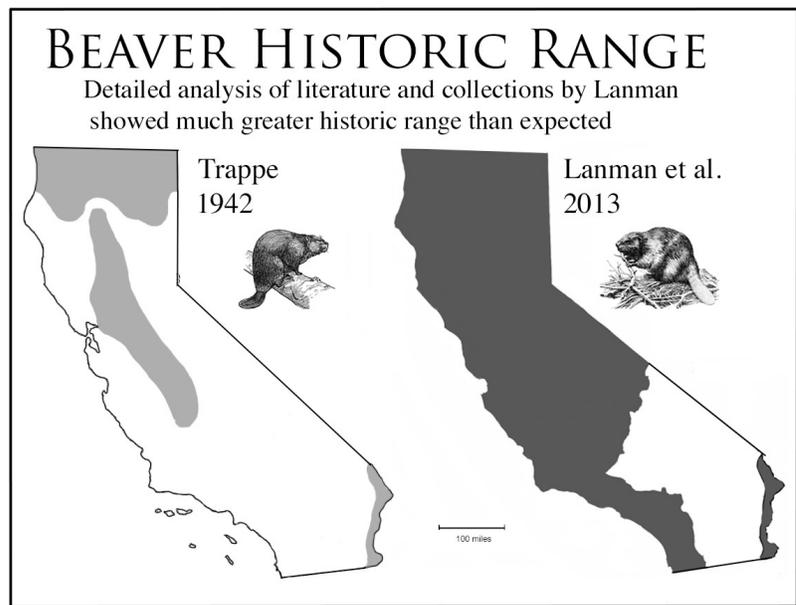


Beaver reintroduction for watershed restoration

David A. Bainbridge

The beaver is a highly social, adaptable and energetic mammal. They are probably second only to humans in their effect on the environment. The North American beaver (*Castor canadensis*) was once very common and widely distributed with populations estimated as high as 400 million in North America before European settlement, trapping, hunting and habitat loss. They ranged from habitat as hot as the Colorado River in the deserts of Arizona and California and the Gulf of Mexico and Florida to the far north of Alaska and Canada. In some areas the First Nations considered beaver ‘people’ related to humans and treated them kindly.

Recent research in California has revealed a much historic greater range for beaver than previous studies suggested. They had been so thoroughly trapped out, so early that biologists thought they had never been there. They were wrong. In 1829 Hudson's Bay Company Trappers from Oregon took 4,000 beaver skins from the shores of San Francisco Bay. Using fur trade notes, pioneer accounts, newspaper articles, and archeological and physical evidence the historic range of beaver was extended to almost all of California except the driest deserts.



Beaver-an introduction

Beaver are large rodents with very sharp and tough front teeth that grow continuously and sharpen against each other. These ivory chisels are used to cut trees and collect bark and leaves for food. They can reach 4-6 feet in length and weigh 50-90 pounds or more. Their very strong muscles are helpful for moving logs and stones for dam building. The front legs are rather short but able to grasp and manipulate items. The rear legs are larger and stronger with webs to improve swimming. The two inside rear toes are specially designed for grooming. Beaver produce the yellowish secretion “castoreum” in two sacks between the pelvis and the tail bone. The paddle like tail is flattened and scaly and up to 10 inches long. It is used to produce the warning slap when danger is perceived. They can dive for up to 15 minutes.

The beautiful and tragic flaw of the beaver is the magnificent fur. Colors range from yellow brown to almost black. The fur is very dense with guard hairs over soft under fur. The hairs interlock to help protect the beaver from the water by holding in air. Secretions from the anal gland provide the water proofing.

Beaver waddle along standing upright unless frightened, when they can move faster in a rather awkward gallop. Their slow speed makes them vulnerable on land and they try to develop and use ponds, slides and canal systems to stay in the water as much as possible. Beaver are most active at dawn and dusk, but will also work at night. Some early reports suggest they were more active in the daytime before hunting and trapping almost exterminated them.

Beaver will typically live 10-15 years but can reach 30. They form long term pair bonds. They usually breed in winter and give birth in spring with only one litter of 2-4 kits. Under good conditions a female may give birth at age 2 or 3. Older mothers tend to have larger, more successful litters. The kits can eat mostly solid food after a month. They can swim at 4 days and dive within 8 weeks. They may stay with the parents for two years or longer to learn how to be a successful beaver. Dispersing beaver face many risks in relocation, particularly if their journey is partly over land.

Beavers are social and live in colonies if the conditions allow it. They may simply be a large family group of adults, subadults and kits, or a group of related beaver on adjacent territories. This can include several generations of beavers. Grooming is a favorite social activity, done mainly inside the house for safety. Some very large dams have had several families living in the same pond and I have seen a number of houses in use even on a relatively small lake. Dominance has been suggested to be matriarchal or size related. Scent marking is used to define territories and little mounds may be set up as markers.

Beaver are highly adaptable and can survive and prosper in very difficult environments ranging from the Colorado River in the desert to the Yukon River in northern Alaska. I have seen a beaver living at a lake at 10,000 feet in the Rockies with nothing but small willows and herbs to eat. I have also seen an urban beaver living in a polluted and grocery cart filled creek in Portland. The most enterprising beaver I have seen was developing a dam and canal system on a small creek on a side slope near Lizard Head peak high in the Colorado Rockies.

A beaver family will set up their home on a lake or small to medium sized creek with relatively low gradients. If sufficient material is available the house is elegantly designed and stoutly built of sticks and mud with the living quarters accessible only by water covered entrances. This will be set out in the lake or pond if possible. If the lake shore drops off to steeply, a river is too wide or swift, or if materials are short the beaver house may be set on or tunneled into the bank. The Colorado River beaver houses are typically bank tunnels.

Dam building provides the basis for the saying "busy as a beaver." Beaver will build quite elaborate dam and canal systems to manage water and improve their quality of life. Downstream branches are set sharp end down and then filled in with a complex web of sticks, vegetation, stones, and mud. The density of beaver dams can be remarkable even on a very small stream. I have seen a stretch of a small creek in Colorado with more than 30 dams. Studies have suggested

that beaver are effectively programmed to build when they hear the sound of rushing water. Special silent water bypasses can help keep beaver from flooding roads and neighborhoods.

Beavers will primarily eat bark if they can get it, with aspen, poplar, and cottonwood favored. They also enjoy leaves and bulbs from some species, with water lilies a favorite. In other locations they have relied on poisonous plants. The Malad River in Oregon got its name from beaver meat that made trappers sick. Beaver digestion is improved by a special cardiogastric gland and a large cecum with microbial populations to help digest the woody materials. When possible they store a large collection of preferred trees and food at the bottom of their beaver pond for use over winter.

Beaver devote many hours of work in the late summer and fall to caching food for winter. This is stored underwater near the lodge. Running out can be deadly because they are very vulnerable while gathering food on foot over the snow.

Risks to beaver

Beaver may be a preferred food for wolves in some areas. Mountain lions, coyotes, bears, wolverines, jaguars, lynx, bobcat and even river otters may also prey on beaver. The lodges offer good protection, particularly when they are frozen in winter. Humans have been the predominant predator. Beaver were hunted by natives for food and fur for thousands of years before Europeans arrived.

When felt hats became popular about 1800 the rush was on because the interlocking hairs made beaver fur an ideal source for felt hats. The best fur quality was found from late fall to spring. Beaver trapping in the Northwest was pursued vigorously to exterminate the beaver and create a fur desert to slow America's westward push. As Governor George Simpson wrote to John McLoughlin in July, 1826, "*It is intended that a strong Trapping Expedition be kept up to hunt in the country to the southward of the Columbia ... and to leave it in as bad a state as possible.*"

The impact of heavy trapping was described by Peter Skene Ogden in the Snake River country on May 28, 1829, "*It is scarcely credible what a destruction of beaver by trapping this season, within the last few days upwards of fifty females have been taken and on an average each with four young ready to litter.*" They quickly drew down and often wiped out the beaver populations taking males, females and kits. Peter Skene Ogden felt some remorse, "*It is almost a sin to see the number of small beaver we destroy and to no purpose. Some of the females taken have no less than five young... [and] rivers subject to overflow their banks require double and treble the time to recruit after being trapped.*" Alexander R. McLeod noted that in 1829, "*Beaver is become an article of traffic on the Coast as at the Mission of St. Joseph alone upwards of Fifteen hundred Beaver Skins were collected from the natives at a trifling value and sold to Ships at 3 Dollars*" By 1837 John McLoughlin noted, "*The (Sacramento) valley, itself, with the numerous streams owing into it, from the surrounding mountains have all been visited and their stores of Beaver considerably reduced.*"

Beaver activity is easily identified and trappers became very skilled at catching them. Female beavers do not mature for three years and do not produce successful large litters until even later,

so a repeated trapping effort can easily wipe out a population. As the adults were trapped out, any young beaver left behind would often be unable to fend for themselves. Widely dispersed survivors would have trouble finding each other and even if a colony restarted it would often be taken in the next year or two as the trappers returned. The rapid decline in population can be seen in decreasing returns from the Snake River country and the California parties. In one case when they revisited a previously trapped area they got only two beaver instead of eighty. David Thompson noted that on the Canoe River a trapper took 850 beaver the first winter, but after a second season they would be gone.

The total number of beaver taken in Alaska, the West and Northwest will never be known accurately as many were illegally trapped or traded and reports are often fragmented and unclear about the origin and destination of the furs. Records in California are limited because virtually all of the parties were in the field illegally or attempting to avoid taxes and tariffs. Many beaver were killed but not recovered when the traps were not set correctly. Beaver skins were also lost or damaged in transit and not recorded. We do know that The Russian American Company collected more than 200,000 beaver pelts from Alaska and the Northwest Coast from 1798-1842. The Hudson's Bay Company took more than more than 400,000 beaver from the Northwest. The beaver take on the Missouri was about 375,000 just from 1815-1830, with many of these from the mountains and some from the Northwest. And finally, perhaps 50,000 beaver were trapped in California and many others in Arizona, New Mexico and Utah. By the 1840s beaver populations were considerably reduced throughout the West and many populations had been wiped off the face of the earth. Trapping continued into the 20th century when only an estimated 1,000 beaver remained in California. Although protected by law in 1911 they faced continued hunting, trapping and loss of habitat. The West had indeed become a fur desert.

Castoreum was also harvested and used as a bait for trapping. It was also used until recent times as a scent enhancer in perfumes and as a food additive because it offered the scent of vanilla or strawberries. For more than 80 years castoreum could be found in some ice cream, gums and other foods as a 'natural flavor.' Traditionally it was considered a useful medicine. These days, castoreum is primarily used for fragrances because it is too expensive to use in food.

Ecological changes from beaver removal

The removal of beaver initiated change in watersheds and ecosystems through the beaver lands, reaching from the San Francisco Bay area, south to the southern San Joaquin Valley, along the western Sierra streams, through the coast range north to Oregon and throughout northern California. Beaver were wiped out on the East side of the Sierra. The Sacramento River delta and San Francisco Bay were particularly rich in beaver as Thomas Farnham noted, "*There is probably no spot of equal extent on the whole continent of America, which contains so many of these much sought after animals.*"

Beaver play important hydrologic and ecological roles in watersheds and their removal leads to undesirable changes. A research project in Wyoming released ten beaver into a river where they had been absent and by the following year they had constructed 55 dams. Not all beaver had dams or lived where dams were possible but removing as many as 750,000 beaver from the West may have taken out more than 2 millions dams. In California taking 50,000 beaver may have led

to the loss of more than 100,000 dams. Before trapping nearly exterminated the beaver their dams may have submerged 234,000 square miles of the US, an area comparable in size to the combined area of Nevada and Arizona. The myriad beaver dams stabilized river flows, improved water quality, controlled floods and provided protection for fish, birds, frogs and many other species.

Beaver dams are ecologically very important. They slow water loss from ecosystems, reduce stream velocity, and minimize erosive power during flood peak flows. Beaver dams also raise and stabilize the surrounding water table, which creates ideal conditions for riparian plants and trees. The often extensive beaver canals and channels also help spread water across flood plains and increase the area of wetland and riparian plant species.

All these factors are critical in the drylands of the West. By helping to maintain wetlands they improve water quality and enhance fish habitat in streams by increasing water depth, maintaining refuges of deeper cooler water, and improving stream flow. They also provide improved habitat for waterfowl, big game, and game birds and improve habitat for other wildlife through vegetative growth. Duck populations, for example, were seventy-five times higher on streams with beaver dams in a paired study comparison in Wyoming.

Beaver dams in the arid West are more likely to be more short lived than those in the North, often lasting only a few years before they are abandoned or washed out and need to be rebuilt or moved. Water storage starts to decline quickly after the beaver are gone; within a week or two the water level will drop six inches to a foot as maintenance work stops. In low gradient streams or rivers this can lead to a rapid loss of wetlands. When a flood causes a dam failure erosion can be locally severe as a large pond drains rapidly adding to the flood flow. Even if the beaver ponds are maintained they may fill in, creating first a shallow marsh and then grassy meadows that may provide unique and rather rare habitat types in arid and semi-arid areas. Studies in Montana showed that a beaver dam may be filled in completely within ten to fifteen years. Summer stream flows often decline or cease if the dams are allowed to deteriorate.

The dam building and foraging of the beaver also shape ecosystems in other ways. If beaver population densities are high then cottonwoods, aspen, and other favored food species may be over-harvested, causing long-term habitat decline for the beavers. This can be seen as a field of stumps with a tree line of palatable trees so far from the pond that the beavers will no longer cross it. The beavers may have to move on to a new location.

Beaver for watershed and ecosystem restoration

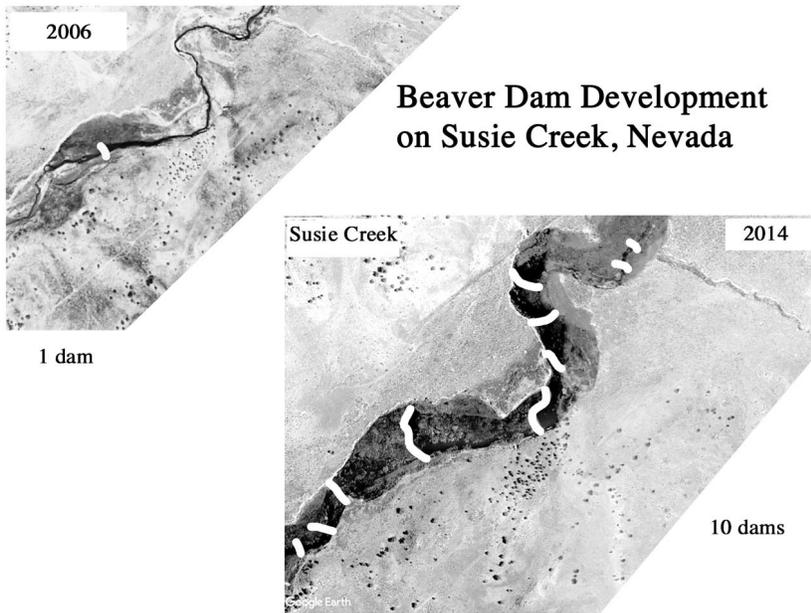
Although the value of returning beavers to their former range is not a new idea, it has gained importance in the last 10 years. One of the most remarkable, and successful restoration efforts involved parachuting beavers in to the Idaho wilderness in the 1940s. After decades of neglect and ignorance beavers are being appreciated for their many ecological benefits. Reintroductions are being made and impacts are being studied more carefully. Problem beavers are more likely to be relocated instead



Beavers in wooden boxes drop from a plane into the Frank Church Wilderness to start a new life.
CREDIT: IDAHO FISH AND GAME

of killed. And strategies for living with beavers are also being developed to avoid unwanted flooding and blocking of drain pipes.

Returning beaver to watersheds has brought water to streams that once dried up in summer. Reduced flood intensity has led to channel filling, reduced erosion and stabilized river banks. The changes in river flow and channel stability and increased areas of open water and wetlands have benefitted a wide range of plant, insect, animal and bird species.



Nutrient capture and retention by beaver ponds is also important and can improve stream water quality and ecosystem health. Total nitrogen increased seventy-two percent in a watershed with beaver, while the more available form of nitrate nitrogen more than doubled. Organic matter increased threefold after beaver dams were built. Phosphorus loss from the ecosystem was cut by two-thirds. These

combined effects typically improve productivity and reduce water pollution.

Beaver reintroduction is not always easy or even possible without human help. Artificial check dams may be needed to hold water long enough for plants and trees to grow large enough to support beavers. The complexity of ecosystem inter-connectivity has been revealed in studies in the Greater Yellowstone ecosystem. When the grey wolf was reintroduced in 1995, there were only 44 beaver colonies in the northern range of the park, but by 2007 there were 127 and more to come. The wolves changed elk behavior and by keeping the elk out of the riparian areas the wolves allowed willows and cottonwoods to thrive and this allowed beaver to return. The dams in turn created riparian areas that offered more food for elk.

Become a beaver supporter and foster watershed recovery. Encouraging beaver to build dams and create ponds is an affordable and effective habitat restoration technique. It is possible to use: passive actions such as: trapping restrictions or changes in grazing to increase food for beavers; simple relocation to help establish colonies;relocating beaver after installing stream stabilizing check dams and planting preferred food species. They often will do better if an established family is moved rather than unrelated individuals.

Beaver are a very effective watershed-scale restoration ‘tool.’ Ideally a beaver community should include several colonies. Help return these remarkable rodents to a waterway near you. Work to stop beaver killing and encourage beaver relocation instead.

Further reading

Bainbridge, D.A. 2007. *A Guide to Desert and Dryland Restoration*. Island Press. 416 p.

Gibson, P.P. and J.D. Olden. 2014. Ecology, management, and conservation implications of North American beaver (*Castor canadensis*) in dryland streams. *Aquatic Conservation and Management of Freshwater Ecosystems* 24: 391–409.

Goldfarb, B. 2018. *Eager-The Surprising, Secret Life of Beavers and Why They Matter*. Chelsea Green. 304 p.

Grey Owl. 1991 [1935]. *Sajo and the Beaver People*. Fitzhenry & Whiteside 187 p.

Pollock, M.M., G.M. Lewallen, K. Woodruff, C.E. Jordan and J.M. Castro (Eds) 2017. *The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains*. Version 2.0. United States Fish and Wildlife Service, Portland, Oregon. 219 p. Online at: <https://www.fws.gov/oregonfwo/promo.cfm?id=177175812>

Mills, E.A. 2010 [1913]. *In Beaver World*. Kessinger Publishing. 278 p.

Lanman, C.W., K. Lundquist, H. Perryman, J.E. Asarian, B. Dolman, R.B. Lanman and M. Pollock. 2013. The historical range of beaver (*Castor canadensis*) in coastal California and the San Francisco Bay Area: An updated review of the evidence. *California Fish and Game* 99(4): 193-221.

Lanman, R.B., H. Perryman, B. Dolman and C.D. James. 2012. The historical range of beaver in the Sierra Nevada: a review of the evidence. *California Fish and Game* 98:65-80.

Ripple, W.J. and R.L. Beschta. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. *Biological Conservation*. 145(1):205-213.

Ryden, H. 1989. *Lily Pond: Four Years with a Family of Beavers*. William Morrow. 256 p.

David A. Bainbridge retired as associate professor of sustainable management at Alliant International University in San Diego. He is co-author of ***Sustainable Agriculture for California: A Guide to Information*** 1991, ***The Straw Bale House*** 1994, and ***Gardening with Less Water*** 2016. He is currently working on a book on the ecological and cultural impacts of the fur trade in the West 1765-1840.