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Ecology of the Beaver

Note: This online review is updated and revised continuously, as soon as results of new scientific research become available. It therefore presents state-of-the-art information on the topic it covers.

The beaver inhabits freshwater streams and lakes of the Northern Hemisphere. In addition, it has been introduced by humans into southernmost South America (Lizarralde et al. 2004). Two species are recognized: *Castor fiber* of Eurasia and *Castor canadensis* of North America.

Ecologists call beaver "ecosystem engineers" because these animals physically alter habitats by cutting down trees, building dams, digging canals and building lodges. In doing so, beaver change the distribution and abundance of many other animals and plants, mostly by indirect interactions. In this series of reports, we review the ecology of beaver and the many diverse effects that beaver

engineering has on other organisms.

When beavers dam a stream they slow the movement of water. Behind the beaver dam, a pond of still water is formed. This pond (impoundment) is then colonized by animals and plants that typically live in lakes rather than streams. Organisms dependent on fast moving water die out in the beaver pond, or move to parts of the stream where the flow of water has not been slowed by the beaver dam. After a beaver dam has existed for ten years or more, the pond it created usually has an abundance of submersed and emergent vegetation, along with the many animals that live in such vegetation.

The forest beside the stream also changes after beaver occupation. When beavers cut down trees for food and for building their dams and lodges, they select the species of trees that they prefer, and leave other tree species standing. Consequently, after many years, the forest beside a beaver pond is usually dominated by different tree species than it was before beaver occupation, and in the gaps where the beavers removed trees, bushes and saplings now grow and with them the animal species that live in the early stages of forest regeneration (Barnes and Dibble 1986; Johnston and Naiman 1990; Pastor and Naiman 1992; Donkor et al. 2000). In addition, when the beaver pond is formed by the dam, water floods and covers the roots of trees that formerly stood along the stream bank. These flooded trees die because the standing water prevents their roots from getting air.

When the flow of water in a stream is slowed by the beaver dam, soil and organic sediment carried in the water usually settle to the bottom of the beaver pond. When beaver subsequently abandon a locality, their dam eventually breaks and the pond drains leaving a large open space. A meadow usually grows on the nutrient-rich soils that once formed the bottom of the pond. These "beaver meadows" usually have more light penetration, higher soil moisture, more nitrogen and a different vegetation than the adjacent riparian forest (Johnston et al. 1995; Wright et al. 2002).

Beaver engineering also includes two other activities: lodge making and canal digging. The construction of lodges by beaver adds coarse woody debris to the beaver pond which some fish species use for

cover (France 1997; Collen and Gibson 2001). Canals are usually about "30 to 60 cm wide and 20 to 35 cm deep, and can extend hundreds of yards into the forest (Stocker 1985; Collen and Gibson 2001). After a beaver has dug a canal, it can float branches from trees it has cut and move them to safer feeding locations.

Effects of beaver engineering on wildlife

Beaver engineering alters the distribution and abundance of so many organisms, that we cannot mention them all on this page. Therefore, we have produced separate reviews for different groups of animals and plants affected by beaver engineering. Click the following links to learn more about the effects of beaver engineering on specific species of plants and animals:

birds amphibians reptiles invertebrates trees

For effects of beaver engineering on fishes, see Collen and Gibson (2001). Salmon stop using certain rivers whose streams are dammed by beaver because the dams block salmon movements upstream. In the arctic, Beluga Whales (*Delphinapterus leucas*) which feed on salmon, also stop entering the same dammed rivers (Huntington and Myrmin 1996; Pierotti and Wildcat 2000).

Effects of beaver engineering on humans

In Wyoming, a survey showed that owners of private lands believed that they benefited from beaver engineering because it elevated water tables, increased the area of riparian vegetation on their lands, and also increased livestock watering opportunities (McKinstry and Anderson 1999). However, these same landowners regarded beaver as pests when these rodents girdled timber, blocked irrigation ditches and culverts with wood, and flooded roads, railroads, crops and timber (McKinstry and Anderson 1999).

In New York state, beaver plug highway culverts with wood, creating "roadside impoundments that damage and sometimes flood the roadbed" (Jensen et al. 2001). However, oversized culverts were less likely to be plugged by beaver, so it was recommended that oversized culverts be installed (Jensen et al. 2001). Although such oversized culverts are more expensive, over the long run they are

regarded as more cost-effective than trapping or debris removal.

In some places, such as the southeastern United States, beaver cause extensive damage to valuable timberland by flooding bottomland forests and eating tree seedlings (Bhat et al. 1993; Conner at al. 2000). Although trapping can control beaver populations, low pelt prices often fail to provide a stimulus to professional trappers, and the landowner is often left with the cost of removing the nuisance beavers.

Unfortunately, after one landowner traps beaver on his property, surplus beaver from neighboring properties often invade the now vacant habitat and the landowner is right back where he or she started. Bhat et al. (1993) argue that all landowners in an area must therefore cooperate together to manage beaver. They propose a long-term trapping program with increased trapping in the initial years. This results in fewer beavers in the total area, less trapping required in subsequent years, and a smaller number of beaver being killed over the long-term. A weakness of this proposal is that it requires all landowners in an area to cooperate. Landowners whose own economic or recreational interests are benefited by beaver and beaver engineering may be reluctant to cooperate.

Relationships with Predators

Many large predators occasionally prey on beaver, however only the wolf (*Canis lupus*) does so regularly and to the extent that it can significantly reduce numbers of beaver (Shelton and Peterson 1983). For example, in southeastern Alaska, 31% of wolf feces contained the remains of beaver (Kohira and Rexstad (1997). In Belarus, the frequency of beaver remains in wolf feces ranged from 6% to 22% over a ten-year period (Sidorovich et al. 2003). Frequent wolf predation on beaver has also been documented in Latvia, Ontario, Minnesota and Alaska (Voigt et al. 1976; Fuller 1989; Thurber and Peterson 1993; Andersone and Ozolins 2004).

On the other hand, wolves benefit beaver indirectly by killing and scaring away potential competitors of beaver. For example, fear of reintroduced wolves caused wapiti (*Cervus elaphus*) in Yellowstone National Park, to avoided some riparian zones where they had

previously over-browsed and eliminated young willow and cottonwood trees. The resulting relief from wapiti over-browsing allowed tree populations in these areas to recover, providing food for beaver which promptly colonized the area (Ripple and Beschta 2004).

Effects of beaver engineering on biodiversity

In the Appalachian Plateau region of New York, active beaver impoundments contained "significantly more bird species and a greater average number of bird species than abandoned beaver ponds and control sites with no record of beaver occupation (Grover and Baldassarre 1995)."

In the Upper Piedmont of South Carolina, the abundance, richness and diversity of reptiles were significantly higher at beaver impoundments than at unimpounded streams, however the "richness, diversity and evenness of amphibians was significantly higher at unimpounded streams than at beaver ponds (Metts et al. 2001).

In the Adirondack region of New York, Wright et al. (2002) found that beaver engineering increased species richness of plants at the landscape scale, because beaver created patches of habitat (beaver ponds and meadows) had a combination of conditions that were not present elsewhere in the landscape, and some plant species that lived in these beaver-modified habitats were not present in habitats unmodified by beaver.

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If you are aware of any important scientific publications that were omitted from this review, or have other suggestions for improving it, please contact the author at his e-mail address:

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