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Valuing the Verde River Watershed: An Assessment

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Valuing the Verde River Watershed: An Assessment

Introduction

The Verde River creates a vibrant and verdant series of ecosystems in central Arizona, supports numerous communities, and faces rapidly growing threats. The river is the last remaining mostly free-flowing river in otherwise arid Arizona. The challenges facing the stakeholders of the river and its environs are numerous and complex. In what we proposed as an preliminary study of the ecosystem services of the Verde River and its watershed, we have conducted numerous interviews, based on a questionnaire and a semi-structured interview with a variety of community leaders. From the interviews we have developed specific recommendations for further research in valuing the watershed and educating its stakeholders. The interviews and the resulting list of values herein are the first step in a valuation study of the Verde River watershed. Next steps include determining metrics for subsequent valuation studies and determining what specific studies will aid decision-makers in the region. The next step would include securing funding and developing a research team to complete specific valuation studies aimed at providing information to decision-makers for more informed decisions about the Verde River and its watershed.

The communities throughout the Verde Valley (Cottonwood, Jerome, Clarkdale, Cornville, Sedona, Rim Rock, and Camp Verde), Chino Valley, Prescott, and Prescott Valley are growing rapidly. The impacts of population growth are of great concern to residents. The watershed drains approximately 6,600 square miles and runs 140 miles (Arizona NEMO 2005, Arizona Department of Water Resources 2008). The Big Chino and Little Chino Aquifers initiate the majority of the flow of the river and combine with tributaries to form the discharge and recharge system for the watershed system. This system provides drinking and irrigation water for the local communities and the Phoenix area and supports various distinct ecosystems that include endangered species. As pressures on the watershed increase, there is an increasingly active public debate as to the management processes required to maintain the competing water flows, the water quality, and the habitat. Investigating these competing and in many instances mutually exclusive ends is the purpose of this study.

We first present a brief description of the watershed for readers not familiar with the geography of central Arizona. This is not intended to be a complete description of the watershed, the relevant ecosystems and geological formations. Such information is readily available from numerous authors and entities. In order to create a valuation for the watershed, a brief review of the literature is provided to frame the discussion that follows. A survey instrument was created and administered to 35 individuals knowledgeable about the watershed. A discussion of the survey instrument and the methodology of the analysis follow the literature review. Subsequent to the interviews, the extensive data were reviewed and an analysis of this review is presented. Finally, a series of recommendations is presented regarding important areas for further research. The intersecting areas of ecosystem management, geology, population dynamics, and economic development are all important to a comprehensive watershed management program.

Description of the Verde River Watershed

The Verde River watershed (watershed), located in the heart of Arizona is a complex and dynamic system. The watershed ranges from 1,323 to 12,617 feet above sea level over its 6,622 square miles (Arizona NEMO 2005). The watershed has over 9,037 mile of streams, but "only 6% (578 miles) of streams are perennial, and are mostly restricted to the main stem of the Verde River" (Arizona NEMO 2005).

From the headwaters in the Chino Valley to Horseshoe and Bartlett Reservoirs, the Verde River is free-flowing and "unlike many rivers in the West, most of the watershed is unregulated (no significant dams) and thus retains a natural flood regime (Pearthree 2008)". The 40.5-milesection of the Verde River between Beasley Flats and Sheep Bridge is designated as "Wild and Scenic." This stretch of river is the only designated "Wild and Scenic" river in Arizona. "Before a river corridor can be considered for

designation as either a Recreation, Scenic, or Wild River Area, the Wild and Scenic Rivers Act (P.L. 90-542) requires a determination that the river and its immediate environments possess one or more specific 'outstandingly remarkable values.'[1] The Environmental Impact Statement approved in 1981 for the Verde River found that this portion of the river corridor contained outstandingly remarkable scenic, fish & wildlife, and historic & cultural values" (National Wildland and Scenic Rivers System 2007).

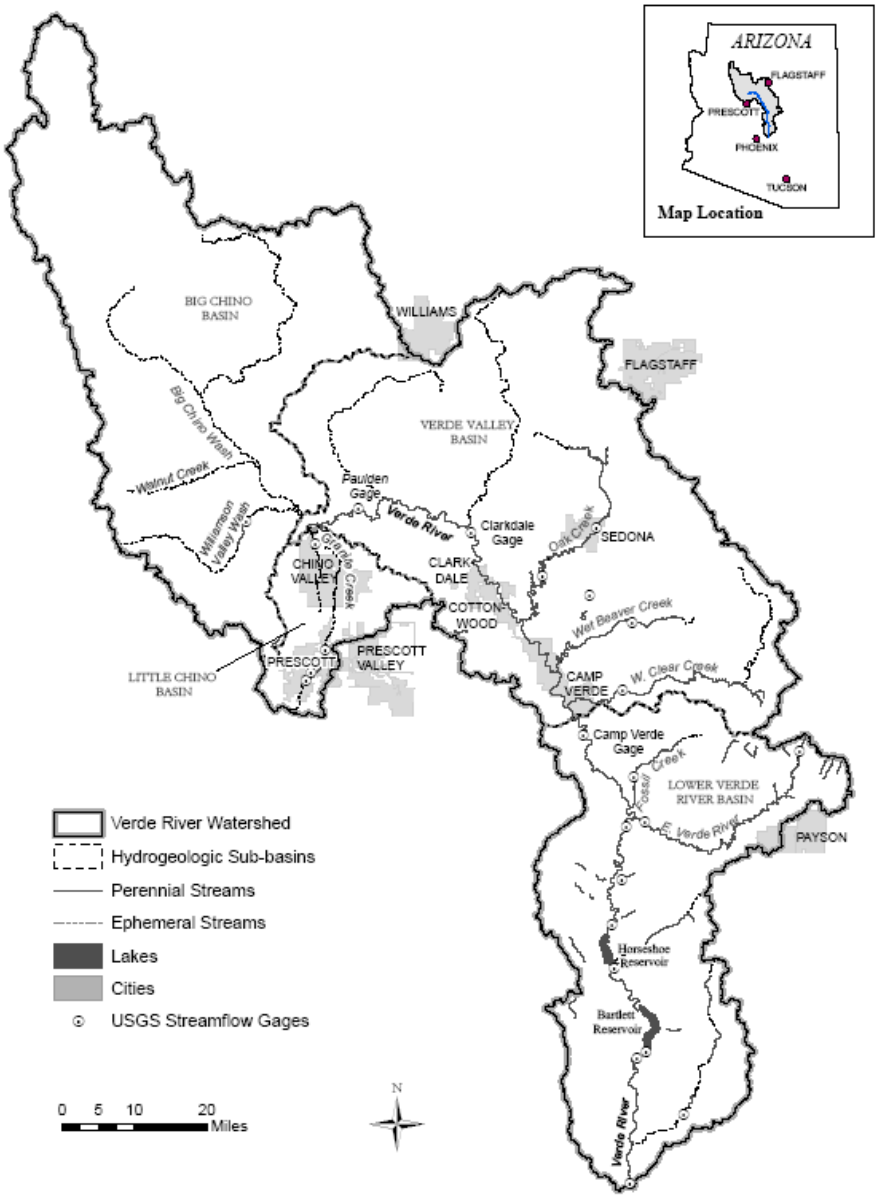

Figure 1: Map of the Verde River Watershed printed with permission by The Nature Conservancy (Springer & Haney 2008).

[1] It should be noted that Arizona wholly contains the Grand Canyon!

Hydrology and Watershed Health

The Verde River Watershed is made up of three subbasins: The Upper, Middle and Lower Verde Watersheds. The discharge at the Verde River springs that feed the perennial start of the river comes from the Big Chino (80%) and the Little Chino (14%) aquifers, as well as a small percentage from surface runoff (Wirt *et al.* 2005, Springer and Haney 2008). "The Big Chino subbasin, in that upper Verde River Watershed is 1850 square miles in area. The Little Chino subbasin in the upper Verde River watershed is the smallest of the three subbasins in the study area and has had the greatest groundwater development" (Blasch *et al.* 2006). Additional groundwater, tributaries, and surface water contribute to the base flow, especially after the first 26 miles (Wirt *et al.* 2005). Human uses and climate conditions affect the base flow and have both contributed to declines in the base flow since 1994 (Springer and Haney 2008). Decreases in base flows can produce many effects on people, flora and fauna, and ecological processes in the Verde River Watershed. One of the changes predicted is a decline in cottonwood and willow abundance (Haney *et al.* 2008).

Arizona Nonpoint Education for Municipal Officials (NEMO) (2005) conducted a watershed-based plan that concluded that "the primary sources for nonpoint source pollutants concerns in the Verde Watershed include abandoned mine sites, new development and increased urbanization, and new road construction." Other threats to the watershed included livestock grazing (Fossil Creek and Cherry Creek), animal wastes and failure of residential septic systems (across the watershed) (Arizona NEMO 2005).

Social/Economic Characteristics

The Verde Watershed spans four counties (Coconino, Gila, Maricopa and Yavapai), although 50% of the watershed is in Yavapai County (Arizona NEMO 2005). The watershed is primarily rural with several urban areas (Sedona, Prescott, and part of Scottsdale), although our study focuses on the upper and middle sections of the watershed (Arizona NEMO 2005). Land managers of the watershed include Forest Service (64%), private landowners (23%), state trust (9%), tribal lands (2%), military (1%), local and state parks (1%), and other (<1%) (Springer and Haney 2008).

The Verde Valley Tourism Survey, conducted from 2006-2007, indicates, "At least one third of the visitors to the Verde Valley came from Arizona (31%)…" (Arizona Office of Tourism 2008). "Visiting state and national parks and visiting historic places were the most popular activities for visitors to the Verde Valley. These were followed by hiking and shopping, bird watching and observing wildlife, and enjoying area streams and rivers" (Arizona Office of Tourism 2008). Aside from shopping, these activities are directly related to the natural beauty of the Verde Valley and often directly linked to the Verde River itself. Visitors to the area bring an estimated "indirect economic impact of $103.8 million and induced impact of $139 million for a total economic impact of $772 million" (Arizona Office of Tourism 2008). The visitors supported 12,130 direct and indirect jobs in the area (Arizona Office of Tourism 2008).

Water Rights

The majority of the rights to the water in the Verde River are held by the Salt River Project (SRP) which consists of the Salt River Valley Water User's Association and the Salt River Agricultural Improvement and Power District (Gooch *et al.* 2007). The shareholders of SRP are the major downstream senior water rights holders on the Verde River Watershed. The predecessor's of the SRP established flow rights as early as 1869, and since its establishment in 1903, SRP has had an interest in maintaining the flows that the shareholders rely upon. Recently, SRP has attempted to maintain the flow by assisting those extracting water from the river illegally to find water elsewhere. When these negotiations have failed, SRP has been forced to litigate to defend the rights of its shareholders.

Biological Attributes

Flora

The Verde Valley is home to many unique plant species and ecosystems which have great intrinsic value, but also serve as habitat for an number of animal species (Stevens *et al.* 2008). Bailey (2002) classifies the vegetation cover in the Verde River Watershed in the "Dry Domain" with the most prominent division being the Tropical/Subtropical Steppe Division (70%) (Arizona NEMO 2005). Brown, Lowe and Pace (1979) classified the vegetation in 9 different biotic communities, the most common being the Great Basin Conifer Woodland (Brown *et al.* 1979, Arizona NEMO 2005). Within this watershed, Arizona Game and Fish identifies 10 types of riparian areas in the almost 14,000 acres. Cottonwood-willow areas cover only 0.13% of the riparian area of the watershed, but are among the riparian types that are more widely used in the watershed by non-fish vertebrates, and are the second most sensitive riparian habitat to changes in streamflow (Stromberg 2008, Stevens *et al.* 2008). These ecosystems provide habitat for the multitude of wildlife found in the watershed including many threatened and endangered species. There are no federally-listed, rare or endemic plant species known to occur in riparian areas in the watershed (Stromberg 2008). The one federally-listed threatened endemic plant in the watershed is the Arizona Cliffrose (*Purshia subintegra*) that has a range limited to a few small limestone outcrops in the Verde Valley.

Fauna

"The Verde River supports an enormous diversity of Arizona's invertebrate and vertebrate species, but anthropogenic activities pose immediate and potentially irrecoverable threats to its aquifers, surface flows, habitat availability and connectivity" (Stevens *et al.* 2008). Of special concern are the threatened and endangered species that make the watershed their home.

The Verde River Watershed is seasonal home to over 248 species of birds (Schmidt *et al.* 2005, Stevens *et al.* 2008). The Verde River Watershed is home to two endangered bird species: the Desert Nesting Bald Eagle (*Haliaeetus leucocephalus*), and the Southwestern Willow Flycatcher (*Empidonax traillii extimus*); and is home to the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) which is a candidate species for listing (Schmidt *et al.* 2005).

Native fish species are threatened by changes in the Verde River.[2] "Historically, at least 13 natives fish species occurred in the Verde River basin, including: Gila trout (*Onchorhynchus gilae*); desert and Sonora suckers (*Catognisus clarki* and *C. insignis*, respectively); speckled dace (*Rhinichthys osculus*); razorback sucker (*Xyrauchen texanus**); longfin dace (*Agosia chrysogaster*); Gila, headwater, and roundtail chubs (*Gila intermedia**, *G. nigra*, and *G. robusta***); spikedace (*Meda fulgida**); Colorado pikeminnow (*Ptychocheilus lucius*); loach minnow (*Tiaroga cobitis*)*; and Gila topminnow (*Poeciliopsis occidentalis*)" (Stevens *et al.* 2008) .

Stevens and others calculated that 92 species of mammals call the Verde River Basin home (Hoffmeister 1986, Feldhamer *et al.* 2003, Schmidt *et al.* 2005, Stevens *et al.* 2008. These include many species of bats and rodents, as well as the more commonly sighted mule dear, elk, bear, raccoon, skunk, etc.. Three species –beaver (*Castor Canadensis)*, river otter (*Lontra canadensis*) and muskrat (*Ondatra zibethecus*) are obligate aquatic mammals and rely solely on riparian habitat, although most species rely on water for some part of their life cycle (Stevens *et al.* 2008).

"The Arizona River Otter (*Lontra canadensis sonora*) is a species with limited distribution. A Louisiana subspecies (*L.c. lataxina*) was successfully introduced into central Arizona (Verde River

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[2] We use the symbols* to denote Federally listed species, and ** to denote Candidate for Federal listing.

drainage) during 1981-1983 and may eventually cause genetic swamping of the native form, if any still exist." (Arizona Game and Fish Department 2002) As of 1994 the population was estimated to be 15-20 breeding pairs (Hanna *et al.* 1994). Because this species relies on riparian habitat along rivers, and adequate prey, changes in riparian areas could affect existing populations (Wilson and Ruff 1999). Human encroachment, habitat destruction, overharvest, and pollution have decreased populations in the past (Tesky 1993, Wilson and Ruff 1999). As stated elsewhere in this paper, if flows are reduced, concentrations of pollutants can increase (Haney *et al.* 2008) and this could cause problems for Arizona River Otters, especially with such a small population.

Some groups of fauna are mostly unnoticed or considered pests by some and their importance is often underestimated. Two of these groups are the invertebrates herpetofauna (reptiles and amphibians). Protected species in these groups are present in the Verde River Watershed (Stevens *et al.* 2008).

Challenges to the Verde River

In 2006, American Rivers pronounced the Verde River as the 10th Most Endangered River in the United States. This was based on the challenges the river is faced with and the diversity of wildlife that rely on the river. Researchers determined that Yavapai County is the fastest growing rural county in the United States (Woods and Poole Economics Inc. 1999). Population predictions estimate that the population of the county will go from 132,000 in 2000 to over 260,000 in 2050. Simultaneously, regional drought persists and creates concerns for water sustainability throughout the state and the region. The combination of population growth and drought conditions is leading to concerns about where the water will come from to support growing populations.

Climate change is predicted to cause water shortages throughout the Southwest U.S. Globally, population growth is predicted to have more of a negative impact than climate changes on water resources, but arid and semi-arid regions face greater challenges because of the already low water supply (Vörösmarty *et al.* 2000).

This combination of factors creates an urgent need to provide information to decision makers about the compromises that will have to be made. The valuation issues in the Verde River Watershed are broad, and many studies cover aspects of the complex situation in the Verde River Watershed. These issues include the following: many stakeholders to include in planning; Native American communities need to be welcomed into the process; non-native species are present; urban and rural needs have to be addressed and are shifting; wildlife habitat may be degraded; and endangered species need to be included in calculations. Valuation of the Verde River Watershed is in its infancy, and this study is one of the first steps in a complex process that should - according to current literature - include a feedback loop with stakeholders, decision-makers and resource managers.

Literature review

Ecosystem services are recognized as important throughout the world for human health and well-being. These services range from providing water and oxygen to providing a feeling of well-being from beautiful places. "Many of these are critical to our survival (climate regulation, air purification, crop pollination) while others enhance it (aesthetics)" (Kremen 2005). Because losing natural resources leads to losing these services, there has been increasing awareness and focus on valuing these services. Sometimes the values assist decision makers in designing policies that preserve or offset the environmental costs of human changes in the landscape (Bingham *et al.* 1995, Knetsch 2007).

Wilson and Carpenter (1999) compiled much of the information on ecosystem services that was available at that time which looked at valuation literature from 1971 to 1997. The most recent comprehensive collection of information on ecosystem services is the series published in 2005 by the Millennium Ecosystem Assessment (2005 a-e). The study "was carried out between 2001 and 2005 to assess the consequences of ecosystem change for human well-being and to establish a scientific basis for

actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being" (Millennium Ecosystem Assessment 2005e, p. vii). This five volume series includes information from and references to most previously published information on the subject of ecosystem services (Millennium Ecosystem Assessment 2005a-e). In addition to this, The Proceedings of the National Academy of Sciences compiled a special feature on ecosystem services in July 2008 (Volume 105, number 28) that includes a wide variety of some of the latest research in the field (Cowling *et al.* 2008, Daily and Matson 2008, Jack *et al.* 2008, Liu *et al.* 2008, Mäler *et al.* 2008, Naidoo *et al.* 2008, Tallis *et al.* 2008).

Ecosystem services have been defined as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life." (Daily 1997) or "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment 2003). As the list of ecosystem services has expanded, there have been attempts to categorize the services. Daily (1997) proposed three categories 1) the provision of production inputs, 2) the sustenance of plant and animal life, and 3) the provision of non-use values, which include existence and option values. Kramer (2005) proposed that "the total economic value of an environmental resource can be calculated as a sum of four main components: use value, indirect use value, option value and nonuse value." The Millennium Ecosystem Assessment (2003) breaks services into 1) Supporting services, 2) Provisioning services, 3) Regulating services, and 4) Cultural services (Figure 2).

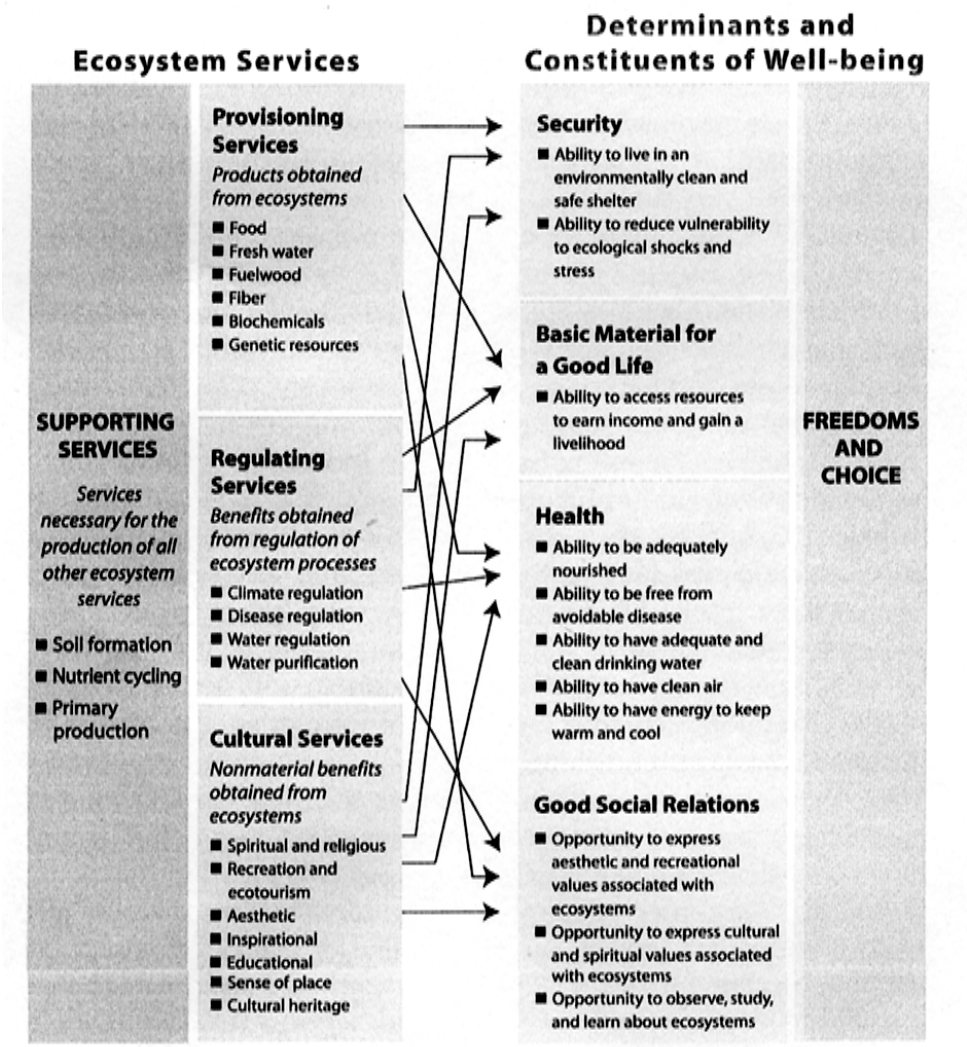

Figure 2. Ecosystem Services and Their Links to Human Well-being (Millennium Ecosystem Assessment 2003, page 5)

The field of Ecological Economics has expanded in many directions over the past twenty years. Here we include some of the shifts that may be of interest for this study and others in the Verde River Watershed. These shifts include changing scales ranging from very local to global (including multiscale approaches), increasing participation of communities and stakeholders, using models to predict changes in ecosystem services, and including biodiversity and all its services in the calculations of value. Bateman *et al.* (2004) suggest that scope is also an important factor in determining the effectiveness of valuations. These changes make the process of evaluating ecosystem services both more complex and more effective.

The shift to include community input, participation and collaboration when managing, valuing, and preserving environmental resources, especially Native American communities, has brought more informed decisions about resource management (Terer *et al.* 2004, Hein *et al.* 2006, Cronin and Ostegren 2007b, Venn and Quiggin 2007). Community participation has always been valued, but techniques for achieving it have been refined over the past 15 years. Part of this shift is to include Traditional Ecological Knowledge (TEK) in valuations and management of natural areas, systems, and resources that are jointly owned, managed and used (Cronin and Ostegren 2007a).

Many recent studies have focused on specific geographic regions because it has been established that valuation is site specific, but sites can range from a specific park or lake, to the protected areas in a country (Ingraham and Foster 2008). These sites can cross political boundaries, which might be some of the most complex studies, such as Lange and others (2007) who did a study documenting the value of ecosystem services in the Orange River Basin, which spans Botswana, Namibia, Lesotho, and South Africa. At the same time these studies tend to be specific to concerns of the area, and aimed at providing information to resource managers and decision-makers for the site. Studies suggest that if research is not focused on the social context in which the values are determined and if the studies are not designed to supply information needed for management decisions within that context then the research may have little value (Cowling, *et al.* 2008).

Many links have been established between tourism and natural resources (Shrestha *et al.* 2006). Sometimes the value differs depending on the type of tourism and the life cycle of the tourism destination (Willis and Garrod 1999, Turpie and Joubert 2001, Hernández and León 2007). As was stated earlier, this mostly rural Verde River watershed relies heavily on tourism and recreation of residents, and therefore this aspect should be evaluated more in subsequent studies.

Many studies seek to improve on the original valuation techniques (Norton and Noonan 2007) including Contingent Valuation (Hanemann1994, Spash 2000, Holmes *et al.* 2004, Wiser 2007, Bateman *et al.* 2006, Marta-Pedroso *et al.* 2007) Willingness to Pay (Bateman *et al.* 2006) and Cost-benefit Analysis (Kuosmanen and Kortelainen 2007). For example, Kontogianni *et al.* 2001 used a combination of focus groups and surveys (on willingness to pay for a variety of options and attitudes about the environment) in order to get results that would be of use to decision-makers. Another shift has been towards modeling. Many studies have used models as a way to value natural resources. Some models include geographically and socially specific indices (Bockstael *et al.* 1995, Ward & Pulido-Velázquez 2008), while others predict what economic implications changes in ecosystem services will have (Jonkman *et al.* 2008). Johnstone and Markandya (2006) used modeling to predict the change in use of a river based on changes in water quality.

Biodiversity has also been valued in many ways -- for its own sake, for its contribution to human well-being and quality of life, and for its economic contribution. Non-timber forest products are one valued aspect of wild places (Croitoru 2007). Kellermann *et al.* (2008) documented the specific ecological and economic services that birds provided to coffee farms in the Blue Mountains of Jamaica. Changes in biodiversity are also tracked by looking at non-native invasive species (or "weeds") (Sinden and Griffith 2007) or evaluated as a separately valued part of the ecological system (Eppink and van den Bergh 2007).

Allen and Loomis (2006) determined that "valuation of wildlife - particularly estimation of non-use and non-consumptive use values for wildlife - is an important input into various policy decisions." Sensitive species, including federally listed threatened and endangered species need to be accounted for (De Nooij *et al.* 2006).

Numerous studies have been performed to evaluate the value of restoration and habitat preservation projects specifically in riparian areas and wetland ecosystems (Costanza 1989, Vicory and Stevenson 1995, Spash 2000, Varady *et al.* 2001, Amigues *et al.* 2002, Holmes *et al.* 2004, Hanley *et al.* 2006, Ojeda *et al.* 2007). These studies are especially urgent in the light that "inland water habitats and species are in worse condition than those of forest, grassland, or coastal systems (medium certainty). It is speculated that 50% of inland water habitats were lost during the twentieth century. It is well established that for many ecosystem services, the capacity of inland water systems to produce these services is in decline and is as bad or worse than that of other systems" (Millennium Ecosystem Assessment 2005a p.553).

This study was based on the typologies presented by Daily (1997), Millennium Ecosystem Assessment (2003), and Kramer (2005). We selected two systems of typology in order to be able to categorize the areas that are of highest value to stakeholders and use that information to design further studies. This process is best suited to this study because of the wide variety and large number of responses received.

Methodology

In order to determine the various uses and values for the Verde River Watershed, a survey instrument was developed.[3] This questionnaire consists of two parts. The first part was a survey completed by mail, and the second part was a semi-structured interview completed using individually recorded interviews. The survey instrument is straightforward and requires little additional discussion. A total of 35 individuals knowledgeable of the watershed and current issues were interviewed. In order to protect the anonymity of the respondents, all personally identifiable information is maintained by the research team.[4]

Following the literature review, one member of the research team determined the best strategy to evaluate the respondents' answers, and then another team member categorized the replies. The description of the values rubric follows.

Values

From the values literature review as described above, it was decided to conduct a two-stage classification of the values indicated during the interviews. The replies for Question 3 a-c were collected and analyzed. (Question 3d concerning specific locations is dealt with below.) In addition to Question 3, Question 6 was also included in the values analysis.

3. How do you use the river?
    a. What plants and animals that rely on the river are important to you?
    b. Do you collect or use any plants or animals that rely on the river? If so, which ones?

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[3] The full questionnaire is available at the website for the full report.
http://www.emaprogram.com/emaweb/ema/site/index.asp

[4] Due to the small size of the community of people directly involved with the Verde Watershed our Institutional Review Board requires us to maintain the complete anonymity of the respondents. As such, we are unable to provide even the most cursory descriptors for the interviewees.

c. Do you have a spiritual, religious, or personal connection to the river? If so, could you describe this connection?

6. What functions, processes or services does the Verde provide that are important to you and the community? (e.g. flooding, filtration, seed dispersal…)

The following rubric was used to evaluate each comment as recorded during the data collection process. [5]As discussed in the literature review above, any such classification will have fuzzy boundaries between categories.

Use

These include goods and services provided by the watershed that the respondents currently use in some form. Irrigation water and fishing are obvious examples. Enjoying one's five-generation family history with the river is a far less obvious use, but it is a value the respondent gains utility from in the present day.

The discussion of flora and fauna was problematic. Unless specifically indicated that the value fell into the other two categories, these were placed under the "Use" category. This is countered by looking at the term "habitat." Ecosystem services and protection were generally placed in the non-use category. On the other hand, specific species of flora and fauna were viewed as specific current uses as opposed to future values of ecosystem protection.

Option

This category involves future use without current use. The primary candidate for this group involved recharging the aquifer. The items in this category were by far the least number identified. Most respondents have a current affair with the watershed and place the highest values on the current uses.

Non-Use

The best example of this category was provided as: "Give value to the person in Wisconsin that may never see it." Indeed, this is a textbook definition of the term non-use. As mentioned above, most items in the non-use list involve ecosystem protection.

Once the comments were evaluated using the use, option, and non-use rubric, a second classification system was used following Figure 1 (Millennium Ecosystem Assesment 2003). This includes 4 different ways of viewing a particular value of the watershed: supporting, provisioning, regulating and cultural.

Supporting

These minimally listed items involve supporting the ecosystem from a structural standpoint such as soil formation.

Provisioning

The items included in this list involve things that people physically take from the watershed: water, plants, animals and minerals. Comments concerning property values and economic growth were also included. The list includes all flora and fauna including endangered species.

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[5] The full collection of values and explanatory comments is included in Appendices B and C of the full report at the website: http://www.emaprogram.com/emaweb/ema/site/index.asp.

Regulating

Water cleansing and pollution mitigation are examples of regulating services. Several respondents itemized the fact that the greenery and watershed provide for temperature reductions in "microclimates." Transportation was included here.

Cultural

Perhaps the most important conclusion from the study is how people interact with the watershed. The most common of values placed on the river fall into the cultural use category: Spiritual, recreational, aesthetic, inspirational, educational and cultural heritage aspects fall into this category.

Data Processing

Once the rubrics for analysis were determined and the data had been entered, the two-stage classification of the replies to questions three and six was conducted. The responses were initially classified as use, option or non-use, and then further classified as servicing, provisioning, regulating or cultural. Following a sorting of the replies, a second team member validated the classification. As presumed, some of the classifications fell into rather fuzzy zones. For example, one respondent said "recreation" in response to how she uses the river. The further discussion then itemized: "Fishing, swimming, hunting, kayaking. Limited recreational use. Inaccessible to the public." This single response was labeled as a cultural use, but could also fit into providing use since it can be presumed the fish and hunted animals are taken. A second respondent also itemized recreation as "Hiking, biking, hang-gliding, picnicking, fishing, gardening, and dog-walking." With nearly 500 individual responses this was expected.

Valuation of the Verde River Watershed

In total, the 35 respondents to the survey mentioned nearly 500 ways of valuing the river and its watershed. As presented in Table 1 below, these fell into two primary categories: provisioning use and cultural use.

Primary value	**Secondary value**	**Number of responses**		
Use		**Question 3**	**Question 6**	**Total**
	Servicing	1	2	3
	Provisioning	145	39	184
	Regulating	6	31	37
	Cultural	167	48	215
		319	120	439
Option				
	Servicing	0	0	0
	Provisioning	3	0	3
	Regulating	5	3	8
	Cultural	2	0	2
		10	3	13
Non-use				
	Servicing	1	0	1
	Provisioning	0	0	0
	Regulating	13	26	39
	Cultural	4	0	4
		18	26	44

Table 1: Ecosystem Values as Collected in Categories

Perhaps the strongest conclusion from the analysis is that people value the river as a place and not just a thing. It is not simply a thing where they acquire goods and services; rather it is a place where they do activities. The ability to use the watershed as a source of water is vitally important, but this is by no means the only value stakeholders place on the system. Less than 40% of the responses can be listed as *provisioning,* and, of that number, most involve aspects and items beyond simple water provision such as ranching and fishing.

Indeed, there were more replies that can be categorized as *cultural* than those listed as *provisioning*. Although very broad in scope – from spiritual to educational – the cultural category includes all the reasons people view the watershed as a place to interact with, as opposed to a thing from which to take resources.

As previously mentioned, most comments regarding flora and fauna were placed into the *use* category. These were then mostly placed into the *provisioning* section. Depending on the secondary comments made by the respondents, this methodology was followed even when it was clear that a particular comment fit into several categories. Included in the itemized valued things were 79 instances of "flora" or "fauna." *Specific* comments regarding the habitat provisions of a particular animal or plant (or flora and fauna in general) were listed as *non-use* and *regulating*. Specific comments regarding protected species (including federally-listed threatened and endangered species) could easily be listed under numerous categories, but were generally placed under *use* and *cultural*. The ability to witness a Bald Eagle is a current use that allows the participant to take the experience from the watershed. Many respondents also itemized a spiritual or other cultural value to having Bald Eagles living near the river. Clearly, most respondents also view this as an option value, and most, if pressed, would also call it a non-use value.

Although the numerical count of the regulating values is small, the respondents were very familiar with the idea of looking at the watershed as a connected system and even a system of systems. Furthermore, the non-use aspects of regulating values shows how people view the importance of the watershed as a watershed. The importance of habitat preservation and the biodiversity of the area are highly valued. At both the micro and macro levels the ecosystems within the watershed are critical. As an area that sustains otters and as a stopover on the flyways of migrating birds, people wish to protect the watershed.

Valued Places

The interviews created a geographical lesson for an adventure map of the Verde River Watershed as discussed during Question 3d.[6] There were 226 individual itemized responses in the 35 interviews. Given the intimate working and living relationship most of the interviewees have with the river, and the requisite vested interests they have in the river, the question concerning the "Valued Places in the Watershed" provided a plethora of information.

The relevant question specifically included the descriptor "watershed" instead of "river." Had the question been limited to areas of the river itself, many of the important realms of interest would have been lost. Indeed many of the interviewees distinguished between the watershed and the river itself. The tributaries can then be distinguished as rivers, springs, creeks, or washes. The former are sources of river water from the aquifer system; whereas, the latter are collectors from rain and snow melt. Several of the respondents included the Big Chino Aquifer having value as a place.

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[6] The full collection of valued places and explanatory comments is included in the full report at the website: http://www.emaprogram.com/emaweb/ema/site/index.asp.

Respondents distinguished between places with easy public access and wild places. The obvious public access places were listed by many of the respondents: Sedona, Oak Creek Canyon, the Beaver Creeks, Montezuma's Castle and Well National Parks Monuments, Arizona State Parks in the region (Verde River Greenway State Natural Area, Dead Horse Ranch State Park, Red Rock State Park, Slide Rock State Park, Fort Verde State Historic Park), Windmill Park, and Tuzigoot National Monument. The remote and even wilderness places are too numerous to list. Several respondents either requested secrecy or refused to indicate their individual special places.

Given the concerns about the geological importance and condition of the Big Chino Aquifer, the headwaters of the river were included by several of the respondents. The historical and archeological importance of the Verde Valley and the watershed was considered as valued by many of the respondents. These include battle sites and Indian ruins.

Threats to the Watershed

The list of the 191 itemized threats to the watershed can be grouped into several distinct issues. For the most part, these are not surprising, but the interviews validate the need for further research into the specific issues regarding the future of the river.[7] Although these are discussed in general herein, future research can be based on the very specific issues addressed by the individual respondents.

Of the 35 interviews, 26 individuals were concerned about the amount of pumping taking place from the aquifer and withdrawals from the river. The concerns include the amount of water that is currently being withdrawn for various reasons: drinking water and irrigation are the primary withdrawals. A consequence of these withdrawals and diversions is the presence of a fragmented river in places where sections of the river are dry during certain times of the year.[8] These dry spots can occur when water is diverted from the river for irrigation, and partially returned to the river downstream.

Closely connected to the concern about pumping is the concern of human development. Twenty-three of the thirty-five respondents itemized some aspect – in many cases several aspects – of the growth of the Verde Valley and environs. As discussed above, the population of the Verde Valley and the Prescott/Chino Valley area is seeing enormous growth and is expecting continued growth into the foreseeable future. The envisioned impacts of this growth on the Verde River and its watershed raise urgent concerns among the population of community leaders interviewed. The Verde River Watershed has been forced to address the issue of changing from a collection of rural communities to a collection of developed communities. This is changing the social norms within the population as concerns the water resources of central Arizona.

The human impact on the water quality is a serious concern of the respondents. 18 of the 35 interviewees included some aspects of pollution as threats to the river. Of those aspects specifically itemized, five included runoff from septic systems. Other concerns are mining runoff, agricultural runoff, and dumping of solid waste.

Invasive species were a concern of eight of the respondents. This opens the possibility, and continuing need, for specific research into specific species and locations.

Six interviewees specifically itemized that climate change is a threat to the river. The primary concern here is the possibility of continuing drought.

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[7] The full collection of threats and explanatory comments is included in the full report at the website: http://www.emaprogram.com/emaweb/ema/site/index.asp.

[8] The current research team has no direct evidence of this situation, although multiple interviewees mentioned this situation.

Among the interviews a series of concerns involved the lack of education and policy concerning the river. The respondents identified a need for increased community policy concerning the management of the watershed resources. Of course, many of these concerns may be mutually exclusive. This requires increased education of the existing residents – as with the presentation at the Arizona Riparian Council meeting in April 2008 and expanded education of new residents and visitors concerning their impact on the watershed.

Conclusions and Recommendations

The principal goal of this project was to collect and analyze data concerning the reasons for valuing the Verde River Watershed. The data have been collected using a series of direct interviews with various stakeholders and the data has been briefly and initially analyzed using a two-stage valuing rubric. We conclude this report by making a series of recommendations for further research, public comment and education, and comprehensive watershed management.

However helpful the series of interviews, they were targeted at specific individuals whom the research team knew had professional and personal interactions with the watershed. As such, they are not representative of the general population of stakeholders living and working within the watershed. Knowingly or unknowingly, anyone living within the watershed or using water from a tap is a current and possibly future stakeholder in the watershed. A less comprehensive survey instrument could be administered at various venues within the geographical area. In addition to the list of valued aspects on the original survey, demographic and locational information could be collected. This broader scoped survey could use general areas of interest collected from this initial survey.

The numerous responses among the interviews regarding flora and fauna indicate a substantial interest among the stakeholders in the wildlife of the watershed. The current rubrics for filtering the values were most problematic regarding wildlife. A new survey instrument needs to pay careful attention to phrasing more specific questions concerning how people value the flora and fauna within the watershed. For example many of the responses indentified how animals use the watershed as a provisioning source for their own food. Then, the local human resident hunts the animal and is thus provisioned.

A much more detailed analysis of the data should be undertaken in the context of Millennium Ecosystem Assessment (2003, 2005 a-e). They link the ecosystem services, as discussed above, with the "Determinants and Constituents of Well-Being" (shown in figure 2) using the categories of security, basic materials for a good life, health and good social relations. This type of analysis would help in explaining not only "what" is important about the watershed, but also "why" it is important.

A major cultural component itemized by the interviewees involves education. A series of public forums and workshops can be developed to educate both stakeholders and decision makers within the region. For example, the current research team made a well-attended presentation at the 22nd Meeting of the Arizona Riparian Council, in Prescott, Arizona in April 2008.

To validate the comments made by our respondents and to increase the overall knowledge of the watershed, the ongoing scientific and policy research should be continued, expanded, and coordinated. The serious issues concerning the health of the aquifer system are perhaps the most important and worthy of expanded investigation. The sustainable access to potable water is vital to the sustainability of the human and non-human population of central Arizona. The importance of understanding both the science and policy issues concerning the watershed cannot be overstated.

We can conclude that the Verde River and its watershed are valued in a multitude of ways. Putting monetary value on these values may be desired in order to make the value of some ecosystem services clear to all stakeholders, but valuation is not necessary to show that the stakeholders value the river itself, not just what it can give to them (i.e. water etc.). *Water and fish have meaningful market values, but an eagle or otter does not.*

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