Wildlife and Habitat Restoration in the Chiricahuas: Bringing Back the Water

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In arid regions, surface water plays an incredibly important role in shaping the animal communities that occupy an area – for many species it's the only means they have for accessing this limiting resource. Large bodied mammals have particularly high water needs. Unlike many of the smaller desert adapted mammals who can get water from their food, larger animals need access to surface water to survive. But this does not mean that simply adding water is the solution.

In arid regions where humans have settled, surface water is also one of the first resources to disappear, or to be diverted into channels and moved elsewhere. A long history of human occupation in Arizona has left many of it's rivers dry – many perennial rivers have become intermittent or even ephemeral. Early accounts of trappers were attracted to Arizona by the vast numbers of beaver, if that's any indication of how different things are now. So to say that humans have changed the availability of water on the landscape in Arizona is an understatement – and in so doing we have reshaped the communities of animals that rely on surface water.

Beaver (*Castor canadensis*), a landscape engineer who specializes in retaining surface water, was among the first to disappear in Arizona – but not because of water shortage. Beaver were an abundant resource that brought some of the first settlers to the desert southwest. In "Man and Wildlife in Arizona", Goode Davis explains how early trappers describe the Gila River, between its confluence with the Salt River (Phoenix) to the Colorado River (Yuma) as: "200 yards wide, with heavily timbered bottoms". Today no water remains in that river section, just as no water from Arizona is able to reach the sea.

Southern Arizona's river systems – and the narrow bands of riparian forest they support – were once natural corridors which promoted the seasonal and annual movement and life cycles of wildlife across an otherwise inhospitable desert terrain. Grizzly bears and wolf packs would follow these threads of green from the Colorado Plateau southward through the Sky Islands and into the Sierra Madre Mountains – a journey that today would be nearly impossible given the almost complete lack of perennial water along the way.

Not just corridors, however, these narrow green strips also support entire ecosystems of plants and animals found nowhere else. But as surface water disappears, so do the cottonwoods, willows and the willow flycatchers they support. Driving across Arizona today it is nearly impossible to imagine

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that rivers and streams (and not just linear irrigation canals) once meandered across the desert connecting the mountains to the sea. But no longer – today we see a different picture. Surface water is almost entirely under the direction of mankind – we channelize it, fence it off and make it nearly inaccessible to nature. Rivers that start in the mountains slowly disappear into the sand to recharge aquifers, depleted by increasingly deep wells, among other things.

Understanding this historical context is critical to thinking about the issues of surface water in the Southwest today, and especially as we continue to try and restore and protect what remains of this limited and limiting resource. Attempts have been made to restore surface water for large vertebrates, namely so called "wildlife water". However, time and time again we have learned that it is not just as simple as putting water tanks out in the desert

To evaluate the impact watershed restoration has had on large vertebrates, we used cameras traps to conduct wildlife surveys across paired watersheds in the western Chiricahua Mountains – Turkey and Rock Creek. Turkey Creek has a 30-year history of watershed restoration in some of its reaches, and provides an excellent example of a free flowing perennial creek (Turkey Pen). Not ironically, watershed restoration is really just mimicking what beaver used to do for us – only using rocks. So for the past 30 years Valer and Josiah Austin, together with countless volunteers, built loose rock structures by the thousands – to slow water down as it came down the western flanks of the Chiricahuas. Slowing the water builds up soil, which acts like a sponge and stores water – slowly releasing it and creating a new riparian microhabitat.

Rock Creek, immediately to the north, has not been restored; however, it is similar to Turkey Creek in many other ways – thus allowing us to make some interesting comparisons. In theory, we have an opportunity to test some assumptions about water restoration projects and wildlife communities in two proximate watersheds with very different surface water availability. However there are many other factors besides water, including fire and grazing histories, which can impact wildlife – so we attempted to balance as many covariates as possible with a robust sample size. Landscapes do not easily comply with our notion of replication in science.

Camera-traps offer a good opportunity to evaluate wildlife species in a given area – and increasingly analytical tools are available to help sort, manage and summarize photographic data. However, this tool is not without its challenges – although camera-traps are rapidly becoming a "go-to" tool for resource and land managers, researchers, and hobbyists to document wildlife – getting an adequate sample size means having a lot of cameras over a large area. This can be expensive and logistically challenging, especially when working outside of protected areas where there can be many land owners. During this study we used approximately 50 cameras in a 1km grid to saturate the available study area.

Immediately, a spatial constraint we faced was needing to limit the study area to avoid designated Wilderness Areas, where the use of such technology can be interpreted to violate the construct of the Wilderness Act of 1964. This limited our access to high-elevation areas and, thus, our ability to look at wildlife use of these habitats seasonally, but it did not influence the

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ability to balance the design between restored and unrestored watershed.

In the course of 2 years of sampling, we obtained over 2 million photographs from these watersheds. This incredibly high volume of pictures (predominantly of grass, to give away the ending) is due to several factors, both related to the environment and to the equipment. First, our study design calls for a semi-random camera grid, in a rough and broken terrain dominated by grasses (at lower elevations) and with sparse means of attachment. To maintain the integrity of the design we often had to place the camera in sub optimal conditions – where even a weed wacker was just a temporary solution.

Although the final results may take some time to get to, the lessons learned and initial observations are clear. Animal communities are not stagnant but change seasonally and over time depending on more factors than we can measure – however, setting up a study design over roughly 20 square miles (50 square kilometers) to test this theory can be daunting. With every compromise is a change in capture probability and, thus, a change in integrity of the data – in other words something to be avoided. But if a picture is worth a thousand words then we are well on our way…

The single most valuable tool for the longevity of almost any site was a weed wacker. It is simply not possible to find areas that do not have grass that would otherwise not bias the sample. This may seem unlikely – but this is a function of the mechanics of the tool being a poor match for the habitat. Whereas camera-traps are a fantastic tool in closed forests where their "heat-in-motion" detectors will almost always be triggered just by warm bodied animals, grasses have a tendency to heat up in the sun and be blown around by the wind. This of course triggers the camera, which can take 3 pictures every 10 seconds. On a sunny windy day, grass and branches alone can take 12,000 images, and in less than a week the memory card will be full and batteries dead. Thus a tool which we would normally expect to yield 6 months of data is reduced to 6 days – and almost as much time to sort through the now meaningless data.

The underappreciated limiting resource for doing such projects is time – sure, it takes a few weeks every few months to keep batteries and memory cards working – but sorting through all of the data is an entirely different monster. A normal human, using some techniques we have developed to accelerate sorting – can go through and sort about 1,000 images an hour (with some practice). Thus 2 million images requires about 2,000 people hours to manage. That's about 50 weeks – or one year of doing nothing else…40 hours a week. Because of this shortfall we raised money to create the Wildlife Research Assistantship at the Phoenix Zoo – both to hire seasonal field assistants but also to get a small team of people focused on sorting images.

Overall this study was designed to look at the differences between wildlife communities in restored versus unrestored watersheds – yet what we have learned about the complexities of this species relationship with water is astounding. It's easy for us to quantify water as "resource necessary for survival"; however, it's really much more. We have countless images of black bears playing with floating logs, rolling in the mud and using water as much more than just a drink.

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Although the verdict is still out on the difference between restored and unrestored watershed in terms of numbers of species, seasonality, activity patterns, etc. – the obvious is clear. When the water is gone, so are the majority of the species. But it is also not that simple; cameras only detect animals within a limited area, thus it is easy to say waterholes are not visited when they are empty – we did not need a 2-year project to find that out. We still do not know a lot of things that the cameras cannot tell us – where do bears go in the winter? How does a constantly changing mammal community structure (in response to water availability) shape other resource use?

From research done at maintained wildlife watering stations, we know that the addition of such a resource has a dark side – it can increase predation, competition, and disease transmission. These results come from water, which is at a point source, much like relictual water holes in an intermittent stream. However, in restored watersheds with perennial flows – water is a linear resource, which releases it from the problems of aggregating animals. Thus, we can think of the effects on communities as being very seasonal – during the driest times of the year when water is limited to point sources, animal communities will be increasingly stressed and take more risks but also work more cooperatively.

Water also has an afterlife in the mud left behind after it is gone, as there is an almost complete shift in species use before and after a water hole dries up. Thus, a waterhole wallowed in by bears, scrapped open by bears and dabbled in by skunks becomes a "cement mixer" for nest building birds, or a cache for a squirrel's nut stash. Each waterhole has its own character – derived from its position in the hydroscape, basement material, slope, etc. – some dry up early, others can retain water all year. Observation of bear images from this study also suggests that individual bears have a vast knowledge of when and where water exists on the landscape – in many cases a skill probably passed down from one generation to another. However, to properly evaluate this we would need a different set of tools – radio collars. Thus, an important follow up to our research would be to follow individuals from a suite of species for multiple seasons to see how space is used, and in many cases shared.

Large-scale research projects are increasingly important as large-scale processes need to be evaluated at the scale at which they operate. We used 50 cameras in this study; however, considering the amount of possible explanatory variables on the landscape, 500 cameras would have been a more robust sample size. However, we are, interestingly, at yet another stage in the development of this important wildlife tool. A tool that 20 years ago we built from scratch with spare parts, 15 years ago used "rolls" of film limited to 36 exposures, and only 10 years ago became fully commercially available in the form we see today. Our current limitation is no longer about the size of the memory card or the longevity of the batteries – humans are now the limiting factor. We need to replace the process of sorting images manually with something faster, something automated. But at what cost? How many animals will it miss, how many animals do we miss after 6 hours of sorting? Over the next few years our challenge is not to get less photos, but to remove the limitations of the human mind from the sorting process.