

What Photos and Neutrons Tell Us: How wildlife water developments benefit nongame wildlife in the Sonoran Desert

By Steven S. Rosenstock
and Blair Wolf

Water has always been a precious resource in the arid Southwest, for humans and wildlife alike. Thirsty explorers and naturalists described at length the diverse and abundant wildlife associated with those rare permanent water sources found in the desert. Modern-day resource managers recognized the importance of reliable water sources and made them a priority.

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Natural rock tanks (“tinajas”) were modified to catch and store more water and shaded to reduce evaporation. Where needed, steps were cut into the rock to increase accessibility. Managers also built catchment systems that captured and stored sufficient rainwater to last through the summer.

Since 1946, the Arizona Game and Fish Department has built more than 1,100 water developments statewide, in cooperation with land management agencies and sportsmen’s groups. Like other active management activities, developing water sources for desert wildlife sometimes has been controversial. Developed waters have been criticized as “single-species management,” because they initially were intended to benefit game animals. Recent studies using the latest technologies reveal that these water developments also are very important to nongame wildlife in the Sonoran Desert.

Focusing In

In 2000, department researchers installed 24/7 video cameras and recorders at several catchments in southwestern Arizona. I remember viewing the premier videotape brought in from the field. The first scenes were encouraging. At sunset, a coyote came in to drink; shortly thereafter, a covey of quail, then a mule deer doe with two fawns.

But after darkness descended, the image was filled with what looked like snowflakes in automobile headlights at 65 mph. I immediately suspected some hardware failure: a camera or VCR fried by the desert heat. Further inspection solved the mystery. The flying objects were bats, moving too quickly to count, much less identify.

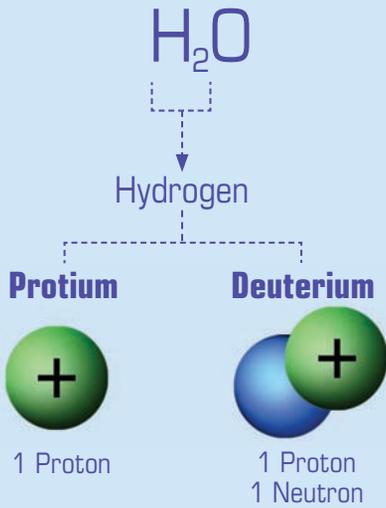
A kit fox (top left) and golden eagles (top right) are shown visiting water catchments, proving that these water developments are used by smaller creatures as well (bottom, cottontail rabbit).



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TOM WHETTEN



Stable Isotopes

What exactly are stable isotopes and how are they measured? Here's a brief chemistry lesson.

Water (H_2O) is composed of hydrogen and oxygen. Each water molecule contains two atoms of hydrogen, one of oxygen.

Both hydrogen and oxygen naturally occur in multiple forms called stable isotopes. "Stable" means the isotope does not break down over time and is non-radioactive. Each stable isotope of oxygen and hydrogen has a different number of neutrons in its atomic structure.

The most common stable hydrogen isotope is protium, which has no neutrons. Adding one neutron yields the heavier isotope deuterium. Oxygen occurs as three stable isotopes, having 16 or 18 neutrons.

In the laboratory, water samples can be analyzed to determine the relative proportions of each hydrogen and oxygen isotope. This is done using a technique called mass spectroscopy.

The daytime video observations had limitations as well. Many perching ("passerine") birds were visiting the catchments, but could not be identified reliably in the somewhat grainy black-and-white images.

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To identify and count birds more effectively, we added higher-resolution color cameras to the video systems and placed human observers at other catchments. In two years of observation, we documented more than 30 different species of songbirds and raptors using the water developments.

For bats, we stationed observers equipped with night-vision goggles near the catchment trough, counting all bats coming in to drink. Species were identified by recording and analyzing acoustic signatures of their echolocation calls. The results were eye-opening. At least seven bat species were present during summer months. The traffic volume rivaled Phoenix's Loop 101 at rush hour. During peak activity periods, we counted up to 2,700 bat visits per hour.

Clearly these catchments were more than just game waters. This raised a larger question — to what degree do nongame species



Blair Wolf removes captured songbird from a mist net near a catchment (left). University of New Mexico students band songbirds and collect blood samples (right).

rely on developed water sources to survive in the harsh Sonoran Desert environment?

Taking It to the Next (Subatomic) Level

In 2006, the department partnered with the University of New Mexico, a first-of-its-kind effort that directly measured how birds and bats use different water sources present in the desert environment. These water sources are of two primary types: liquid water in catchments or natural water features, called "free water;" and "pre-formed water" contained in plant parts and insects consumed as food items. Our overall objective in this study was to determine the relative importance of these different

water sources to desert birds and bats.

This study used newly developed, high-tech research techniques that allowed us to identify the unique isotopic fingerprint of each water source and measure the relative amounts of each contained in an animal's body (see "Stable Isotopes").

Field work for this study was done at three water developments in southwestern Arizona, during spring and summer months when wildlife use is highest. Each development was labeled by adding small amounts of "heavy water," in which deuterium comprised 95 percent of the hydrogen atoms. This gave the labeled developments an isotopic signature dramatically different from other free and preformed water sources.



GEORGE ANDREJKO

64% CATCHMENTS

35% OTHER SOURCES (FRUITS, LEAFS, STEMS AND RAIN)

Blood samples from birds and bats were analyzed similarly. Comparing blood isotope values with those of the water sources showed which sources had been used by each bird or bat.

Dr. Blair Wolf of the University of New Mexico and his students then used mist nets to capture birds and bats at each site. After capture, each animal was identified and measured, then released once the scientists took a small blood sample. At the same time, they also collected samples from available water sources, including the water development, rainwater, insects, and cactus fruits and other plant parts.

In the laboratory, each water source sample was processed by micro-distillation, yielding a small raindrop's worth of pure water. Hydrogen and oxygen isotopes in each tiny sample were then measured using the mass spectrometer. This analysis revealed the distinct isotopic signature for each water source.

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What the Stable Isotopes Tell Us

During the three-year study, the University of New Mexico researchers captured 1,300 birds representing 49 different species. Approximately 25 percent of the individuals had consumed labeled water from the water developments.

Year-round and summer-resident species had the largest proportion of catchment water in their bodies, ranging from 13 percent to 64 percent. These included mourning and white-winged doves, house finches, Gambel's quail, Northern mockingbird, common poorwill, lesser nighthawk and Western screech-owl.

In contrast, neotropical migrants passing through the Sonoran Desert during spring migration rarely consumed catchment water. The water in their bodies was obtained from insects and plant fruits, including those of saguaro cactus, wolfberry and mistletoe. Apparently, they can obtain most or all of the water they need from moisture contained in these food items.

Body-water isotopes were measured in 330 bats. All eight species that are summer residents in our study area were captured, including the pallid bat, Townsend's big-eared bat, California leaf-nosed bat, big brown bat, Yuma myotis, cave myotis, California myotis and Western pipistrelle. Every captured bat had consumed labeled water from the water developments. The proportion of body water from water developments was consistent, comprising 16 percent to 19 percent of the total amount. The remaining body water was obtained from insects, the primary food item for these species.

These efforts shed new light on the value of water developments to Sonoran Desert wildlife. We now know that what were

previously considered "game waters" are of tremendous importance to nongame species, including passerine birds, raptors and bats.

The Sonoran Desert always has been a demanding and dynamic environment. Expanding human populations and a changing climate may make it even more so. Providing reliable water sources for game and nongame wildlife will be an increasingly valuable management tool for the department and other resource managers. 🦉

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