LA FONDATION DE LA FAUNE DU QUÉBEC
Informe

MANAGEMENT GUIDE FOR LAND USED BY BEAVERS IN QUEBEC

MODEL FOREST NETWORK
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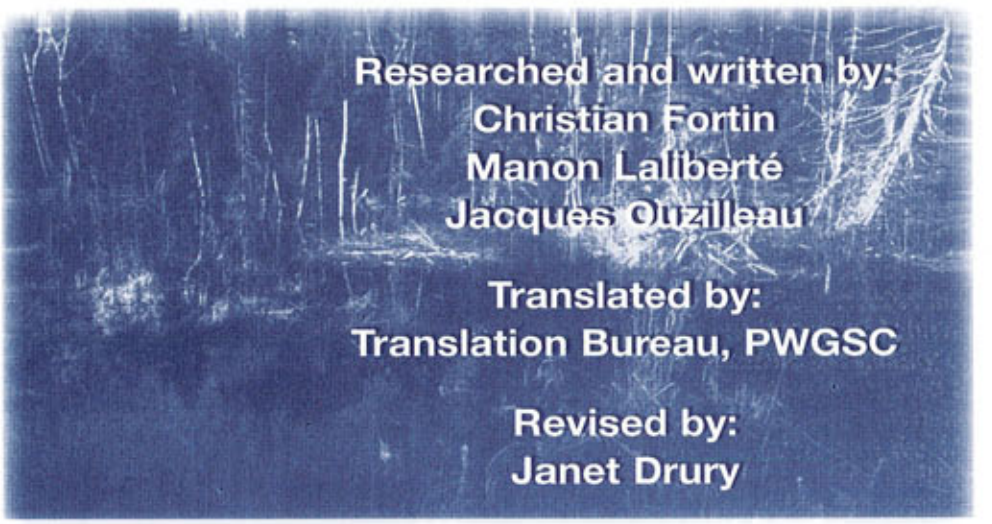
MANAGEMENT GUIDE FOR LAND USED BY BEAVERS IN QUEBEC



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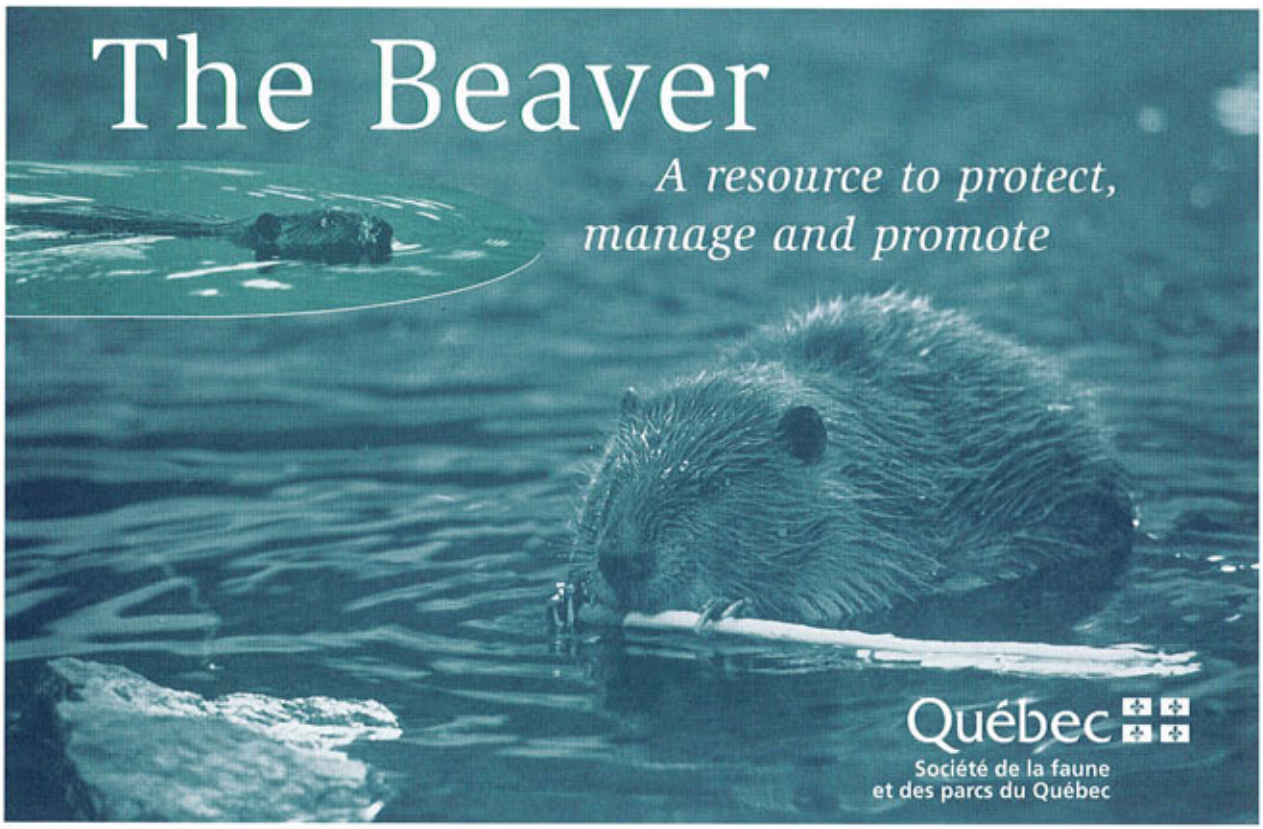

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1 INTRODUCTION

Few animal species have as significant an impact on their environment as the beaver; through the dams it builds, this rodent plays a key role in shaping the structure and dynamics of its habitat. The wetlands it creates evolve into complex ecosystems where living organisms interact in myriad ways.

The beaver's activities, especially its dam building, are often perceived as a nuisance, particularly when it damages the foundations of roads and railways. Intensive logging since the middle of the last century and reduced trapping pressure in recent years have led to marked growth in Quebec's beaver population. In some regions, the number of conflicts arising from beaver activity have escalated, and the costs of repairing and maintaining damaged infrastructure have risen considerably.

By publishing this guide, the *Fondation de la faune du Québec* and its partners seek to raise awareness among land use managers by providing them with a tool to assess the positive and negative repercussions of beaver activity. In this way, they hope to protect and develop habitat while offering a range of options for curtailing and controlling beaver activity.

In addition to wildlife habitat managers (outfitters, ZECs, parks and wildlife reserves), this guide is intended for:

- hunting and trapping associations
- municipalities
- government departments and Crown corporations
- trappers
- forestry interests and regional management agencies for private forests
- habitat management agencies
- farming interests
- students in biology and forestry (technical and academic)
- wildlife habitat protection and development groups

This guide can be read in two ways:

1. On one hand, the text, supplemented by tables, boxes and figures, provides a concise treatment of the points covered in each chapter. In some cases, the section entitled "To find out more" at the end of a chapter points the reader to further sources of information.
2. On the other hand, the text in sidebars and in bold print summarizes the main points covered in the body of the text.

The opening chapters outline the basic concepts needed for an understanding of the problems associated with beavers: their ecology (Chapter 2), their situation in Quebec (Chapter 3), their impact (Chapter 4) and the principles and methods for managing beaver populations in Quebec (Chapter 5). The subsequent chapters give a broad treatment of the various management approaches (Chapter 6), the most widely used management techniques (Chapter 7), monitoring and evaluation measures (Chapter 8), and the applicable legislation and authorizations needed in Quebec (Chapter 9).

The management techniques described are presented in the form of instruction sheets. Each sheet includes a description, a summary of the advantages and disadvantages of the technique, and figures and sketches showing how the devices are used.

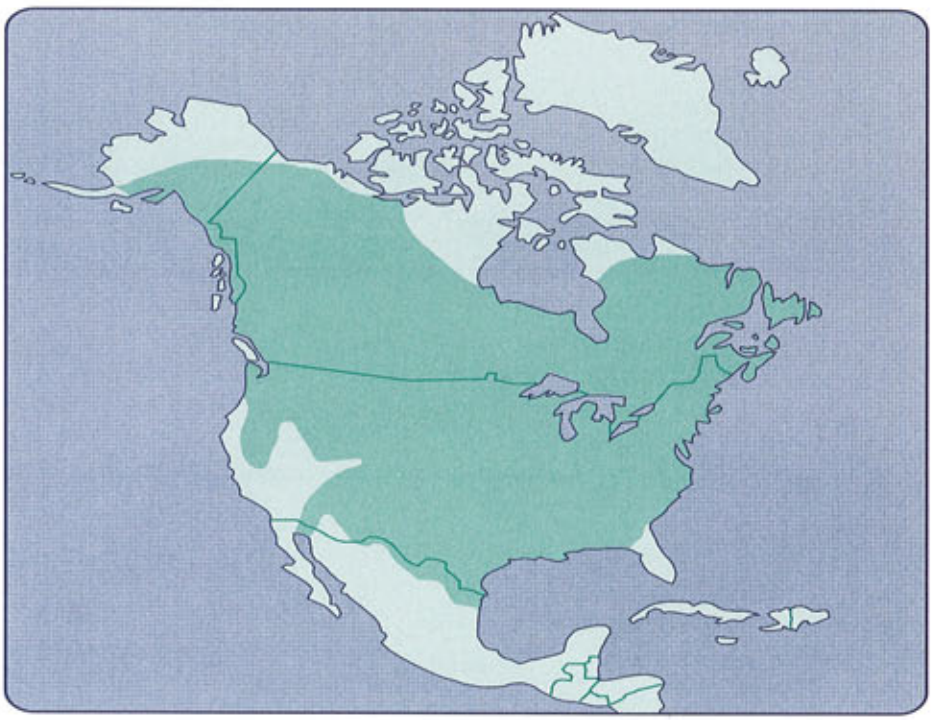
2 BEAVER ECOLOGY

2.1 GENERAL INFORMATION AND HABITS

A wide-ranging **North American** species.

Beavers (*Castor canadensis*) are the largest rodents and the only members of the Castoridae in North America. The only other beaver species, *Castor fiber*, is found in Europe and resembles the Canadian beaver in many ways. In North America, the range of this semi-aquatic mammal extends from the Mexican border to Alaska, and it is very common everywhere in Quebec, except in the northernmost reaches of the province (Figure 1). Beavers usually live on riverbanks, lake shores and marshes bordered by deciduous trees.

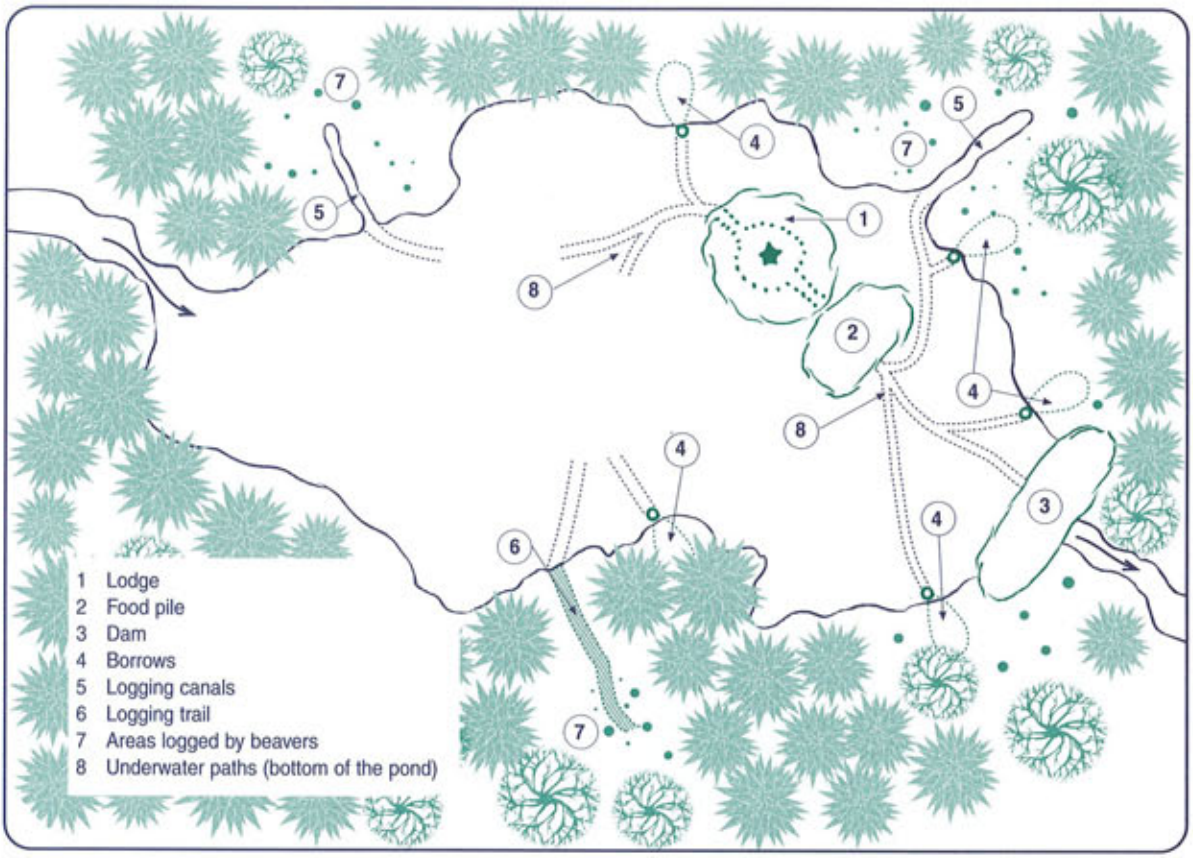
Figure 1 Distribution of Beavers in North America



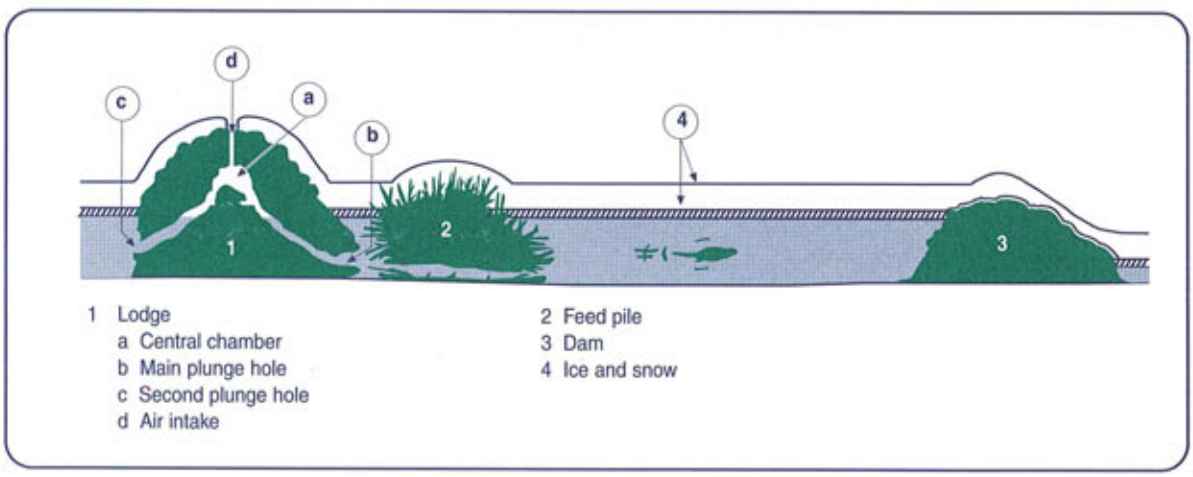
Beavers build **dams** to raise the water-level, construct **lodges** and **burrows** for shelter, and lay **food stores** for winter.

When beavers colonize a new place, they usually build dams with branches, grass, mud and stones in order to raise and maintain the water-level. The resulting pond does not freeze to the bottom, enabling beavers to move about under the ice and store food for winter (Figure 2). In so doing, they extend their aquatic area and get closer to their food sources. In addition, this work provides access to the underwater entrances to their lodges and burrows, keeping them safe from predators. To make it easier to float wood, they sometimes build canals with dykes to maintain the water-level. They also make paths at the bottom of the pond to facilitate movement.

Figure 2 Beaver Habitat



Beaver Pond in Winter



Beavers use two types of shelters: a burrow in the stream bank and a half-submerged lodge built near the shore. The lodge is mainly made of branches and mud and has one or more entrances, a central chamber located above the water-level and an air intake. In the fall, beavers lay aside a food store of hardwood branches piled up near the lodge. Most of this feed pile is underwater, providing food throughout the winter.

Beavers mostly live in **colonies** of two to twelve animals.

Beavers are monogamous and may live alone. However, they usually live in colonies consisting of two to twelve animals, including the parents, kits and yearlings born the previous spring. All the animals help build and maintain the dam and the lodge and share their food. The juveniles leave their parents when they are about two years old and migrate along streams to start new colonies.

2.2 *FEEDING*

Trembling **aspen**: a choice species!

Beavers are strict vegetarians, consuming a variety of woody and herbaceous species. Trembling aspen (*Populus tremuloides*) is their favourite wood, but willows, other types of poplar, birch, alder, ash, cherry and maple are also commonly used. Beavers eat the bark, leaves, twigs and buds of these species. They also eat conifers, especially when there are no deciduous trees around or when there is a food shortage. Beavers usually cut trees near the water, mostly within a 50-metre radius, but when there is a food shortage, they will travel over 200 metres away from the pond along their logging trails. They can get closer to their food sources by building dams or digging logging canals. **Herbaceous plants such as duckweed, water lilies (including the rhizomes), pondweed, horsetail and sedge are an important part of their diet until the pond freezes over.** Beavers become increasingly dependant on woody vegetation as winter approaches and herbaceous vegetation becomes scarce.

2.3 *HABITAT*

A **winning combination:**
- stable water-level
- gently sloping land
- hardwood species (trembling aspen, willow, white birch, alder)
- substrate of loose earth

Beavers live in various aquatic habitats, but they prefer ponds, small lakes with muddy or loamy bottoms, slow-flowing, winding streams and irrigation canals in farmland. Water affords them protection against predators, and land provides them with food and building materials for their dams and lodges. The ideal habitat for beavers features stable water-levels, gently sloping land, banks covered in hardwood species and a substrate of loose earth. Beavers tend to settle in valleys that are wide enough to provide the amount of vegetation they require. They usually avoid swift-flowing water and areas subject to flooding or where water flow fluctuates with the seasons. Plant succession resulting from fire, cutting, insect epidemics and windfall creates a favourable environment for trembling aspen and other pioneering species (birch, cherry, ash, etc.), thus improving habitat potential for beavers.

To find out more:

Allen 1983, Beaudin and Quintin 1983, Novak 1987, Service canadien de la faune 1987, Biorex 1993, Tesky 1993, Fédération des trappeurs gestionnaires du Québec 1998.

Technical Data on the Beaver

Scientific name:	*Castor canadensis*
Family:	Castoridae
Order:	Rodentia
Class:	Mammalia
French name:	Castor du Canada
English name:	Beaver
Weight of adult:	13 to 35 kg
Overall length of adult:	90 to 120 cm
Sexual maturity:	Variable, but approximately 21 months
Mating season:	January to February
Gestation:	105 to 107 days
Parturition:	April to June
Litter size:	3 to 4
Number of litters per year:	1
Weaning:	7 to 10 weeks
Average number of beavers per colony:	4
Life span:	12 years in the wild and 20 years in captivity
Home range:	0.6 to 2.5 km along a river or stream
Activity:	Active mostly at night, all year round
Senses:	Well-developed sense of smell and hearing, poor eyesight
Colour:	Varies, but usually dark brown, except for the feet and tail, which are black and hairless
Causes of natural death:	Harsh winters, starvation, predation, floods and disease (tularemia)
Predators:	Man, coyote, wolf, fisher, lynx, otter and bear
Signs of presence: (recent activity and fresh signs)	Trees cut or gnawed in a conical pattern, logging trails, logging canals, mud mounds and characteristic odour at the water's edge, flooding, feed pile, lodge, dam, burrow, floating wood with bark gnawed off, noise (slap of the tail on the surface of the water)

3 STATUS OF BEAVERS IN QUEBEC

3.1 HISTORY

Beavers: key species in the **fur trade** for centuries.

In North America, the beaver fur trade with Europe began in the early 1600s. At this time, the beaver was the most sought-after natural resource. Over the next couple of centuries, regional beaver populations were overexploited and their numbers declined. At the turn of the 20th century, there was a slump in the beaver fur trade owing to a decline in the popularity of beaver hats and to the increasing scarcity of the species all over North America.

In the late 1930s, the federal and provincial governments began to implement strict conservation measures for the protection of fur-bearing animals. In conjunction with new wildlife management approaches and reintroduction programs, these measures helped increase beaver populations. A network of beaver reserves covering 78% of the province of Quebec was established between 1932 and 1955 to help the populations recover. Commercial logging in climax forests also probably benefited beavers by promoting the regeneration of hardwood species such as the trembling aspen.

A decrease in trapping and enhanced beaver habitats have helped **increase beaver populations** over the last few years.

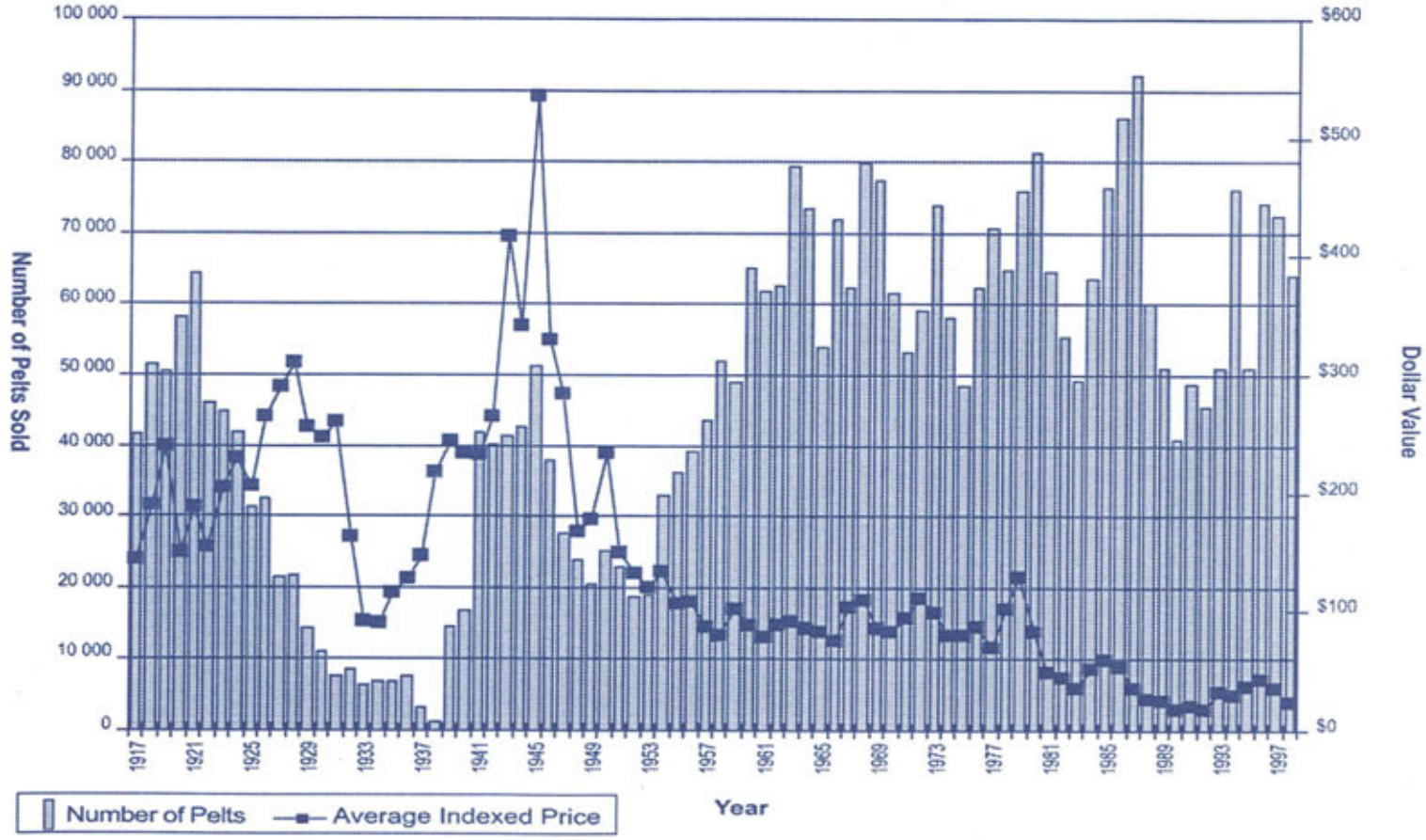
During the 1980s and the early 1990s, the price of beaver pelts hit an all-time low (Figure 3), resulting in a decrease in trapping. In addition, more intensive logging activities have enhanced beaver habitats overall by increasing the food supply in the medium term. Beaver populations have thus been on the rise throughout Quebec in the last few years, and some regions are even experiencing an overpopulation. Consequently, emergent conflicts resulting from beaver activity have multiplied, and costs related to infrastructure damage and maintenance have escalated.

3.2 BEAVER DENSITY BY REGION

Beaver **density** is highest in Abitibi-Témiscamingue and Outaouais.

Beavers are found throughout Quebec, except in the northernmost area. The density of the species varies, however. To better characterize the population, the *Société de la faune et des parcs du Québec* (FAPAQ) did an aerial survey of beaver colonies over a six-year period (1989–1994). The area surveyed was mostly in southern Quebec in the free zones and controlled territories of 13 administrative regions. The survey results (Table 1) indicate that beaver density is highest in the western part of the province (Outaouais and Abitibi-Témiscamingue) and decreases toward the east. The lowest density areas are in the south (Montérégie and Chaudière-Appalaches) and east (Gaspésie and Îles-de-la-Madeleine).

Figure 3 Number of Beaver Pelts Sold From 1917 to 1998 and Average Price (Indexed to 1999 Dollars)



Source : *Société de la faune et des parcs du Québec*

Table 1 Average Density of Beaver Colonies (Colonies/10 km²) in 13 Administrative Regions of Quebec, 1989 to 1994 (Unpublished Data, *Société de la faune et des parcs du Québec)*

Administrative Region	Free Zone Density*	Controlled Territory Density*	Average Density
Abitibi-Témiscamingue	6.6	5.1	5.5
Outaouais	4.9	4.9	4.9
Laurentides	3.9	2.7	3.5
Lanaudière	3.1	3.9	3.3
Mauricie-Bois-Francs	2.2	3.5	2.7
Côte-Nord	1.8	2.3	2.2
Saguenay-Lac-Saint-Jean	1.8	1.8	1.8
Québec	1.9	1.0	1.3
Estrie	1.3	2.8	1.3
Bas-Saint-Laurent	0.9	1.8	1.1
Gaspésie, Îles-de-la-Madeleine	0.7	1.0	0.7
Chaudière-Appalaches	0.5	--	0.5
Montérégie	0.4	--	0.4
Average	**2.3**	**3.6**	**2.9**

* See Section 5.2.1

3.3 BEAVER HARVEST AND YIELD BY REGION

In 1998, a report was produced on beaver trapping in Quebec for the 1995 to 1997 seasons. Data on harvests (number of beavers captured over a year) and yields (captures/100 km²) were provided for each of the 16 administrative regions (Table 2). The yield is a more effective method for regional comparison because the harvest is calculated in terms of a comparable surface area.

The largest **harvests** and **yields** are in the western part of the province.

Outside the beaver reserves, the largest harvests in 1997 were in Abitibi-Témiscamingue (18 058), Outaouais (8 706), Saguenay-Lac-Saint-Jean (7 345) and Mauricie-Bois Francs (6 727). A regional analysis showed that the greatest yields were in Abitibi-Témiscamingue (50.1 beavers/100 km²), Outaouais (38.7), Saguenay-Lac-Saint-Jean (32.9) and Laurentides (31.6). Therefore, the western regions of the province played a predominant role, which is not surprising since these regions have the highest beaver densities in Quebec.

3.4 ANALYSIS

Beavers are **flourishing** in Quebec.

Beaver populations have been expanding over the last few years in many Quebec regions owing to the decline in trapping, coupled with a favourable habitat. Today the species is flourishing, especially in the western regions of Quebec (Abitibi-Témiscamingue and Outaouais), which have very high beaver densities despite abundant harvests and yields.

Table 2 Beaver Harvest and Yield by Administrative Region in 1997 (Data Taken From McNicoll and Lafond 2000)

Administrative Region	Harvest (Captures/Year)	Yield (Captures/100 km²)
Abitibi-Témiscamingue	18 058	50.1
Outaouais	8 706	38.7
Saguenay-Lac-Saint-Jean	7 345	32.9
Laurentides	5 342	31.6
Lanaudière	2 218	26.2
Mauricie-Bois-Francs	6 727	22.4
Bas-Saint-Laurent	3 298	15.8
Côte-Nord	3 616	13.9
Montérégie	1 237	12.5
Estrie	1 330	12.2
Chaudières-Appalaches	1 585	10.6
Québec	2 603	8.9
Gaspésie, Îles-de-la Madeleine	1 154	6.0
Nord-du-Québec	5 651	N/A
Montréal	270	N/A
Laval	93	N/A
Total Harvest and Average Yield	**69 233**	**23.6**

N/A: Data not available

To find out more:

Hill 1982, Novak 1987, Cotton 1990, Pilon and Macquart 1991, Canac-Marquis and Dubois 2000, McNicoll and Lafond 2000.

4 IMPACT OF BEAVER ACTIVITY

Beavers profoundly **alter** their **habitat**.

4.1 IMPACT ON WETLANDS

Dams control **water-levels** and **water flow.**

The first effect of beaver dam construction is the creation of an impoundment where the water collects, regulating the water flowing downstream. The dams thus help reduce erosion caused by peak flows. In addition, they help maintain the water table, purify the water by acting as sedimentation sites for many pollutants, and regulate the flow during spring floods, as long as the dam is well maintained and the surface of the pond reasonably large.

By slowing the water flow, beaver dams cause sediment and organic matter to accumulate upstream from the dam, reducing the turbidity of the water downstream. This organic debris will continue to collect as long as the dam is still intact, settling to a thickness of several centimetres in an oxygen-poor environment and thus decaying very slowly. A decline in the water flow can also cause the pond to warm up, which can be beneficial for many wildlife species and harmful to others.

Beaver pond **productivity** is high at the beginning and diminishes over time.

Beaver pond productivity varies greatly over time. It is generally high during the first years with the flooding of the forest habitat, which promotes the suspension of many nutriments found in the soil. These nutriments become available to aquatic vegetation and invertebrates, which are at the bottom of the food chain in the beaver pond. The retention of sediment and organic matter also provides the wetlands with other nutriments. However, after a few years, productivity generally diminishes if the water-level remains stable. Once beavers have abandoned the pond, and it has dried out, the accumulated nutriments can be used by the forest flora. This habitat is continually transformed as a result of beaver use and abandonment.

Sometimes a series of beaver dams is built on a stream, creating large reservoirs of water. The succeeding dams may be washed away in heavy rains or when one of the dams is no longer maintained. Even with regular repairs, beaver dams may wear down over time and eventually give way, especially if they are built on rock or on sandy shorelines. When a dam or series of dams breaks, there may be a rush of water, which leaches the banks, releases a significant amount of nutriments, and pushes the debris, accumulated upstream from the dam, downstream.

4.2 IMPACT ON VEGETATION

The life cycle of a pond is from 10 to 30 years.

Beaver activity helps increase landscape diversity by promoting plant communities that change over time as the ponds are abandoned and reflooded. The complete cycle (colonization, abandonment and recolonization of the pond) takes about 10 to 30 years. The plant succession described below

corresponds to habitats with acidic granitic substrates (parc des Laurentides, Haute-Mauricie, Côte-Nord, Abitibi, Baie-James, Nouveau-Québec, etc.), which are usually found in boreal forests.

In forests, the flora growing along stream embankments are part of a generally linear riparian habitat that differs in structure and in flora composition from the adjacent forest habitat. Because riparian habitats are affected by the mechanical action of water and ice, the vegetation often goes through a shrub stage and a herbaceous stage, consisting mostly of species found in open environments.

With the **rise in water-level**, riparian and aquatic plants begin to grow, creating a wetland habitat.

When a stream is harnessed by a beaver dam, the higher water-level and ensuing hydrologic stability foster the growth of plants characteristic of wetland habitats, which soon replace the forest vegetation, thus greatly altering the habitat. In the long term, riparian vegetation characteristic of swamps (sphagnum, heath) begins developing at the water's edge. Some aquatic species (pondweed, bur-reed, water lilies) may also take root in the deeper water.

As the pond **dries**, a beaver meadow emerges, succeeded by the growth of the original plant associations.

When a pond has been abandoned and the dam gradually breaks down, the stream returns to its original water-level, exposing the bottom of the pond. This is relatively flat because of sedimentation, characterized by a thick layer of silt and organic matter. This habitat is generally quickly overgrown with single-species stands of meadow sedge. With the gradual drying of the meadow, other riparian plants that were probably present before the arrival of the beavers slowly start to develop, including willows, alders, spirea, violets, willow-herb, rushes, bittercress and other grass-like plants (sedge grass, bulrushes, etc.). Forest species, especially fir trees, slowly begin to surround the meadow, while the riparian species shift toward the new stream banks. Over time, the forest and riparian habitats return to their original state before the arrival of the beavers, except for the drainage, which may have been altered by the layer of silt, and the local topography, which may have become more uniform.

This habitat does not promote the growth of **rare plant species**.

The overall habitat is subjected to a series of disturbances over several decades. Plant species that take root at various stages of the cycle are pioneer or opportunistic species that usually have a high tolerance range. Habitats that undergo such successive changes do not promote the growth of rare species.

Beavers alter **succession** in plant communities.

Tree felling carried out by beavers for their dietary and building needs can alter natural succession in plant communities. In cutting their favourite hardwood species, they create gaps in the forest canopy. By singling out a given species, beavers can affect its representation in the local habitat. Therefore, in an environment dominated by conifers, beavers can decrease habitat diversity by systematically cutting hardwood species, thus promoting the regeneration of conifers. Where hardwood species dominate, beaver activity can be beneficial by rejuvenating the stand. For instance, a stand of mature trembling aspen could be replaced by a fir forest if it were not for the beaver.

By cutting trees along riparian forest strips, beavers expose other trees to bad weather in which they can be uprooted by strong winds and erosion. More trees may fall for this reason than as a result of beaver activity.

4.3 IMPACT ON FAUNA

Cold-water stream productivity usually increases following beaver activity. Higher water temperature, the sedimentation of fine particles and the accumulation of nutriments generally foster algae and plankton growth, which

increases the freshwater invertebrate population that feeds various fish species. In addition, beaver ponds make better breeding and feeding grounds than rivers for many insect, reptile and amphibian species.

Beavers generally do more good than harm to **brook trout**.

Brook or speckled trout (*Salvelinus fontinalis*), which live in the shallow waters of cold flowing streams, usually benefit greatly from beaver ponds. The ponds provide brook trout with resting and feeding areas, shelter, and a winter habitat. Since the habitat is generally more productive, it provides more food, thus enhancing brook trout growth. However, beaver ponds can also be detrimental to brook trout. If the water gets too warm, it can harm the fish by significantly lowering the concentration of dissolved oxygen. Furthermore, in reducing drainage, beaver dams can flood spawning grounds (sedimentation and possible destruction of spawning grounds) and impede fish migration. For spawning grounds located downstream from the dams, lower peak flows leave a deposit of organic matter and branches on the substrate. In some cases, beaver activity results in lower brook trout survival and recruitment rates, reducing fish yields in some areas. An overabundance of beaver dams and the presence of dams in streams where brook trout are found could therefore be harmful to this population. However, beavers usually do more good than harm to brook trout in Quebec. For more information on managing beaver–brook trout problems, we recommend the following specialized publication: *Le castor et l'omble de fontaine : modalités de gestion interactive* (Bernier *et al.* 1997), available in French only.

Beaver ponds provide a good environment for **waterfowl** during mating, breeding and moulting.

Beaver ponds also attract waterfowl, including the American black duck (*Anas rubripes*), the wood duck (*Aix sponsa*), the Hooded Merganser (*Lophodytes cucullatus*) and the ring-necked duck (*Aythya collaris*). The ponds are very good areas for mating, breeding and moulting because they provide a habitat that offers both food and cover. Many songbird species benefit from the openings that beavers make in the forest canopy, which often results in denser bird populations than those in neighbouring areas. Ruffed grouse (*Bonasa umbellus*) also benefit from increased food production on the pond shores and a good habitat for raising their young if the vegetation is dense and leafy. Standing dead trees (snags) caused by flooding also provide feeding substrates, resting places and nesting cavities for other bird species (woodpeckers, etc.).

Birds generally benefit from beaver ponds.

Many **mammals** are also drawn to beaver ponds.

Beaver ponds also attract many mammal species. The aquatic, herbaceous and shrub-like plants growing around the ponds or in the beaver's cutting areas are sought by moose (*Alces alces*) and white-tailed deer (*Odocoileus virginianus*), among other species. Muskrat (*Ondatra zibethicus*) also profit from beaver presence (lodges, canals, leftover food) and enjoy the deeper water in winter. Predators like the otter (*Lutra canadensis*), mink (*Mustela vison*) and raccoon (*Procyon lotor*) are drawn to the ponds for food (brook trout, amphibia, etc.). Beavers also attract their own predators such as wolves (*Canis lupus*) and coyotes (*Canis latrans*). In addition, black bears (*Ursus americanus*) are fond of the berries on the bushes in the beaver cutting areas.

Beaver ponds help increase **biodiversity**.

Beaver ponds thus help significantly increase local biodiversity, favouring a greater species density and a large number of species that are different from those found in nearby rivers and streams.

4.4 IMPACT ON HUMAN INFRASTRUCTURE AND THE ECONOMY

Beavers cause damage mainly by building dams, which can wash out trails, roads and railway tracks, and flood farmland and commercial forests. Beaver

Beavers cause significant **damage**.

activity can also erode road embankments and obstruct access routes. Beavers sometimes block irrigation systems and the mouths of culverts and can do extensive damage to fruit trees and ornamental trees.

Control and repair **costs** are high.

Every year, heavy economic losses resulting from beaver activity exceed fur revenues. Annual damage caused by beavers in the United States was estimated at almost US$100 million in the early 1980s. **In Quebec, repairs related to beaver damage cost several million dollars annually.** Every year, Canadian National (CN) pays about $1000 per kilometre of track for beaver damage management.

Beavers can generate substantial **economic spin-offs**.

Beaver ponds, beaver trapping and the commercial use of various beaver parts generate substantial economic spin-offs in some regions. The beaver habitat attracts a diversified fauna, improving hunting, fishing and trapping, and brings in revenue from the leasing rights for these sports. Beaver meat is edible, highly valued in some communities, and makes good bait for trapping fur-bearing animals. Castoreum, which is secreted by the beaver, is used as a lure in trapping some fur-bearing animal species and is marketed primarily as a perfume ingredient. Since the beaver habitat often harbours a diversified fauna and flora, it can be an excellent site for nature study and interpretation. Moreover, beaver ponds located near major access roads are useful places for raising public awareness of wildlife management concepts.

4.5 IMPACT ON HUMAN HEALTH

Certain routine **precautions** reduce the minor risk of infection.

The two main diseases carried by beavers and transmitted to humans are giardiasis (beaver fever) and tularemia. Although they may seriously affect human health, only a few serious cases are diagnosed yearly, and this minor risk can be reduced by routine precautions. Like all mammals, beavers can contract rabies, but they are not considered to be a significant vector for this disease. Other diseases that occasionally affect beavers, such as leptospirosis and pseudotuberculosis, are caused by infectious agents that are potentially transmissible to humans.

Giardiasis

Giardiasis generally causes an **asymptomatic** infection.

Giardiasis is caused by a flagellate protozoan called *Giardia lamblia*, which is very widespread in Quebec. This disease affects other mammals too, including muskrats, dogs and cats, as well as birds and amphibians. The protozoan, which lives in the small intestine of a host, usually causes asymptomatic infection in humans, but can result in nausea, vomiting, diarrhea, constipation, abdominal cramps, low-grade fever and fatigue. The symptoms of the disease are cyclic and vary in intensity from one person to the next. There are thus many healthy human carriers of this parasite. In 1999, 15.3 cases per 100 000 people were reported to Quebec public health officials, and the numbers are growing. This is a very conservative estimate, however, because the infection often has no symptoms.

The life cycle of this parasite includes an infectious reproductive stage and a dormant cyst stage. Animals and humans can become infected by water or food that has been contaminated with feces containing cysts, or by physical contact (fecal-oral contamination). The parasite can also migrate in water tables and natural springs. Because the cysts remain infectious in water for about 30 days, infection can easily spread in an area with a well-developed drainage system. Proper filtration of drinking water destroys a significant number of these parasites, even if the chlorine concentration is not high enough to eradicate the cysts.

Tularemia

Tularemia, a disease that can be found throughout Quebec, is caused by *Francisella tularensis* bacteria. It affects a wide range of animals (birds, reptiles, domestic animals, etc.), especially rodents and lagomorphs (eastern cottontails, hares, beavers, muskrats and voles). The disease lasts a couple of days in animals and is usually fatal. Tularemia may be a significant mortality factor in certain beaver and muskrat populations.

Tularemia can be transmitted to humans by infected animals, but is not usually passed from one person to another. People can become infected by coming into direct contact with the carcass or fur of a diseased animal, inhaling infected hairs and dust, eating undercooked meat, being bitten by infected arthropods (including ticks) or drinking contaminated water. In Quebec, 2 to 13 cases of tularemia per year were reported to public health officials between 1990 and 1999.

Tularemia can be a fatal disease in humans if it is not treated in time.

Initial symptoms include excessive perspiration, fever, vomiting, nausea, headache, muscle pain and generalized weakness, which generally appear in two or three days and vary in intensity. This is followed by painful inflammation at the site of the infection and swelling of the lymph nodes. **A doctor should be consulted as soon as the symptoms appear.** Tularemia is sometimes fatal, but is easily treated with antibiotics as long as treatment is administered in time. It can take weeks, or even months, for a complete cure.

The next page contains a list of precautions for reducing the risk of contamination with giardiasis and tularemia.

4.6 SUMMARY OF POSITIVE AND NEGATIVE EFFECTS OF BEAVER ACTIVITY

A summary of the effects of beaver activity on the environment can be found on page 17.

To find out more:

Wilde *et al.* 1950, Rupp 1955, Knudsen 1962, Hardy 1965, Reese and Hair 1976, Hill 1982, Barnes and Dibbles 1986, Fréchette 1986, McDowell and Naiman 1986, Naiman *et al.* 1986, 1988, 1994, Addison *et al.* 1987, Novak 1987, Auerbach and Geehr 1989, Lévesque *et al.* 1995, Alain 1997, Bernier *et al.* 1997, Fédération des trappeurs gestionnaires du Québec 1998, Donkor and Fryxell 1999, Edwards and Otis 1999, Gabor *et al.* 1999, Terwilliger and Pastor 1999.

Basic Precautions for Reducing the Risk of Contamination With Giardiasis and Tularemia

Giardiasis:

1. The best way to guard against giardiasis is to avoid drinking untreated water or using it for household needs unless it has been boiled for five minutes. This recommendation is a golden rule that should also be applied in areas not colonized by beavers, and prevents infection from other pathogenic agents carried in water.
2. Hikers should carry portable water filters that provide full protection against protozoans.
3. Giardia cysts are almost totally resistant to chlorination.
4. Basic hygiene is a must! Wash hands regularly, etc.

Tularemia:

1. Avoid drinking untreated water or using it for household needs unless it has been boiled for five minutes or disinfected (chlorinated). Hikers should carry portable water filters to reduce the amount of bacteria in drinking water.
2. Avoid all contact with animals that look abnormal or behave strangely. Hikers should also avoid touching dead animals in the forest.
3. Wear heavy-duty, waterproof gloves, protective clothing (sweat suit, apron, long sleeves that are tight around the wrists), and a mask and goggles when handling or dismembering animals.
4. Wet the fur before skinning the animal to keep the dust and fine hairs down.
5. Wash the work surface and tools with a strong disinfectant such as concentrated bleach mixed with water (1:10 dilution).
6. Scrub your hands and arms with warm, soapy water and use a disinfectant. If you have a cut, thoroughly clean and disinfect the wound while letting the blood flow freely to expel the potential pathogenic agent.
7. Consult a physician if you come down with a fever or diarrhea, or if ulceration or swelling occurs on the wound or in the armpits.
8. Do not feed the carcasses to domestic or ranch animals (dogs, cats, mink, etc.) because the disease can also be transmitted by carnivorous domestic animals.
9. Report all suspected or obvious cases of Tularemia to the regional wildlife protection office of the *Société de la faune et des parcs du Québec* or the *Centre québécois sur la santé des animaux sauvages* (CQSAS).
10. Cook game thoroughly to destroy the bacteria that cause this disease.
11. Protect yourself against insect bites with insecticides containing DEET (concentration of 30% for adults, and 3–6% for children over 3 years of age; not recommended for children under 3 years of age) and wear long sleeves and trousers when hiking in the woods.

Summary of Positive and Negative Effects of Beaver Activity

Positive Effects

- **Stabilization of wetlands and soil**
  - Increase in the surface and volume of water
  - Regulation of water flow downstream from the dam
  - Reduction in speed of water flow and soil erosion
  - Temporary retention of sediment upstream
  - Reduction of turbidity downstream
  - Maintenance of water table and decrease in peak flows caused by spring run-off

- **Increase in productivity**
  - Improved productivity of cold waters through increase in temperature
  - Increase in production of invertebrates in first few years
  - Increase in primary production upstream from the dam

- **Increase in biodiversity**
  - Improvement in habitats of many mammals, including moose, white-tailed deer, muskrat, otter, mink, wolf, coyote and black bear
  - Creation of habitats for waterfowl, many songbird species, amphibia and a variety of other species
  - Contribution to landscape diversity through changes in plant community succession

- **Enhancement of fish habitat and fish production**
  - Creation of resting and feeding areas, shelter, and winter habitats in shallow streamss
  - Increase in size of fish harvested in ponds

- **Economic spin-offs**
  - Greater hunting, fishing and trapping opportunities; increase in leasing revenues for these sports
  - Better potential for nature study, interpretation and enhancement

Negative Effects

- **Impact on human infrastructure**
  - Felled trees around holiday resorts
  - Washed out trails, roads and railway tracks
  - Blocked pipes, culverts and bridges and risk of serious damage from breached dams and freshets

- **Impact on riparian habitat and wetlands**
  - Flooding of woodlots and farmland
  - Temporary eradication of vegetation cover on pond shorelines
  - Potential decrease in available oxygen caused by decomposition
  - Contamination of some sources of drinking water with the *Giardia lamblia* parasite carried by beavers and transmissible to humans

- **Gradual destruction of fish habitats**
  - Hindrance to fish migration
  - Blocking or destruction of salmonid spawning grounds
  - Increase in temperature in slow-moving warmer water, which can be harmful to brook trout

- **Cost**
  - Cost of damage
  - Cost of management techniques

FORAMEC

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FORAMEC has developed special expertise in the management of land used by beaver.
The following services are offered:

- habitat and risk assessment,
- planning of interventions,
- monitoring of site developments.

Founded in 1985, the FORAMEC environmental consulting firm works in the fields of forestry, site development and ecology. Its professional and technical team comprises complementary fields such as biology, geography, geomatics...

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Animal ecology and wildlife habitats

Plant and wildlife rare species, endangered or designated at risk

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Geomatics and cartography

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5 MANAGING BEAVER POPULATIONS IN QUEBEC

5.1 MANAGEMENT PRINCIPLES

Basic management principle: beaver conservation and development.

Wildlife is a public good, and stewardship of this natural resource falls to government. As the custodian of this natural heritage, the *Société de la faune et des parcs du Québec* is responsible for the conservation and development of wildlife resources under the terms of the *Act respecting the conservation and development of wildlife*. The basic responsibility of government with respect to wildlife is to preserve and develop this renewable resource for the benefit of both present and future generations. This responsibility is framed by an overarching principle that guides management approaches: maintaining accessibility to wildlife and related activities. This is the principle underlying all hunting, fishing and trapping activities.

Wildlife management thus has two main purposes:

1. Conserving wildlife by creating and maintaining conditions in which wildlife can generally thrive and each species is plentiful enough to sustain the population.

2. Developing wildlife by educating the public about it, by making wildlife more accessible and by allowing as many people as possible to enjoy this resource and to derive dietary, recreational and economic benefits from it.

Accordingly, priority is given to conservation of wildlife populations. Hunting, fishing and trapping are managed on the basis of sustainable yields: only surpluses can be harvested.

5.2 MANAGEMENT ACTION

The management techniques discussed here are presently used in Quebec to manage the harvesting and monitoring of populations and for research purposes.

5.2.1 Management of harvesting

In this section, we look at management units, trapping areas, seasons, capture limits and permits in the context of commercial trapping. **None of these considerations applies to pest control operations.**

a) Furbearer management units

Each **trapper** must be licensed for a specific UGAF.

Quebec is divided into 86 management units; these units are specifically tailored to the management of fur-bearing animals and are known as UGAFs (***unités de gestion des animaux à fourrure***, or "furbearer management units"). The main purpose of this system is to ensure better local monitoring of commercial trapping and to expedite wildlife management decision-making. This new term replaces the former *zones de chasse, pêche et piégeage* ("hunting, fishing and trapping zones") and was

introduced within the framework of the trapping reforms instituted in the summer of 1999. Henceforth, a trapper must be licensed for a specific UGAF.

b) Trapping areas

Geographical distribution of trapping areas in Quebec:
a) Beaver reserves: 78%
b) Free zones: 12%
c) Controlled territories: 9%
d) No-trapping areas: 1%

Trapping is banned in parks, forest sites, ecological reserves and the other areas specified in the brochure entitled *Trapping in Quebec*, published by the Government of Quebec (2000b). These areas account for less than 1% of the territory of Quebec. Figure 4 illustrates where trapping restrictions apply in the rest of Quebec.

Beaver reserves

Almost all beaver reserves are on public lands where Aboriginal peoples have exclusive trapping rights. These reserves cover some 1 175 000 km^2, representing 78% of the territory of Quebec.

Free zones

Free zones are uncontrolled and include private lands and some public lands where a general resident trapping permit is the sole requirement. These areas cover about 175 000 km^2, representing 12% of the territory of Quebec.

Controlled territories

Controlled territories are public lands that have been divided into exclusive trapping territories and leased to trappers. This approach is used for wildlife reserves, ZECs and other public lands designated for trapping. These areas cover 135 000 km^2, representing 9% of Quebec territory.

c) Season

Beaver are trapped in **winter**, but season dates vary among UGAFs.

Trapping seasons preclude harvesting during the whelping season and promote the taking of pelts when their quality is at its peak. The timing and duration of seasons may vary. In Quebec, the beaver trapping season varies from one UGAF to another. It generally starts in October or November and ends no later than mid-March. This is the time of year when pelt quality is at its best, and it excludes the whelping season. See the Quebec government brochure entitled *Trapping in Quebec* (op. cit.) for the season in specific UGAFs.

d) Capture limits

There is no regulatory **capture limit** for beaver.

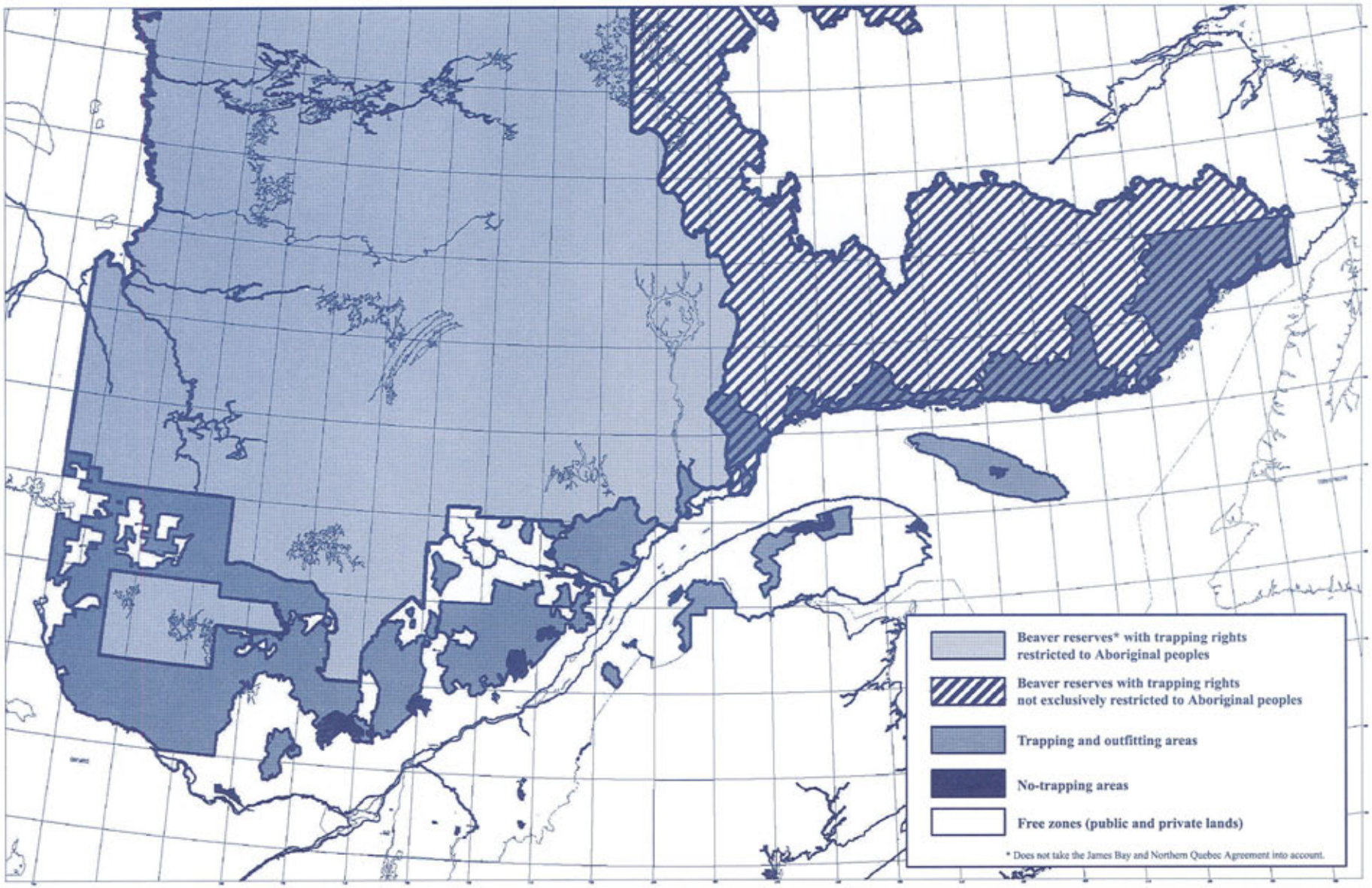
Quotas are set on the basis of the harvesting potential of a given territory. This management method may be applied as either a voluntary or a mandatory measure. At present, there is no binding regulatory capture limit on beaver in Quebec.

e) Permits

Trappers must hold a permit.

Quebec residents have the exclusive right to trap fur-bearing animals. However, non-residents holding a general non-resident permit may trap on land for which an outfitter has exclusive trapping rights or on their own land. Trapping permits (general, professional or assistant) are mandatory, and trappers must keep them in their possession at all times. To obtain a permit, Quebec residents must hold a valid trapping certificate, issued by the *Fédération des trappeurs gestionnaires du Québec* after successful completion of a course approved by the *Société de la faune et des parcs.*

Figure 4 Quebec Trapping Areas



Source: *Société de la faune et des parcs du Québec*

5.2.2 *Population monitoring*

Harvest tallying is the only beaver population monitoring mechanism currently in use in Quebec.

The main method for monitoring beaver populations in Quebec is harvest tallying, which is used to determine the size, evolution and source of the catch. The results obtained by this method, however, can be skewed by fluctuations in fur prices and by trapping pressure. Yield is the most effective measure for comparing administrative regions, since the harvest can be analyzed in terms of 100 km² units. Aerial population censuses can also be taken in the fall. An aerial inventory plan was implemented in Quebec from 1989 to 1994, but has since been discontinued. For other species deemed sensitive to exploitation, the annual compilation of data obtained through collaboration with trappers (percentage of young, sex, etc.) has proved to be a valuable tool for identifying management and harvesting problems. Two of these methods are the trapper's log and the carcass collection.

5.2.3 *Research*

Research targets the effects of logging on beaver habitat and the effectiveness of various management techniques.

Since beavers are not a vulnerable species in Quebec and their basic ecology is well documented, few studies has been done on them. Current research emphasizes two main themes: the impact of logging on beaver populations, and the effectiveness of various prevention and management measures. For example, as part of the management plan for riparian forest strips in the Montmorency Forest (Québec region), a study is underway to determine how cutting patterns can improve beaver habitat, thus stabilizing the beaver population while allowing logging to continue. For several years, organizations such as Ducks Unlimited, La Mauricie National Park and the Lower St. Lawrence Model Forest have been testing the effectiveness of various management and prevention techniques. Protected areas (e.g. national parks) may serve as long-term control areas for monitoring trends in unharvested populations and in habitats free of large-scale human interference.

To find out more:

Brunelle *et al.* 1989, 1995, Brunelle and Ouzilleau 1991, Courtois and Potvin 1994, Potvin and Breton 1997, Gouvernement du Québec 2000b, McNicol and Lafond 2000.

6 MANAGEMENT APPROACHES

A territory-wide **action plan** is the **ideal approach.**

Although prevention and monitoring concepts are increasingly recognized and applied, **most problems arising from beaver activity are still dealt with on an *ad hoc* basis. This reactive approach** means that managers (or landowners) only move when a problem looms. Damage has often already been done by the time action is first taken, and prevention, when finally addressed, is an afterthought. Management is thus done on an isolated, case-by-case basis, and the range of analysis is limited to the problem under consideration. In this context, the procedure outlined in 6.1 should be applied.

A comprehensive regional vision is needed to prevent potential damage, improve the safety of infrastructure and property, and substantially reduce overall management and maintenance costs. The success of this endeavor implies **a proactive approach aimed at developing a sustainable action plan**. By means of a comprehensive beaver habitat management and monitoring strategy, a variety of problems can be handled simultaneously. **This approach calls for joint action among many users.** In this context, development of beaver ponds is favoured, wherever possible. **Overall cost reductions can be made** by reducing the number of beaver-related incidents, focusing energy where it is most needed and taking more effective action (co-ordination, expertise, shorter response times, more appropriate methods, etc.). The actual fieldwork is still done on a case-by-case basis, but the concepts and plans characteristic of the reactive approach are integrated into a proactive approach.

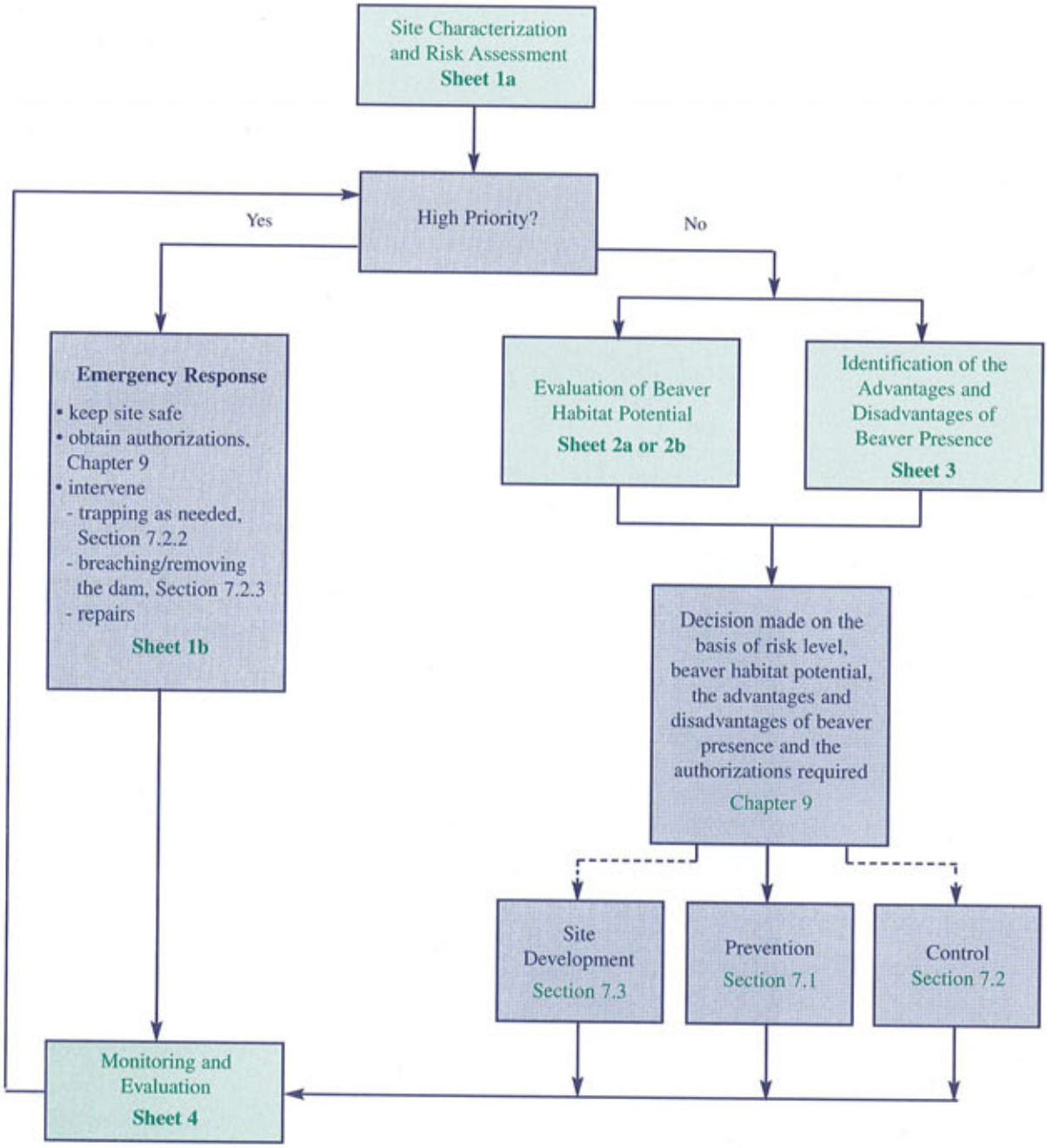
6.1 REACTIVE APPROACH

Figure 5 presents the decision-making process and identifies the types of measures (emergency, preventive, development and control) taken in risk management. The left-hand loop highlights emergency action to be taken in high-priority cases and thus by-passes the other steps in the process. The right-hand loop illustrates the full range of steps to be taken when a problem does not have to be addressed immediately.

This process provides the conceptual framework within which the chief decision-maker operates. Used separately, it does not enable the identification of specific actions to solve particular problems. Given the idiosyncrasies of each site, **decisions must be made on a case-by-case basis**, even if this process requires prior knowledge of the basic concepts outlined in this guide (ecology, legislation, management techniques, etc.).

The six sheets presented in Appendix 1 identify the essential data that should be taken into careful consideration in the decision-making process. Decision-makers can then identify the appropriate types of measures and management actions, given the short and long-term risks, the beaver habitat potential, the advantages and disadvantages of beaver presence and the required authorizations. **The essential character of the preventive measures is highlighted** (solid lines) in contrast to the non-exclusive nature of the other two types of measures (broken lines).

Figure 5 Procedure to Be Followed in a Reactive Approach



6.1.1 *Site characterization and risk assessment*

Starting point: characterize the site and assess the risks. **Sheet 1a**

The decision-making process begins with the definition of the problems caused by beavers. This step involves the characterization of the site and of the infrastructure built by beavers and the identification of any damage. The primary objective is to assess risk levels so that situations can be prioritized (**Sheet 1a**).

6.1.2 *Emergency response*

Act immediately in **emergencies**. **Sheet 1b**

In case of emergency (priority code 1), sites have to be safeguarded, appropriate emergency response and relevant actors identified, priorities established and the necessary authorizations obtained. **Sheet 1b** details emergency response procedures.

6.1.3 *Evaluation of beaver habitat potential*

Assess beaver habitat potential. **Sheet 2**

To prevent potential problems arising from beaver activity or to assess the need for a trapping program, it is important to determine how attractive a given area is to a species. Two procedures for evaluating habitat potential are outlined in Appendix 1. **Sheet 2a** enables the qualitative evaluation of habitat potential in terms of the main variables, i.e. the stream gradient, the quality of the winter food supply and the stability of water-levels. **Sheet 2b** can be used for the quantitative evaluation of habitat potential and is based on two models, the first developed by the Lower St. Lawrence Model Forest and the *Université de Québec à Rimouski*, and the second by Allen (1983) in the United States. The decision as to which sheet to use depends on the information available, knowledge of the concepts and tools presented in this document, and the time available to obtain the required information.

6.1.4 *Identifying the advantages and disadvantages of beaver presence*

Identify the **advantages and disadvantages** of beaver presence. **Sheet 3**

Alhough beavers are often considered a nuisance, they may also have beneficial effects on the environment. **The positive impact of beavers is significant and must be taken into account in integrated resource management.** As far as possible, ways should be found to profit from their presence while limiting the damage they may cause. Evaluations such as these are made on the basis of management objectives and policies specific to each territory (park, reserve, municipality, etc.). Accordingly, **Sheet 3** presents the advantages and disadvantages of beavers and is designed to facilitate the decision-making process.

6.1.5 *Monitoring and evaluation*

Monitor to assess the state of a site after measures have been taken. **Sheet 4**

Each measure is monitored and evaluated (**Sheet 4**) to reassess risk levels, track changes and validate its usefulness and effectiveness. Over the long term, the entire process is reviewed in the light of new data.

6.2 *PROACTIVE APPROACH: TERRITORY-WIDE ACTION PLAN*

6.2.1 *Territorial boundaries and scale of work*

The territorial boundaries targeted for an action plan vary according to factors such as the users' sense of attachment to the land (outfitting operations, ZECs, woodlots, trapping areas, etc.) and the portion of the territory in which beaver activity may be problematic. Boundaries should be defined in consultation

Establish the **territorial boundaries** and the **scale of the work.**

with the main users of the land. **The watershed (or sub-watershed) is the scale** suggested for assessing the advantages and disadvantages of beaver activity, for rating risks and for elaborating management, development and monitoring strategies. A watershed includes the entire catchment area of a watercourse.

6.2.2 Procedure for developing an action plan

The following is the suggested procedure for developing an action plan. Depending on how much information is known about the territory and on the role or mandate of the organization, the action plan may be developed differently or the steps may be in a different order.

1 Delimit the area to be inventoried:

- Depending on the identified priorities, delimit one or several sectors in accordance with main or sub-watershed boundaries.

Assess the risk associated with each site. Intervene as appropriate. **Sheets 1a and 1b**

2 Make a cursory inventory of the territory:

- Using information gleaned from managers, consultants, forestry technicians, MRCs, trappers, aerial photographs or maps (1:20 000), locate beaver ponds.
- Locate sectors where there is a potential for conflict with beavers in the near future.
- Assess the risk for each site where there is potential for conflict in the near future (**Sheet 1a**):
  - For #1 priorities (emergency), take the "reactive approach" (left-hand loop in Figure 5; **Sheet 1b**) and introduce preventive (Section 7.1) or control (7.2) systems;
  - For #2 or #3 priorities, only monitoring is required in the short term, as the site will be reassessed once an exhaustive inventory has been made (**Sheet 4**).
- Find out whether there are any active trappers in the territory or any agreements between landowners (or managers) and trappers.

3 Make an exhaustive inventory of the territory:

Assess the beaver habitat potential territory-wide. **Sheet 2a or 2b**

- Assess the beaver habitat potential of the sector or territory. The HSI (Habitat Suitability Index) software developed by the Lower St. Lawrence Model Forest and the *Université de Québec à Rimouski* as well as **sheets 2a and 2b** can be used.
- Using aerial photographs, forestry or forest ecology maps, topographical maps, aerial surveys or field inspections, determine the local topography and features: infrastructure, roads, land ownership, spawning grounds, access, bodies of water suited to beaver activity, etc.
- Characterize sites passed over in cursory inventories and assess the risk level of sites where potential for conflict exists (**Sheet 1a**).
- Rate the development potential by identifying the advantages and disadvantages and determining the vocation of each sector or stretch of river (**Sheet 3**).
- Transfer relevant data from this inventory to a map covering the area in question and ideally including one or more whole watershed or sub-watersheds.

4 Develop a management, development and monitoring strategy for the whole territory:

A territory-wide management strategy.

- Define the various types of riparian habitats in relation to the specific objectives and zone the watershed(s) or sub-watershed(s) based on the needs of wildlife and users:
  - For example, some streams or stretches of streams may serve as brook trout spawning beds and should be left intact, whereas in other cases the priority can be placed on improving habitat in order to stabilize beaver populations. In sectors that serve as reservoirs for community drinking water, beavers should be controlled in order to protect water quality.
- Specify the measures required and set priorities for their implementation.
- In concert with all users, finalize the strategy for the territory-wide action plan:
  - For example, develop a controlled trapping network based on agreements between landowners (or managers) and trappers; sign shoreline management agreements with logging companies and governmental agencies.
- Set up a training and public awareness program, especially for those most directly concerned.
- Implement the action plan. Fill out a sheet for each measure taken (**Sheet 1b**).

5 Monitor the action plan:

Monitoring the action plan also means monitoring each measure taken. **Sheet 4**

- Periodically assess all sectors that require field inspections, ideally once in the spring and once in the fall (**Sheet 4**).
- Review agreements each year and adjust them as needed.
- Keep a record of performed or planned tasks, of eliminated or potential risks, of the number of beaver colonies, of the number of high-risk sites, etc.

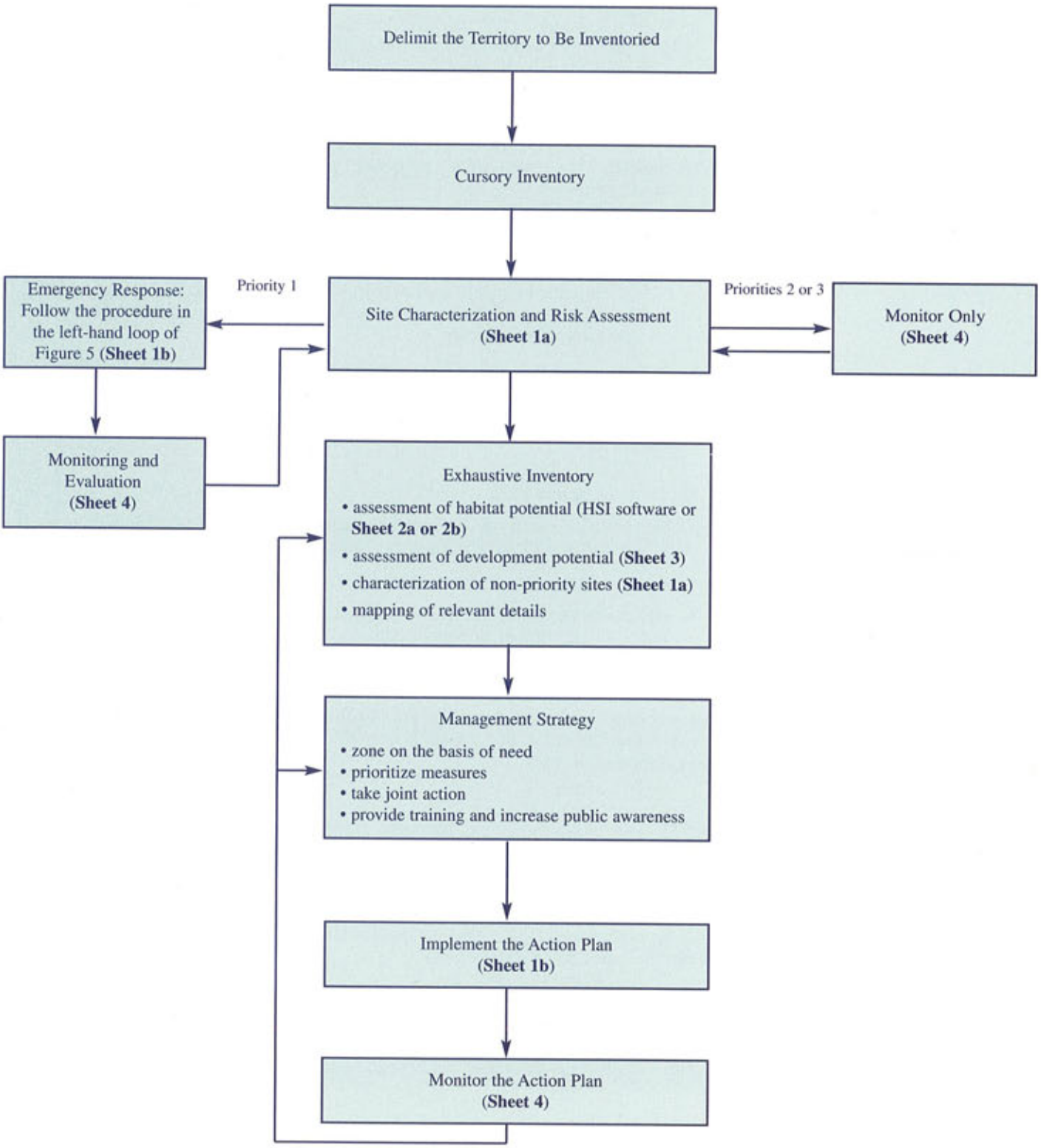
Figure 6 summarizes the procedure for developing a territory-wide action plan. Those unfamiliar with HSI or with how to develop action plans should consult specialists in this field.

NOTE: HSI models cannot precisely predict the carrying capacity of an environment because they simplify the interactions among the parameters defining a species' habitat. They are often developed for specific regions and do not necessarily apply to the whole range of the species. Moreover, they ignore land use planning works that may enhance habitat potential, such as those located along roads. This geomatics software can be obtained from the Lower St. Lawrence Model Forest.

To find out more:

Bhat *et al.* 1993, Ricard 1997, Snodgrass 1997, Larocque *et al.* 2000.

Figure 6 Procedure for Developing a Territory-wide Action Plan



7 MANAGEMENT TECHNIQUES

Management techniques can focus on methods to prevent or control local beaver damage. They can also be aimed at developing beaver ponds as a way of promoting biodiversity. **However, there is no perfect system suited to all cases. The best approach is generally to adapt established techniques to each situation.** The decision as to which technique to use should also take factors such as the urgency of the situation, the accessibility of the site, the availability of materials and labour, the high water mark and water-level fluctuations into account. Table 3 (page 57) summarizes the various management techniques.

7.1 PREVENTION

Prevention remains the best way to avoid costly emergencies.

The adverse effects of beavers often stem from faulty land use management. When planning and building infrastructure (roads, railway lines, docks, etc.), the potential of the selected site to become a beaver habitat should be assessed before work begins in order to avoid having to correct the situation later. Prevention is the best way to avoid emergencies and costly solutions. **Various factors should therefore be taken into consideration before a site is selected: beaver habitat potential, local beaver presence, size of the watershed, etc.** This approach will not eliminate all problems, but it will significantly reduce their incidence.

7.1.1 Infrastructure planning

When planning linear infrastructure (roads, railways, power lines), routes that cross the fewest permanent or temporary watercourses and stay furthest from bodies of water or depressions are preferable. This simple measure will prevent many conflicts with beavers, especially in areas where ecological integrity needs to be preserved.

Culverts on gently sloping (1% to 10%), relatively wet land close to hardwood stands are **ideal sites** for beavers.

In some cases, however, linear infrastructure may have to be built across a watercourse. Culverts on gently sloping land (1% to 10%), which is relatively wet and close to hardwood stands, are ideal sites for beaver. It then becomes important **to ensure that construction standards for the planned works are adhered to and that culvert dimensions are adequate to cope with the flow generated by the drainage of the watershed.**

Several agencies recommend pre-damming as an effective measure to be applied systematically wherever new infrastructure crosses a watercourse. Unfortunately, this precaution is often dropped as a way of cutting construction costs, yet it has a direct bearing on subsequent maintenance costs.

7.1.2 Riparian forest strip management and protection

Alhough they can adapt to shrubs such as willow and alder, beavers prefer shade-intolerant hardwoods, particularly trembling aspen and paper birch, for both food and construction material. When colonies abandon a territory, it often takes a number of years for vegetation to grow back sufficiently to attract the species again.

Protective bands of softwood left standing along watercourses discourage beaver.

Territory with a poor food supply, in terms of either quality or quantity, will have little appeal for beaver. Protective bands of conifers left standing after logging along riverbanks are effective in limiting the germination and growth of tree species sought by the animal. However, the clearing of corridors for infrastructure construction (roads, railways, power lines) opens spaces suitable to such colonizing species as paper birch and poplar.

To dissuade beavers from settling in a protected area, all hardwoods within 50 m of the banks of a stream should be felled and the cleared ground replanted with conifers such as spruce, cedar, balsam fir and pines. On public lands, however, forestry practice standards must be met.

7.1.3 Remedial and preventive work

Relocating a stretch of trail may be the most economical solution.

It is sometimes easier to relocate facilities such as trails or docks than to battle the beaver head to head. In the medium term, this may be a more economical solution than installing water-level control devices requiring regular maintenance.

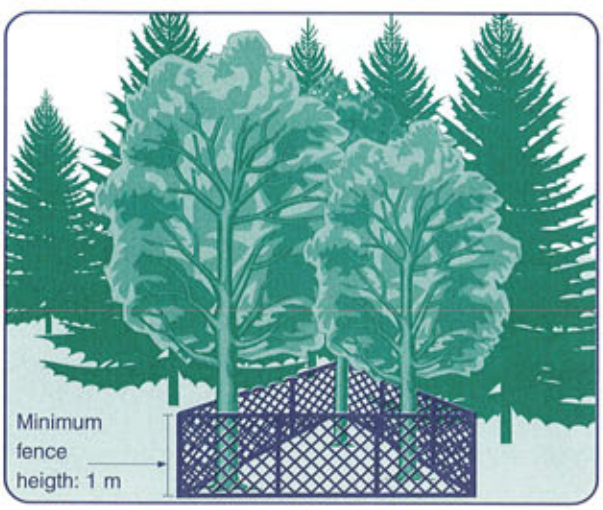
A section of hiking, ski or other trail can usually be quite easily relocated away from the floodplain at little cost, and in some cases the presence of a beaver colony may be an added attraction for hikers.

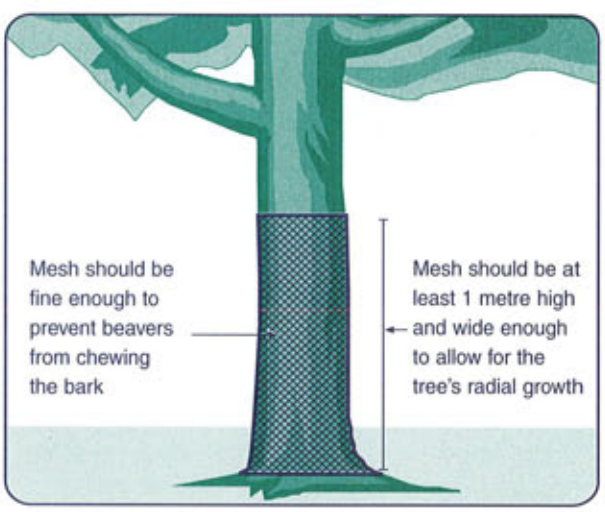
Docks should be built to include a system allowing for adjustment to changing water-levels. Several such systems are available for purchase or can serve as models for low-cost makeshift solutions. Outright removal of the dock is an alternative if no other solution works.

Replacement of culverts with wider ones may also be a viable solution. Beavers seem less likely to block wide culverts (1.25 m or more). In some cases, pre-damming and higher road surfaces should be tried to prevent conflicts.

Protect hardwoods with **fine wire mesh** (1 cm x 1 cm) to a height of at least 1 m.

In populated areas, hardwood trees can be protected from beaver incisors with fine metal mesh (1 cm x 1 cm) placed either directly on the trunk or around it like a fence. In either case, the mesh should extend at least one metre above the ground and even higher if snow is likely to accumulate. **If the mesh is placed directly on the trunk, it will have to be enlarged regularly to accommodate the tree's radial growth.** Although effective, this method is aesthetically unappealing and may be costly, especially if many trees need protection.





Besides remedial work, **various techniques are used to prevent beavers from building dams too close to existing infrastructure.** The following pages present five preventive management techniques that have been used and tested in Quebec. The first four are designed specifically for keeping culverts open, whereas the fifth is intended to protect roadside drainage ditches.

The choice of technique depends on a range of factors, such as the presence of spawning grounds upstream, site accessibility, availability of materials, budget allocations, availability of manpower to monitor and maintain the system, etc. **In many cases, the installation of a system may require prior authorization. See Chapter 9.**

Symbols Used in the Management Techniques

	Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
Low		$				
Moderate		$ $				
High		$ $ $				

Management Technique No. 1

PRE-DAMMING

Description

Beavers usually build their dams at the narrowest point of the stream, hence the attraction of culvert entrances. Pre-damming (also known as dam starting) is permanent work carried out upstream of a culvert. It prompts the beaver to build its dam where it will not be a nuisance. This is a proven method of preventing the flooding of roads or railways, if it is done correctly.

Before pre-damming, the area at risk for flooding, in the event that a beaver decides to build a dam, must be evaluated to prevent washouts and to avoid disputes with adjoining landowners. In some cases, agreements may have to be made with owners of land located upstream from a culvert, or additional land may have to be acquired.

Positioning

As a rule, pre-damming should be carried out where the ecological characteristics are favourable to beaver. Analysis of recent aerial photographs and field visits will enable the identification of watercourses where this type of work should be carried out. Trappers may also be a good source of information on the habits of beavers in the area.

Design

Pre-damming can be carried out using earth fill with rip-rap, a few large boulders, or a simple chain link fence. The management technique chosen depends on local conditions (availability of materials, type of soil, topography, etc.). For more information, consult management techniques 1A and 1B.

Maintenance and Remarks

Although efficient, pre-damming does not lend itself to all situations (topography, inaccessibility, materials, etc.). **Pre-damming must not be carried out under the following conditions:**

- a spawning site could be affected by the device;
- the ground around the culvert is unstable;
- the denivellation downstream from the culvert is too steep; building a dam upstream may create overloading and cause the road or railway to collapse;
- the groundwater could be contaminated.

The device must be inspected annually to ensure its effectiveness. Pre-damming has been done in many Quebec parks and wildlife reserves (Portneuf, Duchesnay, Papineau-Labelle, Gatineau, Forillon, etc.).

Advantages

- Permanent solution
- Efficiency of the culvert is maintained
- During floods, water can flow freely between the dam and the culvert
- Promotes a more stable water level
- Maintains beaver habitat and enables habitat management

Disadvantages

- May be costly
- Requires occasional inspection
- Requires the permission of owners of land located upstream, and may involve the purchase of supplementary land
- Plans and specifications may have to be approved by the *ministère de l'Environnement*

Management Technique No. 1A

PRE-DAMMING WITH RIP-RAP

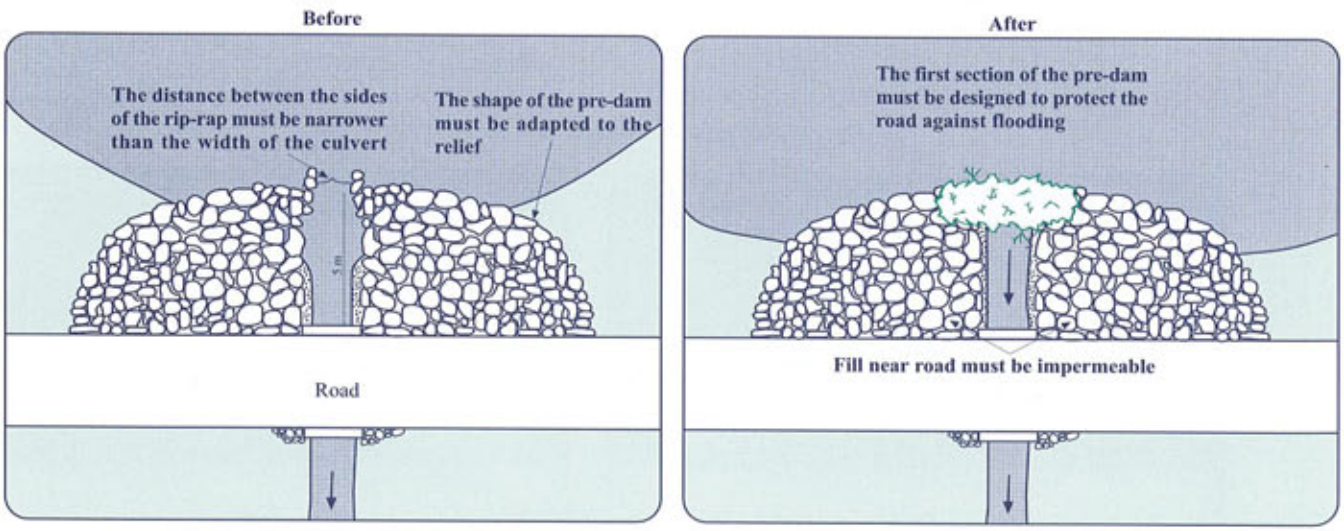
Installation

Using heavy machinery, pile rip-rap material (large stones, rocks, gravel) on each side of the upstream end of the culvert in such a way as to effectively protect the road foundations. Coarse material must be used to prevent erosion of the fill and washing of the finer components downstream. However, fill material near the road must be impermeable to avoid water infiltration. The passage should not be too wide nor the rip-raps V-shaped, otherwise beavers will be attracted to the culvert entrance. So the space between the rip-raps must be slightly narrower than the entrance to the culvert.

The pond should be quite shallow (about 10 cm) at the centre of the pre-damming site where the beaver will build its dam, because if the beaver does not have a platform on which to build, it will block the culvert entrance. To entice the beaver to build a dam in the middle of the pre-dam area, some sticks and stones may have to be placed on the site to simulate the beginning of a dam. The distance between the culvert and the dam depends on the site layout, the availability of materials, machinery, etc. A distance of 5 m is generally considered sufficient. Some sections of the road may have to be raised to improve the performance of the device.

Remarks

Plans and specifications may be necessary for pre-damming with rip-rap. Costs associated with pre-damming vary from one site to another and depend on factors such as the availability of materials and the cost of machinery. For instance, pre-damming carried out during road construction will be much cheaper than retrofitting. **However, pre-damming carried out as a preventative measure is usually cheaper than repair work that must be done due to flooding after a beaver has blocked a culvert.**



Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$ to $ $ $			☆☆☆	

Management Technique No. 1B

OTHER TYPES OF PRE-DAMMING

Installation

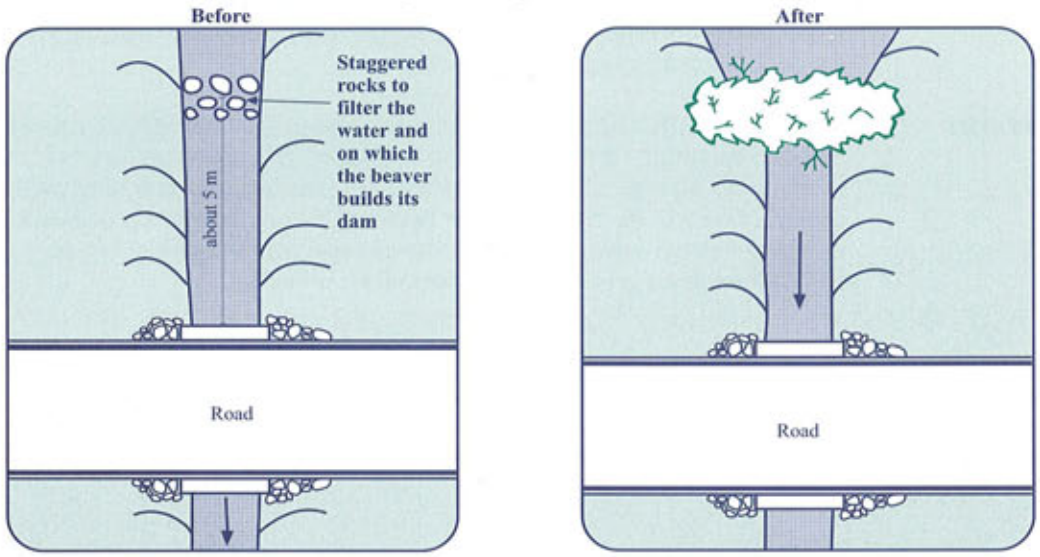
Pre-damming may be carried out upstream from a culvert by placing large rocks in a staggered fashion or by using a chain link fence in places where the road is not in danger of being affected by rising water levels.

To persuade the beaver to build its dam in the desired location, place some stones in the area, or erect a fence that the beaver cannot circumnavigate, so as to provide a support point for the dam. It is important that the stream be quite shallow (about 10 cm) upstream of the pre-damming, or the beaver will block the entrance to the culvert even if the rest of the pre-damming is carried out properly. Some sticks can be added to simulate the beginning of a dam. **The distance between the culvert and the pre-damming depends on the site layout; a distance of approximately 5 m is recommended.**

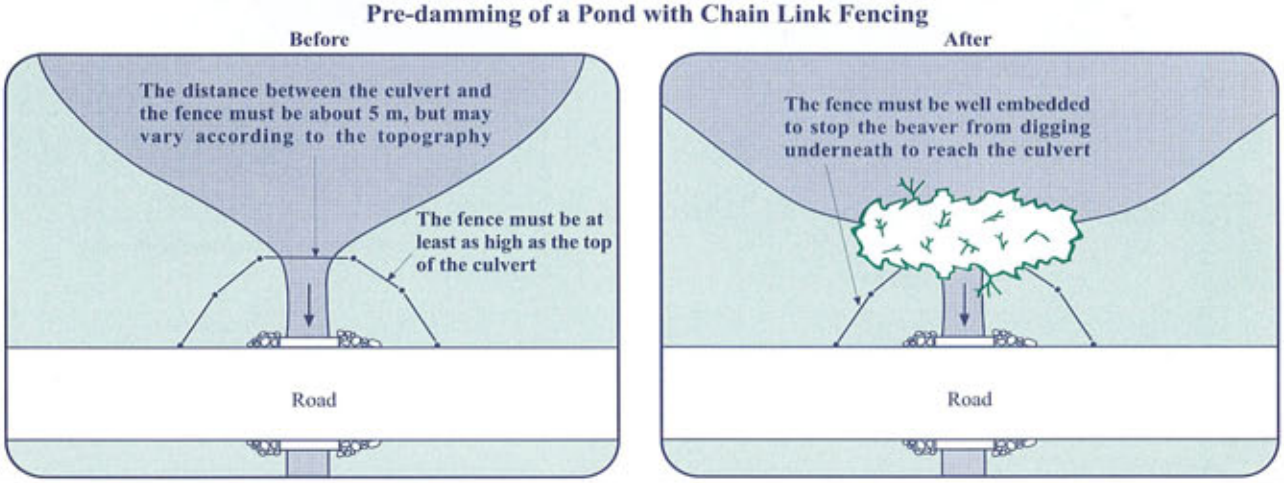
Remarks

The installation of a chain link fence requires thorough knowledge of the beaver's habitat and behaviour.

Pre-damming of a Steep-sided Watercourse



Pre-damming of a Pond with Chain Link Fencing



Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$ to $ $			☆☆☆	

Management Technique No. 2

WIRE MESH BAFFLE

Description

A rigid wire mesh (6 or 7 gauge) may be used to prevent beavers from entering the culvert and blocking it. This type of wire mesh is common in construction work and is used as light reinforcement for concrete. It is thus cheap and readily available. A mesh of at least 10 to 15 cm must be used to avoid any risk of obstruction and to allow the free passage of fish.

Installation

Install two sections of wire mesh at the mouth of a culvert, at right angles to one another. The horizontal section keeps the beaver from going under the mesh. Two metal stakes may be used to fix the mesh in position.

Maintenance and Remarks

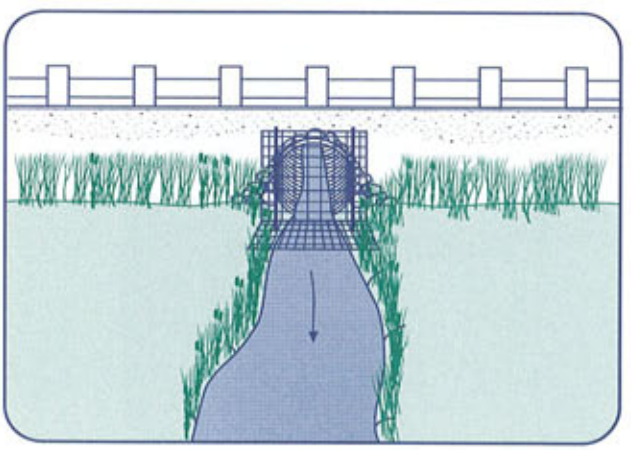
If mesh is placed on the upstream side of a culvert, the risk of it becoming clogged with debris transported by the current is quite high unless regular maintenance is carried out. Beavers may also use the mesh as a support for their dam. **Wire mesh is thus only recommended for use on the downstream side of culverts, another method is proposed for the upstream side (see Management Technique No. 4).**

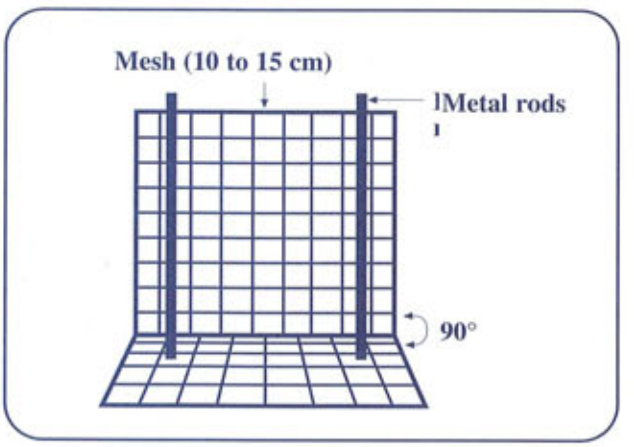
Advantages

- Inexpensive to build
- Easy to install
- Works well if maintained regularly

Disadvantages

- High risk of blockage on the upstream side
- Requires regular maintenance
- May reduce the flow of water
- May impede the movement of fish





Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$			☆☆	

Management Technique No. 3

METAL STAKES

Description This device is the simplest and cheapest of all, and simply involves pushing metal rods approximately 2.5 cm in diameter into the stream bed above the culvert. The number of rods required to ensure that the installation works properly will vary depending on the size of the culvert.

Installation Drive at least three rods, 10 to 15 cm apart, directly upstream from the culvert so as to form a protective screen. The rods may be placed vertically or at an angle. They should be at least 1.2 m long so as to be easily held and adjusted depending on the depth of the water and the amount of mud in the stream.

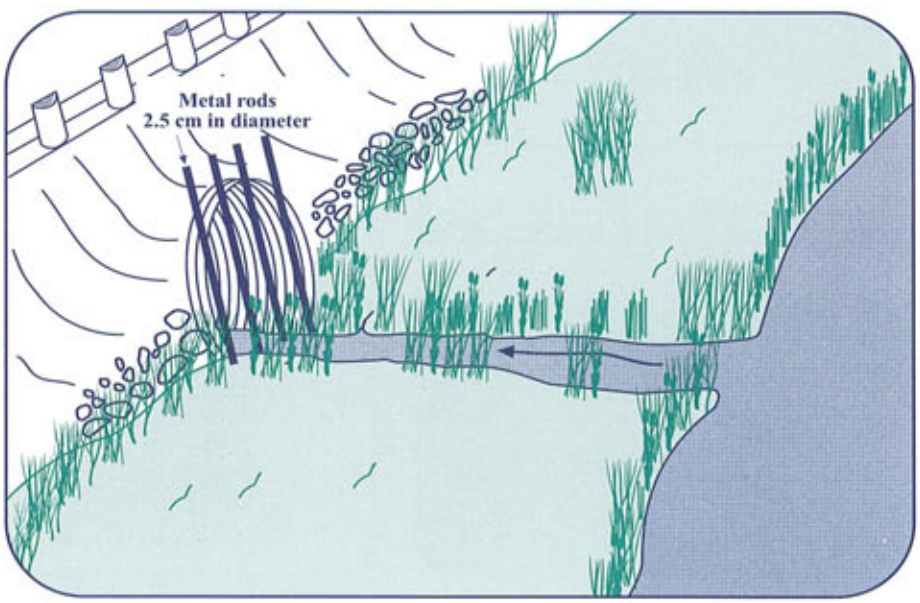
Maintenance and Remarks **This method requires constant monitoring** because the beaver will use the rods to anchor its dam. If this occurs, remove the rods and let the current wash away the partially completed dam.

Advantages

- Inexpensive
- Material readily available
- Easy to transport and install
- Does not block the flow of water
- Efficient

Disadvantages

- Requires constant supervision to ensure efficient operation
- The stream bed must be soft to allow the rods to be pushed into place.
- If an appreciable quantity of debris accumulates, spawning grounds downstream may be filled in.



Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$			☆☆	

Management Technique No. 4

CULVERT PROTECTION SYSTEM

Description

This is a long, cylindrical device made up of a 6 or 7-gauge, 10 to 15 cm wire mesh. The upstream end is closed with a similar wire mesh cut in a circle. For maximum effectiveness, the cylinder must have a diameter of at least 120 cm, even if the diameter of the culvert is smaller. The downstream end of the cylinder should be adjusted to form a joint between the cylinder and the culvert. Such devices can be purchased ready-made.

Installation

This device may be installed on the upstream side of a culvert or directly through a beaver dam. In the latter case, place mesh over both ends of the cylinder. Ideally, the cylinder is made up of four 1.5 m long sections, for a total length of 6 m. The sections are joined together and anchored in place by T-section metal rods. To improve effectiveness, two agricultural drains 15 cm in diameter may be laid inside, along the base of the cylinder. The downstream end of the culvert must be protected by a wire mesh baffle, as described in Management Technique No. 2. The ends of the rods should be painted so that snowmobilers do not hit them in winter.

Maintenance and Remarks

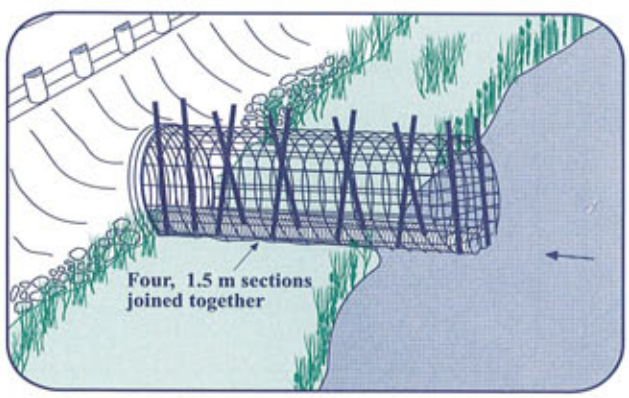
Two visits per year, in the spring and the fall, are generally sufficient to check the installation. **This system must never be installed on a culvert that drains a stream with very high banks. In sudden heavy rain, the risk of blockage is very high, and the resulting flooding could cause serious damage.**

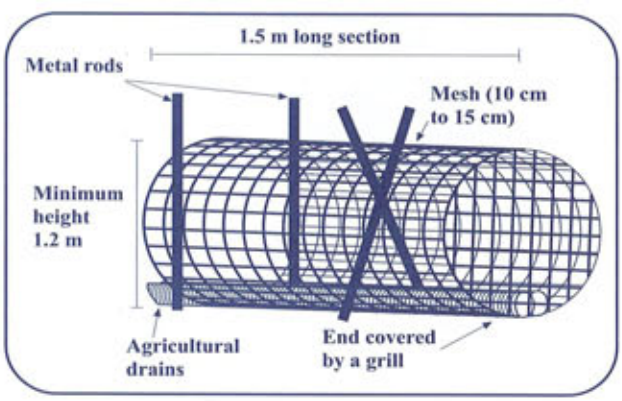
Advantages

- Minimal maintenance required, two visits per year
- Very effective
- Allows free passage of most fish species
- Versatile
- Durable

Disadvantages

- This system must not be used in narrow streams with high banks where sudden floods could damage infrastructure (roads and railways)
- In periods of low water, the drains may hamper the free passage of fish





Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$ $			☆☆☆	

Management Technique No. 5

FRENCH DRAINS

Description

This technique is used to prevent beaver dams from blocking ditches along the side of a road. One or two agricultural drains are laid along the bed of the ditch and covered with coarsely graded stone. Water percolates through the stone bed, flows into the drains and away from the protected area. The beavers cannot prevent the water, which would otherwise have accumulated behind their dam, from draining through the stone bed.

Installation

Begin by grading the bottom of the ditch, then lay one or two agricultural drains over the full length. Cover the drains with coarse stone or rocks (3 cm or larger). The regular "crusher run" type of stone (0 - ¾") cannot be used for this work as the finer material would block the holes in the agricultural drain. Preferably, use drains that are covered by a geo-textile sheathing or lay a layer of geo-textile material over the drains to prevent the pipes from becoming blocked.

Maintenance and Remarks

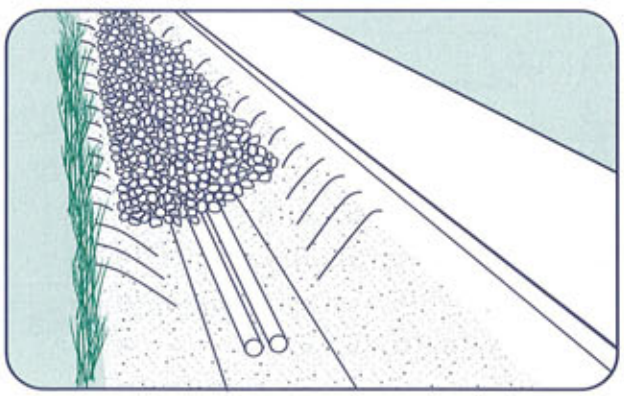
No special maintenance is required once the work has been completed. This method requires some technical and financial resources that are not always readily available. It should only be used in areas where recurrent problems have occurred and in habitats free of fish.

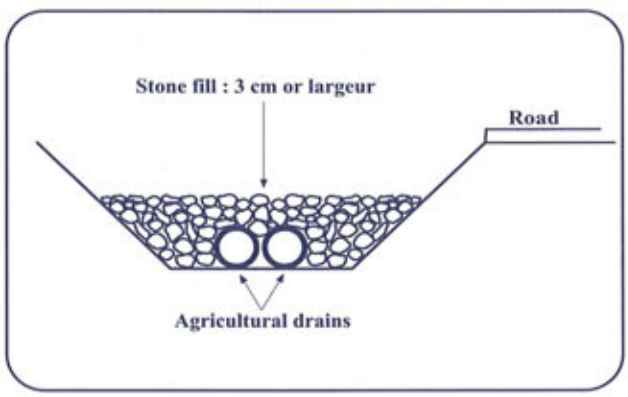
Advantages

- The only technique that protects roadside ditches
- Material readily available
- No maintenance
- Durable
- Very effective

Disadvantages

- Costly, labour-intensive or requires heavy machinery
- May require large quantities of stone, depending on the length of the ditch to be protected





Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
to	$$ to $$$			☆☆☆	

7.2 CONTROL METHODS

There **are no** infallible control methods.

Whether the aim is to keep beavers in the area while limiting the damage they may cause, or to prevent them from establishing themselves, no infallible control method exists. Indeed, some beavers show great tenacity and patience in outsmarting control methods.

Up to now, no single control method has been able to cover every eventuality; **every situation has to be treated on a case-by-case basis.** A combination of several control methods may increase the effectiveness of measures aimed at preventing the harmful effects of beavers.

7.2.1 Water-level control devices

Water-level control devices allow a beaver dam to be **saved** while limiting the damage caused by flooding, but they may impede the passage of fish.

Water-level control devices in beaver ponds may play an important role in a beaver management program for a particular sector. This type of installation eliminates or at least controls damage caused by flooding and preserves the environmental diversity of the sector, but may interfere with the passage of fish.

These devices conserve beaver dams and maintain their productivity while controlling the water-level. However, care must be taken not to lower the water-level so far that the beavers cannot survive the winter. In some cases, beavers may decide to abandon their pond after control devices have been installed.

Three important points must be considered when deciding whether to use a water-level control device:

1. The depth of the water and the structure of the site must allow the device to be properly installed.
2. The normal flow of water must not exceed the capacity of the device.
3. The water-level may be higher for short periods of time (spring run-off, heavy rainfall).

The water-level control devices shown on the following pages have all been used and tested in Quebec. They are the most effective and least costly; they can be made by any competent person using materials that are readily available. There is a whole range of devices on the market aimed at preventing damage caused by beavers, but costs can escalate prohibitively when an area containing many possible areas of conflict has to be managed.

Despite their differences, the devices detailed here are all based on the principle of communicating vessels; they allow the water-levels in the beaver ponds to be controlled by inserting one or more pipes through the beaver dam to act as an overflow and keep the water at the desired level. As the flow of water in the stream may vary, it is important to correctly size the pipes so as to quickly bring the water-levels back down to normal after a period of heavy rain.

Galvanized steel pipes are preferred because they are more economical and more durable.

The diameter of the pipe will depend on the volume of water to be drained off. The most frequently used diameters are 20 cm and 25 cm. If required, several pipes may be laid through the dam to better control the water-level. **The length of drainage pipe is determined by the characteristics of the site;** a 3 m long pipe may be sufficient, although a longer one is sometimes necessary. Galvanized steel pipes are preferred over plastic ones because they are cheaper, more durable and are available in a vast range of lengths and sizes. We highly recommend that the various components of the device be anchored using T-section metal stakes at least 1.2 m long, but concrete blocks may also be used in some cases.

The addition of a **flexible pipe** downstream lessens the sound of flowing water that could attract the beavers.

A breach must be made in the dam, either by hand or using an excavator, to install the pipe. This opening must normally be made at the spot where the water originally flowed. The beavers will eventually plug the breach and incorporate the pipe into their work. **Downstream, the pipe must extend one or two metres beyond the dam; the height of this end controls the water-level in the pond.** The addition of a flexible pipe on the downstream end, carrying the water further away from the dam, will lessen the sound of flowing water that could attract the beavers.

Do not use these water-level control devices to **drain normal run-off** from drainage areas measuring 10 km² or more.

The upstream end of the pipe must be kept totally, or at least partially, submerged, or else the sound of flowing water will show the beavers where the leak is and they will try their best to block it. The upstream end of the pipe must not touch the bottom of the pond, because its effectiveness will be reduced, and the beavers will succeed in blocking it more easily. A pipe of the correct length should be used rather than soldering two sections together, because soldered joints do not weather well.

Water-level control devices are especially effective when the flooded surface exceeds 4000 m² and the depth of the pond is at least 50 cm. However, these installations cannot cater to the normal run-off from drainage areas that exceed 10 km².

Each of the five water-control devices described on the following pages may be left in position throughout the winter, but ice in the drainage pipe may reduce the effectiveness of the installation. **They all require monitoring and regular maintenance. Some of these devices may be effective in some locations but useless in others;** there does not appear to be any consistent pattern in the effectiveness of the various devices. It is important to note that **the more vital the water-level is to the survival of the colony, the more ingenious and persevering the beavers will become in finding a solution to this new problem.**

Management Tehnique No. 6

MORENCY CUBE

Description A water-level control device consisting of a pipe inserted into a wire mesh cube.

Installation A steel pipe 5 to 10 m long is placed into a hole that has been made in the dam. The upstream end of the pipe is protected by a wire mesh cube at least 1.2 m in width. The cube is made from the type of mesh usually used to reinforce concrete, and the opening in the mesh should be at least 10 cm wide to avoid clogging with floating debris. The sides of the cube are held together with tire wire (wire used to tie concrete reinforcing bars together) to ensure the overall flexibility of the device. The pipe is inserted into the cube in such a way that the end of the pipe is in the middle of the cube. The pipe hole should be reinforced to prevent fraying. Both the pipe and the cube must be solidly held in place by metal stakes.

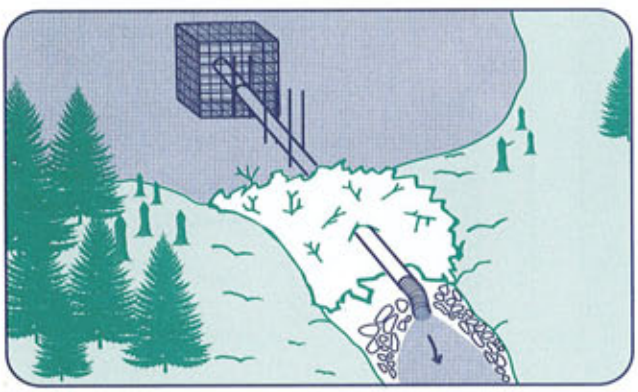
Maintenance and Remarks The height of the cube may be lowered to help camouflage it. This system generally requires maintenance in the spring and in the fall. It has been successfully used for many years in La Mauricie National Park (see the cover page photograph).

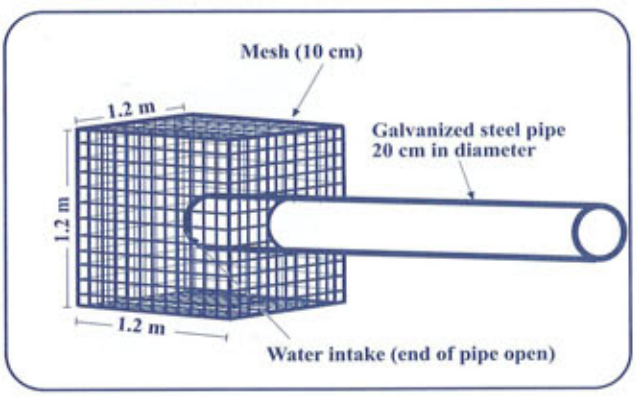
Advantages

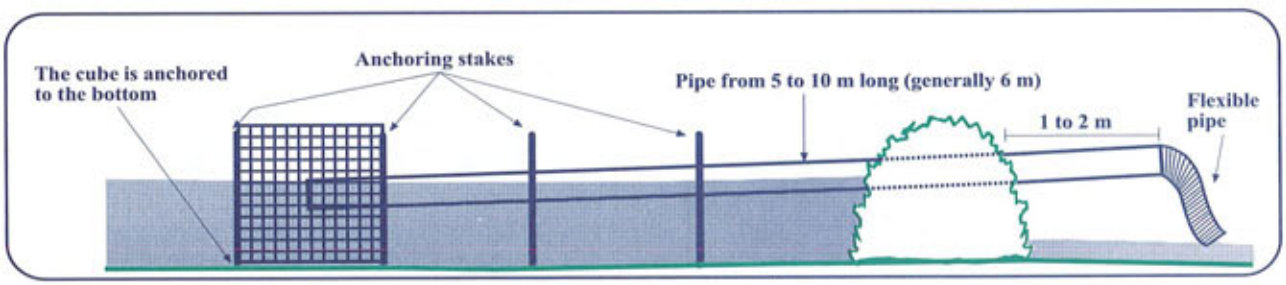
- Inexpensive, requires little material
- Material is readily available
- Easy to make, transport and install
- The wire mesh will rust and become almost invisible
- Very effective
- Two pipes may be installed to increase the flow

Disadvantages

- In some instances, the beavers manage to block up the device
- Impedes the passage of fish







Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$			☆☆☆	

Management Technique No. 7

ELBOW PIPE

Description Water-level control device consisting of an elbowed pipe inserted into a cylindrical wire cage.

Installation A steel pipe is installed in a hole in the dam and a 90° elbow is welded onto the upstream end of the pipe, which is then protected by a circular wire mesh cage at least 1.2 m in diameter and installed vertically. To avoid blockage, the water intake must not be placed too close to the stream bed. The cylindrical cage is made from the kind of wire mesh generally used to reinforce concrete. The mesh should be at least 10 cm wide to prevent matting with debris. The cylinder and the pipe must be firmly anchored with metal stakes.

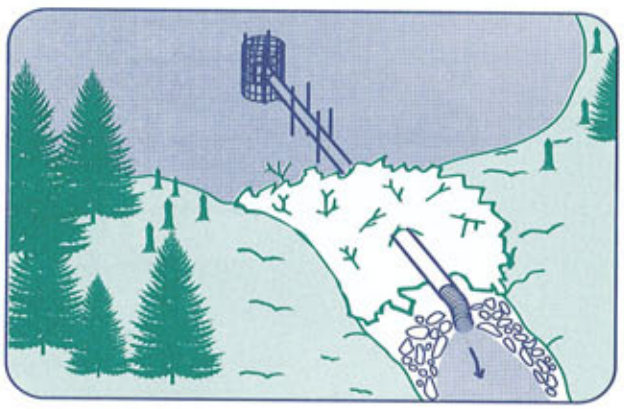
Maintenance and Remarks **To be effective, this device must be installed in water that is at least 2 m deep.** The weld that attaches the elbow to the pipe will generally not withstand the effects of the weather. Maintenance in spring and fall is recommended.

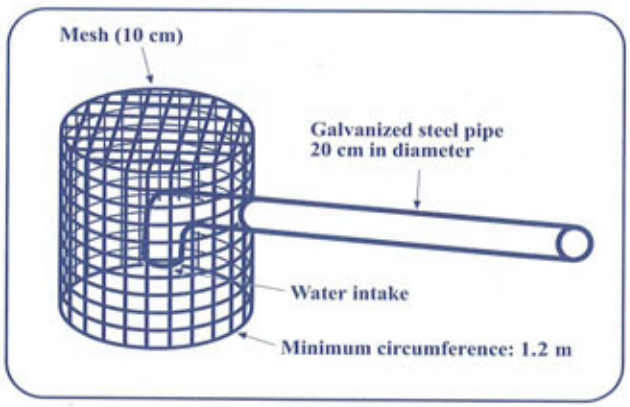
Advantages

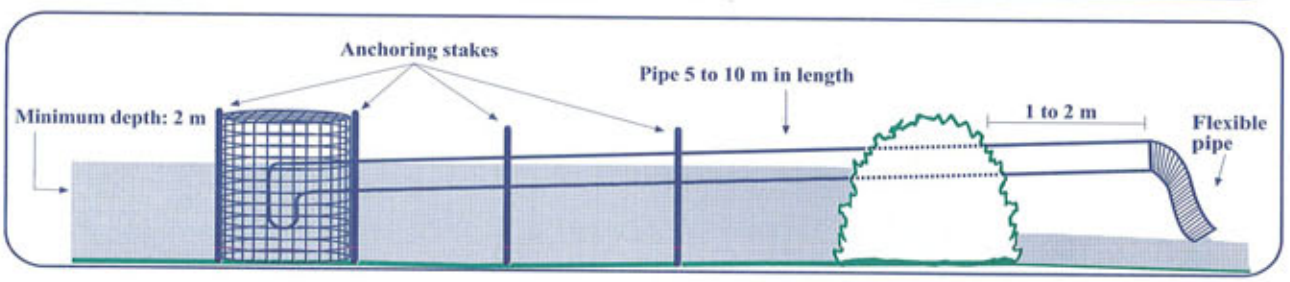
- Inexpensive
- Material readily available
- Easy to transport and install
- Two pipes may be placed side by side to increase the flow
- The wire mesh will rust and become almost invisible

Disadvantages

- In some instances, the beavers manage to block up the device
- The welds have to be repaired in the spring
- Water must be at least 2 m deep
- Impedes the passage of fish







Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$			☆☆	

Management Technique No 8

T-SHAPED PIPE

Description Water-level control device consisting of a T-shaped pipe.

Installation Two galvanized steel pipes are welded together in a "T" shape. The vertical section of the "T" is inserted through the dam. The crosspiece, which serves as a water intake, is at least 2 m long by approximately 7 cm in diameter and is perforated on the top and the bottom. Each end of the crosspiece is protected with wire mesh. The device must be firmly held in place with metal stakes

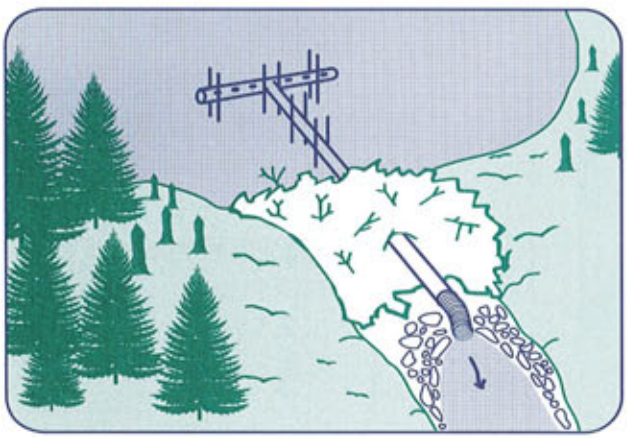
Maintenance and Remarks **This device can only drain a limited amount of water,** and usually only one pipe can be inserted into the dam. Regular maintenance (spring, summer and fall) must be scheduled.

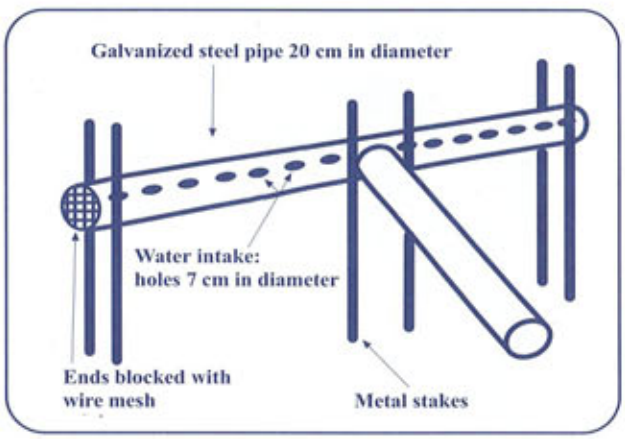
Advantages

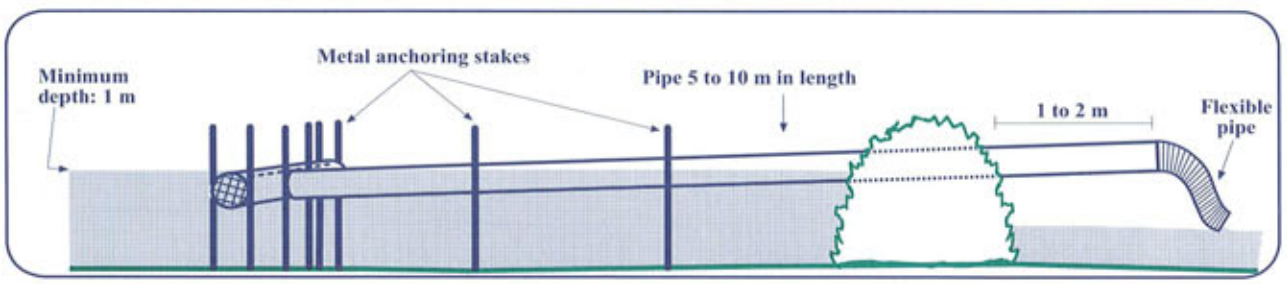
- Material is readily available
- Inexpensive
- Effective when installed in water at least 1 m deep

Disadvantages

- Difficult to transport
- Joints (welds) are easily damaged
- Intake holes are easily blocked by sediment from the stream
- Can easily be dislodged by ice
- Limited flow capacity
- Impedes the passage of fish







Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$				

Management Technique No. 9

MORENCY SPONGE

Description A water-level control device consisting of a pipe inserted into an intake section made up of agricultural drains.

Installation A galvanized steel pipe at least 20 cm in diameter is inserted through the dam and agricultural drains (10 cm in diameter and 1.5 m in length) are wrapped around the first metre of the upstream section. The drains are fastened parallel to the pipe and wrapped in wire mesh to act as an intake filter. The ends of this "filter" are covered with 10 cm wire mesh and a solid cover is placed over the upstream extremity. The whole device is held in place by metal stakes.

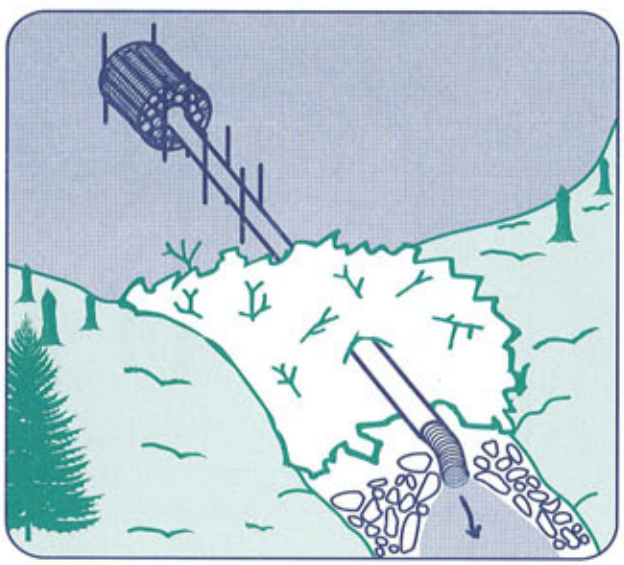
Maintenance and Remarks **Only a limited flow of water can pass through this device,** and it is difficult to install more than one pipe. Spring and fall maintenance is recommended.

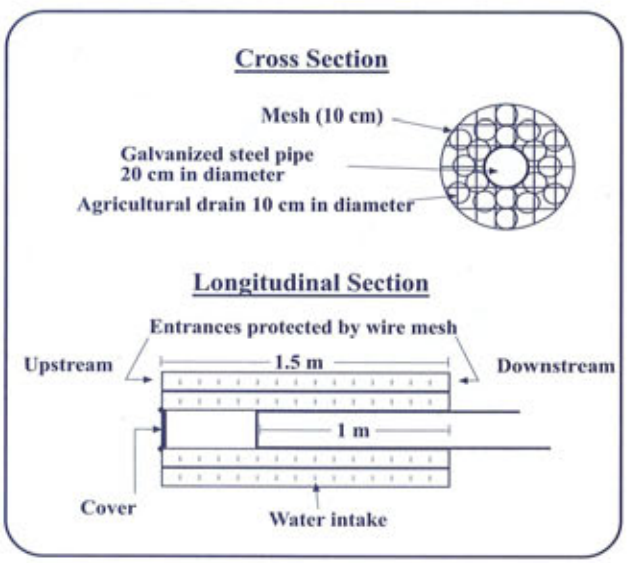
Advantages

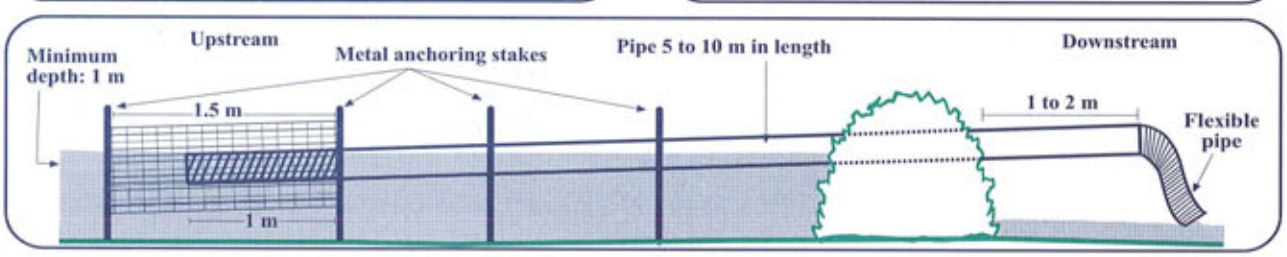
- Inexpensive
- Materials are readily available
- Easy to transport
- Effective when installed in water that is at least 1 m deep

Disadvantages

- More complicated to make than other control devices
- Muskrats and beavers can gnaw away the agricultural drains
- Limited flow
- Impedes the passage of fish







Material Needed	Cost	Installation	Maintenance	Effectivenes	Durability
	$			☆☆	

Management Technique No. 10

AGRICULTURAL DRAIN

Description A water-level control device consisting of an agricultural drain (a flexible pipe 15 cm or 20 cm in diameter).

Installation Agricultural drains have numerous holes around the circumference that allow water to enter the pipe. The upstream end must be closed with a properly sized piece of rubber held in place by a collar similar to those used by plumbers. The device is easy to install – insert one or more drains through the dam making sure they extend 5 m or more beyond the upstream side of the dam. The drains must be held in place by stakes to prevent them from floating to the surface. Enough drains must be installed to handle the volume of water. The downstream end of the drains can be camouflaged under a pile of branches.

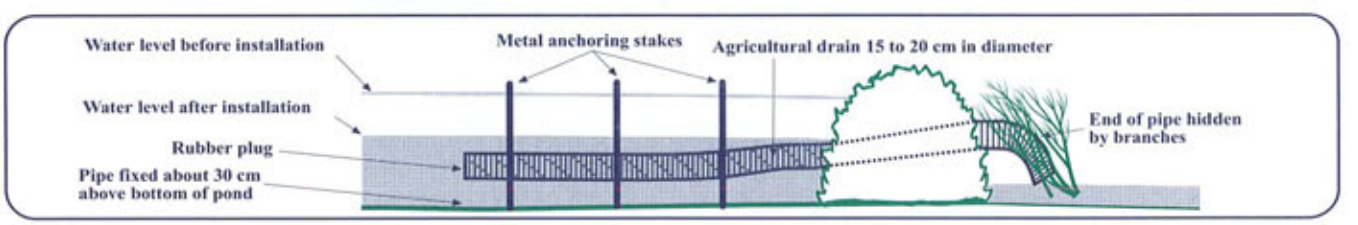
Maintenance and Remarks **Although economical, this method has many drawbacks.** There is a high risk of the holes becoming blocked in areas where the ground is soft or where the stream has a high organic load. Muskrat and beaver can gnaw away the drain, littering the water with debris.

Advantages

- Inexpensive
- Material is readily available
- Quick to install
- Easy to transport anywhere
- Two pipes may be installed to increase the flow

Disadvantages

- If not properly anchored, the drain can float and become ineffective
- The holes may block up
- Requires regular maintenance
- Stays in the environment
- May be crushed under the weight of winter ice
- Impedes the movement of fish
- Muskrat and beaver can gnaw away agricultural drains



Material Needed	Cost	Installation	Maintenance	Effectiveness	Durability
	$		to		

7.2.2 *Capture*

From a sustainable development perspective, capture is a technique that can help maintain the beaver population at a reasonable density while limiting the damage they cause to an acceptable level.

In Quebec, the organized trapping network is subdivided into traplines for which trappers have exclusive leases. An agreement should be made with the trapper(s) in a particular location concerning the capture of unwelcome beavers. This will enable the trapper(s) to assess the situation and provide monitoring or an annual control. When required, the regional trappers' association may be contacted. In all cases, the location of the site must be checked to see whether it is covered by an exclusive lease. **To find out the name of the trapper in charge of an area, or to obtain more information on this subject, simply call the *Société de la faune et des parcs du Québec* (FAPAQ) in the area concerned.**

Live Capture and Relocation

Through capture and relocation, beavers may be removed from sites where they are becoming a nuisance and encouraged to colonize unoccupied sites. This solution can be used when other control measures have failed or when the situation requires a rapid response and it is impossible to wait until the trapping season begins.

Short–term solution.

However, this method is unsuitable if a lot of animals have to be caught, because it is very labour-intensive. It is also only a short-term solution because, if one beaver colony finds a site attractive, then so will others. Consequently, **it is highly recommended that this method be coupled with other control techniques to prevent beavers from settling in the area.**

As a general rule, beavers do not stay on the site where they are set free. Often, family groups separate and individual animals can die of stress or fall victim to a predator following their relocation. To reduce stress to a minimum, beavers must be handled as little as possible and quickly set free.

Before starting to capture beaver, the right relocation **site** must be chosen.

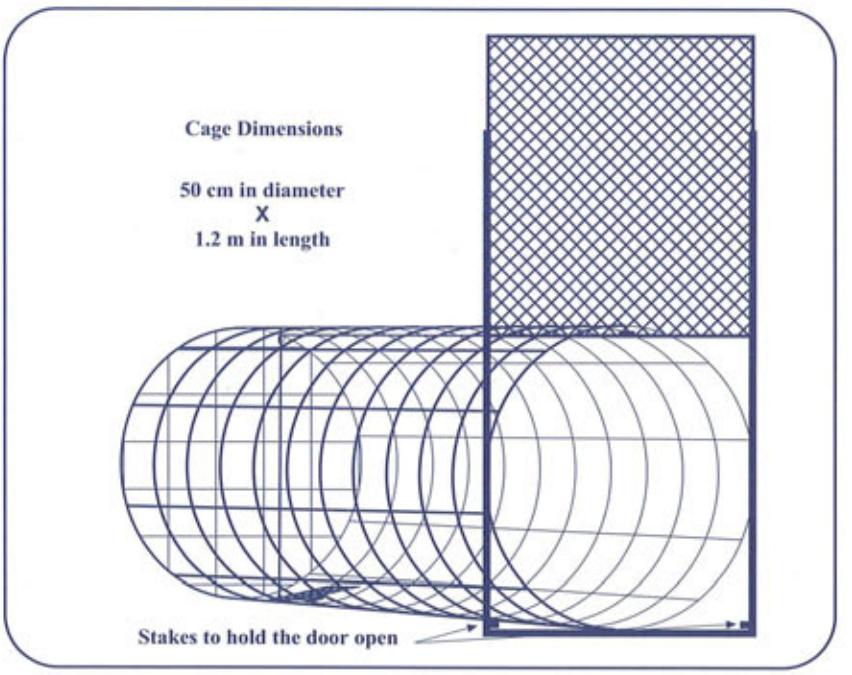
A permit must be obtained from the FAPAQ before starting any capture and relocation work. One or more suitable relocation sites must be chosen ahead of time to ensure that the problem does not simply recur somewhere else. Ideally, the site must be far away from inhabited areas, roads, railways, and other human infrastructure works, and must not already be occupied by another beaver colony. Small lakes (less than 20 ha) located near a forest (of which at least 25% is deciduous) are ideal, as are stretches of rivers and streams where the current is slow. A beaver density of one colony per 20 ha of lake surface or one colony per 2 km of watercourse is recommended, including the upstream and downstream portion of the watercourse. Sites that do not have a good water supply (e.g. swamps, stagnant water) should be avoided. **Check the suitability of the relocation site with the trapper licenced for that area or with the FAPAQ.**

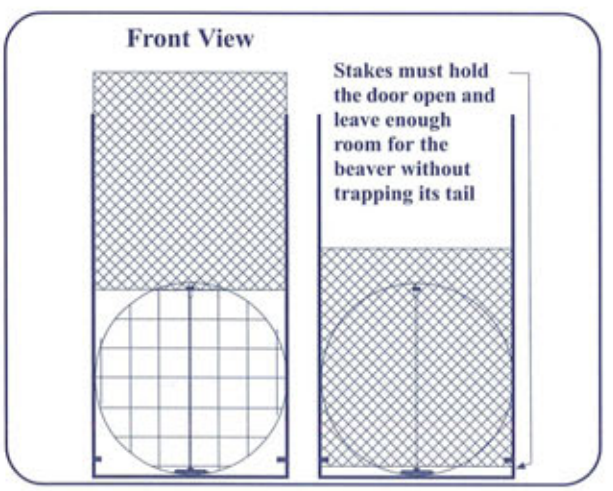
A 1.2 m x 1.2 m x 2.5 m long holding cage must be provided to house individual animals until the whole family has been caught. The cage must be placed in the shade and on the shoreline, so that the beavers have access to water while they are in captivity. A supply of aspen branches must also be provided as food for the animals while in captivity.

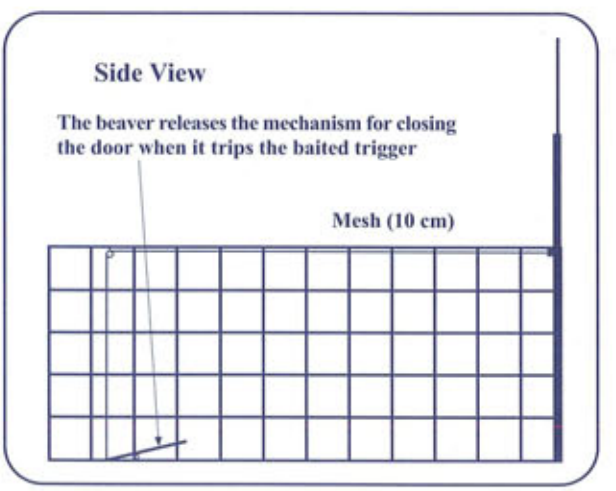
When these steps have been completed, capturing the beavers may begin. Many types of specially designed cages for capturing live beaver are available on the market. The most frequently used model is the "Hancock", but it is quite

expensive. Cages can be made quite easily using the appropriate materials. To attract beavers, bait (twigs of trembling aspen) or a lure (beaver castors) must be placed in the cage.

Example of a Home-made Cage for Capturing Live Beavers







The water-level in the pond must remain stable throughout the period when the colony is being rounded up. No breaches should be made in the dam to lower water-levels before all the animals have been taken. Traps should never be set too close to the water's edge once the water starts to drain through the breaches, otherwise the trapped animals will drown when the rest of the colony repair the dam.

When a beaver is captured, it should be kept in the trap cage until it can be moved to the holding cage. Avoid handling, as beavers can become highly aggressive when caught. Gloves should be worn to reduce the risk of injury and of transmitting tularemia.

When beavers are held captive or transported, the presence of humans and pets should be kept to a minimum. The beavers should also be provided with adequate cover (softwood branches) and food (poplar, trembling aspen, birch). In transit, they should be given water at least once an hour. Enclosed vehicles are preferable, but otherwise a pale tarpaulin can be used.

To improve the chances of survival for relocated beaver, they should be **captured** before September.

If the colony includes that year's young, it is better to wait until early August before capturing them to maximize the beavers' chances of survival. In the meantime, water-level control devices should be applied. In general, colonies with newborns are very reclusive from May to July, becoming more active until winter sets in. Conversely, colonies without young will be very active all spring and as late as early July. Beavers will stand a much better chance of survival if captured before September.

Relocating beavers is demanding work requiring selection of a suitable release site, preparation of a holding area pending capture of all colony members, and provision of a water supply during transit. Sometimes it is difficult to capture a whole colony, especially when wilier individuals have witnessed the capture of one of their fellows. For all these reasons, and to optimize the chances of success, **beavers should be caught and relocated only by qualified personnel; most experienced trappers can do this.**

In most parks and wildlife reserves in Quebec, this technique is no longer used because it has proved to be relatively ineffective, and the entire operation can be demanding and costly.

Advantages

- Little equipment required
- Unoccupied sites can be colonized
- Resources can be conserved

Disadvantages

- The problem may recur in another sector
- Requires regular site monitoring
- Jeopardizes the survival of the relocated animals
- The animals may not stay on the relocation site
- Demanding and costly operation

Selective trapping methods

Beaver **trapping** in season makes for optimum use of a renewable resource.

Beaver trapping in season enables the optimal use of a renewable resource, which is one of the principles of sustainable development; beaver pelts have been used in the fur industry for centuries, and the flesh is edible. For many Aboriginal communities, beaver trapping is a traditional activity that still plays an important role in their way of life. For Aboriginal peoples, as for trappers generally, this activity is a major source of income.

Trapping may be done out of season, but FAPAQ authorization is required if the purpose is to prevent property damage. If damage has already occurred, no authorization is needed, but all captured animals must be reported to a wildlife conservation officer.

Hire a **licenced trapper** to avoid risk of injury and of capturing species other than beaver.

To avoid risk of injury and of capturing other species, a licenced trapper should be hired to do the work. He will be able to ensure compliance with prevailing trapping standards.

To be certified, a trapper must successfully complete the training course offered by the *Fédération des trappeurs gestionnaires du Québec*. Although certification is not mandatory in the event of depredation, this course is highly recommended for anyone who has to set traps.

Controlling beaver population densities through lethal trapping is one of the best techniques for stopping them from spreading to areas where they will cause damage. Trapping also gets rid of nuisance beavers when other control methods have failed.

Two types of traps are recommended for capturing beaver:

1. Conibear-type traps, sizes 280 or 330.
2. Snares (3/64 under water or 1/16 under ice).

Advantages

- Controls population densit
- Gets rid of nuisance animals
- Makes optimum use of a renewable resource

Disadvantages

- Risk of capturing other species
- Loss of a resource if done out of season

Trapping techniques for beaver vary; the three examples shown here are taken from the book entitled *Trapping and Management of Fur-bearing Animals* published by the *Fédération des trappeurs gestionnaires du Québec*, 1998.

Setting a Conibear-type trap on a beaver logging trail

In a riparian environment, the trails used by beavers to reach their feeding site and to carry mud to spread on their lodge are ideal sites for setting Conibear-type traps.

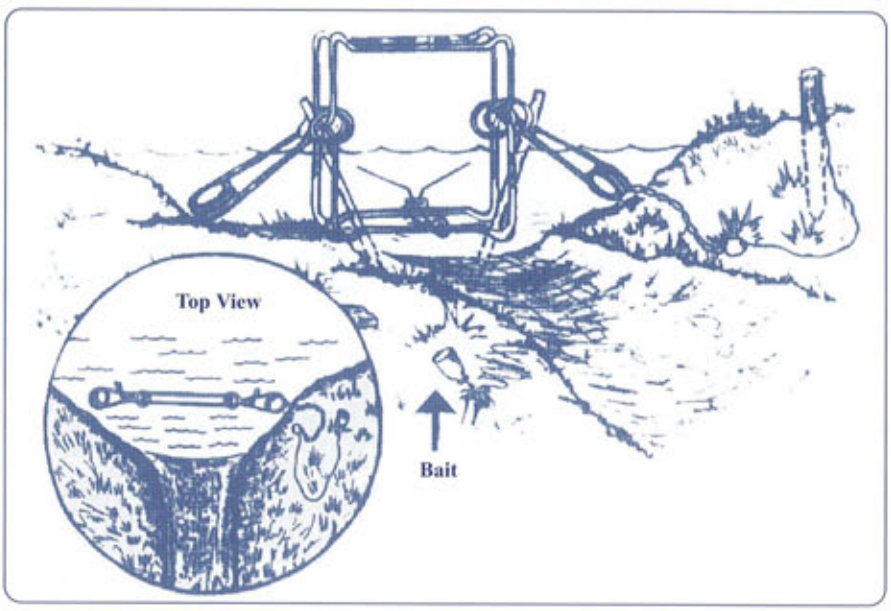
Since beavers spend less time on land than in the water, they have to have a good reason to come ashore. Although there may be many signs indicating that the beavers may soon return, it is a good idea to lure them with bait.

Ideally, a Conibear-type trap should be set in a beaver logging trail, but if there is a risk of frost, the trap should be set near the edge of the water. The trap should be raised just clear of the ground by inserting two small dry sticks under the jaws so that the dog, the trigger and the jaws do not freeze to the ground. The trigger is set on the side where the beaver will approach. The trap is held in place by sliding two small stakes through the spring arms and then pushing them into the ground. The last step is to pull the spring arms down.

To keep the trap at the proper height, wedge it on the knots of the retaining stakes or use stakes with a large enough diameter to prevent the trap from slipping.

The trap's chain should be firmly attached to a wire that is solidly anchored on land and that is long enough to let the beaver sink and stay submerged once trapped, thus protecting it from sunlight and predators.

Setting a Conibear-type Trap on a Beaver Logging Trail



Excerpt from: *Trapping and Management of Fur-bearing Animals.* Fédération des trappeurs gestionnaires du Québec (1998)

Fresh aspen twigs can be used as bait by piling them on the ground behind the trap to lure the animal up the trail. Beaver castors, covered with wet grass to stop birds from stealing them, can be added.

If beaver castors are used, make sure that the source animal is from another colony so that the foreign scent will attract local beaver.

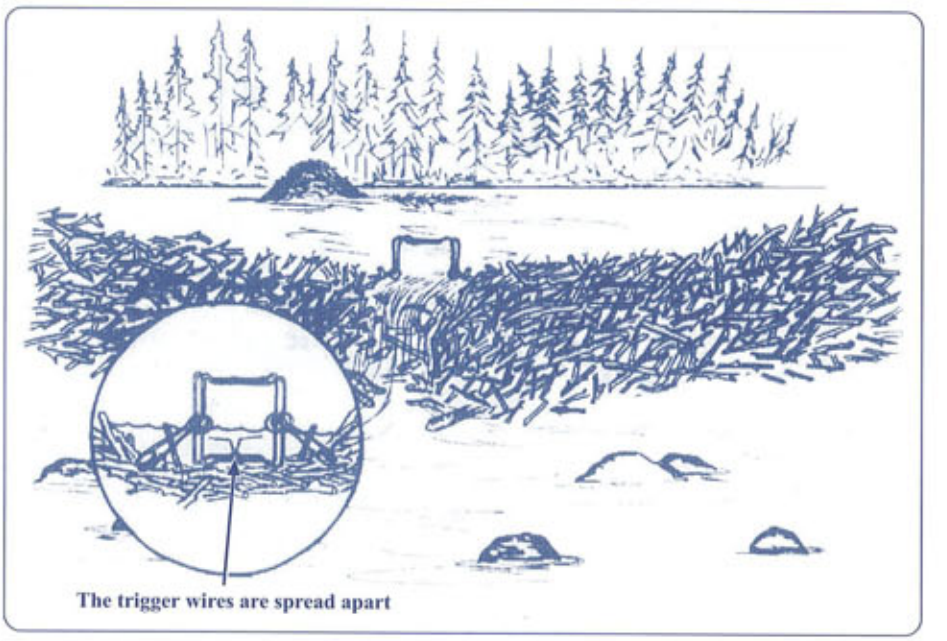
Finally, to stop the animal from going around the trap, block off adjacent openings with stumps, rocks or any other materials on hand that the beaver will not eat.

Setting a Conibear-type trap on a dam

This technique involves setting a Conibear-type trap right in the main spillway of a beaver dam. Secure the trap with short dry sticks and make sure that the trigger and the dog face, but do not touch, the bottom. Enough space must be left to allow the trigger to operate effectively, each of the two trigger wires must be spread out in an inverted "U" shape, and the trigger should not be visible from above the water.

Again, it is important to attach the trap's chain firmly to a length of wire solidly anchored to the dam and long enough to keep the beaver submerged once trapped, thus protecting it from sunlight and predators.

Setting a Conibear-type Trap on a Dam



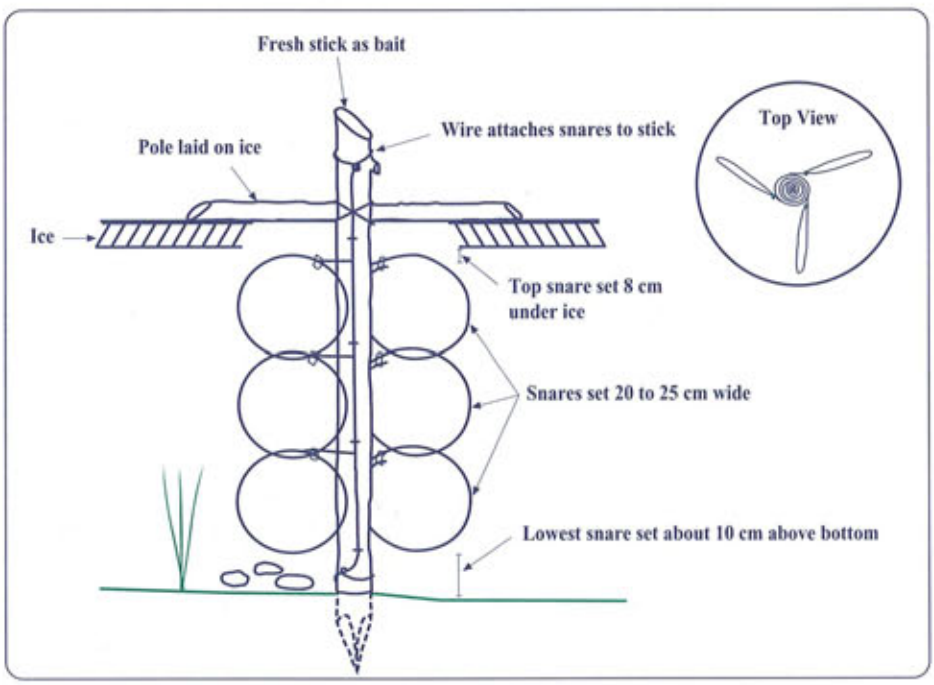
Excerpt from: *Trapping and Management of Fur-bearing Animals.* Fédération des trappeurs gestionnaires du Québec (1998)

Snares set under the ice

The wire used is generally 3/64 or 1/16 inch gauge. The snares may be fitted with a slide lock (self-locking slide). They should be set at a diameter of 20 to 25 cm. The snares should be attached by a wire to a dry stick so that the beaver cannot cut them away. The snare opening should be set deep enough in the water to ensure that the animal dies quickly.

This arrangement can be set near a food pile or lodge. A freshly cut stick, preferably aspen, is set between two rows of snares to attract the beaver. The snares should overlap so that the animal cannot slip between them. The number of snares used depends on the depth of the water, and the top ones should be about 8 cm under the ice. It is important to drive the stick firmly into the bottom and to attach it to a dry stick laid horizontally on the ice. To stop the hole from freezing over too quickly, cover it with conifer branches and pile snow generously on top.

Top Snare Set Under the Ice



Excerpt from: *Trapping and Management of Fur-bearing Animals.* Fédération des trappeurs gestionnaires du Québec (1998)

7.2.3 Removing beaver dams

Removal is permitted where beaver dams have **caused damage** to property, but a FAPAQ permit or approval by the Department is required if the aim is to **prevent** damage.

Removal of beaver dams is only authorized when they have caused damage to property. Where action is taken to prevent property damage, either a FAPAQ permit or authorization by the Department is required.

Before a beaver dam is removed, care must be taken to capture all the animals that built it or ensure that there are no signs of beaver presence; otherwise the dam will soon be rebuilt.

It is important to plan the work to ensure that the risks are properly assessed and that no irreparable damage will be made to local infrastructure or to aquatic habitats upstream or downstream from the dam. The Guide technique sur le démantèlement d'embâcles (Technical Guide to Breaking Log Jams) published in French only by the Fondation de la faune du Québec (Therrien, 1997), explains the factors to be taken into account before proceeding with dam removal. A thorough understanding of the watershed will allow for accurate projection of the effects of the destruction on the natural and human surroundings.

If the dam is thought to be fragile, the water-level should be lowered before a breach is made to avoid sudden failure. This can be done using an unperforated agricultural drain of a suitable diameter (at least 30 cm). One end of the drain is stopped with a rubber plug, and the whole drain is lowered into the pond to fill up with water. Once full, the open end is hoisted over the dam and quickly dropped on the downstream side. The plug is then removed, and the drain acts as a syphon, lowering the water-level so that the dam can be safely removed.

Caution: use of **explosives** to remove beaver lodges or dams is banned in Quebec.

To remove the dam, begin by making a breach about 2 m wide where the stream bed originally flowed. If there is a culvert downstream from the dam, the breach should be no wider than the culvert. The resulting debris should be dumped outside the riparian forest strip and well above the high water mark. **Open the breach gradually to allow the water to slowly drain away, avoiding surges, which could have the same impact as a sudden dam rupture.** The rest of the dam can be removed once the water upstream has reached its lowest level. If machinery is used, it must never cross the stream or operate from within it. Moreover, the use of explosives to remove beaver lodges and dams is banned in Quebec.

Removal should be done from April 1 to October 1, when the effects of dam removal on aquatic habitats are likely to be minimal. **It is also important to comply with all applicable forestry standards and regulations.**

If the site is well suited to beaver colonization, with plentiful food resources, it is highly likely that other beavers will settle in the same place. Other control methods will therefore have to be considered.

7.2.4 Other control methods

Various other methods of controlling the adverse effects of beaver activity have been tested, but most have only been used in highly specific circumstances and have proved to be of limited effectiveness.

Electric fences like those used for livestock may dissuade beavers from repairing dams or keep them away from trees used for building. Such systems require a regulator and a 12 V battery yielding a low-amperage current. Though effective, this control method provides only a temporary solution, since beavers eventually find a way around such obstacles. A single branch in contact with water disables the system, and there is always the risk of the equipment being stolen.

Repellants have little deterrent effect on beaver.

Hitherto, commercially available repellants do not seem to be an effective deterrent to stop beavers from settling an area or to protect trees and infrastructure. Cayenne pepper is somewhat effective, but it must be re-applied after each rainfall to be effective.

The urine of predators (wolf, lynx, etc.) is also thought to have some repellant effect, but it may also attract these very predators.

7.3 DEVELOPING BEAVER PONDS

In general, beaver ponds increase local **biodiversity**.

Both active and abandoned beaver ponds attract other wildlife. The presence of these wetlands promotes a multitude of interactions among living organisms and increases biodiversity. Measures taken to promote beaver presence may thus have a positive impact on the dynamics of the ecosystem.

7.3.1 Clearing

One of the limiting factors for beavers is a lack of the hardwood stems they need for food and for their various building projects. Through their activities, beavers may change the surrounding forest environment so much that it no longer provides adequate resources to meet their own needs. A colony that has exhausted the food potential of its territory will abandon its lodge and dam and settle elsewhere, often leading to depredation.

An abandoned site may evolve into a belt of softwoods, and it may take many years before natural factors (fire, deadfalls) or logging modify the landscape once again and promote the regrowth of the species sought by beavers.

Land use managers should try to develop beaver-friendly habitat in areas where these animal's activities are not likely to lead to conflict.

Stimulate growth of **hardwoods** by clearing small patches of forest. by clearing small patches of forest.

Beavers can be attracted to settle a site by promoting the growth of shade-intolerant hardwoods, especially trembling aspen. Natural aspen regeneration can be stimulated by clearing small patches of forest (about 0.4 ha) within 60 m of a watercourse or beaver pond. **However, in public forests, care must be taken to comply with the provisions of the Regulation respecting standards of forest management for forests in the public domain and to use methods and machinery that do not damage the soil and that minimize the risk of erosion.**

Additional clearing may be required to meet the needs of a beaver family and to keep them there. Therefore, felling must be properly planned so as to provide for a constant food supply over the years.

Clearing should be done both in areas where aspen is already established and in those where it is underrepresented. Cleared areas should be a certain distance from the river bank to avoid the risk of erosion. It takes five years for an aspen stand to get established, and the stand provides a reserve of food for a further five to eight years.

7.3.2 Consolidating beaver dams

Abandoned dams may give way under the pressure of peak flows.

A beaver colony may stay in a suitable area with plenty of food for decades. However, once the colony leaves, nature takes its toll, and the dam starts to break down and to leak the water it was holding back.

Old dams that have not been repaired as well as those built on rock or on fine sand are at high risk of breaking. Dams that have been abandoned for four or five years are at risk under normal water flow conditions and even more likely to give way during peak flows.

Sudden dam failure may have spectacular and undesirable consequences, especially if a large volume of water was impounded. The surge may raise the sediment load, increasing the erosion potential and the risk of major environmental damage. The sudden stirring up of accumulated sediments and nutrients from the bottom of the pond may cover spawning grounds and eutrophy bodies of water further downstream.

A series of dams on a stream may impound huge quantities of water. If an upstream dam breaks, the surge may cause failure of the dams downstream, creating a domino effect. A small brook may thus turn into a raging torrent carrying away everything in its path. The increased flow may exceed the capacity of culverts and lead to serious damage.

Safe **consolidation** of a dam calls for thorough knowledge of the surroundings and of construction techniques. A specialist should be consulted.

Caution is therefore called for when deciding to conserve and maintain dams after beavers have left. Safe consolidation of dams requires thorough knowledge of the environment and of construction techniques. It is essential to take into account the configuration and size of the watershed, the dimensions of the dam and any other factors that may have a bearing on the success of the operation. For these reasons, an engineer or hydraulics specialist should be consulted before starting to consolidate a beaver dam.

Any action designed to maintain a dam must be authorized (see Table 4, page 62) before work begins. It should also be kept in mind that in case of failure, the owner of the property where the flow-modifying structure was located remains liable for any damage.

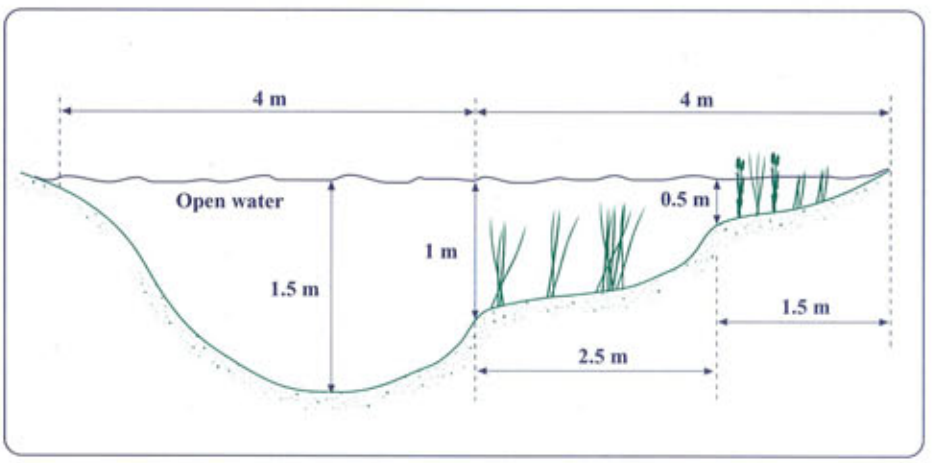
7.3.3 Supplementary arrangements

To attract **waterfowl**, nesting structures can be set up around beaver ponds.

To promote nesting by ducks that make their nest in hollows and by other bird species, the dead trees around ponds must be left standing. Nesting facilities can also be built (nest boxes, platforms, islands, etc.) to attract waterfowl, especially in places where there is a dearth of hollow trees and natural cavities. The number of these installations may vary according to the natural nesting limits, the size and accessibility of the pond, and also on the targeted or preferred species. Ponds chosen for such facilities should have an abundance of submerged and emergent aquatic vegetation. Cover for concealment and a bountiful supply of invertebrates are generally associated with such ponds and provide an ideal nesting and moulting habitat for waterfowl.

If water-level control devices are installed, part of the pond should be kept at a depth ranging from 50 cm to 1 m to provide feeding grounds for dabbling ducks.

Cross Section of a Waterfowl Pond



From: *Aménagement des boisés et des terres privées pour la faune*
Fondation de la faune du Québec and FAPAQ (2000)

The productivity of a site abandoned by beavers can be enhanced by lowering the water-level. As the pond dries out, the sediments and organic matter are exposed to aerobic conditions, thus speeding up decomposition and the return of plant communities.

7.3.4 Installing a fish ladder

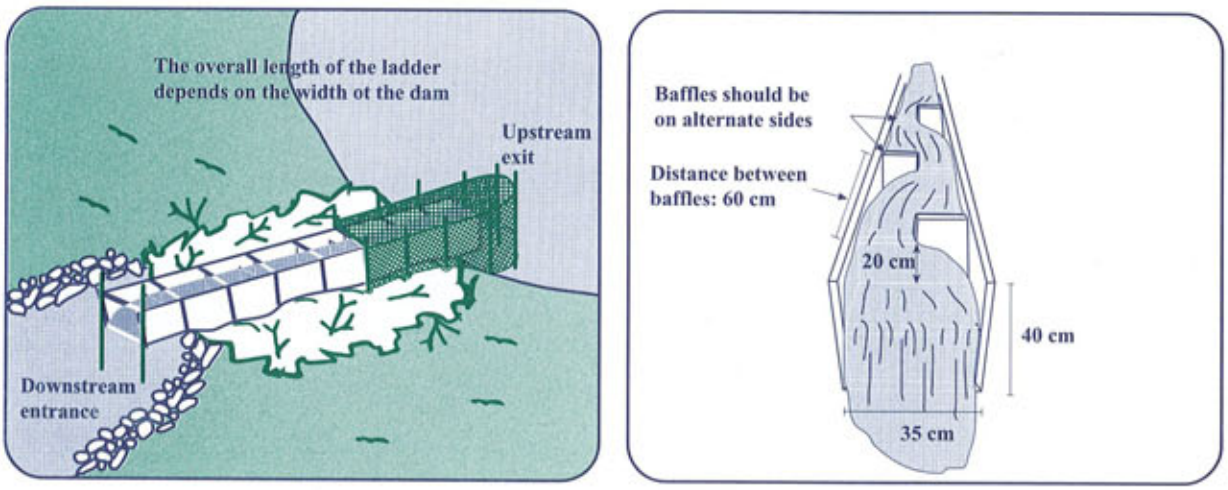
Installing a temporary **fish ladder** lets fish get to spawning grounds upstream of beaver dams.

In cases where beaver dams interfere with fish migration, a temporary fish ladder can be installed. This is generally a small structure 2 to 3 m long set in a breach in the dam and designed to allow fish to reach spawning grounds upstream. The overall length of the ladder depends on the width of the dam, whereas its gradient depends on the difference in water-level on either side of the dam. The gradient should not exceed 30%. The gentler the gradient, the easier it will be for small fish to make their way through. The gradient can be adjusted by raising the downstream end of the ladder, which is anchored with metal stakes. However, the first pool at the entrance should be half submerged.

In the spring, when brook trout are on the move, ladders should be made early in the season to allow the fish to take advantage of the run-off. This is the time of year when beaver are least inclined to patch up leaks. Installing a fish ladder nevertheless calls for constant monitoring and maintenance to keep it operating properly. Brook trout are also very mobile in the spawning season, which can occur from late August to mid-November, depending on the region.

It may also be necessary to stop beavers from building dams on the tributaries of streams known to be spawning grounds. Management logging to reduce hardwood resources makes sites less appealing to beavers.

Illustration of a Fish Ladder



To find out more:

Major *et al.* 1980, Banville 1984, De Laborie 1987, Biorex 1993, D'Eon *et al.* 1995, Alain 1997, Therrien 1997, Larocque *et al.* 2000.

Table 3 Summary of Management Techniques

Management Technique	Quantity of Materials	Cost	Assemblyet and Installation	Maintenance	Effectiveness	Durability	Chief Advantage	Chief Disadvantage
Prevention								
Planning	-	+	-	-	+++	+++	Best preventive measure	None
Management and protection of riparian forest strips	+	+ to ++	+	+	+++	++	Simple	Alters forest cover
Remedial work	+ to +++	+ to +++	+ to +++	+	+++	+++	Effective	May be costly
Mesh for trees	+	+	+	+	+++	+++	Easy to install	Ugly
Pre-damming	+ to +++	+ to +++	+ to +++	+	+++	+++	Effective	May be costly
Wire mesh baffle	+	+	+	++	++	++	Easy to install	Risk of blockage
Metal stakes	+	+	+	++	++	++	Economical	Regular maintenance
Culvert protection system	++	++	+	+	+++	+++	Effective and durable	Cannot be installed on a steep-sided watercourse
French drain	+ to ++	++ to +++	+++	+	+++	+++	Effective	In roadside ditches
Control methods								
Morency cube	+	+	+	+	+++	++	Effective and adjustable	Occasional blockages
Elbow pipe	+	+	+	++	++	+	Effective	Risk of blockage
T-shaped pipe	+	+	++	++	+	+	Economical	Fragile and hard to transport
Morency sponge	++	+	++	++	++	+	Effective	Complex to make
Agricultural drain	+	+	+	++ to +++	+	+	Economical	Long life in the environment
Capture/relocation	++	+++	++	++	++	++	Allows new sites to be colonized	Adaptation of beavers uncertain
Trapping	+	+	+	++	+++	++	Gets rid of nuisance beavers	Wasted resource if out of season
Removal of dams	+ to +++	+ to +++	-	-	+++	+++	Eliminates flood risk	Habitat destruction

- : not applicable + : low ++ : moderate +++ : high

Managing beaver activity:
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8 MONITORING AND EVALUATING THE MEASURES TAKEN

Once a site colonized by beavers, or likely to be so, has been characterized, a monitoring and evaluation program should be implemented in order to track the progress of the situation and validate the relevance and effectiveness of the measures taken. Managers can refer to **Sheet 4** in Appendix 1 to perform the monitoring.

The first section of the sheet refers to the identification and characterization of the site and to the assessment of the risk level established during the site investigation (**Sheet 1a**). The purpose of the ensuing action could be to prevent beavers from colonizing the site, to control the damage caused by their presence or to enhance the site.

Using the Monitoring and Evaluation Sheet (**Sheet 4**), the owner or manager can evaluate the **relevance** and **effectiveness** of the measures taken.

The second section of the sheet can be used to describe the initial measure (**Sheet 1b**), and to indicate the means used and the cost of carrying out the work to achieve the objectives sought. Ultimately, this description will make it possible to evaluate the benefits of the technique used. The manager will also be able to use it as a reference in estimating the cost of similar measures on other sites.

The last section is for subsequent measures. It can be used to evaluate the effectiveness of the initial measure and its impact on the habitat, where applicable. It can also serve to describe the type of action carried out and, if necessary, to recommend further measures. Copies can be made for use during each visit.

The Monitoring and Evaluation Sheet will enable the manager to evaluate the cost, relevance and effectiveness of the measures and draw conclusions accordingly. The management techniques used on a site can be documented over time, making it easy to keep track of the work required to maintain them. In this way, sites requiring repeated measures can be considered for large-scale works (e.g. pre-damming).

9 LEGISLATION AND AUTHORIZATIONS REQUIRED IN QUEBEC

9.1 LEGISLATION

The **FAPAQ** is usually the first organization to be consulted.

The Act respecting the conservation and development of *wildlife* stipulates approved measures for dealing with beavers and their structures and habitat (Appendix 2). It is administered by the *Société de la faune et des parcs du Québec* (FAPAQ), which is usually the first actor to be consulted before taking measures to limit beaver activity in a given area. Other federal, provincial and municipal acts, regulations, policies and directives also come into play, including the *Environment Quality Act*, the *Watercourses Act*, the *Dam Safety Act*, the *Forest Act* and the *Fisheries Act* (Appendix 2). Because legal documents are routinely amended, **we recommend that you check the application of legislation, regulations and limitations that are in effect in the area concerned when action is taken.**

9.2 AUTHORIZATIONS

The **guidelines** listed in **Table 4** should always be followed.

Authorizations are often required before management techniques for beavers and their structures and habitat can be carried out. These authorizations are issued by the appropriate authorities, usually those who administer the practices. Some techniques, however, do not require the usual authorizations, but when in doubt, check with the appropriate federal (Fisheries and Oceans Canada) and provincial authorities (*Société de la faune et des parcs du Québec, ministère de l'Environnement, ministère des Ressources naturelles*) as well as with municipal bodies.

Although many management techniques can be carried out by various parties, **it is always best to consult qualified people who have the required qualifications and experience** (licenced trappers, biologists, hydraulic engineers, hydrologists, forest engineers, etc.). In addition, some measures can only be executed at certain times of the year. Table 4 provides a list of recommended contacts, appropriate time frames and required authorizations.

To find out more:

Fisheries and Oceans Canada 1986, Government of Canada 1991 Gouvernement du Québec 2000a, Meunier 2000, Meunier and Durocher 2000.

Table 4 Recommended Contacts, Time Frames and Required Authorizations for Each Management Technique

Management Technique	Recommended Contacts	Time Frames	Required Authorizations*
Prevention			
Infrastructure planning	Manager of the territory, a biologist and the appropriate engineers	Before any major construction work	• None at this stage
Riparian forest strip management and protection	Anyone with experience in this type of management. Consult a forest engineer, if necessary	As early as possible in the snow-free period	• Permit issued by the *ministère des Ressources naturelles* under the *Forest Act*
Repairs to existing infrastructure	Person in charge of maintenance	As soon as the problem has been identified	• Authorizations vary according to the nature of the work
Wire mesh baffle, metal stakes, culvert protection system and French drain	Anyone with experience in this type of management	During the snow-free period	• Authorization certificate issued by the *ministère de l'Environnement* under the *Environment Quality Act*, if applicable
Pre-damming	Anyone with experience in this type of management. Consult an engineer or hydraulic engineer, if necessary	During the snow-free period, ideally when the flow coefficient is low (August to September) and not during spawning periods	• Check with the *ministère de l'Environnement* regarding compliance with the *Watercourses Act* and/or the *Dam Safety Act* for structures at least two metres high **or** structures at least one metre high with an impounding capacity greater than one million cubic metres. Authorization may have to be obtained by, or a report made to, the *ministère*
Control methods			
Water-level control device (Morency cube and sponge, T-shaped or elbow pipe, agricultural drain)	Anyone with experience in this type of management. Consult an engineer or hydraulic engineer, if necessary	During the snow-free period	• Permit or authorization issued by the *Société de la faune et des parcs du Québec* under *the Act respecting the conservation and development of wildlife* • Check with the *ministère de l'Environnement* about provisions of the *Watercourses Act* and/or the *Dam Safety Act* for structures at least two metres high or structures at least one metre high **or** with an impounding capacity greater than one million cubic metres. Authorization may have to be obtained by or a report made to the *ministère*
Live captures (if the animals are causing property damage)	Anyone with experience in pest control, ideally a licenced trapper	If the animals are to be relocated, this should be done between spring thaw and mid-September	• Permit issued by the *Société de la faune et des parcs du Québec* under the *Act respecting the conservation and development of wildlife* • Authorization from the landowner to access private property

Trapping to prevent property damage	Trapper holding a valid licence for the problem area (free zone) or trapline owner (controlled territory)	During the trapping season	• Trapping licence
Trapping (when there is property damage)	Anyone with experience in pest control, ideally a licenced trapper	At any time	• None • Report the capture to a wildlife officer
Removal of a beaver dam to prevent property damage	Anyone with experience in this type of management, in co-operation with a licenced trapper	From April 1 to October 1. Ideally, when the flow coefficient is low (August to September)	• Permit or authorization issued by the *Société de la faune et des parcs du Québec* under *the Act respecting the conservation and development of wildlife*
Removal of a beaver dam when there is property damage	Anyone with experience in this type of management, in co-operation with a licenced trapper	Ideally, from April 1 to October 1	• None
Enhancing beaver ponds			
Clearing	Ideally, a forest engineer and a biologist	Variable, depending on the work to be done and the site	• Permit issued by the *ministère des Ressources naturelles* under the *Forest Act* regarding public forests
Consolidation of beaver dams	Civil engineer and hydraulic engineer	During the low water period and not during spawning periods	• Permit or authorization issued by the *Société de la faune et des parcs du Québec* under *the Act respecting the conservation and development of wildlife* • Check with the *ministère de l'Environnement* about provisions of the *Watercourses Act* and/or the *Dam Safety Act* for structures at least two meters high **or** structures at least one metre high with an impounding capacity greater than one million cubic metres. Authorization may have to be obtained by or a report made to *ministère*.
Supplementary structures	Anyone with experience in this type of management	Variable, depending on the nature of the structures	• Authorizations vary according to the nature of the structures

* If a measure does not threaten fish production in fish habitats, no authorization is required. When this risk exists, the project can be submitted for analysis to the Fish Habitat Management Branch at the Department of Fisheries and Oceans.

If change is anticipated in a wildlife habitat (e.g. fish habitat) on public lands, a permit or authorization must be obtained from the *Société de la faune et des parcs du Québec*.

Some Legal Considerations

- Before killing or capturing a beaver, make sure that nothing can be done to scare it off or to prevent it from causing damage. In such cases, no authorization is required to kill or capture it. Wounded or dead animals must be reported to a wildlife conservation officer.

- When a measure affects a third party (private or public), the latter is entitled to recourse, such as removal of the dam or claims for damages.

- The owner or developer of a structure (pre-damming, consolidation, etc.) built in a watercourse is liable for any harm caused to another person.

- The owner or developer of an infrastructure (railway, road, etc.) must use reasonable means to prevent beaver activity.

- Within the meaning of the *Watercourses Act* and the *Dam Safety Act*, beaver dams that are currently being or have been altered by humans (pre-damming, consolidation, etc.) may be considered as works designed to retain the water of a watercourse or a lake. For larger dams, government approval of drawings and specifications for work or an authorization from the *ministère de l'Environnement du Québec* may be required.

- Authorizations are not required when there is no risk that a measure will have a negative impact on fish production in fish habitats. When in doubt, the project can be submitted for analysis to the Fish Habitat Management Branch at the Department of Fisheries and Oceans.

- When planning to make changes to a wildlife habitat (e.g. fish habitat) located on public lands, a permit or authorization must be obtained from the *Société de la faune et des parcs du Québec*.

- The holder of a permit to carry out a wildlife management or recreational measure can perform related activities in a beaver habitat (e.g. clearing). However, compliance with management standards is required in public forests when performing such activities. For more information on this matter, we recommend that you refer to *Modalités d'intervention dans le milieu forestier : fondements et applications* (Gouvernement du Québec, 2000a), which is currently available in French only.

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APPENDIX 1 DATA COLLECTION SHEETS

The purpose of the following sheets is to identify all the data needed to manage a territory used by beavers. When filling out some parts of the sheets, a specialist (biologist, forest engineer, etc.) may have to be consulted. Some aspects, although hard to quantify, are useful for spotting particular problems. If necessary, they can later be investigated in greater depth.

- **Sheet 1a** Site Characterization and Risk Assessment
- **Sheet 1b** Measures Taken
- **Sheet 2a** Qualitative Evaluation of Beaver Habitat Potential
- **Sheet 2b** Quantitative Evaluation of Beaver Habitat Potential
- **Sheet 3** Advantages and Disadvantages of Beaver Presence
- **Sheet 4** Monitoring and Evaluation

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E-mail: foretmodele@fmodbsl.qc.ca Web site: wwwforet.fmodbsl.qc.ca

SHEET 1a - Site Characterization and Risk Assessment (1 of 3)

File number: _____

Location

Type : stream ☐ river ☐ ditch ☐ lake ☐ pond ☐ other ☐

Name of site _____

Latitude _____ N Longitude _____ W Topographical map _____ Scale _____

Description of site

Accessibility: on foot ☐ boat ☐ ATV ☐ truck ☐

Distance from nearest access point: _____ km

Land title: private ☐ public ☐

Trapping status: free zone ☐ controlled territory ☐ beaver reserve ☐

Owner or manager: _____

Other users: _____

Sketch of site and of access road

(roughly indicate relevant distances, lodge, feed pile, dam, etc.)

Photo/slide number:

Site	**Access Road**

SHEET 1a - Site Characterization and Risk Assessment (2 of 3)

Characteristics of beaver infrastructure

Inactive colony ☐

Active colony ☐ approximate number of beavers _____ Lodge ☐

Burrow(s) ☐ number ____ Food pile ☐ Logging site ☐

Dam(s) ☐ number (see sketch) ____

No. 1 ____ approximate age ____ width ____ m length ____ m height ____ m
Condition: good ☐ average ☐ poor ☐

No. 2 ____ approximate age ____ width ____ m length ____ m height ____ m
Condition: good ☐ average ☐ poor ☐

No. 3 ____ approximate age ____ width ____ m length ____ m height ____ m
Condition: good ☐ average ☐ poor ☐

Approximate dimensions of pond:

Length _____ m Width _____ m Depth _____ m

Other ponds upstream ____ downstream ____

Description of neighbouring forest habitat: _____

Nature of damage (actual or potential)

None ☐ Actual ☐ Potential ☐

Road flooded ☐ width affected ____ m length affected ____ m
impassable ☐ depth of water ____ cm

Trail flooded ☐ length affected ____ m impassable ☐ depth of waterv ____ cm

Bridge ☐ or culvert ☐ obstructed steel ☐ wood ☐ concrete ☐ stone ☐ other ☐
diameter ____ m length ____ m
width ____ m height ____ m

Fill eroded ☐

Woodlot(s) or farmland flooded ☐ area affected ____ ha lot No. _____

Stand or crop _____

Trees felled ☐ number of trees affected ____ species affected _____

Infrastructure affected ☐ cottage ☐ outbuilding ☐ other ☐

Infrastructure nearby ☐ distance ____ m description _____

Fish migration impeded ☐ species affected _____

Silting of spawning beds ☐ species affected _____ area affected _____

Water contamination by giardiasis parasite yes ☐ no ☐ unknown ☐

SHEET 1a - Site Characterization and Risk Assessment (3 of 3)

Nature of damage (actual or potential) (cont.)

Other damage ☐ description _____

Proximity of important wildlife habitat (fish, threatened or vulnerable species, waterfowl, etc.) ☐

Damage: yes ☐ no ☐

Nature _____

Description _____

Damage to rare or unique features ☐ description _____

Owners' and users' perceptions _____

Prior damage ☐ cost _____ description _____

Risk level

Points to consider in assessing risk level

- ☐ Dwelling, road, railway, bridge or culvert downstream from dam with no intervening body of water capable of absorbing floodwaters
- ☐ Series of dams on one watercourse, impounding large quantities of water
- ☐ Potential for dam failure under the pressure of heavy rainfall (age, condition)
- ☐ Dam built on rock or on fine sand and subject to failure
- ☐ Possible accumulation of debris capable of blocking culverts in the event of dam failure
- ☐ Risk of fill erosion
- ☐ Proximity of buffer zones that could absorb floodwaters
- ☐ Presence of debris upstream from dam

Priority codes

- ☐ **1** *Emergency response and monitoring.* Signs of imminent dam failure, flooding of infrastructure or property, felling of trees or obstruction of a bridge or culvert with potentially serious consequences.
- ☐ **2** *Medium-term measures and monitoring.* Potential for dam to fail, to flood infrastructure or property or to obstruct a bridge or culvert.
- ☐ **3** *No measures and monitoring.* No potential for beaver/human conflict.

SHEET 1b - Measures Taken (1 of 1)

Fill out this section once a decision has been made. See Chapter 6.

Description of measures

Measures taken: _____

Detailed account (append sketch if required): _____

Date of work: _____ Photo/slide numbers: _____

Hours worked at site: _____ Number of workers: _____

Estimated cost: Materials _____ + Installation _____ = _____

Authorization(s) obtained: _____

Trapper's name: _____ Licence No.: _____

Remarks

Filled out by: _____ Date: _____

SHEET 2a - Qualitative Evaluation of Beaver Habitat Potential (1 of 2)

File number: _____

Need for habitat potential assessment

Is the body of water intermittent (not permanent)? Yes ☐ No ☐

Is the stream gradient greater than 15%?* Yes ☐ No ☐

Do water-levels show extreme seasonal variations? Yes ☐ No ☐

If you answered yes to at least one of these questions, the beaver habitat potential is low or non-existent: do **not continue**. If you answered no to all the questions: **continue**.

* : The gradient is calculated as follows, using a topographical map:

$$DN = \frac{A \times 100}{B}$$

where A: the difference in elevation between two points
B: the distance between these points

Main variables to consider

The stream gradient and winter food supply are the main criteria for assessing habitat potential. The gentler the gradient, the greater is the habitat potential. In the case of major lakes (› 8 ha), this variable is replaced by shoreline development: for a given area, the longer (i.e. the more irregular) the perimeter of the shoreline, the greater the habitat potential. Lakes smaller than 8 ha are considered ipso facto good habitat. Food quality is a function of forest cover and stem size. Stands dominated by hardwoods with a small diameter (2.5 to 15 cm at breast height) increase habitat potential. Food quality should be assessed in a strip extending 100 m from the water's edge on all sides. A third important criterion is water-level stability: stable water-levels enhance habitat potential.

- Potential as determined by gradient for watercourses:
  Low ☐ (10-15%) Moderate ☐ (8-10%) High ☐ (< 8%)

  or

  Shoreline development (sinuosity, irregularity) for lakes larger than 8 ha:
  Low ☐ Moderate ☐ High ☐

- Quality of forest cover:

  ☐ High: stands (trees or bushes) dominated by one or more of the following hardwoods: trembling aspen, other members of the poplar family, willows, birches, alders and maples

  ☐ Moderate: stands dominated by other hardwoods

  ☐ Low: stand dominated by conifers

- Rough percentage of hardwoods with a diameter of 2.5 to 15 cm at breast height:
  Low ☐ (< 25%) Moderate ☐ (25-75%) High ☐ (> 75%)

- Stability of water-level throughout the year:
  Low ☐ Moderate ☐ High ☐

SHEET 2a - Qualitative Evaluation of Beaver Habitat Potential (2 of 2)

Beaver habitat potential

Taking into account all the variables, beaver habitat potential can be rated:

Nil ☐ Low ☐ Moderate ☐ High ☐

Remarks

Filled out by: _____ Date: _____

SHEET 2b - Quantitative Evaluation of Beaver Habitat Potential (1 of 2)

(Adapted from the model developed by the Lower St Lawrence Model Forest and the Université du Québec à Rimouski)

File number: _____

Relevance of evaluating habitat potential

- If the body of water is not permanent (i.e. is intermittent), or if the gradient [A] is steeper than 15%, or if there are extreme seasonal water-level variations, habitat potential is assumed to be negligible or non-existent; **do not continue**.

[A] See the section below entitled " Evaluating water variable" to measure gradient.

- If the body of water is permanent, and if the gradient is gentler than 15%, and if seasonal water level variations are low or moderate, assess habitat potential (Habitat Suitability Index or HSI) by following steps 1 to 3.

N.B.: A strip extending 100 m around the shoreline on all sides is used to assess beaver habitat.

Step 1: Evaluating the WF (winter food) variable

Use Table 1 to determine the WF value on the basis of cover type, species composition and stand height.

Table 1

Cover Type and Species Composition	Stand Height [B]	WF	Check
Hardwoods dominated by aspen, paper birch or other intolerant hardwoods. [C] Alders.	4, 5, 6	1.0	__
	2, 3	0.9	__
	1	0.8	__
Hardwoods including aspen, paper birch or other intolerant hardwoods.	4, 5, 6	0.8	__
	2, 3	0.7	__
	1	0.5	__
Other hardwoods	4, 5, 6	0.6	__
	2,3	0.5	__
	1	0.3	__
Mixed stand dominated by aspen, paper birch or other intolerant hardwoods	4, 5, 6	0.9	__
	2, 3	0.8	__
	1	0.7	__
Mixed stand including aspen, paper birch or other intolerant hardwoods	4, 5, 6	0.7	__
	2, 3	0.5	__
	1	0.3	__
Other mixed stand	2, 3, 4, 5, 6	0.3	__
	1	0.2	__
Conifers	-	0.1	__

[B] See local forest ecology map: **1**: > 22 m **2**: 17 to 22 m **3**: 12 to 17 m, **4**: 7 to 12 m **5**: 4 to 7 m **6**: < 4 m

[C] Shade-intolerant species

SHEET 2b - Quantitative Evaluation of Beaver Habitat Potential (2 of 2)

Step 2: Evaluating the WATER variable

Calculate the WATER variable using Table 2

Table 2

Hydrography		WATER Variable	Check
• Stream with a gradient (G) [D] :			
	G ≤ 6	1	___
	6 < G ≤ 8	0.9	___
	8 < G ≤ 10	0.7	___
	10 < G ≤ 12	0.5	___
	12 < G ≤ 15	0.2	___
	G > 15	0	___
• Lake ≤ 8 ha		1	___
• Lake > 8 ha	0.45 SD [E] - 0.35=___ [F]		___

[D]: Calculate G (gradient) using a topographical map:

$G = \frac{A \times 100}{B}$ where A: the difference in elevation between two points
B: the distance between these points

[E]: Calculate SD (shoreline development):

$SD = \frac{p}{2\sqrt{\pi a}}$ where p: perimeter of the lake (m)
π: 3.1416
a: area of the lake (m^2)

[F]: if the product of the equation is greater than 1, the WATER variable is considered to be equal to 1.

Step 3: Determining the Habitat Suitability Index (HSI)

Determine the HSI value as follows: HSI = WF x WATER = _____ x _____ = _____
Determine the nominal HSI using Table 3

Table 3

HSI	Nominal Value of HSI	
0	Nil	☐
0 < HSI ≤ 0.34	Low	☐
0.34 < HSI ≤ 0.66	Moderate	☐
0.66 < HSI ≤ 1.0	High	☐

SHEET 3 -Advantages and Disadvantages of Beaver Presence (1 of 2)

*File number:*_____

Given the management objectives, determine which of the following items apply:

Effects deemed positive

☐ **Stabilization of water regime and soils**

- Increased water area and volume
- Regulation of watercourse downstream from dam
- Slower flow and reduced soil erosion
- Temporary retention of sediments upstream
- Lower turbidity downstream
- Maintenance of water table and peak flows during spring run-offs

☐ **Increased productivity**

- Higher productivity in cold water due to higher temperatures
- Higher invertebrate productivity in the first few years
- Higher primary productivity upstream from dam

☐ **Increased biodiversity**

- Improved habitat for several mammal species (moose, white-tailed deer, muskrat, otter, mink and black bear)
- Creation of habitat for amphibians, waterfowl, songbirds and other bird species
- Contribution to landscape diversity by modifying the succession of plant communities

☐ **Improved fish habitat and fishery production capacity**

- Creation of rest, feeding and shelter areas and of winter habitat in shallow streams
- Size of fish caught in ponds is greater than in streams

☐ **Economic spin-offs**

- Greater opportunities for hunting, fishing and trapping and leasing of rights to such pursuits
- Greater potential for observation, interpretation and development of nature

Effects deemed negative

☐ **Impact on human infrastructure**

- Felling of trees around resort areas
- Flooding of trails, roads and rail lines
- Blockage of pipes, culverts and bridges and risk of major damage in the event of dam failure or surges

☐ **Impact on shoreline habitat and water regime**

- Flooding of woodlots (loss of timber) and farmland
- Temporary loss of plant cover around bodies of water
- Possible depletion of available oxygen resulting from decay processes
- Contamination of some sources of drinking water by the *Giardia lamblia*, parasite, which is carried by beavers are and may infect humans

☐ **Degradation of fish habitat**

- Impediment to fish migration
- Silting and destruction of salmonid spawning areas
- Higher temperatures in slower, warmer waters, with adverse effects on brook trout

SHEET 3 -Advantages and Disadvantages of Beaver Presence (2 of 2)

Effects deemed negative (cont'd)

☐ **Cost**

- Cost of damage
- Cost of management techniques (prevention, control and maintenance)
- See Table 3 (Summary of Management Techniques) in Chapter 7 for the cost range of proposed measures
- See the "Nature of damage" section on sheets 1a and 1b for costs associated with prior measures.

Cost _____

Description _____

Costs can be defrayeds ☐ cannot be defrayed ☐

Overall rating

☐ Overall, the positive effects are **greater** than the negative effects.
☐ Overall, the positive effects are **less** than the negative ones.
☐ Overall, the positive effects are **equal** to the negative ones.

Remarks: _____

Filled out by: _____ Date: _____

SHEET 4 - Monitoring and Evaluation (1 of 2)

File number: _____

General information

Location of the site: _____ Latitude: _____ N Longitude: _____ W

Owner ☐ or manager ☐ _____

Summary of problem: _____

_____

Priority code (see sheet 1a):
1 ☐ Emergency response and monitoring
2 ☐ Medium-term measures and monitoring
3 ☐ No measures and monitoring

Intervention: Development ☐ Prevention ☐ Control ☐

Description of initial measures

(See Measures Taken on Sheet 1b)

Measures taken: _____

_____

_____

Detailed description (append sketch if needed): _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Date of action: _____

Filled out by: _____ Date: _____

SHEET 4 - Monitoring and Evaluation (2 of 2)

Description of subsequent measures

Type of action: Checking/Evaluating ☐ Cleaning ☐ Repair ☐ Other ☐

Evaluation of the effectiveness of the initial measure: _____

Habitat(s) of other affected wildlife species ☐ If yes, how: _____

Detailed description of the measure: _____

Date of measure: _____ Photo/slide number: _____

Hours worked on the site: _____ Number of workers: _____

Estimated cost: Materials _____ + Installation _____ = _____

Revised priority code: 1 ☐ 2 ☐ 3 ☐

Measure recommended ☐ or planned ☐ _____

Filled out by: _____ Date: _____

APPENDIX 2 EXTRACTS FROM ACTS, REGULATIONS AND POLICIES

This appendix contains extracts from acts, regulations and policies deemed relevant to measures with respect to beavers. This list, however, is not exhaustive, as other acts, regulations and policies may also apply. **This document should not be considered an authoritative version of the acts and regulations in force.** In the event of any discrepancy, only the official texts—those appearing in the *Gazette officielle* or published by the *Direction de la refonte des lois et règlements*— have force of law.

List of acts, regulations and policies:

- *An Act respecting the conservation and development of wildlife*
  - Regulation respecting wildlife habitats
- *Environment Quality Act*
  - Regulation respecting the application of the Environment Quality Act
  - Regulation respecting environmental impact assessment and review
  - Protection Policy for Lakeshores, Riverbanks and Littoral Zones and Floodplains
- *Watercourses Act*
- *Dam Safety Act*
- *Forest Act*
  - Regulation respecting standards of forest management for forests in the public domain
- *Fisheries Act*
  - Policy for the Management of Fish Habitat

AN ACT RESPECTING THE CONSERVATION AND DEVELOPMENT OF WILDLIFE

(R.S.Q., C. C-61.1)

Provincial Act administered by the *Société de la faune et des parcs du Québec*

- **Section 26**

Prohibition. "No person may disturb, destroy or damage a beaver dam or the eggs, nest or den of an animal".

Derogation. "A person or anyone lending him assistance may derogate from the prohibition under the first paragraph if he cannot prevent an animal from causing damage to his property or to property under his care or maintenance".

Authorization. "The Société, on the conditions it determines, may authorize a person to derogate from the first paragraph".

- **Section 26.1**

Trap setting. "Notwithstanding section 26, the holder of a trapping licence may, during the period and on the conditions determined by regulation of the Société, damage a beaver dam to ascertain the presence of beavers or to set a trap".

- **Section 47**

Special licences. "The Société may, for scientific, educational or wildlife management purposes, issue a licence authorizing a person to disregard a provision of section 26 (...) or a provision of the first paragraph of section 128.6".

- **Section 67**

Attacking animals. "No person nor anyone lending him assistance may kill or capture an animal attacking him or causing damage to his property or property under his care or maintenance unless he is unable to frighten the animal away or prevent it from causing damage".

- **Section 68**

Animal killed or found. "A person shall, without delay, in the case of an animal determined by regulation,

(1) if it is unharmed and alive, set it free;

(2) if it is wounded or dead, declare the fact to a conservation officer and, if he requires, deliver it to him so he may confiscate it".

- **Section 128.6**

Prohibitions. "No person may, in a wildlife habitat, carry on an activity that may alter any biological, physical or chemical component peculiar to the habitat of the animal or fish concerned".

Exceptions. "The prohibition in the first paragraph does not apply to

(1) an activity exempted by regulation;

(2) an activity carried on in accordance with the standards or conditions of management prescribed by regulation;

(3) an activity authorized by the Société, the Minister or the Government under this Act;

(4) an activity required to repair damage caused by a catastrophe or to prevent possible damage from an apprehended catastrophe".

- **Section 128.7**

Alteration of wildlife habitat. "The Société may authorize the carrying on of an activity that alters a wildlife habitat".

Regulation respecting wildlife habitats
(O.C. 905-93, 1993 G.O. 2, 3536) [C-61.1, r. 0.1.5-A]

• Section 1

"For the purposes of Chapter IV.1 of the Act respecting the conservation and development of wildlife (R.S.Q., c. C-61.1) and for the purposes of this Regulation, wildlife habitats are habitats located on land in the public domain, having the following features or in which the following conditions prevail and, in the case of habitats described in paragraphs 1 to 5 and 8 to 11, which are demarcated on a chart prepared by the Minister:

(6) **'habitat of a threatened or vulnerable wildlife species'** means a habitat defined by the Regulation respecting threatened or vulnerable species and their habitats (O.C. 950-2001);

(7) **'fish habitat'** means a lake, a swamp, a marsh, a floodplain delimited by the mean high-water-level for a 2-year period of a watercourse, frequented by fish; where the limits of a floodplain cannot be established as indicated, they shall correspond to the natural high-water mark".

• Section 8

"A person may, in a wildlife habitat other than the habitat of a threatened or vulnerable wildlife species, carry on the forest management activities provided for in section 3 of the Forest Act (R.S.Q., c. F-4.1), provided that the person complies with the standards applicable to those activities and prescribed in the Regulation respecting standards of forest management for forests in the public domain (O.C. 1627-88 [F-4.1, r. 1.001]), with any future amendments.

The person shall also carry on those activities in compliance with the forest management permit issued under that Act or in compliance with the forest management plan approved by the Minister of Natural Resources where such permit or plan is required by that Act".

ENVIRONMENT QUALITY ACT
(R.S.Q., C. Q-2)

Provincial Act administered by the *ministère de l'Environnement*

- **Section 22**

Certificate. "No one may erect or alter a structure, undertake to operate an industry, carry on an activity or use an industrial process or increase the production of any goods or services if it seems likely that this will result in an emission, deposit, issuance or discharge of contaminants into the environment or a change in the quality of the environment, unless he first obtains from the Minister a certificate of authorization".

Certificate of authorization. "However, no one may erect or alter any structure, carry out any works or projects, undertake to operate any industry, carry on any activity or use any industrial process or increase the production of any goods or services in a constant or intermittent watercourse, a lake, pond, marsh, swamp or bog, unless he first obtains a certificate of authorization from the Minister".

- **Section 31.1**

Authorization certificate. "No person may undertake any construction, work, activity or operation, or carry out work according to a plan or programme, in the cases provided for by regulation of the Government without following the environmental impact assessment and review procedure and obtaining an authorization certificate from the Government".

Regulation respecting the application of the Environment Quality Act
(O.C. 1529-93, (1993) G.O. II, 7766) [c. Q-2, r. 1.001]

- **Section 1**

"The following projects are exempt from the application of section 22 of the Environment Quality Act (R.S.Q., c. Q-2):

(1) construction, work or activities governed by the Regulation respecting standards of forest management for forests in the public domain (O.C. 1627-88 [F-4.1 r. 1.001]), except the construction, reconstruction, widening or straightening of a road located less than 60 metres from a constant watercourse, a lake, a river or the ocean, where the road is to run thus for a distance of at least 300 metres;

(3) work, construction or projects on a bank or shore, on a flood plain or along the shoreline of a watercourse or lake, where permitted under the Protection Policy for Lakeshores, Riverbanks and Littoral Zones, (O.C. 1980-87 [Q-2, r. 17.1]) provided that specific authorization for such work, construction or projects has been given by a municipality pursuant to a zoning, subdivision or construction by-law; work, construction or projects intended for public access or for municipal, industrial, commercial or public purposes are not exempt from the application of section 22;

(4) the following wildlife management work:

a) the construction or repair of a fish ladder, a fish way or another work allowing fish to travel freely;

d) the installation of obstacles to fish migration;

h) the installation of an upstream dam for beavers;

i) the control of the water-level near a beaver dam; and

j) the dismantling of a beaver dam".

Regulation respecting environmental impact assessment and review (R.R.Q., 1981, c. Q-2, r.9)

- **Section 2**

  List. "The constructions, works, plans, programmes, operations and activities described below are subject to the environmental impact assessment and review procedure provided for in Division IV.1 of the Act and must be the subject of a certificate of authorization issued by the Government in accordance with section 31.5 of the Act:

  a) the construction and subsequent operation of a dam or dyke located at the outflow point of a lake whose total surface area exceeds or will exceed 200 000 square metres, or a dam or dyke intended to create a reservoir whose total surface area exceeds 50 000 square metres;

  b) any programme or project involving the dredging, digging, filling, levelling off or backfilling of a watercourse referred to in Schedule A or of a lake, within the average spring high water line, over a distance of 300 metres or more or an area of 5 000 square metres or more, and any programme or project involving dredging, digging, filling, levelling off or backfilling, for any purpose whatsoever, cumulatively equalling or exceeding the above limits for the same watercourse referred to in Schedule A or the same lake, except for works on a river that drains a watershed of less than 25 square kilometres, surface or underground drainage works on the flood plain of a watercourse referred to in Schedule A, construction of a levy on private agricultural land in the flood plain of a watercourse referred to in Schedule A to protect the land from flooding, as well as any works on a river in accordance with an act of agreement, regulation or municipal report in force before 30 December 1980".

Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains (O.C. 103-96, (1996) 128 G.O. II, 1263)

- **Section 3. Lakeshores, riverbanks and littoral zones**

  Lakes and watercourses subject to protection. "This policy applies to all continuous or intermittent watercourses and lakes. It does not apply to ditches as defined in Subsection 2.6. In public forests, this policy applies to the categories of watercourses defined in the Regulation respecting standards of forest management for forests in the public domain".

  Prior authorization. "The Minister of the Environment and Wildlife recommends that a municipal permit or certificate of authorization be required for all buildings, undertakings and works which are liable to destroy or alter the vegetation cover of a lakeshore or riverbank, expose the soil or affect the stability of the lakeshore or riverbank, or encroach on the littoral zone, with the exception of buildings, undertakings and works related to forest management activities subject to the Forest Act and its attendant regulations".

- **Section 4. Floodplains**

  Prior authorization. "The Minister of the Environment and Wildlife recommends that a municipal or government permit or certificate of authorization, as the case may be, be required for all buildings, undertakings and works which might alter the water regime, hinder the free flow of water during floods, disturb plant or wildlife habitats of special interest or threaten the safety of humans or property".

- **Section 6. Implementation**

  "Under the Act respecting land use planning and development (R.S.Q., c. A-19.1), the municipalities are responsible for adopting and enforcing by-laws to implement the principles of this protection policy in accordance with the development plans and complementary documents of the regional county municipalities".

  "Responsibility for implementing the policy on lands in the public domain is shared between the government and the municipalities".

WATERCOURSES ACT
(R.S.Q., C. R-13)

Provincial Act administered by the *ministère de l'Environnement*

- **Section 5**

Riparian owners. "Every owner of land may improve any watercourse bordering upon, running along or passing across his property, and may turn the same to account by the construction of mills, manufactories, works and machinery of all kinds, and for such purpose may erect and construct, in and about such watercourse, all the works necessary for its efficient working, such as flood-gates, flumes, embankments, dams, dykes and the like".

- **Subsection 13.1**

Damage. "The owner or operator of any work constructed in a watercourse, or of a plant, a mill, a manufactory, works or machinery of any kind contemplated in section 5, is liable for any damage resulting therefrom to any person, whether by excessive elevation of the flood-gates or otherwise".

- **Section 71**

Prior approval of plans and specifications. "Notwithstanding any inconsistent provision of any general law or special act, no person shall erect and maintain a dam, dike, causeway, sluice, embankment or other work serving to retain the waters of a lake, pond, river or stream unless the plans and specifications relating thereto have been approved by the Government, except in the case of works for which plans and specifications must be submitted for the approval of the Government under other provisions of this act or of works of a temporary nature contemplated in section 39".

- **Section 76**

Concession required in certain cases. "If the construction and maintenance of any such work necessitate the taking possession or occupation of any lands in the domain of the State, or if such work must have the effect of flooding or otherwise prejudicially affecting such public lands or any other right of the domain of the State, it shall be necessary to obtain from the Government, in advance, in addition to the approval referred to in section 75, in consideration of an annual rental or other remuneration, a concession of the lands or the public rights which will be so taken, occupied or affected".

- **Section 80**

"Work." "In this division, the word 'work' includes any dam, dike, causeway, sluice, embankment or other construction, even if made in conformity with the plans and specifications approved by the Government, and at whatever time made".

- **Section 81**

Works to ensure safety. "When a work serving to retain the waters of a lake, pond, river or stream is in such condition as to endanger persons or property, any judge of the Superior Court sitting in the district where such work is located may, upon motion by the Attorney General and presented even during a suit, order the owner of such work to perform the works necessary to ensure the safety of such persons or property or, if there is no other effective remedy, to demolish the work within such time as he fixes, and order that, on failure to do so within such time, the Minister of the Environment may perform such works or effect such demolition at the expense of the owner".

DAM SAFETY ACT
(S.Q. 2000, C.9)

Provincial Act administered by the *ministère de l'Environnement*

N.B.: *At the time this document went to press, the* Dam Safety Act *had been assented to but was not yet in force. The Regulations were still being prepared.*

• Section 2

"For the purposes of this Act, "dam" means any works intended to divert or impound the water of a watercourse or of a lake or reservoir listed in the *Répertoire toponymique du Québec* or a supplement to that publication. In addition, a person holding or operating a dam shall be considered to be a dam owner".

• Section 4

"The following dams are considered to be high-capacity dams:

(1) dams 1 metre or more in height having an impounding capacity greater than 1,000,000 m^3;

(2) dams 2.5 metres or more in height having an impounding capacity greater than 30,000 m^3;

(3) dams 7.5 metres or more in height, regardless of impounding capacity;

(4) regardless of their height, retaining works and works appurtenant to a dam referred to in paragraph 1, 2 or 3, and works intended to retain all or part of the water stored by such a dam".

• Section 5

"The construction, structural alteration or removal of any high-capacity dam requires the authorization of the Minister of the Environment. The authorization of the Minister is also required for any change in use of a high-capacity dam likely to affect the safety of the works, and for any permanent or temporary stopping of the operation of the dam".

• Section 19

"The owner of a high-capacity dam must have an impounded water management plan prepared by an engineer according to the conditions and within the time fixed by the Government by regulation, and must keep the management plan current. In addition, the owner of the works must, in collaboration with the emergency preparedness authorities and in compliance with the conditions and time limits fixed by the Government by regulation, prepare and keep current an emergency action plan. The owner of the works is responsible for ensuring that the plans are applied. The plans must remain available for inspection by the Minister. The information contained in the impounded water management plan and in the emergency action plan is public information. The Government shall, by regulation, determine the manner in which the plans are to be made available to the public. A regulation made by the Government pursuant to the first or second paragraph may, however, prescribe the conditions on which dams may be exempted from an obligation set out in those provisions".

• Section 20

"Every high-capacity dam must be monitored and maintained on a regular basis to ensure the timely detection and correction of any deficiency and to maintain the works in good repair".

• Section 28

"The following dams are considered to be low-capacity dams:

(1) dams 2 metres or more in height to which section 4 does not apply;

(2) regardless of their height, retaining works and works appurtenant to a dam referred to in paragraph 1, and works intended to retain all or part of the water stored by such a dam".

• Section 29

"The construction, structural alteration or removal of any low-capacity dam must be declared. The declaration must be filed with the Minister by the promoter or owner of the dam at the same time as an application for authorization under section 22 of the Environment Quality Act (R.S.Q., chapter Q-2), or a notice required under section 31.2 of that Act if the project is subject to an environmental assessment. The Government shall, by regulation, determine the information to be contained in and the documents to be submitted with the declaration".

- **Section 31**

  "The Minister shall establish and keep current a register of all dams 1 metre or more in height. For that purpose, every owner of such a dam is required to inform the Minister of the existence of the works".

- **Section 33**

  "The Minister may, for the purpose of assessing the safety of a dam, order the owner of the works to carry out any test, survey, testing or verification the Minister specifies. The Minister may also, for the same purpose, order the owner to install, within the time specified, any device or apparatus the Minister indicates. Furthermore, the Minister may require the owner to report, in the form and within the time the Minister determines, on any aspect of the construction or operation of the dam and to submit the report with any information or document required".

- **Section 34**

  "Where the Minister is of the opinion that a dam does not sufficiently ensure the safety of persons or the protection of property, the Minister may order the owner of the works to take any measure the Minister considers appropriate, including the lowering of the impounded water-level or the removal of the works".

FOREST ACT
(R.S.Q., C. F-4.1)

Provincial Act administered by the *ministère des Ressources naturelles*

- **Section 1**

  "This Title applies to forests in the domain of the State".

- **Section 2**

  "No one may carry on a forest management activity unless he is the holder of a forest management permit issued for that purpose by the Minister".

- **Section 25**

  "Every holder of a forest management permit shall, in carrying on forest management activities, comply with the standards of forest management which the Government prescribes by regulation".

Regulation respecting standards of forest management for forests in the public domain
(O.C. 498-96, (1996) 128 G.O. II, 2750) [c. F-4.1]

- **Section 2**

  "A holder of a management permit shall preserve a buffer strip 20 metres wide along the banks of a peat bog with a pond, of a swamp, of a marsh, of a lake or of a permanent watercourse, as measured from the line of the stands adjacent to the riparian ecotone.

  This section does not apply to any section of the banks of the peat bog located more than 500 metres from a pond, nor to a holder of a management permit for mining activities where he is carrying out mining activities, to a holder of a management permit for a wildlife or recreational development project, to a holder of a management permit for public utility works, nor in the cases provided for in section 17".

- **Section 4**

  "Notwithstanding section 2, a holder of a management permit may harvest trees in a stand located in the buffer strip where the land in that strip has a slope of less than 40%.

  Notwithstanding the foregoing, when harvesting the trees, the permit holder shall not reduce the number of standing live trees per hectare to less than 500 trees of all species having a diameter of 10 centimetres or more, as measured at a height of 1.30 metres above the highest ground level. Cutting with regeneration and soil protection and strip cutting with regeneration and soil protection are nevertheless prohibited in the buffer strip.

  Notwithstanding the second paragraph, in the case of the stands of species referred to in Part B of Schedule 2, the intensity of the cutting shall be identical to that in the adjacent management sectors having such forests, without reducing the basal area to less than 14 m^2/ha".

FISHERIES ACT
(R.S.C. (1985), C. F-140 [FA-1]

Federal Act administered by the Department of Fisheries and Oceans

• Section 20

(1) ***Fish-ways to be made as the Minister directs.*** "Every obstruction across or in any stream where the Minister determines it to be necessary for the public interest that a fish-pass should exist shall be provided by the owner or occupier with a durable and efficient fish-way or canal around the obstruction, which shall be maintained in a good and effective condition by the owner or occupier, in such place and of such form and capacity as will in the opinion of the Minister satisfactorily permit the free passage of fish through it."

(2) ***Idem.*** "Where it is determined by the Minister in any case that the provision of an efficient fish-way or canal around the obstruction is not feasible, or that the spawning areas above the obstruction are destroyed, the Minister may require the owner or occupier of the obstruction to pay to him from time to time such sum or sums of money as he may require to construct, operate and maintain such complete fish hatchery establishment as will in his opinion meet the requirements for maintaining the annual return of migratory fish".

• Section 22

(1) ***Water for the descent of fish.*** «"At every obstruction, where the Minister determines it to be necessary, the owner or occupier thereof shall, when required by the Minister, provide a sufficient flow of water over the spill-way or crest, with connecting sluices into the river below, to permit the safe and unimpeded descent of fish".

(2) ***Protection during construction.*** "The owner or occupier of any obstruction shall make such provision as the Minister determines to be necessary for the free passage of both ascending and descending migratory fish during the period of construction thereof ".

(3) ***Sufficient water for river bed below dam.*** "The owner or occupier of any obstruction shall permit the escape into the river-bed below the obstruction of such quantity of water, at all times, as will, in the opinion of the Minister, be sufficient for the safety of fish and for the flooding of the spawning grounds to such depth as will, in the opinion of the Minister, be necessary for the safety of the ova deposited thereon".

• Section 32

Destruction of fish. "No person shall destroy fish by any means other than fishing except as authorized by the Minister or under regulations made by the Governor in Council under this Act".

• Section 34

(1) **Definitions.** "For the purposes of sections 35 to 43,

"**deleterious substance**" means (a) any substance that, if added to any water, would degrate or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water.

"**fish habitat**" means spawning grounds and nursery, rearing, food supply and migration areas on wich fish depend directly or indirectly in order to carry out their life processes".

• Section 35

(1) ***Harmful alteration, etc., of fish habitat.*** "No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat".

(2) ***Alteration, etc., authorized.*** "No person contravenes subsection (1) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act".

• Section 36

(3) ***Deposit of deleterious substance prohibited.*** "Subject to subsection (4), no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water".

Policy for the Management of Fish Habitat
(October 1986) [DO-3]

- **Section 1.1**

  Introduction. "Accordingly, pursuant to the Act, this policy will apply to all projects and activities, large and small, in or near the water, that could 'alter, disrupt or destroy' fish habitats, by chemical, physical or biological means, thereby potentially undermining the economic, employment and other benefits that flow from Canada's fisheries resources".

- **Section 2.2.1**

  "The Guiding Principle: No Net Loss of the Productive Capacity of Habitats

  Interpretation. (1) The no net loss principle is fundamental to the habitat conservation goal. Under this principle, the Department will strive to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented".

- **Section 4.1**

  Protection and Compliance. "Protect fish habitats by administering the Fisheries Act and incorporating fish habitat protection requirements into land and water use activities and projects".

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Northern Québec is a territory abounding in wildlife species and fragile ecosystems.
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This document, produced to help solve management problems associated with the beaver, is an essential tool for decision-making, management work, prevention and monitoring activities. It includes:

- Basic notions on beaver ecology, its status in the province of Quebec, the positive and negative impacts generated by its presence, population management, and legislation;
- A description of the different approaches to risk assessment and to reducing intervention and maintenance costs;
- A description of management techniques, including their advantages and disadvantages;
- Data sheets for site characterization and risk assessment, evaluation of beaver habitat potential, identification of advantages and disadvantages associated with its presence, and monitoring.

This guide is intended for hunting, trapping and fishing associations, municipalities, government departments and Crown corporations, forestry interests, regional management agencies for private forests, farming interests, biology and forestry students, and wildlife habitat protection and development groups. By publishing this guide, the *Fondation de la faune du Québec* and its partners seek to raise awareness among land use managers by providing them with a tool to assess the positive and negative repercussions of beaver activity. In this way, they hope to protect and develop habitat while offering a range of options for curtailing and controlling beaver activity.

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une réalisation de la
FONDATION DE LA FAUNE DU QUÉBEC

Québec
Ministère des Ressources naturelles

WILDLIFE HABITAT CANADA
HABITAT FAUNIQUE

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