Water Resources Development Commission
Environmental Working Group
Arizona's Inventory of Water-Dependent Natural Resources

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SUMMARY OF FINDINGS

Overview

The Inventory of Arizona's Water-Dependent Natural Resources provides the Water Resources Development Commission (WRDC) with a significant new tool to evaluate the relationship between the state's waters and the environmental resources those waters support. Developed by the Environmental Working Group of the WRDC in 2011, the Inventory catalogs a wide-range of existing data and research on natural resources associated with rivers, streams, wetlands, lakes and springs throughout Arizona. It builds upon the Arizona Department of Water Resources' (ADWR) Arizona Water Atlas by focusing on the state's riparian and aquatic habitats, the fish, wildlife and natural communities these habitats support, and the conditions currently supporting these resources.

Organized by groundwater basin, the Inventory includes this Summary of Findings, a written overview of this effort along with recommendations based on these findings, and the following:

Tables – tables for each of Arizona's 51 groundwater basins present information on the sub-basins, watersheds, counties, water features, riparian and aquatic-dependent wildlife, and flow volumes supporting these resources associated with each basin.

Maps – groundwater basin and county maps visually represent the water-dependent natural resources characterized in the tables as well as other features.

Basin Summaries – written summaries for each groundwater basin provide additional information in narrative form.

Methodology – written explanation of the methodology and sources used to create the tables, maps, and summaries.

References – a record of the studies and research used to complete this Inventory.

To best understand the water-dependent natural resource information included in this Inventory, the tables, maps, and summaries for each basin should be used conjunctively.

The Inventory of Arizona's Water-Dependent Natural Resources clearly documents the diversity of natural resources that exist in the State of Arizona. Arizona's water and environmental resources both enhance the economy and provide citizens a high quality of life. The inventory denotes some of the following findings about Arizona:

- Arizona's 51 groundwater basins are environmentally unique and diverse.
- More than 5,000 miles of perennial flow are estimated (ADEQ & USGS, 2007).
- Upwards of one million acres of riparian areas exist (AGFD, 1994).
- More than $1.7 billion is generated from wildlife-based recreation activities (Silberman, 2001; Southwick Associates, 2002 & 2003).
- Another $1.7 billion is produced from bird watching activities (Silberman, 2001; Southwick Associates, 2002 & 2003).
- 181 sensitive wildlife species tracked by the Arizona Heritage Data Management System (HDMS) are supported by water-dependent natural resources (AGFD, 2011).

The Inventory is a significant accomplishment that provides a better understanding of Arizona's water-dependent natural resources as we look at how to meet statewide water demands in the next 25, 50, and 100 years. The Inventory also demonstrates that additional data, quantification, and research are needed to ensure we continue to increase our understanding of water-dependent natural resources and anticipate and minimize risks to these resources as we move into the future.

Objective & Scope of the Inventory

The Environmental Working Group was formed under the work plan developed by ADWR for the WRDC. The Environmental Working Group was tasked to 1) identify current water-dependent natural resources; 2) identify conditions necessary to support them; and 3) prepare a summary of findings and recommendations including needed studies and research. Using available scientific data and methods to complete these objectives, the Environmental Working Group compiled an inventory that identifies the state's primary water-dependent natural resources and characterizes, where possible, the physical conditions of the water that supports those natural resources, which includes the state's rivers, lakes, streams, springs, wetlands, riparian and aquatic habitats, and the flora and animals, birds, fish and other wildlife.
More than 50 professionals from nearly 30 agencies, institutions, non-governmental organizations, tribes, and private sector firms stepped forward to participate in and contribute to the Environmental Working Group. Committee members reviewed and discussed over 100 studies and met at least 25 times to develop and prioritize tasks, gather data, prepare and compile the Inventory, and coordinate with other WRDC Committees.

An early decision of the Environmental Working Group was to assess only water currently in use by natural resources based on existing data. The Inventory is a catalog of current conditions; a snapshot in time. The work plan for the WRDC assigned the Environmental Working Group to determine if current and future water supplies are sufficient to meet current and additional demand. Compiling extensive amounts of research and data into one usable inventory that catalogs water-dependent natural resources was a significant challenge considering the time frame given to the Environmental Working Group. The Environmental Working Group did quantify current flow supporting water-dependent natural resources for 12 of the state's 51 basins for which data was available. Data was not available to identify current flow for the remainder of the basins with perennial flow as well as flow volumes needed to support water-dependent natural resources in the future. Developing the information necessary to satisfy these needs would be a lengthy scientific endeavor requiring additional information on perennial stream flow and an assessment of future cultural uses, effects of changing climate, and how these factors will affect riparian and aquatic habitats and the wildlife they support.

Content of the Inventory

The Environmental Working Group cataloged the diverse and unique water-dependent natural resources of Arizona by displaying the information as tables, maps and basin summaries. In addition, maps were created for each of Arizona's 15 counties to show this information at the county level. These materials identify groundwater sub-basins, watersheds, and counties associated with each groundwater basin.

A vast array of water-dependent natural resource data is clearly presented, including:

- The number and type of riparian, aquatic and/or marshland habitat dependent species (e.g. amphibians, birds, fish, etc.)
- Identification of species that are listed as endangered, threatened or candidate species under the Endangered Species Act
- Areas of Critical Habitat designated by the U.S. Fish and Wildlife Service under the Endangered Species Act

- Identification of major perennial streams and tributaries and their cumulative miles of flow
- Quantification of baseflow, evapotranspiration, and total flow supporting water-dependent natural resources for perennial streams in 12 groundwater basins where data was available
- Identification of perennial streams with flood flow components
- Streams classified as Outstanding Arizona Waters pursuant to A.A.C. §R18-11-112
- ADWR information related to instream flow water rights
- Important water resources within federal or state designated conservation and recreation lands such as national and state parks, wilderness areas, national conservation areas and others
- Important Bird Areas identified by the Arizona Audubon Society
- Identification of water courses that may be supported by effluent or other water discharges and the associated volumes
- Identification of Effluent-Dependent Waters pursuant to A.A.C. §R18-11-113
- The number, flow range and cumulative discharge volumes of major and minor springs
- The number of large and small reservoirs and the associated storage volumes
- The number of stockponds and wildlife catchments
- Water-based recreational values
- Federally designated Wild and Scenic Rivers pursuant to the Wild & Scenic Rivers Act

Information related to some categories of water-dependent natural resources as well as important information about legal and institutional characteristics of particular water resources was not included. For example, intermittent and ephemeral streams, which have ecological and hydrological significance (Levick et al., 2008) are not characterized or mapped here. Also, some water in a stream may be the subject of a water right under state or federal law. Some of these rights are well-settled and others have not been quantified and/or adjudicated. While this type of information has an important bearing on water resource planning, it was beyond the scope and capacity of the Working Group to catalog this information.

Quantifying Water Flow for Water-Dependent Natural Resources

While each table contains a significant amount of information, the Environmental Working Group wanted to be able to show the quantifiable current water flow supporting water-dependent natural resources. After evaluating available data and consulting with members of the scientific community (see Methodology Section), the Working Group concluded that it was feasible to develop a set of quantitative estimates of flow volumes for a subset of the state's rivers, which includes 12 of Arizona's 51 groundwater basins (Agua Fria, Aravaipa Canyon, Bill Williams, Cienega Creek, Lower San Pedro, Safford, Salt River, Santa Cruz AMA, Tonto Creek, Tucson AMA, Upper San Pedro, and the Verde River). The tables for the other groundwater basins do not include estimated flow volumes because the comprehensive data and research to access and then quantify a specific water flow is lacking.

The Environmental Working Group recognized there are different methods and data available for estimating flow volumes and that results may vary depending upon which methods and data are used. Rather than select one technique and rely on one set of estimates, two sets of estimates were developed. This approach provides some advantages. First, given the goal was to develop a first approximation rather than a precise set of flow estimates, a range of flow estimates for watersheds is more appropriate. Second, generating a range of estimates enables the members of the WRDC, Environmental Working Group, and scientific community to better understand sources of variation in the different methods and data, which will lead to future refinements in methodologies and the overall certainty of results. To develop a general estimate of current flow volumes supporting water-dependent natural resources, the Working Group started by identifying the components of flow that support these resources. Based on studies of water budgets and discussions with experts in hydrology, two components were identified:

Baseflow is the part of stream flow originating from groundwater discharge and that sustains year-round flow.

Evapotranspiration (ET) refers to the combined amount of water evaporated from riparian soil, open water surfaces, and transpired by riparian vegetation.

The Environmental Working Group did not include two other components, groundwater underflow and flood flow, in the calculations. Ideally, each of these components would be used to calculate water flow estimates but available data were limited. For example, estimates of groundwater underflow, which is subsurface water that flows out of a basin into the next down-gradient basin, are derived through modeling rather than direct measurement. Similarly, flood flows are difficult to incorporate into a quantitative flow estimate. A practical method for integrating these parameters into a quantitative flow estimate was unavailable, and therefore, they were omitted from the estimate.

The omission of the groundwater underflow and the flood flow does not minimize their significant role in the formation and functioning of riparian and aquatic ecosystems. Flood flows, including snowmelt runoff, play a vital role in the transport of sediment, recharge of floodplain and alluvium, recruitment and dispersal of riparian plant species and, among other things, trigger breeding in some aquatic species. In addition to the annual total volume of flood flows, factors such as flood frequency, timing, and duration are also important components that affect a groundwater basin.

Therefore, in the 12 groundwater basins where it was feasible, the Environmental Working Group estimated the flow volume as a sum of the baseflow and riparian evapotranspiration. As stated in the recommendations, it would be useful to have more complete information about the other 39 groundwater basins. The baseflow and ET estimates developed by the Environmental Working Group provides a first approximation of the flow volumes currently supporting water-dependent natural resources, such as aquatic and riparian habitat for fish and wildlife. Presented in the same units of measure as the information developed by the Supply and Demand Working Group, the flow estimates for the 12 basins provide an important baseline that can be used to assess opportunities to maintain or enhance these resources as well as potential impacts to natural resources from future water developments.

Arizona & Water-Dependent Natural Resources

The tables, maps, and summaries for the 51 groundwater basins comprising this Inventory demonstrate the uniqueness and diversity of the state's natural resources. These natural resources are integral to Arizona's overall environment and character as well as to the state's economy. Water in the environment serves important and obvious functions such as drinking water for terrestrial species, water for plants, and aquatic habitat for fish and other species. It supports riparian vegetation that provides cover, food, shade, and sites for wildlife nesting and foraging. Flows of water in the environment also serve plants and animals in less obvious ways such as modulating temperatures, triggering reproduction or other life-cycle changes, contributing to nutrient and waste cycles, and maintaining the form and function of river channels in a manner that affects the functioning of the larger ecosystem. Indeed, freshwater ecosystems are complex systems in which flowing water is a central component (Annear et al., 2002; Nadeau & Megdal, 2011; Silk & Ciruna, 2004).

On the whole, riparian areas are among the most biologically diverse, abundant, and productive in North America and are especially important in semi-arid areas (Briggs, 1996). Sensitive wildlife species occurrences are tracked by Arizona Game and Fish Department through the Heritage Data Management System (HDMS). According to HDMS, 78 obligate aquatic species (those that can only live in water) including 35 native fish

have been documented. Additionally, HDMS tracks 68 riparian species (those that can only live in riparian areas), which include birds, mammals, reptiles, amphibians, and invertebrates. There are also 20 species of insects and 62 plant species dependent on aquatic and riparian systems. Most wildlife relies on water in the environment (Poff et al., 1997). Eighty percent of all vertebrates spend some portion of their life cycle in riparian areas, and the majority of Arizona's threatened and endangered vertebrates depend on riparian habitat (Zaimes, 2007). The connectivity of these habitats is important as well; streams and riparian areas serve as corridors for wildlife movement and as key flyways for migratory birds (Kirkpatrick & Conway, 2007).

Ecosystems throughout Arizona depend not only on the existence of a certain quantity of water but also on the magnitude, frequency, duration, timing, and rate of flow. Each is important and may affect such factors as water quality, energy sources, physical habitat, and biotic interactions. Changes in any of these aspects of a flow can affect the ecological integrity of a water dependent area (Nadeau & Megdal, 2011). Location of a particular flow also matters. Water for natural resources needs to be understood within the context of occurring along a particular segment of stream as well as in relation to a larger system.

The health of Arizona's waters can be affected by actions taken throughout a watershed. For example, higher elevation forested watersheds provide much of the surface water and groundwater recharge in the state. It has been estimated that forested watersheds of Arizona contribute nearly 90% of the total streamflow in the state (Ffolliott & Thorud, 1975) and serve as important recharge areas for large regional aquifers (Pool, Blasch, Callegary, Leake, & Graser, 2011). Changes to land and watershed management may change the timing and rates of recharge to these aquifers (National Research Council [NRC], 2008).

The contributions that water in the environment makes to human life are ubiquitous that they may be overlooked amid the complexities of ecosystem and human social activity. Finding a consistent and appropriate way to assess their value may provide valuable information to decision makers in natural resource management. The concept of "ecosystem services" was developed as a framework to assess these values. Ecosystem services are the ways by which natural resources produces fundamental resources, the natural assets, used by humans (Ecological Society of America [ESA], 2000). Water-dependent natural resources throughout Arizona provide important ecosystem services that may include clean water (by supporting water quality), clean air, flood control and erosion control (by supporting healthy riparian areas), a variety of recreational opportunities, and sustainable water supplies (by contributing to groundwater recharge).

The 51 tables and maps of the groundwater basins demonstrate the importance of water to sustain the natural resources of Arizona. These natural resources are not only important to plants and animals. Rivers, springs, and other water resources are also culturally important to local communities, including Arizona's Native American tribes, and sustain places and provide materials that are culturally important to tribes and other communities. Water in rivers, lakes and streams is also important to Arizonans and those who visit Arizona who care about natural beauty, outdoor recreation, open space, and wilderness values, or just that such water dependent natural resources continue to exist for their children or grandchildren to experience. (Southwick Associates, 2002) "Water in the desert" is a quintessential characteristic of the Arizona landscape and an important part of the state's heritage.

Economics of Water-Dependent Natural Resources

Arizona's water-dependent natural resources offer notable economic opportunities because they attract large numbers of tourists, anglers, hunters, and other outdoor recreationists, while enhancing local property values and business revenues. Fishing, hunting and wildlife watching recreation activities alone generate billions of dollars in retail sales each year.

Economic studies for the state of Arizona, conducted by Southwick Associates Inc. (2003) and Arizona State University (Silberman, 2001), identified the economic benefits from hunting, fishing and wildlife watching. The studies show these wildlife-based recreation activities generated a total economic impact of $2.8 billion in 2001, which includes retail sales and their overall ripple effect through the economy. The table below illustrates the total expenditures from retail sales alone for wildlife-based recreation activities in 2001.

County	2001 Hunting/Fishing Total (Millions)*	2001 Non-Consumptive Total (Millions)*	Totals (Millions)
Apache	$62.8	$24.8	**$87.6**
Cochise	$12.7	$13.7	**$26.4**
Coconino	$101.2	$46.6	**$147.8**
Gila	$39.4	$11.5	**$50.9**
Graham	$7.3	$7.0	**$14.3**
Greenlee	$2.5	NA	**$2.5**
La Paz	$17.8	$1.8	**$19.6**
Maricopa	$409.1	$368.3	**$777.4**
Mohave	$79.9	$30.9	**$110.8**
Navaho	$33.3	$24.4	**$57.7**
Pima	$84.5	$173.5	**$258.0**
Pinal	$20.0	$50.8	**$70.8**
Santa Cruz	$13.9	$11.9	**$25.8**
Yavapai	$40.0	$38.9	**$78.9**
Yuma	$34.2	$12.3	**$46.5**
Statewide	**$959**	**$816**	**$1.7 Billion**

Figure 1. Wildlife-Based Recreation Retail Sales in 2001

For a more localized example, in the San Pedro Riparian National Conservation Area the natural landscape attracts enough visitors to bring in $17.0 to $28.3 million to the local economy (Orr & Colby, 2002).

Southeastern Arizona was identified as the number one birding site in a study evaluating birding economics and demographics in the United States (Kerlinger, 1993). Of the U.S. total birdwatching economic output ($84 billion), over $1.5 billion may be attributed to Arizona in 2001. According to the U.S. Fish and Wildlife Service (2003), approximately 22% of Arizona residents participate in bird watching activities. With the national bird watching population estimated at 50 million people, there is clearly a large pool of U.S. citizens who could be and have been enticed to visit Arizona for birding. This means the Arizona birding industry may have the potential to expand, attract more visitors, and become an even greater economic benefit to the state (Orr & Colby, 2002).

Another water-related component to Arizona's economic success is the value added by riparian areas, wetlands, and natural waterways near private property. This added value has been explored by researchers in the Santa Cruz River Basin more than any other area in the state. Studies conducted in Tucson and the surrounding metropolitan areas all agreed that "homebuyers…place considerable value on those sections of the riparian corridor that support …riparian species" (Bark-Hodgins, Osgood, Colby, Katz, & Stromberg, 2009).

Specifically, Bourne (2007) showed that homes closer to riparian areas carry a "premium" that can increase the home's value by 5.8%. Colby and Wishart (2002) support this estimate of additive home value and also state that vacant land may carry an increase of 10-27% depending on its proximity to riparian areas. Finally, another study showed that an increase in general "greenness" contributes to increased property values (Bark-Hodgins, Osgood, & Colby, 2006).

In summary, wildlife related recreation, outdoor recreation activities, and close proximity to riparian areas all produce notable economic benefits for individuals and businesses across Arizona. Many watchable wildlife dollars are often spent at retailers, manufacturers, and support services in rural or lightly populated areas and constitute a larger contribution to those economies than for more urban and highly populated areas. Thus, the economic contributions of water-dependent outdoor recreation activities are particularly important to Arizona's rural economic base.

Potential Risks to Water-Dependent Natural Resources

The Environmental Working Group did not attempt to assess potential risks to the state's water-dependent natural resources, trends affecting these resources, or the level of legal or other protection afforded to water supporting these resources. Risks to particular resources may exist; human activities and natural events have caused substantial alterations to riparian areas (Zaimes, 2007). The risk to a particular resource will depend on a variety of circumstances that deserve consideration in the future.

RECOMMENDATIONS

This Inventory is a unique accomplishment in cataloging a wide range of research and data into one place, thus providing a snapshot of Arizona's water-dependent natural resources that we enjoy. From the various work involved in compiling this Inventory, the Environmental Working Group proposes the following recommendations:

1. The Working Group recommends that the Inventory be a standalone document that could be used to inform local, regional and statewide decision makers and water resource planners when it comes to issues involving Arizona's water-dependent natural resources.
2. The Inventory demonstrates that additional data and research is needed. Additional knowledge of the condition and trend of resources that depend on water, particularly those that comprise the riparian and aquatic communities, are needed to guide future land and water resource planning. Various data and research projects can be identified but the following are four key examples of such further data and research:
    a. A comprehensive, spatially-explicit inventory of the state's riparian habitat is needed to better plan for the management of the riparian resource.
    b. A complete and current field assessment of the extent of perennial and intermittent surface water would enable a better understanding of how to manage surface water in the future.
    c. Water planning efforts have benefitted from development of detailed modeling data on the relationship between groundwater and surface water. Additional work is needed to characterize this connection in other basins to aid communities in efforts to manage water sustainably for both people and the environment.
    d. The Inventory was able to quantify the current flow supporting water-dependent natural resources in portions of 12 of the 51 groundwater basins. Additional work is needed to identify and quantify such flow in all of Arizona's groundwater basins.
3. Evaluation of future water supply options should include consideration of the potential impacts on and risks to water-dependent natural resources.

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TABLE 1. WATER-DEPENDENT NATURAL RESOURCE INDEX

Water-Dependent Natural Resource Index for the Water Resource Development Commission

BASINS	Perennial Water (Instate)	Basin Includes Colorado River	Major Springs	Waters in Federal / State Conservation Lands	Current GW-SW Connection*	Effluent Dependent Stream Reach	ESA Critical Habitat Designated	ESA Species Observed	Instream Flow Certificate	Audubon Important Bird Area	Water Based Recreation Opportunity	ADEQ Outstanding Arizona Water	Federal Wild and Scenic Designation
AGUA FRIA	▨		■	■	■		■	■	■	■	■		
ARAVAIPA CANYON	▨		■	■	■		■	■	■	■	■	■	
BIG SANDY	■		■		■		■	■			■		
BILL WILLIAMS	▨	■	■	■	■		■	■	■	■	■	■	
BONITA CREEK	■		■	■	■			■			■	■	
BUTLER VALLEY													
CIENEGA CREEK	▨		■	■	■	■	■	■	■	■	■	■	
COCONINO PLATEAU	■	■	■	■	■	■	■	■		■	■		
DETRITAL VALLEY		■		■			■				■		
DONNELLY WASH	■				■		■	■			■		
DOUGLAS				■				■	■		■		
DRIPPING SPRINGS WASH	■		■	■	■		■	■	■		■		
DUNCAN VALLEY	■		■	■	■		■	■			■		
GILA BEND						■		■			■		
GRAND WASH		■	■	■			■	■			■		
HARQUAHALA INA													
HUALAPAI VALLEY		■	■	■			■	■			■		
KANAB PLATEAU	■	■	■	■	■	■	■	■		■	■		
LAKE HAVASU		■		■			■	■			■		
LAKE MOHAVE		■	■	■			■	■			■		
LITTLE COLORADO RIVER PLATEAU	■		■	■	■	■	■	■		■	■	■	
LOWER GILA		■		■			■	■		■	■		
LOWER SAN PEDRO	▨		■	■	■	■	■	■	■	■	■	■	
MCMULLEN VALLEY													
MEADVIEW		■	■	■			■	■			■		
MORENCI	■		■	■	■		■	■		■	■	■	
PARIA	■	■		■	■					■	■		
PARKER		■		■			■	■			■		
PEACH SPRINGS		■	■	■	■		■	■			■		
PHOENIX AMA	■		■	■	■	■			■	■	■		
PINAL AMA						■		■			■		
PRESCOTT AMA	■		■	■	■	■	■	■		■	■		
RANEGRAS PLAIN													
SACRAMENTO VALLEY		■	■	■			■	■			■		
SAFFORD	▨		■	■	■	■	■	■		■	■	■	
SALT RIVER	▨		■	■	■	■	■	■	■	■	■	■	
SAN BERNARDINO VALLEY	■			■	■		■	■			■		
SAN RAFAEL	■			■	■		■	■		■	■		
SAN SIMON WASH								■			■		
SANTA CRUZ AMA	▨		■	■	■	■	■	■		■	■		
SHIVWITS PLATEAU		■	■	■			■	■			■		
TIGER WASH													
TONTO CREEK	▨		■	■	■		■	■	■	■	■		
TUCSON AMA	▨		■	■	■	■	■	■		■	■		
UPPER HASSAYAMPA	■				■		■	■	■		■		
UPPER SAN PEDRO	▨		■	■	■	■	■	■	■	■	■		
VERDE RIVER	▨		■	■	■	■	■	■	■	■	■	■	■
VIRGIN RIVER	■		■	■	■		■	■			■		
WESTERN MEXICAN DRAINAGE			■	■			■	■					
WILLCOX	■		■	■	■		■	■		■	■		
YUMA		■			■			■		■	■		

▨ Hatched cells represent perennial streams within groundwater basins where current flow volumes that support water-dependent natural resources have been estimated.

This table depicts major water-dependent natural resources cataloged by the Environmental Workgroup of the WRDC. It is not meant to be a comprehensive assessment of *all* important water-dependent natural resources, and some potentially important features are not represented here. Rather, this information is meant to be used as a starting point for identifying important water-dependent natural resources in Arizona's counties and groundwater basins. For a more detailed description of known resources in each groundwater basin, please review the Maps, Basin Descriptions and Environmental Conditions Table. For a description of the

*Brown DE, Carmony NB, Turner RM. 1981. Drainage map of Arizona showing perennial streams and some important wetlands. Arizona Game and Fish Department, Phoenix.

*Anning, D.W. and Konieczki, A.D. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. USGS Professional Paper 1702. 37 pp.

BASIN SUMMARIES

AGUA FRIA

The Agua Fria Basin located predominantly in Yavapai County is characterized by mid-elevation mountain ranges and high mesa semi-desert grasslands. The Agua Fria River flows intermittently from east of Prescott to the Gila River west of Phoenix. Vegetation types include Arizona upland Sonoran desertscrub, semidesert grassland, interior chaparral, montane conifer forests and Great Basin conifer woodland. Riparian vegetation is found along the Agua Fria River including mixed broadleaf and Cottonwood/Willow assemblages.

Important Riparian, Aquatic, and Wetland Resources

The Agua Fria River and its tributaries support the riparian system, and drain into Lake Pleasant—a popular recreation area for boating and fishing. The river cuts through Agua Fria National Monument and is fed along the way by several major and minor tributaries including, Big Bug, Ash, Sycamore, and Yellow Jacket Creeks. These ribbons of valuable riparian forests contribute to an outstanding biological resource. Riparian vegetation is primarily mixed broadleaf and cottonwood-willow systems. Common species include: Fremont Cottonwood, various willow such as Narrowleaf, Goodding, and Bebb, Arizona Sycamore, Velvet and Green Ashes, Arizona Alder, Arizona Walnut, and Box Elder.

Many important aquatic and riparian wildlife species occur within the riparian forests and along the shores of Lake Pleasant. Lowland Leopard Frog, Arizona Toad, Peregrine Falcon, Bald Eagle, Belted Kingfisher, Yellow-billed Cuckoo, and Zone-tailed Hawk have all been observed. The endangered Desert Pupfish and Gila Topminnow were historically found within the stream system and were recently reintroduced to isolated springs in the Agua Fria Basin. Other aquatic and wetland species include Longfin Dace, Speckled Dace, and Great Blue Heron. Mule Deer, Javelina, Mountain Lion and Black Bear also visit the canyons and riparian areas. Other State Wildlife Species of concern observed in the basin include the Belted Kingfisher, Common Black-Hawk and Western Red Bat.

Important Conservation Lands

- The Agua Fria National Monument, BLM
- Riparian Corridors within the Agua Fria National Monument, BLM have been identified by the Arizona Audubon Society as Important Bird Areas. Over 28 species of birds have been observed including, Common Black-Hawk, Golden Eagle, Yellow-billed Cuckoo, Lucy's Warbler, Bell's Vireo, and Gray Vireo.
- Agua Fria Wildlife Preserve at Lake Pleasant Regional Park is also identified as a birding area by the Maricopa Audubon Society, Maricopa County, BOR
- Castle Creek Wilderness, USFS
- Hells Canyon Wilderness, BLM
- Cedar Bench Wilderness, USFS
- Pine Mountain Wilderness, USFS
- Horseshoe Ranch Wildlife Area was recently acquired by the AGFD in 2011.

Federally Protected Species and Critical Habitats

Critical habitat is designated for the Gila Chub and Mexican Spotted Owl.

Federally protected species observed in the basin include:

- Endangered- Gila Chub, Desert Pupfish, Gila Topminnow, and Southwestern Willow Flycatcher
- Threatened- Mexican Spotted Owl and the Bald Eagle
- Candidate- Western Yellow-billed Cuckoo (Western U.S. DPS), Roundtail Chub, and Northern Mexican Gartersnake

The Endangered Gila Trout was recently introduced to Grapevine Creek in the Big Bug Creek watershed.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 520,744 Angler Use Days were documented in the Agua Fria Basin, equating to over $81 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/Volume_5_AGF_final.pdf

ARAVAIPA CANYON

The Aravaipa Canyon Basin is located in Graham and Pinal Counties. The basin is characterized by medium-elevation mountain ranges, canyons and valleys. Aravaipa Creek emerges from the Pinaleno, Santa Teresa, and Galiuro Mountains at an elevation of about 3,000 feet. It then flows westward and enters a narrow canyon with pronounced gradient.

Vegetation within the basin is primarily Semidesert Grassland with smaller areas of Great Basin Conifer Woodland, madrean Evergreen Woodland, Interior Chaparral and Arizona Uplands Sonoran Desertscrub. Riparian vegetation includes Cottonwood/Willow, Mesquite and mixed broadleaf.

Important Riparian, Aquatic, and Wetland Resources

Aravaipa Creek's 18-mile-long perennial reach supports the best remaining assemblage of native desert fish in Arizona including, the Roundtail Chub, Speckled Dace, Desert Sucker, Sonoran Sucker, and the Federally listed (threatened) Loach Minnow and Spikedace. Reptiles and amphibians include the Canyon Tree Frog, Lowland Leopard Frog, Red-spotted Toad, Black-necked Gartersnake, and a variety of rattlesnakes. Water resources in the basin provide habitat that was suitable for the reintroduction of Federally endangered Gila Topminnow and Desert Pupfish.

Aravaipa is famed as a birder's paradise, with nearly every type of desert songbird and more than 150 species documented in the wilderness. Birds of prey include Peregrine Falcon, Common Black-Hawk, Zone-tailed Hawk, and Elf Owl. Migratory songbirds include Vermilion Flycatcher, Black Phoebe, Canyon and Rock Wrens, White-throated Swift, Yellow Warbler, and Bell's Vireo. Healthy populations of Desert Bighorn Sheep roam the area, along with 44 other mammals such as Black Bears, Bobcats, Coyotes, and Mountain Lions. Aravaipa Creek also provides important habitat for at least nine species of bats. Other State Wildlife Species of concern observed in the basin include the Northern Gray Hawk, Western Red Bat and Western Yellow Bat.

Flows in the upper reaches of Aravaipa Creek are intermittent. Within The Nature Conservancy Preserve and Aravaipa Canyon Wilderness the flow becomes perennial, fed by springs, seeps, and tributary streams. The Nature Conservancy and the BLM have instream-flow rights that are used to maintain base flows for conservation purposes.

Important Conservation Lands

- Aravaipa Canyon Wilderness, BLM
- Aravaipa Canyon Preserve, The Nature Conservancy
- Aravaipa Canyon State Conservation Wildlife Area, AGFD
- Aravaipa Native Fish Barriers, installed by CAP, to protect and conserve native fish in the canyon; at the confluence of Aravaipa Canyon and the San Pedro River in the Lower San Pedro Basin.
- Aravaipa Creek is designated an Outstanding Arizona Water, ADEQ
- Aravaipa Creek, State Watchable Wildlife Area
- Aravaipa Creek has been identified by Arizona Audubon Society as an Important Bird Area
- Galiuro Wilderness, USFS
- Santa Teresa Wilderness, USFS

The Nature Conservancy has established an active management program to ensure the long-term protection of the stream system and its mixed broadleaf riparian forest composed of cottonwood, willow, walnut, alder, and sycamore trees. This program includes fish monitoring, controlled burning, and removal of non-native species. Their goals also include restoration of grasslands in the upper watershed. BLM management of the wilderness area supports most of these same conservation goals.

Federally Protected Species and Critical Habitats

Critical Habitat is designated for the Mexican Spotted Owl in higher elevations of the basin and for Spikedace and Loach Minnow in Aravaipa Creek.

Candidate Roundtail Chub are present in the creek along with Threatened Loach Minnow and Spikedace. Endangered Gila Topminnow and Desert Pupfish have been reintroduced into tributary and spring habitats in the groundwater basin. Candidate Yellow-billed Cuckoo has also been observed in the canyon. Other federally protected species observed in the basin include the Threatened Chiricahua Leopard Frog and Mexican Spotted Owl.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_ARA_final.pdf

BIG SANDY

Big Sandy Basin within Mohave and Yavapai Counties is characterized by large valleys and mid-elevation mountain ranges and plateaus. Vegetation types include Arizona upland Sonoran desertscrub, plains and Great Basin and semidesert grasslands, interior chaparral, Rocky Mountain and madrean montane forest and Great Basin conifer woodland.

Important Riparian, Aquatic, and Wetland Resources

Knight Creek and Trout Creek drain the northern part of the basin, converging 15 miles north of Wikieup to form the Big Sandy River. The Big Sandy River floodplain, upstream from Wikieup, supports dense riparian vegetation including, cottonwood-willow, mesquite and tamarisk. Sections of Trout Creek support mesquite, cottonwood-willow and mixed broadleaf communities. The Big Sandy River flows approximately ten miles southward, exiting the groundwater basin, eventually converging with the Santa Maria River just above Alamo Lake in the Bill Williams Basin. Meadow Lake is the perennial headwaters of Fort Rock Creek, a tributary of Trout Creek.

Native fish species documented in this basin include Desert Sucker, Longfin Dace, Roundtail Chub, Sonora Sucker, and Speckled Dace. Other species associated with riparian habitats include Lowland and Northern Leopard Frog, Common Black-Hawk, Zone-tailed Hawk, and the federally listed Southwestern Willow Flycatcher, Yellow-billed Cuckoo, and Yuma Clapper Rail.

Important Conservation Lands

- Wabayuma Peak Wilderness, BLM
- Juniper Mesa Wilderness, BLM
- Hualapai Mountain County Park

Hualapai Mountain County Park supports great wildlife viewing opportunities. The habitat is mainly pinion pine forest with many natural springs. It supports bear, elk, Mule Deer, Mountain Lion, Javelina and several other species. Higher elevations are home to Mule Deer, elk, Mountain Lions, foxes and a wide variety of birds.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Southwestern Willow Flycatcher.

Federally listed species occurring within the basin include, the Listed Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail and Hualapai Mexican Vole. Other federally protected species in the basin include the Listed Threatened Mexican Spotted Owl, and Candidate Yellow-billed Cuckoo and Roundtail Chub.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_BIS_final.pdf

BILL WILLIAMS

The Bill Williams Basin, within Mohave, La Paz and Yavapai counties, is characterized by hilly terrain in much of the basin and by several major river drainages. The basin ranges from high elevation forested mountains along the western margin of the central highlands province, to low lying, rugged desert mountains and intervening alluvial valleys in the basin and range province. There is also a range of vegetation types including Arizona upland and Lower Colorado River Sonoran desertscrub, Mohave desertscrub, semidesert grassland, interior chaparral, Great Basin conifer woodland and montane conifer forest. Riparian vegetation is found along streams including cottonwood/willow, mesquite and tamarisk along Bill Williams, Big Sandy and Santa Maria Rivers and mesquite, cottonwood/willow and mixed broadleaf along sections of Burro Creek.

The Bill Williams River originates at the confluence of the Big Sandy and the Santa Maria rivers and is impounded by Alamo Dam that forms Alamo Lake. Prior to the construction of Alamo Dam, the river's flow was perennial. Today, much of the drainage flows only during rainstorms. During times of heavy runoff releases from Alamo Dam may reach as much as 7,000 cubic feet per second (CFS), they are generally less than 40 CFS. These water releases are regulated by the U.S. Army Corps of Engineers, in cooperation with the U.S. Fish & Wildlife Service.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Bill Williams Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Bill Williams River (BWR) ecosystem contains lush riparian vegetation that grows in many locations within its valley, a striking contrast to the adjacent, sparsely vegetated uplands. The BWR supports the largest stand of cottonwood-willow forest remaining along the Lower Colorado River. Riparian vegetation along the BWR is dominated by several woody species common to low elevation southwestern riparian ecosystems, including Fremont Cottonwood, Goodding Willow, Tamarisk, Seep Willow, and mesquite. Herbaceous vegetation tends to be quite sparse, except adjacent to areas where water and light availability are high. The herbaceous flora comprises the greatest plant diversity along the river. Riparian forests along the BWR provide habitat that is valuable to a great diversity of animal species.

Riparian vegetation is found along other streams and rivers in this basin including Big Sandy River, Santa Maria River, Burro Creek, Boulder Creek, Bridle Creek, Date Creek, Francis Creek, Mountain Spring Wash, Sycamore and Wilder Creek.

Vegetation patterns are also influenced by local geomorphology, flood flows and the availability of groundwater. There is a mix of canyon and valley reaches along the BWR. The canyon reaches tend to have narrower floodplains, less complex arrangements of channels, and shallower groundwater tables. The valley reaches may have multiple channels, a broader floodplain, and lower groundwater tables—especially at the upstream end.

More than 300 bird species have been sighted along the BWR, including resident, wintering, and summer breeding and migratory taxa. The BWR attracts bird watchers from around the world and has been designated an Important Bird Area by the Audubon Society and a Globally Important Bird Area by the American Bird Conservancy.

The Sonoran Yellow Warbler, Bell's Vireo, Summer Tanager, Yellow-breasted Chat, Bald Eagle, Peregrine Falcon, Gambel's Quail and Mourning Dove are found along the BWR as well Mule Deer, Desert Bighorn Sheep, and Javelina. Beaver are prevalent and have built dozens of dams along the river in between floods,

influencing the river geomorphology, surface and groundwater dynamics, riparian vegetation and the animals using these habitats. At least 14 bat species occur along the BWR, many of which specialize in consuming the night-flying, nocturnal insects of the riparian zones. Mammalian predators within the BWR include Mountain Lions, Bobcats, Ringtail Cats and Grey and Kit Foxes.

Waterfowl and shorebirds frequent the Alamo Wildlife Area and Alamo Lake, including breeding populations of American White Pelican and Western Grebe. Bald Eagles nest in the wildlife area, as does the Southwestern Willow Flycatcher, Yellow-billed Cuckoo, Black-chinned Hummingbird, Gila and Ladder-backed Woodpeckers, Vermilion, Ash-throated and Brown-crested Flycatchers, Bell's Vireo, Crissal Thrasher, Phainopepla, Lucy's and Yellow Warblers, Yellow-breasted Chat, summer Tanager, Blue Grosbeak, Abert's Towhee, Bullock's Oriole, and Lesser Goldfinch. Common reptiles and amphibians that may be encountered by visitors include Common Kingsnake, Long-nosed Snake, Sonoran Mud Turtle, Desert Spiny and Ornate tree Lizards, and Red-spotted and Great Plains Toads. Other State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, California Black Rail, Clark's Grebe, Common Black-Hawk, Western Red Bat and Western Yellow Bat.

Important Conservation Lands

- Bill Williams River National Wildlife Refuge, USFWS, also a recognized Arizona Audubon Important Bird Area and a Watchable Wildlife Viewing Area
- Aubrey Peak Wilderness, BLM
- Arrastra Mountains Wilderness, BLM
- Granite Mountain Wilderness,
- Rawhide Mountains Wilderness, BLM
- Swansea Wilderness Area, BLM
- Harcuvar Mountains Wilderness, BLM
- Upper Burro Creek Wilderness, BLM
- Tres Alamos Wilderness, BLM
- Aubrey Peak Wilderness, BLM
- Alamo Lake Wildlife Area, AGFD – Arizona Audubon Important Bird Area
- Alamo Lake State Park, AZ State Parks
- Francis Creek, Burro Creek and People's Canyon Creek are designed as Outstanding Arizona Waters, ADEQ

Flow releases from Alamo Dam are being adjusted to meet a variety of natural resource objectives, including the enhancement of cottonwood-willow riparian areas and flood control. There is also an evaluation of management efforts that encourages making necessary adjustments to better achieve a sound balance between various management objectives above and below Alamo Dam.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Endangered Southwestern Willow Flycatcher along the Big Sandy

River and for Mexican Spotted Owl in the upland. Critical Habitat is also designated for the Endangered Bonytail Chub at the confluence of the BWR and the Colorado River. Gila Topminnow and Desert Pupfish have been reintroduced in small populations within tributary springs and wetlands.

Other federally listed species include the Endangered Yuma Clapper Rail, Southwestern Willow Flycatcher, Bonytail, Desert Pupfish, Gila Topminnow, and Razorback Sucker. Candidate Roundtail Chub and Yellow-billed Cuckoo have also been observed. The Mexican Spotted Owl is listed as threatened, as is the desert population of the Bald Eagle under the Endangered Species Act. The BWR and Alamo Lake provide habitat and food sources for these birds of prey.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 167,458 Angler Use Days were documented in the Bill Williams Basin, equating to over $26 million in economic revenue generated by angler activity within the basin.

Web Sources

http://billwilliamsriver.org/default.htm

http://www.wildlifeviewingareas.com/wv-app/ParkDetail.aspx?ParkID=82

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_BWM_final.pdf

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Shafroth & Beauchamp. (2006). Streamflow-Biota Relations: Riparian Vegetation. In P. Shafroth, & V. Beauchamp, (eds.), *Defining Ecosystem Flow Requirements for the Bill Williams River, Arizona* (pp. 31-40). Reston, Virginia: U.S. Geological Survey.

BONITA CREEK

Bonita Creek Basin is located in Graham County and is characterized by medium-high elevation plains and mountain ranges. The vast majority of lands within the basin are located on the San Carlos Indian Reservation. Vegetation is primarily Plains and Great Basin grassland with smaller areas of Great Basin conifer forest, interior chaparral, Chihuahuan desertscrub, semidesert grassland and Arizona uplands Sonoran desertscrub. Riparian vegetation includes mixed broadleaf, strand and mesquite on Bonita Creek.

Important Riparian, Aquatic, and Wetland Resources

A 14 mile perennial stretch of Bonita Creek flows roughly from the northwest to the southeast in a tight steep-walled canyon with scattered stands of large Cottonwood, Sycamore, Walnut, Ash and Mesquite trees. In this stretch of Bonita Creek over 140 species of birds have been recorded, including the Common Black Hawk, Zone-tailed Hawk, and Yellow-billed Cuckoo. More than 70 species nest along the creek. Bonita Creek is also a haven for native fish and frogs. Black bears and javelina are commonly seen. Bonita Creek is popular for bird watching, hiking, and picnicking, and lined with large Cottonwoods, Sycamores, and Willows.

Other State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog and American Peregrine Falcon.

Important Conservation Lands

- Bonita Creek identified as an Outstanding Arizona Water, ADEQ
- Gila Box Riparian National Conservation Area, BLM
- Fishhooks Wilderness, USFS

Federally Protected Species and Critical Habitats

There is no designated critical habitat in this basin.

Federally protected species observed in the basin include the Listed Endangered Gila Chub and the Listed Threatened Chiricahua Leopard Frog. Candidate Yellow-billed Cuckoo and Northern Mexican Gartersnake have also been observed. Bonita Creek is a candidate for native fish reintroductions as well as a proposed fish barrier to prevent non-native fish from the Gila River to move into Bonita Creek. Sensitive species in Bonita Creek consist of Longfin Dace and Speckled Dace, Sonora Sucker as well as the Lowland Leopard Frog.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_BON_final.pdf

http://visitgrahamcounty.com/birdbrochure2

BUTLER VALLEY

The Butler Valley Basin is located in the eastern part of La Paz County. The basin is characterized by a valley bordered by two mountain ranges; Harcuvar and Buckskin Mountains. Vegetation types include Lower Colorado River and Arizona uplands Sonoran desertscrub and a small amount of interior chaparral on the eastern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

There are no perennial streams and no identified springs in the Butler Valley Basin. Cunningham Wash runs northeast to southwest in the northern portion of the basin. Although no observations of wildlife species of concern have been documented within this basin, Cunningham Wash may offer important habitat and movement corridors for reptiles, birds, and mammals.

Important Conservation Lands

- Rawhide Mountains Wilderness, BLM
- Harcuvar Mountains Wilderness, BLM

Federally Protected Species and Critical Habitats

There is no designated critical habitat in this basin.

No additional species of concern have been observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_BUT_final.pdf

CIENEGA CREEK

Cienega Creek Basin is located in Pima, Santa Cruz and Cochise counties and is characterized by a series of mid- to high-elevation mountain ranges, grasslands and woodlands. Vegetation includes Plains and Great Basin and semidesert grasslands, Chihuahuan desertscrub, madrean evergreen woodland and small portion of Rocky Mountain and montane madrean conifer forest. Riparian vegetation includes mixed broadleaf and strand on Red Rock Canyon and mixed broadleaf, mesquite and strand on Sonoita and Cienega Creeks.

Cienega Creek originates in the Canelo Hills and continues roughly 50 miles toward the northwest where it becomes Pantano Wash. From its origin in the Canelo Hills, Cienega Creek flows northwesterly through the upper Cienega basin, a wide alluvial valley separating the Northern Santa Rita and Empire Mountains to the west and Whetstone Mountains to the east. Cienega Creek continues northward through the lower alluvial basin until it bends west/northwest in the vicinity of Anderson and Wakefield Canyons. After crossing I-10, Cienega Creek again becomes perennial. In these stretches groundwater is forced upward through faults in the bedrock from aquifers near the surface.

Important Riparian, Aquatic, and Wetland Resources

The Cienega Creek Basin contains approximately 46 miles of perennial flow in Cienega Creek, Mattie Canyon, Alum Gulch, Harshaw Creek, Redrock Canyon Creek, and Sonoita Creek lined with a mature cottonwood-willow gallery. Cienega Creek flows through some of the last remaining oak grasslands in southeastern Arizona.

Cienega Creek supports outstanding examples of cottonwood-willow gallery forest and mesquite bosque. The rare marshland and perennial aquatic habitat provides a home for a wide variety of amphibians, birds, invertebrates, and riparian plants. Amphibian species include Chiricahua Leopard Frog, Lowland Leopard Frog, Tarahumara Frog, and Western Barking Frog. Diverse migratory and native birds rely on the riparian vegetation around Cienega Creek, including, Elegant Trogon, Mexican Spotted Owl, Southwestern Willow Flycatcher, Yellow-billed Cuckoo, American Peregrine Falcon, and Tropical Kingbird. Cienega Creek is one of the few remaining streams in southern Arizona that has not been invaded by non-native fish. The Las Cienegas National Conservation Area supports the largest natural population of the federally endangered Gila Topminnow in the United States, as well as a healthy population of endangered Gila Chub and the Longfin Dace. Some of the last remaining known communities of the endangered Huachuca Water Umbel can be found in Cienega Creek. Other State Wildlife Species of Concern observed in the basin include; Black-bellied Whistling Duck, Common Black-Hawk, Northern Buff-breasted Flycatcher, Northern Gray Hawk, Thick-billed Kingbird, Violet-crowned Hummingbird, and the Western Red Bat.

Important Conservation Lands

Much of upper Cienega Creek flows through the Las Cienegas Natural Conservation Area (NCA), managed by the BLM. In 1986, the Pima County Board of Supervisors established the Cienega Creek Natural Preserve, which protects over 12 miles of the lower creek. The creek's flow is perennial through roughly half of this preserve.

- Las Cienegas National Conservation Area, BLM
- Cienega Creek Natural Preserve, Pima County
- Patagonia-Sonoita Creek Preserve, TNC, also a recognized Arizona Audubon Important Bird Area
- Santa Cruz River and Tributaries, Arizona Audubon Important Bird Areas

- Rincon Mountain Wilderness, USFS
- Mount Wrightson Wilderness, USFS
- Saguaro National Monument, NPS
- Cienega Creek identified as an Outstanding Arizona Water, ADEQ

Fish monitoring, grazing management and other conservation management activities on the Las Cienegas NCA are directed toward ensuring the long-term protection of the cienega system and associated riparian forest. Instream flow permits in the Cienega Creek Preserve, along with ongoing monitoring and restoration activities are also intended to protect one of the last remaining reaches of perennial flow.

Pima County monitors groundwater levels in the Preserve on a quarterly basis. Between 2002 and 2005, lower than average rainfall dropped water levels in most of the Preserve's monitoring wells by 10 to 20 feet. Groundwater levels throughout the Preserve rose during the fall of 2006, but remain at or below levels measured in 2000. In general, stream lengths have been decreasing over the last five years, with a drop of approximately 3.7 miles since the spring of 2002.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl, Gila Chub, and Huachuca Water Umbel.

The Mexican Gartersnake, identified as a Candidate for listing, has declined throughout its range in the United States, but retains a strong population in Cienega Creek. The federally Threatened Chiricahua Leopard Frog occurs only in the upper reaches of the creek. Other federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Gila Chub and Gila Topminnow. Threatened Mexican Spotted Owl and Yellow-billed Cuckoo and Huachuca Springsnail have also been observed.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_CCK_final.pdf

COCONINO PLATEAU

The Coconino Plateau Basin is located in Coconino County and a small portion of Mohave County. The basin is characterized by rolling high plateaus, deeply-incised canyons, and rounded volcanic mountains. Vegetation types include Mohave and Great Basin desertscrub, Plains and Great Basin grasslands, Great Basin conifer woodland and Rocky Mountain and madrean montane conifer forest. There are small areas of subalpine conifer forest and alpine tundra in the San Francisco Mountains in the southeast corner of the basin.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Coconino Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The most significant aquatic and riparian resources in the basin are the Colorado River through the Grand Canyon, the lower Little Colorado River, Havasu Creek and the lakes around Williams.

A large part of the groundwater moves northward and is discharged from springs along the Little Colorado and Colorado Rivers and Havasu Creek. The largest of these springs includes Blue Springs on the Little Colorado River where perennial flow begins in the stream, and Havasu Springs on Havasu Creek which begins the perennial flow of Havasu Creek. The two springs discharge more than 100,000 gallons per minute and 29,000 gallons per minute, respectively. Havasu Falls is located on the Havasupai Indian Reservation in Grand Canyon and stands 120 feet high. Havasu Springs have a high mineral content and calcium carbonate which precipitates to form the cascading falls, pools and natural travertine dams.

The basin is also home to numerous constructed reservoirs that provide water for the communities around Williams, as well as for recreational opportunity. They include Dogtown, City, Santa Fe, Cataract and Kaibab reservoirs in the headwaters of Cataract Canyon near Williams.

State Wildlife Species of Concern observed in the basin include; Northern Leopard Frog, American Peregrine Falcon, Golden Eagle, Bald Eagle, Osprey, Navajo Mexican Vole, and Western Red Bat.

Important Conservation Lands

- Kendrick Mountain Wilderness, USFS
- Kachina Peaks Wilderness, USFS
- Grand Canyon National Park, NPS
- Grand Canyon National Game Preserve, NPS
- Arizona Audubon Important Bird Areas - Marble Canyon, Grand Canyon (Lipan & Yaki Points)

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Humpback Chub, (translocations have occurred), Mexican Spotted Owl, San Francisco Peaks Groundsel, and Razorback Sucker.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Humpback Chub, Kanab Ambersnail, and Hualapai Mexican Vole. The Listed Threatened Mexican Spotted Owl has also been observed.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 62,866 Angler Use Days were documented in the Coconino Basin, equating to over $9 million in economic revenue generated by angler activity within the basin.

This basin contains portions of AGFD Game management Units 7W, 7E, 9 and 10. Combined, these Game Management Units provide hunting opportunities for mule deer, whitetail deer, elk, pronghorn antelope, mountain lion, turkey, bighorn sheep and black bear. All big game species rely on surface water for maintaining healthy and abundant populations.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_COP_final.pdf

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DETRITAL VALLEY

The Detrital Valley Basin, located in Mohave County, is characterized by a wide north-south trending valley and mountains on the east and west basin margins. Lake Mead forms the northern boundary of the basin. Vegetation is almost exclusively Mohave desertscrub with small areas of semidesert grassland, interior chaparral, Great Basin conifer woodland and montane conifer forest.

Important Riparian, Aquatic, and Wetland Resources

Ephemeral Detrital Wash, the basin's main hydrological feature, runs north-south through the basin, emptying into Lake Mead at the basin's lowest elevation (1,100 feet) at Bonelli Bay.

The Detrital Valley Basin has no additional major lakes or reservoirs and no perennial or intermittent streams or rivers. Streamflow in the Detrital Valley Basin is essentially ephemeral, generated by precipitation in the surrounding mountains. Surface flow rarely reaches the central parts of the valley because of evapotranspiration and infiltration on alluvial fans—areas which provide most of the groundwater recharge.

The American Peregrine Falcon is a State Wildlife Species of Concern observed in the basin. Other species observed include Western Red-tailed Skink and Kingman Springsnail.

Important Conservation Lands

- The Mt. Wilson Wilderness Area, BLM
- Mt. Tipton Wilderness Area, BLM
- Lake Mead National Recreation Area, NPS

Detrital Valley's northern boundary follows the shore of Lake Mead. The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Razorback Sucker along the Colorado River in the northern portion of the basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_DET_final.pdf

DONNELLY WASH

The Donnelly Wash Basin is located in the eastern part of Pinal County. A segment of the Gila River flows east to west through the upper half of the basin, entering just west of Kelvin, through Cochran and exiting the basin at Price. The Gila River is regulated through this portion of the Donnelly Wash Basin. A portion of Box Canyon has perennial flow. The basin is characterized by low elevation hills, washes and canyons. Vegetation is primarily Arizona Sonoran desert scrub with a smaller area of semi-desert grassland.

Important Riparian, Aquatic, and Wetland Resources

State Wildlife Species of Concern observed in the basin include the American Peregrine Falcon, Lowland Leopard Frog and Common Black-Hawk. Other native aquatic species observed include Desert Sucker, Longfin Dace, and Sonora Sucker.

Important Conservation Lands

- White Canyon Wilderness, BLM.

White Canyon Wilderness includes the southeast portion of the Mineral Mountains. The canyon itself is narrow with walls rising as much as 800 feet almost straight up. Throughout the area are numerous side canyons. The canyon is reported to have perennial flow. Mountain lion and black bear have been observed.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Southwestern Willow Flycatcher and Spikedace.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Threatened Spikedace, and Candidate Yellow-billed Cuckoo.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DON_final.pdf

http://www.blm.gov/az/st/en/prog/blm_special_areas/wildareas/whitecanyon.html

http://www.sangres.com/arizona/blm/whitecanyon.htm

DOUGLAS

The Douglas Basin, located in Cochise County, is geographically influenced by the surrounding mountain ranges that include the Swisshelm, Pedrogosa, Perilla, Mule and Dragoon Mountain ranges. The basin is characterized by a large valley, grasslands and desertscrub vegetation. Vegetation is primarily semi-desert grassland with smaller areas of Chihuahuan desertscrub. Riparian vegetation includes cottonwood and willow along Leslie Creek.

Important Riparian, Aquatic, and Wetland Resources

Vegetation and wildlife in the Douglas Basin varies greatly because of the diversity of the landscape. An area of the Coronado National Forest contained in the Basin is the Douglas Ranger District which is primarily used for grazing, timber, and recreational activities. The Douglas Basin is also notable for the wildlife in the Whitewater Draw Wildlife Area and Leslie Canyon NWR. Whitewater Draw and agricultural lands in the area provide habitat and forage for large numbers of Sandhill Cranes and other migratory birds that winter in the area. Other animals commonly observed and range from bats to mountain lions and the Mojave green rattlesnake to the Sonoran box turtle. The Violet-crowned Hummingbird is a State Wildlife Species of Concern observed in the basin.

Watercourses are generally ephemeral in the basin; Whitewater Draw is the largest drainage and flows south into Mexico. Leslie Creek in Leslie Canyon NWR is the only perennial connection in the Basin and in managed by USFWS to protect the endangered Yaqui topminnow and Yaqui chub.

Important Conservation Lands

- Whitewater Draw Wildlife Area, AGFD
- Leslie Canyon National Wildlife Refuge, USFWS

Federally Protected Species and Critical Habitats

There is no designated critical habitat in this basin.

Federally protected species observed in this basin include the Endangered Yaqui-Chub, Yaqui Topminnow, and Huachuca Water-umbel. Threatened Chiricahua Leopard Frog has also been observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/SEArizona/Hydrology/DouglasBasin.htm

http://www.fs.fed.us/r3/coronado/forest/conditions/conditions.shtml

http://www.blm.gov/az/st/en/prog/blm_special_areas/ncarea/sprnca.html

http://www.fws.gov/refuges/profiles/index.cfm?id=22524

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/SEArizona/Hydrology/DouglasBasin.htm

http://www.fws.gov/refuges/profiles/index.cfm?id=22524

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDFs_for_web/Southeastern_Arizona_Planning_Area/Douglas_Basin.pdf

http://www.azgfd.gov/outdoor_recreation/wildlife_area_whitewater.shtml

http://www.azheritagewaters.nau.edu/loc_yaqui_river.html

http://www.adwr.state.az.us/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DOU_final.pdf

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/SEArizona/Hydrology/DouglasBasin.htm

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DOU_final.pdf

DRIPPING SPRINGS WASH

The Dripping Springs Wash Basin, located in Pinal, Gila and Graham counties is characterized by a mid-elevation mountain range and Arizona uplands Sonoran desertscrub, interior chaparral, semidesert grassland and madrean evergreen woodland vegetation. Riparian vegetation includes strand and mesquite on the Gila River and cottonwood, willow, strand and mixed broadleaf on Mescal Creek.

Important Riparian, Aquatic, and Wetland Resources

The Gila River is regulated through the Dripping Springs Wash Basin and considered perennial for three miles. The Gila River creates the boundary between Pinal and Gila counties. The basin is named for Dripping Springs Wash northwest of the community of Christmas, a tributary of the Gila River which has perennial flows for three miles through the basin until its confluence with the Gila. Other noted tributaries are Deer Creek and Ash Creek running roughly parallel to one another southeast of Christmas, and Mescal Creek. Mescal Creek has one mile of perennial flow in the basin.

A noted feature located just outside the Basin is Coolidge Dam on the Gila River, just upstream and out of the basin. Coolidge Dam forms San Carlos Reservoir on the Gila and is located in the Safford Basin.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, American Peregrine Falcon, Common Black-Hawk and Osprey.

Important Conservation Lands

- Needles Eye Wilderness Area, BLM

The Mescal Mountains cut across the middle of Needles Eye Wilderness, their southwestern flank forming a spectacular striped slope of Paleozoic limestone that rises more than 2,500 feet high. The Gila River flows across the wilderness and forms its southern border. The river threads through a section of steep-walled canyon so narrow it's earned the name Needle's Eye. Several small slickrock side canyons wind down to the Gila, bisecting the area. The narrow river channel is dense with riparian growth.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Southwestern Willow Flycatcher, Mexican Spotted Owl, and Razorback Chub.

Federally protected species of concern observed in the basin include the Endangered Southwestern Willow Flycatcher and Gila Topminnow. The Bald Eagle is also listed as Threatened.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DSW_final.pdf

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=403

http://www.blm.gov/az/st/en/prog/blm_special_areas/wildareas/needles.html

http://en.wikipedia.org/wiki/Area_of_Critical_Environmental_Concern

http://www.fs.fed.us/psw/programs/rna/

http://www.blm.gov/pgdata/etc/medialib/blm/az/pdfs/nepa/library/resource_management/safford.Par.29271.File.dat/appendices.pdf

http://www.fws.gov/southwest/es/arizona/Documents/Redbook/Southwestern%20Willow%20Flycatcher%20RB.pdf

http://www.fws.gov/southwest/es/Arizona/Documents/CountyLists/Gila.pdf

http://www.fws.gov/southwest/es/Arizona/Documents/CountyLists/Pinal.pdf

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2004_register&docid=fr31au04-14

DUNCAN VALLEY

Duncan Valley Basin, located predominantly in Greenlee County and a small section of Cochise County is characterized by mid-elevation mountain ranges and Chihuahuan desertscrub, semidesert grassland and madrean evergreen woodland vegetation. Riparian vegetation includes mesquite and tamarisk on the Gila River.

Important Riparian, Aquatic, and Wetland Resources

The Gila River flows north from New Mexico in the vicinity of Duncan and exits the basin west of Guthrie for over 20 miles. These areas support native fish including Desert Sucker, Longfin Dace, Sonora Sucker and Razorback Sucker.

The 23,000-acre Gila Box Riparian National Conservation Area (NCA) falls partially within the Duncan Valley Basin. The NCA has four perennial waterways - the Gila and San Francisco Rivers and Bonita and Eagle Creeks. The Gila River canyon section, known as the Gila Box, is composed of patchy mesquite woodlands, mature cottonwoods, sandy beaches, and buff-colored cliffs. Several raptors can be found in the NCA including, Zone-tailed Hawks and Common Blackhawks. The perennial creek and riparian vegetation make this a cool year-round desert oasis.

Duncan Valley Basin also contains the following perennial waters: Cold Creek, Linden Creek, Apache Creek and Bitter Creek, all of which are located northeast of Duncan, Arizona.

Lowland Leopard Frog and Common Black-Hawk are both State Wildlife Species of Concern observed in the basin

Important Conservation Lands

- Gila Box Riparian National Conservation Area, BLM
- Peloncillo Mountains Wilderness, BLM

A portion of the Gila Box Riparian national Conservation Area, one of only two Riparian national Conservation Areas in the nation, is located in the Duncan Valley Basin. It was established in 1990 to conserve, protect and enhance the riparian and associated values of the area. While it contains four perennial waters, only the Gila River flows in the Duncan Valley Basin.

Desert Bighorn Sheep have been reintroduced into the Peloncillo Mountains Wilderness. Deer and Peregrine Falcon also inhabit that canyons and uplands. Vegetation ranges from desert shrub grasslands in the surrounding flatlands to oak juniper woodlands in the higher reaches. One of the more scenic parts of the Wilderness is Little Doubtful Canyon with an extensive forest of Emory and Arizona white oak along the bottom.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Endangered Southwestern Willow Flycatcher and Razorback Sucker.

Economic Values

See Report Discussion.

Web Sources

http://www.blm.gov/az/st/en/prog/blm_special_areas/ncarea/gbox.html

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DUN_final.pdf

http://www.sangres.com/arizona/blm/peloncillomountains.htm

http://www.blm.gov/az/st/en/prog/blm_special_areas/wildareas/peloncillo.html

http://www.aziba.org/az_ibas.htm

http://wildlifeviewingareas.com/default.asp

http://www.azheritagewaters.nau.edu/designated_w.html

http://www.blm.gov/az/st/en/prog/blm_special_areas.html

http://www.blm.gov/az/st/en/prog/blm_special_areas/ncarea/gbox.html

http://www.fs.fed.us/recreation/map/state_list.shtml#Arizona

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/documents/Volume_3_final.pdf

http://www.azgfd.gov/w_c/edits/hdms_status_definitions.shtml

http://www.azgfd.gov/w_c/edits/species_concern.shtml

http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E054

GILA BEND

The Gila Bend Basin in Maricopa County is characterized by washes and a series of small mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub. The principal geographic feature of the basin is the Gila River which runs east to west through the basin. Painted Rock Dam and Reservoir are located in the basin. The dam impounds flood flows from the Gila River.

Important Riparian, Aquatic, and Wetland Resource

Within the Gila Bend Basin, most of the Gila River is ephemeral and flows only in response to precipitation events or water releases from upstream dams. Historically, the river would flow in the spring due to winter rains and melting snow, and in summer following monsoon rains. Today, these flows are controlled by dams.

Important Conservation Land

- Sonoran Desert National Monument, BLM
- North Maricopa Mountains Wilderness, BLM
- South Maricopa Mountains Wilderness, BLM
- Woolsey Peak Wilderness, BLM
- Buckeye Hills Regional Park, Maricopa County Park
- Painted Rock Wildlife Area, AGFD

Depending on the quantity of water in Painted Rock Reservoir after floods, many birds may be present. An exceptionally large, shallow lake can be created by flood flows which serves as a temporary habitat.

The Sonoran Desert National Monument was created in 2001; its purpose is to protect the historic sites, Indian relics, native habitats, vegetation and wildlife. Within the National Monument are the North and South Maricopa Mountains Wilderness areas. These wilderness areas are characterized by two major vegetation communities: Paloverde-Mixed Cacti, which includes the dense “forests” of Saguaro Cactus, Paloverde, and Ironwood Trees that represent the classic popular image of the Sonoran Desert, and the Creosote-Bursage community that covers low elevation valley floors in seemingly unbroken expanses.

Woolsey Peak Wilderness is located in the Gila Bend Basin on the north side of the Gila River. Desert Mesquite, Paloverde, and Ironwood grow in the washes throughout this rugged and expansive desert wilderness. Desert Bighorn Sheep, Mule Deer, Bobcats, Mountain Lions, hawks, and owls might be found in the more remote areas of this wilderness.

A Portion of the Gila Bend Basin is federally owned and managed by the US military as the Barry Goldwater Air Force Range. There are five species of concern on the Goldwater Range, three of which are listed as threatened or endangered under the Endangered Species Act. These include the Sonoran Pronghorn Antelope, Lesser Long-nosed Bat, and the Peirson’s Milkvetch. The Cactus Ferruginous Pygmy Owl was once listed as endangered but was delisted in 2006. It is not known if these species are found on that portion of the range located within the Gila Bend Basin.

There is a small portion of Maricopa County’s Buckeye Hills Regional Park located in the north portion of the Gila River Basin. The primary use of this park is for recreation, although a portion of it overlooks the Robins Butte Wildlife Area along the Gila River outside the basin boundary.

Federally Protected Species and Critical Habitats

There are no critical habitats designated in the Gila Bend Basin.

The endangered Southwestern Willow Flycatcher and the Yuma Clapper Rail have been observed in this basin.

According to the 2001 report "Biological Resources of the Sonoran Desert National Monument, Arizona," special status species known to be present in the Sonoran Desert National Monument include the Desert Tortoise, Swainson's Thrush, the Lesser Long-nosed Bat, the Sonoran Pronghorn, and the Acuña Cactus.

Economic Values

See Report Discussion.

Web Sources

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDUSFS_for_web/Lower_Colorado_River_Planning_Area/Lower_Gila_River_Watershed.pdf

http://www.arizonensis.org/sonoran/places/paintedrock.html

http://en.wikipedia.org/wiki/Painted_Rock_Dam

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=564 (South Maricopa);

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=421 (North Maricopa).

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=659

http://en.wikipedia.org/wiki/Barry_M._Goldwater_Air_Force_Range

http://www.ecr.gov/pdf/bgrange.pdf http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_GIL_final.pdf

http://aznps.com/Floras/sdnm.pdf

GRAND WASH

The Grand Wash Basin, within Mohave County, is part of the Arizona Strip and is located on the western edge of the Colorado Plateau region in the northwest portion of the state. It is a remote, undeveloped area, characterized by cliffs and washes. The terrain is highly faulted with colorful sedimentary and volcanic rock formations. There are incised canyons and high desert plateaus, which offer breathtaking scenery. Vegetation is primarily Mohave desertscrub and Great Basin conifer woodland with small areas of Great Basin desertscrub, interior chaparral and Plains and Great Basin grassland.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Grand Wash Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Colorado River is the only perennial stream in the basin. There are several springs, with Tassi Spring discharging up to 75 gallons per minute and smaller springs discharging at a much lower rate of 2 gallons per minute.

The wildlife in the Grand Wash Basin is diverse. Big game species include bobcat, Desert Bighorn Sheep, and Desert Mule Deer. This area is also inhabited by Gila Monsters, Arizona Toad, Baja California Tree Frog, and Relict Leopard Frog. Bird species include American Peregrine Falcon, Black-Crowned Night-Heron, and Yellow-billed Cuckoo. During the summer, Neotropical song bird species visit the area. Dove and Gamble Quail can be found year round.

Important Conservation Lands

The majority of the land in the Grand Wash Basin is within the BLM Grand Canyon-Parashant National Monument. Other conservation lands include Grand Canyon National Park, NPS; Grand Wash Cliffs Wilderness, Paiute Wilderness, and Mt. Logan Wilderness, BLM.

Federally Protected Species and Critical Habitats

The Grand Wash Basin has designated a critical habitat for Mohave Desert Tortoise and Razorback Suckers. Other federally protected species known to occur in the basin include California Condor, and the Grand Wash Springsnail. Candidate Relict Leopard Frog and Yellow-billed Cuckoo have also been observed.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_GWA_final.pdf

Additional References

Kearsley, M. & Ayers, T. (2009). Riparian vegetation responses: snatching defeat from the jaws of victory and vice versa. In R. Webb, J. Schmidt, R. Valdez, (eds.), *The Controlled Flood in Grand Canyon* (pp. 309-327). Washington, D.C.: American Geophysical Union.

Ralston, B. (2010). *Riparian vegetation response to the March 2008 short-duration high-flow experiment-Implications of timing and frequency of flood disturbance on nonnative plant established along the Colorado River below Glen Canyon Dam.* Reston, Virginia: U.S. Geological Survey.

Valdez, R., Shannon, J., & Blinn. D. (1999). Biological implications of the 1996 Controlled Flood. In R. Webb, J. Schmidt, R. Valdez, (eds.), *The Controlled Flood in Grand Canyon* (pp. 343-350). Washington, D.C.: American Geophysical Union.

HARQUAHALA INA

The Harquahala Basin is located in Maricopa and La Paz Counties. The basin is characterized by a plain bordered by mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub and a small amount of interior chaparral on the northern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

There are no perennial waters or major springs within the Harquahala Basin. Centennial Wash, a large ephemeral wash, runs through the center of the basin.

Wildlife species observed in the Harquahala INA Basin include Lowland Leopard Frog and Western Red-tailed Skink.

Important Conservation Lands

- Big Horn Mountains Wilderness, BLM
- Eagletail Mountains Wilderness, BLM
- Harquahala Mountains Wilderness, BLM
- Hummingbird Springs Wilderness, BLM

Federally Protected Species and Critical Habitats

Harquahala Basin contains no designated critical habitat and no documented occurrences of federally listed species.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_HAR_final.pdf

HUALAPAI VALLEY

Hualapai Valley Basin, located in Mohave County is characterized by a wide north-south trending valley, mountains along the west basin margins and cliffs and plateau on the eastern basin boundary. Vegetation types include Mohave desertscrub, semi-desert grassland, interior chaparral, conifer woodlands and conifer forest. There are no riparian areas within this basin.

Important Riparian, Aquatic, and Wetland Resources

The Colorado River is the only perennial river in the basin. There are three identified major springs. The southern portion of the basin is drained by an ephemeral watercourse, Truxton Wash, which drains north, and after heavy precipitation flows into the normally dry Red Lake Playa, underneath which exists a large salt body. The other major ephemeral watercourse, Hualapai Wash, runs north from Red Lake Playa after heavy precipitation and flows into Lake Mead. The Colorado River, impounded in Lake Mead, forms the northern boundary of the basin.

American Peregrine Falcon and the Bald Eagle are both State Wildlife Species of Concern observed in the basin

Important Conservation Lands

- Lake Mead National Recreation Area, NPS
- Mt. Tipton Wilderness, BLM

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Endangered Razorback Sucker. Hualapai Mexican Vole, listed as Endangered, has also been observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_HUA_final.pdf

www.azdeq.gov/environ/water/assessment/download/hualapai_fact.pdf

www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/default.htm

http://criticalhabitat.fws.gov/crithab/

KANAB PLATEAU

The Kanab Plateau Basin, located in Mohave and Coconino Counties, is characterized by plateaus and canyons. Vegetation types include Mohave and Great Basin desertscrub, Plains and Great Basin grassland, Great Basin conifer woodland, Great Basin subalpine conifer forest and Rocky Mountain and madrean montane conifer forest. There are small areas of subalpine grassland on the Kaibab Plateau south of Jacob Lake.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Kanab Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Kanab Plateau is the largest tributary canyon system leading into the Grand Canyon and contains Kanab Creek, the Paria River and North Canyon Creek. Scattered riparian areas contain cottonwoods and single-leaf ash. These areas provide winter range for Mule Deer and the introduced Chukar Partridge. Kanab Creek contains several native fish such as the Bluehead Sucker, Humpback Chub and Speckled Dace. The Paria River contains the Flannelmouth Sucker and Speckled Dace. The North Canyon area provides habitat for reintroduced Apache Trout, one of two native species of trout, as well as providing habitat for turkeys, the Kaibab Squirrel, and the introduced bison.

State Wildlife Species of Concern observed in the basin include the Northern Leopard Frog, American Peregrine Falcon, and Western Red Bat.

Important Conservation Lands

- Grand Canyon-Parashant National Monument, BLM
- Vermilion Cliffs National Monument, BLM
- Vermilion Cliffs Wilderness, BLM
- Cottonwood Point Wilderness, BLM
- Paria Canyon Wilderness, BLM
- Kanab Creek Wilderness, BLM
- Mount Logan Wilderness, BLM
- Mount Trumbull Wilderness, BLM
- Saddle Mountain Wilderness, BLM
- Glen Canyon National Recreation Area, NPS
- House Rock Wildlife Area, AGFD
- Ryan Cabin Site State Conservation Land, AGFD
- Grand Canyon National Game Preserve, NPS
- Arizona Audubon Important Bird Areas; Marble Canyon, Grand Canyon Lipan and Yaki Points.

Federally Protected Species and Critical Habitat

Critical Habitat is designated for Threatened Mexican Spotted Owl, Endangered Razorback Sucker, and Endangered Humpback Chub.

Other Endangered species found in the basin include the California Condor, Kanab Amber Snail, and Southwestern Willow Flycatcher. The Kanab Amber Snail is critically endangered and can be found in marshes of seeps and springs at the base of sandstone cliffs. Also observed in the area are the Threatened Bald Eagle and Apache Trout.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 127 Angler Use Days were documented in the Kanab Plateau Basin, equating to over $19,000 in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_KAN_final.pdf

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LAKE HAVASU

The Lake Havasu Basin, located in Mohave County, is characterized by a valley adjacent to the Colorado River and Lake Havasu, which form the western boundary of the basin, and by lower elevation mountains along the north and eastern basin boundary. Vegetation types include lower Colorado River and Arizona upland Sonoran desertscrub and Mohave desertscrub. Riparian vegetation includes tamarisk and marsh along sections of the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

The majority of perennial water in the basin is the 38 mile shoreline along the lake. There are no known springs in the basin. Havasu Wildlife Refuge offers marsh and upland farm field habitats for waterfowl, migrating songbirds, shorebirds, and other wildlife. Clark's Grebe and American Peregrine Falcon are State Wildlife Species of Concern observed in the basin.

Important Conservation Lands

- Havasu National Wildlife Refuge, USFWS
- Havasu Refuge Wilderness, BLM
- Cattail Cove, Arizona State Park
- Lake Havasu State Park, Arizona State Park

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Havasu National Wildlife Refuge is one of three refuges that have a land and water agreement in place. The land and water agreements allow the MSCP to use refuge lands and a portion of that refuge's Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Bonytail Chub.

Twenty-six threatened, endangered, or rare species are covered by the Lower Colorado River Multi-species Conservation Plan including the endangered Razorback Sucker, Bonytail Chub, Humpback Chub, Southwestern Willow flycatcher, Yuma \Clapper Rail, Desert Pupfish, and the Desert Tortoise. The Plan includes the Colorado River located along the western boundary of the basin.

Species observed in the basin include the Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail, Bonytail Chub and Desert Pupfish.

Economic Values

The economy of the basin is heavily dependent on water based recreation centered on Lake Havasu and the Colorado River, while the Havasu National Wildlife Refuge offers important wildlife and bird watching opportunities.

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 248,620 Angler Use Days were documented in the Lake Havasu Basin, equating to over $38 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_LKH_final.pdf

LAKE MOHAVE

Lake Mohave Basin, located in Mohave County is characterized by a broad valley along the Colorado River in the southern part of the basin and by mountains in the northern part of the basin. The Colorado River, Lake Mohave and Lake Mead define the western and northern basin boundary. Vegetation is primarily Mohave desertscrub with a small area of lower Colorado River Sonoran desertscrub and tamarisk and marsh vegetation along sections of the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

The basin's main hydrological feature is the Colorado River and impounded Lake Mead at the northern tip, Lake Mohave along the western edge of the basin and Topock Marsh at the southern tip of the basin. This feature forms 122 miles of the basins western edge. Stream flow outside of the Colorado River in the Lake Mohave groundwater basin is essentially ephemeral, generated by precipitation in the surrounding mountains. Seasonal precipitation and surface flow provide most of the groundwater recharge in the basin.

The American Peregrine Falcon and Clark's Grebe are listed as State Wildlife birds of concern observed in the basin.

Important Conservation Lands

- Mount Nutt Wilderness, BLM
- Mount Wilson Wilderness, BLM
- Warm Springs Wilderness, BLM
- Lake Mead National Recreation Area, NPS
- Havasu National Wildlife Refuge, USFWS
- Colorado River Nature Center Wildlife Area, AGFD
- Topock Marsh State Conservation Land, AGFD

Several wilderness areas most notably support populations of Desert Bighorn Sheep. The U.S. Fish and Wildlife Service manage the Havasu National Wildlife Refuge at the southern edge of the basin. From Desert Bighorn Sheep to the Endangered Southwestern Willow Flycatcher and Yuma Clapper Rail, birds and other animals at Havasu National Wildlife Refuge rely on the waters of the Lower Colorado River. The refuge protects 30 river miles - 300 miles of shoreline - from Needles, California, to Lake Havasu City, Arizona. One of the last remaining natural stretches of the lower Colorado River flows through the 20-mile-long Topock Gorge.

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Havasu National Wildlife Refuge is one of three refuges that have a land and water agreement in place. The land and water agreements allow the MSCP to use refuge lands and a

portion of that refuge's Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Razorback Sucker, Bonytail Chub, Mexican Spotted Owl, and Little Colorado Spinedace.

Federally listed species that are dependent on riparian or other water related habitats occur within the basin including the Threatened Bald Eagle and Candidate Relict Leopard Frog and Yellow-billed Cuckoo have been observed in the basin.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 110,714 Angler Use Days were documented in the Lake Mohave Basin, equating to over $17 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_MHV_final.pdf

LITTLE COLORADO RIVER PLATEAU

The Little Colorado River Plateau Basin, located in Coconino, Navajo and Apache Counties is characterized by relatively high elevation, semi-arid mesas and several high elevation mountain ranges. Elevations generally increase from north to south. Vegetation types are primarily Great Basin conifer woodland, plains and Great Basin grasslands and Great Basin desertscrub. At higher elevations vegetation types include subalpine grassland, Rocky Mountain subalpine conifer forest and Rocky Mountain and madrean montane conifer forests. Riparian vegetation is found along streams including: conifer oak, wet meadow, mixed broadleaf, and Russian olive along Tsalie Creek, Kinlechee Creek and Canyon de Chelly; tamarisk on Chinle Creek and Silver Creek; and mixed broadleaf, wet meadow and conifer oak on the Little Colorado River east of Springerville.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Little Colorado River Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

Common riparian native trees and shrubs, depending on location and elevation, include Narrowleaf Cottonwood, Box Elder, Aspen, New Mexico Locust, and Willows. At higher elevations, streams pass through the upland montane forests of mixed-conifer and ponderosa pine communities. The riparian zones themselves are usually narrow, often following relatively steep stream channels in restricted valleys. This basin also counts a number of high elevation wetlands and cienegas that host cattail, Bulrush, sedges, waterweed, Spike rushes, Quaking Aspen, and Colorado Blue Spruce.

Principal waterfowl species that utilize the high mountain wetlands include Mallard, Pintail, Cinnamon Teal, Ruddy Duck, and Redhead. Taller emergent plants such as bulrush provide nesting sites for American Bittern, Yellow and Red-headed Blackbirds, and Marsh Wren. Birds of prey include the Peregrine Falcon, Zone-tailed Hawk, Osprey, and the Bald Eagle. Migratory songbirds include Vermilion Flycatcher, Black Phoebe, Canyon and Rock Wrens, White-throated Swift, Yellow Warbler, and Bell's Vireo. Birds identified as State Wildlife Species of Concern are; Belted Kingfisher, Black-billed Magpie, Bobolink, and Veery.

The Little Colorado River Basin contains much of the remaining native fish habitat for species such as the Apache Trout, Little Colorado Spinedace, Desert Sucker, Little Colorado Sucker and the Roundtail Chub. Reptiles and amphibians include the Arizona Toad, Northern Leopard Frog, Mogollon Rim Treefrog Narrow-headed Gartersnake, and a variety of rattlesnakes. Other mammals observed as State Wildlife Species of concern are the American Water Shrew and Navajo Mexican Vole.

Important Conservation Lands

- Allen Severson Memorial Wildlife Area, AGFD
- Bear Springs, AGFD
- Becker Lake Wildlife Area, AGFD
- Chevelon Canyon Ranch Wildlife Area, AGFD
- Concho Lake, AGFD
- Jacques Marsh Wildlife Area, AGFD
- Lamar Haines Wildlife Area, AGFD

- Lee Valley Lake, AGFD
- Nelson Reservoir, AGFD
- Raymond Ranch, AGFD
- Rainbow Lake Lands, AGFD
- Silver Springs Hatchery, AGFD
- Sipe White Mountain Wildlife Area, AGFD
- Wenima Wildlife Area, AGFD
- White Mountains Grasslands Wildlife Area, AGFD
- Fool Hollow Lake Recreation Area, Arizona State Park
- Homolovi Ruins State Park, Arizona State Park
- Lyman lake State Park, Arizona State Park
- Riordan Mansion State Historic Park, Arizona State Park
- Little Colorado River East Fork, Phelps Cabin Research Natural Area, USFS
- Escudilla Wilderness, USFS
- Mount Baldy Wilderness, USFS
- Kachina Peaks Wilderness, USFS
- Mount Baldy Wilderness, USFS
- Petrified Forest Wilderness, USFS
- Strawberry Crater Wilderness, USFS
- Canyon De Chelly National Monument, NPS
- Lee Valley Creek and Little Colorado River West Fork are designated as Outstanding Arizona Waters, ADEQ
- Arizona Audubon Important Bird Areas; Marble Canyon, Upper Little Colorado River Watershed, Mogollon Rim Snowmelt Draws, Anderson Mesa

Federally Protected Species and Critical Habitats

Critical habitat has been designated for Mexican Spotted Owl, Little Colorado Spinedace, Navajo Sedge, San Francisco Peaks Groundsel, and the Southwestern Willow Flycatcher.

Native fish reintroductions have occurred in several streams. The basin contains 30 miles of occupied native habitat, montane aquatic systems, for the federally threatened Apache Trout, all in streams reclaimed for recovery of Apache trout, including Little Colorado River West Fork, Little Colorado River East fork, Little Colorado River South Fork, Lee Valley Creek, Coyote Creek, Mamie Creek, and Mineral Creek. The basin also

contains all populations and habitat for the federally threatened Little Colorado Spinedace, which is endemic to the basin.

Federally protected species observed in the basin also include:

- Listed Endangered- Southwestern Willow Flycatcher
- Listed Threatened- Chiricahua Leopard Frog, Mexican Spotted Owl, and Little Colorado Spinedace
- Candidate- Yellow-billed Cuckoo, Roundtail Chub, Zuni Bluehead Sucker, New Mexico meadow jumping mouse, and Northern Mexican Gartersnake.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 863,297 Angler Use Days were documented in the Little Colorado River Plateau Groundwater Basin, equating to over $134 million in economic revenue generated by angler activity within the basin.

Web Sources

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LOWER GILA

The Lower Gila Basin is located in Yuma, Pima, La Paz and Maricopa Counties and is characterized by plains and valleys surrounded by low elevation mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands sonorant desertscrub. Riparian vegetation includes tamarisk along the Colorado River and Gila River.

The principal geographic feature of the basin is the Gila River which runs east to west through the entire basin, exiting on the west boundary of the basin before it reaches its confluence with the Colorado River. A short stretch (11 miles) of the Colorado River forms the western boundary of the basin in the vicinity of Fishers Landing. Beyond the river floodplains and valleys, the basin is surrounded by small mountain ranges.

Important Riparian, Aquatic, and Wetland Resources

Within the Lower Gila Basin, most of the Gila River is ephemeral and flows only in response to precipitation events or water releases from upstream dams. Historically, the river would flow in the spring due to winter rains and melting snow, and in summer following monsoon rains. Today, these flows are controlled by dams. Painted Rock Dam was constructed in 1959 at the eastern edge of the basin to control infrequent flood flows. A small lake occasionally forms at the base of Painted Rock Dam, but is frequently dry.

Along the Colorado River, flows are constant. The Colorado is highly regulated by upstream dams, although floods occasionally occur. When the Imperial Dam was completed in 1935, Martinez Lake was formed as part of the Imperial Reservoir.

The Wellton-Mohawk Irrigation District returns surplus irrigation water to the Gila River channel near Dome, Arizona. This influx of water supports flow from Dome a short distance to the boundary of the basin and then to the confluence with the Colorado River.

There are several State Wildlife Species of Concern observed in this basin including, Lowland Leopard Frog, California Black Rail, Peregrine Falcon, Bald Eagle, Great Egret, Least Bittern, Snowy Egret, and Western Yellow Bat.

Important Conservation Lands

- Arizona Audubon Important Bird Areas; Imperial Reservoir, Lower Gila River, Quigley Wildlife Area, Sonoran Desert Borderlands
- Quigley Wildlife Area, AGFD
- Texas Hill Lands State Conservation, AGFD
- Kofa National Wildlife Refuge, USFWS
- Cabeza Prieta National Wildlife Refuge, USFWS
- Imperial Reservoir National Wildlife Refuge, USFWS
- Organ Pipe Cactus National Monument, NPS
- Eagletail Mountains Wilderness, BLM
- Muggins Mountains Wilderness, BLM

- Signal Mountain Wilderness, BLM
- Woolsey Peak Wilderness, BLM
- Organ Pipe Wilderness, NPS

The Quigley Wildlife Area encloses a remnant slough of the Gila River. The area provides magnificent views across the Gila River floodplain to the Castle Dome, Palomas and other mountain ranges. Several rare and endangered species including the Yuma Clapper Rail and Southwestern Willow Flycatcher are recorded here as well as large concentrations of wintering waterfowl and shorebirds can be seen, along with significant numbers of neotropical migrants. Visitors may see mourning and White-winged Doves, Snow Geese, and Osprey. The Arizona Game and Fish Department reports that the marsh habitat at Quigley has in the past supported at least 4-6 pairs of the endangered Yuma Clapper Rail, and that "appropriate habitat" exists at Quigley for the endangered Southwestern Willow Flycatcher (although nesting has not been documented).

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Imperial National Wildlife Refuge is one of three refuges that have a land and water agreement in place. Imperial National Wildlife Refuge protects wildlife habitat along 30 miles of the lower Colorado River in Arizona and California, including the last un-channelized section before the river enters Mexico. The land and water agreements allow the MSCP to use refuge lands and a portion of that refuge's Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

The Kofa National Wildlife Refuge provides essential habitat for Desert Bighorn Sheep, the California Fan Palm, and other wildlife and plants. By enlarging natural water holes, shading them to reduce evaporation, and blasting artificial basins in areas previously without a water supply, refuge managers have greatly increased the availability and reliability of water for Desert Bighorn Sheep and other wildlife. The Refuge also supports a number of amphibians and reptiles, including the desert tortoise. Other species include the Rosy Boa, Coachwhip, Gophersnake, Western Shovel-nosed Snake, Common Kingsnake, five species of rattlesnakes, Western Banded Gecko, Zebra-tailed Lizard, Eastern Collared Lizard, Desert Horned Lizard, Common Chuckwalla, Desert Iguana, Desert Spiny Lizard, Sonoran Desert Toad, and the Red-spotted Toad. Birds include Red-tailed Hawk, Golden Eagle, Ash-throated Flycatcher, Loggerhead Shrike, Cactus and Canyon Wrens, Phainopepla, Scott's Oriole, and Curve-billed Thrasher. Isolated nesting populations of Blue-gray Gnatcatcher, Canyon Towhee, and Black-chinned and Rufous-crowned Sparrows can be found.

Parts of the Basin are within the Sonoran Desert Borderlands are listed as Important Bird Area (IBA), a program administered Arizona Audubon primarily because of the Lower Colorado Desert Microphyll Woodland Major Wash Complex habitat. This largely intact, undeveloped, and un-fragmented IBA encompasses Organ Pipe Cactus National Monument (in its entirety), Cabeza Prieta National Wildlife Refuge (in its entirety), and

the Barry Goldwater Range East and West Units (pending military acceptance).

The Cabeza Prieta National Wildlife Refuge is the third largest refuge in the nation and nearly all is a designated wilderness. Common vegetation includes Creosote bush flats, bursage on the bajadas, Mesquite, Paloverde, Ironwood, and an abundance of cacti, including Ocotillo, Cholla, and Saguaro. Also present are the endangered Sonoran Pronghorn and Lesser Long-nosed Bats, as well as desert bighorns, lizards, rattlesnakes, Desert Tortoises, Elf Owls, and Gila Woodpecker. Refuge staff brings water to artificial catchments and guzzlers throughout Cabeza Prieta NWR for wildlife. The refuge also takes the lead role in Sonoran pronghorn recovery. This endangered species with international significance ranges across the Sonoran desert in small, scattered bands.

Parts of the Barry Goldwater Air Force Range are located in the Basin and used for pilots to practice basic air-to-surface weapons deployment. There are five species of concern on the Goldwater Range, three of which are listed as threatened or endangered under the Endangered Species Act. These include the Sonoran Pronghorn Antelope, Lesser Long-nosed Bat, and the Peirson's Milkvetch.

The Organ Pipe Cactus National Monument, an International Biosphere Reserve, exhibits an extraordinary collection of plants and animals of the Sonoran Desert. Twenty-six species of cactus are found, as well as numerous species of birds, mammals, reptiles and fish. Every summer Organ Pipe Cactus NM hosts a "maternal" colony of 20,000 endangered Lesser Long-nosed Bats.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Razorback Sucker.

Federally protected species observed in this basin include the Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail, Desert Pupfish, Sonoran Pronghorn Antelope, and Razorback Sucker. The Candidate-Yellow-billed Cuckoo is also found here.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 45,970 Angler Use Days were documented in the Lower Gila Basin, equating to over $7 million in economic revenue generated by angler activity within the basin.

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LOWER SAN PEDRO

The Lower San Pedro Basin is split between Cochise, Pima, Graham, Pinal and Gila Counties. The Basin is characterized by high-elevation mountain ranges and washes. Vegetation is primarily Arizona uplands Sonoran desertscrub and semidesert grassland with smaller areas of Chihuahuan desertscrub, madrean evergreen woodland, Rocky Mountain and montane conifer forest and interior chaparral. Riparian vegetation includes strand and mesquite on the San Pedro River and Aravaipa Creek.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the San Pedro River watershed. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

This basin contains a portion of the San Pedro River – one of the last remaining free flowing desert rivers in the world. The Lower San Pedro Basin contains approximately 75 miles of perennial flows in Aravaipa Creek, Bass Canyon, Buehman Canyon, Copper Creek, Devils Canyon, Mill Creek, Mineral Creek, Hot Springs Canyon, Redfield Canyon Creek, and Swamp Springs Canyon Creek. Some reaches of the Lower San Pedro River itself are also perennial.

The Lower San Pedro Basin supports high quality cottonwood-willow riparian gallery forest and adjacent mesquite bosque. The basin provides a lush wildlife movement corridor between the Santa Catalina and Galiuro Mountains.

The middle and lower portions of the San Pedro River have been designated by Arizona Audubon as a Priority Important Bird Area (IBA) due to the large number of birds of concern that rely on the riparian habitat of the basin. The Southwestern Willow Flycatcher, Gray Hawk, Thick-billed Kingbird, Yellow-billed Cuckoo, Northern Beardless-Tyrannulet, and Tropical Kingbird can all be found here. The Lower San Pedro and its tributaries also provide habitat for Chiricahua Leopard Frog, Lowland Leopard Frog, Gila Chub, Spikedace, Loach Minnow, Sonoran Sucker, and is one of the last remaining known locations of the Huachuca Water Umbel. Additional State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Peregrine Falcon, Black-bellied Whistling Duck, Common Black-Hawk, Mississippi Kite, Northern Buff-breasted Flycatcher, and Western Red Bat.

Important Conservation Lands

- Swamp Springs/Hot Springs Watershed Area of Critical Environmental Concern, BLM
- Redfield Canyon Wilderness Area, BLM
- Rincon Mountain Wilderness Area, USFS
- Galiuro Wilderness Area, USFS
- Oracle State Park, Arizona State Park
- Saguaro National Park, NPS
- Audubon Arizona Important Bird Area; Lower San Pedro River
- Middle/Lower San Pedro River, Pima County Preserves

- 3 Links Farm, BOR Conservation Easement and The Nature Conservancy Preserve
- Buehman Canyon Preserve/Conservation Easements, The Nature Conservancy
- Muleshoe Ranch Preserve, The Nature Conservancy
- Lower San Pedro River Preserve, The Nature Conservancy
- Buehman Canyon is identified as an Outstanding Arizona Water, ADEQ

The Nature Conservancy is conducting restoration activities to re-vegetate old pasture lands with native vegetation. Their activities have reduced water consumption along the main stem Lower San Pedro. The conservation easements ensure the permanent protection of some of the most important sections of the basin.

Federally Protected Species and Critical Habitats

Critical Habitat is designated for Mexican Spotted Owl, Southwestern Willow Flycatcher, Razorback Sucker, Gila Chub, Spikedace, and Loach Minnow.

Federally protected species observed in the basin also include:

- Listed Endangered- Southwestern Willow Flycatcher, Gila Chub, and Huachuca Water Umbel
- Listed Threatened- Chiricahua Leopard Frog, Bald Eagle, Mexican Spotted Owl, Loach Minnow, and Spikedace
- Candidate- Yellow-billed Cuckoo and Roundtail Chub

Economic Values

Studies have been conducted that describe the economic contribution of riparian bird habitat, and surveys conducted to identify economic value of wildlife watching in the San Pedro River (Pima County, 2009; Leenhouts et al., 2006).

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MCMULLEN VALLEY

The McMullen Valley Basin is located in La Paz, Yavapai and Maricopa Counties. The basin is characterized by two valleys; the McMullen Valley and the Aguila Valley, which are bordered by the Harcuvar mountain range to the north and the Harquahala mountain range to the south. Vegetation types include Lower Colorado River Valley and Arizona uplands, Sonoran desertscrub with small amounts of interior chaparral and semidesert grassland.

Important Riparian, Aquatic, and Wetland Resources

The main riparian feature is the Centennial Wash which runs east to west through the basin. Centennial Wash is a large, normally dry ephemeral stream which runs through the town of Wenden. It has been known to collect such large amounts of rainfall funneled from surrounding mountains that it overflows and causes serious flooding and the impact of the flow regime is an issue of concern for the local community. Local flows along Centennial Wash have resulted in heavy vegetation growth of Ironwood, Mesquite, and Paloverde trees which serves as habitat for many bird and animal species. Quail are common in the Centennial Wash area between Salome and Aguila. Lowland Leopard Frogs are listed as State Wildlife Species of Concern in the basin. White-tailed Kite and Western Red-tailed Skink have also been observed in the basin.

Important Conservation Lands

- Harquahala Mountains Wilderness, BLM
- Harcuvar Mountains Wilderness, BLM

Harquahala means “running water high up” in the language of one early native tribe. The Harquahala Mountains Wilderness was so named for its numerous perennial seeps and springs that support rare habitat with exceptional diversity among Sonoran Desert mountains. Rare cacti are found in relict “islands” of chaparral and desert grasslands as well as the endangered Desert Tortoise, the largest Mule Deer herd in western Arizona, a sizable raptor population, and one of the few increasing Desert Bighorn Sheep herds.

The Harcuvar Mountains Wilderness includes plant and animal communities and diverse landforms, including a 3,500-acre “island” of interior chaparral habitat that supports a few species of wildlife cut off from their parent populations: Rosy Boas, Gilbert’s Skinks, and Desert Night Lizards. Desert Bighorn Sheep, Mountain Lions, Desert Tortoises, Golden Eagles, and several species of hawks are also found in the basin.

Federally Protected Species and Critical Habitats

No Critical Habitat Designated.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_MMU_final.pdf

MEADVIEW

Meadview Basin is located in Mohave County and is characterized by a south to north trending wash, a mesa in the western portion of the basin, cliffs along the eastern basin boundary and Lake Mead on the north. Vegetation includes Mohave desertscrub and Great Basin conifer woodland.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Meadview Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The only perennial flow in the basin is about 7 miles of the Colorado River, essentially Lake Mead. There are numerous springs of varying discharge located primarily in the southern part of the basin.

The American Peregrine Falcon is a State Wildlife Species of Concern observed in the basin. A native fish, Speckled Dace is also known to occur in the basin.

Important Conservation Lands

- Lake Mead National Recreation Area, NPS
- Grand Canyon National Park, NPS

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Razorback Sucker.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher and Razorback sucker and the Candidate Relict Leopard Frog.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_MEA_final.pdf

Additional References

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MORENCI

The Morenci Basin is located mostly in Greenlee County, Graham County and the southern part of Apache County. The basin is characterized by high-elevation mountain ranges and a diversity of biotic communities including Rocky Mountain and montane conifer forest, Great Basin conifer, madrean evergreen woodland, plains and Great Basin grassland, interior chaparral, Chihuahuan desertscrub and semidesert grassland vegetation.

Important Riparian, Aquatic, and Wetland Resources

Riparian vegetation ranges from wet meadow and mountain scrub on the San Francisco River near Alpine at the higher elevations to mixed broadleaf and cottonwood/willow on the Campbell Blue Creek; cottonwood/willow, mixed broadleaf and mesquite on the Blue River; mixed broadleaf on Cienega and Willow Creeks; and at the lower elevations, mesquite and mixed broadleaf on Eagle Creek and the San Francisco River near Clifton.

Perennial streams are located throughout the basin including San Francisco River, Blue River, Grant Creek, Strayhorse Creek, KP Creek, Willow Creek, Cienega Creek and Eagle Creek. The San Francisco River is declared an Impaired Water by ADEQ for sediment, while KP Creek has been designated an Outstanding Arizona Water by ADEQ.

There are over 450 miles of streams; five species of trout can be found in these waters. Luna Lake State Wildlife Area is home to a variety of wildlife, including the Bald Eagle and migrating waterfowl, as well as a managed sportfishery.

The forested area is home to most big game animals such as antelope, elk, deer, bighorn sheep and turkey. Black Bear, Mountain Lion and Mexican Gray Wolf are even spotted on occasion. There is a large variety of songbirds, waterfowl, small mammals, fish, amphibians and reptiles.

State Wildlife Species of Concern observed in the basin include Peregrine Falcon, Bald Eagle, Lowland Leopard Frog, and Narrow-headed Gartersnake.

Important Conservation Lands

- Escudilla Wilderness, USFS
- Blue Range Primitive Area, USFS
- Gila Box Riparian National Conservation Area (at the southernmost portion), BLM
- Luna Lake State Conservation Land, AGFD
- Arizona Audubon Important Bird Area; Blue River Complex
- KP Creek is identified as an Outstanding Arizona Water, ADEQ
- US Fish and Wildlife Service, the Mexican Wolf Recovery Program
- US Department of the Interior, proposed Native Fish Restoration Project, Lower Blue River

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl, Razorback Sucker, Gila Chub and Loach Minnow. Apache and Gila Trout have been the focus of conservation efforts in this basin.

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher, Gila Chub, and Razorback Sucker
- Listed Threatened- Chiricahua Leopard Frog, Mexican Spotted Owl, Apache Trout, Gila Trout, Loach Minnow, and Spikedace
- Candidate- Yellow-billed Cuckoo, Roundtail Chub, New Mexico meadow jumping mouse, and Northern Mexican Gartersnake

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 27,335 Angler Use Days were documented in the Morenci Basin, equating to over $4 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Vol_3_MOR_final.pdf

Bureau of Land Management (BLM)

United States Forest Service (USFS, Prescott Forest)

United States Fish and Wildlife Service (USFWS)

Arizona Game and Fish Department (AGFD)

Arizona Department of Water Resources (ADWR)

Wildlife Linkages (NAU)

PARIA

The Paria Basin in northern Coconino County is characterized by a plateau and canyons. Vegetation types include Great Basin desertscrub and Great Basin conifer woodland.

Important Riparian, Aquatic, and Wetland Resources

The Paria River originates in southern Utah, draining high plateaus. Near the Arizona border the river enters a narrow canyon of towering sandstone walls streaked with desert varnish, winding past amphitheater formations, natural arches, wooded terraces and hanging gardens. Emerging from the Vermilion Cliffs, the Paria River meets the Colorado River at Lees Ferry.

Although a fairly small perennial stream, the Paria River is capable of generating massive flash floods that deliver huge sediment loads into Grand Canyon. In September 1998, a flood of 6,500 cubic feet per second (cfs) delivered about 800,000 tons of sand to the Colorado River.

The vegetation of the lower Paria River consists of sparse desert riparian grass, forbs and shrubs, dominated by fescue and arrowweed, with relatively low plant cover and diversity. Extensive stands of non-native tamarisk have replaced much of the native vegetation. The only other trees along the Paria River are Fremont cottonwood, and those are sparse with low recruitment. Some evidence suggests that more extensive stands of cottonwood previously occupied the area, but were removed for fuel and construction by early settlers.

Bald Eagles, Golden Eagles, Red-tailed Hawk, Great Horned Owl, Cooper's Hawk, and Peregrine Falcon utilize the riparian habitat along the river, as do flycatchers, swallows, swifts, wrens, hummingbirds, and herons. Bobcats, foxes, Mountain Lions, porcupines, beavers, and Coyotes are found throughout the rugged terrain in the Paria Basin.

Prior to construction of Glen Canyon Dam, the Paria River provided important habitat for several species of fish, now federally endangered. Humpback Chub, Razorback Sucker and possibly, Bonytail Chub spawned in the mouth of the Paria River. Colorado Pikeminnow, another endangered fish, spent time in the mouth of the river as they migrated through Grand Canyon. Formerly a top predator in the Colorado River basin, this large fish would sometimes grow to nearly six feet long and weigh up to 80 pounds.

Important Conservation Lands

- Paria Canyon-Vermilion Cliffs Wilderness Areas, BLM
- Vermilion Cliffs National Monument, BLM
- Arizona Audubon Important Bird Area; Marble Canyon
- Glen Canyon National Recreation Area, NPS

Federally Protected Species and Critical Habitats

Critical Habitat has not been designated in the Paria Basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_PAR_final.pdf

PARKER

The Parker Basin is located in La Paz and Yuma Counties. This basin is characterized by plains and valleys and low elevation mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub. Riparian vegetation includes tamarisk, marsh and mesquite along the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

The Parker Basin is characterized by an extremely arid environment with an average annual precipitation of 4.5 inches. The Colorado River is the basin's main hydrological feature and runs north-south along the western edge of the basin for about 144 miles; Twelve Mile Slough is the only other identified perennial water outside the river channel. The basin begins at Parker Dam and the western edge runs along the Colorado River to the Imperial National Wildlife Refuge.

Numerous backwaters along the Colorado River provide the majority of aquatic features and wildlife habitat. Much of the western basin contains abundant farmland. The central and eastern portion of the basin is made up of low lying mountain ranges. There are about a dozen small springs in the basin.

Several State Wildlife Species of Concern have been observed in the basin including, the Bald Eagle, California Black Rail, Great Egret, Least Bittern, and Western Yellow Bat. Other wading birds observed in the basin include Great Egret, California Black Rail, Great Blue Heron, Least Bittern, marsh Wren and White-faced Ibis. The Western Yellow Bat has also been observed.

Important Conservation Lands

- Buckskin Mountain State Park, Arizona State Park
- East Cactus Plain Wilderness, BLM
- Cactus Plain Wilderness Study Area, BLM
- Gibraltar Wilderness, BLM
- New Water Mountains Wilderness, BLM
- Trigo Mountains Wilderness, BLM
- Cibola National Wildlife Refuge, USFWS
- Imperial Reservoir National Wildlife Refuge, USFWS
- Kofa National Wildlife Refuge, USFWS

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Cibola and Imperial National Wildlife Refuges are two of three

refuges that have a land and water agreement in place. The land and water agreements allow the MSCP to use refuge lands and a portion of that refuge's Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

Federally Protected Species and Critical Habitats

The Parker Basin contains about 12,000 acres of federal critical habitat for the Endangered Razorback Sucker along 144 miles of the Colorado River. Aquatic and riparian habitats associated with the Colorado River provide suitable habitat for numerous other federally listed or sensitive species.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail, Bonytail Chub, and Razorback Sucker. Candidate Yellow-billed Cuckoo has also been observed.

Economic Values

The Parker Strip, below Parker Dam is a heavily utilized waterway for watercraft recreation, fishing and other outdoor and wildlife related recreational activities, especially at the Imperial National Wildlife Refuge. There is one area stocked by the AGFD for fishing, located at La Paz County Park. The lagoon and one off-channel pond are used for fishing clinics each year. The Colorado River and associated backwaters and ponds are also used for waterfowl hunting and fishing activities.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_PKB_final.pdf

PEACH SPRINGS

Peach Springs Basin is located at the intersection of Mohave, Yavapai, and Coconino Counties. The basin is characterized by a relatively high elevation plateau area, steep canyons and relatively small valleys. The Colorado River defines the northwestern basin boundary. Vegetation types include Great Basin conifer woodland, plains and Great Basin grassland, Great Basin and Mohave desertscrub and a small area of mountain conifer forest.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Shivwits Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

Native species observed in the basin include the Arizona toad, Northern Leopard Frog, American Peregrine Falcon, Southwestern Willow Flycatcher, Yellow-billed Cuckoo, Flannelmouth Sucker, Speckled Dace, and Hualapai Mexican Vole. The Northern Leopard Frog and Peregrine Falcon are both State Species of Concern observed in the basin.

Perennial waters include the Colorado River and a short segment of Diamond Creek. There are also a number of major and minor springs.

Important Conservation Lands

- Grand Canyon National Park, NPS

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Razorback Sucker.

Federally protected species observed in the basin include the Endangered Hualapai Mexican Vole and Southwestern Willow Flycatcher and Candidate Yellow-billed Cuckoo.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_PSC_final.pdf

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDFs_for_web/Upper_Colorado_River_Planning_Area/Peach_Springs_Basin.pdf

Additional References

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Ralston, B. (2010). *Riparian vegetation response to the March 2008 short-duration high-flow experiment-Implications of timing and frequency of flood disturbance on nonnative plant established along the Colorado River below Glen Canyon Dam.* Reston, Virginia: U.S. Geological Survey.

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PHOENIX AMA

The Phoenix Active Management Area (AMA) located predominantly in Maricopa County and in Pinal and Yavapai counties. It is one of five AMA's created by the Arizona Groundwater Code. The AMA includes all of the urban Phoenix metro area and many undeveloped areas. It stretches out to include Anthem, to Sacaton, and east/west from Superior to Tonopah.

The basin is characterized by valleys surrounded by mid-elevation mountain ranges. Vegetation types are predominantly Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub with a small area of southwestern interior chaparral in the northeastern portion of the AMA. Riparian vegetation, primarily tamarisk, is found extensively along the Gila River below the 91st Avenue Wastewater Treatment Plant.

Important Riparian, Aquatic, and Wetland Resources

Major surface water sources include the Salt, Verde, Aqua Fria, and Hassayampa Rivers, all of which drain into the Gila River. The Colorado River provides an additional surface water source to the Phoenix AMA and is delivered via the Central Arizona Project (CAP).

The Salt and Verde Rivers are the major water sources for the Phoenix AMA, and these rivers sustain riparian habitat, primarily outside the developed metro area. There are also important riparian areas along the Gila River. While the CAP contributes significant water supplies for Phoenix metro cities, it has little impact on wildlife or riparian vegetation. It is fenced to keep all but the smallest animals out and is subject to routine vegetation control.

Arnett Creek, Camp Creek, New River, Queen Creek, Seven Springs Wash, and Skunk Creek have perennial reaches within the AMA. The Agua Fria River is also intermittent with perennial stretches. A small portion of perennial flow along the Hassayampa River is also found in the Phoenix AMA. These perennial reaches are typically lined with cottonwood and willow trees, and rushes and sedges in the wetter areas. There are also sycamore, mesquite and invasive tamarisk trees. Riparian areas, even those within developed landscapes are important habitats for many fish, birds, and other wildlife.

In addition, there are also extensive riparian areas and wetlands on the west side of Phoenix where the Salt, Gila, and Agua Fria rivers converge with treated effluent water released from the 91st Avenue Wastewater Treatment Plant. In this vicinity, the Arizona Game and Fish Department manages the Base and Meridian, Robbins Butte and Arlington Wildlife Areas and the City of Phoenix manages the Tres Rios wetlands.

The mesquite bosques and reedy marshes of the Tres Rios area are of particular importance to birds. Plentiful food and nesting resources attract hundreds of species of breeding and migratory birds. Some species, White-winged and Mourning Doves in particular, arrive in flocks that number in the thousands. Robbins Butte Wildlife Area is home to more than 115 species of winter-resident birds and is the center of the National Audubon Society's annual Gila River Christmas Bird Count. Many raptors, including the White-tailed Kite and Bald Eagle, are included in this list. Arizona Audubon has identified several Important Bird Areas in this basin including Boyce Thompson Arboretum, Arnett-Queen Creeks, Salt-Verde and Salt-Gila ecosystems and the Gilbert Riparian Preserve.

Wetlands along the Gila River and throughout the Tres Rios area are home to a diverse group of reptiles, a minimum of 19 species, as well as deer, Ring-tail Cats, and other mammals. Northern Leopard Frog, Western Yellow-billed Cuckoo, and the Sonoran Desert Tortoise are also a few of species identified as Wildlife of Special Concern by the Arizona Game and Fish Department that occur in the basin. Seven species of native fish live within the AMA, including Roundtail Chub, Speckled Dace, Desert Sucker, Sonoran Sucker, Loach

Minnow, Gila Topminnow, and Desert Pupfish.

Other basin species include Lowland Leopard Frog and Narrow Headed Gartersnake, Peregrine Falcon, Black-bellied Whistling-Duck, Common Black-Hawk, Least Bittern, Mississippi Kite, Osprey, Western Red and Yellow Bat, and Arizona Skink.

Important Conservation Lands

The Phoenix AMA, although significantly urban and developed, includes several BLM or Forest Service wilderness areas in the surrounding upland and desert landscape.

- Sonoran Desert National Monument, BLM
- Big Horn Mountain Wilderness, BLM
- Hell's Canyon Wilderness, BLM
- Hummingbird Springs Wilderness, BLM
- Sierra Estrella Wilderness, BLM
- Signal Mountain Wilderness, BLM
- South Maricopa Mountain Wilderness, BLM
- North Maricopa Mountains Wilderness, BLM
- White Canyon Wilderness, BLM
- Woolsey Peak Wilderness, BLM
- Superstition Wilderness, USFS
- Arlington Wildlife Area, AGFD
- Base and Meridian Wildlife Area, AGFD
- Powers Butte Wildlife Area, AGFD
- Robbins Butte Wildlife Area, AGFD
- Gila River State Conservation Lands, AGFD
- Hohokam Pima National Monument, NPS
- Arizona Audubon Important Bird Areas; Boyce Thompson Arboretum, Arnett-Queen Creeks, Salt and Verde Ecosystem, Salt and Lower Gila Ecosystem, Gilbert Riparian Preserve
- Boyce Thompson Arboretum State Park, Arizona State Park
- Lost Dutchman State Park, Arizona State Park

In Phoenix, the U.S. Army Corps of Engineers and the city government plan to expand the Tres Rios demonstration wetlands along a 7-mile stretch of the Salt and Gila Rivers. Originally built by Reclamation, the demonstration wetlands treats thousands of gallons of wastewater and provides habitat to a wide variety of

waterfowl and aquatic life, and supports cottonwoods, seep willows and dense stands of cattail. Tres Rios also serves as a laboratory for biologists and hydrologists looking to better understand the interface between urban settlement and native ecosystems.

Federally Protected Species and Critical Habitats

No Critical Habitat has been designated within the Phoenix AMA Basin.

The Yuma Clapper Rail, Lesser Long-nosed Bat, Gila Topminnow, Desert Pupfish, Southwestern Willow Flycatcher, and Sonoran Pronghorn Antelope are classified as endangered and may be found within the AMA. The Sonoran Desert bald Eagle also nests within the AMA and is classified as threatened. The Yellow-billed Cuckoo, Roundtail Chub, and Desert Tortoise are classified as candidates for the Federal endangered species list.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 38,664 Angler Use Days were documented in the Phoenix AMA Basin, equating to over $6 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/ActiveManagementAreas/documents/Volume_8_PHX_final.pdf

PINAL AMA

The Pinal Active Management Area (AMA) is located in Pinal, Maricopa and Pima Counties, and is the second largest of the five AMAs designated by the 1980 Arizona Groundwater Management Act. It is characterized by broad, alluvial Sonoran desert valleys and mid-elevation north to northwest trending fault-block mountains. The Gila River flows east to west in the northern part of the basin while the Santa Cruz River enters the basin from the southeast, flowing toward the northwest. Neither of these rivers have perennial flows in the basin. Elevations range from about 1,000 feet where the Gila River and Santa Cruz River exit the basin in the northwest to over 6,800 feet at Kitt Peak at the southern basin boundary. Vegetation types are predominantly Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub with a small area of semidesert grassland in the western portion of the AMA.

Important Riparian, Aquatic, and Wetland Resources

There are three large reservoirs in the Pinal AMA Basin: Saint Clair, Reach 11 Detention Dike 3, and Picacho Reservoir. Picacho Reservoir is located 11 miles south of Coolidge. Over the years, siltation and vegetation have reduced the capacity and surface area, so that much of the reservoir is a shallow marsh with extensive stands of cattails and rushes. Water level is highly variable, and the lake is completely dry in some years.

Water is diverted from the Gila River at Ashurst-Hayden Diversion Dam twelve miles east of Florence for the San Carlos Irrigation Project (SCIP). This dam serves as a diversion dam only and is not a storage or flood control facility.

There are several State Wildlife Species of Concern observed in this basin including, Lowland Burrowing Treefrog, Western Barking Frog, Western Narrow-mouthed Toad, Great Egret, Least Bittern, and Western Yellow Bat. Other native species observed in the basin include Sonora Sucker, Longfin Dace, Arizona Mud Turtle, Sonoran Green Toad, Great Blue Heron, Great Egret, and Least Bittern.

Important Conservation Lands

- Ironwood Forest National Monument, BLM
- Sonoran Desert National Monuments, BLM
- Coyote Mountains Wilderness, BLM
- Sierra Estrella Wilderness, BLM
- South Maricopa Mountains Wilderness, BLM
- Tabletop Wilderness, BLM
- Casa Grande National Monument, NPS
- McFarland/Picacho Reservoir State Conservation Land, AGFD
- Santa Rosa Wash Cooperative Agreement State Conservation Land, AGFD
- McFarland State Historic Park, Arizona State Park
- Picacho Peak State Park, Arizona State Park

Coyote Mountains Wilderness is a detached mountain adjacent to the Baboquivari Mountain Range. The vegetation includes paloverde, saguaro, chaparral, and oak woodlands. Wildlife includes mountain lion, javelina and bobcat.

Sierra Estrella Wilderness contains an elevation range that supports diverse plant communities: saguaro, cholla, ocotillo, paloverde, and elephant bush lower down, shrub live oak and junipers higher up. A remnant herd of Desert Bighorn Sheep, Gila Monster, Giant Spotted Whiptail Lizard, Desert Tortoise, Mountain Lion, Mule Deer, Coyote, Javelina, Golden Eagle, Prairie Falcon, and Cooper's Hawk are found.

The South Maricopa Mountains Wilderness is characterized by two major vegetation communities -- Paloverde-Mixed Cacti, which includes the dense "forests" of saguaro cactus, paloverde, and ironwood trees, and the Creosote-Bursage community that covers low elevation valley floors. In 2001 the South Maricopa Mountains Wilderness was incorporated into the Sonoran Desert National Monument.

The Table Top Wilderness is dominated by Table Top Mountain (4,373-feet in elevation), which abruptly rises above the nearly level Vekol Valley. The wilderness is characterized by two major vegetation communities -- Paloverde-Mixed Cacti, and the Creosote-Bursage community that covers low elevation valley floors. At the summit of Table Top Mountain is a small, 40-acre area of Sonoran Desert Grassland. In 2001 the Table Top Wilderness was incorporated into the Sonoran Desert National Monument.

The Sonoran Desert National Monument contains more than 487,000 acres of Sonoran Desert landscape including extensive saguaro cactus forest. A small portion of the Monument is located within the Pinal AMA Basin. The Sonoran Desert is the most biologically diverse of the North American deserts. The monument contains three distinct mountain ranges, the Maricopa, Sand Tank and Table Top Mountains, as well as the Booth and White Hills, all separated by wide valleys. The portion of the monument within the Pinal AMA basin is home to the congressionally designated Table Top wilderness area, as well as many significant archaeological and historic sites, and remnants of several important historic trails.

The Ironwood Forest National Monument is partially located in the Pinal AMA Basin. A significant concentration of Ironwood is found in the monument, along with two federally recognized endangered animal and plant species. An array of flora is present in the Ironwood Forest National Monument. The higher elevations contain Pinyon-juniper woodland plant community while the lower elevations are in the Sonoran Desert ecoregion. One of the notable trees native here is the Elephant tree, Bursera microphylla. Small populations of the endangered Nichols Turk's Head Cactus, although not found among Ironwood trees, occur in localized limestone-rich areas within the Monument.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Southwestern Willow Flycatcher and Spikedace along the Gila River, which minimally intersects the eastern edge of the Pinal AMA Basin.

Federally protected species observed in the basin include the Endangered Yuma Clapper Rail and Desert Pupfish and Candidate Yellow-billed Cuckoo.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 1,702 Angler Use Days were documented in the Pinal AMA Basin, equating to over $265,000 in economic revenue generated by angler activity within the basin.

Web Sources

http://en.wikipedia.org/wiki/Area_of_Critical_Environmental_Concern http://www.pr.state.az.us/ohv/downloads/OHV_Sonoran_Desert_NM.pdf

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PRESCOTT AMA

The Prescott Active Management Area (AMA) located in Yavapai County is characterized by rolling hills and broad valleys. It was designated as an AMA by the 1980 Arizona Groundwater Management Act, the smallest of five such areas established. Vegetation types include plains and Great Basin grassland, southwestern interior chaparral, Great Basin conifer woodland and petran montane conifer forest.

Important Riparian, Aquatic, and Wetland Resources

The basin has some significant surface water resources, including the headwaters of the Agua Fria River. The Agua Fria is the longest perennial stream in the basin, and flows perennially for 3.6 miles before it exits the basin south of Dewey-Humboldt. Granite Creek, which also has its headwaters in the basin, flows south to north with 0.90 miles listed as perennial. Flows from Granite Creek, Willow Creek, and Del Rio Springs in the basin contribute significantly to the flow of the Verde River whose headwaters is located just outside the boundary of the basin at Sullivan Lake. Much of the Verde's base flow is dependent on these creeks and springs, fed by interconnected aquifers in the basin.

Watson and Willow Lakes are listed as Important Bird Areas (IBA), a program administered Arizona Audubon. The Granite Dells/upland habitat is a provisionally listed IBA. The Watson and Willow Lakes areas were designated an IBA including: Wood Duck, Lucy's Warbler, and Sonoran Yellow Warbler (breeding); and Bald Eagle and Belted Kingfisher (wintering). From 2005 to 2010 bird surveys here identified nearly 180 separate species.

Watson and Willow Lakes are contained in Watson Lake Park and Heritage Park, City of Prescott facilities that are listed as Wildlife Viewing areas by Watchable Wildlife, Inc. A variety of birds, especially migratory and wintering waterfowl, can be seen along the lake and in the cottonwood gallery forest, which is home to an active Great Blue Heron Rookery and many pairs of Wood Ducks. Bald Eagles and Osprey seasonally appear. Mule Deer, Javelina, and Pronghorn can also be found here. A variety of reptiles and amphibians inhabit the lake and its shores, including, Clark's Spiny Lizard, Plateau Lizard, Eastern Collared Lizard, Terrestrial Gartersnake, Woodhouse's Toad, and Red-spotted Toad. Other species observed include Peregrine Falcon, Belted Kingfisher, and Arizona Skink.

Important Conservation Lands

- Upper Verde, Granite Creek Wildlife Area, AGFD
- Arizona Audubon Important Bird Area; Watson/Willow Ecosystems
- Woodchute Wilderness, USFS

Portions of the Prescott National Forest are contained along the eastern and southern boundaries of the Prescott AMA basin. At the lowest elevation, the primary vegetation is of the Sonoran Desert type. As the elevation rises, chaparral becomes common, followed by piñon pine and juniper. Above that, Ponderosa pine dominates the landscape.

A portion of the Woodchute National Wilderness Area extends into the Prescott AMA basin. The high elevation of this area provides for growth of Ponderosa pine forests. With the dramatic elevation changes from the bottom to the top of this wilderness, wildlife populations are diverse and include Black Bear, Elk, Mule and Whitetail Deer, Mountain Lions, Golden and Bald Eagles.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated within the Prescott AMA for Mexican Spotted Owl.

Federally protected species observed in the basin include:

- Listed Endangered- Razorback Sucker and Hualapai Mexican Vole
- Listed Threatened- Sonoran Desert Bald Eagle and Mexican Spotted Owl
- Candidate- Yellow-billed Cuckoo and Northern Mexican Gartersnake.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 39,660 Angler Use Days were documented in the Prescott AMA Basin, equating to over $6 million in economic revenue generated by angler activity within the basin.

RANEGRAS PLAIN

The Ranegras Plain Basin is in La Paz County and a small part of Yuma County in southwestern Arizona. The basin is characterized by a plain bordered by mountain ranges. The center of the basin is bordered by the Plomosa, New Water and Little Horn Mountains in the west and the Granite Wash and Little Harquahala Mountains in the east. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub.

Important Riparian, Aquatic, and Wetland Resources

Ranegras Plain Basin contains no large or small reservoirs, perennial or intermittent streams, or major or minor springs, and contains just 16 registered stock ponds. Bouse Wash is large dry wash that drains to the Colorado River through the northern portion of the groundwater basin. Average annual rainfall is as high as 14 inches along the eastern basin boundary north of Vicksburg to a low 4 inches in the north central portion of the basin.

Important Conservation Lands

- Eagletail Mountains Wilderness, BLM
- New Water Mountains Wilderness Area, BLM
- Kofa National Wildlife Refuge, USFWS

The New Water Mountains Wilderness area contains important desert bighorn sheep habitat, including the New Water and Dripping Springs lambing areas.

Federally Protected Species and Critical Habitats

Ranegras Plain Basin contains no designated critical habitat and no documented occurrences of federally listed species.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_RAN_final.pdf

SACRAMENTO VALLEY

The Sacramento Valley Basin in Mohave County is characterized by broad valleys and mountains along the eastern and western basin boundaries. The basin trends in a north-south direction and is bounded on the west by the Black Mountains, on the southwest by the Mohave Mountains, and on the east by the Cerbat and Hualapai Mountains. Sacramento Wash, a major ephemeral wash, drains into the Colorado River.

A small segment of the Colorado River defines the westernmost basin boundary. Vegetation is primarily semidesert grassland with smaller areas Arizona upland and lower Colorado River Sonoran desertscrub, semidesert grassland, Great Basin conifer woodland, interior chaparral and montane conifer forest. A small riparian area consisting of marsh and mesquite occurs along the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

There is one perennial stream, the Colorado River, located along the northeastern basin boundary, spanning almost five miles.

The Clark's Grebe is a State Wildlife Species of Concern observed in this basin. Other native species observed include Flannelmouth Sucker, Baja California Treefrog, Marsh Wren, Zone-tailed Hawk, Kingman Springsnail, and Western Red-tailed Skink.

Important Conservation Lands

- Aubrey Peak Wilderness, BLM
- Mount Nutt Wilderness, BLM
- Warm Springs Wilderness, BLM
- Wabayuma Peak Wilderness, BLM
- Havasu National Wildlife Refuge, USFWS

Several areas in this basin have been identified by the BLM as special management lands for Desert Tortoise and Bighorn Sheep.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Bonytail Chub.

The Southwestern Willow Flycatcher, Yuma Clapper Rail and Hualapai Mexican Vole are all endangered federally protected species observed in the basin. The Candidate Yellow-billed Cuckoo is also found there.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_SAC_final.pdf

SAFFORD

The Safford Basin is within Gila, Graham, Greenlee, Pinal and Cochise Counties. The basin is characterized by valleys, high-elevation mountain ranges and a variety of vegetation types including Arizona uplands, Sonoran and Chihuahuan desertscrub, semidesert grassland, Rocky Mountain and montane conifer forest, Great Basin conifer woodland, madrean evergreen woodland and a small portion of Rocky Mountain subalpine forest atop Mt. Graham. Riparian vegetation includes mesquite and tamarisk on the Gila River; conifer oak, mixed broadleaf and mesquite on Ash Creek; conifer oak and mesquite on Fry Canyon; and conifer oak and mixed broadleaf on Deadman Canyon and Cave Creek and its tributaries.

Important Riparian, Aquatic and Wetland Resources

Riparian areas include the Gila River, Cave and Turkey Creeks, and San Carlos River. Native Apache Trout have been reintroduced to Cave Creek and Gould's Turkey has been reintroduced into several of the mountain and riparian habitats.

The 23,000-acre Gila Box Riparian National Conservation Area (NCA) falls primarily within the Safford Basin. The NCA has four perennial waterways - the Gila and San Francisco Rivers and Bonita and Eagle Creeks. The Gila River canyon section, known as the Gila Box, is composed of patchy mesquite woodlands, mature cottonwoods, sandy beaches, and grand buff-colored cliffs. Several raptors can be found in the NCA including, Zone-tailed Hawks and Common Blackhawks. The perennial creek and riparian vegetation make this a cool year-round desert oasis.

There are several State Wildlife Species of Concern observed in this basin; Lowland Leopard Frog, Peregrine Falcon, Northern Buff-breasted Flycatcher, Sonora Sucker, Speckled Dace, Arizona Shrew, Western Red Bat, and Western Yellow Bat. Other native species observed in the basin include Yellow Mud Turtle, Arizona Toad, Plains Spadefoot, Western Green Toad, Zone-tailed Hawk, Desert Sucker, Longfin Dace, Sonora Sucker, and Speckled Dace.

Important Conservation Lands

- Gila Box Riparian National Conservation Area, BLM
- Arizona Audubon Important Bird Area; Chiricahua Mountains
- Chiricahua Wilderness Area, USFS
- Fishhooks Wilderness Area, USFS
- Dos Cabezas Mountains, USFS
- North Santa Teresa Wilderness, USFS
- Peloncillo Mountains, USFS
- Mt. Graham Wilderness Study Area, USFS
- Santa Teresa Wilderness, USFS
- Chiricahua National Monument, NPS
- Clarence May Memorial State Conservation Land, AGFD

- Cluff Ranch Wildlife Area, AGFD
- Roper Lake, AGFD
- Roper Lake State Park, Arizona State Park
- Manhattan Claims State Conservation Land, AGFD
- Cave Creek and Cave Creek South Fork are identified as Outstanding Arizona Waters, ADEQ

The Chiricahua wilderness is a unique intersection between the Chihuahuan and Sonoran Deserts, and the Rocky Mountains and Mexico's Sierra Madres, covering the upper slopes and inner canyons of the largest mountain range in the 'Sky Island' region. There are over 70 species of mammals, 46 species of reptiles, 8 amphibians, and over 170 species of birds documented in the Chiricahuas. The varied habitats and southern location bring a variety of Mexican bird species across the border, such as the Elegant Trogon, Whiskered Screech-owl, Arizona Woodpecker, and the Magnificent Hummingbird. In all, 13 hummingbird species are known to occur here. Common birds in the area include Mexican Jay, Black-headed Grosbeak, Acorn Woodpecker, Yellow-eyed Junco, Painted Redstart, Grace's Warbler, and Spotted Towhee.

Federally Protected Species and Critical Habitat

Critical Habitat has been designated for Mexican Spotted Owl, Mt. Graham Red Squirrel, Southwestern Willow Flycatcher, Razorback Sucker, and Loach Minnow.

Federally protected species observed in the basin include:

- Listed Endangered- Gila Topminnow, Gila Chub, Desert Pupfish, Southwestern Willow Flycatcher,
- Listed Threatened- Loach Minnow, Mexican Spotted Owl, Sonoran Bald Eagle, Chiricahua Leopard Frog
- Candidate- Headwater Chub, Northern Mexican Gartersnake, Yellow-billed Cuckoo,

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 9,597 Angler Use Days were documented in the Safford Basin, equating to over $1 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_SAF_final.pdf

SALT RIVER

The Salt River Basin intersects Navajo, Gila, Maricopa, Pinal, Greenlee, Graham, and Apache Counties. This basin is characterized by mid- to high-elevation mountain ranges, plateaus and canyons. Vegetation types include: Arizona upland Sonoran desertscrub; semidesert, plains and Great Basin and subalpine grasslands; interior chaparral; madrean evergreen woodland; Great Basin conifer woodland; and montane and Rocky Mountain subalpine conifer forests. Riparian vegetation includes Mesquite, mixed broadleaf and Tamarisk along the Salt River and mixed broadleaf along the Black River. Over half of this basin is managed by Native American tribes, principally the Fort Apache and San Carlos Indian reservations.

Important Riparian, Aquatic, and Wetland Resources

The Salt River, a popular whitewater rafting destination, runs east to west through the southern part of the basin from the confluence of the White and Black Rivers. There are numerous perennial streams located throughout the basin, particularly in the high elevation eastern portion, and include the Salt River, Black River, East Fork Black River, West Fork Black River, White River, East Fork White River, North Fork White River, Big Bonito Creek, Carrizo Creek, Cibecue Creek, Canyon Creek and Cherry Creek. Perennial waters also flow through many of the wilderness areas within the basin; Bear Wallow Creek, Campaign, Pinto and Tortilla Creeks, Cherry and Coon Creeks, Devils Chasm Creek, and Rock Creek.

Bear Wallow Creek flows year-round through the wilderness area, shaded by green riparian hardwoods. The creek provides a habitat for the threatened Apache Trout.

Theodore Roosevelt Lake is located in the western portion of the basin and Apache Lake, Canyon Lake and Saguaro Lake are in the vicinity of Tortilla Flat. Hawley Lake, Sunrise Lake, Crescent Lake and Big Lake are found in the high-elevation northeastern portion of the basin. The most common use of the large reservoirs is recreation; boating, fishing, camping, and other water sports.

Portions of perennial flow in Pinal Creek are supported by effluent discharge.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Northern Leopard Frog, Western Barking Frog, Peregrine Falcon, Belted Kingfisher, Common Black-Hawk, Northern Gray Hawk, Osprey, American Water Shrew, Western Red Bat, and Narrow-headed Gartersnake. Other native species observed Mogollon Rim Treefrog, Zone-tailed Hawk, Sonora Sucker, Speckled Dace, and Arizona Montane Vole.

Important Conservation Lands

- Roosevelt Lake Wildlife Area, AGFD
- Three Bar Wildlife Area, AGFD
- Black River and Cunningham State Conservation Lands, AGFD
- Arizona Audubon Important Bird Area; Upper Little Colorado River Watershed, Mogollon Rim Snowmelt Draws, Blue River Complex
- Bear Wallow Wilderness Area, USFS
- Four Peaks Wilderness Area, USFS
- Salome Wilderness Area, USFS

- Salt River Canyon Wilderness Area, USFS
- Sierra Ancha Wilderness Area, USFS
- Superstition Wilderness Area, USFS
- Tonto National Monument, NPS
- Bear Wallow Creek, Bear Wallow Creek North Fork, and Bear Wallow Creek South Fork are identified as Outstanding Arizona Waters, ADEQ
- Hay Creek, Snake Creek, and Stinky Creek are identified as Outstanding Arizona Waters, ADEQ

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Mexican Spotted Owl, Southwestern Willow Flycatcher, Razorback Sucker, and Loach Minnow.

The Apache Trout is one of only two trout native to Arizona. It is officially designated as Arizona's state fish, and was historically found only in the headwaters of the White, Black and Little Colorado Rivers. Once nearing extinction, the Apache trout had been reduced to 13 relict populations, all located in headwater streams that flow into the White and Black rivers within the Salt River basin. A recovery program has restored Apache trout to much of their historic range in the White Mountains on the Fort Apache Indian Reservation (FAIR) and Apache-Sitgreaves National Forest (ASNF). Apache Trout offer anglers a unique fishing opportunity, providing a recreational and economic asset to the state. Apache Trout are stocked in several waters in eastern Arizona including the East Fork of the Black River, lower West Fork of the Black, the Little Colorado River in Greer, the West Fork of the LCR, and upper Silver Creek. The state also stocks some lakes, of which Lee Valley Lake is most notable.

Recovery actions for Apache Trout include stream restoration, fencing, stabilizing stream banks, managing erosion, fish barrier construction, and establishing new populations. New populations that have been or are in the process of being restored in the Salt River basin include:

- Bear Wallow Creek, including North and South Forks (ASNF)
- Conklin Creek (ASNF)
- Fish Creek, including Double Cienega and Corduroy creeks and Ackre Lake (ASNF)
- Hayground Creek (ASNF)
- Home Creek (ASNF)
- Stinky Creek (ASNF)
- West Fork Black River, including Thompson and Burro creeks (ASNF and FAIR)
- Wildcat Creek (ASNF)
- Paradise Creek (FAIR)
- Squaw Creek (FAIR)
- Wohlenberg Draw (FAIR)

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher, Yuma Clapper Rail, Desert Pupfish, Gila Topminnow, and Razorback Sucker

- Listed Threatened- Chiricahua Leopard Frog, Sonoran Desert Bald Eagle, Mexican Spotted Owl, Apache Trout, and Loach Minnow,

- Candidate- Yellow-billed Cuckoo, Roundtail Chub, Three Forks Springsnail, New Mexico meadow jumping mouse, and Northern Mexican Gartersnake

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 1,259,065 Angler Use Days were documented in the Salt River Basin, equating to over $196 million in economic revenue generated by angler activity within the basin. Additionally, while no calculated economic value could be identified, the Salt River Canyon provides one of only a few opportunities for white water rafting, kayaking and canoeing available in Arizona. Reservoirs in this groundwater basin provide some of the best watercraft recreation related opportunities, as well (Roosevelt, Apache, Canyon and Saguaro lakes). Water resources, primarily springs, and small streams, provide needed watering sites for an abundance of back-country wilderness experiences for back-packers and horseback riders. The water resources of the basin also provide needed water for abundant big and small game species that provide recreation opportunity for, and economic benefit from, thousands of hunters each year.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/volume_5_SRB_final.pdf

SAN BERNARDINO VALLEY

San Bernardino Valley is in the extreme southeast part of the state in Cochise County. This basin is characterized by a valley flanked by two mountain ranges; Peloncillo Mountains to the east and Pedregosa Mountains on the northwest basin boundary. Vegetation is primarily semidesert grassland with smaller areas of madrean evergreen woodland and Chihuahuan desertscrub. Riparian vegetation includes Mesquite and Cottonwood and Willow along Black Draw.

Important Riparian, Aquatic, and Wetland Resources

More than 280 species of birds are drawn to the aquatic habitats in the San Bernardino Valley. The San Bernardino Cienega was historically the most extensive wetland in the region, forming an important migratory link between Mexico and North America.

The San Bernardino Valley is dissected by ephemeral streams that flow only during rain events. However, in the central valley just north of the International Boundary, discharge from artesian wells and springs flow into Black Draw, a perennial stream on the San Bernardino National Wildlife Refuge and the largest drainage in the valley.

The wetlands and riparian habitats support a wide diversity of birds including ducks, woodpeckers, cranes, hummingbirds, and raptors. Coyote, bobcat and the occasional mountain lion inhabit the refuge along with Mule Deer, Whitetail Deer, Badger, and Javelina.

The basin is located in the northernmost part of the Yaqui River drainage that extends far into Mexico. Eight species of fish are native to the Yaqui River drainage, including federally endangered Yaqui Chub and Yaqui Topminnow. Yaqui Catfish and Yaqui Beautiful Shiner, both threatened species, were once extirpated in the United States but were successfully reintroduced from Mexican populations. Other fish, native to the drainage, are the Mexican Stoneroller, Longfin Dace, Roundtail Chub, and Yaqui Sucker.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Thick-billed Kingbird, Tropical Kingbird, Violet-crowned Hummingbird, Mexican Stoneroller, and Western and Yellow Bat.

Important Conservation Lands

- San Bernardino National Wildlife Refuge, USFWS
- San Bernardino Wilderness Area, USFS

Extensive watershed renovations on lower Whitewater Draw and upper Black Draw within the San Bernardino National Wildlife Refuge are resulting in a rising water table and the recovery of riparian vegetation. The refuge is internationally significant, playing a critical role in supporting populations of native fish by restoring and maintaining aquatic and riparian habitat in the United States and Mexico.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for Beautiful Shiner, Yaqui Catfish, and Yaqui Chub.

Federally protected species observed in the basin include:

- Listed Endangered- Yaqui Chub, Yaqui Topminnow, and Huachuca Water Umbel
- Listed Threatened- Chiricahua Leopard Frog, Beautiful Shiner, and Yaqui Catfish

- Candidate- Yellow-billed Cuckoo, San Bernardino Springsnail, and Northern Mexican Gartersnake

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_SBV_final.pdf

http://www.azheritagewaters.nau.edu/loc_yaqui_river.html

SAN RAFAEL

The San Rafael Basin is bisected by Cochise and Santa Cruz Counties. The sparsely populated basin is characterized by a high-elevation mountain range, the Huachuca Mountains, and a valley and Great Basin grassland and madrean evergreen woodland vegetation. Riparian vegetation includes Cottonwood and Willow and strand along the Santa Cruz River.

Important Riparian, Aquatic, and Wetland Resources

The San Rafael Basin contains the headwaters of the Santa Cruz River. There are over 10 miles of perennial flow in the basin along the Santa Cruz River and Ramsey Canyon. The Upper Santa Cruz River flows through rolling oak grassland hills and supports cottonwood-willow gallery forests.

The San Rafael Valley is one of the best remaining examples in Arizona of intact native grasslands. The native grasslands and riparian areas support a wide range of important species. The endangered Huachuca Water Umbel grows in the river area and Chiricahua Leopard Frog, Lowland Leopard Frog, Western Barking Frog, and Sonora Tiger Salamander also depend on the riparian area. Surface flows support Gila Chub, Gila Longfin Dace, Gila Topminnow, Desert Sucker and Sonora Sucker. Mexican Spotted Owl, Yellow-billed Cuckoo, Elegant Trogon, Bald Eagle, Zone Tailed Hawk, and Northern Buff-breasted Flycatcher can also be found in the basin.

Important Conservation Lands

- San Rafael Ranch State Natural Area, Arizona State Park
- Miller Peak Wilderness Area, USFS
- Coronado National Monument, NPS
- Bog Hole Wildlife Area, AGFD
- Arizona Audubon Important Bird Area; Huachuca Mountains

Arizona State Parks acquired the San Rafael State Natural Area from The Nature Conservancy and it remains under a conservation easement along with 17,000 acres of deed-lands. The State Natural Area is managed to preserve the native grasslands as well as the historic San Rafael Ranch buildings.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl and Huachuca Water Umbel.

Federally protected species observed in the basin include:

- Listed Endangered- Sonora Tiger Salamander, Gila Chub, Gila Topminnow, Madrean Ladies'-tresses
- Listed Threatened- Chiricahua Leopard Frog and Mexican Spotted Owl
- Candidate- Arizona Tree Frog, Yellow-billed Cuckoo, Huachuca Springsnail, and Northern Mexican Gartersnake

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_SRF_final.pdf

SAN SIMON WASH

The San Simon Wash Basin in Pima County is characterized by plains and valleys bordered by mountain ranges including the Baboquivari Mountains on the southeastern basin boundary. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub, semidesert grassland and madrean evergreen woodland along the eastern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

There are no perennial or intermittent streams in the basin. San Simon Wash is the major basin drainage, flowing ephemerally into Mexico. There is one large reservoir in the southeastern corner of the basin, a dozen small reservoirs and a number of small springs.

State Wildlife Species of Concern observed in the basin include; Lowland Burrowing Treefrog, Western Narrow-mouthed Toad. Other native species observed in the basin include Sonoran Green Toad and Arizona Mud Turtle.

Important Conservation Lands

Approximately 99 percent of lands within the San Simon Wash Basin are Tohono O'odham lands. Very small portions of other conservation lands intersect this basin, including:

- Organ Pipe Cactus National Monument and Wilderness, NPS
- Baboquivari Peak Wilderness, USFS
- Buenos Aires National Wildlife Refuge, USFWS

Federally Protected Species and Critical Habitats

No Critical Habitat has been designated within the basin.

Federally protected species observed in the basin include Candidate species Yellow-billed Cuckoo and Northern Mexican Gartersnake

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_SSW_final.pdf

SANTA CRUZ AMA

The Santa Cruz Active Management Area (AMA) in Pima County and Santa Cruz counties is characterized by mid to high elevation mountains surrounding the Santa Cruz River Valley. Vegetation types include southwestern grassland, madrean evergreen woodland and riparian species, principally found along the Santa Cruz River and Sonoita Creek.

From its headwaters in the San Rafael Valley, the river flows southward approximately 9 miles and enters Mexico. During its 35 mile course through Mexico, the river continues its southward flow for a short distance and then bends northward and enters Arizona five miles east of Nogales. Within the United States, the Santa Cruz River continues northward for 65 miles from Nogales to Tucson, where it continues beyond to the confluence of the Gila River.

Important Riparian, Aquatic, and Wetland Resources

The Santa Cruz Valley contains several stretches of natural river flow, important riparian and grassland habitats, unfragmented wildlife migration corridors, and diverse plant and animal communities, including numerous endangered species. Wastewater is discharged from Nogales and Rio Rico into the river drainage of the Santa Cruz supporting the riparian habitats. The river is perennial through much of the upper valley in the San Rafael Valley and Sonora, supporting many native and migratory species. The ephemeral reaches support woody riparian vegetation of mostly cottonwood and willow; density and diversity increase as the river progresses southward toward the perennial section.

A large number of bird species inhabit the Santa Cruz Valley, and waterfowl migrate through in the spring and fall. The Northern Goshawk, a rare woodland raptor, occasionally hunts for birds and rodents in the foothills.

Sonoita Creek provides a unique array of species from endangered fish to butterflies and birds. The lush riparian area provides habitat for over 200 species of birds including Gray Hawks which nest in the large Fremont Cottonwoods, Zone-tailed Hawks, Common Black Hawks, Thick-bill Kingbirds and Northern Beardless Tyrannulets can also be found along Sonoita Creek.

The TNC Sonoita Creek Preserve protects a Fremont Cottonwood, Goodding Willow riparian forest. Arizona Black Walnut, Velvet Nesquite, Velvet Ash, Netleaf Hackberry, and various willows are also found in slightly different habitats throughout the preserve.

Cienega wetlands, a once common feature of the Sonoita Creek floodplain are now rare in Arizona. A significant number of rare and sensitive plant species are found in the Sonoita Creek watershed including, Huachuca Water Umbel, Santa Cruz Striped Agave, and the Santa Cruz Beehive Cactus.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Western Barking Frog, Western Narrow-mouthed Toad, Peregrine Falcon, Bald Eagle, Black-bellied Whistling-Duck, Elegant Trogon, Osprey, Tropical Kingbird, Violet-crowned Hummingbird, Gila Topminnow, and Brown Vinesnake.

Important Conservation Lands

- Sonoita Creek State Natural Area, Arizona State Park
- Patagonia Lake State Park, Arizona State Park
- Sonoita Creek Preserve, The Nature Conservancy
- Coal Mine Spring Wildlife Area, AGFD

- Arizona Audubon Important Bird Area; Sonoita Creek State Natural Area, Patagonia Lake State Park, Santa Rita Mountains
- Mt. Wrightson Wilderness, USFS
- Pajarito Wilderness, USFS
- Tumacacori National Monument, NPS

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl. The Santa Cruz Valley harbors two federally endangered plants, Huachuca Water Umbel and Madrean Ladies'-tresses, as well as the rare Wilcox Fishhook Cactus. The endangered Gila Topminnow, thought once to be one of the most common fish in southern Arizona and the Gila Chub, a federal candidate species, survive in the perennial segments of the Santa Cruz river, as do several sensitive species of frogs and reptiles.

Other federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher
- Listed Threatened- Mexican Spotted Owl and Chiricahua Leopard Frog
- Candidate- Northern Mexican Gartersnake and Yellow-billed Cuckoo

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 88,811 Angler Use Days were documented in the Santa Cruz AMA Basin, equating to over $17 million in economic revenue generated by angler activity within the basin.

Additional studies have been conducted that describe the economic value of quality riparian habitat in close proximity to home developments, increasing real estate values (Bark et al., 2009; Bourne, 2007; Bark-Hodgins et al., 2006; Colby & Wishart, 2002).

Bark, R. H., et al. 2009. Habitat preservation and restoration: Do homebuyers have preferences for quality habitat? *Ecological Economics* 68, no. 5:1465-1475.

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SHIVWITS PLATEAU

Shivwits Plateau Basin in Mohave County is characterized by plateaus, canyons and cliffs. Vegetation is primarily Great Basin conifer woodland, Great Basin and Mohave desertscrub and Plains and Great Basin grassland with small areas of Rocky Mountain and madrean montane forest and interior chaparral.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Shivwits Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

Water resources in the Shivwits Plateau Basin consist of three perennial streams: Boulder Wash; Colorado River, Spring Canyon and Diamond Creek. There are as many as 56 springs. Spring Canyon is the major spring and has a discharge rate of 331 gallons per minute.

With an elevation of 4000 to 6000 feet, and the highest point reaching 7072 feet at Mount Dellenbaugh, the vegetation in the Shivwits Plateau Basin is diverse. In the higher elevations Rocky Mountain and madrean montane conifer forest can be found along with juniper trees. The lower elevations consist of giant Mojave Yucca, Great Basin conifer woodland, Great Basin and Mohave Desert scrub, Great Plains and Great Basin grassland, and small areas of interior chaparral. Shrubs at the lower elevation include sagebrush and blackbrush. Mountain Star-lily and Red Alum Root are a few of the flowering plants that grow in the basin. Perennial grasses in the Shivwits Plateau region include Bottlebrush Squirreltail, and Blue Grama.

Wildlife that inhabits the Shivwits Plateau Basin includes Desert Mule Deer, Desert Bighorn Sheep, Kaibab Squirrel, and Mountain Lion. Birds of prey include American Peregrine Falcon, Turkey Vulture, and Red-tailed Hawk. Some of the types of fish that can be found in this area include Flannelmouth Sucker, Humpback Chub, and Speckled Dace. Other species observed in the basin include the Great Basin Spadefoot Toad, Western Mastiff Bat, and Wild Turkey.

Important Conservation Lands

Land in the Shivwits Plateau Basin is primarily owned by the Bureau of Land Management and the National Park Service.

- Grand Canyon-Parashant National Monument, BLM
- Grand Canyon National Park, NPS
- Mount Logan Wilderness, BLM
- Grand Wash Cliffs Wilderness, BLM

Federally Protected Species and Critical Habitats

Critical Habitat has been designated along the Colorado River for endangered Razorback Sucker.

There are several other endangered species known to occur in the Shivwits Plateau Basin. These include the California Condor, Mexican Spotted Owl, and Southwestern Willow Flycatcher. The Humpback Chub is another federally protected species found in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_SHV_final.pdf

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TIGER WASH

Tiger Wash Basin, located in Maricopa County is characterized by a valley bordered by mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub and a small amount of southwestern interior chaparral near the northwestern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

Tiger Wash contains no perennial waters or major springs. Tiger Wash, an ephemeral drainage is in the center of the basin.

Important Conservation Lands

- Harquahala Mountains Wilderness, BLM
- Hummingbird Springs Wilderness, BLM

Federally Protected Species and Critical Habitats

Tiger Wash Basin contains no designated critical habitat and no documented occurrences of federally listed species.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_TIG_final.pdf

TONTO CREEK

Tonto Creek in Gila and Coconino counties is characterized by mid-elevation mountain ranges. Vegetation types include Arizona uplands Sonoran desertscrub, semidesert grassland, interior chaparral, Great Basin conifer and madrean evergreen woodlands and montane conifer forests. Riparian vegetation is found along streams including mixed broadleaf, tamarisk and mesquite along Tonto Creek.

The basin is bound on the north by the Mogollon Rim, on the east by the Sierra Ancha Mountains, and on the west by the Mazatzal Mountains. Elevations range from 7,800 feet above mean sea level in the Mazatzal Mountains to 2,200 feet above mean sea level at Roosevelt Lake where Tonto Creek terminates.

Important Riparian, Aquatic, and Wetland Resources

The unique geographic character of the Mogollon Rim provides a wide diversity of vegetation types and ecosystems. The Tonto Creek Basin contains diverse vegetation types such as the Madrean evergreen woodland, which occurs in small areas in the eastern part of the Tonto Creek at elevations of about 5,000 to 6,000 feet. Semidesert grasslands occur in valleys between the desert and woodlands or chaparral at elevations between 3,500 and 5,000 feet and are found south of Payson in the Tonto Creek Basin. Arizona upland Sonoran desertscrub covers parts of the basin below about 3,500 feet.

Along the riparian areas in the basin there is a combination of mixed broadleaf, Cottonwood and Willow, strand and Mesquite vegetation. Canyon habitat consists of Cottonwood, Willow, Arizona Walnut, Sycamore, and Maple. Perennial streams in this basin include Tonto Creek, Haigler Creek, Spring Creek, Dell Shay Creek, Houston Creek, Christopher Creek, Greenback Creek, Gordon Canyon Creek, Marsh Creek, Rye Creek, Lambing Creek, Horton Creek, East Fork Horton Creek and Dick Williams Creek—equaling approximately 129 stream miles. Because of the high elevations and associated higher rainfall and snowfall, this area is included in the state's most important water producing watersheds, the Salt and Verde Rivers. These watersheds contain the greatest concentration of perennial streams found in the state, which in turn support extensive riparian habitat.

A wide range of riparian-dependent birds occur in the basin including, Heron, Belted Kingfisher, Osprey and American Dipper. Riparian breeding birds include Common Black-Hawk, Peregrine Falcon, Rufous, Black-chinned, and Broad-tailed Hummingbird, Black Phoebe, Warbling Vireo, American Robin, Bridled Titmouse, Virginia's and MacGillivray's Warblers, Black-headed Grosbeak, and occasionally Indigo Bunting. Merriam's Turkey, Band-tailed Pigeon, Acorn Woodpecker, Nuthatches, Towhees, and a variety of other woodland birds. The Tonto Creek fish hatchery raises Arizona's state fish, the Apache Trout, as well as Rainbow, Brook and Cutthroat Trout. White-tailed Deer, Elk, Black Bear, Abert's Squirrel, Arizona Gray Squirrel, Rock Squirrel, and Mantled Ground Squirrel are also found in the area. Reptiles and amphibians inhabiting the hatchery grounds and Tonto Creek include Mexican Gartersnake, Terrestrial Gartersnake, Sonoran Mountain Kingsnake, Arizona Black-tailed Rattlesnake, Clark's Spiny Lizard, Madrean Alligator Lizard, Greater Short-horned Lizard, Plateau Lizard, Many-lined Skink, Canyon and Arizona Treefrog, Lowland Leopard Frog, and Arizona Toad. Other native fish observed in the basin include Desert Sucker, Longfin Dace, Sonora Sucker, and Speckled Dace.

Important Conservation Lands

- Mazatzal Wilderness, USFS
- Hellsgate Wilderness, USFS

- Salome Wilderness, USFS
- Arizona Audubon Important Bird Area; Mogollon Snowmelt Draws
- Tonto Creek Fish Hatchery, AGFD - Management goals of the hatchery are to provide for the continued operation of fish culture activities, to protect and enhance the wildlife habitat of the property, and to provide public outdoor recreation opportunities like wildlife watching and educational interpretation.

Federally Protected Species and Critical Habitats

Critical Habitat is designated for the Mexican Spotted Owl and for Southwestern Willow Flycatcher along the Tonto Creek as it flows into Roosevelt Lake. Critical habitat is also being proposed by the Fish and Wildlife Service for spikedace in this basin.

Other Federally protected species that are known to occur in the basin are the threatened Bald Eagle, and the endangered Lesser Long-nosed Bat, Arizona Hedgehog cactus, Chiricahua Leopard Frog, and Yuma Clapper Rail.

Other federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher, Gila Topminnow
- Listed Threatened- Bald Eagle , Mexican Spotted Owl
- Candidate- Northern Mexican Gartersnake, Yellow-billed Cuckoo, Headwater Chub

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 12,928 Angler Use Days were documented in the Tonto Basin, equating to over $2 million in economic revenue generated by angler activity within the basin. Water resources, primarily springs, and small streams, provide needed watering sites for an abundance of back-country wilderness experiences for back-packers and horseback riders. The water resources of the basin also provide needed water for abundant big and small game species that provide recreation opportunity for and economic benefit from, thousands of hunters each year.

Web Sources

http://www.wildlifeviewingareas.com/wv-app/ParkDetail.aspx?ParkID=82

http://www.azgfd.gov/outdoor_recreation/wildlife_area_tonto_creek.shtml

http://www.americansouthwest.net/arizona/tonto_creek/canyon.html

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDUSFS_for_web/CentralHighlands/tonto_creek.pdf

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/CentralHighlands/Streams/TontoCreek.htm

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/Volume_5_TON_final.pdf

TUCSON AMA

The Tucson Active Management Area (AMA) in Pima, Santa Cruz and Pinal counties is characterized by mid to high elevation mountains and broad alluvial basins. The Tucson AMA includes the Tucson municipal area and encompasses the Avra and Altar Valleys. Vegetation types include Lower Colorado River and Sonoran upland desertscrub, southwestern grassland, interior chaparral, madrean evergreen woodland and small areas of petran montane conifer forest. Riparian vegetation is found along some watercourses, notably Sabino, Cienega and Romero Creeks, along effluent dependent reaches of the Santa Cruz River and at Arivaca Cienega.

Important Riparian, Aquatic, and Wetland Resources

The Tucson AMA contains over 40 miles of perennial flow along Arivaca Creek, Cienega Creek, Madera Canyon Creek, Romero Canyon Creek, Sabino Creek, Santa Cruz River, Sycamore Canyon, Sutherland Wash and an unnamed tributary to Madera Canyon.

The Tucson AMA supports a wide diversity of Sonoran Desert and Sky Island habitats. Aquatic species such as the Chiricahua Leopard Frog, Western Narrow-mouthed Toad, Desert Pupfish, Gila Chub, Gila Topminnow, Arizona Mud Turtle, Huachuca Water Umbel, and Arizona Giant Sedge can be found in the Tucson AMA. The Santa Cruz River and other riparian habitats provide a critical winter stopover for migratory and native birds such as the Black-bellied Whistling-Duck, Great Blue Heron, Mexican Spotted Owl, Osprey, Southwestern Willow Flycatcher, Yellow-billed Cuckoo, and Tropical Kingbird. Western Yellow Bat, Arizona Shrew, Huachuca Water Umbel, Goodding Onion, Fallen Ladies'-tresses and Northern Mexican Gartersnakes, among many others, can also be found in the Tucson AMA.

Other State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Western Barking Frog, Peregrine Falcon, Elegant Trogon, Northern Buff-breasted Flycatcher, Northern Gray Hawk, Thick-billed Kingbird, Violet-crowned Hummingbird, Arizona Shrew, and Brown Vinesnake.

Important Conservation Lands

- Buenos Aires National Wildlife Refuge, USFWS
- Pusch Ridge Wilderness Area, USFS
- Pajarita Wilderness Area, USFS
- Mount Wrightson Wilderness Area, USFS
- Rincon Mountain Wilderness Area, USFS
- Arizona Audubon Important Bird Area; Sabino and Bear Creeks, Sycamore Canyon, Pajarita Mountains, Santa Rita Mountains, Arivaca Cienega, Arivaca Creek, California Gulch
- Saguaro National Park, NPS
- Saguaro Wilderness Area, NPS
- Tucson Mountain State Conservation Land, AGFD
- Arivaca Lake, AGFD
- Coyote Mountain Wilderness Area, BLM

- Baboquivari Creek Wilderness Area, BLM
- Ironwood Forest National Monument, BLM
- Altar Valley Ranch, Pima County Preserve
- Canoa Ranch, Pima County Preserve
- Tucson Mountain Park, Pima County
- Tortolita Mountain Park, Marana/Pima County
- Pima County Sonoran Desert Habitat Conservation Plan, Pima County
- Arthur Pack Regional Park, Pima County
- Catalina State Park, Arizona State Park

The Pima County Multi-Species Conservation Plan (MSCP) was created to comply with the "take" provisions of the Endangered Species Act (ESA). Incidental take of a listed species, as the result of carrying out an otherwise lawful activity, is not allowed without a permit from the USFWS. The permit will provide mitigation to impacts on 49 species and approximately 36,000 acres. For the 36,000 impacted acres, Pima County proposes to acquire and protect about 125,000 acres of land by the end of the permit period. By 2009, the county had acquired over 71,000 acres of fee lands and was managing over 130,000 acres of State Trust Lands.

The Pima County MSCP is part of a larger planning effort known as the Sonoran Desert Conservation Plan (SDCP), which covers 5.9 million acres in Pima County and is focused on six elements: habitat, corridors, cultural resources, mountain parks, ranch conservation and riparian protection. The SDCP planning process began in 1998 as a way to create a science-based conservation plan, update the county's comprehensive land use plan, and comply with the ESA. The plan directs growth to areas with the least natural, historic, and cultural resource values as well as sets aside sensitive habitat through land acquisitions.

Federally Protected Species and Critical Habitats

Critical Habitat designated for Mexican Spotted Owl, Gila Chub, and Sonora Chub.

Federally protected species observed in the basin include:

- Listed Endangered- Huachuca Water-umbel, Southwestern Willow Flycatcher, Desert Pupfish, Gila Chub, and Gila Topminnow
- Listed Threatened- Mexican Spotted Owl, Chiricahua Leopard Frog, and Sonora Chub
- Candidate- Northern Mexican Gartersnake and Yellow-billed Cuckoo

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 29,208 Angler Use Days were documented in the Tucson AMA Basin, equating to over $4 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/ActiveManagementAreas/documents/Volume_8_TUC_final.pdf

UPPER HASSAYAMPA

The Upper Hassayampa basin is located in Yavapai and Maricopa counties, south of Skull Valley located on the northerly limit of the basin. The southerly limit is in northern Maricopa County and just south of Wickenburg. The basin is characterized by mid-elevation mountains and valleys. Vegetation types include Arizona upland Sonoran and Mohave desertscrub, semidesert grassland, interior chaparral and small areas of montane conifer forest. Riparian vegetation including Mesquite and Cottonwood and Willow is found along the perennial portions of Hassayampa River.

Important Riparian, Aquatic, and Wetland Resources

The Hassayampa River is the primary surface drainage through the basin. It runs north to south through the center and is fed by drainage from the Bradshaw, Weaver and Date Creek Mountains. French Gulch, Ash Creek, Weaver Creek, Minnehaha Creek, Lion Creek, Martinez Wash and Antelope Creek also supply surface runoff into the Hassayampa River.

Much of the southern portion of this basin is identified as an important wildlife linkage for the Bighorn Sheep, Badger, Mountain Lion, Mule Deer, Black-tailed Jackrabbit, Desert Tortoise, Gila Monster, hawks and several fish species. State Wildlife Species of Concern observed in the basin include the Common Black-Hawk, Peregrine Falcon, Snowy Egret, and Western Yellow Bat. Other native species known to occur in the basin include Arizona Toad, Zone-tailed Hawk, Desert Sucker, Longfin Dace, and Western Red-tailed Skink.

Important Conservation Lands

- Hassayampa River Canyon Wilderness, BLM
- TNC Hassayampa River Preserve

Hassayampa River Canyon Wilderness includes several miles of free-flowing Hassayampa River and its associated riparian habitat. Mexican Garter Snake, Desert Tortoise, Desert Sucker and Longfin Dace are special status species known to occur or potentially occur within this wilderness. The side canyons and the uplands support Chaparral, Paloverde and Saguaro Plant Communities.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Mexican Spotted Owl.

Other Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher**,** Desert Pupfish, Gila Topminnow
- Listed Threatened**-** Mexican Spotted Owl
- Candidate- Yellow-billed Cuckoo

Economic Values

See Report Discussion.

Web Sources

Bureau of Land Management (BLM)

United States Forest Service (USUSFS, Prescott Forest)

United States Fish and Wildlife Service (USFWS)

Arizona Game and Fish Department (AGFD)

Arizona Department of Water Resources (ADWR)

Wildlife Linkages (NAU)

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/Volume_5_UHA_final.pdf

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/arizona/placesweprotect/hassayampa-river-preserve.xml

UPPER SAN PEDRO

The Upper San Pedro Basin located in Cochise, Santa Cruz and Pima counties is characterized by a large valley flanked by a series of mountain ranges. Vegetation is primarily semidesert grassland and Chihuahuan desertscrub with smaller areas of madrean evergreen woodland, plains and Great Basin desertscrub and Rocky Mountain and montane conifer forest. Riparian vegetation includes Cottonwood, Willow, Mesquite and Tamarisk along the San Pedro River and conifer oak and mixed broadleaf along Gardner, Ramsey and Miller Canyons.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the San Pedro River watershed. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Upper San Pedro Basin contains a portion of the San Pedro River – one of the last remaining free flowing desert rivers in the world. The Upper San Pedro Basin contains over 100 miles of perennial flows through much of the San Pedro Riparian National Conservation Area (SPRNCA), the Babocomari River, Bass Canyon, Carr Canyon, Double R Canyon Creek, Miller Canyon, Ramsey Canyon, Garden Canyon Creek, and Turkey Creek.

The SPRNCA provides habitat for over 375 species of birds including, Elegant Trogon, Great Blue Heron, Green Kingfisher, Mexican Duck, Mexican Spotted Owl, Southwestern Willow Flycatcher, Tropical Kingbird, Yellow-billed Cuckoo, Zone-tailed Hawk, and Violet-crowned Hummingbird. Amphibians such as Arizona Treefrog, Chiricahua Leopard Frog, Western Barking Frog, Western Green Toad, and Lowland Leopard Frog also depend on the riparian corridors. Many important native fish occur including Gila Chub, Speckled Dace, Gila Longfin Dace, Desert Pupfish, Gila Topminnow, and Sonoran Sucker. The Huachuca Water Umbel, Madrean Ladies'-tresses, Thurber's Bog Orchid and many other unique plants thrive in this riparian area, adjacent mesquite bosque, and dense Sacaton grasslands.

Other State Wildlife Species of Concern observed in the basin include; Peregrine Falcon, Black-bellied Whistling-Duck, Common Black-Hawk, Mississippi Kite, Northern Buff-breasted Flycatcher, Northern Gray Hawk, Arizona Shrew, Western Red Bat and Western Yellow Bat.

Important Conservation Lands

- San Pedro Riparian National Conservation Area, BLM
- TNC Conservation Easements – Upper San Pedro River
- Miller Peak Wilderness, USFS
- Coronado National Memorial, NPS
- Ramsey Canyon Preserve, The Nature Conservancy
- Appleton-Whittell Audubon Research Ranch
- Arizona Audubon Important Bird Area; Huachuca Mountains, San Pedro Riparian National Conservation Area, Audubon Research Ranch
- Kartchner Caverns, Arizona State Park

The BLM SPRNCA contains nearly 57,000 acres of protected land in Cochise County. The Nature Conservancy and Arizona Land and Water Trust also protect large acreages under conservation easement along the Babocomari River. The BLM continues to manage the SPRNCA for scientific study and is involved in ongoing restoration efforts to the river and watershed.

Federally Protected Species and Critical Habitats

Critical Habitat designated for Mexican Spotted Owl, Huachuca Water Umbel, and Gila Chub.

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher**,** Desert Pupfish, Gila Topminnow, Gila Chub, Sonora Tiger Salamander, Huachuca Water-umbel, and Madrean Ladies'-tresses
- Listed Threatened**-** Mexican Spotted Owl and Chiricahua Leopard Frog
- Candidate- Arizona Treefrog, Yellow-billed Cuckoo, Huachuca Springsnail, and Northern Mexican Gartersnake

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 28,584 Angler Use Days were documented in the Upper San Pedro Basin, equating to over $4 million in economic revenue generated by angler activity within the basin.

Additional studies have been conducted that describe the economic contribution of visitors to natural areas, the value of streamflow and riparian bird habitat, and surveys conducted to identify economic value of wildlife watching in the San Pedro River (Pima County 2009, Leenhouts et al. 2006, and Orr and Colby 2002).

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Stromberg, J., Lite, S., & Beauchamp, V. (2003). Managing stream flow regimes for riparian ecosystem restoration. *2003 Tamarisk Symposium* Grand Junction, Colorado.

VERDE RIVER

The Verde River Basin is within Yavapai, Maricopa, Gila and Coconino Counties. It is characterized by mid-elevation mountain ranges and valleys with high elevation areas along its north central boundary. Vegetation types include Arizona upland Sonoran desertscrub, semidesert and plains and Great Basin grasslands, interior chaparral, Great Basin conifer woodland, montane conifer forests and a very small area of Rocky Mountain subalpine conifer forest in the vicinity of Humphreys Peak. Riparian vegetation is found along streams including mixed broadleaf and mesquite along the Verde River and mixed broadleaf along other streams such as West Clear Creek, Wet Beaver Creek and Oak Creek.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Verde River Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Verde River Basin contains the Verde River, one of Arizona's largest perennial waters. The 170-mile long Verde River drains much of central and northern Arizona, generally flowing south to its confluence with the Salt River. Perennial flow on the Verde River originates from springs located just below Sullivan Lake Dam, an artificial reservoir at the confluence of Little Chino Creek, and the Big Chino and Williamson Valley Washes. From below Sullivan Lake, the Verde flows freely for 125 miles before reaching Horseshoe Reservoir. Perennial tributaries, including Oak Creek, Wet Beaver Creek, and West Clear Creek, as well as ephemeral washes, supply base flow to the Verde River.

The Verde River and associated riparian vegetation provide high-quality wildlife and fish habitat. Until the 1890s, the riparian zone was over a mile wide in places, creating a series of marshes and sloughs that provided habitat for a variety of plants and animals. Common riparian vegetation consists of strand, mixed broadleaf and cottonwood willow communities, wet meadows and emerging marshlands. Important species include Cattail, Bulrush, Freemont Cottonwood, Gooding Willow, Arizona Sycamore, and Arizona Alder.

The ecologically important Verde River provides extensive woody riparian and wetland vegetation, and contains critical habitat for a diversity of native aquatic and riparian-dependent species. Thirty-one native and sport fisheries occur in the Verde River. Many aquatic, terrestrial, arboreal and aerial animal species depend directly or indirectly upon the river and its tributaries. Included within the Verde River's flora and fauna are plants and animals listed as threatened or endangered by Arizona or the federal government.

The Verde River riparian zone is a critical flyway for migratory birds and supports a high density of breeding birds; over 200 resident and neo-tropical migratory bird species have been recorded. Species such as the federally endangered Southwestern Willow Flycatcher and the Yellow-billed Cuckoo depend on the river's woody riparian forests of cottonwood, willow and ash. Other species include the Peregrine Falcon, Desert Bald Eagle, Summer Tanager, Osprey, Vermillion Flycatcher, Blue-throated Hummingbirds, and Great Blue Herons. The Verde River supports the largest number of Bald Eagle nesting sites of any river in the state.

Native fish populations in the upper Verde River are among the most diverse in Arizona. Historically the Verde River supported sixteen native fish species; only ten remain including the federally endangered Razorback Sucker and Colorado Pikeminnow, as well as the threatened Spikedace and Gila Chub. Additionally, the Verde River is one of three Arizonan rivers that sustain populations of River Otter.

Other State Wildlife Species of Concern observed in the Verde Basin include the following: Lowland Leopard Frog, Northern Leopard Frog, Peregrine Falcon, Common Black-Hawk, Bobolink, Belted Kingfisher, Navajo

Mexican Vole, Western Red Bat, and Narrow-headed Gartersnake.

Page Springs State Fish Hatchery is located along the banks of Oak Creek and is the state's largest coldwater fish hatchery, producing nearly 700,000 trout annually. Located nearby is Bubbling Ponds Fish Hatchery which produces not only sportfish, but also native fish species (razorback suckers and Colorado pikeminnow) used for native fish conservation and recovery efforts. The Audubon Society designated the riparian habitat near the hatcheries and along Oak Creek as an Important Bird Area. The Page springsnail is found only at the Page Springs spring complex, from which several main springs and other minor springs arise.

The West Fork of Oak Creek, a tributary of Oak Creek, is another perennial stream in the Verde Basin that provides fish and wildlife habitat. Oak Creek Canyon and its perennial streams are a popular destination, second only to the Grand Canyon.

Wet Beaver Creek is a perennial stream with one major tributary, Dry Beaver Creek. Wet Beaver Creek flows through secluded canyons and the Wet Beaver Wilderness Area before flowing through Montezuma Well and Montezuma Castle, eventually reaching the Verde River near Camp Verde. Wet Beaver Creek provides habitat for stocked trout as well as dense riparian vegetation for numerous species of songbirds. The perennial waters in the Wet Beaver Wilderness attract large numbers of wildlife, including elk, deer, bear, mountain lion, and a variety of smaller mammals, reptiles, and birds.

West Clear Creek is another important perennial stream with headwaters originating from Willow and Clover Creeks. West Clear Creek flows through the 13,600 acre West Clear Creek Wilderness Area and provides extensive riparian habitat along canyon bottoms. Dominant vegetation includes cottonwood, sycamore, and alder along with some ash, willow, walnut and wild grape along the riparian zone. The creek attracts anglers with its stocked populations of trout and smallmouth bass.

Fossil Creek is a unique warm-water perennial stream that supports one of the most diverse riparian areas in Arizona. Fossil Creek flows from a complex of springs that supply a constant 20,000 gallons per minute of 72 degree Fahrenheit water. Over thirty species of trees and shrubs and over a hundred species of birds have been observed along Fossil Creek's riparian area. In 2004, federal and state agencies completed an extensive restoration of Fossil Creek to remove invasive fish species and have since successfully reintroduced native fish species. In March 2009 Fossil Creek became the second Arizona stream to receive federal designation as a Wild and Scenic River.

Important Conservation Lands

- Apache Creek Wilderness, USFS
- Arizona Audubon Important Bird Area; Lower Oak Creek, Tuzigoot NPS
- Cedarbench Wilderness, USFS
- Dead Horse Ranch State Park, Arizona State Park
- East Verde River Wild and Scenic River, USFS
- Fossil Creek Wild and Scenic River: In 2009 Congress designated a portion of Fossil Creek as a federal Wild and Scenic River. Fossil Creek is a major tributary of the Verde River with outstanding and remarkable scenic, fish and wildlife, historic and cultural values. Fossil Creek flows through two congressionally designated wilderness areas (Fossil Springs and Mazatzal Wilderness Areas) and underwent an extensive successful multi-agency restoration in 2005, USFS

- Fossil Creek Wilderness, USFS
- Fossil Springs Wilderness, USFS
- Four Peaks Wilderness, USFS
- Gap Creek Wild and Scenic River, USFS
- Gibson Wildlife Area, AGFD
- Granite Mountain Wilderness, USFS
- Houston Creek Wild and Scenic River, USFS
- Juniper Mesa Wilderness, USFS
- Mazatzal Wilderness, USFS
- Munds Mountain Wilderness, USFS
- Oak Creek and West Fork Oak Creek are identified as Outstanding Arizona Waters, ADEQ
- Page Springs Hatchery, AGFD
- Pine Mountain Wilderness, USFS
- Red Rock Secret Mountain Wilderness, USFS
- Red Rock State Park, Arizona State Park
- Slide Rock State Park, Arizona State Park
- Sunflower Flat State Conservation Land, AGFD
- Sycamore Canyon Wilderness, USFS
- Montezuma Castle, NPS
- Tavasci Marsh, NPS: Situated in the backwaters of the upper Verde River, Tavasci Marsh is one of the largest marshes in Arizona. Designated an Important Bird Area by the National Audubon Society, the marsh supports one of the most diverse bird gatherings in Arizona. Cattails and other wetland vegetation provide nesting and habitat for hundreds of bird species including the notable Red-winged Blackbird and the threatened Bell's Vireo. Herons, egrets, finches, wrens and flycatchers flourish in the dense marsh vegetation. Frogs and turtles are abundant in the marsh. River Otter and beaver are also present; beaver activity supplemented restoration efforts.
- Tonto Natural Bridge State Park, Arizona State Park
- Tuzigoot National Monument, NPS
- Upper Verde River Wildlife Area (796 acres), AGFD: A 796-acre property located along the Upper Verde River and lower Granite Creek managed for riparian habitat and to maintain native fish diversity.
- Verde River Greenway State Natural Area, Arizona State Parks: Designated in 1987, this six mile, 700-acre stretch of Verde River was identified by state officials as a critical natural resource that needed

protection and management. This reach, located between Clarkdale and the Bridgeport State Route 89A Bridge, is part of the Arizona State Parks system.

- Verde Wild and Scenic River: In 1984, Congress designated a forty mile stretch of the Verde River as a Wild and Scenic River for its outstanding remarkable scenic, fish and wildlife, historic and cultural values. The Wild and Scenic Verde River flows through the Mazatzal Wilderness Area.
- West Clear Creek Wilderness, USFS
- Wet Beaver Creek Wilderness, USFS
- Woodchute Wilderness, USFS

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Mexican Spotted Owl, San Francisco Peaks Groundsel, Gila Chub, Razorback Sucker, Southwestern Willow Flycatcher, and Spikedace.

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher**,** Gila Topminnow, Gila Chub, Yuma clapper Rail, Colorado Pikeminnow, Razorback Sucker, and Hualapai Mexican Vole
- Listed Threatened**-** Mexican Spotted Owl, Chiricahua Leopard Frog, Bald Eagle, Apache Trout, and Spikedace
- Candidate- Yellow-billed Cuckoo, Page Springsnail, Northern Mexican Gartersnake, Headwater Chub, and Roundtail Chub,

Renovation (chemical treatment) of Stillman Lake in the Upper Verde River was undertaken to remove non-native aquatic predators and prepare the habitat for reintroduction of Razorback Suckers. Candidate Roundtail Chub have already been reintroduced into Stillman Lake.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 388,652 Angler Use Days were documented in the Verde River Basin, equating to over $60 million in economic revenue generated by angler activity within the basin.

An additional study was conducted in the Verde River Basin that reports on the social valuation of the Verde River (West et al. 2009).

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VIRGIN RIVER

The Virgin River Basin in Mohave County is characterized by the Virgin Mountains on the south, the Virgin and Beaver Dam Mountains on the east, the Utah state line on the north, and the Nevada state line on the west. The primary surface hydrologic features are the Virgin River, which flows from the northeast corner to the Arizona-Nevada state line on the west and the Beaver Dam Wash. Vegetation is primarily Mohave desertscrub with smaller areas of Great Basin desertscrub, Great Basin conifer woodland, interior chaparral and a small area of Rocky Mountain and madrean montane conifer forest. Riparian vegetation along the Virgin River is predominantly tamarisk.

The Virgin River flows through Arizona from the Utah border downstream over 30 miles to the Nevada border. After a winding route through the Beaver Dam Mountains the river enters the Virgin River Gorge. The river emerges abruptly from the gorge and flows into the broad Virgin River Valley. A few miles farther downstream it is joined by the short perennial reach of Beaver Dam Wash just before it passes Littlefield, a small town, but the largest in the basin. The river flows another dozen miles through Mohave desertscrub and riparian vegetation dominated by salt cedar to the Nevada border, the lowest point in the basin (1600 feet).

Important Riparian, Aquatic, and Wetland Resources

The Virgin River and the short reach of Beaver Dam Wash flowing into the Virgin from the north just above Littlefield are the only significant surface water resources in the basin. The mean annual flow of the Virgin River at Littlefield is about 175,000 acre-feet. The highest flow recorded at Littlefield was nearly 600,000 acre-feet in 2005. Most of the annual flow comes as spring snow melt runoff and contributions from the springs in the gorge.

The canyon riparian areas are relatively narrow from the Utah border through the gorge, but widen after the river emerges from the gorge. The vegetation includes Willow and riparian brush, but for its entire length in Arizona, riparian areas are completely dominated by Tamarisk. Although the diversity of the riparian habitat is limited, the endangered Southwestern Willow Flycatcher and other species occupy this habitat.

The Virgin River and Beaver Dam Wash supports several native fish species, including two federally listed endangered species, the Woundfin and the Virgin River Chub. The Virgin River is also habitat for additional state Wildlife Species of Concern including Flannelmouth Sucker, the Virgin Spinedace, and the Speckled Dace. Lowland Leopard Frog, Peregrine Falcon, Common Black-Hawk and Virgin Spinedace are all State Wildlife Species of Concern observed in this basin.

Important Conservation Lands

The Bureau of Land Management manages nearly 92 percent of the land in basin. The remaining acreage is divided between state trust land and private ownership. BLM-managed land includes two wilderness areas, The Beaver Dam Mountain Wilderness on the north side of the Virgin River Gorge, and the Piute Wilderness on the south side of the gorge. BLM also manages three “Areas of Critical Environmental Concern in the basin:” the Beaver Dam Slope, the Virgin River Corridor, and the Virgin Slope. These are areas where special management is needed to protect important historical, cultural, scenic, and natural areas, or to identify areas hazardous to human life and property.

Federally Protected Species and Critical Habitats

The entire length of the Virgin River, including within Arizona, has been designated as Critical Habitat for two federally listed endangered species, the Woundfin and the Virgin River Chub. Sections of Virgin River riparian

areas, mostly above the Virgin River Gorge, have also been designated as Critical Habitat for the federally listed Southwestern Willow Flycatcher. Substantial areas of the Virgin River Basin below the gorge have also been designated critical habitat for the Mohave Desert Tortoise.

Federally protected species found in the basin include the Endangered Southwestern Willow Flycatcher, Virgin River Chub, and Woundfin. Candidate Yellow-billed Cuckoo is also found here.

Economic Values

Although data on economic contribution of water-dependent activities is not available for the Virgin River, some recreational activity does occur. A recreation area is maintained by BLM on the river above the gorge. Also, some rafting does occur during spring high flows.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_VRG_final.pdf

WESTERN MEXICAN DRAINAGE

The Western Mexican Drainage Basin is split by Yuma and Pima Counties. It is characterized by desert valleys and low elevation mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub.

Important Riparian, Aquatic, and Wetland Resources

Located along the southwest border with Mexico, there are no perennial flows in the Western Mexican Drainage Basin. There is one major spring, the Quitobaquito, and not more than half a dozen total springs. Most of the basin is within the Cabeza Prieta National Wildlife Refuge and the Organ Pipe Cactus National Monument. The Quitobaquito springs supports a population of the Quitobaquito Pupfish, while the refuge is home to the Sonoran pronghorn, both of which are endangered species. In both cases, there are numerous species of birds and wildlife that are associated with both of these areas.

Other State Wildlife Species of Concern observed in the basin include the Western Narrow-mouthed Toad and Tropical Kingbird.

Important Conservation Lands

- Cabeza Prieta National Wildlife Refuge, USFWS
- Organ Pipe Cactus National Monument, NPS

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Quitobaquito Pupfish.

The Endangered Yuma Clapper Rail and Quitobaquito Pupfish, and Candidate Sonoyta Mud Turtle are federally protected species observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_WMD_final.pdf

WILLCOX

The Willcox Basin located in Cochise and Graham Counties is characterized by a series of medium-high to high-elevation mountain ranges. Vegetation is primarily semidesert grassland with smaller areas madrean evergreen woodland and Rocky Mountain and montane conifer forest. Riparian vegetation includes conifer oak and mixed broadleaf on Turkey Creek and conifer oak on Rucker Canyon.

Important Riparian, Aquatic, and Wetland Resources

Willcox Playa is a sparsely vegetated desert grassland, strongly dominated by alkalai Sacaton and Saltgrass, with some cover of Little Bluestem and other grasses. Shrub cover increases towards the periphery, with saltbushes, mesquites and non-native tamarisk. Scattered Fremont cottonwood and Goodding's willow grow in or along the network of ditches that have been built to drain sections of the playa over the past century. The playa also supports a population of a rare plant species, the Chiricahua Mountain tansy-aster. Willcox Playa is best known to the public for its wintering population of Sandhill Cranes that migrate to the playa in large numbers, particularly in wet winters. It is not unusual to see several thousand cranes in winter at the power plant ponds viewing area on the southwest side of the playa, or at the Arizona Game and Fish Department's 600-acre Wildlife Area on the southeast side. The cranes feed and court, migrating after February to their summer breeding grounds in the northern Great Plains.

Willcox Playa also supports other large water birds, including White-faced Ibis, as well as many raptors, including several wintering hawks. Red-tailed Hawks, Northern Harriers, Harris's Hawks, Prairie Falcons, Bald and Golden Eagles, Caracaras, Great Horned Owls, and Burrowing Owls all utilize the habitat. The shrubs and trees on the periphery of the playa support migrating Northern Flickers, White-necked Ravens, and many songbird species. Sometimes more than 10,000 birds will congregate at the playa.

An array of other vertebrates also lives on and around Willcox Playa including several distinctive amphibian and reptile species, including Chiricahua and Plains Leopard Frogs as well as Texas Horned Lizards. Mammals include Desert Cottontails, Black-tailed Jackrabbits, Kangaroo Rats, other desert herbivorous rodents, and Collared Peccaries.

Less well known is the extraordinary diversity of tiger beetles found at Willcox Playa, one of the highest concentrations in a single small area in the United States. Several endemic species exist there, including the Willcox Nevada tiger beetle and the Sulphur Springs Williston's tiger beetle.

The Willcox Basin is a closed basin that drains into Willcox Playa. The Willcox Basin contains over 30 miles of perennial flows through Big Bend Creek, Big Creek, Grant Creek, Leslie Creek, Post Creek, Rucker Canyon, Soldier Creek, Turkey Creek, and Ward Canyon.

The Willcox Basin, especially the western slopes of the Chiricahuas, contains a broad diversity of wildlife. American Avocet, American Peregrine Falcon, Black-necked Stilt, Elegant Trogon, Mexican Spotted Owl, White-faced Ibis, Yellow-billed Cuckoo and Zone-tailed Hawk all occur in the Basin. The Basin's streams provide aquatic habitat for Apache Trout, Mexican Stoneroller, Yaqui Chub, Yaqui Longfin Dace, Chiricahua Leopard Frog, Plains Leopard Frog and Western Green Toad. Arizona Shrew, Cockrum's Desert Shrew, White-bellied Long-tailed Vole and Western Red Bat all live in this diverse region along with a diversity of plant species that mingle on this intersection between the Sonoran Desert and Chihuahuan Desert. Other State Wildlife Species of Concern include the Bald Eagle, Gray Catbird, Northern Buff-breasted Flycatcher, and Violet-crowned Hummingbird.

Important Conservation Lands

- Chiricahua National Monument, NPS
- Mt. Graham Wilderness Study Area, USFS
- Chiricahua Wilderness, USFS
- Dos Cabezas Mountains Wilderness, USFS
- Chiricahua National Monument, NPS
- Arizona Audubon Important Bird Area; Willcox Playa, Chiricahua Mountains
- Willcox Playa Wildlife Area, AGFD
- Leslie Canyon National Wildlife Refuge, USFWS
- Galiuro Wilderness Area, USFS

The Willcox Playa IBA and Wildlife Area are managed to optimize waterfowl habitat for migratory birds that winter at the playa.

Willcox Playa is managed for multiple purposes. The Arizona Game and Fish Department Wildlife Area is managed to support wildlife habitat in perpetuity, and to maintain opportunities for public hunting and other forms of wildlife-oriented recreation.

Federally Protected Species and Critical Habitats

Critical Habitat designated for Mexican Spotted Owl and Mt Graham Red Squirrel.

Federally protected species observed in this basin include the Endangered Yaqui Chub, Threatened Apache Trout, Mexican Spotted Owl and Chiricahua Leopard Frog, and Candidate Yellow-billed Cuckoo.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 9,712 Angler Use Days were documented in the Willcox Basin, equating to over $1 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_WIL_final.pdf

http://www.azheritagewaters.nau.edu/loc_wilcox_playa.html

YUMA

The Yuma basin in Yuma County is characterized by desert valleys and mountain ranges. Vegetation type is Lower Colorado River Valley Sonoran desertscrub. The Gila and Colorado River confluence is located in this basin.

Important Riparian, Aquatic, and Wetland Resources

The Colorado River is the major source and drain for the region. The Gila River joins the Colorado within the basin, but it is regulated and managed upstream such that there is no downstream flow, except during flood events. However, the many agricultural returns to the river channel maintain abundant surface flow and a diverse riparian gallery along the lower Gila valley. There are no additional perennial streams in the area. Colorado River flow into the basin is determined by outflow from Imperial Dam. Colorado River outflow from the basin into Mexico is defined by treaty and strictly managed.

Game fish species in the Colorado River are Channel Catfish, Flathead Catfish, Largemouth Bass, Smallmouth Bass, Striped Bass, Rainbow Trout, Carp, Crappie, Bluegill, Sunfish, and Tilapia. Fortuna Pond, constructed within the lower Gila River floodplain also provides angler opportunities for similar species.

Mittry Lake, north of Yuma, is operated jointly by BOR, BLM, and Arizona Game and Fish Department. Mittry Lake has about 600 acres of open water surface, significant marshlands with cattails and bulrushes, and is part of a 2,400 acre wildlife habitat. The primary purpose of Mittry Lake is for hunting and fishing. The most common fish caught in Mittry Lake are Largemouth Bass, crappie, Channel and Flathead Catfish, tilapia, Bluegills, and carp. There are also bullfrogs, Bullhead Catfish, Redear and Green Sunfish. Hunting is for waterfowl, dove, quail, and rabbit.

The larger mammals in the area are Javelina, Coyotes, Bobcat, and Mule Deer. There are Desert Bighorn Sheep in limited locations. There is a large, diverse bird population along the river and at Mittry Lake, including the Cattle-Egret.

The Great Blue Heron, Least Bittern, California Black Rail, Great Egret, Snowy Egret, Western Yellow Bat, and Lowland Leopard Frog are species of concern to the state of Arizona.

Important Conservation Lands

- Mittry Lake Wildlife Area, AGFD
- Audubon Important Bird Area; Lower Colorado River Gadsen Riparian Area, Mittry Lake Wildlife Area

Constructed wetlands in the Yuma Basin provide habitat for many rare and endangered birds along the Colorado River.

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

There are no critical habitat areas within the basin.

Endangered birds known to occur in the basin are the Yuma Clapper Rail, and Southwestern Willow Flycatcher. The Yellow-billed Cuckoo is classified as a candidate on the federal list.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 83,999 Angler Use Days were documented in the Yuma Basin, equating to over $13 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_YUM_final.pdf

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INTRODUCTION AND PURPOSE

The Environmental Working Group was formed under the work plan of the Water Resource Development Commission (WRDC). The Environmental Working Group was tasked to 1) identify current water-dependent natural resources; 2) identify conditions necessary to support these resources; and 3) prepare a summary of findings and make recommendations regarding the need for further research and studies.

Available scientific data was used to identify the state's primary water-dependent natural resources. The physical conditions currently supporting these natural resources were also identified and characterized, where possible. This information presents clear evidence about the diversity and unique conditions provided by the state's rivers, lakes, streams, springs, wetlands, and riparian and aquatic habitats, but also that the existing information is incomplete and more research is needed.

A summary of the Environmental Working Group's findings, entitled *Arizona's Inventory of Water-Dependent Natural Resources*, includes a compilation of natural-resource data. This data is presented in a variety of formats including narrative summaries, data tables and maps for each groundwater basin and county. This document provides a description of the data sources and methodologies used to develop *Arizona's Inventory of Water-Dependent Natural Resources*.

Note on Mapping Efforts: To maintain clarity at the given scale and preserve the purpose of the maps, symbols representing certain features were slightly exaggerated. These features include critical habitat for fish and other species constrained to river and stream courses, surface water filings in-stream, riparian habitat and effluent dependent streams.

Amplification of features is an accepted part of the cartographic process, and enhancement of the symbols was not meant to exaggerate their meaning, but only to improve legibility and accommodate the associated symbology.

HYDROLOGIC COMPONENTS

Groundwater basins (ADWR, 1984a)

Water-dependent natural resources are identified for each of Arizona's 51 groundwater basins. According to ARS 45-402(13) "Groundwater basin" means an area which, as nearly as known facts permit as determined by the director pursuant to this chapter, may be designated so as to enclose a relatively hydrologically distinct body or related bodies of groundwater, which shall be described horizontally by surface description. ADWR Groundwater Basins include the five Active Management Areas (AMAs).

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Summaries, Tables & Maps

Groundwater sub-basins (ADWR, 1984b)

According to ARS 45-402(34) "Subbasin" means an area which, as nearly as known facts permit as determined by the director pursuant to this chapter, may be designated so as to enclose a relatively hydrologically distinct body of groundwater within a groundwater basin, which shall be described horizontally by surface description.

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Tables

Watersheds (ADWR, 1982; USGS, 2008))

A watershed is an elevation or a divide separating a catchment area, or drainage basin, of one river system or group of river systems from another system or group of systems. The term is synonymous with drainage basin (8-digit HUC (hydrologic unit code) level).

Data available from the USGS (2008) and ADWR (1982) were used to identify watersheds in relation to each groundwater basin.

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Tables

Springs (ADWR, 2008; 2009-2010; & 2010a)

Basin tables list the number of major (discharge ≥10 gpm) and minor (discharge <10 gpm) springs, the annual range of spring discharge in gallons per minute, and the combined spring discharge rate in acre-feet per year. The combined annual discharge rate was calculated using data from the Arizona Water Atlas Volumes 2-8 (ADWR, 2009-2010), which lists discharge rates for each major and minor spring. This calculation assumes that the spring discharge at the time of measurement is constant throughout the year.

Original data sources include the USGS, universities, and other government agencies including the USFS, NPS and BLM. These datasets were compiled into a database by ADWR (ADWR, 2008). A detailed description of the methods used to compile information on springs is provided in the Arizona Water Atlas, Volume 1 (ADWR, 2010a).

Major and minor springs are also identified in the basin and county maps. Two GIS layers were used to represent these springs. The statewide springs dataset provided by ADWR was supplemented by the Pima County springs dataset (ADWR, 2009-2010). Major and

minor springs were identified by filtering an attribute field containing gallons per minute information. Springs from both layers were symbolized identically.

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Tables & Maps

Streams (ALRIS, 1993)

Streams classified as major, minor were identified using the ALRIS stream dataset by filtering the attribute field for cartographic order (CO). Major streams have a cartographic order of 1 through 3, while minor streams are limited to a cartographic order 4. Cartographic orders 1 through 3 include Arizona's major rivers, the main stem of each drainage basin and all Reach File 1 streams. Minor stream orders include all Reach File 2 streams and streams with names.

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Maps

Perennial Streams (Anning & Parker, 2009; ADEQ, 2010)

Perennial stream reaches are identified in the basin tables and maps. The perennial stream reach length within each basin was calculated and the information is presented in the basin tables.

Several datasets depicting perennial flow were initially evaluated by the Environmental Workgroup. ADEQ (2010) appeared to be most complete and up-to-date. However, there are some limitations with the dataset that users of this information should be aware of. In certain cases the dataset may not depict ALL perennial stream reaches in Arizona, and because of the changing nature of the environment, users should re-evaluate areas of interest to identify where perennial waters exist. In addition, the length of the perennial stream reach may differ from other datasets.

Limitations of the ADEQ dataset are identified by Anning and Parker (2009). They explain that, "In general, a significant objective of developing regional-scale models is to apply them and obtain predictions throughout the study area. A clear limitation to the models developed in this study is the requirement of having discharge measurements to obtain hydrologic regime predictions."

According to Arizona Game and Fish Department staff, based on relational analysis of the ADEQ dataset and statewide fish records, "When I map 33,382 fish collection records within the state, 22,696 of them fall within 100 m of the Perennial ADEQ layers. That means that 10,686 fish records are found in systems other than perennial streams classified by that ADEQ layer. Many of those are likely reservoir collections, isolated sites etc. When I remove from that about 10,000 sites that have "spring, lake, tank, pond, reservoir, drain or canal" in the 'sitename' of the fish record, there are about 4,722 fish records left that fall on sites that were not identified as perennial by the ADEQ layer. That's not too bad." (AZGFD, pers. comm.)

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Summaries, Tables & Maps

Perennial stream reaches and springs located in federal/state designated conservation areas (Anning & Parker, 2009; ADEQ, 2010; ADWR, 2008, 2009-2010, & 2010a)

Information pertaining to perennial stream reaches and springs located within federal and state conservation lands is presented in the basin summaries, tables and maps. The Environmental Workgroup decided to enumerate perennial stream reaches and springs located within federal and state conservation lands because they represent a subset of waters that had additional conservation values due to their inclusion on lands with specific conservation measures.

Working with data sets from multiple agencies presented problems for GIS analysis. Because of overlapping jurisdictions (see Figure 1), there was the potential for double counting perennial waters. To avoid duplicate counts and accurately identify what perennial waters exist within conservation lands, it was necessary to first build a composite layer of like boundaries before performing any GIS analysis (see Figure 2). Separate composite layers were made for federal and state designated conservation lands.

The process was as follows:

1) Merge all like lands (ex. state managed conservation land) into one feature

2) Dissolve internal boundaries

3) Clip the perennial stream reaches to the boundaries of protected areas

4) Query for perennial stream name and number of stream miles

These same composite layers were later used to identify major springs located in federal or state designated conservation lands.

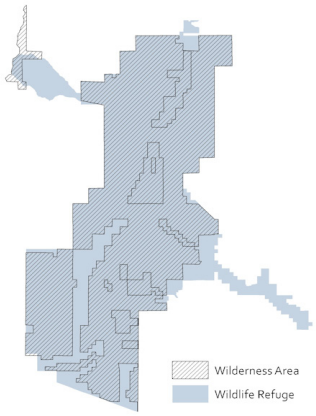

Figure 1: Overlapping jurisdictions

Figure 2: Composite of overlapping jurisdictions

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Summaries, Tables & Maps

Stream gages (ADWR, 2007; Fisk et al., 2006; Marshall et al., 2010)

A stream gage or *streamgage* is a device used to measure specific characteristics of a stream. These characteristics typically include the stream's surface elevation ("stage") and/or volumetric discharge (flow).

Stream gages are an invaluable tool used to assess the condition of Arizona's rivers and streams. These devices are installed, maintained and monitored by many government and private agencies for the benefit of water management decisions, recreation activities, and wastewater treatment plant operations. Stream gage networks are also used to monitor and protect populated areas from potential natural disasters such as flood flows and drought conditions. As part of Arizona's Flood Warning System, federal, state and local agencies cooperatively maintain and monitor stream gage data across the state (available at http://data.afws.org).

As part of the National Streamflow Information Program (NSIP), real-time streamgage data collected by numerous entities is made available via the USGS National Water Information System (available at http://waterdata.usgs.gov/az/nwis/rt). According to the USGS, for the purposes of the NSIP, (unless otherwise stated) a *"streamgage"* is an active, continuously functioning measuring device in the field for which a mean daily streamflow is computed or estimated and quality assured for at least 355 days of a water year or a complete set of unit values are computed or estimated and quality assured for at least 355 days of a water year.

The Environmental Working Group identified and presented stream gage locations on each of the basin maps (where applicable). A subset of stream gages were also identified on the basin maps (in yellow) within certain basins where streamflow measurements were evaluated to calculate baseflow volumes (Marshall et al., 2010). Baseflow estimates were enumerated for 12 groundwater basins, and included in the basin tables (Section 6 of this document describes the methodology for enumerating baseflow).

Presented In:

Tables & Maps

Stockponds (ADWR, 2009-2010; 2010a)

The total number of registered stockponds is listed in each of the basin tables. Information available from ADWR's registry of surface water rights and adjudication claims was used to identify stockponds with a capacity of 15 acre-feet or less as presented in, and obtained from, the Arizona Water Atlas Volumes 2-8 (ADWR, 2009 & 2010). A detailed description of the methods used to compile information on stockponds is provided in the Arizona Water Atlas, Volume 1 (ADWR, 2010a).

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Tables

Reservoirs (ADWR, 2009-2010)

Information on surface-water reservoirs is presented in the basin tables and maps. Reservoirs include natural water bodies such as dry and intermittent lakes and man-made reservoirs.

Basin tables display the total number of large and small reservoirs in the basin and their combined maximum storage capacity or surface acres. Large reservoirs are water bodies with a maximum storage capacity of 500 acre-feet or greater or a maximum surface area of 50 acres or greater. Small reservoirs are water bodies with a capacity of greater than 15 acre-feet but less than 500 acre-feet or a maximum surface area of between 5 and 50 acres. The combined annual large and small reservoir capacity was calculated using data from the Arizona Water Atlas Volumes 2-8 (ADWR, 2009 & 2010), which provides information for each large reservoir and

an aggregate total for small reservoirs. A detailed description of the methods used to compile information on reservoirs is provided in the Arizona Water Atlas, Volume 1 (ADWR, 2010).

Large and small reservoirs are displayed on the county and basin maps using unique symbology for each. The volume and capacity values used to classify a reservoir as large or small are the same as those used in the basin tables.

Four distinct GIS layers were used to display reservoirs on the maps. Within Active Management Areas (AMA), reservoir data layers available from the USGS (USGS_Reservoirs) and the National Inventory of Dams (NID_Reservoirs) were used. Large reservoirs in the USGS layer were defined as values >50 in the "ACRES" attribute field; likewise, small reservoirs were defined as values <50. In the NID layer, large reservoirs were defined as values >500 (acre-feet) and small reservoirs were defined as values < 500 (acre-feet) in the "Max_storag" attribute field.

To display reservoirs located outside of an AMA, data from the Arizona Water Atlas (2009-2010) was used (ADWR_Reservoirs, and smallReservoirs). To avoid any potential overlaps with the layers used for the AMAs, the attributes of both GIS layers were filtered using the following criteria: NOT "BASIN_NAME" LIKE '%AMA'. Small and large reservoirs were defined in the ADWR_Reservoirs layer using the "WaterAtlas" field. The smallReservoirs layer only includes small reservoirs, so no additional filters were needed.

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Tables & Maps

Effluent-Dependent Waters (A.A.C., 2008; ADWR, 2009-2010 & 2010a; NEMO, 2009)

Effluent-Dependent Waters (EDW), as classified by ADEQ pursuant to A.A.C. R18-11-113, are identified in the basin tables and maps. In general, Effluent-Dependent Waters are characterized as streams or stream reaches that are naturally ephemeral, but have surface flow in response to the discharge of treated wastewater.

A compilation of two datasets (ADWR, 2009-2010 & 2010a; & NEMO, 2009) were used to identify and illustrate EDW. Using GIS software, the two datasets were merged and manually edited to create a new unique feature that is used within the Environmental Working Group's report. Within each groundwater basin, the EDW stream segments were identified and their reach lengths were calculated for inclusion in the basin tables.

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Tables & Maps

VEGETATION/RIPARIAN

Arizona Riparian Inventory and Mapping Project (AGFD, 1994; Valencia et al., 1993)

This dataset was developed at the Arizona Game & Fish Department (AGFD) in 1993 – 1994 and discussed by Valencia, et al. (1993). It identifies riparian vegetation associated with perennial waters mapped in response to the requirements of the Waters - Riparian Protection Program (Laws 1992, CH. 298). The AGFD created maps using two major sources of imagery - Landsat Thematic Mapper digital satellite data and Multiple Resolution Aerial Videography. Riparian imagery was ground-truthed in the field. The dataset was distributed in June 1994.

Limitations: While working with the AGFD 1993-94 data, limitations were encountered. First, the dataset is fairly dated. Second, the dataset includes several non-riparian classes and several others for which we don't have data on evapotranspiration. Non-riparian classes were removed from the dataset for the Environmental Working Group's mapping purposes and for estimating ET rates. Lastly, the *1993-94* dataset was not a comprehensive statewide approach, and several areas of the state were not mapped.

Habitats excluded and rationale:

- *Areas not Ground Verified* (not able to verify if vegetation was present; total acres = 428)
- *Conifer Oak* (not a riparian habitat type)
- *Mountain Scrub* (not a riparian habitat type)
- *Mesquite* (excluded from this dataset but is captured by the SW ReGAP/SWAP dataset, which covers a larger area and thus will capture more of the mesquite habitat type throughout the state; total unique acres not captured by SW ReGAP/SWAP = 849)
- *Marsh* (ET values for emergent wetland habitat types not available; total acres = 51)
- *Wet Meadow* (ET values for emergent wetland habitat types not available; total acres = 771)
- *Flood Scoured* (flood scoured habitats are areas of bare sand that are likely spots for future riparian recruitment; total acres = 7,000). Including these areas would likely have overestimated riparian acreage.

To augment the 1993-94 dataset, the Environmental Workgroup also utilized a Riparian Habitat Model (Lowry et al., 2007), developed by the Arizona Game and Fish Department, to identify additional areas of the state with potential riparian habitats.

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Maps

Arizona Game and Fish Department State Wildlife Action Plan (SWAP) Riparian Model (Lowry et al., 2007; Valencia et al., 1993)

At the time this model was developed, two sources of riparian data were available for Arizona: the Southwest Regional Gap Analysis Project (SWReGAP) landcover database (Lowry et al., 2007) and the Arizona Game and Fish Department's (Department) Riparian Inventory (Valencia et al., 1993). Both were reviewed for accuracy by an internal team familiar with riparian areas throughout the state. The SWReGAP landcover layer was found to under represent riparian in much of the state while misclassifying large areas of mesquite

woodlands as riparian. These misclassified pixels were re-assigned to mesquite forest in the original data. The 1993 Department's Riparian Inventory was discovered to be out-of-date and incomplete since riparian vegetation was only mapped along perennial drainages and not intermediate ones.

In an attempt to fill in the blanks left by those datasets, the Department modeled the potential riparian vegetation along lakes and perennial and intermittent streams by calculating cost weighted distance from each stream and lake using slope as the cost surface, essentially mapping the flood plain around each stream and lake. The resulting output was constrained by an upper cost limit and by distance from the stream or lake. The model was combined with the Department's riparian inventory and the SWReGAP riparian categories to create a comprehensive map of potential riparian vegetation. Known areas of development, agriculture or dewatering were erased from the model. In recognizing the importance of riparian vegetation in Arizona, the Department chose methodology that may over represent the presence of riparian habitat in Arizona as opposed to methodology that under represents riparian habitat.

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Maps

WILDLIFE

Catchments (Wildlife Waters) (AGFD, 2010)

The number of catchments identified within each basin is presented in the tables.

A **wildlife water catchment** is a watering device for wildlife. It collects precipitation, holds the water in a covered tank to minimize evaporation and maintain adequate water quality, and dispenses water into a basin or reservoir from which animals can drink. Catchments are manufactured in several styles, including inverted umbrella and apron. They often are used in remote wilderness locations.

To provide water to wild animals fencing is usually built to surround the catchment. Catchments are a wildlife management tool, and are widely used in the southwest United States, where periodic droughts may cause population crashes in game animals unless water supplies are provided.

Spatial data for wildlife water catchments/resources within Arizona Game & Fish Department Wildlife Water Development Database to which AZGFD holds responsibility. Data does not include Forest Service or BLM owned/operated/managed water catchments.

Presented In:

Tables

USFWS Designated ESA Critical Habitat Areas by Species (USFWS, 2011b)

The Endangered Species Act of 1973 allows the U.S. Fish and Wildlife Service and National Marine Fisheries Service to designate specific areas as protected "critical habitat" zones.

The provision of the law in Section 4 that establishes critical habitat is a regulatory link between habitat protection and recovery goals, requiring the identification and protection of all lands, water and air necessary to recover endangered species. Critical habitats are areas considered essential for the conservation of a listed species.

The GIS files and their associated coordinates are not the legal source for determining the critical habitat boundaries. The user is referred to the critical habitat textual description in the appropriate final rule for the species as published in the Federal Register.

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Summaries, Tables & Maps

Arizona Game and Fish Department State Wildlife Action Plan (AGFD, 2011b)

The Arizona Game and Fish Department (AGFD) modeled species distributions for their 2011 revision of the Statewide Wildlife Action Plan (SWAP). Not all species in Arizona were modeled; modeling efforts were limited to those species identified in the SWAP as having the greatest conservation need. Data sources included the following: Arizona Breeding Bird Atlas (ABBA) (Corman & Wise-Gervais, 2005), Southwest Regional GAP (SWReGAP) Land Cover Dataset (Lowry et al., 2007), SWReGAP Animal Habitat Models (Boykin et al., 2007), and the Lower Colorado River Basin (LCRB) Aquatic Gap Analysis project (Whittier et al., 2010e.

Species Distribution Models

The AGFD developed species distribution models for the species of greatest conservation need as identified in the Arizona SWAP. These species distribution models represent the historic, present, and potential distribution for an individual species. A specific set of parameters was used for each species distribution model, including vegetation, elevation and slope associations, and known occurrences.

Several base data layers were used for a majority of the predictive distribution models, including:

- SWReGAP landcover to map vegetation associations for individual species.
- Digital elevation model (DEM) to map elevational and slope associations for individual species.
- 10-digit HUC (watershed) boundaries and species occurrence data were used to identify watersheds associations for individual SGCN species.

After the SGCN species distribution models were created, the parameters that went into each model were entered into the database. This created a straightforward way to access the model parameters via queries and tables. The species distribution parameters database is fully linked to the SWAP database, so future updates to the SWAP database (e.g., taxonomic or legal status changes) will be reflected in the species parameters database.

Methods for species distribution models were generally consistent within higher taxonomic levels (e.g., invertebrates, amphibians, birds, etc.), but occasionally species specific parameters were employed (see discussions below). However, all of the data sources discussed above were used in compiling the distribution models for the SGCN, and were further refined through expert opinion and through validation with the HDMS element occurrence data (if those data were available). For most species, validation with HDMS data has not yet occurred. We are continuing to refine models as time permits.

Regardless of methods, there are assumptions inherent in all of the models:

1. Most of the models are built using SWReGAP Landcover as a base layer and have a base pixel size of 30 m. However, the models, as is the Landcover database, are meant to be used for landscape level analysis at a scale of 1,000 ha or greater (Boykin et al., 2007).

2. Each model represents a *predicted* range distribution for a species. Species are expected to occur within that range, but are not assumed to be present at every point within the geographic range. Also, the models do not provide information on species abundance or on habitat quality within the predicted range.

The SGCN species distribution models were reviewed by AGFD biologists before they became finalized. The SGCN species distribution models were created using the best available data at the time, and will be updated as data become available in the future.

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Summaries, Tables & Maps

SWAP Data Sources

Arizona Breeding Bird Atlas: First statewide survey of Arizona birds containing a wealth of information regarding the actual locations and habitat preferences of over 370 species of birds. The survey was based on the U.S. Geological Survey's (USGS) 7.5 minute topographic maps. Each quad was divided into six blocks and a block from each quad was randomly selected for sampling. Each block was visited several times during the breeding season to detect each bird species and confirm breeding of as many species as possible. In addition, field personnel

noted other environmental information such as vegetation types and elevational ranges in which each species was detected (Corman & Wise-Gervais, 2005).

Southwest Regional GAP (SWReGAP): The U.S. Geological Survey mapped landcover and terrestrial vertebrate species using 1999-2001 satellite imagery (Prior-MaGee et al., 2007). The landcover map served as a proxy for vegetation in the species distribution models.

The SWReGAP developed 819 terrestrial vertebrate models based on environmental parameters that define Wildlife Habitat Relationships (WHRs). Vegetation alliances were the primary parameter for modeling wildlife habitats followed by elevation and distance to water. WHRs were restricted to 8-digit Hydrological Unit Codes (HUCs) that the species had historically occurred in. A full description of the modeling process can be found in chapter 3 of the Southwest Regional Gap Analysis Final Report (Boykin et al., 2007).

Lower Colorado River Basin Aquatic GAP Analysis: Identified areas with native aquatic fauna diversity to support development of future conservation strategies for the Lower Colorado River Basin (Whittier et al., 2010e. Project collected fish observation data from federal and state agencies, universities, online fish databases and museums.

Riparian

Existing SWReGAP riparian was supplemented with modeled riparian (see SWAP Riparian Model discussion in previous section) and coded to "AZ05 – Riparian." In addition, the development team felt that xeric riparian, an important vegetation type for many species, was seriously under represented. We addressed that problem with a very simple modeling exercise in which named washes were extracted from the Arizona State Lands Department's Arizona streams dataset (ALRIS, 1993). The washes were assumed buffered by 60 meters below 4,000 feet elevation and by 30 meters at higher elevations. The 4,000 foot elevational limit corresponds roughly to the elevational ranges of Fremont cottonwood (lower elevations) and sycamore (higher elevations).

Invertebrates

Invertebrate species models were created using several approaches. Aspect, slope, elevational and vegetation associations for individual species were identified by AGFD biologists. Aspect, slope, and elevational associations were extracted from a 30 meter Digital Elevation Model. Vegetation associations were extracted from SWReGAP vegetation layer. Occurrence data from the HDMS were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer down to only those watersheds in which the individual species occurs. The aspect, slope, and elevational association layers were then used to further restrict the updated vegetation association layer.

In some cases, the watershed distributions identified by HDMS occurrence data were used to locate water springs located within the selected watersheds. When the water springs were used in the invertebrate species distribution models, a spatial buffer was used around each spring to ensure that the springs are present in the final version of each distribution model.

Fish

Three hydrological data layers were used to create the fish distribution models. Two hydrologic data layers with stream features created by AGFD were used to extract intermittent and perennial stream features. A hydrologic data layer with lake features created by the Arizona Department of Environmental Quality (ADEQ) was used to query a subset of lakes.

AGFD staff used LCRB Aquatic GAP Analysis Project to identify 10-digit level watersheds. The identified

watershed range was used to restrict hydrological features to only those watersheds in which the individual fish species was known to occur. The hydrological features were merged together to create a final distribution model for each SGCN fish species.

Amphibians

The amphibian distribution models were created using several approaches. Elevation and vegetation associations for individual species were identified by AGFD staff. Those associations were extracted from a DEM of Arizona and the SWReGAP vegetation layer. Occurrence data from the primary literature, the Riparian Herpetofauna Database, HDMS and other AGFD sources (e.g., internal reports) were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer to only those watersheds in which the individual species was known to occur. Then the elevation association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have the associated vegetation types and fall within that elevational range.

In some cases species distributions were inferred from distribution maps in field guides e.g., Brennan & Holycross, 2007) or species accounts in the Catalogue of American Amphibians and Reptiles (published by the Society for the Study of Amphibians and Reptiles). This information was coupled with staff knowledge and literature reviews of habitat types and elevational ranges. Additional species distribution models created by the SWReGAP project were used for the SWAP. When Arizona-specific species information was available, such as elevational range, vegetation associations, and occurrence information, the SWReGAP species distribution models were modified to incorporate those data.

Reptiles

The reptile distribution models were created using a similar approach as for amphibians. Elevation and vegetation associations for individual species were identified by AGFD staff and selected from a DEM of Arizona and SWReGAP vegetation layer. Occurrence data from the primary literature, the Riparian Herpetofauna Database, Desert Tortoise Database, HDMS and other AGFD sources (e.g., internal reports) were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer to only those watersheds in which the individual species was known to occur. The elevation association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have the similar vegetation types and elevational ranges.

In some cases species distributions were inferred from distribution maps in field guides (e.g., Brennan & Holycross, 2007) or species accounts in the Catalogue of American Amphibians and Reptiles (published by the Society for the Study of Amphibians and Reptiles). This information was coupled with staff knowledge and literature reviews of habitat types and elevational ranges. Species distribution models created by the SWReGAP project were used to map a few reptile species distributions for the SWAP. When Arizona-specific species information was available, such as elevational range, vegetation associations, and occurrence information, the SWReGAP species distribution models were modified to incorporate those data.

Birds

The bird distribution models were created using similar methods as the reptiles and amphibians. Elevational

and vegetation associations for individual species were identified by AGFD staff, and extracted from DEM and SWReGAP vegetation layers. Occurrence data from the Arizona Breeding Bird Atlas were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer down to only those watersheds in which the individual species was known to occur, and then the elevational association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have the associated vegetation types and fall within that elevational range.

Mammals

The mammal distribution models were created using a combination of new models and SWReGAP mammal distributions. Elevational and vegetation associations for individual species were identified by AGFD staff and those associations were extracted from DEM and SWReGAP vegetation layers. Occurrence data from a variety of sources, including the HDMS, were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer down to only those watersheds in which the individual species occurs, and then the elevational association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have similar vegetation types and elevational ranges.

In some cases species distributions models created for the SWReGAP project were used as the species distribution models for the SWAP. If Arizona specific species information was available the SWReGAP species distribution models were modified to incorporate the refined data such as elevational range, vegetation associations, and occurrence information.

SWAP Species data were filtered to represent aquatic, marshland and riparian species. Data subsets were then queried by groundwater basin, and presented in the Basin Table as a numeric summary of Birds, Amphibians, Fish, Invertebrates or Mammals. It is also noted of those enumerated how many are listed under the Endangered Species Act.

Limitations: SWAP Species Models are based on habitat characteristics and other features associated with each species. In many instances the models also utilize species occurrence data. However, some models may overestimate the potential occurrence of particular species.

<u>Presented In:</u>

Summaries, Tables & Maps

Arizona Game and Fish Department, Heritage Data Management System (AGFD, 2011a)

Arizona's Heritage Data Management System (HDMS), housed in the Arizona Game and Fish Department, is part of an international network of natural heritage programs and conservation data centers operating in all 50 American states, Canada, Latin America and the Caribbean. The HDMS collects and manages detailed local information on plants, animals, and ecosystems and is the leading source of information about rare and endangered species in the State of Arizona.

HDMS data is compiled from many sources and carefully documented. Information included in the HDMS

comes from published and unpublished reports, data collected by cooperating agencies, museum and herbarium collections, the scientific and academic communities, and many other sources. The Arizona Heritage Data Management System (HDMS) tracks species that are federally listed as threatened or endangered under the Endangered Species Act of 1973 (ESA), or are candidate species for listing under ESA. The HDMS also tracks some species that have been identified as sensitive species by other agencies, notably the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). The BLM has a Bureau Sensitive Species list to focus management on species that may be declining or for which habitat may be limited or susceptible to alteration. The USFS's Threatened, Endangered and Sensitive (TES) Species list identifies species that need special management attention and habitat restoration. The HDMS also tracks species included on the Navajo Nation endangered species list managed by the Navajo Natural Heritage Program.

Not all species have been systematically surveyed throughout the state, meaning that some species may not be accounted for in all basins. In general, sensitive species tracked by the HDMS are declining due to habitat losses and modifications, competition with other species and weather-related drought. Additional species get added to the HDMS tracking system when they become federally listed or are identified as candidate species for federal listing. The Arizona Game and Fish has also identified Wildlife of Special Concern; these data are also included in the HDMS.

All natural heritage programs and conservation data centers use standardized methods for gathering, managing, and analyzing biological and ecological data. These methods focus on documenting location and condition of species and ecosystems, with particular focus on those that are of greatest conservation concern. HDMS also contains information on conservation status, taxonomy, distribution, life history, and habitat requirements of the species and associated ecological communities.

Species summaries for the WRDC report were generated using the HDMS Geographic Information System (GIS) dataset. This dataset depicted element occurrences, a spatial representation of a species or ecological community at a specific location. An element occurrence generally delineates a species population or ecological community stand, and represents the geo-referenced biological feature that is of conservation or management interest. Element occurrences are documented by voucher specimens (where appropriate) or other forms of observations. A single element occurrence may be documented by multiple specimens or observations taken from different parts of the same population, or from the same population over multiple years.

HDMS data are used to promote sound environmental planning and conservation measures concerning the plants, animals, and communities that compose Arizona's diverse natural heritage. Users of HDMS information include cooperating agencies, naturalists, educators, researchers, resource managers, consultants, planners, policy makers, developers, environmentalists, and the general public.

HDMS species data were provided by AGFD. The database was queried to provide a subset of information relating only to aquatic, marshland, and riparian species. The data subset was then filtered by groundwater basin to identify which species have been observed and documented in each groundwater basin.

These data are described in the narrative Basin Summaries. It is also noted in the Basin Summaries which species are listed under the Endangered Species Act.

Limitations: Not all species have been systematically surveyed throughout the state, meaning that some species may not be accounted for in all basins.

Presented In:

Summaries, Tables & Maps

Economics of Fishing (AGFD, 2001; Silberman, 2001)

Data were provided by AGFD from 2001 evaluating Angler Use Days at water bodies throughout Arizona. The value of an Angler Use Day in 2001 is calculated using economic data on fishing in a study prepared by Jonathan Silberman, PhD, ASU School of Management.

Using information presented by Silberman (2001): Table 4: Total Fishing Expenditure ($831,493,493) divided by Table 3: Total Angler days (5,302,707) = $156 per Angler Use Day in 2001.

These data are described in the narrative Basin Summaries.

Limitations: Not all water bodies have been systematically surveyed throughout the state, meaning that some economic impacts from fishing opportunities have not been estimated.

Presented In:

Summaries

ADMINISTRATIVE DESIGNATIONS AND BOUNDARIES

Cities (ALRIS, 2006)

Major Arizona cities are presented in the maps.

This dataset represents point locations of cities and towns in Arizona. As described by the ASLD, the data contains point locations for incorporated cities; Census designated places and populated places. Several data sets were used as inputs to construct this data set. A subset of the Geographic Names Information System (GNIS) national dataset for the state of Arizona was used for the base location of most of the points. Polygon files of the Census Designated places (CDP), from the U.S. Census Bureau and an incorporated city boundary database developed and maintained by the Arizona State Land Department were also used for reference during development. Every incorporated city is represented by a point, originally derived from GNIS. Some of these points were moved based on local knowledge of the GIS Analyst constructing the data set. Some of the CDP points were also moved and while most CDP's of the Census Bureau have one point location in this data set, some inconsistencies were allowed in order to facilitate the use of the data for mapping purposes.

During development, an additional attribute field was added to provide additional functionality to the users of this data. This field, named 'DEF_CAT', implies definition category, and will allow users to easily view, and create custom layers or datasets from this file. For example, new layers may created to include only incorporated cities (DEF_CAT = Incorporated), Census designated places (DEF_CAT = Incorporated OR DEF_CAT = CDP), or all cities that are neither CDP's or incorporated (DEF_CAT= Other).

Presented In:

Maps

Counties (ALRIS, 1988)

This dataset consists of the county boundaries in Arizona. As described by the ASLD,

the data was created to serve as base information for use in GIS systems for a variety of planning and analysis purposes.

Presented In:

Tables & Maps

Presented In:

Summaries, Tables & Maps

State Managed Conservation Lands (AGFD, 2011c & 2011d; & ASP, 2010)

The state managed conservation lands data sets were provided by the AGFD and ASP; boundaries include Arizona state parks, historic parks and natural areas, AGFD deeded lands (ranches, wildlife areas, nesting areas etc), and AGFD designated wildlife areas.

Presented In:

Summaries, Tables & Maps

Federally Protected Lands (ALRIS, 1990 & 2011; BLM, 1992, 1999, & 2001; UMT, 2010; USFS, 2004; & USFWS, 2011a)

Federally protected lands data sets are from BLM, UMT, USFS, USFWS and ALRIS. Boundaries include USFWS national wildlife refuges, BLM conservation areas, national monuments and wilderness areas, USFS wilderness areas, national parks, and national recreation areas.

Presented In:

Summaries, Tables & Maps

Wild and Scenic Rivers (National Wild and Scenic Rivers System Act of 1968; AGFD, 2011e; USFS, 2007; & WSRC, 2009)

The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. There are three designations under the Act: 1) Wild Rivers or sections of rivers are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted; 2) Scenic Rivers or sections of rivers are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads; and 3) Recreational Rivers or sections of rivers are readily accessible by road or railroad, may have some development along their shorelines, and may have undergone some impoundment or diversion in the past.

As described by the AGFD (2011e), modifications were made to the USFS Wild and Scenic Rivers dataset (2007) and the Wild & Scenic River Council's dataset (2009):

> Data was downloaded from Wild and Scenic Rivers website (http://www.rivers.gov/index.html). Data for Fossil Creek were selected from the dataset and buffered 1/4 mile since a Comprehensive River Management Plan (CRMP) has not been developed for Fossil Creek. Per USFS-Region 2 office, 1/4 mile is the interim Wild and Scenic corridor before a CRMP is approved. Data was merged with the approved Verde River Wild and Scenic data downloaded from the Tonto NF GIS data download site.

Presented In:

Summaries, Tables & Maps

Outstanding Arizona Waters (A.A.C., 2008; & ADEQ, 2009)

Outstanding Arizona Waters, as classified by ADEQ, are identified in the basin tables and maps. The term "outstanding Arizona waters" (OAW) was formerly known as "unique waters"; these terms are considered to be synonymous. R18-11-101(28) "Outstanding Arizona water (OAW)" means a surface water that is classified as an outstanding state resource water by the Director of ADEQ under R18-11-112.

Unique waters are designated only by administrative rulemaking. Members of the public may nominate surface waters for unique waters classification or the DEQ may initiate the rulemaking. The director of the DEQ may classify a surface water as a unique water by making a finding that a surface water is an "outstanding state resource water" because it meets decision criteria set out at R18-11-112(D). In general, a surface water has to be perennial, in a free-flowing condition, have water quality that meets or is better than applicable water quality standards, and meet one or both of the following: 1) The surface water is of "exceptional recreational or ecological significance," or 2) threatened or endangered (T&E) species are known to be associated with the water body and maintenance and protection of existing water quality is essential to the maintenance of the

threatened or endangered species or the surface water provides critical habitat.

Presented In:

Summaries, Tables & Maps

Instream Flow (ADWR, 2010b)

An instream flow water right is a non-diversionary appropriation of surface water for recreation and wildlife use. An application to appropriate public water for instream flow purposes must be submitted to the Arizona Department of Resources, which makes the determination of whether to approve or reject the application. If a permit is approved, the Department issues a Certificate of Water Right. All permits and certificates are for specific uses at specific places. The Department maintains a database that tracks the status of instream flow applications.

Presented In:

Tables & Maps

National Hydrography Dataset (USGS, 2008)

The basin tables and maps utilized data available in the National Hydrography Dataset for water features and geographic boundaries in Arizona. These features include watersheds as defined by the 8-digit hydrologic unit codes, surface water bodies and streams.

The NHD is a national framework for assigning reach addresses to water-related entities, such as industrial discharges, drinking water supplies, fish habitat areas, wild and scenic rivers. Reach addresses establish the locations of these entities relative to one another within the NHD surface water drainage network, much like addresses on streets. Once linked to the NHD by their reach addresses, the upstream/downstream relationships of these water-related entities (and any associated information about them) can be analyzed using software tools ranging from spreadsheets to geographic information systems (GIS). GIS can also be used to combine NHD-based network analysis with other data layers, such as soils, land use and population, to help understand and display their respective effects upon one another. Furthermore, because the NHD provides a nationally consistent framework for addressing and analysis, water-related information linked to reach addresses by one organization (national, state, local) can be shared with other organizations and easily integrated into many different types of applications to the benefit of all.

The National Hydrography Dataset (NHD) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. This high-resolution NHD, generally developed at 1:24,000/1:12,000 scale, adds detail to the original 1:100,000-scale NHD. (Data for Alaska, Puerto Rico and the Virgin Islands was developed at high-resolution, not 1:100,000 scale.) Local resolution NHD is being developed where partners and data exist. The NHD contains reach codes for networked features, flow direction, names, and centerline representations for areal water bodies. Reaches are also defined on water bodies and the approximate shorelines of the Great Lakes, the Atlantic and Pacific Oceans and the Gulf of Mexico. The NHD also incorporates the National Spatial Data Infrastructure framework criteria established by the Federal Geographic Data Committee.

Presented In:

Summaries, Tables & Maps

WATER-DEPENDENT NATURAL RESOURCE INDEX

Groundwater/Surface Water Connections

Basin	Sub-basin	Current GW/SW Connection? (h=historic connection; may not currently exist)	Description of GW/SW Connection
Agua Fria	None	YES	Agua Fria basin contains perennial reach on Horseshoe Ranch and other locations; BLM National Monument
Aravaipa Canyon	None	YES	Aravaipa basin contains perennial Aravaipa Creek, on TNC and BLM managed property.
Big Sandy	Fort Rock	YES	Fort Rock subbasin contains the upper perennial reach of Big Sandy River.
	Wikieup	YES	Wikieup subbasin contains a perennial reach of the Big Sandy River; managed by the BLM, I believe it has an ISF permit.
Bill Williams	Burro Creek	YES	Burro Creek subbasin contains perennial reaches of Burro Creek.
	Alamo Reservoir	YES	Alamo Reservoir subbasin contains perennial reaches of lower Burro Creek, Santa Maria River, and Big Sandy River.
	Clara Peak	YES(h)	Clara Peak subbsin contains flowing reachs of Bill Williams River downstream from Alamo dam (gaining reaches?)
	Skull Valley	YES	Skull Valley subbasin contains a perennial reach of Kirkland Creek.
	Santa Maria	YES	Santa Maria subbasin contains perennial reaches of: Kirkland Creek; Peoples Creek; Date Creek; Santa Maria River; Sycamore Creek; Smith Canyon; Cottonwood Canyon
Bonita Creek	None	YES	Bonita Creek basin contains the lower perenial reach of Bonita Creek; City of Safford infiltration gallery captures much of the perennial flow.
Butler Valley	None	NO	Bulter Valley contains ephemeral washes (Cunningham Wash)
Cienega Creek	None	YES	Cienega Creek basin contains perennial reaches of Cienega Creek (BLM NCA) and Sonoita Creek
Coconino Plateau	None	YES	Coconino Plateau basin contains perennial Blue Spring and the South Rim springs.
Detrital Valley	None	NO	Detrital Valley contains ephemeral washes (tributary to the Colorado River)
Donnelly Wash	None	YES(h)	Donnelly Wash contains a regulated reach of the Gila River between Florence and Colidge Dam
Douglas	Douglas	----	----
	Douglas INA	NO (h)	Douglas INA - Brown, Camory, and Turner (BCT) document an historically perennial reach on Whitewater Draw just north of the International border.
Dripping Springs Wash	None	YES(?)	Dripping Springs Wash subbasin contains a regulated reach of the Gila River and a perennial(?) reach of Ash Creek
Duncan Valley	None	YES	Duncan Valley basin contains a perennial reach and a formerly perennial reach of the Gila River - sw diversions and gw pumping in the Duncan-Virden area have depleted streamflow.
Gila Bend	None	NO (h)	Gila Bend basin contains a formerly perennial reach of the Gila River
Grand Wash	None	NO	Grand Wash basin contains ephemeral washes
Harquahala	None	NO	Harquahala basin contains ephemeral washes (Centential Wash)
Hualapai Valley	None	NO	Hualapai Valley basin contains ephemeral washes
Kanab Plateau	None	YES	Kanab Plateau basin contains N. Rim perennial creeks: Kanab, Crystal, Tapeats, Deer, Bright Angel, Clear, Vishnu, N. Canyon, Nankoweap
Lake Havasu	None	NO	Lake Havasu basin contains ephemeral washes
Lake Mohave	None	NO	Lake Mohave basin contains ephemeral washes (tributary to the Colorado River)
Little Colorado River Plateau	C-aquifer	YES	Little Colorado River Plateau C-aqufer discharges to springs and perennial reaches along Little Colorado River
	D-aquifer	YES(?)	Perennial reaches(?)
	N-aquifer	YES(?)	Perennial reaches(?)
	Joseph City INA	YES	Joseph City INA contains a perennial reach of the Little Colorado River
Lower Gila	Childs Valley	NO (h)	Childs Valley subbasin contains a formerly perennial reach of the Gila River
	Dendora Valley	NO (h)	Dendora Valley subbasin contains a formerly perennial reach of the Gila River
	Wellton-Mohawk	NO (h)	Wellton-Mohawk subbasin contains a formerly perennial reach of the Gila River
Lower San Pedro	Camp Grant Wash	YES	Camp Grant Wash subbasin contains a perennial reach of Camp Grant Wash (BCT); spans the downstream boundary of this subbasin
	Mammoth	YES	Mammoth subbasin contains perennial reaches of the Lower San Pedro River
McMullen Valley	None	NO	McMullen Valley basin contains ephemeral reaches
Meadview	None	NO	Meadview basin contains ephemeral washes
Morenci	None	YES	Morenci Basin contains San Francisco and Blue rivers and Eagle Creek, perennial with perennial tributaries. Snow-melt and rainfall driven flow, but summer flow likely gw discharge.
Paria	None	YES	Paria River is perennial

Anning, D.W. and Konieczki, A.D. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. USGS Professional Paper 1702. 37 pp.

Groundwater/Surface Water Connections (continued)

Basin	Sub-basin	Current GW/SW Connection? (h=historic connection; may not currently exist)	Description of GW/SW Connection
Parker	Cibola Valley	NO	Parker basin contains ephemeral washes (CRIR and Cibola tributary to Colorado River)
	Colorado River Indian Reservation	NO	
	La Posa Plains	NO	
Peach Springs	None	YES	Peach Spring basin contains a short perennial reach in Spencer Canyon and part of N. boundary of basin is coincident with the perennial reach of Diamond Creek
Phoenix	Carefree	YES	Cave Creek subasin contains a perennial reach of Cave Creek
	East Salt River	?	East Salt River subbasin contains a short perennial reach on Queen Creek
	Fountain Hills	YES	Fountain Hills subbasin contains a perennial reach of Camp Creek and a regulated reach of lower Verde River
	Hassayampa	YES	Hassayampa subbasin contains part of the lower perennial reach Hassayampa River
	Lake Pleasant	YES	Lake Pleasant subbasin contains a perennial reach of New River
	Rainbow Valley	NO	Rainbow Valley contains ephemeral washes
	West Salt River	YES	West Salt River Valley contains formerly perennial Gila River, now effluent dominated
Pinal	Aguirre Valley	NO	Aquirre Valley subbasin contains ephemeral washes
	Eloy	NO(h)	Eloy subbasin contains a formerly perennial (now regulated) reach of the Gila River
	Maricopa-Stanfield	NO	Maricopa-Stanfield subbasin contains ephemeral washes
	Santa Rosa	NO	Santa Rosa subbasin contains ephemeral washes
	Vekol Valley	NO	Vekol Valley subbasin contains ephemeral washes
Prescott	Little Chino	YES	Little Chino subbasin contains Del Rio Spring and the Upper Verde River
	Upper Agua Fria	YES	Upper Agua Fria subbasin contains a perennial reach of Agua Fria River adjacent to Young Farm
Ranegras Plain	None	NO	Ranegras Plain basin contains ephemeral washes
Sacramento Valley	None	NO	Sacramento Valley basin contains ephemeral washes (tributary to the Colorado River)
Safford	Gila Valley	YES	Gila Valley subbasin contains perennial and formerly perennial reaches of the Gila River
	San Carlos Valley	YES	San Carlos Valley subbasin contains the perennial San Carlos River and formerly perennial and regulated reaches of the Gila River
	San Simon Valley	NO	San Simon Valley subbasin contains ephemeral washes (perennial water only at high elevations)
Salt River	Black River		A groundwater/ surface water connection is exhibited for some of the perennial streams that carry C-aquifer baseflow that originate along the southern flank of the Mogollon Rim. Otherwise, for most other portions of the SR basin, the streams carry runoff over consolidated sedimentary rocks, and/or igneous and metamorrphic rock formations that probably have minimal connections to groundwater. Per Frank Corkhill, ADWR.
	Salt River Canyon		
	Salt River Lakes		
	White River		
San Bernardino Valley	None	YES	San Bernadino Valley basin contains a perennial reach of Black Draw and the San Bernadino National Wildlife Refuge
San Rafael	None	YES	San Rafael Valley contains perennial reaches of the Santa Cruz River
San Simon Wash	None	NO	San Simon Wash basin contains ephemeral washes
Santa Cruz	None	YES	Santa Cruz AMA basin contains perennial reaches of Potero Creek, Sonoita Creek, Peck Canyon, and Santa Cruz River (effluent dominated)
Shivwits Plateau	None	NO	Shivwits Plateau basin contains ephemeral washes; southern boundary coincides with the Colorado River in the western Grand Canyon
Tiger Wash	None	NO	Tiger Wash basin contains ephemeral washes
Tonto Creek	None	YES	Tonto Creek basin contains perennial Tonto Creek and numerous other perennial creeks
Tucson	Avra Valley	YES	Avra Valley subbasin contains Arivaca Creek and Sycamore Canyon; otherwise, ephemeral washes
	Upper Santa Cruz	YES	Upper Santa Cruz subbasin contains Cienega Creek and formerly perennial reaches of the Santa Cruz River; plus mountain creeks such as Sabino Creek
Upper Hassayampa	None	YES	Upper Hassayampa basin contains perennial reaches of the Hassayampa River (downstream from Wickenburg at TNC preserve; upstream from Wickenburg at the Box; and upstream at Wagner) and Minnehaha Creek.
Upper San Pedro	Allen Flat	YES	Allen Flat subbasin contains Bass Canyon Creek and Double R Canyon Creek on Muleshoe preserve; otherwise ephemeral washes
	Sierra Vista	YES	Sierra Vista subbasin contains perennial reaches of the San Pedro and Babocomari rivers, O'Donnel Canyon Creek, Turkey Creek, and Brown Canyon Creek
Verde River	Big Chino	YES	Big Chino subbasin contains perennial reaches of the Verde Rivera and Williamson Valley wash
	Verde Canyon	YES	Verde Canyon contains perennial reaches of the Verde River and tributaries (East Verde River, Fossil Creek; Deadman Creek, Lime Creek, and others)
	Verde Valley	YES	Verde Valley subbasin contains perennial reaches of the Verde River and tributaries (Sycamore Creek; Oak Creek; Beaver Creek; West Clear Creek
Virgin River	None	YES	Virgin River basin contains perennial reaches of the Virgin River
Western Mexican Drainage	None	NO	Western Mexican Drainage contains ephemeral washes
Willcox	None	NO	Willcox basin contains perennial water only at higher mountain elevations; otherwise ephemeral washes
Yuma	None	YES	Yuma basin contains formerly perennial reaches of the Gila River and reaches of the Colorado River

Anning, D.W. and Konieczki, A.D. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. USGS Professional Paper 1702. 37 pp.

SUMMARY OF METHODS USED TO DEVELOP FIRST APPROXIMATION ESTIMATES OF FLOW VOLUMES CURRENTLY SUPPORTING WATER-DEPENDENT NATURAL RESOURCES

By Rob Marshall, The Nature Conservancy

Primary Differences in the Datasets Used to Estimate Current Flows Supporting Water-Dependent Natural Resources

The Commission developed two sets of estimates of current flows. The two estimates both use the same formula for estimating flow volumes [flow volume = *(baseflow + groundwater underflow + (riparian acres x ac-ft of evapotranspiration)*] and the same data for estimating baseflow. The primary difference between the two is in the data used to estimate riparian acreage and evapotranspiration.

Riparian Estimates

The USGS data used for the first set of estimates (estimate 1) derived values for riparian acreage from remotely-sensed imagery. The imagery was used to calculate riparian acreage along a 100 m buffer centered on river drainages. Sampling vegetation laterally 50 m on either side of the river channel likely underestimates riparian acreage in some areas and overestimates in others. For example, riparian habitat found in valley bottoms may extend several hundred meters laterally from the river channel. Conversely, within steeper parts of watersheds the method likely captures non-riparian vegetation types. So in flat valley bottoms the method may underestimate riparian habitat extent, while in steeper areas it may overestimate.

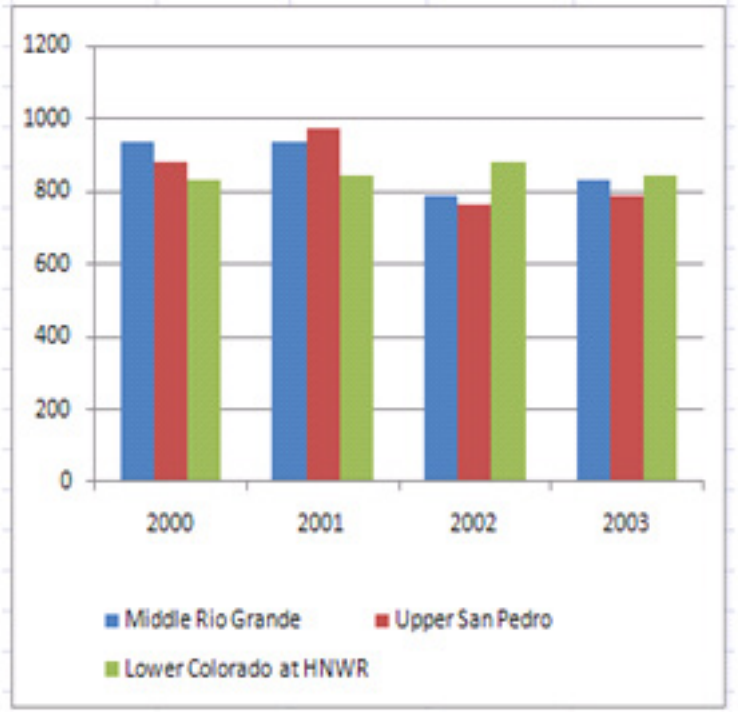
For the Committee's second set of riparian habitat estimates (estimate 2) two data sources were used. The first was a study conducted in 1993 by the Arizona Game and Fish Department that used a combination of aerial photography, aerial videography and ground verification. That study was limited to the larger perennial river basins and to the wider, valley-bottom sections of those watersheds. As a result, a substantial portion of the state's riparian habitat was not surveyed. To include areas not surveyed by the AGFD 1993 study, the Committee also used a dataset produced by USGS called the Southwest ReGAP project. The SW ReGAP was completed using remotely-sensed imagery (although a different type of imagery than what Tillman and others used for estimate 1 described above). To improve the accuracy of the SW ReGAP product, the Arizona Game and Fish Department modified the dataset for use in their State Wildlife Action Plan. Those modifications are described in detail further down on this page.

Evapotranspiration Estimates

Evapotranspiration for the first set of estimates was based on reflectance values from the same remotely-sensed imagery that Tillman and others used to estimate riparian acreage. Different vegetation types have different signatures on remotely-sensed imagery that show up as differences in the amount and bandwidth of the light reflected off of vegetation. The different reflectance values were correlated with field data on evapotranspiration, which enabled USGS to estimate evapotranspiration directly from the imagery across a large portion of Arizona (all areas south of the Colorado Plateau/Mogollon Rim).

The Committee's second set of estimates for evapotranspiration relied on empirical data developed by USGS (Nagler et al., 2005). The data in the graphic box below are from Table 4 in Nagler et al. (2005). The data show the results of field studies that measured evapotranspiration for stretches of three rivers in the Southwest: Rio Grande, Upper San Pedro, and Lower Colorado River. The values are in mm/year. The graph and table demonstrate that rates across the three study areas show little variation. Based on the close correspondence across these study basins, the Committee selected the mean value (859 mm/yr converted to English units = 2.828 ft/yr) to use for the Committee's second set of estimate for evapotranspiration.

	Middle Rio Grande	Upper San Pedro	Lower Colorado at HNWR	
2000	937	881	832	
2001	934	973	846	
2002	791	763	881	
2003	832	790	844	
Mean (SEM)	874 (74)	852 (95)	851 (21)	*Mean = 859*



The Committee's review of the overall flow estimates derived using these datasets revealed a counter-intuitive result – while the overall riparian acreage in the first set of estimates was twice as high as those in the Committee's second set of estimates, the overall amount of evapotranspiration in the first set of estimates was half of the value estimated in the Committee's second set. Further analysis revealed that this was a direct artifact of the different methodologies and datasets used.

The USGS remote-sensing data used in the Committee's first set of estimates superimposed a 100 m buffer over a watershed's drainage network. The network of drainages tends to get more extensive and complex as you move up a watershed, with many small drainages branching off of larger ones. As noted above, using a 100 m buffer to estimate riparian habitat likely underestimates riparian extent in valley bottoms but probably captures considerable acreage of non-riparian vegetation types higher up in watersheds. Conversely, the riparian studies used for the Committee's second set of estimates attempted to delineate discrete patches of riparian habitat, which should have omitted much of the areas higher up in watersheds that do not contain riparian vegetation types.

The difference in evapotranspiration between the two sets of estimates is likely the result of the evapotranspiration rates applied to the two riparian datasets. The USGS remote-sensing study used a variable evapotranspiration rate based on reflectance values in the remotely-sensed imagery. True riparian vegetation types have higher reflectance values (more evapotranspiration), so even though this method may have

captured areas higher up in watersheds with non-riparian vegetation types, the evapotranspiration from those types would be relatively small. Conversely, because the riparian data used in the Committee's second set of estimates attempted to delineate discrete patches of riparian habitat and, thus, should have relatively little non-riparian vegetation included, the Committee used a constant rate of evapotranspiration taken from Nagler's empirical studies of cottonwood-willow types across the southwestern U.S. Evapotranspiration rates for cottonwood-willow are among the highest rates documented, so while the Committee's second set of riparian estimates are lower, the constant evapotranspiration rate applied across this acreage is likely higher than that used in the USGS's study that relied on remotely-sensed imagery.

Despite these differences in data and methodologies, the overall flow volumes from the two sets of estimates are within ten percent of one another. The close correspondence of the two overall estimates increases the overall certainty of the result and illustrates the benefit of using the two different approaches in a comparative manner.

Methods and Data Used in the Commission's Estimate of Riparian Habitat Extent

Below is a list of specific habitats selected and excluded from 1993 AGFD dataset used for estimating riparian habitat. Also explained below are the modifications AGFD made to the SW ReGAP data for their State Wildlife Action Plan.

Habitat types from the 1993 AGFD riparian data included in estimate of riparian acreage

Cottonwood Willow (11,400 acres)

Mixed Broadleaf (18,861 acres)

Tamarisk (5207 acres)

Russian Olive (0)

Strand (5732 acres)

These types represent tree-dominated riparian habitat types. Tree types are what we have ET estimates for from the scientific literature.

Habitats excluded and rationale

Areas not Ground Verified (no way to know what if any vegetation was present; total acres = 428)

Conifer Oak (not a riparian habitat type)

Mountain Scrub (not a riparian habitat type)

Mesquite (excluded from this dataset but is captured by the second dataset we are using – SW ReGAP/SWAP, which covers a larger area and thus will capture more of the mesquite habitat type throughout the state; total unique acres not captured by SW ReGAP/SWAP = 849)

Marsh (we do not have ET values for emergent wetland habitat types; total = 51 acres)

Wet Meadow (we do not have ET values for emergent wetland habitat types; 771 acres)

Flood Scoured (flood scoured habitats are areas of bare sand that are likely spots for future riparian recruitment; total acres = 7,000). Including these areas would likely have overestimated riparian acreage.

Methodology AGFD Used to Refine the SW ReGAP Riparian Data for Use in the Department's State Wildlife Action Plan

At the time this model was developed, two sources of riparian data were available for Arizona: the Southwest Regional Gap Analysis Project (SWReGAP) landcover database (Lowry et al., 2007) and the Department's Riparian Inventory (Valencia, 1993). Both were reviewed for accuracy by an internal team familiar with riparian areas throughout the state. The SWReGAP landcover layer was found to under represent riparian in much of the state while misclassifying large areas of mesquite woodlands as riparian. These misclassified pixels were re-assigned to mesquite forest in the original data. The 1993 Department's Riparian Inventory was discovered to be out-of-date and incomplete since riparian vegetation was only mapped along perennial drainages and not intermittent ones.

In an attempt to fill in the blanks left by those datasets, the Department modeled the potential riparian vegetation along lakes and perennial and intermittent streams by calculating cost weighted distance from each stream and lake using slope as the cost surface, essentially mapping the flood plain around each stream and lake. The resulting output was constrained by an upper cost limit and by distance from the stream or lake. The model was combined with the Department's riparian inventory and the SWReGAP riparian categories to create a comprehensive map of potential riparian vegetation. Known areas of development, agriculture or dewatering were erased from the model. In recognizing the importance of riparian vegetation in Arizona, the Department chose methodology that over represents the presence of riparian habitat in Arizona as opposed to methodology that under represents riparian habitat.

Rationale for the Baseflow Estimates Selected for the Bill Williams and Lower San Pedro Rivers

Estimates of baseflow were not available in the scientific literature for the Bill Williams and Lower San Pedro rivers. Due to the importance of these two systems for riparian and aquatic natural resources, the Commission evaluated available gage data to estimate baseflow values.

For the San Pedro River available data were compiled in the table below. Based on a review of the data, the Commission selected 5 cfs, which is close to the median value, for baseflow in the San Pedro River below Benson.

Base flow for the San Pedro River below Benson

Name	GageNo	Median
San Pedro River at Winkelman (66-78)	09473500	3.4
San Pedro near Winkelman (1962-1965)	09473400	9
San Pedro River bl Aravaipa Creek nr Mammoth (Oct 79 - Sep 83)	09473100	12
San Pedro River near Mammoth (May 31- Jun 41)	09472500	0
San Pedro River near Benson (1966-1976; 2006-Oct2010)	09471800	0
Gage 3400 and Gage 3500 (1962 - 1978)	------	4.9
Average of all instantaneous measurements at San Pedro River Preserve	------	4.5

For the Bill Williams River, data was reviewed from the following gages:

Bill Williams River **near Parker** gage record is from 10/1/1988 to present; **median flow = 8 cfs**

Bill Williams River **below Alamo Dam** gage is from 10/1939 to present; **pre-dam period (1940-1967), median flow = 9.4 cfs; for the concurrent period of record (10/1/1988 to present) median flow = 25 cfs**

Based on a review of these data, the Commission selected 8 cfs as the baseflow value for the Bill Williams River, which is the median flow near the Parker gage. This value represents current conditions in the watershed.

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Environmental Flow – Figures

Figure 1: First Approximation of Current Flow Volumes Supporting Water-Dependent Natural Resources

First Approximation of Current Flow Volumes Supporting Water-Dependent Natural Resources (acre-feet/year)

River	USGS Estimate	Commission Estimate
Agua Fria River	36,265	29,599
Aravaipa Creek	28,283	19,384
Arivaca Creek	2,440	3,492
Bill Williams River	85,307	132,040
Cienega Creek	8,819	9,096
Gila River	234,456	279,071
Salt River	373,140	365,156
Upper San Pedro River	32,307	58,676
Lower San Pedro River	65,709	62,805
Santa Cruz River	24,018	38,805
Tonto Creek	36,295	36,675
Verde River	309,308	340,332
Total	**1,236,347**	**1,375,131**

Arizona Water Resources Development Commission, Environment Committee (March 1, 2011)
The information in this workbook was based on the best available scientific information and compiled to provide a first approximation of current river flow volumes supporting water-dependent natural resources, such as riparian habitat, fish and other aquatic organisms. The 11 rivers selected were based on the availability of suitable data. Flow estimates in the scientific literature have been developed using several methods. Results can vary depending upon the data, methods, and assumptions used. To better understand the magnitude of this variation, the Committee developed two sets of flow estimates using different datasets.

This summary page contains a snapshot of the two sets of estimates.

The tabs to the right labeled *"USGS Est"* and *"Commission Est"* present the data used to derive the two sets of estimates. "USGS Est" refers to estimates derived from data provided by the U.S. Geological Survey. "Commission Est" refers to the estimates prepared by the WRDC's Environment Committee from several data sources in the scientific literature.

The Metadata tab provides additional information on the data, methods, and scientific studies used to support the Commission's work as well as the Environment Committee members and other contributors who prepared the estimates.

Figure 2: Estimates of Current Flow Volumes Supporting Water-Dependent Natural Resource Using Data from the U.S. Geological Survey (Estimate 1)

River/ Watershed	Annual Baseflow (acre-ft/yr)	Groundwater Underflow (acre-ft/yr)	Riparian Extent (acres)	Average Annual ET (acre-ft/yr)	First Approximation of Current Flow Supporting Water-Dependent Natural Resources (acre-ft/yr)
Agua Fria River	1,811		27,028	34,454	36,265
Aravaipa Creek	11,591		12,565	16,692	28,283
Arivaca Creek	304		1,190	2,136	2,440
Bill Williams River	5,796		79,733	79,511	85,307
Cienega Creek	797		5,683	8,022	8,819
Gila River	127,503		87,695	106,953	234,456
Salt River	236,170		87,271	136,970	373,140
Upper San Pedro River	9,417	440	17,916	22,890	32,747
Lower San Pedro River	3,622		43,368	62,087	65,709
Santa Cruz River	11,591		7,710	12,427	24,018
Tonto Creek	15,213		14,130	21,082	36,295
Verde River	194,151		82,334	115,157	309,308
Total	**617,966**	**440**	**466,623**	**618,381**	**1,236,787**

Flow volume estimates are in acre-feet/year using the following formula:

flow volume = (baseflow + groundwater underflow + (riparian acres x ac-ft of ET))

All flow volumes are for the watershed area above the specific USGS gage used to estimate baseflow. See Figure 4 for USGS gages used.

These estimates were based on the following studies:

baseflow: adapted from the methods of Blasch et al. (2006); Marshall et al. (2010); Fisk et al. (2006)

groundwater underflow: Correll et al. (2006)

evapotranspiration [ET]: adapted from the methods of Tillman et al. (in review) and Nagler et al. (2009)

riparian extent: adapted from Tillman et al. (in review)

Figure 3: Estimates of Current Flow Volumes Supporting Water-Dependent Natural Resources Using Alternative Datasets (Estimate 2)

River/ Watershed	Annual Baseflow (acre-ft/yr)	Groundwater Underflow (acre-ft/yr)	Riparian Extent (acres)	Average Annual ET (acre-ft/yr)	First Approximation of Current Flow Supporting Water-Dependent Natural Resources (acre-ft/yr)
Agua Fria River	1,811		9,861	27,788	29,599
Aravaipa Creek	11,591		2,766	7,793	19,384
Arivaca Creek	304		1,131	3,188	3,492
Bill Williams River	5,796		44,799	126,244	132,040
Cienega Creek	797		2,945	8,299	9,096
Gila River	127,503		53,786	151,568	279,071
Salt River	236,170		45,772	128,986	365,156
Upper San Pedro River	9,417	440	17,480	49,259	59,116
Lower San Pedro River	3,622		21,002	59,183	62,805
Santa Cruz River	11,591		9,657	27,214	38,805
Tonto Creek	15,213		7,616	21,462	36,675
Verde River	194,151		51,874	146,181	340,332
Total	**617,966**	**440**	**268,689**	**757,165**	**1,375,571**

Flow volume estimates are in acre-feet/year using the following formula:

flow volume = (baseflow + groundwater underflow + (riparian acres x ac-ft of ET))

All flow volumes are for the watershed area above the specific USGS gage used to estimate baseflow. See Figure 4 for USGS gages used.

These estimates were based on the following studies:

baseflow: adapted from the methods of Blasch et al. (2006); Marshall et al. (2010); Fisk et al. (2006)

groundwater underflow: Correll et al. (2006)

evapotranspiration [ET]: adapted from the methods of Nagler et al. (2005)

riparian extent: adapted from Valencia et al. (1993); Lowry et al. (2007)

Figure 4: USGS Gages and Riparian Habitat Acreages

USGS Gages and Riparian Habitat Acreages Used in WRDC Study			Riparian acres USGS	Riparian acres SWAP/AGFD
River	**Gage #**	**Gage Name**	**(Tillman & others 2011)**	**(Valencia & others 1993; Lowry & others 2007)**
Agua Fria River	9512800	Agua Fria River near Rock springs	27,028	9,861
Aravaipa Creek	9473000	Aravaipa Creek Near Mammoth	12,565	2,766
Arivaca Creek	9486590	Arivaca Wash near Arivaca	1,190	1,131
Bill Williams River	9426620	Bill Williams near Parker	79,733	44,799
Cienega Creek	9484600	Pantano Wash Near Vail	5,683	2,945
Gila River	9448500	Gila River At Head Of Safford Valley Near Solomon	87,695	53,786
Salt River	9498500	Salt River near Roosevelt	87,271	45,772
Upper San Pedro River	9471000	San Pedro River at Charleston	17,916	17,480
Lower San Pedro River	9473500	San Pedro at Winkelman	43,368	21,002
Santa Cruz River	9481740	Santa Cruz River at Tubac	7,710	9,657
Tonto Creek	9499000	Tonto Creek abv Gunn Creek	14,130	7,616
Verde River	9508500	Verde River below Tangle Creek	82,334	51,874