Techniques for Mitigating Human/Beaver Conflicts in Urban and Suburban Environments

June 2015

Animal Alliance Environment Voters Party of Canada

ANIMAL ALLIANCE OF CANADA

Illustration: Barry Kent MacKay

Lethal measures are the most common approach to resolving human/beaver conflicts in Canada. Beavers are trapped or shot and their lodges and dams destroyed. The purpose of this manual is to provide parks and wildlife personnel, government officials, advocates of wildlife preservation and restoration ecology, city engineers and planners, wildlife managers, and individuals facing human/beaver interactions and conflicts with information on the best management practices and techniques for mitigating conflict. This manual provides the tools that will allow wildlife managers to maintain beavers and their contributions to healthy ecosystems, while mitigating conflicts and ensuring public safety. These approaches are most applicable to North American ecosystems.

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1 Purpose and Intent of this Manual

Lethal measures are the most common approach to resolving human/beaver conflicts in Canada. Beavers are trapped or shot and their lodges and dams are destroyed. The purpose of this manual is to provide parks and wildlife personnel, government officials, advocates of wildlife preservation and restoration ecology, city engineers and planners, wildlife managers, and individuals facing human/beaver interactions and conflicts with information on the best management practices and techniques for mitigating conflict. This manual provides the tools that will allow wildlife managers to maintain beavers and their contributions to healthy ecosystems, while mitigating conflicts and ensuring public safety. These approaches are most applicable to North American ecosystems.

When managing human/beaver conflicts, politicians, particularly those at the municipal level, play a critical role in the process and are necessary if any positive changes are to come. The common view of municipal staff is that flow devices and tree-wrapping are unsuitable for urban areas. However, most areas of development that are being impacted by beaver activity are at the edges, in suburban areas. These areas were rural not that long ago, and the distinction between urban, suburban, and rural is becoming increasingly blurred. Solutions such as tree-wrapping and flow devices are effective in nearly every area if they are implemented properly.

Another common belief of municipal staff is that stormwater infrastructure is unsuited to flow devices. In reality, there are many examples where flow devices are performing excellently in stormwater infrastructure, and even more importantly, practices focused on prevention have been and will continue to be demanded of municipalities by the public for a number of reasons. In recent years, there has been an increasing push for green infrastructure solutions. Additionally, stormwater ponds are very often in the view of the public, located in highly-populated neighbourhoods, and used for recreational purposes. People are horrified at the thought of animals struggling and dying in Conibear traps right beside their recreational paths, and there is the serious issue of public safety when kill traps are used in places where children and pets play.

Finally, the motivation for creating this manual comes from the fact that municipalities are all facing the same circumstances. These circumstances are:

- Fewer and shrinking wetlands
- Increasing development of lands
- A growing body of research proving the importance of beavers to the environment and water quality and availability
- New, innovative solutions for managing human/beaver conflicts, and improvements on older solutions
- The economic realization that preventative measures cost eight times less than reactive and repetitive measures, when costs buried in road, drainage, stormwater, and forestry department budgets are considered
- The public demand for environmentally progressive, safe, cost-effective, humane, and sustainable solutions

Together with the encouragement of upper-tier governments for municipalities to adopt green infrastructure solutions, all of these scenarios present an ideal opportunity for municipalities to put in place a comprehensive program for managing beavers on the basis of best practices.

2 Acknowledgements

The information in this manual has been compiled and developed by Emma Hawley-Yan and reviewed by: Mike Callahan, Beaver Solutions; Barry Kent MacKay, Director, Animal Alliance of Canada; and Donna DuBreuil, President, Ottawa-Carleton Wildlife Centre.

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Special thanks need to be extended to the following people and organizations for providing the photographs used in this manual: Doris Potter, Garden State Wildlife Control, Beaver Solutions LLC, Sierra Wildlife Coalition, Debbie Risberg of Animal Protection of New Mexico, Cheryl Reynolds and Heidi Perryman of Worth A Dam, Barry Kent MacKay, Beavercone Products, and Beaverculvert.com.

3 Introduction

3.1. Information About Beavers

3.1.1. Physical Characteristics

Photo: Cheryl Reynolds, Worth A Dam

The beaver (scientific name *Castor canadensis*) is the largest North American rodent, weighing anywhere from 16 to 32 kilograms (35 to 70 pounds) and reaching sizes of up to 1.3 metres (4.3 feet) long when stretched out, including the tail, once the animal is fully grown. Beavers are very well adapted to life in the water, with the ability to reach

swimming speeds of nearly 7 kilometres (4.4 miles) per hour, the ability to seal their nostrils and ears when submerged, and have a specialized transparent membrane to protect their eyes, allowing them to see clearly below water. The impressive tail of a beaver can measure up to 30 centimetres (11.8 inches) long, 18 centimetres (7 inches) wide, and 4 centimetres (1.6 inches) thick, and is flexible and strong, while also firm and stiff when being used for balance. Though the body of a beaver is covered in brown fur, the tail has a somewhat leathery texture and is sparsely adorned with coarse hairs. It serves the beaver's lifestyle well, allowing the beaver to sit or stand upright while on land by helping to brace the animal and by counterbalancing the weight of branches, mud, or stones that the beaver may carry in its front paws when walking on its hind legs.

The tail acts as a four-way rudder, capable of moving up or down or side to side, while the beaver is swimming. The hind feet are large and webbed, with five long toes and blunt claws, while the forepaws are small, unwebbed, and have five shorter toes with sharp claws. The hind feet are used to propel the beaver through the water, whereas its forepaws are well-designed for digging, carrying and holding building materials and food, and other tasks that require dexterity. Both the front and hind feet are used for grooming. Each hind foot has one double-clawed toe, which acts as a tiny set of pliers, perfect for combing.

Beavers have dense fur that is kept waterproof by constant preening and oiling. They have a 2 centimetre (0.8 inch) long coat of fine underfur, and a 7 centimetre (2.8 inch) long coat of thicker guard hairs, and even after six or seven minutes of being in the water, the beaver's skin remains dry. Two glands near the anus secrete a strongly scented oil, and the beaver applies this over its entire body to maintain its waterproof characteristics. Beavers of the same family will preen each other, removing dirt, straightening fur, and removing insects or mites. In spring and in late autumn of each year, the beaver will moult its outer coat of guard hairs to prepare for the growth of a new coat.

The beaver's teeth are long, sharp, incredibly strong, and capable of felling even large hardwood trees. They are constantly growing and the front surfaces of the teeth are covered in very hard, dark orange enamel. The teeth keep their chiseled sharpness as the upper and lower incisors grind together.

Another adaptive trait of beavers is their ability to seal the lips behind the incisors, allowing the beaver to chew twigs even while its mouth is sealed from the water.

3.1.2. Communication and Social Interactions

Beavers communicate through physical markers such as "mud pies" (a pile of mud with their paw print and a deposit of their musky oil) and through noises. These noises can be low whines and bellows, or the slap of their tails on water. The gunshot-like sound created by this slap is used to warn other beavers nearby of danger.

Beavers are generally social and peaceful, at least in interactions with their own family members. They groom each other, work together to build and maintain their lodge and dam, and the young beavers in the family will often wrestle and play with each other.

The young will also watch the older beavers build, as if observation and imitation, along with experience, play a role in their ability to build dams and lodges and dig canals.

Photo: Heidi Perryman, Worth A Dam

This basic ability, however, is innate. Although they are very close to each other within their own family, beavers will generally not allow unrelated beavers to live in the same pond. The pond is surrounded with scent mounds (piles of mud mixed with their unique body oil) to discourage other beavers from entering their territory. If an outside beaver does enter the territory, the adult beavers will defend the family home by attacking the intruder. They will only attack to defend their territory, themselves, or their family; otherwise beavers are very peaceful, gentle animals.

3.1.3. Habitat and Range

Beavers prefer forested areas, although they will also settle in unforested habitats as long as there is an adequately sized body of water, surrounded by palatable trees and shrubs. Beavers are found throughout much of Canada and the United States, and a very small part of northern Mexico. Refer to figure 1.

Figure 1. Distribution of the beaver
Environment Canada & Canadian Wildlife Federation, 2003

3.1.4. Lifespan and Habits

Beavers can live up to 12 years. They alternate between active and rest periods each day, doing most of their activity from dusk to dawn and generally resting in the lodge midday. This is their general daily schedule in all seasons. They do not hibernate.

3.1.5. Feeding

Beavers eat leaves, twigs, bark, and both terrestrial and aquatic vegetation. They prefer young trees that are easy to fell and move. Certain tree species, such as trembling aspen, poplar, willow, and birch, are more desirable to beavers than other species of trees and plants. The thick stems and roots of aquatic vegetation such as pond lilies and cattails are another great food source for beavers, especially because they don't have to leave the safety of the water to obtain them. In the winter, they can still access these in the bottom mud, below the ice. In the spring and summer, beavers have a more varied diet eating the new grasses, herbs, leaves, and fruits, as opposed to the woody diet they stick to in the winter months.

Beavers construct food piles/caches each fall, close to their lodge in deep water, so that they have enough food stored up to survive the winter. They clear nearby trees and gnaw them into short, manageable lengths to carry back and store underwater. They use small, leafy branches of tree and plant species they don't like that much to build a thick top layer, so that most of their food pile remains below the surface of the water. The top protective layer prevents snow from reaching the rest of the cache, insulating that section of the water body, so it will be less likely to freeze around the winter forage. During winter, the beavers normally can access the food cache underwater, and bring sticks back to the lodge for feeding. Refer to figure 2.

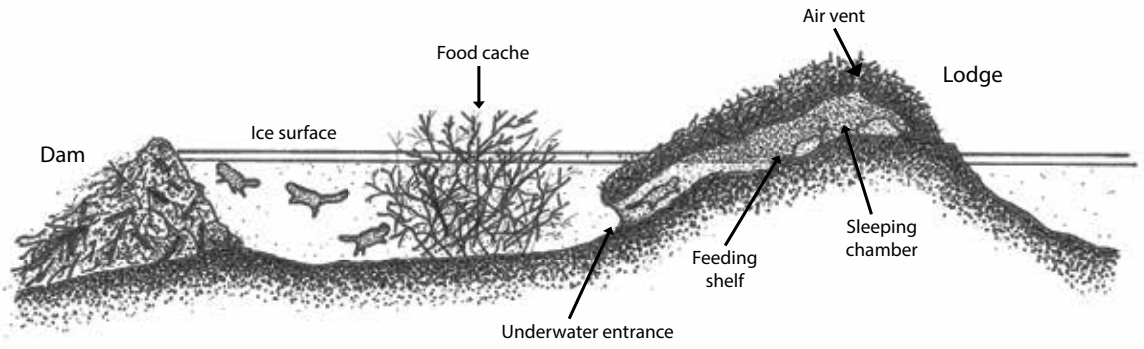


Figure 2. Generic relative locations of beaver lodge, food cache, and dam in water. Drawing by Shelly Hawley-Yan, 2015

3.1.6. Breeding

Photo: Doris Potter

Beavers are monogamous, taking only one mate for life. They live in families, with the female as the head. The female establishes the home, and remains with the family even if the male mate has disappeared, in which case in the following mating season, a different male will join the female. Males, however, will often abandon the family and the site if the female partner is killed and there are no female offspring to fill the position. Each beaver family has two parents and the offspring of the past two or three years, most often meaning a family of six or seven beavers, though this number could be lower or much higher depending on litter size and availability of food in that location.

Photo: Shutterstock

Mother beaver and two kits

At the start of each year, in January and February, the mating process begins. Shortly before the birth of the kits, the male is driven from the lodge, and usually dwells temporarily in an old lodge or a burrow in the riverbank. In May or June, after a 100-day

gestation period, one litter of one to six (averaging three or four) kits is born. Beaver kits are approximately 125 mm long and weigh about 450 grams at birth, and are born with fur and teeth. The kits can see, walk, and swim at birth. Despite their high level of development at birth, the beaver kits usually won't leave the safety of the lodge for at least the first month. If they need to move elsewhere, due to a threat, they will be gently carried in the mouth of their mother. After being raised by their parents, the young beavers will stay with them for two and sometimes three years, and in the second summer of their lives, they help support the family by cutting food, performing repairs on the lodge and dam if there is one, and digging canals.

The following spring, the offspring will disperse, travelling anywhere from a few kilometres to 250 kilometres, along streams or across land. They will travel until a mate and suitable building site are found, at which point they will establish their own home. This can be a dangerous task for young beavers, as they are at increased risk of being caught by predators, or hit by cars, on their way to find a new place to live. They also must avoid wetlands already inhabited by other beavers, or risk attack by the resident beavers. Only a small percentage of the landscape is suitable beaver habitat, and so as beaver populations rise, it becomes increasingly difficult for them to find a good place to settle down.

3.1.7. Population Self-Regulation

Beaver populations are considered "self-regulating," meaning that populations will not grow exponentially; they will naturally remain at a healthy level due to their territoriality, and other factors such as food availability.

Beavers are territorial, and will generally not allow another beaver or family of beavers to inhabit areas too close to their own. Various studies have found that one kilometre of stream can support, on average, 0.4 to 1.24 beaver families (Hodgdon, 1978, as cited in Massachusetts Society for the Prevention of Cruelty to Animals–Angell Animal Medical Center, 2014). This territoriality restricts beaver population growth; beavers will only reproduce when there is enough available habitat to support a larger population.

Additionally, beavers will not reproduce if their population exceeds the available food supply. Natural predators, such as wolves and coyotes, also help to regulate beaver populations.

Attempting to manage beaver populations through lethal methods can actually increase population growth by stimulating beavers to become sexually mature earlier in their lives. In a study comparing beaver populations exploited through trapping, and those left unexploited, it was found that on average, the females in unexploited populations became sexually mature at 32 months, whereas in populations managed through trapping, the sexual age of maturity in females averaged two years, or 24 months (Hodgdon, 1978, as cited in Massachusetts Society for the Prevention of Cruelty to Animals–Angell Animal Medical Center, 2014).

Essentially, managing human/beaver conflicts is more effective than attempting to keep the population down. From an ecosystem point of view, beaver populations simply do not grow exponentially.

3.1.8. Predators

In their aquatic habitat, beavers are quite well-protected from predators; however, on land they are more vulnerable. Where present, wolves, coyotes, foxes, bears, lynx, bobcats, mountain lions/cougars and wolverines prey on beavers when they are on land collecting trees for building and food, or when they are travelling by land to find new building sites. Even eagles have taken beavers. Accidents such as falling into abandoned wells and getting hit by cars frequently cause mortality. Also, if the water level fluctuates suddenly, beavers may have to leave their lodges and remain on shore, putting themselves in significantly increased danger. In the lodge, river otters can enter through the underwater entrance in an attempt to kill the kits, so an adult beaver will be with them at all times, to protect them. Once the kits emerge from the lodge, they may fall prey to predators such as great horned owls. When faced with a predator, beavers do not back down easily. They will stand on their hind legs, produce loud hissing and growling noises, and bite their attacker. Their bites can be damaging, thanks to their strong, sharp teeth. Humans are the greatest predator to the beaver, and being caught in a trap is the most common way for a beaver to die.

3.1.9. Construction – What Beavers Build and Why

Photo: Cheryl Reynolds, Worth A Dam

Beavers must fell trees so that they have food to eat and the materials they need to build their lodges and dams. A beaver cuts down an average of 216 trees per year, and usually works alone. Occasionally, two beavers will work together to cut down a large tree. Beavers can cut down trees up to 40 centimetres (16 inches) in diameter. The structures that beavers create depend on where they are living, and what the habitat is like when they begin. The three main structures they build are dams, lodges, and canals. Mud, sticks, roots, and rocks are most commonly used in the construction process.

Photo: Shutterstock

Beaver dam

Beavers build dams only when the body of water they have settled in is not big enough for them to have access to the vegetation they need for building their lodge and their food pile, or deep enough for them to move around below the ice in the winter. By raising the water level, the radius of the pond increases, allowing the beavers to travel a further distance by water, and reach more vegetation without having to travel over land, where they are awkward and significantly more vulnerable to predators. Beavers generally won't go more than 50 metres (164 feet) from the edge of the water to cut trees. When the vegetation in this radius is entirely used up, they will either raise the pond level by further damming, or move somewhere else.

The technique that beavers use when building a dam is very effective and results in a strong, stable structure that can hold back very large amounts of water and withstand great pressure. Dams can reach heights of 5.5 metres (18 feet) but typically do not exceed 1.5 metres. Beavers will first lay sticks and rocks at the narrowest point of the river feeding their water body, with the fastest current. They secure the sticks in the riverbed at an angle going against the current, so that the stones and mud and additional sticks get wedged into the spaces as the current tries to push them downstream. They add multiple layers until the dam is high enough to create the size and depth of pond or small lake that they need. They inspect the dams daily, adding more material if a break is found. Dams vary in length from a few meters to about 100 (a few feet to 330 feet) and the world's biggest dam is in Alberta, Canada. It is 2,790 feet (850 metres) in length and can be seen from space.

Photo: Doris Potter

A conical lodge in the winter

Photo: Shutterstock

Bank lodge

Lodges are where beavers live, sleep, eat, groom, give birth to, and raise their babies. Beavers usually build them over the course of one month in the fall, so they can prepare for the upcoming winter. There are two types of lodges – the conical and the bank lodge. The most common type is the conical lodge, which is the typical dome-shaped structure made of sticks, mud, rocks, and whatever other suitable material they can find, usually in or near the middle of the water body. The bank lodge, which is dug into the bank of the river or other water body, is used when the water is moving too fast or is too deep to build a lodge in the centre, where it will be surrounded by water on all sides.

The lodge has one large chamber, laid with a bedding of grass, reeds, and wood chips that is changed regularly. This chamber, the den, sits on a platform approximately 10 cm (4 inches) above the average surface of the water, so that it will not flood. Beavers leave the peak of the lodge open, don't fill it with mud, to leave a shaft for air to move through. They plaster the rest of the exterior with mud, so that once temperatures drop to freezing, the mud hardens and the lodge is solid and strong enough to usually prevent large predators from breaking in. A heavyset person may be able to stand on top of a lodge without breaking through.

A lodge always has at least two underwater exits, so that if a predator enters the lodge, the beavers always have a backup escape route. Also, by exiting underwater, they can avoid being spotted by predators, and can swim below the water from there.

The walls of the lodge are insulated very well, and keep the temperature inside the lodge regulated to a degree comfortable for the beavers. In the winter, despite external temperatures, the temperature inside a beaver's lodge will never drop below freezing, as the body heat they emit is retained inside the lodge thanks to the well-insulated lodge walls. Most lodges measure about 5 metres (16 feet) across, with a height of approximately 2 metres (6.5 feet), although some lodges are bigger or smaller than others, depending on how many beavers are in that family group, how long they've been living in that lodge, and how much the water level in that area fluctuates.

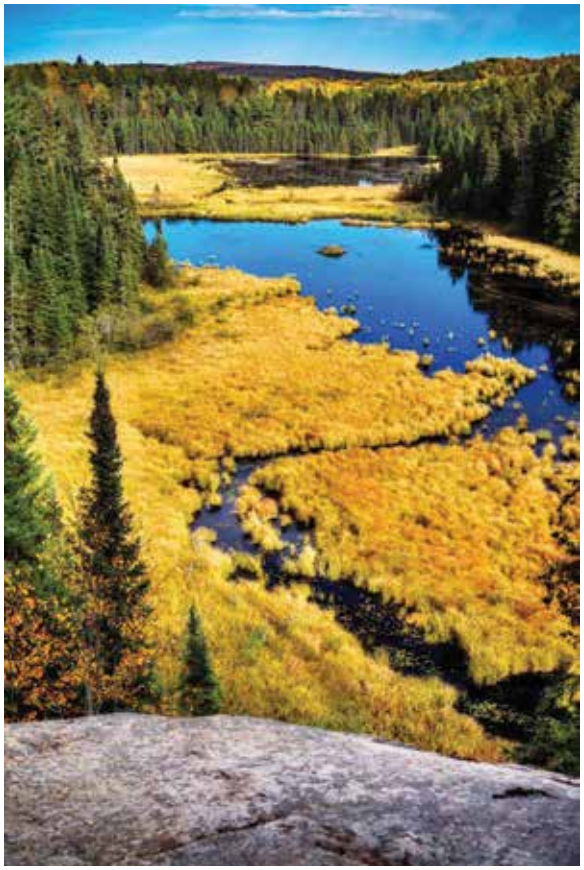


Photo: Shutterstock

Beaver canals

Canals are dug along the base of forested hills, usually about 1 metre (3.3 feet) deep and approximately 1.5 metres (5 feet) wide and sometimes several hundred metres (several hundred yards) long, so that the beavers can more easily transport food supplies by swimming, rather than walking across land and possibly falling prey to predators. They may also dam these canals, or divert nearby streams into the canal, so that the water level is maintained throughout, especially across uneven ground.

3.2. Conservation Plans in Effect and Existing Framework

Photo: Doris Potter

By the early 1900s, the native North American species of beaver, *Castor canadensis*, was nearly completely extirpated from North America due to trapping for the fur trade, and from loss of wetland habitat due to draining for agricultural purposes. At the peak of the fur trade era, approximately 200,000 pelts were sold each year, most shipped to England to be made into hats. As the fashion trend of beaver hats became less popular (and it became harder to even find beavers to trap) the trend of killing beavers slowed; however, in many regions where it had previously occurred the beaver was completely gone for most of the first half of the 20th century. In some regions massive deforestation and urban sprawl rendered the habitat unsuitable for the species. In the late 1930s, the beaver conservation movement began thanks largely to Grey Owl – an Englishman posing as a Native American – who turned his back on trapping and gained widespread fame writing and lecturing about the unfortunate state of the beaver populations, and Canadian wildlife and nature as a whole.

The beaver trapping season was closed for many years following Grey Owl's conservation work, and populations have now recovered in all areas where there is suitable habitat, and even in urban regions. In Canada, federal and provincial governments, in co-operation with trappers, have put conservation plans into effect, and they have re-introduced beavers into places that were previously depopulated. Federal, provincial, and municipal acts, policies, regulations, and by-laws have been created that can protect beavers. Thanks to these actions, beaver populations have been able to grow and are now healthy, though still believed to be below historic levels. A list of the federal, provincial, and municipal acts, policies, regulations, and by-laws that are relevant to managing human/beaver interactions in Canada can be found at the end of this manual in the Additional Resources section.

In many cases, the most pressing issue regarding beavers is not how to protect or manage their populations, but rather how to minimize conflict between humans and beavers. The most common of these conflicts are flooding (and the related damage

to farmland and crops, roads, and private property) and damage to vegetation. There are many ways to manage these conflicts effectively, humanely, and safely, and it is important to approach these conflicts the right way, rather than by simply trapping and killing every troublesome beaver and tearing down every dam.

Canada's history has been more greatly influenced by the beaver than any other animal, as it was the search for the beavers' pelts that encouraged settlers to move deeper into the wilderness. Beavers are the national symbol of Canada, and hundreds of lakes, towns, rivers, and hill ranges are named after the beaver. The importance of beavers is evident, and they must be managed very carefully.

4 Ecological and Environmental Importance of Beavers

Beavers are a keystone species, meaning that they play a critical role in the biodiversity of ecosystems, and that many species, some endangered or threatened, rely on beavers and the landscapes they engineer. There are numerous benefits that other species, including humans, can derive from beavers. The ecological importance of beavers includes the benefits derived from the wetlands they create, including water quality and availability, and their contribution to local biodiversity.

Photo: Cheryl Reynolds, Worth A Dam

4.1. Wetlands and Water Quality

Photo: Doris Potter

Wetlands are vitally important to maintaining water quality and quality of life for many species, including humans.

They act as a sponge, storing excess water when needed, and releasing it slowly. This helps to prevent flooding; can help reduce or prevent erosion caused by fast-flowing currents; protects the environment from deleterious effects of drought, as the water can be stored and released slowly in drought seasons; and recharges drinking water aquifers as the water is allowed to seep down deep into the soil, rather than be lost to erosive runoff.

Wetlands are also beneficial by virtue of their ability to remove pollutants that accumulate in the water. The algae, cattails, and other aquatic and semi-aquatic plants absorb dissolved nutrients and toxins such as heavy metals, pesticides, and fertilizers, effectively removing them from the water.

In their study, Westbrook et al. (2006) explain how overbank flooding is important to biogeochemical cycling, biotic diversity and productivity, groundwater recharge, and to maintaining riparian zones, and how for most rivers, it naturally occurs for a short period of time – a few days to weeks – once every couple of years. They determined that "beaver dams and ponds greatly enhanced the depth, extent, and duration of inundation associated with floods; they also elevate the water table during both high and low flows" (p.1). They found that the effects of beavers were not restricted to the immediate area around the beaver pond, but were also significant downstream of the dam. This study "provide[s] empirical evidence that beavers can influence hydrologic processes during the peak flow and low-flow periods on some streams, suggesting that beavers can create and maintain hydrologic regimes suitable for the formation and persistence of wetlands" (p.1).

4.1.1. Maintaining Boreal Wetlands During Climate Change

In addition to creating wetlands, new studies show that beavers are important to maintaining open water wetlands in areas affected by extreme drought and rising temperatures brought on by climate change. In the article *Beaver (Castor canadensis) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada*, Hood and Bayley (2008) explain how as drought and warming temperatures are brought on by climate change, these wetlands are becoming more and more vulnerable, often shrinking or disappearing entirely. In their important study, Hood and Bayley acquired 12 area photo mosaics of the wetlands in the mixed-wood boreal region of east-central Alberta. The mosaics represented a 54-year period, from 1948 to 2002, and were examined to determine how beaver activity influenced the area of wetlands as mean temperature and precipitation varied. The study covered periods of wet and dry weather, as well as periods when beavers were absent, as well as when they were once again well established in the regions. In the 19th century, the study area lost all beavers, until they returned in 1954.

The results of the study showed that over 80% of the variability in open water area could be explained by the number of active beaver dams at that time, that beaver presence vs. beaver absence was correlated with a ninefold increase in open water area, and that other factors such as temperature, precipitation, and climatic variability were not nearly as important as beaver activity in maintaining the amount of open water.

This study demonstrates that as climate change brings on increasingly higher temperatures and extreme drought, one of the most important factors in maintaining wetlands and water availability is beaver activity, and that removing beavers should be avoided, as it would cause a significant wetland disturbance (Hood & Bayley, 2008).

4.2. Biodiversity

As beavers cut down the trees around their pond, the holes in the tree canopy allow sunlight to reach the water, triggering the growth of aquatic plants that previously couldn't survive for lack of sunlight. Algae and other plants provide the basis for complex food webs, supporting microscopic organisms, invertebrates, insects, fish, birds, and mammals. Additionally, as the trees on shore are cut down, grasses, saplings, and other new vegetation will grow in, providing a renewable food source for other animals. Even some felled trees will often re-grow as multi-branched "bushes" suitable for nesting songbirds. The number and variety of species present in and around a beaver pond can be truly remarkable.

Many plant and animal species, including those that are at risk, thrive in the habitats that beavers create. These include deer, herons, songbirds, ducks, grebes, frogs and toads, salamanders, painted and snapping turtles, muskrats, snakes, otters, minks, black bears, raccoons, Canada geese, owls, hawks, and bald eagles. Black ducks, a species generally in decline, have a particular affinity for beaver ponds as nesting sites, and will even nest on abandoned lodges. Goldeneyes, hooded mergansers, wood ducks, and other waterfowl nest in the cavities of drowned trees standing in water, and great blue herons often favour such trees for nest colony sites. Rails, gallinules, and various songbird species utilize emergent vegetation for nest sites. Salmon and trout thrive in the cool, deep pond habitat that beavers create, and their populations often abound in beaver ponds.

Beaver dams catch sediment that would otherwise be washed downstream, and therefore help to prevent sedimentation of spawning areas of many fish species downstream. Common aquatic plants such as water-shields, common bladderworts, white water lilies, and bullhead lilies will grow in beaver ponds, and not only provide food for beavers, but also shelter for the larvae of dragonflies and damselflies, whirligig beetles, and water striders.

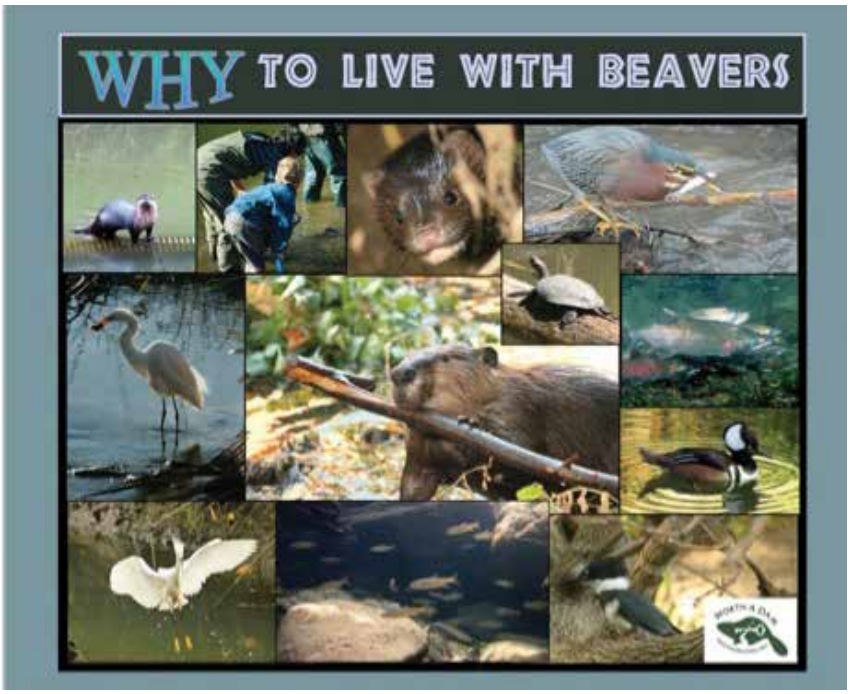


Photo: Cheryl Reynolds, Worth A Dam

Some of the benefits of living with beavers

Basic general information in sections 3 and 4 was drawn from a number of different sources, including Beaver Solutions LLC, n.d.; Beavers: Wetlands & Wildlife, n.d.; Boyle & Owens, 2007; Callahan & Perryman, n.d; Environment Canada & Canadian Wildlife Federation, 2003; Giannetta, 2011; Knight, n.d.; Kurta, 1995; National Geographic, 2014; Naughton, 2012; Reid, 2006; The Friends of Algonquin Park, 2005; The Humane Society of the United States, 2009.

5 Human/Beaver Conflicts

Beaver activity has many positive impacts on the environment and on human interests. However, interaction between humans and beavers sometimes results in conflict, when beaver activities conflict with the intended use of the land by humans, or human health and safety is perceived as compromised.

5.1. Property

The most common conflicts involve effects on private and public property, including the flooding of timber and agricultural land, houses, and municipal infrastructure such as roads, bridges, and storm water management ponds. Beavers may dam or block culverts and pond drains, often causing flooding of land to degrees deleterious to human interests. Their damming can also obstruct, at least temporarily, the flow of water to downstream areas that may have relied on that source for residential, industrial, agricultural, or other purposes. Beavers also take down trees, including desired fruit, shade, or ornamental trees and shrubs, and can negatively impact some agricultural practices. Their burrowing may weaken dams, dikes, and road or possibly even rail beds.

Many municipalities have a zero tolerance approach to the presence of beavers, particularly as it pertains to roads, bridges and storm water management systems.

The City of Ottawa's Wildlife Strategy (2013) expresses common municipal concerns regarding beavers:

In addition to the requirement for maintenance of municipal drains, the City is sometimes required to carry out beaver management activities for the protection of physical infrastructure, especially roads. Road culverts and bridges are favoured places for beavers to build dams, creating natural choke points on watercourses and providing strong auditory triggers for dam-building activities. Beavers tend to build much higher dams at culverts than under normal circumstances. The resulting beaver ponds can cause both flooding and physical damage to road beds, creating public safety hazards and requiring expensive repairs.

Beavers are also sometimes attracted to engineered storm water facilities, especially those that have been designed to function as attractive public spaces. In most cases, beavers do not linger in these facilities, but quickly move to more suitable, natural habitats. In some cases, however, beavers try to establish lodges and/or dams, sometimes within the associated storm water pipes. Such activities impair the functioning of these storm water facilities, creating risks to both public and private property, especially in large storm events. Beavers also damage or destroy neighbouring trees, which have often been planted by the City at the cost of many thousands of dollars. (p. 32)

5.2. Human Health

There are a couple of diseases that are often blamed on beaver. The first is giardiasis, or "beaver fever". It is caused by protozoan parasites in the *Giardia* genus, which live in the intestines of many animals, humans included, or as a spore-like cell, called a cyst, which can survive in the external environment once excreted. There are different species of *Giardia*, though *Giardia duodenalis* is the one most commonly found in mammals, and the only one which causes illness in humans (The Center for Food Security & Public Health, Iowa State University, 2012). It can spread when the parasite or the cyst is ingested through the process of ingesting contaminated water, putting something in the mouth that has come in contact with infected animal or human feces, eating raw or undercooked contaminated food, inadequate hand sanitation, or contact with infected feces during sex. The parasite can only cause infection when it is swallowed; blood that comes in contact with the parasite will not become infected. It was nicknamed "beaver fever" after hikers at Banff National Park drank stream water that had been contaminated with beaver feces, and contracted *Giardia* (Centers for Disease Control and Prevention, 2012; Ontario Ministry of Health and Long-Term Care, 2012). However, despite its nickname, it has more recently been found that human usage of the watersheds may be more to blame for giardiasis outbreaks than beavers, and that humans may actually be infecting the water that is then carrying the disease to beavers (Erlandsen et al., 1990). It has never been proven that the giardiasis that appears in humans is caused by the same species of *Giardia* that beavers carry (Link, 2004). Within the *Giardia duodenalis* species group, there are multiple different genetic assemblages. Assemblages A and B occur in a broad variety of hosts, and are almost always the types that cause illness in humans. The other assemblages, however, infect a narrower, more specific host range.

The potential for transmission between animals and humans is "currently thought to be of minor significance in human illness" (The Center for Food Security & Public Health, Iowa State University, 2012). The U.S. Environmental Protection Agency has found many different species of *Giardia* in a number of different varieties of mammals, birds, reptiles, amphibians, and fish, suggesting that soil and water can be contaminated through feces and municipal sewage water practices. It is probable that municipal waste waters and all surface waters always contain *Giardia* cysts (United States Environmental Protection Agency, 2000). Because of these findings, beavers cannot be blamed for the spread of giardiasis, and fear of contracting giardiasis from beavers is not a conflict on its own that should prompt removal of the beaver(s).

Another disease which is commonly associated with beavers is tularemia. It is transmitted from animal to animal by insect bites or contaminated water. Tularemia can be contracted by humans if they drink contaminated water, eat undercooked or raw infected meat, get bitten by an infected tick or fly, inhale dust from contaminated soil, or by touching the open wound of an infected animal and bringing one's fingers in contact with one's mouth or mucous membrane. It is uncommon in humans, and the most common way to become infected is by handling infected dead animals in the absence of appropriate hygiene and other precautions. It is easily treated with antibiotics (Link, 2004).

Due to the more recent findings that giardiasis may be blamed more on human than beaver usage of watersheds, and that tularemia is uncommon, being contracted primarily through handling of dead animal carcasses, neither disease is cause for public health concern, nor are they true conflicts that should prompt removal of beavers.

6 Applying Best Management Practices

As residential and commercial developments encroach on beaver habitat, human/beaver interactions increase, so people need to learn how to co-exist with beavers. There are a number of techniques that may be implemented in order to resolve both direct human/beaver conflicts, and indirect human health issues related to beavers. This manual addresses non-lethal techniques such as: teaching tolerance through education and encouraging community action; setting up enclosures around vegetation that is to be protected; and installing water level control devices to reduce and prevent flooding. The most commonly utilized approaches by the Ministry of Natural Resources and private property owners are lethal removal, and breaching and removing dams, although these are not the most effective, long-term solutions. This manual explores all the available non-lethal options, and the pros and cons of each, and demonstrates that non-lethal is the more effective and cost-efficient longer-term solution. It is important to note that each of these strategies is not generically applicable to any given conflict, and each situation must be approached and assessed individually to determine the best plan.

6.1. Teaching Tolerance: Education and Community Action

The general principle behind this teaching tolerance strategy is that the public, and municipal, provincial, and federal governments, can learn to tolerate the presence of beaver on their lands, and will generally find that co-existing with beavers provides more pragmatic or actual benefits than perceived harm. In situations in which beavers are simply an inconvenience to landowners, tolerance is the easiest solution. Observing the natural activities of the beaver building lodges, dams, and canals can be very exciting and educational. Sometimes, if you watch the peak of a beaver's lodge when it's very cold in the winter, the breath of the beavers inside can be seen escaping through the ventilation shaft. Quite often the habitat set up by beavers is highly attractive to a variety of wildlife, and quietly observing or photographing the other wildlife drawn to the area can be an enjoyable experience.

6.2. Enclosures: Preventing Vegetation Impact Issues

Enclosures are meant to protect specific trees from being felled by beavers, or to protect large areas of land (such as orchards) from the effects of beavers. It is important to note that this solution alone won't directly help solve flooding issues. It discourages beavers from bringing down certain trees; however, if there are other suitable trees available nearby, they will still likely build dams causing subsequent flooding. However, this is a good solution to protect specific trees, and it is also a very good option to implement alongside a flow device.

Photo: Ottawa-Carleton Wildlife Centre

Tree wrapped with 14-gauge wire

Individual trees can be wrapped in wire fencing to prevent beavers from chewing them down. For maximum effectiveness and protection, it is best to use 2" x 4" galvanized (to prevent rusting) welded wire, often called utility fencing, minimum 14 gauge to ensure the ability of the fencing to stand freely (the smaller the gauge, the stronger the wire).

Typically, this fencing is bought in rolls that are 15 to 30 metres (50 to 100 feet) long, and 1.2 to 1.8 metres (4 to 6 feet) high. For projects where many trees are to be wrapped, the larger roll is more cost effective.

The fencing must stand at least 30 centimetres (1 foot) from the tree trunk on all sides, (to allow for growth) and extend 0.6 metres (2 feet) higher than the highest snow level. Under most Canadian snow conditions, the 1.2 metre (4 foot) high fencing is adequate. It is recommended not to wrap trees with fencing any shorter than this. The bottom of the fencing should be cut so that it lies flush with the ground. If the ground is sloping or if there are any prominent roots, be sure to cut the wire so that it fits properly, otherwise beavers will work under the wire and chew these roots.

If the tree-wrapping project is extensive, or if there will be numerous areas where tree-wrapping will have to be done, hog ring plier stapler and hog ring staples will be a good investment. These will make attaching the ends together faster and less laborious.

Hog ring plier stapler

Hog ring staples

It is critical to choose the right material when wrapping trees. Chicken wire should never be used because it is too lightweight to stand on its own so it doesn't provide for the 30 centimetres (1 foot) of distance required around the tree, defeating the purpose of keeping the beaver away from the tree. It will become too rusted to be effective within a couple of years, requiring unnecessary time and money to be spent on replacing it and maintaining the protection, and also risks girdling and damaging the tree. Hardware wire mesh will work, although it is very noticeable, not very aesthetically pleasing, and more expensive. Galvanized welded wire or utility fencing, 2" x 4" and 14 gauge, is the best option as it will be able to last and withstand damage and winter conditions, and can be purchased at most hardware stores (Beaver Solutions LLC, n.d.; Ottawa-Carleton Wildlife Centre, 2013).

For enclosing orchards or other large areas of land, standard fencing of any sort will usually suffice. As long as the perimeter is continuous, there are no breaks that a beaver could fit through, the fence is flush with the ground around the entire perimeter, (to prevent beavers from crawling under the fence) and the fence is at least 1.5 metres (5 feet) high, the enclosed area should be safe from beaver activity, as beavers are not strong climbers.

Both tree-wrapping and installing standard fencing are long-term, relatively inexpensive solutions that allow beavers to remain in the area and provide the benefits that they offer without damaging the vegetation to be protected.

6.3. Discouragement

There are other small actions to take to discourage beaver activity in certain areas of a property. Rather than trying to prevent beaver activity in an entire lake or pond, in some situations it is enough to encourage them to inhabit certain areas, and discourage activity in others.

One way to do this is, if possible, to eliminate the trees and vegetation that beavers find most desirable, in the areas you do not want them living, and plant less desirable species instead.

Beavers prefer:

- Aspen
- Apple
- Poplar
- Willow
- Cherry
- Cattails
- Cottonwood
- Birch
- Water lilies
- Alder
- Sugar maple
- Sedges

(Beaver Solutions LLC, n.d.; Beavers: Wetlands & Wildlife, n.d.; Haemig, P.D., 2012; Ontario Ministry of Natural Resources and Forestry, 2014). It is important to note that while beavers do prefer certain species, this is only a preference, and if faced with a situation where their preferred species are unavailable, they may still eat less desirable vegetation. They may also use less desirable tree species as building material even if they prefer not to eat them. It is also important to note that not all of the species listed above are native to all areas of North America. When planting new vegetation, choosing those species which are native to the area is recommended.

If you have certain plants you care about, do not place them near areas where you know beavers are active. This is most applicable regarding planting new vegetation, as moving pre-existing vegetation is often not a realistic option.

Drawing by Shelly Hawley-Yan

Trees are coppiced – or cut close to the ground – in fall/winter and shoots grow rapidly and densely the following spring. This creates low, dense habitat and promotes the growth of willow and cottonwood.

Planting new trees to replace the ones the beavers have cut down can not only discourage beavers from chewing down the trees you care about and don't want harmed, but can also improve the health and growth of that area, stabilize the soil, and prevent erosion and sedimentation. The types of trees that beavers prefer are generally fast growing, so in fact, due to beaver activity, the growth the following spring will likely be greater and healthier. As an example, the stump left behind from a willow tree that a beaver has cut down can sprout multiple new stems. Other tree species, such as poplars, will regrow from the same roots.

By allowing beavers to fell the species of trees they prefer, and planting more of these species, the overall vegetative growth and biodiversity of the area can be increased, while some other plant or tree species may also benefit from the activity of the beavers. Additionally, by allowing the trees to be cut by beavers and then regrow, the root system below ground will grow and develop extensively, stabilizing the soil and the riverbank/shore. This prevents erosion and downstream sedimentation. (Beavers: Wetlands & Wildlife, n.d.)

Photo: Sierra Wildlife Coalition

Tree trunks painted to prevent beaver damage

Covering tree trunks in a paint and sand mixture can be somewhat effective in discouraging beavers. This might be an alternative where there is a large stand of trees that need protection. A mixture of **latex** exterior paint and fine sand (30 ml or 70 ml) in a ratio of 5 oz sand per quart of paint can be applied to tree trunks to discourage beavers from chewing. This is visually discreet as the paint can be selected to match the tree trunk. It is also relatively quick to apply. Mix only the amount you will use as it does not store well and remember to stir the mixture often as the sand will settle. This method is not recommended for saplings less than six feet high, so protect them with wire fencing. For best results, do not paint every tree and leave some for beaver food.

6.4. Water Level Control Devices/Flow Devices: Resolving Flooding Issues

There are a number of devices which can prevent flooding due to beavers making dams or blocking culverts. They go by a number of different names, and vary in their exact design, but follow the common principle of allowing water to flow through the blockage in a way that cannot be prevented by the actions of the beavers. The following is a list of the different devices, a description of what each is and what exact purpose it serves/how it works, a photo, and a reference to either where they can be found, or further information on how to build one yourself. Flow devices are a great option for managing flooding issues caused by beavers, because they are a long-term, cost-effective, environmentally-friendly and humane solution, and they preserve the benefits of beaver-created wetlands. In this manual, all known designs at this time are presented; however, it is important to note that not all of the following have been thoroughly tested and proven effective. It is recommended that should you wish to install a flow device, you choose a design that has been thoroughly tested, proven effective, and been successfully installed and that has lasted long term in many different locations and situations.

6.4.1. Pond Leveling Devices

The **Clemson Beaver Pond Leveler** was developed at Clemson University with the primary goal of minimizing flood damage to agricultural and timber lands, and the secondary goal of maintaining or improving the biodiversity and associated benefits of beaver dams. It consists of a perforated solid pipe installed through the dam to prevent flooding. Water flows through the pipe and the beaver lacks the ability to block the holes. The standpipe height determines the pond level. This device has successfully been in use for many years, though it is hard to install and expensive, and is limited in the volume of water it can move (Clemson University, 1994). It is also prone to damage from freezing so is not ideal for use in Canada. Nevertheless, in warmer climates it is still a better solution than lethal trapping and breaching/removing the dam. A Flexible Pond Leveler™ discussed on the following page is likely a better recommendation for colder climates.

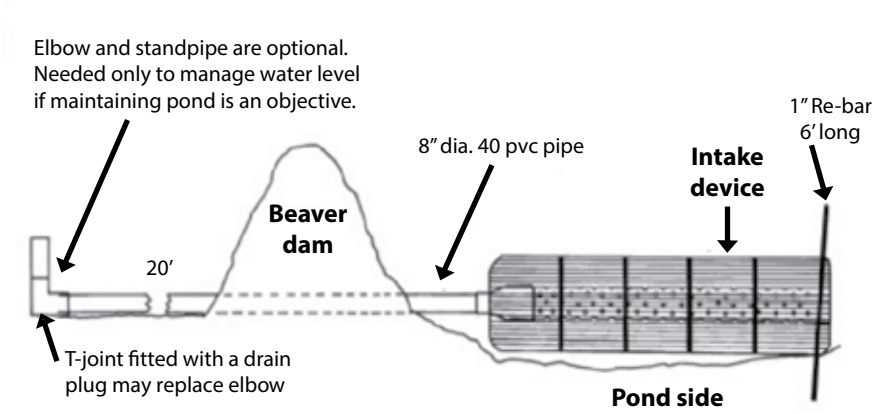


Diagram of a Clemson Beaver Pond Leveler (Clemson University, 1994)

Photo: Garden State Wildlife Control

A Clemson Beaver Pond Leveler installed through a beaver dam

Further information about this device, and a contact should you wish to install this device, can be found at http://www.clemson.edu/psapublishing/PAGES/AFW/AFW1.PDF.

The Flexible Pond Leveler™ is a flexible pipe and round fence that was invented by Michel LeClair, a Canadian flow device pioneer from Quebec. It works because it eliminates the ability for beavers to hear and feel the flow of water into a pipe. If a beaver can detect flow of water into a pipe, it will seek to plug that pipe with mud and sticks. With this device, a cylindrical fence enclosure blocks the pipe entrance, so that a beaver outside the fence can't hear or feel the water flowing into the pipe, and thus has no desire or instinctive urge to plug it. When installing one of these devices, it is important to consider that the more the water level is lowered, the more wetland acreage will be lost, and the more likely it is that the beaver will just build another dam. The key to a successful Flexible Pond Leveler™ is finding the perfect middle ground, where the water level has been lowered enough to resolve the threat of flooding, but the beaver can still access the vegetation it needs, and won't simply build another dam (Beaver Solutions LLC, n.d.). One key consideration is that the depth of the water must be sufficient to prevent the pond from freezing to the bottom, leaving enough room for the beavers to be active beneath the ice, and have access to their winter food cache of sticks from the underwater entrances to their lodge.

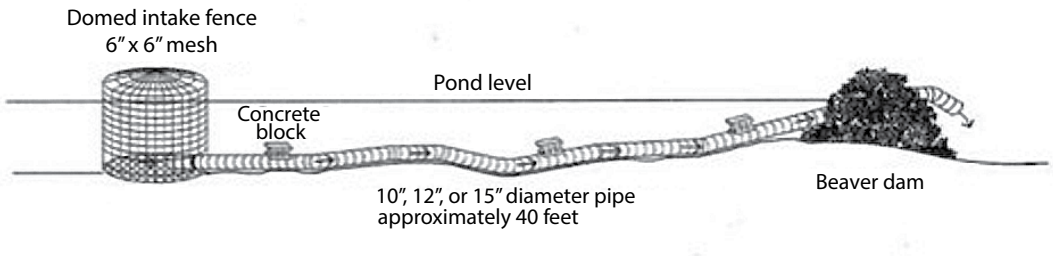


Diagram showing how a Flexible Pond Leveler™ works once installed (Beaver Solutions LLC, n.d.).

Photo: Beaver Solutions LLC

A Flexible Pond Leveler™ before submersion

Further information on this device, and contact information should you wish to install this device, can be found at http://www.beaversolutions.com/. A How-To Flow Device Instructional DVD is also available from this web site.

The Castor Master™ was invented by Skip Lisle of Beaver Deceivers International, and is a double-walled pipe and round fence (filter) used to prevent flooding by lowering the pond height.

Photo: Debbie Risberg, Animal Protection of New Mexico

A newly installed Castor Master™

Further information about this device, and contact information should you wish to install this device, can be found at http://www.beaverdeceivers.com/.

6.4.2. Culvert Protecting Devices

To a beaver, a culvert may look like a hole in a dam, and it will immediately try to plug that hole with mud and sticks. This can turn the road bed into a dam. It is a very common beaver issue, and is a major problem because highway departments spend much time and money repeatedly clearing dams from culverts. When beavers dam a culvert, it can wash out roads, cause tens of thousands of dollars in road and property damage, and create a public safety risk. Thus, there are clear financial and safety reasons to protect culverts from beaver damming. Much like the solutions previously mentioned for dealing with pond flooding issues, there are a number of different devices available to prevent culvert damming by beavers, and road bed flooding.

The **Trapezoidal Culvert Protective Fence** (a.k.a. the **Beaver Deceiver™**) was invented by Skip Lisle of Beaver Deceivers International, and is essentially a trapezoidal fence built around a culvert opening to prevent damming. It works because of its long perimeter of 40'–50' which is difficult for the beaver to dam. Also, its triangular shape causes them to dam further and further from the culvert, thereby reducing the feel and sound of flowing water. (Beaver Solutions LLC, n.d.).

Photo: Beaver Solutions LLC

Photo: Barry Kent MacKay

Trapezoidal culvert protective fences

The fence pictured on the right is another trapezoidal culvert protective fence. This fence is the correct shape, although it would be more effective if the sides extended past the culvert inlet, as in the previous photograph, as opposed to flush with the opening. Additionally, wooden posts may potentially be chewed by beavers; metal posts, like those pictured in the previous photograph, are a far more effective choice of material to use in flow devices.

Further information about this device, the instructional DVD and contact information, can be found at http://www.beaversolutions.com/.

The Fence and Pipe System is used to encourage beavers to build "diversion" dams rather than build in the culvert. There is a small, often rectangular culvert fence placed to encourage beavers to construct a dam on it, but a pond leveler pipe gets installed through the culvert fence to maintain flow of water. This controls where and how high beavers can dam, and requires little maintenance. This device works best in locations where there is at least 90 centimetres (3 feet) of water upstream of the culvert opening, and when the road bed is quite a bit higher than the pond level (Beaver Solutions LLC, n.d.).

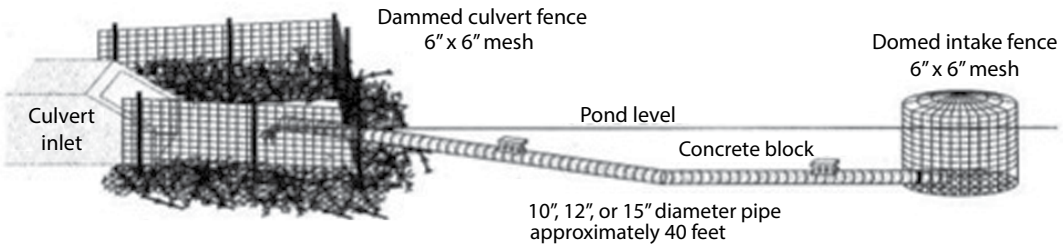


Diagram of a Fence and Pipe System (Beaver Solutions LLC, n.d.)

Photo: Beaver Solutions LLC

A Fence and Pipe System

Although beavers have built a dam on the culvert fence, water flow continues through the pipe, and through the open culvert should excess storm runoff reach above the height of the dam.

Further information on this combination device, and contact information should you wish to install this device, can be found at www.beaversolutions.com.

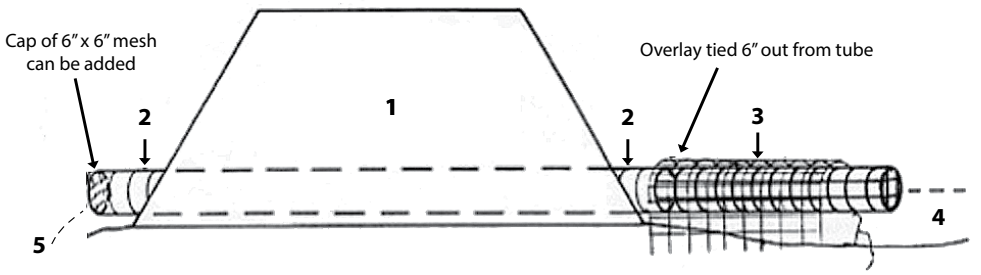
French drains

Where there isn't enough difference between the level of the road bed and the water, there could be an opportunity for a French drain. This involves dredging the ditch and using a substrate that will allow better drainage. This can be an effective solution until road upgrading raises the road bed, allowing for proper culvert drainage. It is important to note that a French drain is not a long-term, permanent solution, merely a temporary fix until proper road engineering adjustments can be made.

Diversion dams are built upstream of a culvert protective fence, and are useful in situations where there is a narrow streambed and a large trapezoidal fence will not fit. A rectangular culvert fence is installed to prevent the culvert from being dammed, and a diversion dam approximately 3 metres (10 feet) upstream of the fence creates a more attractive place for the beavers to dam. Diversion dams are either made of concrete reinforcing wires and metal fence posts, or even simply strategically placed stones in the water to create the stimuli of flowing water and riffling noises that encourages beavers to dam. If the beaver diversion dam gets too high a Flexible Pond Leveler™ pipe can be installed through the diversion dam and the culvert fence to control the water at a safe level. (Beaver Solutions LLC, n.d.; Beavers: Wetlands & Wildlife, n.d.).

Further information can be found at www.beaversolutions.com/diversion_dams.asp or http://www.beaversww.org/solving-problems/manage-flooding/.

The **Beaver Baffler** or **Beaver Stop®** was invented by Nick Thurber of Beaver Stop, and is essentially a double cylindrical fence that goes on the inlet end of a culvert (Unexpected Wildlife Refuge, 2014; Canada Culvert, 2014). Beaver Solutions initially used a similar but simpler single cylindrical fence design but abandoned its use due to a 30% failure rate. The downside of these devices is that they don't reduce the sound and feel of flowing water, so the beavers still want to dam as much as before. They also require more maintenance, and don't allow for access to the inside of the culvert (Beaver Solutions LLC, n.d.).



LEGEND:

1. Road, railroad, dam or other man-made structure.
2. Culvert or conduit through structure to allow water flow.
3. Restricting device.
4. Water flowing into culvert or conduit.
5. Water flow downstream of culvert or conduit.

Diagram showing how a Beaver Stop® works (Unexpected Wildlife Refuge, 2014).

Diagram of a single cylindrical culvert protective fence (Beaver Solutions LLC, n.d.)

The Beavercone®

This device is essentially a wire cone that fits over the end of a culvert to prevent damming, while allowing water to continue flowing through. They are pre-made and fit any size of round or square culvert (Beavercone Products, n.d.). The Beavercone® does not eliminate the feel of water movement into the culvert, so beavers may dam on the cone.

Photo: Beavercone Products

A Beavercone® installed on a culvert

Extensive, thorough field testing has yet to be done on these devices; therefore, we do not recommend them at this time as the best management practice.

The Beaver Proof Add-On®

This device is a plastic T-shaped tube that attaches to the opening of the culvert, with the grated opening facing up as opposed to horizontally, as the culvert would normally open. This prevents beavers from damming the opening, while water flow can continue through the culvert. They can be built for culverts of any shape, up to 240 cm (95 inches) in diameter, including the sloped culverts. Although these have not been around as long as some of the other flow devices discussed earlier, over 2,000 of these devices have been installed and the company reports they have been successful so far (Beaverculvert.com, 2014). However, this device does not eliminate the feel of water into the culvert, so the mechanism of how they work is unclear.

Photo: Beaverculvert.com

A Beaver Proof Add-On® installed over a culvert

Extensive, thorough field testing has yet to be done on these devices; therefore, we do not recommend them at this time as the best management practice.

6.4.3. Effectiveness and Cost Benefits of Flow Devices

Not only are flow devices a humane alternative, but studies show that they are also more effective, provide flood relief and prevention for much longer, and are more cost-beneficial than trapping, breaching and removing dams. In *Report on the Efficacy and Comparative Costs of Using Flow Devices to Resolve Conflicts with North American Beavers along Roadways in the Coastal Plain of Virginia,* Boyles (2006) found that 100% of the flow devices being monitored in the study were functioning correctly and satisfying the expectations and objectives of the Virginia Department of Transportation and all private landowners, 22 months after installation. The study also found that the low installation and maintenance costs make the devices very cost-beneficial, as they prevent the need to repeatedly spend time and money on road maintenance and repairs, and annual beaver population management. Prior to flow device installations, the Virginia Department of Transportation had spent $300,869 a year on preventative maintenance, road repairs, and beaver population control. It is important to note that within the beaver management costs, the trapper's fees are only a very small portion of the overall cost which includes regular inspection and reporting and the unblocking of culverts and ditches using municipal equipment and manpower. The initial labour and materials cost of installation for the 33 flow devices at 14 different sites was $44,526, with a very small annual maintenance cost of $276.50. Preventative maintenance, road repairs, and beaver population control following installation was not needed, and cost reduced to zero.

Beaver Management Costs/Year	Before Flow Devices	With Flow Devices (Including installation costs)
Beaver management*	$155,869.39	$44,526.00
Beaver damage repair	$145,000.00	$276.50
Total Costs	**$300,869.39**	**$44,802.50**

Figure 3: *Boyles (2006): The trapper's fees are a very small portion of the overall cost of beaver management. The much larger cost involves regular inspection and reporting and the unblocking of culverts and ditches using municipal equipment and manpower.

The installation of flow devices can also indirectly save money and resources by satisfying the "no net loss" wetlands conservation programs in effect. Beavers will naturally create wetlands, so by installing flow devices and allowing beavers to continue damming, money and time can be saved on trying to replace the wetlands. Boyles (2006) explains:

> …in order to advance the "no net loss" wetlands conservation program instituted by U.S government, federal agencies should explore developing programs that reward state transportation departments and cooperating landowners for using non-lethal methods, such as flow devices, to manage beavers while permitting these animals to restore and create valuable wetlands (National Research Council, 2001). An incentive-based program could result in a substantial increase in the restoration of natural wetlands while reducing property damage and maintenance costs. (p.10 –11)

In a separate study, published by the Association of Massachusetts Wetland Scientists, Callahan (2005) further proves this conclusion:

> This study provides further evidence that Culvert Protective Fences and Pond Leveler Pipes are the most cost-effective, long-term and environmentally friendly methods to manage most beaver/human conflicts. When compared to the cost per acre and the lower success rates of wetland restoration by humans, a very strong case can be made for promoting the use of flow devices to maximize restoration of historic inland wetlands by beavers. (p.14)

Studies also show that in most cases, the clients are satisfied with the effectiveness of their flow device. In *Solving Beaver Flooding Problems through the Use of Water Flow Control Devices,* Simon (2006) shares the results of a study exploring the effectiveness of the devices and satisfaction of customers after installation. A very high percentage of customers were satisfied (89%) and would recommend to others the use of a flow device (94%). Spock (2006) explains in *Effectiveness of Water-flow Devices as Beaver Conflict Resolution Tools, a Satisfaction Survey of Massachusetts Clients,* the results of a survey finding that 93.3% of clients were satisfied with their professionally installed flow devices (as cited in Beavers: Wetlands & Wildlife, n.d.).

Multiple studies show that flow devices are highly effective, cost-beneficial tools for individual properties as well as larger regions.

6.5. Effective Wildlife Damage Compensation Programs

Another approach that helps reduce financial damages caused by beavers for those in the agriculture industry is Wildlife Damage Compensation. These programs are funded by federal and provincial governments, and essentially provide financial compensation to producers whose crops or livestock have been damaged or killed by wildlife. Some of these programs include a recommendation that producers utilize preventative measures, and work with their municipalities to eliminate beaver problems. For these programs to be effective, they need to:

- Define clearly all preventative measures that producers can take, and provide the knowledge and resources they need to understand all the options available to them.
- Provide financial aid to producers to implement preventative measures, rather than simply paying for damages later on.
- Explain that all humane solutions, such as flow devices, tree-wrapping, and discouragement techniques should be used first, as they are often more effective and provide long-term protection from flooding and related issues.
- Ensure collaboration between producers and municipalities to encourage a long-term, large area improvement approach to beaver management, rather than leaving producers to handle individual conflicts separately. Holistic approaches are more effective.

Compensation programs can be a great tool for preventing beaver damage, and reducing the financial damage suffered by producers managing beaver conflicts, if they emphasize and provide financial aid for prevention and non-lethal, long-term approaches. Programs which simply provide compensation once damage occurs do nothing to encourage prevention, or long-term improvements. It is much more beneficial to invest in preventing damage than to repeatedly pay to repair the same damage.

6.6. Highway and Waterway Engineering

There is a reason that beavers choose to dam culverts, and that is because of the way roads are designed. Most road crossings force flowing water into a narrower pathway, such as a culvert, effectively speeding up the water flow and creating riffling sounds. These sounds and speeding water may instinctively trigger beavers to try to dam these water sources and create ponds. While the culvert-protecting flow devices discussed above do prevent beavers from damming these constricted streams and rivers, a better long-term approach is to actually change the way that roads crossing over water are engineered. By building multiple box culverts or bridges, rather than narrow cylindrical culverts, the stream remains wider and deeper, less constricted, and the fast flow and noise are not there to encourage beaver damming. The bigger space under a bridge or in a multiple box culvert is much harder for a beaver to dam, and they may get discouraged and move on, damming elsewhere. This approach also provides more habitat for fish and other aquatic life. If highway and waterway engineers recognize that current common road designs will possibly encourage beaver damming and the

associated flooding, road damage, public safety risk, and expenses, and consider these factors in the design phase of road developments, much energy, money, and time can be saved. It is recommended that all new projects should consider the potential for beaver conflicts in their environmental impact statements and benefit-cost analyses (Grannes, n.d.). Beavers, like climate, are part of the environment and should be accommodated in the design stage of road building projects.

Road ecology, as defined in *A Guide to Road Ecology in Ontario* by The Ontario Road Ecology Group (OREG), Toronto Zoo (2010) is "an emerging science that is gaining momentum as citizens and transportation planners strive to achieve efficient road networks that work in harmony with and conserve the natural environment" (p. 2). The OREG is an excellent resource not only for road and waterway engineering regarding conflicts caused by beavers, but for road engineering that will work in harmony with all wildlife and the natural environment.

7 Beaver Management Practices Not Recommended

7.1. Electric Fencing

As mentioned previously in section 6.2., enclosures to protect trees are an effective, non-lethal tool for managing human/beaver conflicts. However, although it may be tempting to take the approach one step further and install electric fencing around areas of land to keep beavers out, this is generally unnecessary and excessive, and not as effective as standard fencing. The electric shock delivered by these fences is unpleasant but not lethal or harmful to the animal, and is considered humane because the shock will only continue if the animal repeatedly makes contact with it. However, should the animal get caught in the fence, repeated shocks can cause severe stress resulting in an inhumane death. Other risks also accompany the installation and use of electric fencing, such as the risk of fire when there is vegetation nearby (which there always is, in areas that beavers are drawn to), and the risk of other wild animals, pets, or humans coming into accidental contact with the fence. Additionally, sticks, vegetation, fallen trees and non-insulated posts that make contact with the fence can close the circuit in the place of the animal it intends to keep out, rendering the fence ineffective, delivering only a very small (if any) charge should a beaver try to pass. There may even be legal liability issues, and maintenance, especially during wet weather or onerous winter conditions.

Because of these risks and concerns, electric fences must be checked very regularly for trapped animals or materials closing the circuit unintentionally, therefore requiring much more maintenance and time commitment than a standard fence. Zoning laws must also be checked before the installation of an electric fence, and on certain properties, an electric fence may not even be a possibility (Redbeacon, 2014; Get Bear Smart Society, n.d.). Ultimately, electric fencing is more expensive, requires more maintenance, and is less effective than standard fencing; for those reasons it is not recommended.

7.2. Repellents

Studies show that repellents are very limited in their effectiveness against beavers. While there are sprays and pellets available for the purpose of keeping beavers away from an area, or preventing them from chewing specific trees or vegetation, none has been found to be entirely effective. Additionally, if there is not enough available food alternatives, beavers may become less selective and chew the trees with repellent regardless (McPeake, n.d.; Wildlife Animal Control, 2014; Wagner & Nolte, 2000). These also require frequent reapplication, and environmental and health risks often accompany chemical sprays and pellets. Thiram, which is sometimes recommended as a beaver repellent for use on vegetation, is considered moderately toxic through oral, dermal, and inhalation exposure, irritates the eyes and skin, and sensitizes skin. It is a neurotoxicant and developmental toxicant, and can cause severe fetal malformations (United States Environmental Protection Agency, 2004). Applying a paint and sand mixture, or wrapping trees is a much better way to get beavers to stop chewing vegetation – it requires less maintenance, is safer, and it is more effective in discouraging beavers.

7.3. Frightening Devices

One approach that is sometimes used is to set up frightening devices such as strobe lights, sirens, whistles, high-frequency noise generators, firecrackers, radios, propane cannons, etc., in an attempt to scare beavers away from an area. With beavers, it appears to be most effective when both visual and auditory stimuli are present, and if the devices are set off when they detect motion, or they go off at random intervals of time, as opposed to devices which are constantly active, or active at regular intervals. The major downside of this strategy is that it appears that beavers will only be cautious of the devices for a short period of time, sometimes only a few days, before they grow accustomed to them and settle in the area anyway. Therefore this strategy is not highly recommended, as its effectiveness is extremely limited (McPeake, n.d.).

7.4. Breaching and Removing Dams

Breaching and removing a beaver dam is only a temporary solution that may be considered for immediate relief from flooding, though in general it is not recommended and will not improve the situation long term. If nothing is done to make the area undesirable, the beaver, or others that move into the area, will rebuild very quickly. If the beaver is lethally removed, another beaver will likely move into the area.

Dangers of breaching and removing the dam include downstream flooding, sediment deposition, property damage, and the degradation of natural habitats. If this approach is taken, the installation of a flow-control device and/or implementation of the discouragement methods discussed in this manual would be useful to provide long-term management of the situation, and prevent the necessity for another dam breach and removal in the future.

7.5. Live Trapping and Relocation

This process is not recommended for many reasons. Most often, the relocated animal does not survive, and is put through considerable stress and often suffers a prolonged death. If the live trap is not monitored regularly, the beaver(s) or other, non-targeted species such as muskrats, could die from stress or hypothermia if trapped in the cage for too long. If they do survive, and are relocated, they will continue to dam and lodge in their new location, and may cause a problem for someone else. If another beaver is already living in the release location, conflict between the two will arise. The area that the beaver was originally removed from is still desirable to other beavers, and new ones may very likely move in, hence the original problem is not truly resolved. Under the Ontario Fish and Wildlife Conservation Act, relocation is allowed only up to 1 km from the original site for adult animals, so the problem is not resolved but only moved to a slightly different location. The same release restrictions also apply to other provinces. This also means it is not difficult for the beaver to return to the original site as beavers can easily traverse that distance. Because young beavers remain with their parents for at least two years after birth, if a parent beaver is removed and a kit is left behind, the ability of that kit to survive is severely compromised. Beaver orphans will often approach humans, and if taken to a wildlife rehabilitator, cost a lot of money, time, and energy to be raised properly for the next two years. (Beavers: Wetlands & Wildlife, n.d.).

7.6. Lethal Trapping and Removal/Shooting

Lethal removal is a short-term solution commonly used to handle beaver problems; however, it is not recommended for a number of reasons. Legally, a land owner may humanely kill or trap beavers that are damaging or about to damage their property, so long as firearm regulations and local bylaws are followed. They may also choose to hire a licensed trapper to act on their behalf (Ontario Ministry of Natural Resources and Forestry, 2014).

Lethal trapping and removal is not recommended because it is inhumane, and does nothing to discourage other beavers from moving into the vacated habitat. This is not a long-term solution.

Additionally, many of the traps that are most commonly used to trap and kill beavers have the potential to kill inhumanely, and are not selective, often killing or injuring other animals in the process. Conibear traps, commonly set for beavers, consist of two metal jaws hinged at the centre, with two spring that snap the jaws together when triggered. They are supposed to provide an instant kill by snapping the animal's neck at the base; however, this is not what happens most of the time (Born Free USA, n.d.). Studies show that less than 15% of animals caught in these traps die quickly, and more than 40% of the time, the death is slow and painful, crushing their abdomens or heads (Lunn, 1973 as cited in Born Free USA, n.d.).

While modifications have improved the Conibear trap's ability to kill quickly, it only does so for a few specific species in controlled lab tests (Proulx, 1999 as cited in Born Free USA, n.d.). Additionally, studies have proven that Conibear traps, being non-selective, kill approximately two non-target animals for every target animal caught (Novak, 1987

Photo: Alice Willems, Special to the *Hamilton Spectator*

as cited in Born Free USA, n.d.). The Conibear trap is commonly set to catch beavers, but often traps dogs, raccoons, and even bald eagles. Children have also been injured by these traps. One major problem with this trap is that unless you know the technique, the device is difficult to open. Families have filed lawsuits after watching their pet die in these traps and they were unable to release it. A study showed that, despite its original design as a "fast kill" trap, most often the beaver is caught in a less than ideal position, and the death is indeed protracted, painful, and inhumane.

Another common technique is to drown the beaver by trapping it underwater. This has been found inhumane because the beaver has the ability to hold its breath for more than 10 minutes, forcing it into a slow painful death. Snares often will not kill the beaver but only injure it, sometimes even disembowel it, causing it pain and suffering, and a compromised ability to survive in the wild (Beavers: Wetlands & Wildlife, n.d.).

8 Summary and General Dos and Don'ts

Beavers provide many ecological benefits, including creating precious wetland habitat, and improving water quality and biodiversity, both of which also benefit humans. They are a keystone species and are vital to maintaining the ecosystems they share with numerous other species. When human/beaver conflicts arise, whether they be flooding and related damage, damage to vegetation, or simply being a nuisance, there are many effective strategies that can be implemented to solve the conflict and also prevent future problems, if the situation is assessed and managed carefully. The following are some general dos and don'ts to follow when managing beaver conflicts.

DO implement all applicable non-lethal options available to you as the best course of action to mitigate the conflict. If beavers are present, it means there is suitable habitat and they will continue to return from time to time, so preventing the conflict is the only long-term solution that makes cost-effective sense.

DO understand the beaver and the behaviour that is causing the conflict. By thinking about the situation from that perspective, your ability to solve the issue will greatly improve, and you will more likely find common ground, where both you and the beaver are satisfied and the environmental assets created by beaver activity are preserved.

DO consider how big an issue the beaver is actually creating. If they are only a slight nuisance, but not doing any real harm, the ecological, educational, and recreational benefits they provide quite often outweigh the annoyance factor.

DO consider using more than one strategy to address the problem, as many of them work well when implemented together. For example, installing a flow device and wrapping trees will solve any flooding issues, current or present, and also protect any vegetation that the property owner does not want damaged.

DO recognize how important beavers were historically, are ecologically, and how symbolic they are to Canada, and that by choosing humane, long-term solutions, you are doing a great thing to improve the quality and variety of plant and animal life in your region, improve water quality and human health, and creating wonderful opportunities for your community.

DO make sure that any actions you take are in accordance with all federal, provincial, and municipal laws, policies, and regulations.

DO seek assistance if you think that managing the conflict on your own is beyond your capability. There are many great resources out there. Professionals can be hired to assess a situation, install the appropriate flow device, and ensure that the issue is resolved properly, safely, and humanely. See the additional resources listed at the end of this manual for further information, and remember that more such resources are available.

DO collaborate with others, and encourage community involvement when dealing with beavers. If tolerance is the chosen strategy, allow everyone the opportunity to watch and learn from the beaver. If the land the beaver is affecting is public, involve the others who share that land – discuss the potential strategies, and implement them as a community, working together to wrap trees, plant new vegetation, etc. If new developments are being planned for your city, contact the appropriate people to make sure potential beaver habitat is being considered in the plans. For example, highway and waterway engineers should consider designs that will not constrict streams to such a great extent. Then the damming of culverts won't become an issue.

DON'T use lethal trapping and removal. It can be costly and time consuming, it is inhumane, and ineffective and can cause social divisiveness. If nothing is done to make the habitat less desirable, a new beaver will soon move in and the same issues will continue to arise.

DON'T use live trapping and relocation. It is inhumane, putting unnecessary stress on the beaver(s) and often leads to the death of the animal. It also does nothing to make the area less desirable to beavers, and new beavers will move into the vacated space, thus perpetuating the problem.

DON'T use electric fencing. It is not as effective as standard fencing against beavers, and creates unnecessary risks, costs, and other problems.

DON'T breach and remove dams. This can cause flooding, damage downstream properties, requires permits and special permission to do so, and will not do anything to make the area less desirable to beavers, or prevent them from rebuilding the dam. This is not a long-term solution.

DON'T plant trees or other vegetation that you care about close to known beaver habitats, especially if it is a preferred species such as willow or aspen, unless you are fully prepared and able to protect it with beaver-proof wrapping. Otherwise beavers will chew it down, and this will only create additional conflict that could have easily been prevented.

9 Application of the Approach

Understanding the beaver, its importance ecologically and otherwise, all the legal policies surrounding this species, and all the various strategies available for managing conflicts provide you with the tools you need to assess and improve a situation. It can be daunting approaching what seems like a major issue, but with the right knowledge and resources, the situation can be resolved effectively and efficiently. There are a few different ways to approach any situation, and the best way differs if you are an individual property owner, with a single beaver conflict issue that you wish to handle, compared to a municipal government with a large region to manage.

For private property owners

If you are dealing with a single beaver conflict, implementing one or more of the strategies listed in section 6 – Applying Best Management Practices – will often be enough. Following these steps will help you evaluate the situation thoroughly, implement the right approach for your unique situation, and achieve long-term success.

1. Observe the area. Identifying that you even have a beaver problem is the first step. Ask yourself: Is there any flooding? How extensive is it? Is it actually doing any damage? What about the vegetation – are there any big trees hanging somewhere that could pose a danger risk, or is the beaver just cutting down smaller trees and dragging them to the pond? If, after observing the situation, you realize that the beaver isn't really causing any damage, you should consider choosing the "tolerance" approach discussed earlier.
2. Note the extent of the issue. More extensive issues require greater actions, so determining exactly how big a conflict you are dealing with is key to deciding which strategy you will implement. If three acres of your farmland are flooded, you will need to do more to resolve the issue than if the pond in your backyard has expanded and is flooding part of your vegetable garden, and the beavers are starting to chew your favourite apple tree.
3. Consider all the options available to you. One purpose of this manual is to inform you of all the different approaches that exist, so don't write any of them off just because you've never heard of it before! At least think about whether each one is something that would work for your unique situation.

4. Divide the problem into sections. Is the only problem flooding? Is the only problem that beavers are cutting down trees? Depending on what type of damage you are dealing with, the solutions you want to implement will be different. If the only problem is the tree damage, but there is no flooding, there is no need to install a flow device – wrapping some trees may be all you need to do.
5. Budget your time and money. How much time and money do you realistically have to put towards resolving the issue? There are many inexpensive and easy-to-implement actions you can take, so time and money should not be the deciding factor as to which solution you choose. The more expensive, high-maintenance option is not always the better one.
6. Choose your solutions. Don't hesitate to use more than one solution – a lot of them work even better when they are used together.
7. Make a plan. Once you know which solutions you want to implement, decide how you are going to go about doing so.
8. Check all regulations and apply for permits, if necessary. Some of the strategies introduced in this manual, such as installing a flow device, may require you to obtain a permit for things like breaching a beaver dam. Make sure you check all federal, provincial, and municipal regulations, policies, acts, and by-laws and consider seeking legal advice to make sure your actions are in accordance with any such regulations, and apply for and acquire any necessary permits before beginning your work.
9. Ask for help or contact an expert. It's okay if you don't feel that you know everything! There are many valuable resources out there if you need help managing a conflict, or installing a flow device, for example. Check out the additional resources listed at the end of this manual.
10. Gather supplies. If you are wrapping trees, painting trees, planting new vegetation, installing a flow device, fencing an area, etc., then you will likely need to visit a hardware store and buy the necessary materials. It is a good idea to make a list of what you will need before you go. If you are unsure of exactly what you will need, check with someone with experience, or check out the additional resources. It is a good idea to invest in good quality materials that will last. Though tempting to buy the cheapest supplies, they will degrade quicker and need replacing or additional maintenance, costing you more in the end. Spending a little extra upfront for good quality supplies will give you the most effective results.
11. Set time aside. Some of these approaches can take about an hour, others may take a whole day. Make sure you have enough time set aside to start and finish the project – it is easier to complete it in one stretch than leaving it unfinished and returning to it later. If you are not handy with tools, seek help from people experienced and comfortable with using such tools and materials.
12. Implement your approach. Take your time, and do a good job. Be thorough. Doing things carelessly and sloppily will only result in insufficient protection, and the beavers will find a way around what you have tried to do to stop them. Taking your time and making sure everything is done carefully and properly will make everything last longer, and require the least amount of additional time and money spent later on.

13. **Check/maintain the area as necessary.** Some approaches may need regular maintenance. For example, tree painting may need reapplication once every year or so, depending on conditions of the area. Tree-wrapping of small young trees may need to be redone in a few years to accommodate growth. If you choose to plant new vegetation, you may want to continue doing so over the course of a few years. Other approaches, such as installing a flow device, should not require any maintenance, but it is always a good idea to check on it once in a while to make sure everything is still working as it should be.
14. **Enjoy!** Make sure you take advantage of the benefits that properly managed beaver habitat can provide, and admire the thought and work you put into making the compassionate and effective decision.

For municipal staff and large businesses

If, on the other hand, you are managing a larger region with multiple beaver conflicts throughout, such as an entire municipality, a multi-stage approach may be required. Municipalities are the main players regarding beaver management, and this application of the approach will provide municipal staff with the resources needed to implement the most cost-effective, long-term solutions and best management practices. Beaver Solutions LLC, explains that "Comprehensive Beaver Management Plans are important planning tools for towns, railroads, utilities, or other businesses with large land management responsibilities." Using crisis management for each individual problem is discouraged, and Beaver Solutions LLC instead recommends developing a comprehensive plan to evaluate and prioritize the big picture, plan finances, prevent future issues, and save money. The following approach is what Beaver Solutions LLC lays out as the components of a comprehensive plan.

1. List all current beaver conflict sites.
2. Identify all potential beaver conflict sites.
3. Evaluate each conflict site.
4. Develop specific recommendations for each site.
5. Submit written cost estimates for each site.
6. Prioritize conflict site interventions.

There are a number of beaver management consultants for hire, including Beaver Solutions LLC, who will complete a similar comprehensive beaver management plan for your town or company, and help you implement the decided approach. Check out the additional resources at the end of this manual for a list of beaver management consultants. It is also possible to create a management plan for your own region without hiring a consultant; however, if you have limited experience with innovative beaver management techniques, such as flow devices, it is recommended that a professional consultant be hired. If you are responsible for managing a larger region, such as a municipality or town, it may still be possible to approach the problem using the steps listed for private landowners to follow, if the number of conflict sites in your region is limited and/or isolated.

10 Additional Benefits

The ecological benefits of beavers were discussed in section 4 – Ecological and Environmental Importance of Beavers. However, in addition to these ecological benefits, the proper management of beaver conflicts can lead to economic benefits, as well as recreational, leisure, and educational opportunities.

10.1. Economic

Managing beaver conflicts effectively can save time and money, and can lead to healthier ecosystems. While it may seem easiest and cheapest to kill beavers and tear down their dams when a conflict arises, as is the common approach taken by most municipalities, this is simply not true. This approach involves financial investment, as trappers must be hired and/or traps must be bought, along with a significant investment of time to breach and remove dams. The biggest economic problem with this strategy is that it is very short term. Beavers will continue to return to the site, and rebuild dams, and more money and more time will be devoted to managing these conflicts, without any real long-term, permanent improvement. However, strategies such as installing flow devices, protecting certain trees with wraps or paint mixtures, planting certain species for beavers to chew down, and simply tolerating the beaver(s) when they have chosen a location that is not truly harmful or damaging, require some initial investment, but over time remain effective, and actually improve the location, ultimately costing less money and less time in the long run. Less road and infrastructure damage will be caused by flooding, therefore less time and money will be spent repairing it. The flooding and erosion that would otherwise be impacting the production of crops would be absent, making agricultural practices healthier. The recreational, leisure, and educational opportunities that beaver-created wetlands provide can enhance the tourism industry, and local businesses such as canoe and kayak rentals or bird-watching guides. The improved water quality and availability brought on by beaver activity can save cities and towns much stress and emergency planning in times of drought. The economic benefits of proper beaver conflict management are extensive, and if the conflicts are not managed properly, or short-term approaches are the only ones implemented, the economic consequences can be severe. Therefore, it is extremely important to manage beaver conflicts properly, especially on larger scales such as municipally or even provincially.

10.2. Recreational, Leisure, and Educational Opportunities

Photo: Shelly Hawley-Yan

Canoers enjoying the beautiful landscape maintained by beaver activity

In addition to creating valuable wetlands and elevating biodiversity, beavers and the habitats they create provide many educational and recreational opportunities for humans to enjoy. The habitat created by beavers is ideal for educational wildlife observation, canoeing or kayaking, fishing, photography, bird watching, and quiet relaxation (Beaver Solutions LLC, n.d.).

11 How to Educate the Public and Encourage Community Involvement

Public involvement and education are key to managing beaver conflicts effectively, especially at larger scales such as municipally or provincially. It is important for everyone to understand the crucial role of wetlands and the beaver's contribution to these vital areas, what is being done to manage beaver conflicts (the approach), as well as how and why that course of action was chosen and is being implemented. The Paul Lindsay Park case study, which is included later in this manual, is an example of a beaver conflict being managed poorly, causing significant public outrage that could have been prevented with better communication between the municipal body and the residents of the area. In some cases, people who are unaware of what flow devices are or how they work have vandalized and damaged them, believing incorrectly that they were large beaver traps (Simon, 2006). These are just two examples of why it is extremely important for the public to have at least a basic knowledge of beaver management strategies, and be informed on what is happening in their region, and for municipalities to hear and respond to the residents. Proper beaver management should be a joint effort if any long-term harmony is to be found. Taking on a Pilot Project will not only demonstrate the leadership of the municipality or the conservation authority in adopting best management practices but will encourage pride and ownership in the project on the part of the community.

Governments and other organizations:

- Make educational resources such as this manual easily accessible to the public.
- Make your plans transparent and available.
- Hold community meetings before taking action, and involve the residents in the decision, as they will be the ones affected by it.
- Place informative signage around flow devices or tree-wrappings so passersby understand the purpose of them.
- Enlist the participation of organizations that provide educational presentations within the community on coexisting with beavers and other wildlife.
- Recruit volunteers from the community to help with tree-wrapping or the installation of flow devices.

Residents and private landowners:

- Educate yourself and your community members on beaver management strategies.
- Involve yourself and voice your opinion in the decision-making process – it is going to affect you directly, and you should have your say in the matter.
- If you don't like the way a beaver conflict is being handled, do something to change it! Bring this manual to your municipality's attention. Inform them of their different options, of which they may be unaware.
- Work with your community members. Most of the time you will find that others want to achieve the same goal you do!

12 Case Studies

12.1. Fletcher Wildlife Garden, Ottawa, Ontario

Tolerance and tree-wrapping

The Fletcher Wildlife Garden is a site containing a variety of different natural habitats, located near the centre of Ottawa, and is a project of the Ottawa Field-Naturalists' Club. The garden is intended to provide habitat for many species of wildlife, and is also open to naturalists, gardeners, schoolchildren, and the public, with volunteers restoring and enhancing the garden (Fletcher Wildlife Garden, 2013).

On October 24, 2009, a young beaver was spotted in the Amphibian Pond at the Fletcher Wildlife Garden, sitting and eating cattails. Those at the Fletcher Wildlife Garden had seen beavers show up in the past, but they had only ever remained for up to a few days. However, this particular beaver started building a dam and a food cache, and it became clear to observers that the beaver was planning on settling in for the winter. There was concern around how many trees the beaver would remove, as well as concern about how unsuitable the small, shallow pond was for a beaver. It was decided that the best approach for handling this beaver moving in would be to wrap some of the trees they wanted protected, but otherwise just let the beaver be. Comments from the

garden's visitors showed that many people were misinformed about beavers, and so signs were posted near where the beaver was living, telling people that the beaver was accepted, and providing some information about the species. Additionally, a volunteer at the garden wrote an article titled "Beaver *(Castor canadensis)* at the Fletcher Wildlife Garden" with further information about the species in general, and a more detailed story about how this particular beaver came to be a resident at the garden. The Fletcher Wildlife Garden case study is a perfect example of a situation where tolerance and a small amount of tree-wrapping is the best solution, and of a community benefitting from the educational opportunities that beavers provide (Hanrahan, 2009). More information about the Fletcher Wildlife Garden can be found at http://www.ofnc.ca/fletcher/about/index_e.php.

12.2. Graham Creek, Nepean, Ottawa, Ontario

Tree-wrapping and planting new vegetation

In the spring of 2009, the Graham Creek community found that the juvenile beavers living in their community were taking down large trees. The community rejected the advice to trap and kill the beavers, correctly believing that it "was a purely reactionary measure that would not provide a sustainable long-term solution," (DuBreuil, 2009) and instead began to research alternative options. The community opted for a non-lethal solution. Kate Partridge, one of the local homeowners said, "Via such simple measures as wrapping the older, larger trees and planting a food source for the beavers in the future, we were able to implement some cost-effective, long-term, preventative problem-solving measures as an alternative to the advice of trapping and killing the beavers" (DuBreuil, 2009). More than 300 trees and shrubs were planted, and although the property belonged to the city, many residents pitched in and helped with the project. The City of Ottawa supplied the trees with the support of Councillor Rick Chiarelli and the experts who advised which trees to plant and how/where to plant them through its community tree planting grant program. Not only did this project serve as a non-lethal, long-term solution to the city's beaver conflict, but it also helped satisfy the city's mandate to "increase, enhance, and preserve forest cover in the city" (DuBreuil, 2009). Sue Twine, a homeowner in Graham Creek, said that this project has "helped residents to understand human-beaver conflict. We have used environmentally friendly methods to protect the existing woodland, avoiding reactionary and cruel beaver trapping. The tree-planting scheme is helping us repopulate trees along the creek. Overall, we will all benefit from the beauty of Graham Creek, including the hugely diverse wildlife" (DuBreuil, 2009). After five years, the vegetation is very lush, beavers still utilize the area from time to time, and residents who consider it a model project are very pleased with the result. The Graham Creek case study is an excellent example of a situation where tree-wrapping and planting new vegetation for the beavers to feed on was the perfect solution, not only resolving the conflict humanely, but also bettering the natural area for residents and wildlife alike.

12.3. Martinez, California

Tree painting, planting new vegetation, flow device, education and community involvement

In October 2007, a beaver dam in Alhambra Creek, Martinez, California was posing a flood hazard, and so it was planned that the beavers would be killed and the dam torn down. Relocation was offered as an alternative, but the public responded with the opinion that keeping the beavers may be a better option, and a beaver subcommittee was formed to look into other management techniques. The subcommittee consisted of two councillors and five residents, including a creek expert, a flood control district engineer, an attorney, and two local beaver advocates. Skip Lisle was brought in to evaluate the situation, and a Castor Master™ flow device was installed to manage water levels and prevent flooding. The dam, at a reduced height, has been maintained successfully since then, proving the flow device to be a successful long-term solution. Sand and paint mixtures have been applied to some trees, and willow and cottonwood saplings have been replanted to provide suitable vegetation for the beavers. The beavers have been honored in art projects, and in a song, and a non-profit organization called "Worth A Dam" works to replace natural habitat, educate the community, hold an annual beaver festival, and even provide advice and funding to other towns wishing to manage their beaver conflicts with non-lethal solutions. The beavers have become a source of pride for the citizens of Martinez, and the beaver family is closely monitored and greatly cared about (Worth A Dam, 2010). Martinez, California is an amazing example of community involvement, education, a flow device, and some tree painting and planting, working to pull a community together, and to non-lethally manage a human/beaver conflict. More information about the Martinez beavers and the Worth A Dam organization can be found at http://www.martinezbeavers.org/wordpress/about-2/.

12.4. St. Catharines, Ontario

Education and community involvement

In St. Catharines, Ontario, in 2009, the beaver population seemed to suddenly increase, and concerns over the number of trees being cut down, as well as reports of a territorial male beaver charging people in the park, led to the parks and recreation department hiring a trapper to kill and remove the beavers that were causing the damage (Bergsma, 2009a). When news became public of how the city was managing the beaver conflicts, many were upset that the beavers were being killed. Tree-wrapping or painting were suggested as alternatives, and Audrey Tournay, a former St. Catharines resident who founded the Aspen Valley Wildlife Sanctuary, recommended simply leaving them alone, or live trapping and relocating the animals if they had to be removed from the city. Jerry McLaughlin, acting manager of parks services, stated that lethal removal was the only option for the city, as the tree damage needed to stop. The belief was that the Conibear trap being used was the most humane way to kill the beavers, and that tree-wrapping would be too expensive. Part of the defence against the public upset was that "other cities are dealing with similar issues, and they, too, are using killing traps" (Bergsma, 2009b). A major concern of the city was that if nothing was done to control the beaver population, it would grow and grow, and cause flooding, damaging the agriculture industry as well as roadways. However, the beavers in question were not damming

any waterways at all, but rather taking advantage of the pond already in existence, that was big enough for their needs (Bergsma, 2009c). Many residents pointed out that Conibear traps are definitely not humane, that beavers are part of the natural habitat, that the fact that they were making a comeback despite the pollution and habitat damage humans have caused should be celebrated, not destroyed, and the idea that perhaps we shouldn't be killing beavers because they are cutting down trees to make their homes, as we do exactly the same thing. After hearing the public response, and being contacted by Niagara Action For Animals, McLaughlin agreed to consider other beaver management options (Bergsma, 2009b). Another issue surrounding this situation was that most city councillors were apparently unaware that the beaver management practices were lethal. Even the mayor didn't know, and had been assuming that the city was using live traps and relocation methods, only learning of the killings when the story was published in the local newspaper. Ultimately, city council voted to stop the lethal trapping, and explore other options (Bergsma, 2009c). St. Catharines, as a case study, is an example of why education, as well as open communication between all municipal councillors, city staff, and the public, is so important when managing beaver conflicts.

12.5 London, Ontario

Wildlife-friendly policies and protocols in London, Ontario – 2014/2015

In 2014, citizens in London, Ontario as well as that city's Animal Welfare Advisory Committee proposed that a 'Humane Urban Wildlife Conflict Policy' be adopted by London's City Council. This policy would act as a guideline to species-specific protocols that would follow. Animal Alliance of Canada and Zoocheck Canada offered ongoing consultation on this policy.

The Policy was adopted by London's City Council in November of 2014 and the Animal Welfare Advisory Committee, along with other London-area citizens, presented recommendations for a humane Beaver Protocol to Civic Administration.

In support of these efforts, Animal Alliance of Canada hired the services of a respected contractor who installs flow devices that mitigate the effects of beavers on waterways and surrounding infrastructure. In December of 2014, Mr. Mike Callahan, owner of Beaver Solutions LLC, toured four different locations in London where beaver activity was a potential concern. Mr. Callahan met with members of Civic Administration and staff from the Upper Thames Conservation Authority to discuss how the installation of flow devices could be beneficial in these locations.

Mr. Callahan also gave a public presentation on flow devices and humane beaver activity mitigation. This presentation was attended by members of three different Civic Administrations and members of the public. Mr. Callahan continued to communicate with members of London's Civic Administration as they completed their proposed Beaver Protocol.

In March of 2015, the Civic Administration developed a draft Beaver Protocol using their environmental research and engineering expertise and recommendations made by Mr. Callahan, local London citizens, the Ottawa-Carleton Wildlife Centre and Animal Alliance of Canada. Their work was progressive and respectful of the need to treat beavers humanely, and to allow them to peacefully co-exist in the urban environment while fulfilling their natural behaviours.

This progressive Beaver Protocol was adopted by London's City Council and work is already underway on the construction of flow devices to be installed in area waterways.

12.6. Paul Lindsay Park, Ottawa, Ontario

Unsuccessful live trapping and relocation

The Paul Lindsay Park case study shows that it is very important to be informed, to respect and follow expert advice, and to engage the community, in order to best manage beaver conflicts and satisfy all stakeholders in the matter, especially residents of the area.

In the fall of 2011, two adult beavers were living in the Paul Lindsay Park storm water pond in Ottawa, Ontario. A storm water pond is a man-made pond designed to collect run-off water after a storm, to mitigate against the risk of flooding.

The city wanted the beavers trapped and killed, until an overwhelming public response petitioning against this forced the Mayor, Jim Watson, to suspend the trapping. The following summer, in spite of the fact that there were now two newborn kits, the city was still determined to remove the beavers, and this time refused to engage the community and public opinion. They first tore down the lodge, putting the kits in danger. In their notice to residents, the City said that by removing the lodge, they were encouraging the family to move to a different nearby habitat that was more suitable. They justified the appropriateness of this approach by saying that any first-year kits born during the winter were able to leave the lodge. This is entirely incorrect. Kits are born in May and June, not the winter, so the city was actually tearing down the lodge during the season where young kits were just being born, and were totally dependent on the lodge and their parents.

The City also said that the beavers would relocate, and some city staff had claimed that they had already vacated the lodge and pond. However, only hours after the lodge destruction, residents witnessed and photographed Lily, as the mother beaver was named, desperately repairing the damage. The adult male beaver, given the name, Lucky, mysteriously disappeared at the time of the lodge destruction and was never seen again.

When it was suggested by experts that, if the beavers must be removed, they be relocated to Aspen Valley Wildlife Sanctuary, the Ministry of Natural Resources staff refused to do so. The experts then suggested to at least allow the beavers to remain in the pond over the winter.

The City's argument for not allowing them to stay the winter was that they were living in a culvert, essentially a sewer, and they needed a more suitable habitat. In reality, Lily had successfully built a second lodge on the bank, which the City dismissed as being nothing more than a mass of branches.

Residents witnessed the family living there, and on the day of the removal, the city truck was parked at the lodge, not at the culvert, where the City claimed they were. In September 2012, residents saw that something was going on at the pond, and their concern for Lily and the kits, Hope and Harmony, grew.

The Ministry of Natural Resources gave approval to relocate them, and it was explained that no one would be allowed to observe the trapping, or be told exactly where they were being released. It was later revealed that they were live trapped and released at Morris Island. Experts and the community tried to inform the city that at this new location, Lily and the two kits had no territory, food cache, or shelter, and that given the time of year, so close to the onset of winter, they would not be able to survive the winter. The city released a video and photo of the beavers swimming in their new home, but there was much controversy over whether the beavers portrayed were even the same ones. It was impossible to tell from the images on the video.

12.7. Ottawa, Canada's Capital

Ineffective lethal removal and breaching and removing dams

In Ottawa, Canada's capital, the National Capital Commission (NCC) is responsible for beaver management on federal lands and the National Capital Greenbelt. The primary method of managing beaver conflicts used by the NCC is lethal removal, and breaching and removing dams. This approach, however, is proving to be expensive, time consuming, inhumane, and ineffective long term. This case study is based on information obtained through Access to Information legislation.

In the 2010–2011 fiscal year, an estimated 205.5 hours were dedicated to beaver management by NCC conservation officers. Out of the total of 205.5 hours, 28.5 of these hours were spent on repairing infrastructure, 73.5 were spent on trapping, 68.5 hours were spent "managing" dams, 29 hours were spent supervising hired trappers, and six hours were spent doing inventory.

In addition to this, hired trappers spent 100 hours on beaver management, setting and checking traps. In the 2011–2012 fiscal year, 126.5 hours were dedicated to beaver management by NCC conservation officers. Out of the total number of hours, 27 were spent on repairing infrastructure, 49.5 were spent on trapping, 39 hours were spent "managing" dams, and 11 hours were spent supervising hired trappers. In addition to this, hired trappers spent 69.5 hours on beaver management, setting and checking traps.

This all shows that a significant amount of time went into beaver management, which often involved revisiting the same conflict sites. If this approach is continued in the future, these hours will have to be put in year after year, with no foreseeable end. If, however, a flow device or tree-wrapping as a long-term solution were implemented, the amount of time devoted to beaver management in successive years would not be nearly as high.

The amount of money spent on beaver management could also be reduced by choosing long-term, non-lethal alternatives.

In addition to being expensive and time consuming, the current approach has led to a significant amount of other wildlife being caught in the traps intended for beavers, including muskrats, otters, raccoons, turtles, and woodchucks.

From 2010 until the end of February 2012, a total of 160 beavers were caught by conservation officers and contract trappers. Most of the beavers caught were living in the Greenbelt. There are a large number of different sites that the NCC has been actively trying to manage, and nearly all of them require multiple visits with only a temporary resolution found. Many of them also require further management in successive years. This shows that the approach currently being used by the NCC is not providing any sort of long-term solution, and this will continue until a different strategy is employed.

In addition, 50 non-target species were trapped including 25 muskrat, 13 turtles most likely involving "at risk" species, six otters, two raccoons and four woodchucks. The total number of animals that died in traps in those two years was 210.

Ultimately, the approach the NCC is taking regarding beaver management is proving ineffective, expensive, time consuming, short term, inhumane and has resulted in the deaths of many non-target species.

12.8 Manitoba, Canada

Education

In Manitoba, the provincial and federal governments are working together to educate farmers, the public, and other stakeholders about the various solutions when it comes to handling beaver issues. In farming communities, farmers and landowners often face serious problems with crop production, flooding, and erosion, due to beaver activity.

A four-year, $1,000,000 program launched in the summer of 2014 aims to provide the resources that individuals need to be able to reduce flooding and other beaver-caused damage, through humane management techniques. The focus of this program is to find "effective, sustainable, and humane solutions" (Government of Manitoba, 2014). This program has the potential to greatly improve the way Manitoba manages human/beaver conflicts, and shows a positive directional shift from the province's previous management approaches.

From 1993, when the province's beaver management subsidy program was launched, to 2011 (18 years) 121,000 beavers had been trapped in Manitoba (Manitoba Conservation, 2011). Yet in 2010, the "abundance of beavers that are causing substantial damage in some areas of the province" (CBC News Manitoba, 2010) caused the province to raise the subsidy on problem beavers from $15 to $20 per animal for rural municipalities to deal with increasing beaver problems (CBC News Manitoba, 2010). Manitoba has been resorting to lethal removal for nearly 20 years and it has clearly not been effective, sustainable, or humane. This new, innovative program, it is hoped, will create some positive, lasting effects. Additional benefits of the program include economic benefits for the agricultural sector, healthy aquatic environments, and avoiding the cost of rebuilding damaged infrastructure. Doug Dobrowolski, president of the Association of Manitoba Municipalities, explains that "proactive approaches are a much more effective use of resources" (Government of Manitoba, 2014). Manitoba, as a case study, is an example of how large-scale education and the exploration of all non-lethal, long-term solutions can not only resolve human/beaver conflicts, but also provide numerous other economic, financial, and ecological benefits.

Prairie fooding

Manitoba, along with the other Prairie provinces (Alberta and Saskatchewan), has been experiencing extreme flooding in recent years, and studies have found that the loss of wetlands is a major factor contributing to this devastating damage. These floods are impacting not only farmers, but the general population as well. The flooding in Southern Alberta in 2013 was recorded as the worst natural disaster in all of Canadian history.

Canada is home to approximately 25% of the world's wetlands, and most of them are in the Prairie provinces. However, over the past 40–60 years, approximately 350,000 hectares of the wetlands in southern Saskatchewan and southwestern Manitoba have been drained or otherwise lost (Mortillaro, 2014).

John Pomeroy, Canada Research Chair in Water Resource and Climate Change, as well as director for the Centre of Hydrology at the University of Saskatchewan, found in his studies that during floods, stream-flow is strongly impacted by wetland drainage. "The drainage of 96 square kilometres in the Smith Creek wetlands between 1958 and 2008 increased the 2011 flood peak by 32 per cent" (Mortillaro, 2014). Based on model simulations, "completely draining the remaining 43 square kilometres of Smith Creek wetlands would have increased the 2011 flood peak by 78 per cent and ramped up yearly flood volume by 32 per cent" (Mortillaro, 2014). This research demonstrates clearly that wetland drainage across the Prairies has exacerbated flooding. Pomeroy says that it is "one of the strongest land-use impacts [on water movement] [he has] seen anywhere in the world" (Semeniuk, 2014). The full report *Improving and Testing the Prairie Hydrological Model at Smith Creek Research Basin* by Pomeroy et al. (2014) can be found at http://www.usask.ca/hydrology/reports/CHRpt14_PHM_SCRB.pdf.

While there is some understanding that wetlands need to be preserved in order to help prevent the damage caused by these extreme flooding events, a key factor that is being overlooked is the beneficial role of beavers. The Alberta government is considering ways to mitigate against flooding in the future; however, its focus is almost exclusively on infrastructure. It is looking at building diversion canals and dry dams, ignoring the advice of scientists to consider the beavers, and their ability to maintain wetlands and mitigate flooding.

Cherie Westbrook, an associate professor in wetland ecohydrology at the University of Saskatchewan, explains how, during the flooding in Kananaskis Country, Alberta, in June 2013, there was actually a lot of water being stored behind beaver dams, and that the flood waters were slowed down because of these dams. She explains how, before the flooding hit, the beaver ponds had been fairly empty, and when the farthest downstream beaver dam became overwhelmed with water, part of it blew. This resulted in some flooding; however, it was not nearly as bad as it could have been, thanks to the beaver dams' retention of flood waters.

Glynnis Hood, an associate professor in environmental science at the University of Alberta, agrees, explaining how "the water comes down, hits these buffering features – the beaver ponds – so the water slows down, has a bit of resistance with the dams and then gets to the next one…you end up having these stop gaps along the way" (Derworiz, 2014). Hood explains how regular spring melts or quick thaw events would

be helped by beaver ponds and dams (Derworiz, 2014). Their effectiveness depends on how much water is coming down, and how fast it is doing so.

The Prairie flooding is another example of why non-lethal beaver management approaches are the best practices. Beaver populations are maintained, and the wetlands are preserved. This, in turn, provides the flood retention needed in the Prairie provinces to minimize the damaging effects that have been impacting the landscape and the human population in recent years.

13 Additional Resources and Beaver Management Consultants

Animal Protection of New Mexico
apnm.org/campaigns/beavers

The Association for the Protection of Fur-bearing Animals
http://furbearerdefenders.com/
Adrian Nelson
(604) 435-1850
Email: Adrian@furbearerdefenders.com or fbd@furbearerdefenders.com

Beaver Deceivers International
www.beaverdeceivers.com
Skip Lisle
1187 Cabell Rd.
Grafton, VT 05146
802-843-1017
Email: skiplisle@vermontel.net or skip.lisle@yahoo.com

Beaver Management Forum on Facebook
https://www.facebook.com/groups/339105817425/

Beaver Solutions LLC
www.beaversolutions.com
Michael Callahan
Southampton, Massachusetts
(413) 695-0484
Email: info@beaversolutions.com or mike@beaversolutions.com

Beavers: Wetlands & Wildlife
http://www.beaversww.org/
Owen & Sharon Brown
146 Van Dyke Rd.
Dolgeville, NY 13329
(519) 568-2077
Email: castor@frontiernet.net or BWW@BeaversWW.org

Ontario Road Ecology Group
David Ireland, Managing Director
Centre of Discovery in Biodiversity
Royal Ontario Museum
100 Queens Park
Toronto, Ontario
M5S 2C6
(416) 586-8092
Email: davei@rom.on.ca

Ottawa-Carleton Wildlife Centre
www.wildlifeinfo.ca
P.O. Box 11051, Station H
Ottawa, ON, Canada
K2H 7T8
(613) 726-8178
Email: ocwc@ncf.ca

Sierra Wildlife Coalition
https://www.facebook.com/pages/Sierra-Wildlife-Coalition/166390266746187?sk=timeline
Sherry and Ted Guzzi
PO Box 7763
Tahoe City, California
96145
(530) 320-9923
sierrwildlifecoalition@gmail.com

Worth A Dam
www.martinezbeavers.org
Email: mtzbeavers@gmail.com

The following are some of the federal, provincial, and territorial acts, policies, strategies, and regulations that are relevant to managing human/beaver interactions in Canada. Please note this legislative list may not be complete. Any beaver mitigation measures must comply with applicable federal, provincial and municipal laws.

CANADA

The following apply to all of Canada:

- Canada Wildlife Act
- Water Act
- Fisheries Act
- Species at Risk Act
- Canadian Biodiversity Strategy

BRITISH COLUMBIA

The following apply specifically to the province of British Columbia:

- Wildlife Act
- Water Act
- Drainage, Ditch and Dike Act

ALBERTA

The following apply specifically to the province of Alberta:

- Wildlife Act
- Water Act
- Environmental Protection and Enhancement Act: Wastewater and Storm Drainage Regulation

SASKATCHEWAN

The following apply specifically to the province of Saskatchewan:

- Wildlife Act
- The Wildlife Regulations
- The Drainage Control Regulations

MANITOBA

The following apply specifically to the province of Manitoba:

- Wildlife Act
- The Environment Act

ONTARIO

The following apply specifically to the province of Ontario:

- Fish and Wildlife Conservation Act
- Drainage Act
- Water Resources Act
- Environmental Assessment Act
- Lakes and Rivers Improvement Act
- Planning and Development Act
- Municipal Act
- Endangered Species Act
- Conservation Land Act
- Conservation Authorities Act
- Ontario Wetland Evaluation System
- Ontario's Biodiversity Strategy

QUEBEC

The following applies specifically to the province of Quebec:

- An Act Respecting the Conservation and Development of Wildlife

NEW BRUNSWICK

The following apply specifically to the province of New Brunswick:

- Fish and Wildlife Act
- New Brunswick's Biodiversity Strategy
- Clean Water Act

NOVA SCOTIA

The following apply specifically to the province of Nova Scotia:

- Wildlife Act
- Water Resources Protection Act
- Water Act
- Ditches and Water Courses Act

PRINCE EDWARD ISLAND

The following applies specifically to the province of Prince Edward Island:

- Wildlife Conservation Act

NEWFOUNDLAND AND LABRADOR

The following apply specifically to the province of Newfoundland and Labrador:

- Water Resources Act
- Wildlife Act

YUKON TERRITORY

The following apply specifically to the Yukon Territory:

- Waters Act
- Wildlife Act

NORTHWEST TERRITORIES

The following apply specifically to the Northwest Territories:

- Waters Regulations
- Biodiversity Action Plan
- Wildlife Act

NUNAVUT

The following apply specifically to Nunavut:

- Nunavut Waters and Nunavut Surface Rights Tribunal Act
- Wildlife Act

Although not listed in this manual, the United States has similar policies in place. If managing human/beaver conflicts in the United States, be sure to check all federal, state, and local laws, policies, strategies, and regulations before taking any actions to manage human/beaver conflicts.

Please note that laws, policies, strategies, and regulations can change regularly and those currently in existence may differ from those listed above. Be sure to check all federal, provincial, territorial, state, municipal, and local policies, such as biodiversity strategies, wetland evaluation systems, drainage acts, agricultural regulations, and other relevant by-laws, before taking any actions to manage a beaver conflict.

14 References

Animal Protection of New Mexico. (2007). Nonlethal Mitigation Training for Conflicts with Beavers: Completed Castor Master. Retrieved 07/21, 2014, from http://www.apnm.org/campaigns/beavers/2007training/pages/12%20Completed%20castor%20master.htm

Beavercone Products. (n.d.) The Beavercone. Retrieved 07/21, 2014, from http://www.beavercone.com

Beaverculvert.com. (2014). The Beaver Proof Add-On. Retrieved 07/21, 2014, from http://www.bpao.ws/

Beaver Solutions LLC. (n.d.) Retrieved 07/21, 2014, from http://www.beaversolutions.com/

Beavers: Wetlands & Wildlife. (n.d.) Retrieved 07/21, 2014, from http://www.beaversww.org/

Bergsma, M. (2009a, Wednesday, January 14). On the hunt for 'animal predators': Beavers beware. *The Standard*. http://www.stcatharinesstandard.ca/2009/01/14/beavers-beware

Bergsma, M. (2009b, Thursday, January 22). Former resident offers to take in 'intelligent creatures': Keep your paws off the beavers, city told. *The Standard*. http://www.stcatharinesstandard.ca/2009/01/22/keep-your-paws-off-the-beavers-city-told

Bergsma, M. (2009c, Tuesday, January 27). City will examine alternatives to trapping and killing animals: Beavers spared -- for now. *The Standard*. http://www.stcatharinesstandard.ca/2009/01/27/beavers-spared-for-now

Born Free USA. (n.d.) Exposing the Myths: The Truth About Trapping. Retrieved 07/21, 2014, from http://www.bornfreeusa.org/facts.php?p=53&more=1

Boyle, S., & Owens, S. (2007). North American Beaver (*Castor canadensis*): A Technical Conservation Assessment. Retrieved 08/18, 2014, from www.fs.fed.us/r2/projects/scp/assessments/northamericanbeaver.pdf

Boyles, S. L. (2006). *Report on the Efficacy and Comparative Costs of Using Flow Devices to Resolve Conflicts with North American Beavers along Roadways in the Coastal Plain of Virginia. Christopher Newport University, Newport News, VA: http://www.beaversww.org*/assets/PDFs/BoylesReport2006-1.pdf

Callahan, M. (2005). Best Management Practices for Beaver Problems. *Association of Massachusetts Wetland Scientists*, 53, 12-14. http://www.beaversolutions.com/PDF/amwx-Apr-05.pdf

Callahan, M., & Perryman, H. (n.d.) What Good Are Beavers? Retrieved 07/21, 2014, from http://www.beaversolutions.com/what-good-are-beavers.asp

Canada Culvert. (2014). Beaver Stop(R). Retrieved 07/21, 2014, from http://www.canadaculvert.com/product/beaver-stop/

CBC News Manitoba. (2010, November 25). Manitoba raises bounty on problem beavers. *The Canadian Press*. http://www.cbc.ca/news/canada/manitoba/man-raises-bounty-on-problem-beavers-1.969914

Centers for Disease Control and Prevention. (2012). Giardiasis Frequently Asked Questions. Retrieved 08/01, 2014, from http://www.cdc.gov/parasites/giardia/gen_info/faqs.html

City of Ottawa. (2013). *Wildlife Strategy*. Retrieved 08/05, 2014, from http://documents.ottawa.ca/sites/documents.ottawa.ca/files/documents/wildlife_strat_en.pdf

Clemson University. (1994). The Clemson Beaver Pond Leveler. Retrieved 07/21, 2014, from http://www.clemson.edu/psapublishing/PAGES/AFW/AFW1.PDF

Derworiz, C. (2014, Friday, March 28). Looktothebeaverforfloodprevention, scientistssay. *Calgary Herald*. hppt:// www.calgaryherald.com/news/alberta/Look+beaver+flood+prevention+scientists/9674728/story.html

DuBreuil, D. (2009, Friday, October 9). Nepean residents prove it is possible to live in harmony with nature. *Nepean-Barrhaven EMC*, pp. 10.

DuBreuil, D., Utas, A., & White, L. (2012). *Backgrounder: A story of harassment and persecution of Lucky, Lily, Hope and Harmony and misinformation by the City of Ottawa*. Retrieved 07/21 from http://www.animalalliance.ca/wp-content/uploads/2011/07/backgrounder-Lily-and-kits1.pdf

Environment Canada & Canadian Wildlife Federation. (2003). Hinterland Who's Who Beaver. Retrieved 07/21, 2014, from http://www.hww.ca/en/species/mammals/beaver.html

Erlandsen, S. L., Sherlock, L. A., Bemrick, W. J., Ghobrial, H., & Jakubowski, W. (1990). Prevalence of Giardia spp. in Beaver and Muskrat Populations in Northeastern States and Minnesota: Detection of Intestinal Trophozoites at Necropsy Provides Greater Sensitivity than Detection of Cysts in Fecal Samples. *Applied and Environmental Microbiology*, 56(1), 31-36. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC183246/pdf/aem00066-0053.pdf

Fletcher Wildlife Garden. (2013). About the FWG. Retrieved 07/21, 2014, from http://www.ofnc.ca/fletcher/about/index_e.php

Garden State Wildlife Control. (2014). *Beaver Damage Management and Flood Control*. http://www.gardenstatewildlifecontrol.com/images/Clemson_Pond_Leveler_Installation.JPG

Get Bear Smart Society. (n.d.) Electric Fencing. Retrieved 07/21, 2014, from http://www.bearsmart.com/becoming-bear-smart/community/electric-fencing

Giannetta, J. (2011). The Beaver. Retrieved 08/18, 2014, from www.aitc.sk.ca/saskschools/animals/bvr1.html

Government of Manitoba. (2014, May 16, 2014). Beaver control program to reduce damage to agricultural land. http://news.gov.mb.ca/news/index.html?item=30991

Grannes. S.G. (n.d.) Beaver Dam Information Site: Conflicts. Retrieved 07/21, 2014, from http://www.beaverdam.info/?page_id=128

Grant, B. L. (2013). Painting Tree Trunks White: How To Paint Tree Bark. Retrieved 07/21, 2014, from http://www.gardeningknowhow.com/ornamental/trees/tgen/painting-tree-trunks-white.htm

Haemig, P. D. (2012). Beaver and Trees. Retrieved 08/01, 2014, from http://www.ecology.info/beaver-trees.htm

Hanrahan, C. (2009). Beaver (*Castor canadensis*) at the Fletcher Wildlife Garden. Retrieved 07/21, 2014, from http://www.ofnc.ca/fletcher/flora-fauna/beaver/FWG-Beaver-illus.pdf

Hood, G. A., & Bayley, S. E. (2008). Beaver (*Castor Canadensis*) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. *Biological Conservation*, doi:10.1016/j.biocon.2007.12.003

Knight, A. (Webmaster, Knight's Canadian Info Collection).The Canadian Beaver. Retrieved 08/18, 2014, from www.members.shaw.ca/kcic1/beaver.html

Kurta, A. (1995). Mammals of the Great Lakes region. Toronto, Canada: Fitzhenry & Whiteside.

Link, R. (2004). Living with Wildlife: Beavers, adapted from "Living with Wildlife in the Pacific Northwest". Retrieved 07/21, 2014, from http://wdfw.wa.gov/living/beavers.pdf

Manitoba Conservation. (2011). 2011-2012 Trapping Guide. Government of Manitoba. http://digitalcollection.gov.mb.ca/awweb/pdfopener?smd=1&did=20687&md=1

Massachusetts Society for the Prevention of Cruelty to Animals–Angell Animal Medical Center. (2014). About the Beaver Population. Retrieved 08/05, 2014, from http://www.mspca.org/programs/wildlife-resources/species-information/beaver/about-the-beaver-population.html

McPeake, R. (n.d.) Beaver Damage Prevention and Control Measures. (No. FSA9085). University of Arkansas Division of Agriculture and Natural Resources. http://www.uaex.edu/publications/PDF/FSA-9085.pdf

Mortillaro, N. (2014, July 9). What's to blame for Manitoba flood? Loss of wetlands, for one. *Global News*. http://globalnews.ca/news/1438750/whats-to-blame-for-manitoba-flood-loss-of-wetlands-for-one/

National Geographic. (2014). Beaver *Castor canadensis*. Retrieved 08/18, 2014, from www.animals.nationalgeographic.com/animals/mammals/beaver/

Naughton, D. (2012). *The Natural History of Canadian Mammals*. Toronto, Canada: Canadian Museum of Nature and University of Toronto Press.

Ontario Ministry of Health and Long-Term Care. (2012). Giardiasis. Retrieved 07/21, 2014, from http://www.health.gov.on.ca/en/public/publications/disease/giardiasis.aspx

Ontario Ministry of Natural Resources and Forestry. (2014). Wildlife Management: Living with Beavers. Retrieved 07/21, 2014, from http://www.mnr.gov.on.ca/en/Business/FW/2ColumnSubPage/290005.html

Ontario Road Ecology Group, Toronto Zoo. (2010). *A Guide to Road Ecology in Ontario*. www.rom.on.ca/sites/default/files/imce/oreg_final.pdf

Ottawa-Carleton Wildlife Centre. (2013). Tree Protection Against Beaver Damage: Specifications for Ontario Winter Conditions. *Newsletter Spring* 2013. p.6. http://www.wildlifeinfo.ca/newsletters/spring13.pdf

Pomeroy, J. W., Shook, K., Fang, X., Dumanski, S., Westbrook, C., & Brown, T. (2014). *Improving and Testing the Prairie Hydrological Model at Smith Creek Research Basin*. (No. 14). Saskatoon, Saskatchewan: Centre for Hydrology, University of Saskatchewan. http://www.usask.ca/hydrology/reports/CHRpt14_PHM_SCRB.pdf

Redbeacon. (2014). Pros and Cons of Electric Fences. Retrieved 07/21, 2014, from http://www.redbeacon.com/hg/pros-and-cons-electric-fences/

Reid, F. A. (2006). *Peterson Field Guides: Mammals of North America* (4th ed.) Houghton Mifflin Harcourt.

Semeniuk. I. (2014, July 9). Loss of ponds, wetlands exacerbated Manitoba flooding: report. *The Globe and Mail*. http://www.theglobeandmail.com/news/national/loss-of-ponds-wetlands-exacerbated-manitoba-flooding-report/article19539797/

Simon, L. J. (2006). Solving Beaver Flooding Problems through the Use of Water Flow Control Devices. *22nd Vertebrate Pest Conference*, University of California, Davis. 174-180. http://www.beaversww.org/assets/PDFs/Simon2006.pdf

The Center for Food Security & Public Health, Iowa State University. (2012). Giardiasis. Retrieved 08/05, 2014, from http://www.cfsph.iastate.edu/Factsheets/pdfs/giardiasis.pdf

The Friends of Algonquin Park. (2005). The Science Behind Algonquin's Animals: Introduction to Algonquin Park Habitat: Beaver Ponds. Retrieved 07/21, 2014, from http://www.sbaa.ca/about.asp?n=278&o=1&cn=284

The Humane Society of the United States. (2009). What to Do About Beavers. Retrieved 07/21, 2014, from http://www.humanesociety.org/animals/beavers/tips/solving_problems_beaver.html

Unexpected Wildlife Refuge. (2014). Solutions to Problems Caused by Beavers. Retrieved 07/21, 2014, from http://www.unexpectedwildliferefuge.org/BeaverSolns.htm

United States Environmental Protection Agency. (2000). Giardia: Drinking Water Fact Sheet. Retrieved 07/21, 2014, from http://water.epa.gov/action/advisories/drinking/upload/2009_02_03_criteria_humanhealth_microbial_giardiafs.pdf

United States Environmental Protection Agency. (2004). R.E.D. Facts: Thiram. Retrieved 07/21, 2014, from http://www.epa.gov/oppsrrd1/REDs/factsheets/0122fact_thiram.pdf

Wagner, K. K., & Nolte, D. L. (2000). Evaluation of Hot Sauce® as a repellent for forest mammals. *Wildlife Society Bulletin*, 28(1), 76-83. http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1828&context=icwdm_usdanwrc

Westbrook, C. J., Cooper, D. J., & Baker, B. W. (2006). Beaver dams and overbank floods influence groundwater–surface water interactions of a Rocky Mountain riparian area. *Water Resources Research*, 42(6). doi:10.1029/2005WR004560

Wildlife Animal Control. (2014). Beaver Repellent Analysis. Retrieved 07/21, 2014, from http://www.wildlifeanimalcontrol.com/beaverrepellent.html

Worth A Dam. (2010). Our Story. Retrieved 07/21, 2014, from http://www.martinezbeavers.org/wordpress/about-2/

Beavers are the great comeback story — a keystone species that survived ice ages, major droughts, the fur trade, urbanization and near extinction. Their ability to create and maintain aquatic habitats has endeared them to conservationists, but puts the beavers at odds with urban and industrial expansion. These conflicts reflect a dichotomy within our national identity. We place environment and our concept of wilderness as a key touchstone for promotion and celebration, while devoting significant financial and personal resources to combating "the beaver problem."

We need to rethink our approach to environmental conflict in general, and our approach to species-specific conflicts in particular. Our history often celebrates our integration of environment into our identity, but our actions often reveal an exploitation of environment and celebration of its subjugation. Why the conflict with the beaver? It is one of the few species that refuses to play by our rules and continues to modify environments to meet its own needs and the betterment of so many other species, while at the same time showing humans that complete dominion over nature is not necessarily achievable.

Dr. Glynnis Hood, *The Beaver Manifesto*

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