

Research Recommendations

Daniel G. Neary, Alvin L. Medina, John N. Rinne

Introduction

This chapter contains a number of research recommendations that have developed from the 15 years of research on the UVR conducted by the Southwest Watershed Science Team, as well as from insights from key cooperators and contacts. It is meant to be our best insight as to where efforts should go now. Achieving these recommendations will depend on a number of factors, including agency budgets of the USDA Forest Service, USDI Geological Survey, USDI Fish and Wildlife Service, and Arizona Game and Fish Department. A key to future success in marshalling resources to conduct research on the UVR is partnerships with other Government agencies at the Federal, State, and local levels and with non-Government organizations and private individuals. Rocky Mountain Research Station will need to work with cooperators such as private landowners, the USDA Forest Service's Prescott National Forest, USDI Geological Survey, USDI Fish and Wildlife Service, USDI Bureau of Reclamation, Arizona Game and Fish Department, Arizona Department of Water Resources, Arizona Department of Environmental Quality, University of Arizona, Northern Arizona University, The Nature Conservancy, and the Verde Watershed Association.

Research Recommendations

Hydrology

- The main hydrologic data gathering is done by USDI Geological Survey at the Paulden gauge. This effort is sustained through a cooperative agreement with the USDI Geological Survey, the Prescott National Forest, and the local landowner. The USDI Geological Survey analyzes and reports the data and the Prescott National Forest funds the operation and maintenance of the gauging station. Access is provided by an agreement between the USDI Geological Survey and the Verde River Ranch. **It is important for the USDA Forest Service to provide assistance in maintaining this work, including access and site protection.**
- The influence of Sullivan Dam as a sediment and chemical source and sink is unknown. Many hydrological physical processes are affected by the structure. When completed in 1939, the dam was filled with bedload within two years. This bedload is necessary to sustain the dynamic equilibrium of the system downstream and has been held in check for 70 years. All evidence suggests that deprivation of this bedload has resulted in the channel degradation, erosion of historical terraces, loss of the critical hyporheic zone, aquatic habitats for fish, and disturbance of once productive streamside habitats and wetlands. **A Rosgen level IV assessment (Rosgen 1994) is needed to determine the**

sediment-bedload relationships, and stream stability, and to ascertain the benefits to society and the UVR of removing the dam for the purpose of restoring the physical processes to the system.

Groundwater

- The chemical attributes of accumulated sediments in Sullivan Dam and upstream for several miles should be determined. Of specific interest is the presence of chemical “cocktails” commonly referred to by the U.S. Environmental Protection Agency as Pharmaceuticals and Personal Care Products (PPCPs). In 2009, tests were conducted across the United States and it was determined that water bodies and other sources, e.g., soils, contain varying quantities and products that may pose harm to humans or the environment. The basin above Sullivan Dam has historically been used commercially for agricultural production of forage products and industrial business (such as gravel mining); more recently, it has become a dense urban community. **It is important to determine if PPCPs are present and potentially contributing to water pollution in the UVR downstream in such a manner that disrupts biological processes, e.g., reproduction.**
- All of the groundwater research has been done by USDI Geological Survey as well as the State of Arizona. **No USDA Forest Service involvement is needed, but some material support may be needed for future work if research budgets continue to be cut at the State and Federal level.**

Vegetation

- Considerable effort has been invested in implementing a riparian monitoring program (1996 to 2010) that includes permanent vegetation stations. These stations provide trend information that is useful for management of the riparian habitats. The stations provide specific information about composition, density, frequency and structure that is useful for examining changes in regards to land uses or climate change. Point photos provide real-time contrasts of habitat changes and alert managers of riverine conditions. **The vegetation monitoring program instituted for the Prescott National Forest should be continued and the database should be archived. A repeat measurement interval of three to four years is suggested, depending on major floods or other management needs.**
- Vegetation studies have permitted the development and implementation of invasive plant treatments, e.g., removal of tamarisk, for the Prescott National Forest. This information is being used locally by other agencies and private enterprises to develop similar treatments in the middle Verde Valley. Preliminary studies have also revealed the presence of many other invasive plants of importance to the Prescott National Forest. **Additional vegetation surveys should be conducted to identify management options for the array of invasive herbaceous and woody species. It is important to identify maintenance programs for the control of nonnative plants, treated and untreated, for the purpose of sustaining plant communities for a variety of wildlife, especially TES species.**
- Grazing still remains a practical and economical tool to control and manage vegetation, including invasive species. New grazing programs, such as “targeted grazing” (American Sheep Industry 2006) have proven successful under various

scenarios. Livestock grazing of the UVR can provide additional resource protection from unwanted vegetation and reduce risks to aquatic habitats. **Research on the effectiveness of different weed management strategies, including biological, weed control, and operational techniques in the UVR is needed.**

- UVR has incurred major changes in woody plant species and densities. It is uncertain how woody plants affect the productivity of wetland communities. It is also uncertain how woody plants affect site productivity, streambank stability, and other erosional processes. **Studies are needed that address the relationships among woody plants, channel dynamics and site productivity. These are useful for management of key habitats for willow flycatcher, amphibians, and other aquatic-dependent wildlife.**
- Overstory canopy of deciduous trees can influence the chemistry of water in the stream. **Evaluation of water chemistry influenced by overhead vegetation canopy closure and its effects on the relative roles of primary and secondary production levels in native fish sustainability needs to be examined.**

Geomorphology

- Considerable effort has been invested in implementing a riparian monitoring program that includes permanent geomorphic stations where Rosgen “type” level II assessments are completed (Rosgen 1994). **These stations are important to maintain and measure at two to three year increments (more so after major floods) to ascertain the relative stability of the channel, as well as to corroborate associated changes to terrestrial and aquatic habitats, especially for TES species.**
- Permanent geomorphology transects provide a means of clearly documenting changes in the UVR over time and between climatic events. Changes in agency personnel at the Prescott National Forest, Rocky Mountain Research Station, USDI Geological Survey, etc., might result in future misunderstandings of the dynamics of the UVR. **A set of geomorphology transects was established in the 1997 to 2000 time period. These transects should be re-measured periodically to follow future trends in the river.**
- Fish are directly affected by habitat changes in the UVR. There has been a history of misinterpretations of fish response to land management activities and changes in the UVR geomorphology and vegetation. **Additional studies are needed to refine the fish-habitat linkages that are important to native fish survival in the UVR.**
- The geomorphology of the UVR is strongly influenced by episodic flood events. Floods pre-dating European settlement of the Verde Valley have had major impacts on the current geomorphology and aquatic habitats. **Any future large-magnitude floods that reset the UVR’s geomorphology should be documented to better understand geomorphic changes after long return-interval floods.**
- Climate change, urbanization of the Chino Valley, and groundwater withdrawals for the cities of Prescott and Prescott Valley have been implicated in regional aquifer declines and reduced streamflow in the UVR. **The influence of declining streamflows on stream geomorphology and aquatic habitats must be evaluated. This work can be a part of the riparian monitoring program.**

- Videography of the UVR has been historically used to assist in research site selection and identification of changes in conditions. **Additional remote sensing data, e.g., LiDAR, should be conducted used to provide a current and more portrayal of riverine conditions, and the database archived.**

Fishes

- Despite efforts to repatriate native fish (spikedace and loach minnow) into the upper headwaters above Perkinsville, nothing is known of the suitability and availability of habitat for these species. **It is imperative that surveys/assessments be conducted to establish these criteria before the projects are implemented.**
- It is useful to establish permanent stations (e.g., vegetation, channel, and fish data collected) where pre- and post-treatment data can be collected for the purpose of assessing success of fisheries, vegetation, and land management projects. Proposed monitoring station segments are not being grazed by livestock and as such would provide additional insight about no-grazing effects on fish and their habitats. **Additional studies should be initiated to understand the relationships between nonnative fishes, flow regimes, and management activities, such as fisheries and livestock grazing management in the riparian corridor and extrinsic land use activities on the watershed on native fish sustainability.**
- The relative roles of predation/competition by nonnative fishes and other invasive species such as crayfish, Asiatic clams, and bullfrog and their effects on native fish sustainability are poorly understood. **Research should be conducted to better understand inter- and intra-species relationships of nonnative aquatic species.**
- Spikedace have not been collected in periodic time-constrained surveys since 1997. These surveys have focused on habitats favored and those avoided by the fish. Surveys have included fixed sites as well as complete perennial channels in the river corridor. **An assessment should be conducted to determine the benefits of restocking UVR with spikedace from stock of the Gila River.**
- There is considerable controversy over the role of and need for woody debris in UVR channels. Woody debris became much more prevalent in UVR channels in the latter few decades of the Twentieth Century and has been implicated in proving habitat for predatory nonnative fish. **The role woody debris plays in sustainability of native fish species and riparian habitats needs to be re-searched for the UVR and other Southwestern streams.**
- The native fish fauna of the Southwest has evolved with drought and flood disturbance regimes. **The precise role of disturbance in the restoration and sustaining of native fish species and their habitats needs to be better understood for the UVR and other Southwestern streams.**
- Fish populations and communities on the UVR have been studied at seven fixed sites since the flood of 1993. This is a valuable resource because of its long-term nature, and it is probably the most complete environmental database for any river in the Southwest. **Continued monitoring and research relative to the long-term fish/habitat database on the UVR is needed.**

- Mechanical removal of nonnative fish has proven to be a promising method for reducing predatory nonnative fishes. Prescott National Forest managers, Rocky Mountain Research Station scientists, and fish resource management agencies should strongly consider collaborative efforts to test native fish response to the removal of nonnative fish efforts relative to the presence and or absence of management activities such as livestock grazing. **Studies of the mechanical removal of nonnative fish be continued in out years is highly recommended.**
- Chemical removal of nonnative fishes is not fish population specific and has the potential to adversely affect macroinvertebrates that are crucial to the native fish food supply, as well as potential human health issues. **Physical removal efforts should be a prerequisite to considering chemical removal of nonnative fishes in the uppermost reaches of the Verde River.**
- Laboratory studies such as those of Carpenter and Mueller (2008) suggest that juveniles of even smaller-sized nonnative fishes can have a potentially impact on native fishes. **Because of the ever-increasing literature on the impact of direct predation by nonnative fishes and other aquatic invasive species, this impact should be examined in the UVR by new studies.**
- Although studies have been conducted by the University of Arizona that lay a groundwork for future studies, primary and secondary production studies have not been a component of the past 15 years of study. **Primary and secondary production as related to flow regimes should be studied intensively enough to determine their role in the sustainability of native fishes in the UVR.**
- Spikedace restoration efforts must be coordinated with mechanical removal efforts and land management activities. On-going monitoring indicates that there is a high probability that the spikedace species has already been extirpated from the UVR. The combined monitoring efforts of the Rocky Mountain Research Station, Arizona Game and Fish Department, and the USDI Fish and Wildlife Service over the past decade and over the upper 60 km (38 mi) of river have failed to collect the species. Collaborative efforts should be initiated and pursued by these same agencies to experimentally introduce the species in the Arizona Game and Fish Department property and Black Bridge long-term site reaches. **There should be a continued effort to monitor the UVR for spikedace, as well as an increased emphasis on restoring the species to the UVR, as is a component of the Recovery Plan (USDI Fish and Wildlife Service 1990).**

Aquatic Ecology

- There are many key interactions with native and nonnative aquatic species for which we have little information. **The whole arena of aquatic ecology of the UVR needs to be explored.**
- The combination of warm temperatures, abundant sunlight, and organic matter inputs from a well-developed riparian zone have created a high potential for aquatic productivity in the UVR. **Primary production in the UVR relative to the food chain for native and nonnative fishes needs to be thoroughly investigated to more clearly define its role in the fish ecology of the river.**
- Macroinvertebrates commonly provide an important part of the ecology of fish populations in streams like the UVR. However, very little is known about this component of the UVR ecosystem. **Characterization of macroinvertebrate**

populations, their genetics, and their ecology in the UVR is needed to assess the sustainability of native fish populations.

- Changes in the hydrology of the UVR have the potential to adversely affect macroinvertebrate populations and their food sources. **The relationships between macroinvertebrate populations and flows in the UVR need to be examined.**

Water Quality

- Water quality data collected at the Verde Ranch and Y-D Ranch sites were not intended to guide land management actions or determine cause-and-effect relationships of upland management activities—they are too limited in extent, duration, and flow range sampling. At best, one can say that the water quality of the sampled reaches of the UVR is within the range of variability of warm water standards for the Southwest and does not raise any particular concerns. **However, a water quality monitoring program should be developed to assist in interpreting cause and effect relationships from integrated studies listed elsewhere. This program should be consistent with Arizona Department of Environmental Quality protocols.**
- Water quality is a key component of the UVR ecosystem but its role in sustaining or deteriorating aquatic productivity is poorly understood. **There should be a major expansion of water quality studies to compliment the fish, aquatic ecology, and geomorphology studies that may be done on the UVR.**

Database Management

- Many years have been invested in developing long-term databases for vegetation, hydrology, fishes, water quality, and photo point monitoring. The design of this archival system is applicable to historic databases as well and can set the example for archival of all other studies for the UVR. **These databases require a curator to organize and archive the data for retrieval and access to other scientists and managers. This is an important task to be completed as soon as possible, before personnel familiar with the data move or retire.**
- The photo point database is rich in content and is well organized, but will require periodic repeat photos in order to sustain a consistent temporal timeline. **Repeat photos should be taken at four- to five-year intervals, and more frequently in the event of major floods or other events.**

Management Opportunities

- The UVR Adaptive Management Partnership (UVRAMP) demonstrated its capacity to function as collaborative group for promoting science-based decisions to invoke management of the multiple resources at risk in the UVR. Vested parties from agencies and private landowners had opportunities to actively participate in dialogue about management issues and direct emphasis toward problem solving in a collaborative atmosphere. This type of award winning partnership is highly encouraged to assist the Prescott National Forest in long-term planning. **UVRAMP should be reactivated and used to promote holistic community-based resource management strategies for the UVR.**

- This synthesis of the UVR has provided many options for guiding management opportunities aimed at restoration of critical habitats, e.g., wetlands, fishery. **A comprehensive management strategy should be developed that incorporates various multiple aspects of the ecology of the UVR and integrates them with the socio-economic needs of the communities and the UVR ecosystem. Restoration plans and strategies need to be made part of this effort.**

Funding Sources

Research and monitoring documented in this report have been funded from a variety of resources including Federal government appropriated funds for the U.S. Forest Service and USDI Geological Survey. State government funds and University grants have also been used. In the current economic environment, these sources of funding are becoming increasingly constrained or eliminated. Future research will require partnerships of Federal, State, and University scientists to obtain funding from sources such as the National Science Foundation, special Federal appropriations like climate change, non-government organizations such as The Nature Conservancy, and private foundations. Limited amounts of land management agency funds can be directed toward monitoring, practical questions, and data needs, but these funds are generally not available for research.