Water Storage and the American Beaver (Castor Canadensis). A Solution to Colorado's Aquatic Resources Challenges

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Introduction

The American beaver, a nuisance to some and an afterthought to others, may in fact be Colorado's most effective tool to improve watershed health and regulate the state's water supply.

Among the first adventurers in North America was the fur trapper, whose transient presence left what today we might consider the first wave of mass ecological degradation. Although most fur-bearing species were sought out, the beaver pelt held the distinction of being one of the first true forms of currency, like wampum, on the North American continent. Thus, it follows that in relatively short order the beaver, and by default their dams and ponds, were extirpated in most regions of the continent.[1]

According to The Lands Council (Spokane, WA; 2010), in their study conducted in Eastern Washington State on water storage by the beaver, they estimate that 10 acre-feet (ca. 3.26 million gallons) of water storage can be attributed to a single beaver due to its dam-building prowess. According to the authors, this is a conservative estimate of the amount of surface water and groundwater water held back by the average beaver included in their study. If this is an accurate figure, then it would take about 40-million beavers to store the equivalent amount of water that the entire United States used for all sectors – public and domestic supply, irrigation, livestock, aquiculture, self-supplied industrial, mining, and thermoelectric power – in the year 2010 (129.6 trillion gallons; USGS.) The beaver population of North America was estimated at 6-12-million (Naiman, 1988) and currently "is probably 10 percent, or less, of the original number" (Brown and Fouty, 2011.) The beaver population before the European fur trapper has been estimated at between 60-400-million (Seton, 1929), so the amount of water that the beaver once stored on our land was potentially sufficient to easily satisfy today's water storage requirements, at least in absolute terms.

The beaver is largely absent from Colorado's discussion on water issues. These statistics alone show that beavers should be central to the state's plans going forward.

The Functional Extirpation of the American Beaver and Its Connection to Water Storage in Colorado

In order to understand the potential for beavers to help solve Colorado's water resources challenges, lets consider water storage from both a historical[2] and modernistic perspective. The "new normal"

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[1] As discussed here, the extirpation of beavers and other fur-bearers dramatically altered the ecosystem. Hood and Bayley (2008), after having studied the activities of the beaver in Alberta, Canada, across a 54-year period, went so far as to state "the removal of beaver from aquatic systems should be recognized as a wetland disturbance equivalent to in-filling, groundwater withdrawal, and other commonly cited wetland disturbances."

[2] For our purposes, the "historical context" includes the conditions in which the first European pioneers found themselves within the "New World" through today. The "modernistic context" includes the most advanced information on watershed science, in which one cannot isolate water storage or any one aspect or attribute from other aspects and attributes of the watershed. In the modernistic context everything is interrelated, including ecological systems, aquatic resources, and ecosystem products and services found within and derived from a given watershed.

differs markedly from that of bygone days. Along with the arrival of the European pioneers came the gun and the steel trap. In an instant in geological time, ecosystems were altered in large measure by ongoing removal of top predators, "bushmeat" species such as elk and pronghorn antelope, and furbearers. As a consequence of the loss of keystone species, including the gray wolf, prairie dogs, bison, and the beaver, ecosystems drifted away from conditions that had spanned across several millennia.[3] Mounted upon the loss of these species, along with the resulting widespread changes in species composition, were radical manipulations of water resources: wetlands drained, streams diverted and channelized, roads in riparian corridors that constrain stream function, inter-basin water transfers, and verdant valleys flooded behind massive dams.

Yet, the arguably most destabilizing shock to Colorado's natural aquatic ecosystems came in the mid 1800's with the functional extirpation of the industrious "ecosystem engineer," the American beaver. The extirpation of the Colorado beaver occurred before Colorado became a state in 1876, and thus the once abundant American beaver is absent from the state's "new normal." The nearly complete removal of the beaver from the local landscape led to an ongoing decline in productive natural Colorado ecosystems and ecosystem services that beaver engender. Today, although beaver populations have partially recovered, their abundance is only a small fraction of what it was prior to the arrival of the European pioneers.

Historic beaver populations and their workings, such as beaver dams, ponds and beaver meadows, stored massive amounts of water and carbon, as has been recently reported (Wohl, 2013.) The valley bottoms are areas that were occupied throughout geologic time by the beaver. Beaver activities are believed to have resulted in aggraded valley bottomland with accumulations of sediment in beaver meadows over the past 12,000 thousand years (Ruedemann, 1938; Ives, 1942), minus the last 150 as the beaver was rendered functionally extinct by the new arrivals.

Beavers and Ecosystem Services

Recent studies reveal that beavers offer tremendous ecosystem benefits—increased natural water storage and improved watershed health, among many other things. Indeed, above ground water storage of a beaver pond is only part of the total amount of water stored due to beaver workings. The beaver dam increases the width of the stream channel and leads to an expanded zone of saturated soil within the proximity of the dam. In fact, more than two-thirds of the water stored by a beaver colony is shallow ground water (Pollock et al. 2015.) That water detained behind beaver dams slowly seeps into and through the hyporheic zones of the stream. Every stream has a hyporheic zone, the region of a stream channel where mixing of surface and ground water occurs. But the hyporheic zone of the beaver-occupied stream is much larger and thus stores more water than that of a stream devoid of beaver.

Beavers live in family units, or colonies. An adult beaver pair will generally have two to four young per year. Second-year offspring leave the colony to start their own colony. When young beavers happen upon favorable habitat, they generally remain in the location and get to work. Beavers find a suitable location along the stream channel and temporarily block the flow by building their dam of mud, sticks and rocks. The result is that water spreads out and percolates into a much wider area than if the dam was not built. Habitat where beavers are active changes dramatically. Water fills in behind beaver dams

[3] Ecosystem conditions varied little in the Holocene Epoch, an unusually stable geologic epoch that began after the last ice age and has persisted for almost 12,000 years.

to create natural ponds. Because the beaver dam is porous, much of the area below the dam becomes saturated wetlands. Over a period of years or decades beaver ponds fill in with sediment and beavers abandon the pond. The dam becomes breached but the remaining nutrient-rich sediment supports pioneer plants, which initiates a new round of plant succession. This is the beaver meadow. Thus, the beaver workings include the pond, downstream wetland habitat, and beaver meadows, which change over time with a high degree of regularity. The result is a mosaic of beaver-influenced habitats. From pond, to marsh, to meadow, each stage in the succession of beaver ponds supports a new and different suite of plentiful and diverse plant and animal life, much more than the little ribbon of flowing water in the channel of a stream devoid of beavers.

Furthermore, a flowing stream is said to be a “lotic” environment and ponded water is said to be a “lentic” environment. Lotic and lentic environments have two distinctly different assemblages of species. When beavers occupy a stream, both of these assemblages are present and species diversity soars, especially in the arid west where the beaver pond is an oasis of plenty, attracting and nurturing life. Natural diversity enhances stability and thus diverse ecosystems are resilient. Resiliency is the capacity of a system to “bounce back” from a disaster, such as flooding, or to resist catastrophes such as disease outbreaks or wildfires. These are vital ecosystem services.

Beaver Reintroduction Offers Colorado a Potentially Effective Path Towards Water Security

The recently released Colorado Water Plan provides a comprehensive guide on how Colorado intends to address its future water challenges, including the anticipated water supply-demand gap. The over 500-page document is impressive in scope, and covers topics such as safeguarding the state’s water compacts, protecting the doctrine of prior appropriation, upholding water law, and improving municipal conservation, among other things. Precious little space, however, is dedicated to ecosystem services or the beaver.

So how does the natural environment fit into Colorado’s water picture? Nature’s needs are our needs because society is reliant upon ecosystem products and services for its continued prosperity, particularly since anthropogenic climate change is looming. If we take hints from nature, as has been suggested by Janine Benyus in her book “Biomimicry” (2009), we would be better served with “innovation inspired by nature” than if we continue to exert dominance over nature. And there are indications of greater awareness of the importance of ecosystem services, as evidenced by much of the content of the Colorado Water Plan. Still, not enough attention is paid to the benefits of nature on issues like our state’s water supply.

Thus, we get to the question of how do we sustain and secure Colorado’s water supply. Rather than focus on the antiquated prior appropriation system or continue to build massive, hugely expensive gray infrastructure, we should look to the original inhabitants of the region, the American beaver, for some answers. Reintroduction of the beaver, the original ecosystem engineer, and sustainable beaver management in a state like Colorado has the potential to affordably store greater quantities of water than that which could reasonably be held back by expensive dams and water storage reservoirs. Water held back by beaver dams naturally percolates into Colorado earth at times of plenty and is slowly released at times of scarcity—maintaining more even stream flows throughout the year. Moreover, a proliferation of valuable ecosystem services, in addition to water storage, accompanies the restoration of beaver populations, including the following: water cleansing; flood attenuation and stream flow moderation; carbon storage/sequestration; groundwater recharge; greater native species diversity; Aspen recruitment; refugia for fish, amphibians, songbirds, and waterfowl; preservation of habitat during forest fires; sub-irrigation for agricultural crops; and many other important attributes that benefit people. Yes, there are annoyances such as beaver gnawing on trees and blocking culverts and diversion ditches, but there are new, inexpensive, non-lethal, and effective remedies for these annoyances (Pollock, 2015.)

Beavers, which ranged across most of the North American continent prior to the arrival of the early European immigrants, should have the inherent right to re-inhabit its range. Given the opportunity, the beaver will get to work storing water in a distributed manner across Colorado's landscapes. For those who do not agree that beavers should of their own merit be allowed to exist, perhaps we can agree that it would be wise to take advantage of the industrious beaver for the benefit of society. The benefits of beaver reintroduction are potentially immense, and will cost significantly less, in terms of direct and externalized costs, than flooding more valleys with yet more dams and reservoirs.

Harnessing beavers to increase water storage capacity and ecosystem services is gaining recognition in several states across the U.S. This is an approach to water storage in the "modernistic" context, with a broader focus on aquatic ecosystem restoration, and the beaver and other modern ecosystem restoration practices, which include beaver dam analogs that mimic natural beaver dams, should not be overlooked (Pollock, 2015.) Potentially, the easiest, cheapest way to accomplish this end is to allow nature to regenerate where practicable to its previous state with the mighty ecosystem engineer, the American beaver, breaking the trail. In fact, restoring and protecting the beaver population is consistent with the intent of the Colorado Water Plan – store water, conserve aquatic resources, and close the approaching water supply gap – and goes further to deliberately enhance ecosystem productivity and resilience.

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