USGS
science for a changing world

Upland Free Water in the Southwest

A Research Program for Management of a Critical Resource in the Arid & Semi-Arid West

Natural upland free water is scarce in the Colorado Plateau, Great Basin, and desert Southwest. Other than very rare perennial streams and springs, natural free water occurs largely as ephemeral channeled torrents or ponded longer-lasting tanajas that wax and wane with precipitation events. Humans radically altered hydrologic regimes in this region during the last 120 years. Beginning in the late 1800s, livestock producers and other land managers began constructing what ended up being a comprehensive network of earthen and metal tanks provisioned by natural flows, wind-powered pumps, or transported water. Since the 1930s, wildlife managers have constructed water developments to benefit targeted wildlife species, including quail, elk, and desert bighorn sheep. These human modifications have resulted in increased spatial and temporal availability of free water for wildlife that use this resource

The future promises continued change in upland free-water regimes of the interior arid and semi-arid West. The livestock industry is in decline as are related incentives to maintain existing livestock water developments. Controversy over the ecological effects of wildlife water developments has forestalled new construction and precipitated critical evaluation of those that remain. Of perhaps greatest importance, on-going drought and foreseeable climate warming and drying promise substantial diminishment of water input and retention. The future of free water availability is clearly entangled with issues of climate change, land use, and wildlife management, framed by geomorphic and hydrologic regimes.

Despite the critical importance of free water in the interior arid and semi-arid West, little is

known about landscape-level effects of free-water on wildlife communities. Little is also known about how climatic, geomorphic, geologic, and hydrologic features affect availability of upland free water. A limited body of research informs managers about the effects of wildlife water developments, primarily in hot dry deserts and primarily with reference to single species. Some work has also been done on use of water sources by a limited suite of game animals. However, our current knowledge is grossly insufficient for appraising or anticipating the effects of land use and climate change on upland free water, or for managing landscape-level effects of free water on wildlife communities. Stakeholders that potentially include all land and wildlife management agencies of the arid and semi-arid West are without the tools they will need to cope with changes in availability of free water.

The USGS Southwest Biological Science Center has embarked on a research program to remedy deficiencies in our knowledge regarding determinants of upland free water and effects of this resource on wildlife communities. Our near-term goals are to (1) model free water as a function of weather, land use, and geologic, geomorphic, and hydrologic features, and (2) explain patterns of free-water use by wildlife in terms of water

U.S. Department of the Interior
U.S. Geological Survey

January 2005

Upland Free Water in the Southwest



available from vegetation, snow, and liquid sources, and as a function of the life history of investigated species. Longer-term, with knowledge gained from initial studies, we plan to investigate community-level and demographic responses to experimental manipulation of water availability. Pilot studies funded by the National Park Service are underway in the Flagstaff Area National Monuments (NMs) and another is proposed for Canyon de Chelly NM.

Our proposed research program is explicitly interdisciplinary and will draw on all the disciplinary talent of USGS. Geologists, geomorphologists, and hydrologists will be key sources of insight, expertise and data for explaining and predicting availability of upland free water. Remote sensing experts will be critical to developing and applying techniques for mapping water available from vegetation, snow, and liquid sources. GIS experts will be essential to developing, managing and modeling spatially-explicit data. Finally, wildlife scientists will provide the skills and insight needed to investigate species behaviors and demography.

This research program will be phased and contingent on bureau support. Initially we will undertake four concurrent tasks: (1) We will use pilot studies to gather preliminary data and develop and refine methods for remotely monitoring wildlife use of water sources; (2) We will collaborate with NASA and USGS physical scientists to identify, refine, and preliminarily apply methods for remotely sensing free water and water available in vegetation and snow; (3) We will establish a core working group representing the USGS disciplines to develop a comprehensive research plan; and (4) We will engage stakeholders, clients, and collaborators to gauge and develop support and to elicit feedback for refinement of goals and methods. We propose to seek funds through reallocation of existing local and regional USGS assets, the USGS Global Change Program, the developing USGS Water Availability Initiative, and non-USGS sources as they are identified.

Contact: David Mattson, USGS Southwest Biological Science Center, Colorado Plateau Research Station,
P.O. Box 5614, Northern Arizona University, Flagstaff, AZ 86011
Telephone: 928-556-7466 x 245
Email: David_Mattson@usgs.gov