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# FURRY ENGINEERS: HOW BEAVERS CAN CHANGE AN ENTIRE ECOSYSTEM

***Hugo Enrique Reyes Aldana*** [1,2*], ***Ute Risse-Buhl*** [3,4] ***and Daniel Graeber*** [2]

[1] *Department of River Ecology, Helmholtz Centre for Environmental Research – UFZ, Magdeburg, Germany*
[2] *Department of Aquatic Ecosystem Analysis, Helmholtz Centre for Environmental Research – UFZ, Magdeburg, Germany*
[3] *Department of Ecology, Faculty of Biology, University of Technology Kaiserslautern, Koblenz-Landau, Landau, Germany*
[4] *Institute for Environmental Sciences, University of Koblenz-Landau, Landau, Germany*

YOUNG REVIEWERS:


CECILIA
AGE: 13


VINCENT
AGE: 11


WILLIAM
AGE: 14

Every living being plays an important role on our planet. Some species create and modify the environment for others. These species can be called *ecosystem engineers*. By interacting with the environment and altering it, ecosystem engineers create favorable conditions for many other species. Beavers are excellent examples of ecosystem engineers. Just by building their homes and dams, these rodents modify the environment and allow other plants and animals to live in rivers and lakes. In this article, we will understand some of the ecological functions that bevers develop, how they help other species and ecosystems, and despite how helpful they are, why we should not place them everywhere.

**ECOSYSTEM ENGINEERS**

Organisms that through their activity are able to build and modify large parts of an ecosystem.

**ECOSYSTEM**

Set of living and non-living elements interacting in a specific space and time.

**BIOLOGICAL TRAITS**

Specific characteristics of organisms that allow them to interact with their environment, for example their body shapes, behaviors, sizes or types of food they eat.

**RODENTS**

Group of mammals characterized by upper and lower pairs of continuously growing teeth.

**NICHE**

Set of environmental conditions to which organisms are adapted.

## WHY DO WE CALL ORGANISMS ECOSYSTEM ENGINEERS?

Engineers use scientific principles to create solutions to meet people's needs—for example, building a bridge that connects two pieces of land. To build a bridge, a civil engineer needs to calculate all the physical forces, including the vehicles running over the bridge, the weight of the materials, and natural forces such as gravity or wind. Civil engineers are not the only engineers that make our lives a little easier. There are mechanical, chemical, agricultural, medical, and many other kinds of engineers. But have you ever heard about **ecosystem engineers**?

Unlike other types of engineers, people cannot *become* **ecosystem** engineers—you must be born one! Ecosystem engineers are organisms that, through their **biological traits**, can modify, maintain, and even create ecosystems [1]. Many organisms such as trees, grasses, or kelp algae are considered ecosystem engineers. But beavers are the perfect example of this concept.

## GET TO KNOW THE BEAVER

Beavers are **rodents**, just like guinea pigs, hamsters, rats, and capybaras (Figure 1). Beavers are semiaquatic organisms. That means they can live on land as well as in water, although they seem more comfortable in water. There are two species of beavers, the American (*Castor canadensis)* and the Eurasian beaver (*Castor fiber*) [2]. Both species have very specific and essential **niches**, and despite being relatively small (both species are around 1 m long), entire ecosystems depend on them. Thus, beavers have earned the title of ecosystem engineers.


**Figure 1**

Rodent species. **(A)** North American Beaver (*Castor canadensis*). **(B)** Norway rat (*Rattus norvegicus*). **(C)** Brazilian Agouti (*Dasyprocta leporina*) [Photo credits: Smithsonian's National Zoo & Conservation Biology Institute under Creative Commons Zero (CCO) license].

Beavers live along medium-sized rivers and eat plants and algae. They feel a little more comfortable in water, as it offers them protection from

predators such as wolves, bears, or bobcats. Water also gives them the opportunity to build their homes. Like other animals, beavers need a place where they can rest, eat, and take care of their families. Instead of just digging a burrow on the margins of a river, beavers are unique in that they build their homes surrounded by water. These structures are called lodges (Figure 2). Lodges are made of wood that beavers collect and arrange into structures that can protect them from swimming predators such as alligators and snakes. These structures have multiple entrances and places where beavers can hide, rest, and have babies. Beavers also build dams to slow down the flow of the river, allowing them to swim more easily.

**Figure 2**

Beaver lodge in Fish Creek Provincial Park, Calgary, Canada. The picture shows a beaver-made pond. In the center there is the lodge, which is surrounded by logs that form the beaver dam walls (Photo credit: Wikimedia commons, author: Borbrav, Released to the public domain in August 2005).


Figure 2

By moving wood around, beavers engineer the ecosystem. To cut down trees that are far away from their lodges and dams, beavers dig channels through the land. Those channels fill up with water and allow beavers to reach distant areas without having to walk [2]. Imagine dragging a log across the land—that would require much more strength than moving it while it is floating on the water. Using water allows beavers to transport wood and plants more easily.

## HOW DO BEAVERS CREATE ECOSYSTEMS?

You might be asking yourself why beavers are considered ecosystem engineers if their actions only make their own lives better. It might seem like beavers are selfish, hoarding water and wood for themselves and building their comfortable, safe, floating mansions with private pools. But this seemingly selfish behavior actually generates all the conditions necessary to create and maintain ecosystems.

**CANOPY**

Upper part of the plant community, generally dominated by trees.

**DETRITIVORES**

Group of organisms that eat the remains of dead trees and other dead organisms, as well as leaves and droppings.

While beavers search for food or wood for their lodges and dams, they cut down surrounding trees—some of which may already be old or too big. The trees (especially the big ones) capture light and nutrients, which other plants need, too. When a tree falls, light penetrates the **canopy** and reaches the soil, where many seeds and small plants are ready to receive it and start growing. This increases the diversity of plants in the area and allows younger plants to grow and reproduce.

Beavers may not use the whole tree. Instead, they might select some branches and leave the logs behind. The remaining dead wood provides food and nice and cozy homes for interesting organisms called **detritivores**. Some detritivores are fungi, bacteria, insects, worms, and crustaceans.

By digging the channels through which they travel and transport wood, beavers provide water to places where it was not so easily available. With that, they promote the growth of some groups of plants and sometimes generate areas where new meadows and wetlands can form. Naturally, the land becomes wetter, and some of that water may contribute to the natural underground water storage known as groundwater. Finally, beaver dams can become a place where other animals can obtain water, even wolves, bears, and bobcats.

In the dammed-up water itself, changes are also impressive. Here, some species of fish, water-borne insects, and other aquatic creatures can live without being carried away by strong water flows. The reduced water flow can also increase the accumulation of sediments (sand and mud) above the dam. Those sediments are rich in nutrients, which are necessary for the growth of water plants. Eventually, beaver dams can become areas where multiple plant species can grow, and of course, the fish and other animals can eat some of them. The small animals do not only get a nice place to live—the branches and logs that make the lodges and dams also create small, safe environments that can be used as nurseries where the next generation can grow.

So, in some ways, beavers are not just benefitting themselves. Instead, they create a spot where many other plant and animal species can grow and obtain water, even the beavers' predators. So, maybe they are not so selfish after all!

## BEAVERS CAN HELP US TO HELP THE ENVIRONMENT

Due to all of the benefits we just mentioned, beavers have been used in efforts to bring back the natural conditions of ecosystems. Beavers can assist with restoration (ecosystem recovery) in areas where humans have not succeeded at doing so—and at a much lower cost than using lots of people and big machines [3, 4]. Because they do not need us to do their job, they are considered a nature-based solution. In

many places of the world, it has been shown that the reintroduction of beavers helps the recovery of ecosystems—not only for other animals and plants, but for the structure of the entire landscape [2, 4].

## WHY NOT USE BEAVERS EVERYWHERE?

Unfortunately, introducing beavers in areas outside their natural areas can create larger problems. For example, North American beavers introduced to Argentina (South America) in the 1940s have expanded their territory to neighboring Chile. These beavers have caused trouble because they are not a natural part of South American ecosystems. They take the resources other species need and destroy the natural structure of the region's ecosystems (Figure 3) [5]. In South America, the plants do not benefit from beaver behavior because the plant species are different from those in the natural habitats of beavers. These plants get eaten and chopped down but cannot grow back as fast as the beavers destroy them. Also, because some local fish are not used to beaver dams, it can make their **migration** impossible. Moreover, beavers have no natural predators in these regions, so their populations can grow too quickly.

**MIGRATION**

The intentional movement of a species between distant locations to search for better living conditions. For example, European migratory birds migrate to Africa during winter to escape cold weather.


**Figure 3**

Effects of beaver presence in Tierra del Fuego, Argentina. The picture shows the many trees that have been cut down by beavers and a dam wall creating an island. The trees cannot grow fast enough to recover and are heavily damaged (Photo credit: Wikimedia commons, author: Piergiorgio Rossi, Released to the public domain in January 2006).

## A NEW PERSPECTIVE

Now you know why beavers are considered ecosystem engineers and how multiple types of organisms and even entire ecosystems depend on them. You have also learned why it is not a good idea to introduce beavers *everywhere* to restore ecosystems. Just like human engineers, ecosystem engineers each have their specialty. Maybe you are now curious to know about other types of ecosystem

engineers—where they live and what they do? If so, check out this article, or this one.

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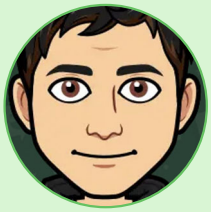
## YOUNG REVIEWERS

**CECILIA, AGE: 13**
Cecilia is a bright young lady that loves to play chess and is very curious about all kinds of random things. She loves to learn new scientific facts.

**VINCENT, AGE: 11**
I love animals, sports, video games, the outdoors! I play baseball daily. I love science and STEM topics. I was in the Science Olympiad Team for my elementary school. I have built water rockets and I also study animals, plants, and birds as a Backyard Biologist for my team. I want to be a vet when I grow up because I like animals. I like reading about science, and I love visiting national parks.



**WILLIAM, AGE: 14**
I love science and everything to do with it. My passion for science helped me land a spot in the Science Olympiad for my middle school, for which I have gone to the National tournaments in the U.S. I am more of a hands-on person, wanting to go to medical school when I grow up, and every aspect of science is interesting for me. I also play multiple sports, soccer, swimming, and baseball.

## AUTHORS

**HUGO ENRIQUE REYES ALDANA**
I studied biology at the National Autonomous University of Mexico. Then, I moved to Germany to study for a master's degree in evolution, ecology and systematics at the Ludwig-Maximilians-Universität München, and I conducted my thesis at the Chair of Restoration Ecology of the Technical University of Munich, working with invasive species. Currently, I am a Ph.D. student of the TRACER (Trajectories for Water Security) program at the Department of River Ecology and Aquatic Ecosystem Analysis of the Helmholtz Centre for Environmental Research—UFZ in Magdeburg. Here, I study multiple interactions that could help rivers to be restored and become healthier. *hugoraldana@ciencias.unam.mx

**UTE RISSE-BUHL**
Ute Risse-Buhl is a principal investigator at the Technical University Kaiserslautern and University Koblenz-Landau. She is a biologist by training and mainly interested understanding the microscopically small organisms that form the slimy covering on submerged surfaces. She is interested in the biodiversity of these microorganisms, the interactions between different trophic groups, and their role in carbon flow and nitrogen cycling of running water ecosystems.

**DANIEL GRAEBER**

I am a research group leader at the Helmholtz-Centre for Environmental Research in Magdeburg in Germany. I am an ecologist and chemist by training. With my research, I want to understand how we can improve the quality of water, both for us and for water organisms, using natural ecosystem processes. For example, I investigate the uptake of nutrients released from agriculture by bacteria and algae in streams, to prevent those nutrients from polluting lakes and estuaries later.