Climate Change and Beaver Activity
How Restoring Nature's Engineers can Alleviate Problems

By Suzanne Fouty

Variability is a defining principle of our global climate. Both species and stream/riparian ecosystems evolved with that reality. There have always been years when the rains did not come or years when the rains came too soon or too much. Species responded by developing survival mechanisms, such as wide distributions and variable timing of flight or spawning. These mechanisms combined with complex, widely-distributed, highly stable stream/riparian ecosystems, allowed species to survive even when local groups disappeared due to a disturbance. Beavers were key in the development of these complex and highly stable ecosystems essential for species survival.

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Euro-Americans arrived on a continent teaming with abundance. Their quest for commodities and wealth drove Euro-Americans to systematically and rapidly log, mine, graze, beaver trap, farm, dam rivers, etc. They systematically and rapidly stripped watersheds of all the features that had provided complexity, stability and water retention capability.

Many of these watershed changes predate photographs or detailed records and scientific studies. Instead, historical documents and journals provide us with snapshots in time of small areas – snapshots often separated by several decades and located at different places within a watershed. Fortunately, the story of stream and riparian ecosystem response to Euro-American land use and the speed at which it happened can be pieced together by combining and comparing information found in the journals of early trappers, later military expeditions, settlers, along with post-settlement historical records and recent scientific studies. These documents reveal that watersheds have undergone multiple, large-scale changes such that current conditions bear no resemblance to pre-Euro-American conditions. Responses to climate change and climate variability have been greatly amplified as a result of those changes. Beaver trapping was the first large-scale Euro-American alteration of watersheds. As beavers were trapped out and their dams failed from neglect, channels began to form in the soft sediments trapped behind the dams. Over time these channels became increasingly connected. Streams and adjacent riparian zones shifted from systems dominated by ponds, multiple channels, wetlands, marshes, and wide riparian zones abundant in fish and wildlife to the simple, incised, overly wide, single-thread channels with narrow strips of riparian vegetation that we know today. These changes in streams and drainage networks have led to decreased system stability and complexity. The result is lowered water tables, reduced summer base flows, higher flood magnitudes with more frequent flooding, reduced wetland acreage, and greater sensitivity to drought. Our watersheds no longer store and slowly release water, help dampen flood peaks, or sustain stream flows during droughts. Rather the connected and incised river systems now function as sewer lines, rapidly moving water from the upper to the lower watershed, and severely compromising the ability of human and wild communities to successfully deal with climate change and

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Figure 1. Price Creek, MT (1995). Beaver-dam controlled reach just upstream of Reach 3 in Table 2.

Figure 2. Price Creek, MT (1998). This is Reach 1 (see Example 5), downstream of Figure 1. In both 1995 and in 1998, this section lacked beaver dams.

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the extreme weather events it brings.

Rapid restoration of watershed systems is critical for our survival. The return of abundant, actively maintained and widespread beaver dams is critical to that restoration. The following five examples from different areas demonstrate the role that beavers and beaver trapping play in enhancing or degrading stream/riparian stability and complexity, including water storage capability. These five examples show that the beaver's influence is not limited by geography.

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Example 1: Upper Mississippi and Missouri River Basins (Hey and Phillip 1995).

The researchers estimate that beaver ponds covered 51,100,000 acres in 1600 compared to 511,000 acres in 1990. They estimated wetlands at 44,700,000 acres in 1780 versus 18,900,000 acres in 1980. This reduction in ponds (surface water stored) and wetlands (groundwater stored) has resulted in a huge loss of flood control, and system stability during droughts and years with high precipitation.

Example 2: Kabetogama Peninsula, Minnesota (Naiman et al 1988).

This study evaluated changes in stream and riparian systems between 1940 and 1986 as a result of beavers returning to the area. Table 1 shows the increase in ponds, wetlands and wet and moist meadows – indicating more surface and ground water storage – during the expansion of beavers and beaver dams. It is certain that dry periods and wet periods occurred during the 46 years, yet over that time the amount of water stored increased.

Table 1: ***Change in ecosystem type, abundance and water stored in the drainages of the Kabetogama Peninsula, Minnesota between 1940 and 1986.***

Cover type	Area (acres) 1940	Area (acres) 1986
Forest	8668	0
Moist	531	3378
Wet	69	2542
Pond	40	3388
Total	9308	9308

Example 3: Elk Island National Park in east-central Alberta, Canada (Hood and Bayley 2008).

This study examined changes in the amount of open water during dry and wet years between 1948 and 2002 due to the presence, or absence, of beavers. 1950 and 2002 were both very dry years. Beavers were absent in 1950 and wetlands held 61% less open water (565 acres) then, than in 2002 when beavers were present (1467.5 acres). The average pond size in 1950 was 9.6 acres compared to 87.7 acres in 2001 (ponds were measured in 1948, 1950, 1996, and 2001). The 2001 values represent a huge increase in the amount of water stored in the system. The beaver dam building and maintenance made the area much less sensitive to drought and helped decrease downstream flood peaks by increasing the river's rapid access to its floodplain during high flows .

Example 4: Crane Creek, Oregon (Schaffer 1941).

Prior to 1924 beavers were present in Crane Creek and the meadows had stirrup-high native grasses. The grasses were sub-irrigated by beaver ponds. In 1924 the beavers were trapped out. In 1925 the channel began to incise and by 1935 the channel had deepened 25 feet. Instead of stirrup- high native grasses, there were clumps of new sagebrush and only sparse remnants of original grasses, showing just how fast channelization and transformation could occur. In 1936 beavers were reintroduced, and by 1938 the water table had risen and the hay meadow production had improved. 1939 was a drought year, yet water was abundant on the ranch with beaver ponds, while absent downstream on the ranch without beaver ponds.

Example 5: Price Creek, Montana (Fouty 2003).

This study showed the impact of the return of beavers and their trapping on water storage. Although beavers were trapped out between 1994 and 1995, the beaver dams inside the cattle exclosure were still largely intact and functional in 1995. In contrast, dams were absent downstream of the exclosure (Reach 1), though remnant dams had been noted during the 1994 survey of Reach 1.

Table 2 shows the average water depths and the variability in water depths (standard deviation) in the three reaches in 1995 and 1998. In 1995, the average water depths in Reaches 2 and 3 (beaver-dam controlled reaches) were twice the average depths in Reach 1 (no beaver dams). In addition, the variability in water depths in Reaches 2 and 3 was greater than in Reach 1, indicating more variable channel bed habitat with possible fisheries and macroinvertebrate benefits. By 1998, the dams in the cattle exclosure had either completely disappeared or were actively breaching. Water levels were now similar in all three reaches.

Photos on page 4 (Figures 1 and 2) show the difference between reaches with and without beaver dams.

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Table 2. ***Comparison of maximum water depths in Price Creek, MT in 1995 and 1998. By 1998 all the dams in the beaver-dam controlled reaches had either totally failed or were failing after beavers had been trapped.***

Stream Reach	**Average water depth (ft)**		**Standard Deviation (ft)**	
	1995	1998	1995	1998
Reach 1 (no beaver dam influence)	0.9	0.75	0.36	0.32
Reach 2 (beaver dam influence)	2.15	0.9	0.7	0.42
Reach 3 (beaver dam influence)	1.73	0.8	0.75	0.4

Coping with climate change

We are entering a period of increased climatic variability with more droughts and severe floods. At the same time our demands for water are growing while the quality and quantity is decreasing. Groundwater levels continue to drop, perennial streams go seasonally dry, wet meadows transform into sagebrush-dominated systems in the West, and large floods appear to be increasing.

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Too often the response has been to build more reservoirs or build more or higher levees along rivers. These activities may give us greater control over the short-term, but little else. Reservoirs do not provide habitat or wetlands or groundwater storage. Reservoirs often serve only a very few people at the expense of many species and communities. Confined rivers do not recharge water tables or develop complex habitats. Instead, they increase downstream flooding by severing the connection between the river and its floodplain – so there is nowhere to temporary store water.

Competition is increasing between communities and groups for this limited, vital resource. It is time to systematically, strategically, and rapidly restore the stability, complexity and water retention capability of stream and riparian ecosystems. Beavers are key to this restoration. In order for beavers to successfully aid us in restoring watershed vibrancy, stability, and complexity, we must first begin to restore riparian woody vegetation to stream banks – the food and habitat of the beavers – and we must change beaver trapping regulations to provide them greater protection.

The return of beavers and recognition of their contribution, combined with thoughtful assessments of local constraints, will lead to rapid increases in surface and groundwater storage, decreased large floods, improved water quality and increased water quantity within a few years. Beaver restorations will not make sense everywhere because of the extent of human development. There are large areas of public land, however, where beavers could be allowed greater freedom to expand, as well as private lands where beavers would be welcomed. These areas would become water storage zones – complex ecosystem reservoirs that would provide huge benefits to many human and wild communities. Early identification of the suitable areas for beavers, and the acceptable limits of beaver-driven changes, would allow planning to minimize beaver conflicts and maximize benefits.

Time is short. There are many things human and wild communities can live without. Water is not one of them.

The author Suzanne Fouty is a hydrologist who recently spoke on beaver restoration as a strategic response to climate change at a Wildlife Society beaver workshop in Oregon.

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