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Beavers

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Figure 1. American beaver *(Castor canadensis).*

Quick Links

Human-Wildlife Conflicts

The American beaver (*Castor canadensis*) (Figure 1) is known as an "ecosystem engineer" because of the benefits their dams provide to biological diversity and ecosystem function. It also is considered a "keystone species" because of its ability to transform its environment, creating new habitats upon which other species depend. Despite the many positive benefits beavers provide through foraging and dam building, beavers also create conflict with people when their activities cause damage. The authors of this publication acknowledge and appreciate the many positive benefits that beavers provide; however, the focus of this publication is to provide basic information on beaver ecology, damage, and management. In general, beavers cause damage by 1) gnawing on trees or crops; 2) flooding trees, crops, property, or transportation corridors (roads, airports, railways) through dam building; and 3) degrading and destabilizing banks and levees through burrowing.

Figure 2. Beaver damage to trees.

Figure 3. Beaver damage and the collapse of beaver dams can lead to structural damage of roadways and blocked culverts.

Landscapes

Beavers occupy a variety of landscapes from desert to taiga, although beaver-human conflicts are fairly consistent across all landscapes. In general, beavers cause damage to human resources by 1) gnawing on trees or crops; 2) flooding trees, crops, property, or transportation corridors (roads, airports, railways) through dam building; and 3) degrading and destabilizing banks and levees through burrowing. The scale and scope of beaver damage to human resources are dependent on many factors including floodplain size, water availability, beaver population size, and juxtaposition of beavers and humans. Not all beavers build dams; however, beaver dams are generally constructed prior to seasonal high water events.

Beavers will gnaw on trees of all sizes and most species (Figure 2). Beavers, like most rodents, need to gnaw to keep their teeth at the proper length. Thus, they sometimes girdle trees that they do not fell. Large diameter trees are sometimes felled by beavers, who feed on twigs and haul small stems to dams and lodges. Beavers sometimes fell large trees that they do nothing with, such as conifers. The value of trees and crops damaged by beavers may depend on their aesthetic, cultural, ecological, economic, or historical importance. The damming of one small stream; however, may cause potential harm to human life and overshadow all other values.

Human Health and Safety

Residential buildings are sometimes damaged when large beaver dams fail, generally due to rapid increases in water velocity. Risk to residents is high during flash flood events, and reports of economic damage to structures during single events are estimated in the millions of dollars.

Unexpected beaver dam failure also has led to the collapse of railroad structures, roads, and airport runways (Figure 3). These events not only result in significant economic loss, but also have led to human fatalities.

Beavers are hosts for several ectoparasites and internal parasites including nematodes, trematodes, and coccidians. *Giardia lamblia* is a pathogenic intestinal parasite transmitted by beavers, which has caused human health problems in water supply systems. Beavers also are known to carry tularemia, which can be transmitted to humans through direct contact.

Damage Identification

The effects of beaver behavior are viewed as positive or negative depending on people's perceptions and tolerance levels. Habitat modification by beavers, caused primarily by dam building, is often beneficial to fishes,

furbearers, reptiles, amphibians, bats, waterfowl, shorebirds, cavity nesting birds, and mammals. However, when this modification comes into conflict with human objectives, the perceived negative impacts may far outweigh the benefits. Identifying beaver damage generally is not difficult. Signs include the presence of dams; plugged culverts, bridges, or drain pipes resulting in flooded lands, timber, roads, and crops; girdled, partially girdled, or felled trees; and burrows in banks and levees.

Management Methods

There are several lethal and nonlethal damage management tools and techniques for resolving beaver conflicts. Lethal methods include shooting and trapping. Although lethal methods may be appropriate in many situations, modern wildlife damage management also includes several non-lethal options. Non-lethal techniques for reducing beaver damage include exclusion, habitat modification, repellents, and relocation. To be the most effective at reducing damage, it is recommended that several management methods be used in combination.

Flooding by beavers generally occurs where beavers dam streams or plug culverts. Conflict resolution in either case requires human intervention to control water levels. Mechanical removal of dam material often is used to seek immediate results (Figure 4); however, beavers can rapidly replace dam material. Under certain hydrological conditions, flooding can return within 24 hours. Lethal trapping is used to supplement dam removal with a goal to remove the dam-building beavers from the area. Similarly, live-capture and relocation are used to supplement mechanical dam removal where permitted by state law. While these techniques generally provide immediate success at the point of damage, other beavers may occupy dam sites up- or downstream and flooding reoccurs. Furthermore, relocating damming beavers may lead to damage at the release site, and cause undue stress to relocated beavers.

Use of flow devices modifies beaver habitat and offers a more long-term solution to flood control (see Habitat Modification section). Flow devices should be implemented, where applicable, in beaver management plans before damage occurs, and may be used in conjunction with trapping and mechanical dam removal after initial flooding is abated.

Figure 4. Damage associated with flooding by beavers generally occurs where beavers dam streams or plug culverts. Mechanical removal of dam material often is used to seek immediate results.

Repellents and tree exclusion are not useful in controlling flooding by beavers; however, they may help reduce tree cutting. These techniques may be integrated into management plans along with lethal control measures where protection of high-value trees justifies costs of installation, application, and maintenance.

Habitat Modification

Flow devices are tools that combine exclusion and deception to maintain positive water flow where beavers dam culverts and streams. Flow devices are often most effective at dams or culverts when corrugated pipe is used

Figure 5. An example of a flow device using an exclusion fence at the culvert intake (lower right corner), corrugated pipes and round fences.

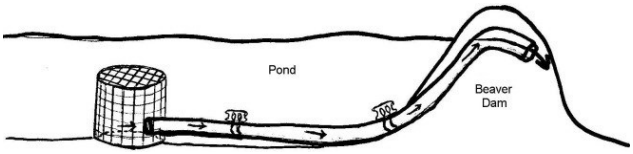


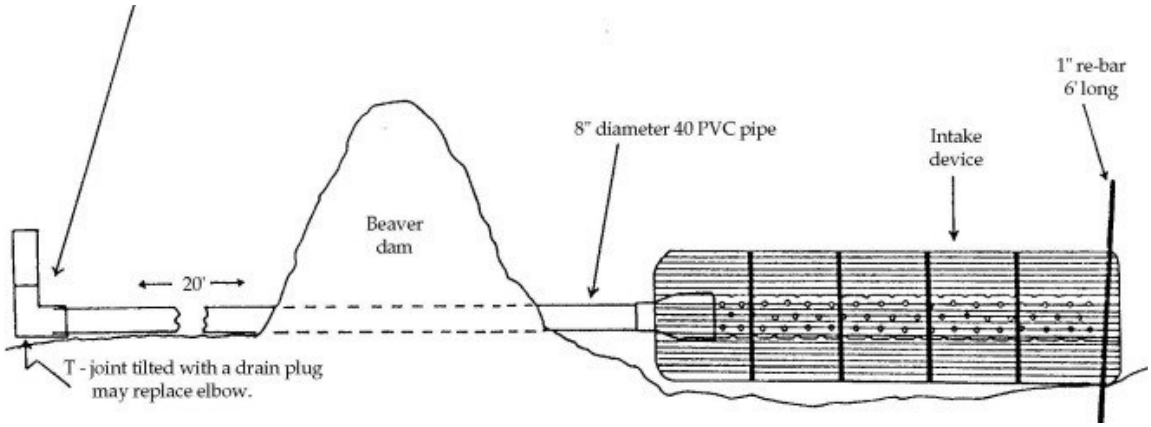
Figure 6. An example of a flexible pipe with a round fence used to control the water level at a dam.

in conjunction with an exclusion fence (Figure 5). Flexible pipe and round fence also can be used to reduce water levels at dams (Figure 6). Clemson pond levelers are another example of a flow device (Figure 7). They are most often utilized to control water at dams, but also can be used with culverts.

Breaching dams may provide immediate relief, but it does not prevent rebuilding and is not a long-term solution. Mechanical breaching is a common method used to reduce or remove dams. This may range in effort from a few minutes with a rake or hoe, to several hours with heavy machinery. Other methods, including high pressure water pumps and explosives, can breach dams; however, they require specialized training and are generally done by trained government employees.

Exclusion

To protect trees from gnawing, total exclusion with fencing (e.g., chain link) is the only proven technique. However, this technique is often cost prohibitive and is not practical in uneven terrain. Wrapping individual trees with wire mesh and T-posts can reduce gnawing; however, beavers can chew through wire. Additionally, changing water levels may submerge the fencing or other barriers, providing beavers foraging opportunities. Seedling tubes are ineffective for protecting individual seedlings from beavers.



Figures 7. An example of a Clemson pond leveler used to control the water level at a dam.

To reduce flooding, fencing may be placed upstream of culverts to exclude beavers from damming culvert intakes. These fences may be referred to as deep water fences or culvert fences. Culvert fences can be effective when maintenance requirements are low; however, culvert fencing is most effective when combined with corrugated pipe to create a flow device (see Habitat Modification).

Exclusion devices such as culvert grates or T-culverts, which are placed directly on or adjacent to culverts, are not recommended to reduce flooding. They typically catch floating debris and require a lot of maintenance. Additionally, beavers can dam the device which has the same function as directly plugging the culvert.

Frightening Devices

Not applicable.

Repellents

There are no chemical repellents registered for beavers. General herbivore repellents will not deter beavers from damming or plugging water flow structures, but they may be useful in protecting vegetation. Although herbivore repellents do not deter beavers from gnawing through trees, they can reduce the palatability of plants and seedlings when applied directly to the foliage. Research has shown that textural repellents (e.g., masonry grade sand and latex paint) may reduce tree damage. One study showed that treating trees with red maple extract inhibited feeding by beavers, but this may not be effective where red maple does not occur naturally.

Predator odors have also been shown to have some effect at deterring beaver, but over time may become less effective without the presence of predators. The success of any repellent is dependent on the palatability of the treated species and the availability of alternative food sources. During certain seasons and when food is scarce, repellents may be completely ineffective. Other studies have used a combination of dam removal and repellent soaked rags (Thiram 80 and/or paradichlorobenzene) to discourage beavers with varying degrees of success. It has been shown that beavers are less likely to colonize sites treated with a mixture of beaver castoreum anal gland secretion than untreated sites. It may be possible to prevent beavers from settling in an area by treating the area with castoreum; however, the feasibility of such an approach is still unknown.

Toxicants

None registered.

Shooting

In some states, it is legal to shoot beavers. Before attempting to shoot beavers, check regulations, and if applicable, secure permits and notify local law enforcement personnel of your intentions.

Beavers are most active from late afternoon to shortly after daybreak, depending on the time of year. They usually retire to a lodge or bank den for the day. Therefore, if night shooting is not permitted, the early evening and early morning hours are most productive. Creating a breach or break in the dam may draw beavers to this spot making it easy to locate and target them. Choice of weapons depends on the range and situation. Most shooting is done with a shotgun at close range at night. Shooting alone is generally not effective in eliminating all beaver damage in an area. However, shooting can be used to quickly reduce immediate conflict by removing damage-causing individuals.

Trapping

Trapping is the most commonly used method to reduce beaver damage. The effectiveness of trapping is strongly dependent upon the trapper's knowledge of beaver habits and food preferences, his/her ability to detect and "read" beaver sign, and his/her ability to select, use, and properly place the trap.

A good trapper with a dozen traps can generally trap all the beavers in a given pond (behind one dam) in a week's worth of trap nights. Obviously in a large watershed with several colonies, more trapping effort will be required. Those with trapping experience and some outdoor "savvy"

can become an effective beaver trapper in a short time. In an area where beavers are common and have not been exposed to trapping, anyone experienced in trapping can expect good success. Additional expertise and improved techniques will be gained through experience.

Trapping regulations vary from state to state. Some types of traps and trapping methods, although effective and legal in some states, may be prohibited by law in other states. Individual state regulations must be reviewed annually before beginning a trapping program.

In some states where beavers have become serious economic pests, special regulations and exemptions have been passed to allow for increased control efforts. For example, some states categorize beavers as "predators" and allow their removal throughout the year. Others, however, prohibit trapping except during established fur trapping seasons. Some states allow exemptions for the removal of beavers only on lands owned or controlled by persons who are experiencing damage.

A variety of trapping methods and types of traps are effective for beavers. In 2006, the Association of Fish and Wildlife Agencies published the Best Management Practices for Trapping in the United States (http:// www.fishwildlife.org/files/Introduction_BMPs.pdf). A chapter for beaver is included which details trapping methods, as well as several trap manufacturers and trap designs (http://www.fishwildlife.org/ files/ Beaver_BMP_2016.pdf). Although not all manufacturers are included in this manual, it provides insight into the commonly accepted standards for beaver traps and trapping methods.

When trapping for beaver, special attention should be given to look for signs of river otter. In areas where both species occur, river otters occupy the same habitat and are frequently caught in beaver traps. To avoid capturing river otter, search for their signs and avoid setting traps at high probability otter travel-ways, particularly paths connecting bodies of water, shoreline trails, and inactive beaver bank dens or lodges. One should also attempt to avoid lures that may attract river otters. Over trapping an area may also increase the risk of capturing otter. Set an appropriate number of traps for the number of beavers perceived in an area and avoid leaving traps for extended periods of time. Carry a catchpole or similar device to assist with releasing live otters.

Bodygrip Traps

The bodygrip trap is one of the most effective lethal traps for capturing beaver. This trap kills beavers almost instantly. When properly set, the trap also prevents any escape by a beaver, regardless of its size. Designed primarily for water use, it is equally effective in deep and shallow water. Generally, only one trap per site is necessary. The trap exerts tremendous pressure and impact when tripped. Appropriate care must be exercised when setting and placing the trap. Special caution should also be taken when using bodygrip traps in urban and rural areas where pets (especially dogs) roam free. See the Trap Sets section to select the best set to avoid capturing non-target species.

If using a bodygrip trap, additional equipment, such as an axe, hatchet or large cutting tool; hip boots or waders; wire; and wire cutters, may be useful. With bodygrip traps, some individuals set the trap using a tool called "setting tongs." Others use a piece of 9 or 13 mm ($^3/_8$ or ½ in) nylon rope. Most individuals who are experienced with these traps use only their hands to set them. Regardless of the techniques used to set the trap, care should be exercised.

Earlier models of bodygrip traps came with round, heavy steel coils which were dangerous to handle unless properly used in setting the trap. They are not necessary to safely set the trap. However, the two safety hooks, one on each spring, must be carefully handled as each spring is depressed, as well as during trap placement. On newer models an additional safety catch (not attached to the springs) is included for extra precaution against inadvertent spring release. The last step before leaving a set trap is to lift the safety hook attached to each spring and slide the safety hook back from the trap toward the spring eye, making sure to keep hands and feet safely away from the center of the trap. If the extra (unattached) safety catch is used, it should be removed before the safety hooks are attached to the springs to keep it from

getting in the way of the movement of the safety hooks.

Bodygrip traps are best set while on solid ground with dry hands. Once the springs are depressed and the safety hooks are in place, the trap or traps can be carried into the water for proper placement. Stakes are needed to anchor the trap down. In most beaver ponds and around beaver dams, plenty of suitable stakes can be found. At least two strong stakes, preferably straight and without forks or snags, should be chosen to place through each spring eye (Figure 8). Additional stakes may be useful to put between the spring arms and help hold the trap in place. Do not place stakes on the inside of spring arms. Aside from serving to hold the trap in place, these stakes also help to guide the beaver into the trap. Where needed, they are also useful in holding a dive stick at or just beneath the water surface (Figure 9). If necessary, the chain and circle attached to one spring eye can be attached to another stake. In deep water sets, a chain with an attached wire should be tied to something at or above the surface so the trapper can retrieve the trap. Otherwise the trap may be lost.

There are many sets that can be made with a bodygrip trap (for example, dam sets, slide sets, lodge sets, bank den sets, "run"/trail sets, under log/dive sets, pole sets, under ice sets, deep water sets, drain pipe sets), depending on the trapper's capability and ingenuity. In many beaver ponds, however, most beavers can be trapped using dam sets, lodge or bank den sets, sets in "runs"/trails, dive sets or sets in slides entering the water from places where beavers are feeding. Beavers swim both at the surface and along the bottom of ponds, depending on the habitat and water depth. Beavers also establish runs or trails which they habitually use in traveling from lodge or den to the dam or to feeding areas, much like cow trails in a pasture. Place traps directly across these runs, staked to the bottom (Figure 10).

Use a good stake or "walking staff" when wading in a beaver pond to locate deep holes, runs, or trails. The staff can also help locate good dive holes under logs as you follow runs or trails. In older beaver ponds, particularly in bottomland swamps, it is not uncommon to find runs and lodge/bank den entrances where the run or hole is 0.6-0.9 m (2-3 ft) below the rest of the impoundment bottom.

To stimulate nighttime beaver movement, tear a hole in a beaver dam and get the water moving out of a pond. Beavers quickly respond to the sound of running water as well as to the current flow. Timing is also important if you plan to make dam sets. Open a hole in the dam about 46-60 cm (18-24 in) wide and 60-90 cm (2-3 ft) below the water level on the upper side of the dam in the morning. This will usually move a substantial amount of water out of the pond before evening. Set traps in front of the dam

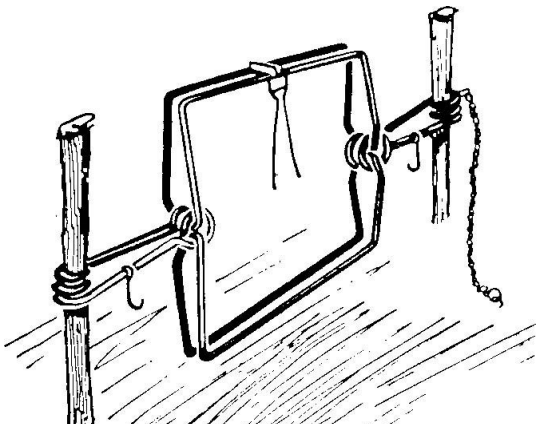


Figure 8. Basic method of setting and staking a double-spring bodygrip trap.

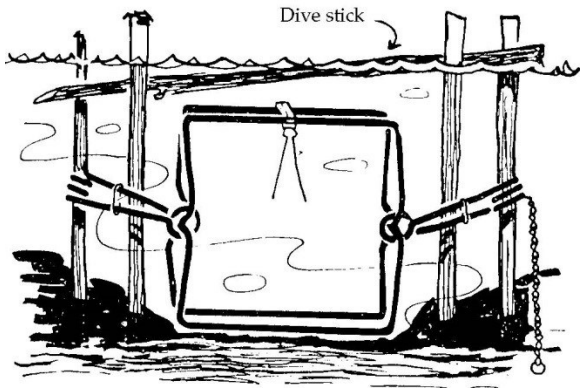


Figure 9. Double-spring bodygrip trap used in a dive set. Note the dive stick placed at the top of the set to encourage the beaver to dive under water through the trap.

Figure 10. Bodygrip trap set half-submerged in a beaver run with trigger on the bottom jaws.

opening late that same evening. Two problems can arise if you set a trap in the morning as soon as a hole is made: 1) by late evening, when the beavers become active, the trap may be out of the water in and ineffective; or 2) a stick, branch, or other debris in the moving water may trip the trap, rendering it ineffective.

The best dam sets are placed about 30-45 cm (12-18 in) in front of and on the upstream side of the dam. Using stakes or debris on either side of the trap springs, create a channel to encourage the beaver to swim through the jaws of the trap. Always set the bodygrip trap trigger in the first notch to prevent debris from tripping it before the beaver swims into the trap. The two heavy gauge wire trippers can be bent outward and the trigger can be set away from the middle, if necessary, to keep debris from tripping the trap. This can also keep small beaver, fish or turtles from accidentally springing the trap. In areas where river otters are present, use a "side-parallel" position on the trigger by moving the wires to one side of the bodygrip trap. Placing a stick in front of the wires will help prevent an otter from hitting the wires. Using traps with 2-way or adjustable tension triggers also prevents non-target captures.

Foothold Traps

Double-spring foothold traps have been used for hundreds of years and are still very effective when used properly (Figure 11). Use at least No. 3 double (long) spring or coil spring type foothold traps or traps of equivalent jaw size, spread, and strength. Include a submersion set attachment with a weight when using a foothold trap. When a beaver trips a foothold trap, it will immediately head for the water. The submersion set with a weight will hold the trapped beaver underwater until it drowns. If a submersion set attachment is not used, it is likely that the beaver will escape.

Placement is even more critical with foothold traps than with the bodygrip traps. Place foothold traps at the water's edge, slightly underwater, with the pan, jaws, and springs covered lightly with leaves or debris or pressed gently into the soft mud. Make sure there is a cavity under the pan so that when the beaver's foot hits the pan, it will trigger the trap and allow the jaws to close. Place traps off-center of the beaver trail or run to prevent "belly pinching" or missing the foot or leg. With some experience, beaver trappers learn to make sets that catch beavers by a hind leg rather than a front leg. The front leg is much smaller and easier to pull out of the trap. To avoid capturing river otter, use castor mound sets with traps placed 20-25 cm (8-10 in) deep in the water.

When using foothold traps, it may be beneficial to create two trap sets in the beaver's slide, run, dam, or feeding place to increase trapping success. In some situations, a combination of trapping methods can shorten trapping time and increase success.

Trappers have come up with unique methods of making submersions sets. One of the simplest and most practical is a slide wire with a heavy weight attached to one end, or with an end staked in shallow water (i.e., less than 0.9 m (3 ft) deep). The other end of the wire is threaded through a hole in a small piece of angle iron. The trap chain is attached to a hole in the other end of the angle iron. The end of the wire is then attached to a tree or stake driven into the bank (Figure 12). When the beaver gets a foot or leg in the trap, it immediately dives back into the water. As the angle slides down the wire, it prevents the beaver from reaching the surface. The angle iron will not slide back up the wire, thus preventing the beaver from coming up for air. Trappers should be prepared to quickly and humanely dispatch a beaver that is caught in a trap and has not drowned.

Figure 11. Number 4 double-long spring trap.

The foothold trap set in lodges or bank dens is also effective, especially for trapping young beavers. Place the set on the edge of the hole where the beaver first turns upward to enter the lodge or den, or place it near the bottom of the beaver's dive hole. To set the trap so that a swimming beaver's foot can trip the pan, keep the trap's jaws and pan from resting on the bottom of the pond by pulling the springs backward. Stake the set close to the bottom or wire the trap to a log or root on the bottom. This avoids needing submersion weights, wires, and angle irons. Generally, more time and expertise are needed to make effective sets for foothold traps and snares, than bodygrip traps.

Use castor scent or freshly cut cottonwood, aspen, willow, or sweetgum limbs to entice beaver to foothold trap sets. Bait or scent is especially useful around beaver castor mounds and slides along the banks or dams. Most trappers who use bodygrip traps do not employ bait or scent. In some states it is illegal to use bait or scent.

Live Traps

Suitcase-style live traps are becoming more widespread due to lethal trapping restrictions. The traps are rarely used, however, except by professionals in urban areas where anti-trap sentiment or other reasons prevent the lethal trapping of beavers. These traps are heavy (typically weighing around 13.6 kg (30 lbs)) and costly, particularly when multiple traps are required. Muller-Schwarze and Haggart (2005) recommend the Hancock live trap (Figure 13), however, other manufacturers are available. Most suitcase traps are similar in design and, like the Hancock trap, consist of two spring loaded jaws surrounded by wire mesh. A trigger plate is located in the center of the trap, which when triggered, causes the trap to close and surround the beaver in wire mesh like the closing of a suitcase (Figure 14). Safety should be considered when using a suitcase style trap. Although not as dangerous as a bodygrip trap, the springs on the suitcase traps are strong and may cause injury. One problem is that the safety device for the Hancock live trap is located near the trigger plate inside the trap, causing the trapper to reach inside the trap to release the safety. A piece of wire or twine can be tied to this safety ring, which will allow the user to disengage the safety from outside the trap. A more involved and intricate safety modification is also described in Muller-Schwarze and Haggart (2005).

Snares

Non-powered cable devices (snares) can be a very cost-effective method for capturing beavers (Figure 15). Snaring equipment costs far less than trapping equipment and is more convenient to use in many situations. In addition, beavers can be captured alive by snaring and released elsewhere if desired and legal.

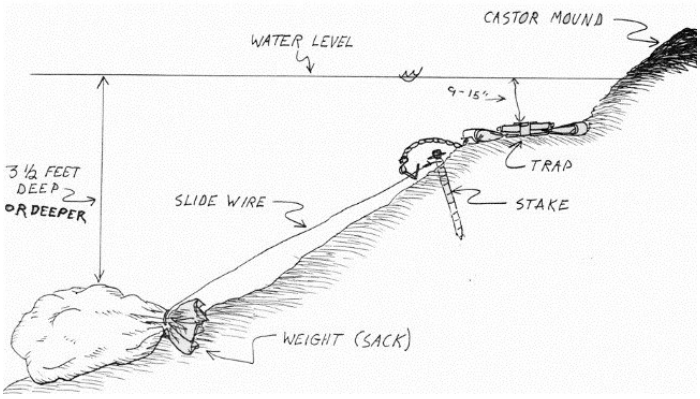


Figure 12. Diagram of a traditional drowning set. Note the a food lure with shaved branches can be used instead of castor.

Figure 13. A Hancock live trap (suitcase-style) set along a streambank with a scent stick placed in the back of the trap.

Figure 14. Beaver captured in a suitcase-style live trap using a bank set

Snare placement is similar to trap placement. First, look for runways and fresh sign that indicate where beaver activities are focused. Find a suitable anchor such as a large tree, log, or root within 3 m (10 ft) of the runway where the snare will be set. If necessary, anchor snares with rods driven into the ground. Attach three, 14-gauge wires to the anchor so that each can swivel freely. Cut each wire to length so they reach about 30 cm (1 ft) past the runway. Twist the wires together to form a strong braided anchor cable. Drive a supporting stake into the ground near the runway and wrap the free end of the anchor cable around it twice. Prepare a new, dyed, No. 4 beaver or coyote snare, consisting of 107 cm (42 inches) of 2.4 mm (3/32-inch) steel cable with an attached wire swivel and slide lock. Twist the free ends of the three anchor wires around the wire swivel on the end of the snare cable. Wrap the longest anchor wire around the base of the wire swivel and crimp it onto the snare cable about 5 cm (2 in) from the swivel. Use both the stake and the supporting anchor wire to suspend a full-sized loop about 10 cm (4 in) above the runway. If necessary, use guide sticks or other natural debris to guide beaver into the snare.

The described snare set is very common, but there are several variations and sets that can be used. Snares are frequently placed under logs, near bank dens, and next to castor mounds. Drowning sets can be made using underwater anchors, slide cables, and slide locks.

Snares should be checked at least every 24 hours. Dispatch snared beavers with a small caliber gunshot to the head. Beavers can be chemically immobilized and transported to suitable sites for release, if desired and legal.

Snares must be used with great care to avoid capturing non-target animals. Avoid trails or areas that are used by livestock, deer, or dogs. To avoid capturing river otter, use a 23-25 cm (9-10 in) loop with a 10 cm (4 in) loop stop. Check with your local wildlife agency for regulations associated with trapping and snaring. Snaring is not allowed in some states.

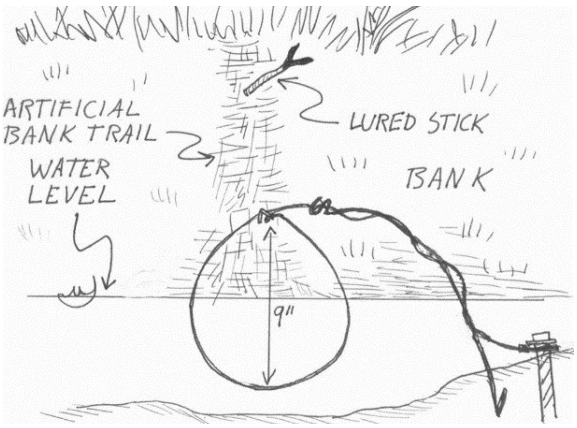


Figure 15. Diagram of a non-powered cable device (snare) set with bait.

For more information about the use of snares see *A Guide to Using Snares for Beaver Capture* (Weaver et al. 1985), *Using Snares to Live-Capture Beaver, Castor canadensis* (McKinstry and Anderson 1998) and *Use of Snares to Live-Capture Beavers* (McNew et al. 2007) listed at the end of this publication.

Fertility Control

Fertility control using immunocontraception is gaining popularity as a nonlethal method; however, it has not been tested for use with beavers. Surgical sterilization of the adult male or female beaver in a colony has been shown to reduce fecundity and alter beaver behavior. This method is not a practical solution for managing large, free-ranging beaver populations because it is expensive, time consuming, and involves surgery. Furthermore, sterilization does not reduce beaver damage.

Handling

When handling any wild animal, including beavers, wear disposable latex or nitrile gloves. Be sure to keep your distance from the beaver's mouth and feet. Beavers can reposition themselves quickly and cause severe damage from biting and clawing. A restraining or catch pole may be used to keep a beaver penned for a short period of time. As a rule of thumb, thoroughly wash your body and clothes after trapping and handling beavers to reduce chances of contracting a zoonotic disease, such as tularemia.

Relocation

Relocation has been effectively used to restore beaver populations in areas where they were previously extirpated. More recently, efforts to restore and enhance wetlands through beaver relocation have generally failed. Reasons for this include: 1) relocated beaver often move great distances from release sites, and 2) relocated beaver have low survival rates because of predation and disease.

In general, relocation is not a recommended management method and is often prohibited in many states. In states that allow beaver relocation, one should consider both the benefits and risks involved before initiating a relocation program. Will beavers stay at the release site? Will they create the desired effects (i.e., increase biodiversity) or undesirable effects (i.e., human-beaver conflicts)? Will relocation cause increased disease risk with local native species?

Euthanasia

According to the 2013 American Veterinary Medical Association (AVMA) Guidelines on Euthanasia, *"approaches to euthanasia that ignore recent advances in technology, and that do not minimize risks to animal welfare, personnel safety, and the environment for a particular set of circumstances, are unacceptable."* Most people will not have access to wildlife pharmaceuticals to euthanize beavers. However, when possible, the use of a sedative followed by an intracardiac injection of barbituates is an acceptable method of euthanasia for free-ranging wildlife, such as beavers.

Inhaled agents are not a practical methods of euthaniasia for beavers given the beaver's ability to hold its breath for several minutes. Adjunctive methods such as exsanguination, cervical dislocation, and thoracic compression are not practical due to the physical build of the species.

A gunshot to the head (targeted to destroy the brain) is an AVMA-approved method of euthanasia for free-ranging, captured, or confined beavers. Where guns are prohibited, manually applied blunt force trauma to the head may be used to euthanize beavers.

Disposal

Check your local and state regulations regarding carcass disposal.

Economics

There are a limited number of economic studies on beaver damage and most include outdated statistics. A study in the late 1970s in Mississippi estimated annual loss to agriculture (including timber) at $2.5 million. Another Mississippi study estimated beaver damage to timber ranged from $25 to $118 per hectare, a potential annual economic loss of $215 million in 1985 U.S. dollars. A 2011 economic study evaluating Mississippi's Beaver Control Assistance Program (BCAP) found that for every dollar spent on BCAP between $39.67 and $88.52 were saved from reduced beaver damage to timber and the state's economy.

Economical tradeoffs between the potential loss of a resource (e.g., estimated value of timber at harvest or the cost of repairing a damaged road) and the cost of beaver management should be assessed prior to implementing a beaver management plan.

It is important to identify and anticipate beaver problems in advance. Once beaver colonies become well-established, management can be difficult and costly. For instance, management can be impeded if adjacent landowners do not allow beaver management on their property. In this situation, long-term strategies are necessary to achieve management goals.

Species Overview

Identification

The American beaver *(Castor canadensis)* belongs to the Family Castoridae in the Order Rodentia. It is one of two extant beaver species. The other species is its Eurasian counterpart, the European beaver *(Castor fiber)*.

Physical Description

The American beaver is the largest rodent in North America (Figure 16). Most adults weigh from 16 to 23 kg (35 to 50 lbs), although individuals can exceed 45 kg (100 lbs).

The beaver is a stocky rodent adapted for aquatic environments. Many of the beaver's features enable it to remain submerged for long periods of time. It has a valvular nose and ears. Its lips close behind four large front (incisor) teeth. Each of its feet has five digits. The hind feet contain webbed skin between each digit to aid in swimming and a split claw on the second digit that is used for grooming. The front feet are small in comparison to the hind feet (Figure 17). The underfur is dense and generally gray in color, whereas the guard hair is long, coarse and ranging in color from yellowish brown to black, with reddish brown being the most common color. The prominent tail is flattened dorsoventrally, scaled, and nearly hairless. It is used as a prop while the beaver is sitting upright and for a rudder when swimming. Beavers also use their tail to warn others of danger by abruptly slapping the surface of the water. The beaver's large incisors are bright orange in color on the front and grow continuously throughout its life. These incisors are beveled so that they are continuously sharpened as the beaver gnaws and chews while feeding, girdling, and cutting trees. If a beaver is unable to chew, its teeth would overgrow and eventually cause its death.

The most common way to distinguish between the sexes (unless the female is lactating) is to feel for the

Figure 16. American beaver with radio-transmitter attached to its tail.

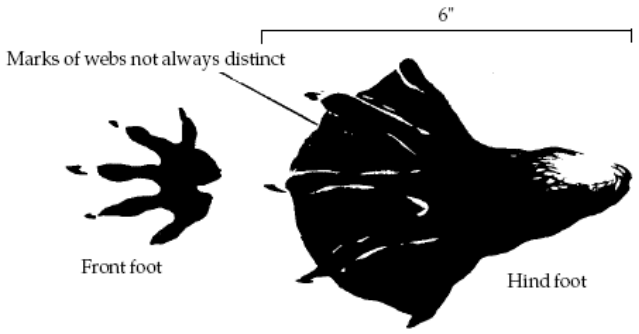


Figure 17. Beaver tracks.

presence (male) or absence (female) of a baculum or penile bone. It is also possible to distinguish between males and females by inspecting the cloaca (the single urogenital opening on both males and females). Anterior to the anus two openings are present in the female, with only one in the male. Anal gland secretions (AGS) also vary in color and viscosity between the sexes, with the males AGS generally being darker and more viscous. None of these field techniques are completely reliable and require experience to differentiate. If sexing is crucial, a genetic analysis is recommended.

Range

American beavers are found throughout North America, except for the extreme arctic tundra, parts of peninsular Florida, and desert areas devoid of free-flowing water (Figure 18). The species may be locally abundant wherever aquatic habitats are found. Populations of *C. canadensis* are exotic to parts of Europe where they were introduced and coexist with the Eurasian beaver *(C. fiber*). They also are present in the Tierra del Fuego region of South America where they are considered an invasive species.

Voice and Sounds

Beavers communicate by vocalizations, posture, tail slapping, and scent posts or castor mounds placed around banks and dams (see Tracks and Signs).

Tracks and Signs

The beaver's castor glands secrete castoreum, a substance that is deposited on mud mounds to mark territorial boundaries (Figure 19). These scent posts are found year-round in active ponds, but are more frequent during the spring, which may coincide with dispersal. Signs of beaver activity also include tree cutting/girdling, slides, and fecal pellets.

The presence of active dams and lodges are indicative of beavers, but are not good indicators of beaver presence or relative abundance. Many beavers live in bank dens among steams and rivers and do not build dams. Bank dens can be identified during low water. In areas with harsh winter habitat, food caches may be found near lodges.

Figure 18. Range of beaver in North America.

Figure 19. Castor mound created by a beaver to mark its territory.

Reproduction

Beavers are socially monogamous, however, recent genetic studies have shown that they do participate in promiscuous mating if opportunities are available. Copulation may take place either in the water, lodge, or bank den.

After a gestation period of approximately 128 days, female beavers generally give birth to 3 or 4 kits between March and June, and nurse them for 6 weeks to 3 months. The kits are born fully furred with their eyes partially opened and incisors erupted through the gums. They generally become sexually mature after 1.5 years.

Denning

Beavers build lodges (Figure 20) or bank dens, depending on the available habitat. All lodges and bank dens have at least two entrances. The lodge or bank den provides shelter and protection from predators, and is used for raising young, sleeping, and storing food. In extremely cold environments where water freezes for long periods of time, beavers also cache food near lodges and bank dens for easy access. Lodges are typically constructed in lentic systems (e.g., lakes, ponds, swamps); whereas, bank dens are generally used by beavers in lotic systems (e.g., streams, rivers) where lodges would not withstand rapid water flow.

Mortality

In the absence of predators, beavers have relatively long life spans, with individuals known to have lived up to 21 years. Most, however, do not live beyond 10 years.

Beavers have only a few natural predators besides people, including coyotes and bobcats. River otters and mink are known to prey on young kits. In other areas, bears, mountain lions, wolves, and wolverines may prey on beavers. In the southeastern states, alligators are known to be occasional predators of both juvenile and adult beavers; however, their predation has limited impact on beaver damage.

Population Status

Methods to estimate beaver populations are generally unreliable; therefore, their population status is unknown. Relative measurements, such as trapper harvest and nuisance complaints, are often used to detect trends; however, this does not reflect population size. In areas where beavers live in bank dens and do not build dams, their population size is likely underestimated.

Figure 20. Cross section of a beaver lodge.

Habitat

Beavers are found in a variety of habitats from sea level to 3,400 m (>11,000 ft) and are generally found wherever there is a constant source of water. Example habitats include rivers, streams, lakes, ponds, swamps, roadside ditches, canals, mine pits, oxbows, railroad right-of-ways, water treatment facilities, and below natural springs or artesian wells.

Beavers build dams to increase water surface area, which increases survival and the growth of desired foods. However, not all beavers build dams. Where beavers build dams, the slope of the land is generally between 1 and 5 percent.

Dam building is thought to be stimulated by running water; however, this is not always the case. The length or height of a dam varies depending upon the amount and flow of water behind it. While wood is a main component of dams, beavers also use other available materials found nearby, such as fence posts, bridge planking, crossties, rocks, and wire. In areas where wood is scarce or unavailable (e.g., canals in large agricultural fields), beavers may build dams with corn stalks, soybean vines, sorghum stalks, other plant materials, and mud. Well-constructed dams generally consist of several interwoven branches perpendicular to the flow of current. Beavers carry mud and pack it between the branches using their front legs. Some dams last many years and others are ephemeral (lasting days or weeks) depending on water flow and the geomorphology of the stream.

Bridges and culverts used to channel water under transportation corridors (roads, railways, runways, etc.) provide easy damming opportunities for beavers because they require little work.

A beaver's dam and its subsequent pond provides safety from predators. The flooding of outside stream channels also increases the growth and availability of desirable forage. Thus, dam-building beavers help create their own habitat.

Behavior

Beavers are semi-aquatic and herbivorous. It is not uncommon to see beavers during the day; however, they are generally nocturnal or crepuscular. The phrase "busy as a beaver" is appropriate as they are often seen outside of dens/lodges, constructing or maintaining dams. Beavers are territorial. A colony typically consists of 4-8 related beavers, which resist additions or outsiders. However, close kinship is not a strict requirement for colony membership. Recent genetic studies have documented unrelated individuals residing in a colony and unrelated lactating females sharing the same bank dens. Young beavers are frequently displaced from the colony shortly after they become sexually mature, at about 2 years old; however, dispersal age and patterns vary. Some beavers disperse in their first year, while others may remain in the colony for three years or more. This variation may be affected by several ecological factors, including population density. Beaver often disperse to another area to start a new colony, but some become "solitary hermits" inhabiting old abandoned ponds or farm ponds. Individuals not associated with family units (i.e., colonies) may be referred to as "floaters".

Food Habits

Beavers require a mixed diet to meet their nutritional needs. They are considered "central place foragers" as they search in all directions from their lodge/den site to forage on plants. Beavers are best known for eating the bark, leaves, and twigs of a variety of tree species, but also spend a considerable amount of time consuming other plant materials, such as corn, sorghum, soybeans, vines, shrubs, grasses, forbs, and aquatic vegetation.

The size and species of trees cut by beaver are highly variable—from a <2.5cm (1 in) diameter at breast height (DBH) softwood to a 1.8 m (6 ft) DBH hardwood. Beavers sometimes girdle larger trees without felling them. Some tree species, such as sweetgum, which ooze storax (a type of resin) when girdled, may provide compounds necessary for the formation of castoreum. Castoreum is used for scent marking.

Figure 21. Fresh willow cutting by beavers.

Food selection may vary greatly by availability, season, and region. Beavers forage on aspen and willow (Figure 21) where available, but will eat a variety of species including, but not limited to alder, ash, beech, birch, cherry, cottonwood, hornbeam, maple, oak, salmonberry, and sweetgum. Beavers also eat conifers like spruces, firs, red cedars, and pines. Select parts of conifers are more readily eaten in late winter and spring which may coincide with rejuvenated sugar flow through the trees. Trees with large quantities of phenolic compounds, like red maple, are usually avoided, but will be consumed if other tree species are not present. Beavers become more selective the further they venture from the lodge, selecting smaller specimens and more preferred species. Beavers tend to select smaller diameter trees of non-preferred species, while foraging on all size classes of more preferred species. In agricultural areas, beavers will eat crops, often traveling 90 meters (98 yards) or more from a pond or stream to find corn, soybean, and other growing crops. They cut the plants off at ground level and drag them back to the water. They eat parts of these plants and often use the remainder as dam construction material.

Legal Status

The legal status of beavers varies from state to state. In some states, the beaver is protected except during furbearer seasons. In others, it is classified as a pest and may be taken year-round when causing damage. Because of their aesthetic, recreational, and ecological values, beavers are generally not considered a pest until damage exceeds a landowner's tolerance level. Low fur prices for beaver in some states have made trapping for profit uneconomical. In some northern states, trapping is prohibited near lodges or bank dens to protect and perpetuate beaver colonies. Fur prices for beaver pelts are historically higher in these areas.

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Figure 12 and 15. Diagrams by Bob Noonan
Figure 17. Diagram by Jill Sack Johnson
Figure 18. Map from Schwartz and Schwartz (1981)
Figure 20. Diagram from Schwartz and Schwartz (1981)

Glossary

Castoreum: A secretion that is deposited by beaver on mud mounds to mark territorial boundaries.

Crepuscular: Primarily active at twilight (i.e., the period immediately after dawn and before dusk)

Floater: A lone beaver not associated with a family unit or colony.

Flow Device: A tool that combines exclusion and deception to maintain positive water flow where beavers dam culverts and streams.

Girdling: The complete removal of a strip of bark from around the entire circumference of a branch or trunk of a woody plant.

Herbivorous: Eats only plants

Key Words

Beaver, *Castor canadensis,* Culverts, Dams, Flooding, Flow devices, Gnawing, Roads, Trapping, Trees

Disclaimer

Wildlife can threaten the health and safety of you and others in the area. Use of damage prevention and control methods also may pose risks to humans, pets, livestock, other non-target animals, and the environment. Be aware of the risks and take steps to reduce or eliminate those risks.

Some methods mentioned in this document may not be legal, permitted, or appropriate in your area. Read and follow all pesticide label recommendations and local requirements. Check with personnel from your state wildlife agency and local officials to determine if methods are acceptable and allowed.

Mention of any products, trademarks, or brand names does not constitute endorsement, nor does omission constitute criticism.

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Appendix

Damage Management Methods for Beavers

Type of Control	Available Management Options
Exclusion	To protect trees from gnawing, total exclusion with fencing (e.g., chain link) is the only proven technique. However, this technique is often cost prohibitive. Wrapping individual trees with wire (e.g., hog wire or wire hardware cloth) and T-posts can reduce or delay gnawing; however, beavers can chew through wire. Seedling tubes are ineffective for protecting individual seedlings from beavers. To reduce flooding, fencing may be placed upstream of culverts to exclude beavers from damming culvert intakes. Culvert fencing is most effective when combined with corrugated pipe to create a flow device (see Habitat Modification).
Frightening Devices	Commercial frightening devices are available, but typically do not deter beavers.
Habitat Modification	Flow devices are tools that combine exclusion and deception to maintain positive water flow where beavers dam culverts and streams. Flow devices are often most effective at dams or culverts when corrugated pipe is used in conjunction with an exclusion fence. Breaching dams may provide immediate relief, but it does not prevent rebuilding and is not a long-term solution. Common methods used to reduce or remove dams include mechanical, explosive, and high pressure water pumps.
Repellents	Repellents are not effective at altering damming/flooding behavior, but some have been shown to temporarily affect food selection in some cases. Among these are herbivore repellents, textural repellents, unpalatable plant compounds, and predator odors.
Shooting	Shooting may provide very short-term immediate relief (where legal), but like trapping, it does not prevent reinvasion.
Toxicants	None available
Trapping	Trapping reduces immediate impacts but does not prevent reinvasion. It is an effective method for controlling beaver damage as part of a long-term integrated strategy. Consult state and local regulations first as they vary on acceptable trap types, trap check requirements, and season. Bodygrip traps are a common and effective method for lethal trapping of beaver. Foothold traps (longspring and coil-spring types with equivalent jaw spread and impact) may be used for lethal trapping of beaver in submersion sets. “Suitcase” style traps are primarily used for live trapping in dry sets or on the waters edge, but can be used as a lethal tool in submersion sets. These traps may also be useful to capture beavers for research studies or where state regulations restrict lethal trapping. Walk-in cage traps also are used for live trapping and can be used on land sets. Like “suitcase” traps, they may also be useful to capture beavers for research studies or where state regulations restrict lethal trapping. A relatively new cage trap, commonly referred to as the Comstock beaver trap, can be used as a walk-in or swim-in trap. Non-powered cable devices (commonly referred to as snares) can be useful, particularly in submersion sets and can also be used for live restraint.
Other Methods	Electric barriers have been used to deter beavers from entering culverts; however, the overwhelming risks to humans and non-target species should carefully be considered before using this method.