, nuts, orchard, and U-Pick vegetable operations. U-Pick operations have become a primary tourist attraction in Cochise County's during summer months (Dunn and Clark 1997).

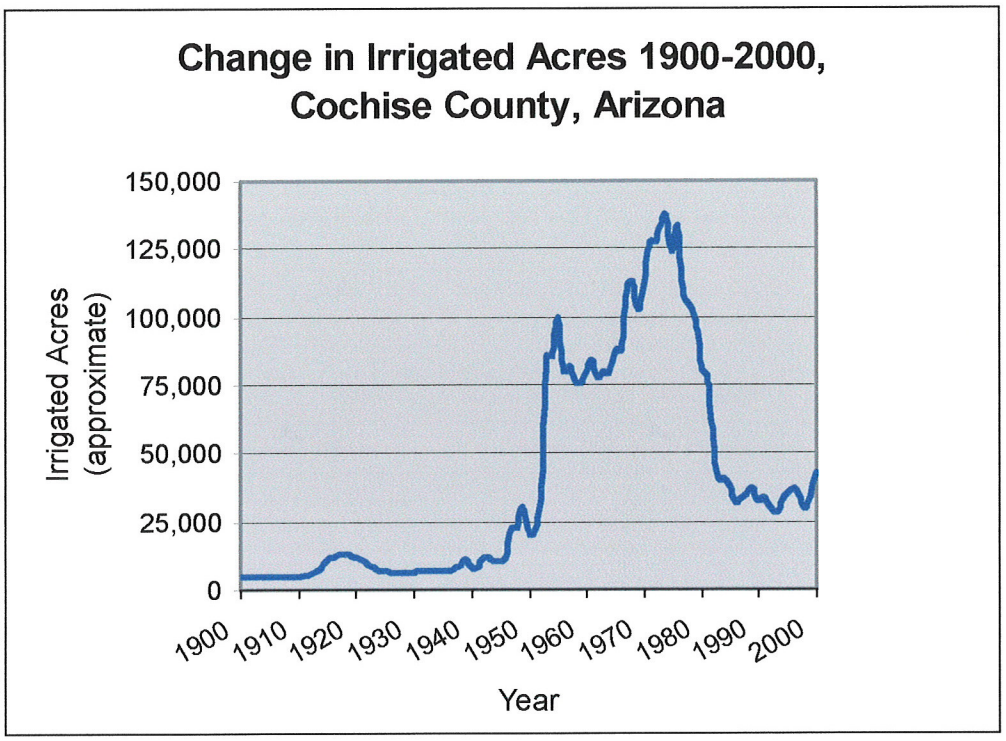
Arizona is predominantly a public land state, with only 18% of its land in private ownership. Cochise County is therefore unusual in having 41% of its land in private ownership. Currently 66,300 acres of Cochise County land is under agricultural production (excluding green chop pasture hay and grazed acres). This land can be divided into three main growing areas: the San Simon River Valley in the northeast corner, the central Sulphur Springs Valley area, and the San Pedro River Valley on the west side of the county (Dunn and Clark 1997). The San Pedro Valley is by far the smallest farming area both in terms of current and potential acreage, representing only 1% of current agricultural acreage and less than 4% of potentially cultivable land (Table 2.3).

TABLE 2.3. Cultivable land in the three growing areas of Cochise County.

Growing Area	Current Acreage Under Production	% of Cultivatable Acreage Under Production	Potential Cultivable Land*
San Simon/Bowie	8,000	12%	19,700 – 90,000
San Pedro Valley	800	1%	6,000 – same
Sulphur Springs Valley	57,500	87%	79,600 – 71,000
Total	66,300	100%	105,300 – 167,000

*Potential Cultivable Land: first number is land that has been cropped, based on the Cochise County Agricultural Survey (1958). Second number is total farmable land mass, according to the U.S. Department of Agriculture Farm Service Agency (Willcox) as cited in Dunn and Clark (1997).
Adapted from: Dunn and Clark 1997

Dunn and Clark (1997) point out that countywide there are over 100,000 acres of potentially cultivatible land that could be brought into production under the right economic conditions. They estimate that 6,000 of these acres pertain to the San Pedro Valley, some of which were previously irrigated farmland. The decline in acres under production began in the early 1980s when over 80,000 acres were abandoned due to lower water tables and higher pumping costs associated with increased electricity prices (Figure 2.1). The impact of the decline is also evident in monetary terms. The cash receipts from crop production in Cochise County amounted to just under $42 million in 1998, down from $89 million in 1978.



Notes: Acres planted for some crops were not published to avoid disclosure of individual operations.
Data Sources: Arizona Agricultural Statistics 1966-2000; Stubblefield *et al.* 1967.

FIGURE 2.1. Irrigated acres in Cochise County from 1900 to 2000.

2.2.2 Agricultural Conditions: The Upper Basin

Until recently the Upper San Pedro River Basin was almost entirely rural, a characteristic now charging due to rapidly growing cities, growth of recreation/retirement/bedroom communities, and the division of traditionally ranched rangeland into much smaller ranchettes (Finan and West 2000). These changes have contributed to the decline of traditional agricultural (farms cultivating field and vegetable crops) in the Basin.

Like the trend in Cochise County as a whole, the number of acres available for irrigated production and the number of actively irrigated acres in the Upper San Pedro

have declined significantly. This trend is particularly evident in the Sierra Vista and Benson sub-basins. These two sub-basins form the Upper San Pedro River Basin as defined for the purpose of this study. Today, five areas of productive agriculture remain in the Upper Basin, all located within the boundaries of Cochise County Arizona. Three of the areas are located in the Benson sub-basin in the vicinity of Cascabel, Pomerene and St. David, and two in the Sierra Vista sub-basin in the vicinity of Sierra Vista and Palominas.

The Arizona Department of Water Resources (ADWR 1991) estimated that approximately 2,600 acres out of a potential 6,700 acres of farmland were actively irrigated in the Sierra Vista sub-basin. ADWR classified the remaining acres as discontinued, noting that the lands had been cultivated in the 10 years prior to the study, but not during the most recent five years. Differing estimates now suggest that actively irrigated acres in the Sierra Vista sub-basin have declined from approximated 2,600 acres to between 282 acres (Sharma, MacNish, and Maddock 2000) and 540 acres (Corell *et al.* 1996) over the past 10 years.

Similar trends have occurred in the Benson sub-basin. ADWR (1991) estimated that there was approximately 5,800 acres of farmland actively irrigated out of the total 6,500 potential farmland in the Benson sub-basin. Recent estimates now suggest that as few as 600 acres are currently irrigated in this sub-basin (Finan and West 2000). The fertile flood plain of the San Pedro River does present opportunities for non-traditional agriculture. A few growers at Curtis Flats, south of Benson at the river's edge have recently begun production of garden vegetables. Seasonal roadside stands and the

proximity to Tucson provide outlets to market the produce (Hackenberg and Benequista 2001).

It should be noted that while the recent estimates suggest an overall sharp reduction in the number of acres actively irrigated in both sub-basins, the remaining pockets of private inactive farmland technically could be brought into production at any time. The potential farmland available for irrigated agriculture is still officially estimated to total approximately 6,000 acres for the San Pedro Valley in Cochise County (Dunn and Clark 1997) (Table 2.4). The change in available irrigated acres in the sub-basins of the San Pedro Valley suggest a 66% decrease in land available for irrigated agriculture over the past 10 years.

TABLE 2.4. Active and available agricultural acres in the Upper San Pedro.

Acreage Type	Mid to Late 1980's	Mid to Late 1990's
	Sierra Vista and Benson Sub-Basins	Sierra Vista and Benson Sub-Basins
Actively Irrigated	8,393	800
Total Available Acreage	13,190	6,000†

† Based on the Cochise County Agricultural Survey (1958), and total farmable land mass, according to the U.S. Department of Agriculture Farm Service Agency (Willcox) as cited in Dunn and Clark (1997).
Data Source: ADWR 1991; Dunn and Clark 1997.

In the last decade, land use and cover data have been developed with the advances in computer technology, geographic information systems (GIS) and the use of remotely sensed imagery. Research managed by the Environmental Protection Agency (EPA) suggests that less than 3% of the land area, or 35,000 acres is dedicated to agriculture dominated by hay and alfalfa production (Kepner 2000). This figure deviates substantially from other estimates. This EPA research was based on the classification of land into broad

classes based on an assessment of spectral data. It did not attempt to distinguish the types of agricultural land, though it did include a class for "barren" land. This may in part explain why the EPA landcover assessment agricultural land totals are significantly different from the ADWR and Cooperative Extension reporting on irrigated agriculture in the Basin. Barren and agricultural lands were labeled low-accuracy classes when an accuracy assessment was completed on the 1997 EPA land cover map estimates (Marsh *et al.* 2000). Two other factors contribute to the discrepancy in agricultural land totals. Irrigated pastures are included in the EPA data, whereas only field and vegetable crops are included in the ADWR and Cooperative Extension estimates. Finally, the EPA figures also included irrigated acres in Mexico.

Regardless of the acreage discrepancy, few would argue with the conclusion that acreage dedicated to traditional field and vegetable crop production is on the decline. Today remaining pockets of traditional irrigated agriculture in the Upper San Pedro River Basin have adapted to changing conditions with traditional crops (alfalfa, small grains and pasture) being substituted for higher value grapes, pecan, and fruit tree orchards (Table 2.5). However, no newer data on crop types are currently available. The declining trend in agricultural production is becoming more commonplace throughout the entire San Pedro watershed, and is most pronounced in the Sierra Vista and Benson sub-basins (ADWR 1991).

The water supply for irrigated practices in the Upper San Pedro River Basin comes from surface flows and groundwater pumping. Groundwater is pumped particularly during the summer growing season to supplement surface flows. There are two irrigation water

providers in the Upper San Pedro River Basin, the Pomerene Water User Association and the St. David Irrigation District. Both provide water to individual irrigators, predominately between November and May (Finan and West 2000). The St. David Irrigation District was established in 1881 and supplies both surface water and groundwater to its customers. The Pomerene Water Users Association owns the Pomerene water diversion channel first used in 1912. The Pomerene Association supplies only surface water to its users but the canal system can be used to convey privately pumped groundwater as well.

TABLE 2.5. Irrigated acres by crop type.

Primary Crop Type	Sierra Vista Sub-Basin		Benson Sub-Basin	
	Acres	%	Acres	%
Alfalfa	257.4	11.8	1,530.0	28.7
Pasture	1,168.8	53.6	2,893.1	54.2
Small Grains	106.3	4.8	581.8	10.9
Turf	227.5	10.4	44.5	0.8
Grapes	242.3	11.1	0.8	0.0
Pecans	20.8	0.9	124.0	2.3
Orchard	64.1	2.9	38.2	0.7
Melons	53.8	2.4	5.6	0.1
Sorghum	0.0	0.0	29.6	0.5
Corn	0.0	0.0	22.4	0.4
Fruit Trees	0.9	0.0	0.0	0.0
Mixed Vegetables	20.8	0.9	0.0	0.0
Pine Trees	1.4	0.1	48.0	0.9
Landscaping	17.0	0.7	11.6	0.2
Total Cropped Acres	2,181.1	100%	5,329.6	100%

Data Source: ADWR, 1991

2.2.3 The Value of Water in Agricultural Production

This analysis presents the estimated average net returns per acre based on the two primary crops for the Upper San Pedro River Basin, alfalfa and wheat, in addition to returns from a higher value produce such as melons. Data on other higher level produce such as apples were not available. The on-farm economic value of water in agricultural

production is defined as the residual of gross returns minus all non-water related variable production costs. The residual figure is the returns to the production activity exclusive of the cost of water. The value ascribed to water is the maximum cost an irrigator could incur or pay per acre-foot of water and still cover the cost of production. The valuation highlights the range of water costs an irrigator could incur before driving profits to zero. The valuation is based on a short-run perspective, as fixed costs are not included(Willett, 1975).

Net returns per acre represent the residual of gross returns minus all non-water variable production costs per acre. The gross returns per acre were based on a marketable yield per acre multiplied by the price per unit in dollars. The assumption is made that the physical yield per acre is equal to the marketable yield per acre. The yield estimates are based on a five-year average for Cochise County from the Southeast Arizona Field and Vegetable Crop Budgets, 1998-99. The price data also represent a five-year average but for the State of Arizona (Arizona Agricultural Statistics 1999), as county level crop price data were not available.

The variable costs per acre for wheat were taken from crop budgets for the Upper San Pedro River Basin (personal communication with T. Teegerstrom 2000). The variable costs per acre for the alfalfa and melon produce were taken on farm budget data based on representative farm conditions for a Cochise County (Teegerstrom and Clark 1999). In all cases, the budgeted variable costs per acre were adjusted to reflect only non-water variable costs. Net returns were then calculated by subtracting the net return per acre from the total non-water variable cost estimates per acre.

Irrigation water in the Upper San Pedro River Basin utilizes surface and groundwater resources, acquired in part from irrigation water providers and from private diversions and groundwater wells. In the absence of publicly available irrigation water rates, groundwater was assumed to be the primary water source in computing water costs for this area. Water costs are dependent on three variables including (a) the depth from which the water is pumped (converted to an estimated pump lift), (b) the unit cost of energy, and (c) the overall efficiency of the pumping plant (Hathorn 1980). In this analysis, the pumping costs per acre-foot which include variable energy and repair costs were obtained from a personal communication with Trent Teegerstrom, relating to work he has conducted in Cochise County. The pumping costs per acre are multiplied by the number of acre-feet applied (Teegerstrom and Clark 1999) to arrive at the projected water cost.

The returns over cash operating expenses represent the difference between total income and the cash operating expenses. If this figure is positive the returns represent the funds available to pay overhead, ownership expenses, land expenses and management services plus profits (Teegerstrom and Clark 1999). The returns to risk (profits) represents the funds remaining after all such expenses have been accounted for (Figure 2.6).

The calculated net returns per acre were greater for the non-traditional melon crop, compared to the more traditional crop choices, wheat and alfalfa. However, the increased net returns per acre by crop choice cannot be attributed to any one variable. Product prices, operating costs and water applications per acre all play a role in generating the increased net returns per acre. The results suggest that by switching to higher value

crops, opportunities may exist where the number of acres and the volume of water could be reduced without sacrificing the economic returns of the agricultural sector in the Upper San Pedro River Basin. A more rigorous assessment of reasonable levels of specialty acreage would require an analysis of many other factors including exploring climate suitability, market niches, risk factors, and capital conversion costs. The research and use of more detailed site-specific data, rather than state and county level data would also be necessary.

In terms of basinwide water management, it should be noted that the acre-feet of water applied in agricultural production differs from the consumptive use of water. ADWR (1991 page C-94) defines consumptive water use as "the amount of water used by plants in transpiration, retained in plant tissue, and the evaporation of water from adjacent plant and soil surfaces during a specified time period." The weighted average consumptive use of water by alfalfa, small grains such as wheat, and melons crops are 4.11, 2.23 and 1.98 acre-feet per acres respectively based on conditions for the entire San Pedro River watershed (ADWR 1991). Sharma, Mac Nish and Maddock III use the consumptive use rate of 3 acre-feet per acre to estimate the consumptive use of irrigated acreage for the amount of cropped acres in the Sierra Vista Sub-Basin of the Upper San Pedro River Basin (2000). Applying this rate to the estimated 800 acres of irrigated agriculture in the Upper Basin (i.e. the Benson and Sierra Vista sub-basins), the consumptive use of water by the agricultural sector totals 2,400 acre-feet (783 million gallons). Compared to urban water use based on population figures and per capita daily consumption, the agricultural sector consumes 1/5 of the water used by the urban sector.

TABLE 2.6. Projected net returns and irrigation water costs (per acre).

Net Returns/Irrigation Water Costs	Crop Type		
	Alfalfa‡	**Wheat**	**Watermelons**
Projected Gross Returns Per Acre			
Marketable Yield/Acre	5.9 Tons/Acre	5,000 Lbs/Acre	10 Tons/Acre
Price per Unit ($)	$96.70/Ton	$0.06/Pounds	$122.60/Ton
Projected Gross Returns ($/Acre)	570.53	300.00	1,226.00
Projected Variable Costs Per Acre			
Cash Operating Costs *Excluding* Irrigation (Energy and Repairs) Costs ($/acre)	173.27	166.79	666.95
Projected Net Returns Over Variable Costs Per Acre ($) (excl. water costs)	**397.24**	**133.21**	**559.05*** **
Pumping Costs Per Acre-foot (AF)			
Variable Costs † Energy	17.97	17.97	17.97
Repairs	1.92	1.92	1.92
Variable Pumping Costs ($/acre-foot)	19.89	19.89	19.89
Water Applied by Crop (AF/Acre)	5.66	1.5	4.83
Projected Water Costs Per Acre	**112.58**	**29.84**	**97.07**
Irrigation Costs as a Percentage of Net Returns over variable Costs *excluding* Water Costs	28%	22%	17%
Total Ownership Costs*	**383.57**	**90.74**	**380.91**
RETURNS TO RISKS (PROFITS)**	**(98.91)**	**12.63**	**81.07**

‡ Establishment costs have not been included in this calculation. Teegerstrom and Clark (1999) estimate that the per acre establishment of an alfalfa stand costs $198.22 in operating costs and $113.66 in ownership costs.
† The energy costs are calculated based on the formula [(lift*price per KWH*conversion factor for KWH to lift 1 AF water)/ over all pump efficiency]. The repair costs are based on the formula [cost per acre* lift] (Hathorn 1982). A pump lift of 160ft, with a price per KWH of .059¢, and a pump efficiency of .54 were used in the above calculations. These data were obtained from personal communication with Trent Teegerstrom, Research Specialist, University of Arizona.
* Total ownership costs include overhead, ownership expenses, land expenses and management services.
**The returns over cash operating expenses represent the difference between total income and the cash operating expenses. If this figure is positive the returns represent the funds available to pay overhead, ownership expenses, land expenses and management services plus profits (Teegerstrom and Clark 1999). The returns to risk (profits) represents the funds remaining after all such expenses have been accounted for.
***The calculated net returns per acre were greater for the non-traditional melon crop, compared to the more traditional crop choices, wheat and alfalfa. However, melons are subject to greater price and yield variability than customary crops.

3. The CVM: Theory And Practice

3.1 The Origins And Evolution Of The CVM

The first published reference to the contingent valuation methodology is credited to Ciriacy-Wantrup (1947). Later, in his book "Resource Conservation: Economics and Policies Ciriacy-Wantrup suggested that the benefits of soil erosion prevention could be measured by asking individuals directly about how much they would be willing to pay for successive increments of abatement (Ciriacy-Wantrup 1952; Portney 1994). It was not until 1963 that the contingent valuation methodology (CVM) was first applied in academic research. Robert David used CVM as a technique to value recreational use of natural resources (Loomis 1999).

Contingent Valuation got its name because the values revealed by respondents are contingent upon a constructed or simulated market presented in the survey. The objective is to estimate the benefits of levels or increments of prevision of the good or service under study. The CVM is based upon a hypothetical scenario that depends on some reference operative conditions (Cummings, Gerking, and Brookshire 1986). The CVM elicits values directly from individuals (via interviews or surveys) in the form of statements of a maximum willingness to pay (WTP) or a minimum willingness to accept (WTA) compensation for hypothetical changes in good or services being evaluated (Mitchell and Carson 1989). The selection of WTP or WTA depends on the nature of the property rights of the good or service.

Throughout the 1960's and 1970's the CVM was used to assess the economic value of a host of natural resources. In 1969, Hammack and Brown (1974) sent a mail questionnaire to a large sample of western hunters eliciting from them how much they would be willing to pay to keep or willing to accept to give up their rights to hunt waterfowl. In 1970, Cicchetti and Smith (1973, 1976a, 1976b) conducted a study of visitors hiking in a wilderness areas asking them how much they would be willing to pay to reduce congestion in the area from other hikers. Darling (1973) used the CV method in personal interviews to value the amenities of three urban parks in California (Mitchell and Carson 1989).

By 1979, Robert Davis was working for the Office of Policy Analysis in the Department of Interior. He and other economists lobbied successfully to have procedures for acceptable contingent valuation studies published in the 1979 US Water Resources Council cost-benefit regulations for water-related Federal agencies. These agencies included the US Army Corps of Engineers (COE) and the US Bureau of Reclamation (Loomis, 1999). The first study implemented by the COE valued construction of small boat marinas and urban recreation as part of a flood control planning initiative (Loomis 1999; Hansen et al. 1990)

The U.S. Environmental Protection Agency played an important role in the development of the CVM. In the mid-1970's the EPA funded a program of research to determine the promise and problems of the CVM. The EPA had a vested interest in the research because valuing the benefits of pollution control regulations and implementing the regulations was to become their responsibility (Mitchell and Carson 1989).

In the late 1980's, a milestone in the evolution of the CVM occurred when the National Oceanic and Atmospheric Administration (NOAA) was faced with the question of assessing the legitimacy of using CVM for environmental valuation purposes (NOAA 1993). The impetus for the formation of the NOAA panel was the 1989 Exxon Valdex oil spill in Prince William Sound, Alaska and the associated demand for regulations governing damage assessments (Portney 1994). The NOAA appointed panel of experts included two Nobel Prize economists, Kenneth Arrow and Robert Solow (Loomis 1999). The panel concluded that CV studies could produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values (Mitchell and Carson 1989).

In addition to its use in the judicial process of damage assessment, the contingent valuation method has been used to provide information on contentious water allocation issues. State governments are generally vested with the power and responsibility to allocate water rights; many began using the CVM to assist in this process. One prominent case concerned the City of Los Angeles diversion of water from streams that supported Mono Lake in California. The draining of water from Mono Lake had serious consequences for the bird population. The assessed values of the CVM were used as part of the information used to decide how much to reduce Los Angeles water rights in order to protect Mono Lake (Loomis 1999).

Today, while not without its opponents, contingent valuation has received acceptance in the United States as a tool for assessing the value of goods and services, including natural resources. It is also the only method currently available to measure other

resource values, such as the benefits the general public receives from the continued existence of unique natural environments, wildlife or plant species (Loomis 1999). The U.S. Fish and Wildlife Service has deemed the contingent valuation method acceptable for the valuation of human use of natural resources outside the traditional market. In addition, the EPA lists the CVM among four basic methods for valuing the environmental benefits of proposed regulations.

Opponents of contingent valuation are still not convinced that the monetary estimates of environmental benefits based on CV represent valid measures of WTP. The CVM is vieved as particularly suspect in measuring non-use valued by respondent's unfamiliar with the rescue. Other concerns such as protesting by respondents (a response that shows zero value out of disagreement with the mechanism or the hypothetical scenario rather than a bid of no willingness to pay), insensitivity to scope effects, and the sheer magnitude of the values generated have also been raised (Macmillan *et al.* 2000). Despite its opponents, the CVM has achieved a status as a commonly used and important tool in the assessing of economic value on natural resources.

3.2 Theoretical Framework

Willingness to pay comes out of consumer theory. Chambers, Chambers and Whitehead detail the theoretical framework supporting the non-market value or willingness to pay for preservation as derived from a contingent valuation methodology in their article "Contingent Valuation of Quasi-Public Goods: Validity, Reliability, and

Application to Valuing a Historic Site." The following theoretical context has been adapted from their work to reflect the valuing of natural resource preservation.

> WTP can be theoretically derived by considering a model where consumers have a utility function u(r,x,z) where u is utility, r is the quality of the natural resource (i.e. the quality of its preserved state), x is bird-watching or other trips to see the site, and z is a composite commodity of all other goods. In this model neither the ownership of the resource nor the travel to the site are necessary conditions for inclusion of r as an argument in u(•). Consumers can gain utility from simply knowing that the natural resource is preserved.
> If consumers minimize expenditures subject to a utility constraint, $u = u^*$, the expenditure function, $e(p,r,u^*)$, results where u(•) is the minimum amount of expenditures necessary to produce u^*, and p is the price of x. The price of x is measured as the travel and time costs of a trip to the site. The price of z is assumed constant and suppressed in the expenditure function. The negative of the first derivative of e(•) is the Hicksian demand for visits to the riparian areas. If quality of the riparian areas and visits are complementary goods, than improvements in site quality will increase the number of visits (Whitehead, 1995).
>
> The economic value of preservation is WTP, the equivalent variation measure of welfare
>
> $$WTP = e(p,r^0,u^*) - e(p,r^1,u^*)$$
>
> Where r^0 is a degraded level of riparian area preservation and r^1 is the preserved (higher quality) level.
>
> Since the preserved site provides the consumer with utility, the reference level of utility can be achieved with lower expenditures on other goods when the site is preserved. When the site is degraded, the consumer must spend more on other goods in order to remain at utility level u^*. The difference between what the consumer must spend in the case of degradation and the level spent with preservation represents the willingness to pay to preserve (Chambers, Chambers and Whitehead 2001).

The contingent method permits willingness to pay to be estimated directly and the determinants of willingness to pay to be empirically estimated (Whitehead 2000). When a large number of the willingness to pay responses are anticipated to be zeros due to the

choice of payment elicitation method (the payment card), the tobit model for censored data is appropriate. With upper and lower censoring, where y is equal to

$$\begin{aligned} &WTP_L && \text{if } WTP^* \leq WTP_L \\ &WTP^* = \alpha'w + e_i && \text{if } WTP_L < WTP^* < WTP_U \\ &WTP_U && \text{if } WTP^* \geq WTP_U \end{aligned}$$

where α is a vector of coefficients, w is a vector of independent variables, WTP* is an unobserved variable, and e is a normally distributed error term (Long 1997). For the latent outcome, $E(WTP^*|w) = w\alpha$.

3.3 Methodological Challenges

3.3.1 Developing the Scenario

The scenario is the mechanism that elicits the data for the estimate equation. It must be carefully designed so that there are no misunderstandings between the interviewer and respondent. A combination of words, drawings, photographs, charts, and maps can be used to communicate the characteristics of the resource being valued. The descriptions should be concise and neutral. The scenario presented to the respondent should be meaningful, realistic, and plausible. It should also indicate the reference level of utility from which the respondent's answers are to be based, the nature of the public good, the relevant prices of other goods, and the conditions for the provision of the good and payments for it (Mitchell and Carson 1987).

3.3.2 Payment Elicitation Format

The value payment or payment elicitation is the component of the contingent valuation study that directly solicits the respondent's WTP or WTA for the resource bring valued. Two commonly used payment elicitation categories are open-ended and closed-ended questions. Many early CV surveys asked the open-ended question: "What is the maximum amount of money that you would be willing to pay for ....." The open-ended question is more difficult to answer particularly if the respondent is unfamiliar with valuing such a good or resource. The alternative to the open-ended question format is the closed-ended question. They include the payment card, bidding game and the referendum contingent valuation questions (also called the closed ended, dichotomous choice or the take-it-or-leave-it method (Table 3.1).

TABLE 3.1. A typology of contingent valuation elicitation methods.

	Actual WTP obtained	Discrete indicator of WTP obtained
Single question	Open-ended/direct question	Take-it-or-leave-it offer
	Payment card	Spending question offer
	Sealed bid auction	Interval checklist
Iterative series of questions	Bidding game	Take-it-or-leave-it offer
	Oral auction	(with follow-up)

Source: Mitchell and Carson, 1989.

The direct open-ended method typically asks the respondent to state his or her maximum WTP. The answer to this question represents the respondent's WTP in dollars. The payment card approach is similar. With this approach, the respondent is asked to peruse a range of values and to circle the highest amount they would be willing to pay. The respondent's true "point" valuation is inferred to lie somewhere in the interval between the circled value and the next highest option (Huhtala 2001). Payment cards are

easy to peruse, and they also reduce the effort needed to arrive at a bid. The design of the payment card can influence the results; the design process should take due care to minimize the problem of bias.

In the iterative bidding game an initial price for the goods or services is suggested to the respondent. The respondent is then asked to indicate whether of not he or she would pay. If the respondent indicates they would be willing to pay the amount specified then the price is raised and this process is repeated until a no is recorded. The highest dollar amount is recorded as the respondent's WTP. The bidding game gives the respondent an opportunity to think about the price, and the process (the bidding game) ultimately allowing the respondent to arrive at a more accurate WTP value (Cummings, Gerking, and Brookshire 1986).

The take-it-or-leave-it question (also called closed-ended, dichotomous choice, or referendum question) offer the respondent just one randomly assigned amount/price and asks the respondent for a simple yes or no willingness to pay that amount. The randomly assigned values dictate that a large number of responses be collected and careful empirical specification are required to identify estimated individual valuations. This method does not require much effort on the part of the respondent and it has the advantage of resembling ordinary market decision most people make on a daily basis (Mitchell and Carson 1989). The take-it-or-leave-it process can take the form of one round of questioning or an iterative process.

The payment elicitation format is a crucial component in the CVM. It should be designed in a format that is incentive compatible to the respondents. A payment elicitation

format is thought to be incentive compatible when the respondents have the incentive to thruthfully and fully reveal their preferences. When the respondent thinks that his or her behavior will have some impact on the study's results and future actions, the respondent has a positive incentive to behave truthfully and respond honestly. The hypothetical scenario presented to the respondent must have a degree of credibility to induce thruthful demand revelations. Champet al. (1999) note that emphasis on credibility rather than potential effects has been highlighted in previous studies.

3.3.3 Choosing The Payment Vehicle

Establishing the WTP in a hypothetical market scenario requires a payment mechanism. The payment mechanism is the means by which the respondent would hypothetically pay the amount specified in the valuation process. The respondent can be asked to pay their WTP in several ways such as higher taxes, higher product prices, or payments to a non-government foundation. The payment vehicle is chosen to match the characteristics of the hypothetical market created by the researcher.

3.3.4 Survey Methodology

The survey instrument may be given to or read to the respondent in person or over the telephone, or may be sent in the mail with a request to complete and return the instrument. The choice of method should be determined given the complexity of the scenarios, the need for careful explanation, the benefit of visual aids, and the need to control, pace or sequence the interview.

The advantage of the physical presence of the interviewer is the opportunity to motivate the respondent to cooperate fully with a complex or extended interview. The physical presence of the interviewer facilitates the use of visual aids that can help convey complex ideas or large amounts of information. Telephone and mail surveys are generally less costly than in-person interviews. The cost savings of a telephone methodology needs to be weighed with the potential information costs of the technique: the impersonality of the telephone and inability to use visual aids. Mail surveys as opposed to telephone interviews and in-person interviews have the advantage of avoiding the possibility of interviewer bias. They are vulnerable to serious sample non-response bias problems and to problems resulting from the self-administration of the survey, i.e. miss-interpretation or failing to understand questions (Mitchell and Carson 1989).

4. Methodology

This research was based on a contingent valuation of visitors willingness to pay for the preservation of the San Pedro Riparian National Conservation Area. The WTP was estimated from the results of a questionnaire-based survey of visitors at two key visitor locations. The survey included questions concerning visitation patterns, visitor expenditures, and general demographic information (Appendix A). The key component of the survey was a payment card eliciting visitor's willingness to pay based on a hypothetical scenario involving photographs depicting both healthy and degraded riparian habitat. The analysis of these data was based on a heteroskedastic tobit regression model to determine what variables influence the respondents willingness to pay for nature tourism.

4.1 Sample Frame And Data Collection

Due to the complexity of creating scenarios to elicit willingness to pay for something hypothetical, contingent valuation studies tend to address a much smaller sample size then that used for more traditional socio-economic surveys used to generalize to a population (Mitchell and Carson 1989). Unfortunately, contingent valuation studies require a relatively large sample size due to the large variance of WTP responses (Mitchell and Carson 1989). Leones (1998) provides a guide to determining an adequate sample size for visitor surveys (Table 4.1).

TABLE 4.1. Determining an adequate sample size.

Sample Size (n) = [(4 * Variance) / limit squared]
$= [(4*139.43)^2/ (11.02)^2$
$= 619$

The variance is the standard deviation squared and the limit is the amount we will allow the sample mean to differ from the population mean at the 15 percent confidence level. The standard deviation and mean are taken from a previous contingent valuation study that estimated WTP for the preservation of the riparian habitat of the SPRNCA and the continued existence of the gray hawk at the site (Kirchoff 1994). The determined sample size is close to the more general recommended minimum sample size of 600 usable responses for estimating benefits from WTP responses for policy purposes (Mitchell and Carson 1989).

The Upper San Pedro data collection spanned 5 months during which 843 surveys were collected. Of these, 551 qualified[1] as usable for the heteroskedistic tobit model, close to the sample size recommendations of Mitchell and Carson (1989). Ideally, to represent the annual population of tourists, the survey would have been administered throughout the entire year. However, interviews with key respondents familiar with nature tourism in the area revealed that the Spring migration of birds attracted the bulk of the annual visitation, followed by a secondary influx of tourists in late summer, early fall associated with the reverse migration. Due to project budget and logistical constraints, data collection was limited to these peak periods. Thus, the surveys were collected over the months February

through May, the spring bird migration season, and in August the return migration season. The surveys were carefully administered on varying week and weekend days and over different times of day during the months.

The target population for the survey were visitors living outside the Upper San Pedro River Basin. Residents of the area were administered a separate questionnaire (Appendix B) that did not figure into the contingent valuation. Resident surveys were omitted from the CVM study as the primary focus of this research was the economic influence of visitors from outside the study area. The contingent valuation questionnaire was administered at two key visitor focal points, the San Pedro House at the SPRNCA and the Ramsey Canyon Visitor Center on the Ramsey Canyon Preserve. These two sites were defined as among the most commonly visited spots by visitors, permitting access to a relatively high daily volume of visitors. In order to cover both locations simultaneously, we partnered with the Nature Conservancy volunteers at the Ramsey Canyon Preserve. In March 2001, we conducted a training with over 30 volunteers and then worked with the volunteers for two weeks. A "visitor contact sheet" was created to facilitate volunteer interaction with respondents (Appendix C,D). The contact sheet, each tailored to the specific site, explained the timing of visitor contact, how the survey would be introduced and explained, and how the results would be used.

On average, 6 questionnaires per day were collected by the Ramsey Canyon volunteers over approximately 70 days. Because we were unable to recruit volunteers at

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[1] See section 4.41 for a detailed discussion on why only 551 surverys qualified as "usable."

the San Pedro House, we conducted the survey ourselves, averaging 11 questionnaires per day across 40 days.

The total number of visitors to Ramsey Canyon over the course of a year was tallied through a Nature Conservancy visitor log at Ramsey Canyon. The equivalent was not available at the San Pedro House, as the conservation area has multiple access points unlike the single entry point at the Ramsey Canyon Preserve. The total visitor count for the San Pedro House was estimated based on the observed visitor patterns during the survey months, and adjusting those patterns by the % visitation volumes recorded by month at the Ramsey Canyon Preserve.

A visitor tally sheet (Appendix E,F) was used at both sites to track the number visitors approached as well as the number who agreed to participate in the survey. The tally sheet was also used to track repeat visitors, and visitors from the same household or group. Only one respondent was solicited per household and no more than three or four members of a group were asked to complete the survey. Any repeat visitors at either site were surveyed only once. Based on these guidelines, 84% of eligible visitors contacted participated in the study (Table 4.2).

TABLE 4.2. Summary of visitor contacts.

Study Site	Participants	Non-Participants			
		Same Household	*Repeat Visitors*	*Refusals*	*On trail-not approached*
San Pedro	405	276	63	80	790†
Ramsey Canyon	394	Not recorded	42	52	Not recorded
Wings Festival	43	Not recorded	Not recorded	7	Not recorded
Total (incl. Pretest)	843			139	

† The majority of visitors represented in this category are tour group visitors. No more than 3-4 visitors associated with any one group were invited to participate in the survey.

The mode of data collection for this survey followed the NOAA contingent valuation panel recommendations (NOAA 1993; Portney 1994) discussed in Chapter 3. The panel recommended that the application of contingent valuation rely on personal interviews rather than telephone surveys where possible, and on the telephone surveys in preference to mail surveys (Mitchell and Carson 1989). Each respondent was presented with a brief introduction describing the purpose of the study, brief details about the nature and length of the questionnaire, followed by details on the respondent's own role in the study if they chose to participate. The on-site collection allowed for the immediate completion of the surveys, clarification of any points of confusion raised by the participants while completing the survey.

4.2 Survey Instrument Design

The questionnaire was divided into four parts: visitation patterns, expenditures, willingness to pay payment card bid, and the socio-economic and demographic characteristics of the visitors (Figure 4.1; Appendix A). The sequencing of questions then flowed from the more general and less intrusive to the more specific and potentially more sensitive topics (i.e. personal income). The first section of the questionnaire was designed to help familiarize the respondents to with the study's subject matter. It included a graphic that defined the physical boundaries of the study area (Figure 1.2) and it also included questions on visitor travel patterns (Appendix A, pages 1-2). The second section of the questionnaire (Appendix A, page 3) elicited trip expenditure data, and information on the

number of nights and types of accommodation chosen by the visitors while visiting the study area.

The third section (Appendix A, pages 4-5) addressed the heart of the contingent valuation by eliciting responses that would be used to assess willingness to pay. This was accomplished by introducing a hypothetical scenario, followed by the WTP payment card, photographs of healthy and degraded riparian landscaped, questions on the visitor's anticipated change in visitation, and related WTP questions. The final section of the survey instrument addressed demographic and socio-economic concerns (Appendix A, page 6).

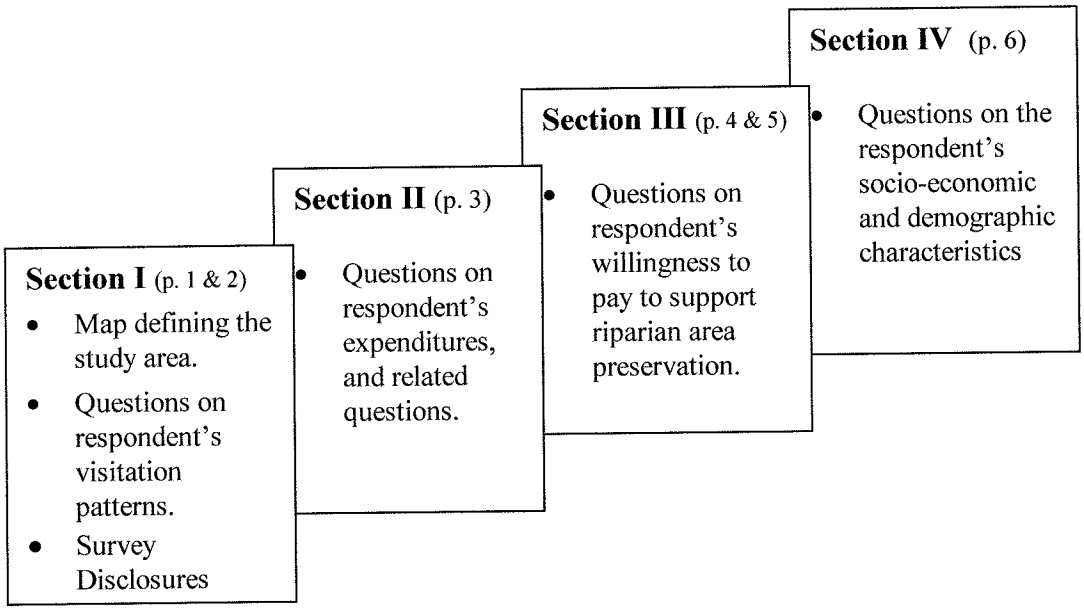

FIGURE 4.1. Structure of the survey.

The questionnaire was pre-tested in February 2001. The pre-testing took place at the SPRNCA and the Ramsey Canyon Preserve in order to administer the survey to respondents similar to those who would participate in the final sample. The pre-testing

allowed for polishing, trimming, rearranging, and other refinements of the instrument. Based on two days of data collection with 22 respondents, the pre-test clarified areas of respondent confusion and verified the time necessary to complete the survey and the acceptability of the overall subject matter.

4.3 The Constructed Market

The goal of the contingent valuation is to provide respondents with a context within which they can assess the value of something that is traditionally outside consumer markets. In this study, the "constructed market" involved the use of a hypothetical example. To understand how this scenario could be used to construct a contingent valuation market, it is necessary to define the scenario used, the payment vehicle and bid interpretation strategy, and the use of photographs in the scenario.

4.3.1 The Scenario

The survey respondents were presented with a market hypothetically constructed to fund the preservation of the SPRNCA. The market was presented to the participants with a hypothetical scenario that described: (1) the purpose of the proposed riparian area preservation initiative, (2) the baseline level of riparian ecosystem health and the increment in preservation given participation in the market, (3) the market institution, and (4) a value elicitation question asking the participant how much they would be willing to contribute to the riparian area preservation initiative.

To inform the respondents of the constructed market at hand and the preservation initiative being hypothesized, respondents were presented with a brief "scenario" of the

current status of and the threats to the preservation of the SPRNCA. The scenario began with a definition of the word riparian. The definition was presented in order to ensure uniform understanding and interpretation of the term riparian across all survey participants (see Appendix A for the complete survey):

> "The word riparian refers to an area where plants and animals thrive because of water availability at, or just below, the land surface. Water is the critical element. Without adequate water the riparian ecosystem will gradually degrade---represented in Photograph 2 (the Santa Cruz River, 50 miles east of the study area)."

The hypothetical scenario from which the WTP bid was being elicited immediately followed the introduction:

> "Congress created the 56,000-acre San Pedro Riparian National Conservation Area (RNCA) in order to protect and enhance this desert riparian ecosystem. The diversity of birds and other wildlife foundation the San Pedro RNCA is largely due to lush riparian forest along the river's bank, which depends on adequate water (Photograph 1). To remain healthy, this riparian area requires the continual movement of groundwater from the underground aquifer of the San Pedro River valley into the riparian area. It is this underground water that keeps the river flowing, even during long dry periods.
>
> Suppose that these water flows are threatened and a non-profit foundation has been formed to acquire water and to promote regional water conservation in order to maintain the San Pedro RNCA as it is today. If the foundation does not receive enough contributions from individuals like you, adequate water flows will not be available. Trees and other plants would begin to die, degrading the riparian habitat and reducing the abundance and diversity of birds and other wildlife (Photograph 2)."

4.3.2 The Payment Vehicle and Bid Interpretation

The value elicitation question immediately followed the scenario. The wording chosen for this question follows closely to the Water Resources Council's Principles and

Guidelines for Water and Related Land Resources Implementation Studies recommended wording (Mitchell and Carson 1989). The question asked the respondents to:

> "...check the most, you as an individual, would be willing to contribute to this non-profit foundation, in the form of a one-time contribution, in order to permanently preserve the San Pedro RNCA habitat as it is today."

Respondents could choose amount thirteen bid categories in a payment card-type format: $0, $10, $20, $30, $50, $75, $100, $150, $200, $300, $500, $750, $1,000, and a category "other amount: please specify". The bid categories were determined based on previous CVM studies of the riparian habitat of the SPRNCA. In theory, the payment amount chosen is not an exact statement of WTP but an indication that the WTP lies somewhere in the interval between the chosen amount and the next highest option (Huhtala 2001). The respondent's true "point" valuation lies somewhere in the interval between the indicated amount and the next highest option. The WTP point valuation used in this study followed this standard practice, but also estimated the WTP function based on actual WTP bids.

Finally, follow-up questions were presented after the value elicitation question and associated photos to determine reasons for positive or zero bids to the preservation initiative. Positive bidders were queried on where they would obtain the money for their hypothetical bid to insure they had fully thought through their bid. "Zero" bids were questions in order to distinguish valid WTP bids of "$00" or zero dollars from "protest" bids. A protest bid represents someone who objects to the hypothetical market for natural resources, while a valid bid of zero is someone who accepts the constructed market, but is not willing to pay for preservation.

4.3.3 The Use of Photographs

Photographs of the healthy and degraded riparian habitat directly followed the value elicitation question. The objective of the photos was to depict both healthy and degraded riparian area conditions. The first photograph depicted a reach of the San Pedro River in 1991 where the water table is high enough to maintain the riparian habitat (Figure 4.2). The second photograph represented a stream reach where water table decline has resulted in a degraded riparian area (Figure 4.3). For purposes of illustration, this photograph was of a reach of the Santa Cruz River (also in southeastern Arizona) in 1991. The photograph of a suitably representative site for a full-functioning riparian area along the San Pedro was provided by the BLM (BLM 1991). Barbara Tellman at the Water Resources Research Center at the University of Arizona provided the photograph of the degraded stream reach. Both rivers are located in southeastern Arizona, approximately 50 miles apart, the former representing a healthy riparian area, and the latter a degraded river ecosystem. While the scenario presented to the respondents for the San Pedro River was hypothetical, the degradation as represented by the photograph of the Santa Cruz River, in close proximity to the San Pedro River, is a reality.

The respondents based their willingness to pay for preservation on both the description of the SPRNCA and their assessment of the two photographs. They also indicated any changes in their anticipated visitation patterns to the SPRNCA over a two-year period should the riparian area be degraded.

FIGURE 4.2. Healthy riparian habitat supported by adequate water flows.
Photograph: Bureau of Land Management, San Pedro RNCA.

FIGURE 4.3. Degraded riparian habitat, due to inadequate water flows.
Photograph: B. Tellman, Arizona Water Resources Research Center, Santa Cruz River.

The use of photographs in survey research can provide essential information, particularly for contingent valuation where a hypothetical market must be constructed. However, evaluating photographs depends on fundamental assumptions that influence the effectiveness of the technique researchers (Handley and Ruffell 1993). Three important limitations must be highlighted in this case. First, it is difficult to ensure that photos in a pair differ only with respect to the most essential attributes and that the respondent interprets the differences in the photos to reflect the differences the researcher is trying to communicate. In the case of the two riparian area photographs, the primary focus is the difference in riparian vegetation. Second, it is not possible to measure from photos the levels of attributes in terms of management-relevant units. For instance, we cannot communicate the quantities of water needed to sustain the habitats as shown in the two photographs and thus we cannot estimate per-unit values of streamflows, which is precisely the result that would be more useful to inform water management decisions. Finally, the hypothetical example does not frame the time period within which the change associated with water table decline might occur. Despite these limitations, photographs do convey a meaningful contrast, quickly focusing and communicating to the respondents the nature of the change being defined by the scenario in question.

4.4 Statistical Estimation Methods and Analysis

The questionnaire and survey methods were designed to be consistent with NOAA (1993) recommendations for improved contingent valuation (Portney 1994). Table 4.3 summarizes those recommendations and the steps we took to try and address each.

TABLE 4.3. Implementation of the NOAA panel recommendations.

Recommendations	Implementation in this study of the SPRNCA
1. "Applications of the contingent valuation method should elicit willingness to pay to prevent a future incident rather than minimum compensation required for an incident that has already occurred.	WTP elicited.
2. Applications of the contingent valuation method should utilize the referendum format; that is, the respondents should be asked how they would vote if faced with a program that would produce some kind of environmental benefit in exchange for higher taxes or product prices. Then panel reasoned that because individuals are often asked to make such choices in the real world, their answers would be more likely to reflect actual valuations than if confronted with, say, open-ended questions eliciting maximum willingness to pay for the program.	Payment card format, eliciting a one-time contribution for riparian area preservation (question 11a).
3. Applications of the contingent method must begin with a scenario that accurately and understandably describes the expected effects of the program under consideration.	Definitions, descriptive passages, and photographs used.
4. Applications of the contingent valuation method must contain reminders to respondents that a willingness to pay for the program or policy in question would reduce the amount they would have available to spend on other things.	Reduced spending reminder included (questions 11f and 11g).
5. Applications of the contingent valuation method must include reminders to respondents of the substitutes for the "commodity" in question. For example, if respondents are being asked how they would vote on a measure to protect a wilderness area, they should be reminded of the other areas that already exist or are being created independent of the one in question.	Substitute commodity reminder included (question 11e).
6. Applications of the contingent valuation method should include one or more follow-up questions to ensure that respondents understood the choice they were being asked to make and to discover the reason for their answer.	Follow-up question included (question 11f).
7. Applications of the CVM should rely upon personal interviews rather than telephone surveys where possible, and on the telephone surveys in preference to mail surveys."	Survey was administered in person.

Source: Portney 1994, pp 9 and 10.

4.4.1 The Actual Willingness to Pay Bids

In a willingness to pay survey, not all surveys qualify as "useable". Reasons for disqualification include a) non-response to WTP questions, b) protest bids, c) inconsistencies among income-related variables, d) WTP reported at greater than 5% of income, and e) item-specific non-responses among other variables impacting the WTP model. Among the 843 surveys collected for this survey, a total of 292 surveys did not qualify as "usable".

The first step in identifying useable surveys for the WTP model was to identify all those questionnaires where no response was given to the value elicitation question. Of the 843 respondents, 70 supplied no response to this question. The second step in identifying useable surveys was to organize the remaining 773 surveys by payment card bid value category (Table 4.4), in order to separate out zero bids.

The zero bids were then reviewed to identify those which were actually protest bids. All respondents who bid $0 were asked in a follow-up question to choose a statement which best described *why* they were not willing to contribute toward the preservation initiative. Responses which demonstrated that a $0 bidder disagreed with the hypothetical scenario or the constructed market were considered protest bids. Zero bids were categorized as either protests or genuine zeros, depending on the motive given by the respondent (Table 4.5). A total of 45 protest zero bids accounted for 31% of all zero bids, and 6% of all zero and non-zero bids. Thus, the majority of respondents (the remaining 94%) found the hypothetical market to be realistic, and placed a positive monetary value in the form of a WTP bid for the riparian area preservation.

TABLE 4.4. Actual and valid bids by payment card bid value category.

Payment Card Bid Values	Actual Bids Frequency	%	Valid Bids Frequency	%
$0	145	18.7	100	13.8
$1	1	0.1	1	0.1
$5	8	1.1	8	1.1
$10	78	10.1	78	10.7
$20	93	12.0	93	12.8
$25	1	0.1	1	.1
$30	57	7.4	57	7.8
$50	163	21.1	163	22.4
$75	15	1.9	15	2.1
$100	128	16.6	128	17.6
$150	16	2.1	16	2.2
$200	27	3.5	27	3.7
$300	11	1.4	11	1.5
$500	19	2.5	19	2.6
$750	0	0	0	0
$1,000	10	1.3	10	1.4
$10,000	1	0.1	0	0
Total Valid Bids:	773	100%	727	100%

Table 4.5. Assessment of zeroWTP bids to identify protest bids.

Reason that best explains the zero bid	Valid Bids	Invalid/ Protest Bids
	No. of bids	**No. of bids**
I would not benefit from preservation of the San Pedro RNCA riparian habitat.	10	
Preservation of this riparian habitat should be undertaken at no cost to me.		9
I can go to other locations to enjoy riparian habitat and diverse bird and wildlife species.	9	
I need to spend money on other priorities.	36	
I did not fully understand what I was being asked to do.		2
I found the question offensive or implausible.		6
I'd rather make an annual contribution	1	
Other reasons:		
I already contribute to other organizations.	16	
Live elsewhere, and support local causes.	28	
Pay via admission fees and volunteering.		6
The government should pay via taxes.		7
Find a solution via the legal system.		1
Inadequate question and/or mechanism.		4
Don't know exactly.		10
Total Zero WTP Bids:	**100**	**45**

As described below the methodology also required an assessment of outliers and inconsistencies. If the respondent gave a positive bid, they had the opportunity to respond to a follow-up question evaluating why they gave a positive bid (Table 4.6).

TABLE 4.6. Reasons for a positive wtp bid.

Reason why the subset of people would pay	Total Surveys	
	No. of resp.	%
I am a regular visitor to the SPRNCA.	35	5.6
I plan to become a regular visitor to the SPRNCA.	14	2.2
I want this riparian area to be maintained so that others can enjoy it.	211	33.6
I receive satisfaction from knowing that this riparian habitat will be maintained.	290	46.3
Other reason.	35	5.9
No reason given.	42	6.7
Total	627	100%

Respondents were then asked to demonstrate where they would obtain the funds necessary to meet the bid they had projected. This question was designed to insure they had fully thought through the amount they had bid on the value elicitation question (Table 4.4). Among the seven key NOAA (1993) panel recommendations (Table 4.3) is the suggestion that applications contain reminders to respondents that a willingness to pay for a program or policy would reduce the amount they have available to spend on other things. Respondents were asked to identify a category of spending from which they would deduct their preservation contribution (Table 4.7).

TABLE 4.7. Categories of reduced spending to finance the wtp bids.

Categories of reduced spending	Total Surveys N	%
1. Groceries	18	2.9
2. Entertainment	140	22.3
3. Savings	55	8.8
4. Contribution to environmental causes	113	18.0
5. Vacation	119	19.0
6. Charitable contributions	22	3.5
7. Other	89	14.2
8. No answer	71	11.3
Positive WTP	627	100%

Note that 42 respondents (Table 4.6) and 71 respondents (Table 4.7) gave no answer to this follow-up questions, respectively. To insure valid WTP responses in these questionnaires, each was checked to determine if income, expenditure, and WTP were otherwise consistent. In all of these cases, the responses were logical and thus were included in the WTP model.

Respondents whose WTP answers were more than 5% of their household income (before taxes) were discarded as outliers (a criterion used by Tyrvainen, 2001). In this study, just one respondent exceeded this threshold, stating a WTP of $10,000 (the bid was made in the "other amount, please specify" category). This response was cross-checked to see whether the respondent had, in general, answered the survey logically and if the stated WTP was realistic with respect to the respondents stated income. Based on this criterion the $10,000 bid (reference survey RC522) was discarded as an invalid bid.

Finally, all other variables associated with the WTP model were evaluated for non-response. Using a listwise deletion (deletion of the entire record) of incomplete observations, a further 176 surveys were removed from the WTP model. Approximately half of these (84) were due to income, as a number of respondents were uncomfortable providing personal information. The remaining 92 were due to a variety of other variables that were used to explain willingness to pay. This resulted in a usable sample size of 551 for the WTP model. This deletion pattern is not uncommon for contingent valuation surveys where non-response rates of 20 to 30 percent for the WTP elicitation questions alone can be expected. The non-responses typically occur where (1) the sample includes people of all educational and age levels (2) the scenario is complex, and (3) the object of valuation is an amenity which people are not accustomed to valuing in dollars (Mitchell and Carson 1989).

These steps to insure a valid sample resulted in 551 useable surveys out of the original 843. The breakdown of steps and resulting valid samples is summarized in Table 4.8.

TABLE 4.8. Survey validation for the WTP model.

Total surveys collected		843
Missing wtp responses	(70)	
Protest zero bids	(45)	
Inconsistent responses	(0)	
5% criterion	(1)	
Listwise deletion		
Income	(84)	
Other	(92)	(292)
Usable surveys		551

4.4.2 Regression Analysis Methods

A WTP dependent variable can be analyzed in several ways, the most common being ordinary least squares or a tobit regression model. Ordinary least squares often proves to be inappropriate for contingent valuation studies where the data (1) are censored at the lower end (zero) and higher end ($1000) and (2) the willingness to pay values are not continuous data but interval (Greene 1997). The tobit model proposed by James Tobin ("Estimation of Relationships for Limited Dependent Variables, Econometrica, January 1958) is a nonparametric method often used when variables have extreme skews and thus do not meet parametric assumptions. The tobit model is therefore the more theoretically correct method for WTP data sets (Halstead 1991).

The tobit model is a censored regression model. The important feature of a censored data set is that the data are available on the entire sample but the dependent variable is censored at some value. Censoring occurs where the dependent variable, but not the independent variables, are observed within a restricted range so that all observations on the dependent variable which are below or above a threshold level are treated as if they were on the threshold (Breen 1996). In a model censored at both a lower and upper threshold, the values below or above the threshold correspond to censored observations while the intermediate values correspond to actual transactions.

In this study the form of tobit model employed was a two-limit censored regression model discussed in Maddala 1983, originally presented by Rossett and Nelson in 1975 (Maddala 1983). Johnston and DiNardo (1997) suggest a formal test to determine if indeed a tobit model is the correct choice. The test involves a comparison of ratio

likelihood estimates of the betas divided by the estimated standard errors across a probit and a tobit model. The results should be comparable when treating all positive bids as one in the probit model. In this study, the results from the statistical software LIMDEP (version 7.0) were similar suggesting the tobit model is not mis-specified. The variables specified in the model were guided by economic theory (Table 4.9). Most variables are taken directly from the survey questions. Several variables were included in logarithmic form depending on which provided a better fit. One variable, called "repeat_visitor," was created by combining the responses of two questions. This dichotomous variable was created to determine the sub-sample of visitors that had visited the study area previously, and would return to the SPRNCA (within a two-year period) if the riparian area remained in its current healthy state. By this classification, an individual is considered an active/repeat visitor if he or she visited the study area previously and anticipated a return visit.

TABLE 4.9. Definitions of variables and expected signs.

Variable	Description	Type	Expected Sign
wtp_actual	Actual stated willingness to pay (WTP) ---the dependent variable in this payment card WTP contingent valuation model	Discrete	
wtp_interval	Assigned interval of willingness to pay (WTP) --- the dependent variable in this payment card WTP contingent valuation model	Discrete	
purpose_trip	Purpose of trip to the study area (1=birding was the main purpose, 0 otherwise)	Dummy	+
ln_days_birding	The natural log of the number of days spent birding per year	Continuous	+
change_visits	Change in visitation if the riparian area is degraded	Discrete	-
ln_income_mid	Natural logarithm of income	Continuous	+
exp_pp_pd	Expenditure per person per day	Continuous	+
gender	Respondent's sex (1=female, 0 otherwise)	Dummy	+/-
ln_age	Natural log of the age of the respondents	Continuous	+/-
employ_full	Employment status (1= full-time, 0 otherwise)	Dummy	+
retired	Employment status (1=retired, 0 otherwise)	Dummy	+
education	Level of education (1=Graduate education, 0 otherwise)	Dummy	+
member	Membership of conservation/environmental organization (1=yes, 0 otherwise)	Dummy	+
repeat_visitors	Repeat visitors (1 = yes, 0 otherwise)	Dummy	+

In regression analysis, the presence of heteroskedasticity, or nonconstant variance of the error term, is problematic, particularly when analyzing censored regression models. This is because least squares estimators are consistent, though not efficient, under heteroscedasticity, whereas censored estimators are neither consistent nor efficient (Breen 1996; Amemiya 1984). Tests comparing a regular and a heteroskedastic tobit were conducted for the purpose of this analysis. The signs of the coefficients and the statistical significance of the coefficients were used to guide the model choice. The likelihood ratio test was used to evaluate the appropriateness of the heteroskedastic tobit regression.

The likelihood ratio test is based on the log likelihood values of the model. The log likelihood values represent the likelihood the data would be observed given the parameter estimates. The larger the value, the closer the negative value to zero, the better the parameters do in estimating the observed data. However, the likelihood value cannot be used directly to evaluate a model as the value increase the number and effectiveness of parameters, inaddition to the goodness of fit, and therefore the likelihood ratio test is used Pampel, 2000).

The likelihood ratio test compares a baseline (restricted model) with an unrestricted model. In this analysis, a baseline or restricted log likelihood was calculated from including only a constant term in the model. The resulting log-likelihood was used as the restricted log-likelihood (L_0). The baseline model was compared with an ordinary tobit model with a constant and the relevant independent variables (but uncorrected for heteroskedasticity). The greater the reported difference between the baseline log likelihood (restricted tobit) and the model log likelihood (unrestricted tobit), the more likely the model coefficients will (along with the independent variables) produce the observed sample values. The difference in the baseline and model log likelihood values evaluate the null hypothesis that beta coefficients simultaneously equal zero ($b_1 = b_2 = ... b_k = 0$), determining whether the difference is larger than would be expected from random error alone (Pampel 2000).

Taking the difference between the baseline log likelihood and the model log likelihood and multiplying that difference by -2 gives a chi-square value with degrees of freedom equal to the number of independent variables (Menard, 1995). The number of

independent variables does not include the constant, but including squared and interaction terms. Comparing the resulting value with the chi-square table significance value tests the null hypothesis that all coefficients other than the constant equal zero. The larger the chi-square value (for a given degree of freedom), the greater the model improvement over the baseline model, and the less likely it is that all the coefficients of the variables in the population equal zero (Pampel 2000).

The coefficients specified in the regular tobit model was then run with the correction for heteroskedasticity. The likelihood ratio test was computed again based on the difference in the likelihood without and with the correction for heteroskedasticity. The model chi-square χ^2 was significant therefore the tobit coefficients from the analysis that includes heteroskedasticity are the correct specification (He 2001). It should be noted that the formula for pseudo R^2 (as presented by STATA, a second statistical package used to verify the analysis) is in effect, a reworking of the model chi-squared χ^2, which is $2(L_1-L_0)$. Therefore, this research reports the model chi-squared and its p-value, not the pseudo R^2 (Sribney 1997).

Multicollinearity, or the extent to which the data are collinear, was another estimation problem that was addressed in this research. Collinearity or multicollinearity is a problem that arises when independent variables are correlated with one another. While collinearity is easy to detect, there are few acceptable remedies (Menard 1995). The backward selection technique was used to deal with multicollinearity in this study. The backward selection technique provides every independent variable a chance to have a statistically significant effect by eliminating (one at a time) the variable(s) with the weakest

effect until the model reaches the acceptable level (no obvious collinear problem). The logic is to let the variance shared between the dependent variable and the weakest independent variable sort itself out among other independent variables. This technique is not without it's limitations as relevant variables may be deleted and insignificant variables may subsequently be reported as significant.

The tobit coefficients that are typically produced by tobit estimation routines in most software packages relate directly to the unobserved latent variable, WTP*. The WTP* is a (partially) latent variable which is observable only for values above or below the threshold. The reported coefficients show the effect of a change in a given independent variable on the expected value of the latent variable, holding all other independent variables constant. The tobit ß's can therefore be interpreted in the same way as the ß's from an ordinary least squares regression (OLS) with respect to the partially latent variables (Breen 1996). The tobit coefficients reported in this research are interpreted in relation to the underlying latent variable (WTP bids for non-censored observations and the unobservable observations above and below the censor points) that might be considered as the household's propensity or willingness to pay for riparian area preservation.

4.4.3 Aggregate WTP

In this survey, data were collected for only one incremental change in riparian area quality, thus a marginal benefit curve could not be constructed for differing levels of riparian habitat quality. Instead, the average individual WTP estimated was applied to the total visitation to estimate the aggregate WTP for riparian habitat preservation. This

procedure of using the mean WTP is commonly used in CVM studies (Strol and Johnson 1984; Sanders, Walsh, and Loomis 1990; Crandall, Colby and Rait 1992; Kirchoff 1994). To estimate the aggregate total benefits associated with the preservation of the riparian habitat of the SPRNCA, the average WTP estimate was multiplied by the estimated total annual visitation at the two visitor contact points. This procedure assumes that the bid formation and visitor characteristics do not vary seasonally and that the sampling points (Ramsey Canyon and the San Pedro House) are spatially representative of visitors to the two sites.

5. Empirical Results

5.1 Visitor Travel Patterns, Preferences And Profiles

The travel patterns preferences and profiles of the 843 nature-based tourists are summarized from the survey responses. This information is presented to more fully describe the population of visitors touring the Upper San Pedro River Basin. These data and associated descriptive statistics provide the foundation upon which the WTP model was designed and executed.

The visitors surveyed at the San Pedro House and the Ramsey Canyon Preserve ranged in age from 18 to 92 years (Table 5.1). The mean age of the visitors participating in the survey was 55 years, and almost half had completed graduate or professional school (Table 5.2). The survey population was divided evenly divided between full-time and retired persons (Table 5.3). The mean household income of these respondents (before taxes) in the year 2000 was $94,000. Over 72% of the survey respondents indicated they were members of organization that supported conservation, environmental or wildlife concerns. The organizations most often cited were the Nature Conservancy, the Audubon Society, and the Sierra Club.

TABLE 5.1. Age distribution of survey respondents.

Age (in years)	Frequency	%
18-29 years	14	1.7
30-39 years	79	9.8
40-49 years	165	20.5
50-59 years	224	27.8
60-69 years	217	26.9
70-79 years	93	11.6
80-89 years	12	1.5
90 and older	1	0.1

TABLE 5.2. Level of education of the survey respondents.

Level of Education	Frequency	%
High School	39	4.8
Some College/technical School	102	12.7
Completed College/Technical School	197	24.5
Some Graduate/Professional School	102	12.7
Completed Graduate/Professional School	364	45.3

TABLE 5.3. Employment status of survey respondents.

Employment Status	Frequency	%
Employed full-time	358	43.9
Employed part-time	80	9.8
Retired	335	41.1
Homemaker	23	2.8
Unemployed	14	1.7
Student	5	0.6

The average group size of visitors frequenting the Ramsey Canyon Preserve and the Nature Conservancy was 3.6 persons, with a range from 1 to 40 persons per group, and a median of 2. The groups observed as visiting the SPRNCA during the study period included the Elder Hostel, Geronimo Educational Travel Studies, Cub Scouts, BLM researcher trainees, Columbia University and University of Arizona student field trips,

locally organized equestrian tours, Botanical Gardens Society of Tucson, Friends of the San Pedro guided tours, and many school groups.

On average overnight visitors spent 4.7 nights in the study area. During their stay 66% of the visitors chose accommodation in Sierra Vista, 16% in Benson, the remaining in St. David, Bisbee, Tombstone and other locations. The overnight visitors primarily chose hotels and motels (38%) and recreational vehicle (RV) parks and campgrounds (35%) for their accommodation. The remaining visitors stayed at the homes of family or friends, at Bed and Breakfasts, or at other types of accommodation.

Of all visitors sampled, 52% were repeat visitors to the Upper San Pedro River Basin. Repeat visitors were defined as those who traveled to the study area during the years 1999 and 2000, and anticipated returning to the SPRNCA within a two-year period. In terms of actual visits, the 434 repeat visitors visited the basin 1,337 times in 1999 and 2000, an average of 1.58 visits per person.

Why did the visitors travel to the Upper San Pedro River Basin? The vast majority of respondents (87%) tie the purpose of their visit to birding as either the main purpose of their trip (62.7%) or one of several important reasons (24.3%) (Table 5.4).

TABLE 5.4. Purpose of visit to the Upper San Pedro River Basin.

Reason that best describes the purpose of the trip	Frequency	%
Visiting birding sites/natural areas is the main purpose for this trip.	528	62.7
Visiting birding sites/natural areas is one of several important reasons for this trip.	205	24.3
I visited the study area for other reasons and just happened to make a side-trip to birding sites/natural areas.	109	12.9

The respondents were also asked to indicate the primary reason for visiting birding sites and natural areas, as opposed to visiting the study area in general. The birding sites and natural areas specifically mentioned were the SPRNCA, the Ramsey Canyon Preserve, Garden Canyon, Carr Canyon, Coronado National Memorial, Beatty's Orchard, Miller Canyon, and Kartchner Canyon. A total of 468 (57%) respondents noted general birding as the single most important reason for visiting specific birding sites and natural areas. A further 65 respondents (8%) noted that looking for a specific bird was the most important reason. In total bird watching motivated 65% of the respondents to visit one or a number of the birding sites and natural areas in Upper Basin. Besides the SPRNCA and the Ramsey Canyon Preserve, Garden Canyon and Miller Canyon were cited as the most frequented natural areas (Table 5.5) Walking, hiking, and viewing wildlife, enjoying the riparian area, and visiting archeological and historical sites accounted for the remaining visitors.

TABLE 5.5. Frequency of visits to natural areas.

Sites Visited (other than the survey collection sites)	Number of Visits
Garden canyon	254
Miller Canyon	215
Beatty's Orchard	190
Coronado national Memorial	146
Carr Canyon	139
Kartchner Caverns State park: Trails	75
Kartchner Caverns State Park: Cave tours	79
Other sites frequently mentioned were French Joe Canyon and the Saint David Monastery.	85

5.2 WTP Regression Model

Willingness to pay for riparian area preservation was estimated and explained through a regression model selected to reflect the nature of the data. Regular tobit and heteroskedastic tobit regressions were estimated using the statistical software LIMDEP (version 7.0). The heteroskedastic tobit model was estimated due to the extreme sensitivity of the tobit regression to heteroskedasticity. Conducting the likelihood ratio test between the regular tobit and the heteroskedastic tobit determined that the regular tobit model be rejected in favor of the heteroskedastic model, i.e. the results with a heteroskedastic error term were chosen because the likelihood ratio test strongly rejected homoskedasticity (Table 5.6). The likelihood ratio test result for the heteroskedastic tobit is $\chi^2(6) = 199.36$. The critical value at the 0.5% significance level is $\chi^2_{0.005}(6) = 18.54$.

TABLE 5.6. Likelihood ratio tests.

Constrained versus Regular Model (6df)	Baseline Model LL_0	Regular Model LL_1	$-2(LL_0 - LL_1)$
	-3,240.91	-3,183.18	-2[(-3240.91- (-3,183.18)] = 115.46
Regular tobit (6df) versus Heteroskedastic tobit (6df)	Regular Model LL_1	Heterskedastic Model LL_2	$-2(LL_1 - LL_2)$
	-3,183.18	-3,083.92	-2[(-3,183.18 - (-3,083.92)] = 198.52

The heteroskedistic tobit model contained six independent variables regressed on the dependent variable WTP (Table 5.7) The model included behavioral, demographic, and economic variables.

TABLE 5.7. Willingness to pay heteroskedastic tobit model.

Dependent variable	WTP (actual)
Number of observations	551
Iterations completed	141
Log likelihood function	-3,083.923
Lower Bound	0.00
Upper Bound	1,000.00

Variable	Coefficient	Standard Error	b/se	P[|Z|>z]		Mean of X
Primary Index Equation for Model						
Constant	-27.454	99.326	-0.276	0.782		
ln_income	22.573	8.260	2.733	0.006	***	11.159
expenditure	0.571	0.217	2.629	0.008	***	63.739
repeat_visitor	37.388	15.600	2.397	0.016	**	0.434
ln_age	-53.629	26.122	-2.053	0.040	**	3.949
ln_days_birding	5.161	3.896	1.327	0.184		2.824
member	-0.61	14.250	-0.043	0.965		0.773
Heteroscedasticity Term						
ln_income	0.213	0.044	0.000	0.000		11.159
expenditure	0.007	0.000	0.000	0.000		63.739
repeat_visitor	0.370	0.041	0.000	0.000		0.433
ln_age	-0.170	0.093	0.069	0.097		3.949
ln_days_birding	0.068	0.014	0.000	0.000		2.824
member	0.238	0.065	0.003	0.003		0.773
Disturbance standard deviation						
Sigma	8.579	5.441	1.577	0.114		

* Significant at 10% confidence level
** Significant at 5% confidence level
***Significant at 1% confidence level

The economic variable "income" was included in the model in logarithmic form. The variable was positive and significant, indicating that WTP increased as income increased. This finding holds with economic theory. Those respondents most able to pay for preservation were more likely to state positive and higher WTP amounts—riparian area preservation is a normal good.

A second economic variable "expenditure" per person per day while in the study area was also specified in the model. This variable was positive and significant. The higher the visitor's expenditures in the study area, the higher their WTP. The amount visitors will pay to actually travel to and enjoy the areas is positively linked to their WTP to preserve it.

The first behavioral trait addressed was the dichotomous variable "repeat_visitor," which represented respondents who had visited the study area in 1999 and 2000, and intended to return to visit the SPRNCA within a two year period, given the riparian area remained healthy. A positive response to this dummy variable suggests a high propensity to visit the study area. The positive sign of the "repeat_visitor" variable indicates that the more active the visitor, the higher the willingness to pay. This finding suggests that repeated visitation (repeated non-consumptive use of the resource) is a positive influence in WTP contributions, however, other survey data qualify this interpretation. Question 11h, a follow-up question to the WTP bid, asked the respondent to indicate the one reason that best described their WTP for riparian area preservation (NB: this question only pertained to respondents who made a positive bid and thus could not be included in the final model). Less than 8% of the respondents indicated that being a regular visitor or intending on becoming a regular visitor was the one reason that best explained their contribution. Meanwhile, 80% of the visitors indicated existence value as the reason best explaining their contribution (Table 5.8). In this context, the significance of the "repeat_visitor" variable is interpreted to mean the more active the visitor (number of repeat visits), the higher the WTP, but their motives generally are based on existence

values rather than repeated use values. The second behavioral variable "days bird-watching" in logarithmic form is not significant.

TABLE 5.8. Repeated use versus existence value.

Motive	Question 11h. Reason for WTP contribution	Total Surveys No. of responses	%	
Repeated Use Value	I am a regular visitor to the SPRNCA.	35	5.6	
	I plan to become a regular visitor to the SPRNCA.	14	2.2	7.8
Existence Value	I want this riparian area to be maintained so that others can enjoy it.	211	33.6	
	I receive satisfaction from knowing that this riparian habitat will be maintained.	290	46.3	79.9
Other	Other reason.	35	5.9	
	No reason given.	42	6.7	12.6
	Total	627	100%	100%

The variable “age” in logarithmic form is significant but negative. If this variable is linked to repeated use, it would intuitively suggest that as visitors get older they are less likely to visit the riparian area and less willing to contribute to preservation. This interpretation appears at odds with the earlier finding that existence and not repeated use value is the one reason that best explains why respondents were willing to contribute. A scatter-graph plotting age against the reasons for WTP contributions highlights that respondents 40 years and older almost exclusively account for the subset of respondents who indicated personal repeated use was their primary reason for contributing, shedding some light on the model results that age negatively influences WTP.

The variable "member" represented respondents who were members of an organization that supports conservation, environmental or wildlife concerns. The

membership variable was not significant. This finding suggests that philosophical and active support of environmental causes through organization membership does not influence WTP.

Overall the results suggest that there are statistically significant and theoretically justified relationships between WTP responses and some of the specified explanatory variables. This adds to the validity of using the model-estimated coefficients to calculate the average mean WTP measure. The model estimated mean WTP is $79.31, in the form of a one-time contribution for preservation of the SPRNCA. It is interesting to compare this model-generated estimate with the mean WTP generated from direct descriptive statistics on the raw *wtp* data. That mean was $78.50 (Table 5.9). These two figures are almost identical, suggesting the model accurately predicts willingness to pay.

TABLE 5.9. Raw willingness to pay bids: summary statistics.

Variable	Obs	Mean	Median	Standard Deviation	Min	Max
wtp actual	727	78.50	50	141.6436	0	1,000

5.3 Aggregate WTP

The data collected pertained to only one incremental change in riparian area quality. Given this data limitation the marginal benefit curve could not be constructed. However, the estimated mean individual WTP can be applied to the total visitation to estimate the aggregate WTP for riparian habitat preservation across all visitors. In this study, the aggregate WTP refers only to the annual visitors frequenting the Ramsey Canyon Preserve and the SPRNCA (from the San Pedro House access point) (Tables 5.11

and 5.12). Aggregate benefits across all visitors to the Upper San Pedro River Basin was not estimated due to limited visitation data.

The procedure of using the mean WTP has been used in other contingent valuation studies (Strol and Johnson 1984; Sanders, Walsh and Loomis 1990; Crandall, Colby and Rait 1992; Kirchoff 1994). The aggregate total benefits represent the mean WTP multiplied by the total annual visitation at the two visitor contact points. It was assumed that the model variables and the pertinent visitor characteristics did not vary seasonally.

The visitor patterns at the Ramsey Canyon Preserve were estimated using a sign-in log at the visitor's center, the only entrance point to the preserve. Most visitors are invited to sign the log on arrival at the preserve. The visitors are asked to note where they had departed from for the trip. This information was used to destinguish resident and non-resident visitors and to estimate an annual non-resident visitor count for the preserve.

TABLE 5.10. Monthly non-resident visitor counts-Ramsey Canyon Preserve.

Month	Non-Resident	%
June 2000	1,250	7.7
July 2000	1,550	9.6
August 2000	1,150	7.1
September 2000	1,050	6.5
October 2000	850	6.3
November 2000	1,000	6.2
December 2000	800	5.0
January 2001	725	4.5
February 2001	1,200	7.4
March 2001	2,100	13.0
April 2001	2,450	15.2
May 2001	2,025	12.5
Total per log book	**16,150**	**100%**
Estimated one in five visitors who did not sign the log	3,230	20%
Total estimated visitation	**19,380**	**100%**