Northeast Science & Technology

The Beaver Handbook:

A Guide to Understanding and Coping with Beaver Activity

NEST Field Guide FG-006
March 1995

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NODA · EDNO
CANADA
ONTARIO
Northern Ontario Development Agreement
Entente de développement du nord de l'Ontario
Forestry • Foresterie

Natural Resources Canada
Ressources naturelles Canada
Canadian Forest Service
Service canadien des forêts

Ontario
Ministry of Natural Resources
Ministère des Richesses naturelles

Funding for this project and for the publication of this field guide has been provided through the Northern Ontario Development Agreement (NODA), Northern Forestry Program.

Publication Information

Canadian Cataloguing in Publication Data
D'Eon, Robert G. (Robert George), 1964-
The Beaver Handbook
(NEST field guide, ISSN 1195-4558; FG-006)
ISBN 0-7778-3745-5
1. Beavers, I. Title. II. Ontario, Northeast Science & Technology. III. Series.
QL737.R632D46 1995 599.32'32 C95-964023-1

Illustrations by Shayna LaBelle-Beadman

1995, Queen's Printer for Ontario
Printed in Ontario, Canada
NEST field guide FG-006
50659
ISBN 0-7778-3745-5
ISSN 1195-4558
(2.5 k PR., 15-Mar-95)
Copies of the publication are available from the Ontario Ministry of Natural Resources through:
Northeast Science & Technology
60 Wilson Avenue
Timmins, Ontario
P4N 2S7

Cette publication spécialisée n'est disponible qu'en anglais

This Field Guide should be cited as:
D'Eon, R.G., Lapointe, R., Bosnick, N., Davies, J.C., MacLean, B., Watt, W.R., Wilson, R.G. 1995. The beaver handbook: a guide to understanding and coping with beaver activity. OMNR, Northeast Science & Technology. FG-006. 76p.

Acknowledgments

We would like to thank:

- The 505 survey respondents, without whom much of the information presented in this handbook would be absent. We are especially thankful to those who sent us photographs, videos, and other material.
- Bruce Adamson, Don Barnes, Doug Brooks, Mike Buss, Rick Dickson, Jack Cavanagh, Dave Holla, Paul Millette, Milan Novak for providing thoughtful reviews.
- Shayna LaBelle-Beadman for all illustrations and technical drawings, Wendy Copps for layout and design, Louise Clement for proofreading, and Doug Skeggs for questionnaire design, editing, and for co-ordinating the publication of this field guide.
- Bob MacLean, Ned Bosnick, Russell Williams, Paul Weedon, Neil Dawson and Ron Lapointe for the original project proposals.
- Don Barnes for providing a comprehensive beaver bibliography; Jack Cavanagh for providing local beaver management information; Kim Armstrong and Wayne Fiset for input on aquatic ecology; and Louise Clement, Marianne Hendry, Andrias Kroltz, Darlene Landriault, and Jane Stringer for help with questionnaire data and follow-up calls.

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A typical problem on forest access roads. This road was flooded out when beavers blocked a culvert.

How This Handbook Will Help You

- Do beavers disrupt your operations?
- Do you repeatedly clean out blocked culverts?
- Do you have to deal with costly road washouts due to beaver activity?
- Do you lose valuable land and timber to beaver-related flooding?

This handbook will help resource managers and field staff in northern Ontario deal with problems related to beaver activity (hereafter referred to as beaver problems). When faced with beaver problems, the usual course of action is to remove the beavers and destroy the associated dams.

In some situations, beaver removal may be the best solution. In other situations, maintenance and regulation of beavers and their impoundments can be an ecologically-sound and cost-effective alternative.

This handbook presents methods and ideas for dealing with beaver problems. Biological information that will help managers make informed decisions based on beaver behavior and characteristics is also provided.

Much of the information in this handbook reflects opinions and experiences of over 500 people from across North America who deal with beaver problems.

We encourage adaptations of the ideas presented in this handbook to suit individual circumstances. In fact, most successful methods are developed from local variations to common principles.

Using this handbook in combination with thoughtful management and ingenuity, will result in better decision-making and increased cost savings.

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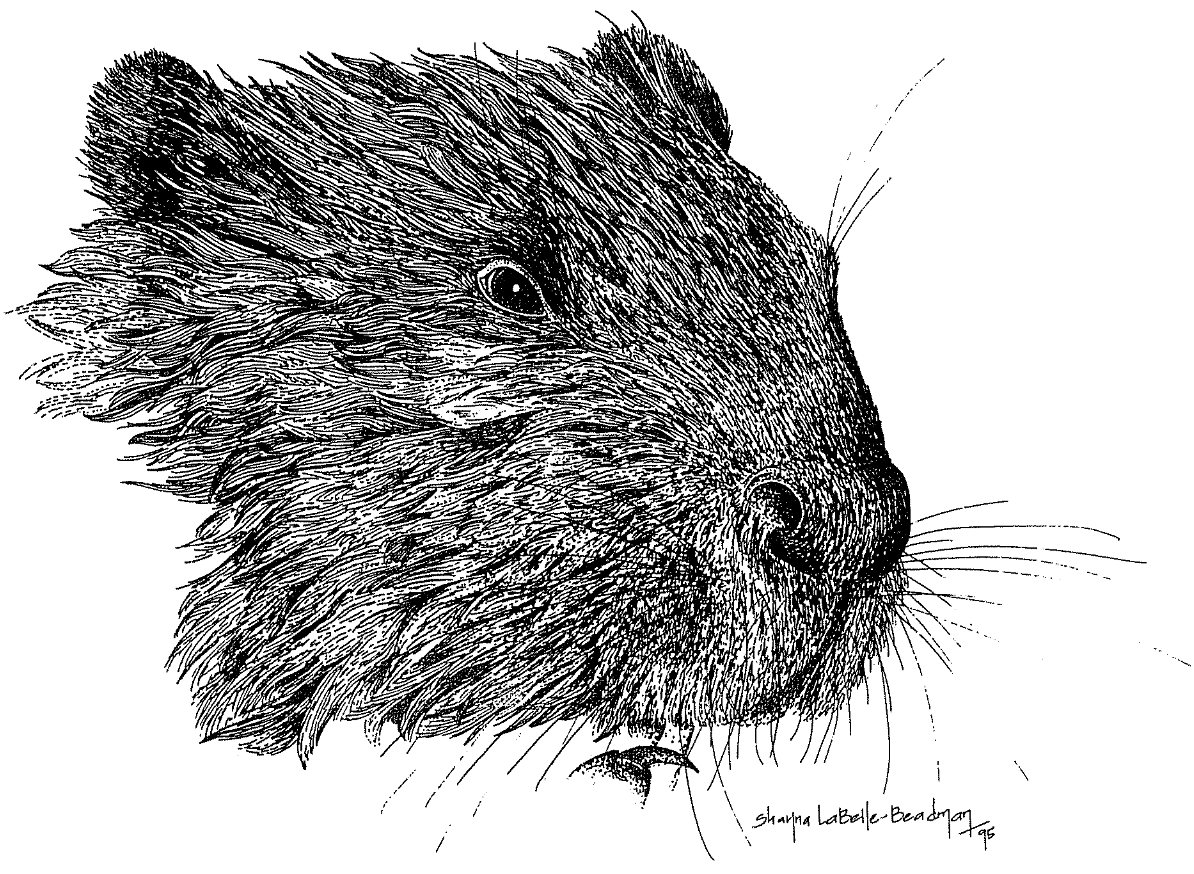

Shayna LaBelle-Beadman '95

Part I: Introduction

Few wildlife species rival the beaver (*Castor canadensis*) in importance to the natural and cultural heritage of North America. It was the value of beaver pelts that brought early trappers and fur-traders to northern areas of the continent.

By the end of the last century, beavers had been trapped almost to extinction throughout North America. With the advent of wildlife laws and new management techniques in the early 1900s, beavers have made a remarkable recovery throughout their range. Nowhere is this more obvious than in northern Ontario.

Beaver reintroductions, land management practices favoring good beaver habitat, and reduced trapping levels due to low fur prices, have resulted in the highest beaver population levels since European settlement of North America.

Beavers are an important part of North American ecosystems. Their activities benefit countless other species. Unfortunately, beaver activities are often in conflict with human use of the land base. Road wash-outs, flooded land, and lost timber resources often result.

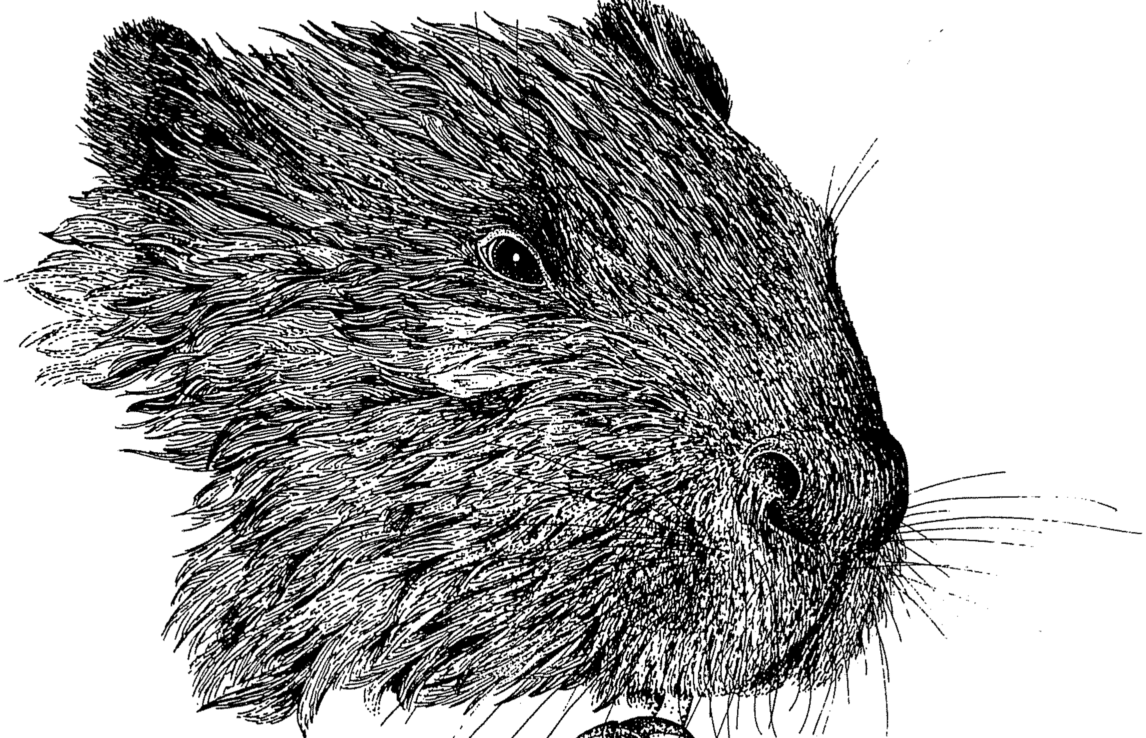
Each year, companies and government agencies in northern Ontario spend millions of dollars responding to beaver problems. This cost is increasing and reports of beaver problems are higher than ever.

In direct response to client demands, the Northeast Science & Technology (NEST) unit of the Ontario Ministry of Natural Resources (MNR), investigated alternatives and solutions for dealing with beaver problems.

We employed two strategies. One was a North America wide survey of people with experience and knowledge in dealing with beaver problems. We received over 500 responses to the survey.

Our second strategy involved a literature review on beaver biology, management, and related topics.

Both of these efforts were combined to produce this handbook providing the most up-to-date information for dealing with beaver related problems in northern Ontario.



Part II: Survey Results

Part II: Survey Results

We created a questionnaire (Appendix) to gather specific information from people with hands-on experience in dealing with beaver problems. This information was extremely useful in providing experience and suggestions not usually found in the conventional literature.

A total of 1750 questionnaires were sent out to government and private organizations across North America:

- 115 within the MNR Northeast Region (NER)
- 135 elsewhere in Ontario
- 500 elsewhere in Canada
- 1000 in the United States.

Overall, 505 (29 percent) completed questionnaires representing nine provinces, two territories, and 39 states were returned:

- 50 from within the NER
- 90 from elsewhere in Ontario
- 132 elsewhere in Canada
- 219 in the United States (14 did not provide an address).

The results of the survey showed interesting regional differences and provided information on many different techniques for dealing with beaver problems (**Tables 1 and 2**).

The most serious types of problems and damage varies from flooding of bottomland timber in the southeast U.S. to road damage due to blocked culverts in northeastern Ontario. Frequency of beaver-related incidents is high throughout with 70 percent of respondents (88 percent in MNR NER) indicating they deal with more than five problems annually.

Beaver problems in the NER appear to be concentrated in May and June and then decline through the summer and fall. A similar peak in beaver problems occurs across North America in May and June but they persist through the winter, presumably due to warmer climates.

Table 1: Survey Results*

Response	North America	MNR Northeast Region
Number received	505	50
Percentage - Government	86 %	48 %
Percentage - Private	11 %	52 %

Kinds of Problems (Proportion of respondents indicating damage affects operations)

	North America	Northeast Region
Road flooding/damage	71 %	86 %
Culvert blockage/damage	82 %	84 %
Damage to standing timber	48 %	30 %
Flooding of land	57 %	34 %

Frequency of beaver-related problems requiring attention annually
(Proportion of respondents indicating frequency of problems requiring attention annually)

Frequency	North America	Northeast Region
1 to 5	25 %	8 %
6 to 20	30 %	40 %
over 20	40 %	44 %

Time of year (Percentage of respondents indicating time of year problems occur)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North America	9	11	24	47	69	65	52	52	58	49	26	11
Northeast Region	0	0	2	28	82	82	70	64	66	42	16	0

*Figures do not always sum to 100 % because some respondents did not answer all questions.

Table 2: Survey Results*

Methods used and success (Overall percentage of all respondents using method, and proportion of those indicating success rate; MNR Northeast figures in brackets)

	Uses	Always Successful	Sometimes Successful	Never Successful
Remove Beavers by:				
trapping	94 % (94 %)	34 % (43 %)	65 % (57 %)	1 % (0 %)
shooting	75 % (66 %)	18 % (24 %)	78 % (70 %)	4 % (6 %)
live-trapping/relocating	41 % (32 %)	10 % (6 %)	62 % (56 %)	28 % (38 %)
Destroy dams by:				
explosives	55 % (48 %)	22 % (29 %)	71% (67 %)	7% (4 %)
manually	83 % (74 %)	12 % (16 %)	69 %(62 %)	19 % (22 %)
mechanical	75 % (70 %)	14 % (28 %)	79% (63 %)	7% (9 %)
Control water levels by:				
barriers/grills	45 % (42 %)	5 % (5 %)	79 % (76 %)	16 % (19 %)
syphons/pipes	40 % (18 %)	6 % (0 %)	82 % (78 %)	12 % (22 %)
low-flow crossings	22 % (12 %)	3 % (0 %)	69 % (50 %)	28 % (50 %)
reinforce dams	10 % (8 %)	2 % (0 %)	46 % (25 %)	53 % (75 %)
replace dams	11 % (10 %)	2 % (0 %)	48 % (20 %)	50 % (80 %)
electric fence	15 % (12 %)	3 % (0 %)	65 % (17 %)	32 % (83 %)
Prevention by:				
bridges vs. culverts	40 % (24 %)	12 % (0 %)	76 % (67 %)	12 % (33 %)
larger culverts	49 % (32 %)	4 % (0 %)	77 % (56 %)	19 % (44 %)
site selection	35 % (32 %)	7 % (6 %)	79 % (56 %)	14 % (38 %)
road design	34 % (28 %)	6 % (14 %)	75 % (43 %)	18 % (43 %)

*Figures do not always sum to 100 % because some respondents did not answer all questions.

Removing beavers and their dams is the most common solution to beaver problems throughout North America. Use of alternative water control and preventative methods is generally low, especially in northern Ontario. Many people commented on this saying that information on alternatives and options is needed.

Out of the total 505 respondents, 451 (89 percent) indicated they destroyed dams, and 476 (94 percent) indicated they removed beavers. Only one person indicated they successfully solved beaver problems by removing dams without removing beavers. Almost all respondents who destroy dams indicated beavers must also be removed or dams will be rebuilt within days.

In removing beavers, 99 percent and 96 percent of respondents had some success with trapping and shooting, whereas only 78 percent had success with relocating beavers. Comments suggest that this lower figure is due to the scarcity of non-occupied habitats available as relocation sites and difficulties associated with live-trapping.

Respondents destroying dams with explosives and mechanical means indicated they have some success 93 percent of the time, as compared to 81 percent of the time using manual means. Comments suggest that manual methods were employed only when mechanical access was not possible. Many respondents expressed concern for the dangers involved in using explosives, including one respondent who witnessed a fatal accident while destroying a beaver dam with explosives. Many indicated that explosives are banned in their jurisdiction, or they simply do not use them for safety reasons.

Success rates for water control methods was highest using barriers/grills and syphons/pipes, with 84 percent and 88 percent of respondents indicated some success with these methods. The lower figures in the other methods may be a result of lack of use. Many respondents commented that diligence and experience are critical to success in using the various methods.

Preventative methods (from questionnaire-Appendix) were rated relatively high with all methods having at least some success 81 percent of the time, but are not commonly used. Considering potential beaver problems in site selection and road design to avert future problems was the most frequent comment.

Some of the more frequent comments are summarized below.

Common Questionnaire Comments

- There is no rule of thumb, must consider individual circumstances
- No one method is 100 percent effective in all situations
- There is a common perception that the only solution is to eliminate beavers
- Few alternatives have been tried
- Actions taken are usually reactive rather than proactive
- Perception that costs of alternative solutions is prohibitive
- Effective program using alternative solutions can be successful and cost-effective
- Usually a combination of methods work best
- Any actions are most effective if done quickly after problem arises
- Any program requires regular, prolonged attention and maintenance, and success depends on diligence and effort
- The potential for beaver problems should be incorporated into road design
- There is a general misunderstanding of beavers and their biology
- Removing beaver dams without removing beavers is a waste of time
- The sound of running water must be eliminated

Part III: Beaver Biology and Management

Beaver Biology

Distribution

Beavers are found throughout North America from northern Mexico to the Arctic tundra, except in areas of the arid U.S. southwest, peninsular Florida, and the high Arctic. The recently published *"Atlas of the Mammals of Ontario"* shows beavers to be present in every surveyed block in northern Ontario.

Physical Characteristics

The North American beaver is the largest rodent in North America, usually weighing between 18 and 23 kg (40 to 50 lbs). The largest beaver ever reported weighed 50 kg, but beavers rarely exceed 27 kg in Ontario. Including its tail, a large adult may grow to 120 cm in total length. Female and male beavers appear similar and must be examined internally to determine sex.

Beaver fur consists of a layer of long stiff guard hairs covering an underlayer of soft dense fur. The guard hairs are waterproofed with body oil and form a streamlined exterior that prevents water and dirt from contacting the underfur.

Beavers have poor eyesight, but acute senses of smell and hearing, and rely primarily on these two senses for communication and gathering information about their environment.

On land, beavers lack agility and are vulnerable to predators. Virtually all of the beavers' characteristics have adapted it for living year-round in aquatic environments. They can swim up to 1 km underwater and stay submerged for fifteen minutes. Some of these characteristics are:

- webbed hind feet and wide rudder-like tail
- transparent membrane covering eyes for underwater vision
- ears and nostrils close while submerged
- lips can close tightly around front teeth while gnawing underwater to prevent water entering mouth

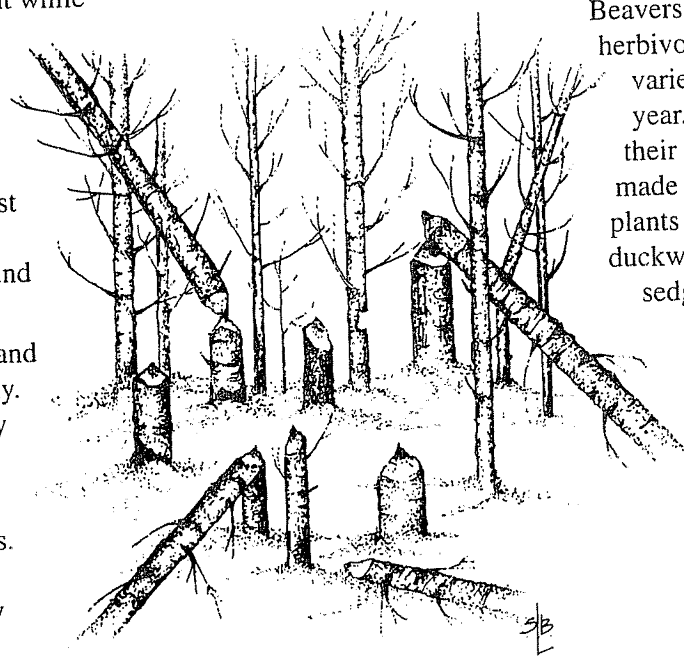
- adaptations to tongue and epiglottis prevent water from entering lungs
- air exchange within lungs is very efficient (five times better than humans)
- heart rate can be lowered by 79 percent while submerged

Habitat and Food

There are essentially two major factors governing where beavers are found. The first is the type of water body; the second, the abundance of food in and immediately around these water bodies.

Water protects beavers from predators and allows them easy access to their food supply. They require a permanent and stable supply of water throughout the year.

Beavers can control water levels on streams, ponds, and lakes by building dams. Large rivers and lakes are usually stable enough that beavers do not have to directly control levels.



Within streams, gradient becomes the limiting factor. Beavers will inhabit streams with gradients up to 14 percent, but gradients of less than 6 percent are optimal. Beavers will also avoid wide expanses of water where large waves build up.

Beavers are completely herbivorous and their diet varies throughout the year. During summer, their preferred diet is made up of herbaceous plants like water lilies, duckweed, grasses and sedges.

During the winter and early spring, they subsist on the bark and wood of tree species within the surrounding area. In some instances, the thick fleshy roots of water lilies may be used as a winter food source, resulting in little or no tree cutting.

Beavers have been known to eat every tree species in Ontario, but their preferred species in northern Ontario is trembling aspen. Other species commonly eaten in northern Ontario are willow, balsam poplar, and white birch.

Reproduction and Mortality

Generally beavers have relatively few offspring, high parental care and low juvenile mortality. Population levels can fluctuate, but there is no evidence that beaver numbers are cyclical.

The basic grouping within beaver populations is the extended family, or colony as it is referred to for management purposes. A beaver family is a closed unit, typically consisting of one monogamous pair of adults and their offspring from one or more generations. Family size varies with habitat quality, but averages 4.2 in northern Ontario.

Within a family, only the adult pair breeds and produces one litter per year. Both males and females are sexually mature at about 21 months and females usually have their first litter at this age. Age of first breeding can be later than 21 months as a result of high population densities.

In Ontario, breeding occurs from January to March. An average litter of three to four kits is born around early May after a 105 to 107 day gestation period. Kits are born fully furred, will make their first trip outside the lodge at about two weeks and are weaned at about two months.

There have been few investigations into beaver mortality. Dispersing young have higher mortality rates than adults, presumably due to higher risk exposure during dispersal movements.

Causes of death vary among populations. In exploited populations, trapping is the most significant mortality factor. Other identified causes of death are severe winter weather, winter starvation, disease, water fluctuations and floods, falling trees, and predation.

Most large predators (e.g. wolf, bear, lynx, otter) in northern Ontario will prey on beaver if the opportunity presents itself. The effect of predators on beaver numbers is variable and depends on local circumstances. In particular, wolves have been reported to consume beavers almost exclusively in some populations during the summer. In these cases, wolves can have significant impacts on beaver numbers.

Under some circumstances, tularemia, an infectious bacterial disease, can decimate beaver populations. There have been reported outbreaks throughout North America in this century. A particularly severe outbreak occurred in Ontario between 1948 and 1951, when beavers nearly disappeared from northwestern Ontario.

Behavior

Annual cycle

Beavers are active throughout the year. During the ice-free period, beavers are most active during dusk and dawn. In early spring as temperatures rise, beavers increase their time above the ice to forage on woody vegetation. As the ice thaws, activity increases and scent marking begins.

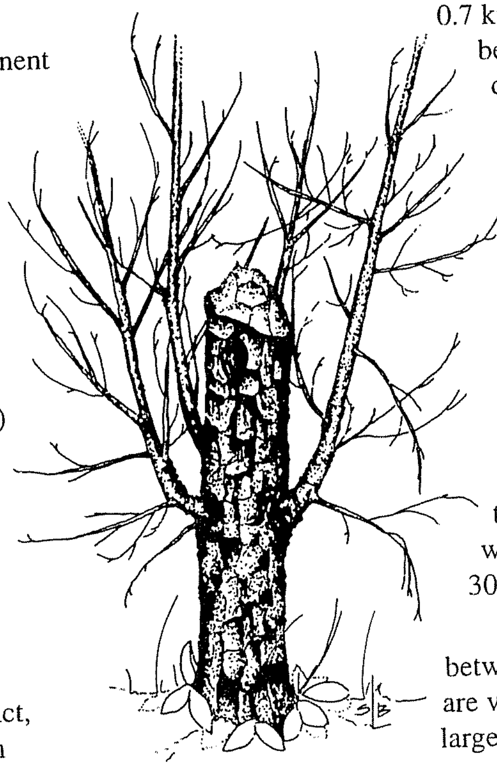
Scent marking is the primary method of territorial establishment in beavers. They will commonly build mounds of mud and vegetation, up to 60 cm high, at the water's edge surrounding their territory. Usually two or three scent mounds are built per territory, but there can be as many as a hundred depending on population densities. All family members mark these mounds by releasing castor and anal gland secretions onto the mound. This activity is most prevalent in early spring and serves to mark territories during the dispersal period.

There is little known about the dynamics of dispersal, site establishment and pair formation in beavers. Dispersing young follow water courses in search of unoccupied areas and begin scent marking upon finding a suitable territory. It appears that pair bonds are established when a suitable mate arrives in the area.

During the spring run-off and other periods of high water, activity focuses on building, repairing, and maintaining dams. With receding water levels during summer, activity shifts towards building and maintaining canals and channels to access new food supplies.

By late summer and early fall, all family members concentrate on repairing and building up dams and the family lodge in preparation for winter. Tree cutting is at its most intense level at this time of year.

In late fall, in preparation for permanent ice coverage, it is critical for beavers to establish a winter food supply. This food cache must supply the entire family with food until the ice melts in the spring.



Dispersal and Territoriality

Young disperse (leave the family unit) in the early spring, usually during the spring run-off, of their second year. Dispersing beavers have been known to travel 8 to 16 km in search of unoccupied habitat, but this distance has been reported to be as much as 236 km.

Each family unit occupies a distinct, non-overlapping, defended territory. In fact, dispersing beavers, when passing through another's territory, can be killed by a resident.

Territory size varies with food availability. In favorable habitat, a beaver family can occupy 0.5 to 0.7 km of a stream, with 150 to 200 m between families. Overall family density is also dependent on habitat quality, but can be 0.4 to 0.8 families per km^2 in favorable habitat.

Tree cutting

Beavers cut down shrubs and trees for food and building materials. Most of their foraging is done within 50 m of the water's edge, but can be up to 200 m from water. Beavers may transport woody material through the water 800 m from upstream sites and 300 m from downstream sites.

Most stems cut by beavers are between 7 and 10 cm in diameter, but they are very capable of cutting large trees. Trees of all sizes are felled close to water, but usually only smaller trees are taken further from the water's edge. Where it is available, a family of beavers will harvest about 0.4 ha of dense aspen per year.

Much of the wood that beavers cut, they do not use. Some of this is felled trees that get caught up in the canopy of other trees and do not drop to the ground. Beavers usually use only the upper branches of large trees. Most branches and twigs under 2 cm in diameter are entirely eaten. Typically, beavers cut large trees only after no smaller trees are available.

Building: Dams, Lodges and Burrows, and Channels

Beavers build dams to provide themselves with a stable body of water deep enough that it will not freeze to the bottom in winter. Dams also create a larger water surface which increases access to trees and other foraging areas. In Ontario, the average size of beaver ponds is about 4 ha.

The sound of flowing water is the primary stimulus causing beavers to begin building a dam. They will continue working in an attempt to eliminate this sound.

All family members participate in dam building and maintenance. Dams are inspected regularly and are maintained throughout the year. Dams vary in size from a small accumulation of woody material to structures 6 m high and over 100 m wide. Large dams often have secondary and tertiary dams associated with them to regulate water levels over large areas. The number of dams built and maintained by a family is usually two or three, but may be as high as 12 or more.

Beavers living on water bodies that maintain a constant level (e.g. lakes, large rivers), do not build dams.

Beaver dens, can be either large mounds of woody material surrounded by water (often called lodges), or burrows dug in banks on the water's edge. Beavers build dens for protection from predators, and warmth and protection from the elements in winter.

Most lodges are about 5 m in outside diameter and 2 m high and constructed of woody material and mud. Usually there is a single living compartment inside, 1 to 2 m in diameter and 1 m high, accessible by two or more underwater entrances.

Burrows have similar inside dimensions but are dug 2 to 3 m into a bank with rising tunnel entrances leading from about 1 m under the water's surface. These burrows are often reinforced with sticks and mud on the ground surface above.

Beavers may reoccupy old abandoned dens before building new dens. One family can have several lodges and burrows, but will typically only use one den during winter.

Beavers may dig channels extending outward from the main water body to provide water access to other foraging areas.

These channels are usually less than 1 m wide and 1 m deep. Their length is limited by terrain and topography, but channels up to 100 m have been observed.

Ecological Relationships within Boreal Forests

As the only North American animal capable of felling large trees and directing drainage patterns of streams and rivers, beavers have a direct, immediate, widespread, and long-lasting impact on the ecology of boreal forests. These effects are numerous and complex. Beavers can:

- modify stream and river geomorphology and hydrology
- increase retention of sediment and organic matter
- create and maintain wetlands
- modify nutrient cycling and decomposition dynamics
- modify riparian zones
- influence the characteristics of water and materials transported downstream
- modify habitat, which ultimately influences community composition and diversity.

Despite relatively high beaver numbers today, recent studies have shown that current beaver populations are still lower than they were, prior to European settlement of North America. Historically, nearly every lake, pond, river, and stream in North America had beavers on them. Basic stream features and ecology may have been substantially changed by the removal of beavers in past centuries.

In untrapped populations, beavers can have long-term influences over 20 to 40 percent of the length of all small rivers and streams and 15 percent of forest land. Some believe beavers to be as important a disturbance factor as fire to boreal forest ecology.

Beavers increase landscape diversity by creating different local drainage and vegetative patterns that change over time as they are abandoned and reflooded. The result is a mosaic of diverse patches with strong long-term influences on a landscape scale. Ultimately, these impacts influence plant and animal community composition and diversity.

Successional pathways

Wetlands created by beaver undergo successional changes. Initially, beaver activity may cause extensive flooding. Trees and shrubs die and fall to the ground or water. The flooded area "opens up" and aquatic plants and other organisms invade the area. Sediment, debris, and other organic material accumulate within the impoundment.

Beavers will leave an impoundment in search of better food resources. Their dams eventually collapse and the impoundment drains. This leaves behind a nutrient-rich substrate available for colonization by pioneer species of plants and animals. The resultant meadow is referred to as a "beaver meadow".

Typically, a beaver meadow forms approximately 15 years after abandonment. This process becomes cyclic when beavers return to reestablish themselves and browse on the new growth.

This process of succession has had a role in shaping much of our landscape in northern North America over the last 10,000 post-glacial years.

Wetland creation

Beaver impoundments contribute significantly to the creation of wetland habitat in boreal forests. Beaver ponds have been referred to as the "potholes" of eastern North America. In Ontario, beaver ponds provide one of the most important sources of waterfowl habitat. Ducks Unlimited's Ontario Beaver Pond Management Program, initiated in

1990, projects major increases in annual waterfowl production through beaver pond management.

Beaver ponds are structurally complex and provide cover to waterfowl. Although waterfowl nesting density is lower, nest success is thought to be higher in beaver ponds than prairie potholes due to the increased cover which results in reduced predation.

A variety of waterfowl species that breed in Ontario rely on beaver ponds and associated habitats for successful nesting. This is particularly true for black ducks, hooded mergansers, wood ducks, ring-necked ducks, and goldeneye. Ontario is a major producer of North American waterfowl due largely to the extensive distribution of beaver ponds and associated habitats throughout the province.

Beaver-created wetlands increase biodiversity on a landscape scale. Countless species of plants, birds, mammals, reptiles, amphibians, insects, and fish are attracted to these wetlands that would otherwise be absent. Beaver created wetlands provide essential aquatic feeding areas for moose. Flooding of forest land creates snags that provide habitat to numerous cavity-using species of birds and mammals. Bird densities in riparian zones associated with beaver ponds have been shown to be three times those in adjacent non-impounded riparian zones.

Jann Atkinson, Ecosurveys Ltd.

An example of how beaver ponds can, over the long-term, alter the local ecosystem.

Riparian (shoreline) zones

Beavers influence the structure, succession, and dynamics of riparian ecosystems.

They remove a much higher proportion of biomass within their range than any other herbivore. One beaver can selectively cut one metric tonne of wood annually in a relatively small area. In an area dominated by aspen, this can result in a virtual clear-cut of all trees in the area.

Plant community changes within riparian zones, also alter the structure and composition of associated soils, litter quality, nutrients, and groundwater. In turn, this affects input from upland areas into streams and rivers, influencing water quality and characteristics.

Hydrologic and aquatic ecosystem effects

Water quality and productivity of beaver impoundments are dynamic and change over time. Due to the initial water contact with surrounding land and vegetation, beaver ponds are usually very productive during the initial years following flooding. After several years, productivity and diversity tend to decrease as decomposition rates and nutrient abundances decrease.

The length of time that a pond will remain at the height of its productivity depends on pond size and physical characteristics, water temperature and depth, flow rate, soil conditions, and vegetation communities. In northeastern Ontario, beaver pond productivity usually begins to decline one to five years after initial flooding. Through successive abandonment and reflooding, these ecosystems are continually renewed.

The effects of dam-building by beavers on stream ecosystems are many and complex. Beaver dams can:

- reduce stream velocity
- shift stream gradient to a stair-step profile
- change sediment and organic matter retention, nutrient and carbon cycling, water quality, and downstream material transport
- modify the accumulation, availability, and movement of ions and nutrients (calcium, magnesium, iron, sulphate, phosphorous, and ammonium) in streams

- increase standing stocks of carbon
- alter stream acidity and water temperature
- reduce downstream flood levels
- change overall stream habitat diversity
- inhibit fish passage

Fire is a primary cause of forest renewal in boreal forest ecosystems. It has a major influence on structure, function, and species composition within boreal forests and affects the quality and quantity of beaver habitat.

Fires return forests to early successional stages. Typically, pioneer species such as aspen will dominate in recently burned riparian areas. These areas, previously abandoned by beavers, can now become suitable and once again, inhabited.

In the absence of fire, forest harvesting in northern Ontario is the most important cause of forest renewal. Many argue that timber harvesting mimics the effects of fire and returns mature coniferous forests to early successional stages. However, the practice of leaving uncut strips of forest (buffers) along water courses, may have important implications to riparian and beaver habitat.

Uncut buffers along water courses can inhibit the natural reversion of mature conifer riparian forests to pioneer deciduous forests. Preventing forest renewal in riparian zones may have long-term negative effects on the quantity and quality of beaver habitat.

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Beaver Management In Ontario

History of Beaver Use

Native people have traditionally used beaver for fur, food, and as a religious symbol. With the availability of firearms and steel traps in the late 1700s, harvests of beaver pelts increased and became an extremely important economic factor in Ontario. Today, fur harvesting continues to be an important part of the culture and economy of northern Ontario. Recent declines in fur markets and prices have reduced the economic importance of trapping.

In recent decades, annual harvests averaged about 150,000 beaver pelts, worth several million dollars to the economy of Ontario. These figures are declining with less than 65,000 beaver pelts harvested in 1992/93. This decline is largely the result of a decline in pelt prices from historic highs of about $45 per pelt to the average 1992/93 price of about $15. However, this downward trend may be recovering with the average 1993/94 pelt price of about $30.

Current Practices

Furbearer management varies throughout North America. In Ontario, the province is broken down into distinct, non-overlapping, registered traplines, which are managed by the MNR. Active traplines have a licensed trapper assigned to them. The trapper and MNR agree on an annual quota of beavers to be harvested off this trapline. If the quotas are not met, or exceeded, the MNR can assign another trapper to this line. All trapping on Crown land in Ontario must be performed by a licensed trapper on a registered trapline (may be outside of a trapline in a nuisance beaver situation).

Beaver quotas are based on population estimates derived by the MNR in consultation with local trappers. Aerial surveys are the most efficient and accurate method of estimating beaver numbers over large areas.

From the aerial surveys, a count of active beaver colonies is obtained based on the presence of a food cache in late fall. This number, multiplied by the average number of beavers per family in the population (derived from field studies), provides an estimate of overall beaver numbers.

Annual harvest quotas in Ontario, are set at 30 percent of the population estimate. The trapper is therefore provided with a quota of between 1.0 and 2.5 beaver per active house for a given trapline.

Damages To Human Values

Damages to human interests caused by beaver activity amounts to over $100 million annually throughout North America. In northern Ontario, costs of beaver problems average millions of dollars annually.

In 1993, the Algoma Central Railway experienced a multi-car derailment near the Agawa Canyon in a washout caused by beaver activity. Damage was estimated at several million dollars. There have also been several fatalities linked to beaver activities. In 1992, a derailment near Nakina, Ontario killed two people. The cause was a breached beaver dam which resulted in a washout of the railway bed.

Damages caused by beaver activity can vary depending on geographic location and amount of human activity. In urban and moderately populated areas damages can include flooding of agricultural crops, destruction of ornamental trees, and unwanted flooding of private land.

In the sparsely populated and forested areas of northern Ontario, damages are largely associated with

Doug Brooks, Ducks Unlimited, Timmins

A wooden bridge was temporarily constructed to allow passage of ATV vehicles over a road washout. Subsequently, the bridge was also damaged by flows resulting from beaver activity.

road networks. Road damage caused by blocked culverts and flooding accounts for the majority of damage. About 85 percent of survey respondents in northeastern Ontario indicated that road flooding and culvert blockage had significant impacts on their operations. A road washout caused by a blocked culvert can easily cost $5000 or more to repair. These washouts can also have negative impacts on downstream aquatic habitat. The release of sediment can damage or destroy fish spawning beds.

Flooding of timber and land is also a concern in northeastern Ontario. About 36 percent of survey respondents indicated that flooding of timber and land had significant impacts on their operations. In these cases, valuable trees are killed by flooding and are unavailable for harvesting.

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Part IV: Dealing With Beaver Problems

The general procedure for dealing with beaver problems on Crown land in northern Ontario is:

- notify MNR immediately
- MNR will co-ordinate actions
- MNR will issue appropriate permits
- local fur council is notified (if decision is to remove beaver)
- council contacts local trapper
- pelts are prepared and delivered to MNR
- all costs are responsibility of complainant ($30 to $150 per beaver payable to trapper)
- all water control devices, culvert modifications, beaver control programs, preventative measures are responsibility of interested parties.

There is no provincial policy governing the handling of problem beaver situations in Ontario. Each MNR district deals with these situations based on local conditions and within the laws regulating furbearer management. It is therefore very important to contact your local MNR office to find out what the procedure is for dealing with problem beavers in your area.

Generally, MNR will only take action on a beaver problem if it occurs on Crown land, or when beaver activity on private land affects adjacent Crown land. MNR staff will also provide advice to private land owners.

Under the Ontario Game and Fish Act, any person may, on their own property, remove a beaver or dam in defence or preservation of property. These land owners can use any available method to deal with problem beavers, with the exception that only a licensed trapper can remove a beaver with a trap or snare. Landowners may be liable for any downstream damages caused by removing beaver dams.

Prevention

Generally, there is very little, short of keeping population numbers low, that can be done to prevent beavers from colonizing suitable habitat. Attempts at discouraging beaver colonization, in areas of high beaver densities, are usually ineffective.

It may be possible to consider the effects of your activities on the availability of beaver habitat. To discourage beavers, you may choose to avoid forest and land practices that generate growth of preferred food species such as poplar and willow along water courses.

This may include encouraging non-preferred species such as spruce and pine in these areas. Several survey respondents commented that they plant only non-preferred species along water courses to discourage beaver colonization. Also, when clearing brush along water courses, avoid piling brush at the water's edge. This may attract beavers to the site by providing a supply of building and browsing material.

To discourage browsing of individual trees, physical barriers can be used. Several questionnaire respondents stated that heavy wire mesh (less than 2.5 cm mesh) or tar paper, wrapped around the trunk of a tree from the ground to 1 m, is very effective in keeping beavers from gnawing trees. This method is relatively inexpensive if a few trees are involved, but can be impractical if a large number of trees must be protected.

For large numbers of trees, fencing can be used to protect an entire area. This method may also be useful to discourage beavers from establishing themselves if enough of the surrounding woody material is fenced off. Wire fences 0.5 m high can be used as well as single-strand electric fencing if appropriate for the location and situation.

There are no registered, practical, effective, environmentally-safe chemical toxicants, biological control agents, aversive agents, fumigants, or repellents available for specific use against beavers. However, there are several commercially available repellents intended for use against deer and small rodents that may be of some use in some situations. Most nurseries, garden centres, and farm co-ops sell these products.

Beaver Control

It is generally agreed that directly controlling beaver numbers is the most effective way of minimizing beaver problems in areas of high beaver densities. This is typically achieved by harvesting beavers through an effective beaver management program.

When incentives to harvest beavers are low (e.g. low pelt prices), beaver numbers may increase. Most respondents in our survey indicated that widespread problems exist during times of low pelt prices, when fewer beaver are harvested.

> If removing dams is warranted to eliminate a beaver problem, you should also remove the beaver.

An effective and continuous beaver control program may avert many future problems. Unfortunately, most beaver problems are dealt with after the problem has occurred and the beavers are established in the area. Annual removal of beaver from potential problem areas is usually more cost-effective than initiating work once problems have become unbearable. This is largely because beavers removed annually from these areas tend to be young dispersers. Dispersing beavers and their structures are much easier and less-costly to remove than well-established families.

The logistics and costs of developing and implementing a continuous beaver control program will vary depending on local conditions. The Algoma Central Railway (Sault Ste. Marie, Ont.) employs a two-person crew from May to September to identify potential beaver problems associated with their rail lines. Once potential areas are identified, beavers and their dams are removed with the assistance of local trappers. The cost of the program is approximately $40,000 per year.

In another situation in the southeastern U.S., a two-person crew was able to effectively control beaver damage by checking traps every two weeks at 150 impoundment sites.

Trapping or snaring beavers must be done by a licensed trapper. Shooting beavers may be done by non-trappers on their own property or if permitted by MNR. Shooting at water surfaces poses dangers due to ricochet and may only result in injuring the animal.

If removing dams is warranted to eliminate a beaver problem, you should also remove the beaver. Over 100 survey respondents commented that destroying a dam without removing the beaver(s) is a wasted effort, as most beavers will rebuild the dam within days. It was suggested that removal of all dams associated with a beaver family will cause them to leave the area.

Dams can be removed manually, with heavy equipment, or explosives. Contact local authorities before removing dams as restrictions on explosives and other procedures exist in some areas. During dam removal, flow must be controlled to minimize surges in water volume and avoid negative downstream effects (e.g. fish habitat, other beaver dams, roads, bridges, etc.).

Methods of beaver control, other than by direct removal, have been investigated. Attempts at biological control, where natural predators are encouraged in an area, have failed. In cool northern climates, beavers remain under ice for much of the year and are largely unavailable to predators.

Fertility control, where individual animals are sterilized, has been investigated for use in controlling beaver populations. Conceptually, this method of beaver control is feasible if either one of the adults in a family can be sterilized. Experiments using surgical methods have been effective. An effective and practical method for inducing sterility in the wild over large areas, has yet to be developed.

Live-trapping and relocating beavers is a common practice in arid areas of the mid-western U.S., where beavers are highly valued for their water conservation activities. In most situations in northern Ontario, live-trapping and relocating beavers is not a recommended option for controlling beaver problems. Densities are high throughout the region and finding an unoccupied area of suitable habitat would be very difficult. Even if a suitable area is found, this would likely export the problem to the new area. Many questionnaire respondents indicated that live-trapping and relocating beavers is expensive, and money is better spent on other options.

Water Control

In many situations, removal of beavers and their structures is neither desirable nor cost-effective. Sites requiring attention tend to be sites with recurring problems. In fact, it is common practice in northern Ontario to revisit the same sites annually to maintain or upgrade water crossings degraded or destroyed by beaver activity. In these situations, the initial cost of installing devices designed to prevent beaver problems through water control, can be much less than the cost of repeated road repairs or annual population control.

In many situations, removal of beavers and their structures is neither desirable nor cost-effective.

In addition to economic considerations, many landowners want to maintain beavers on their property. They recognize the beneficial effects beavers have on wildlife habitat, biodiversity, and aesthetics. In these situations, problems are usually associated with landowners not having any control over water levels or size of impoundments. Under these circumstances, water control devices designed for use in active beaver areas can effectively give landowners control of water levels while maintaining healthy beaver populations.

Problems involving water control in conjunction with beaver activity can be classified into two situations. The first is water crossings where a water control device, such as a culvert, is in place. Here problems typically involve beavers plugging the device resulting in repeated washouts and flooding. The second situation occurs where beaver dams raise water levels to undesirable heights, resulting in excessive flooding of adjacent timber, land, road and rail networks.

In both of these situations, removal of beavers and their dams has proven to be a short-term solution in most cases. The following sections describe numerous devices that may be used to provide more long-term and cost-effective solutions.

Information presented on these devices has been compiled from information gathered from North America. Not every device has been used and field tested in northern Ontario, but similar applications have been documented elsewhere.

It is important to realize that no one solution is 100 percent effective in all cases. Many survey respondents commented on this point, indicating that situations must be assessed individually and that a combination of devices and methods is usually most effective.

When using water control devices to address beaver problems, their impact on water flows and fish passage must be considered.

Working around water control structures can be hazardous and appropriate safety measures should be taken. Be aware of the following:

- fast flowing water
- irregular and slippery bottoms
- cold water
- being drawn into culvert
- isolated work sites
- unstable bottom

The following sections are intended to provide options and ideas for managers dealing with beaver problems. These devices do not eliminate the need for direct beaver control but they may reduce this need.

Working around water control structures can be hazardous and appropriate safety measures should be taken.

Water Crossings

Culvert meshes and grills

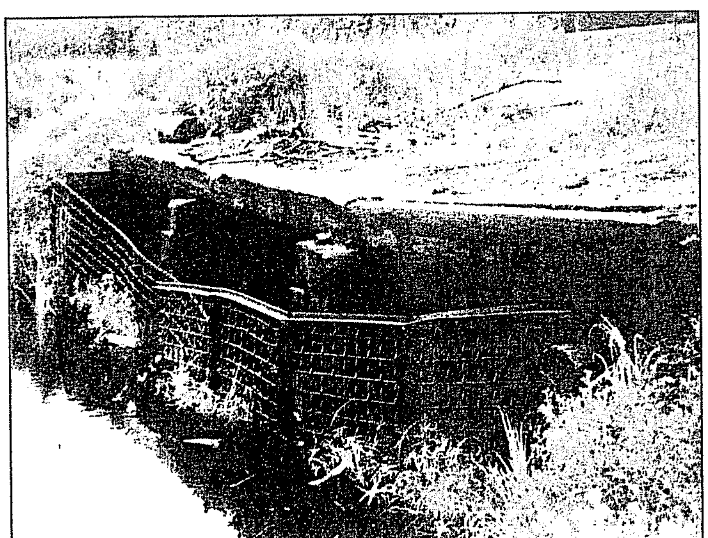
Culverts constrict water flow to a very small area which provides ideal locations for beavers to construct small dams which block the culvert and water flow. Typically, beavers will enter a culvert and build up material inside. This creates a difficult and potentially dangerous situation for anyone having to unblock the culvert.

To prevent beavers from entering a culvert, a screen mesh or grill can be placed on the upstream end of the culvert (**Photo**). Beavers will use the mesh or grill as a framework for building a dam, and block water flow. The advantage to these devices is that they are far easier to clean and maintain than a culvert blocked from the inside. Usually, the meshes and grills will require regular cleaning and maintenance throughout the ice-free period.

There are countless variations of culvert meshes and grills in use. Essentially any apparatus that will keep beavers out of a culvert and allow adequate water flow, will suffice. A simple grill may be nothing more than a piece of wire mesh draped over a culvert opening. Discarded bedsprings are commonly used in northern Ontario. More sophisticated devices such as a triangular screen can be attached to the mouth of the culvert (**Diagram 1**).

Some adaptations can be fashioned for easier cleaning. For example, a system of removable "pull posts" can be constructed (**Diagram 2**). Similarly, a hanging chain grill with a tail chain which can be attached to a vehicle and pulled up onto the road, can be constructed for quick and frequent cleaning (**Diagram 3**).

To ensure beavers will not enter a culvert from the downstream end, a screen or mesh cap should be placed on the downstream end of the culvert.



Ron Lapointe, NEST

One example of the various types of screens or grills used to prevent beavers from getting inside the culvert. This particular device was installed by the Ministry of Transportation.

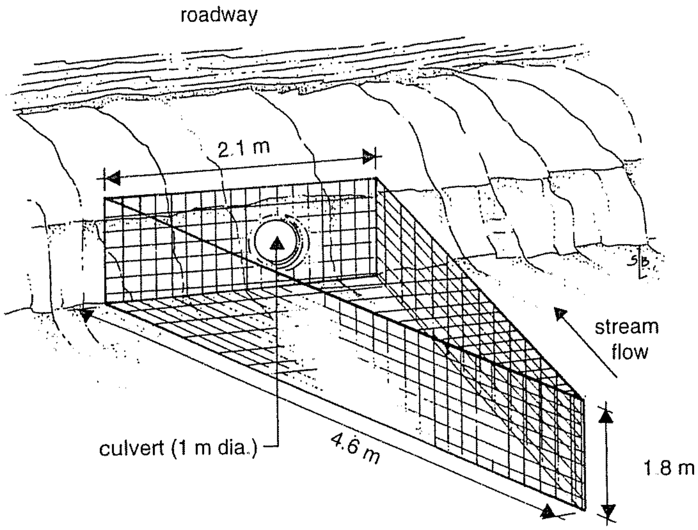


Diagram 1 - Triangular screen mesh design

Constructed from 2" mesh welded wire; placed on upstream end of culvert; should be removed during winter to prevent ice damage; dimensions shown are for 1 m culvert, increase measurements if required. (Drawing not to scale)

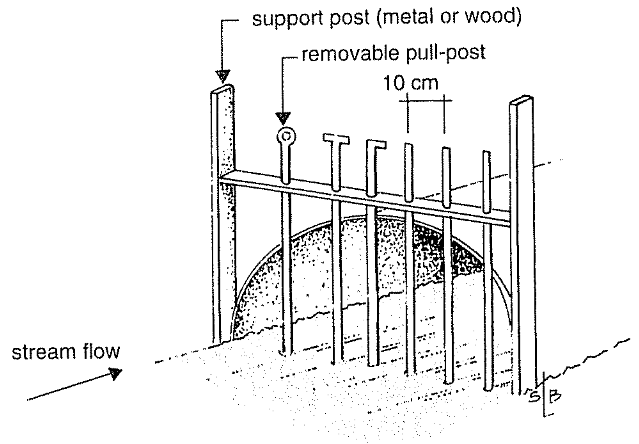


Diagram 2 - Removable pull rod grill

After most material is cleared, posts can be pulled out to wash away remaining material. Posts should be driven about 10 cm into streambed.

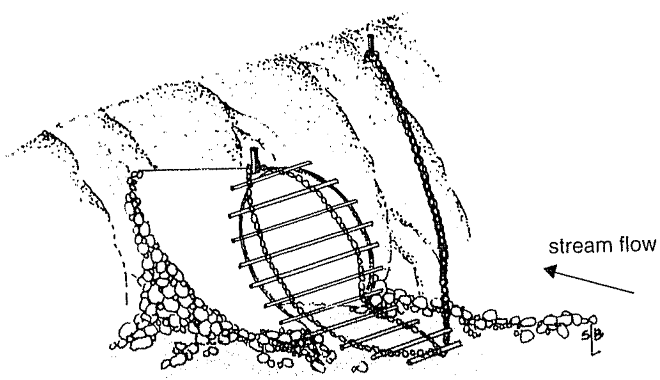


Diagram 3 - Culvert protector-cleaner

Constructed by welding steel rods (10 cm apart) across a looped chain; upper end is held by a bolt placed through the top of the culvert; tail end is looped back and anchored on road bank; end of chain can then be attached to a vehicle and the grill flipped up onto the road to clear culvert.

Culvert Meshes and Grills Pros (+) and Cons (–)

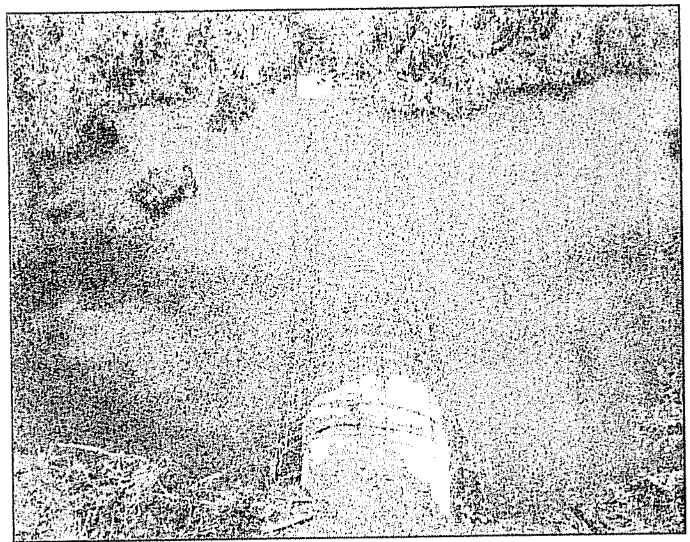
+ Relatively inexpensive
+ Easy installation
+ Works well if regular cleaning can be maintained
– Requires frequent and regular cleaning
– May reduce discharge capacity (water flow) from original culvert design
– May block fish passage
– May be damaged by ice

The Beaver Stop

The Beaver Stop is a wire mesh cylinder system that extends out from the intake portion of a culvert (**Photo**). In principle, the wire mesh prevents beavers from blocking water flow into the culvert. Each culvert is fitted with a wire mesh cap on the outlet portion. Large culverts up to 3 m diameter have been successfully fitted with Beaver Stop.

Beaver Stop
Pros (+) and Cons (–)

- \+ Patented product with 90-day guarantee
- \+ Built and installed (if desired) by manufacturer
- \+ Very good success rate
- \+ Low maintenance
- – Relatively expensive
- – Manufacturer's head office in Calgary, Alberta



DCP Consulting Ltd.

A typical installation of the Beaver Stop. This patented product manufactured in Alberta has been used and proven successful in several Canadian provinces.

Beaver Stop is a patented product available from D.C.P. Consulting Ltd. (see address below). In 1993, the average cost per installed unit was $2300 (installed by D.C.P.) in western Canada. D.C.P. will install Beaver Stop in Ontario, but travel costs will be charged. Pre-packaged, self-installed units are available on order starting at $1100 (price depends on culvert size).

The device has been used throughout western Canada with very good success. D.C.P. claims the device will work effectively with little to no maintenance for up to 10 years. They cite 99 percent of their 600 installations since 1987 have required no maintenance and were not damaged by ice.

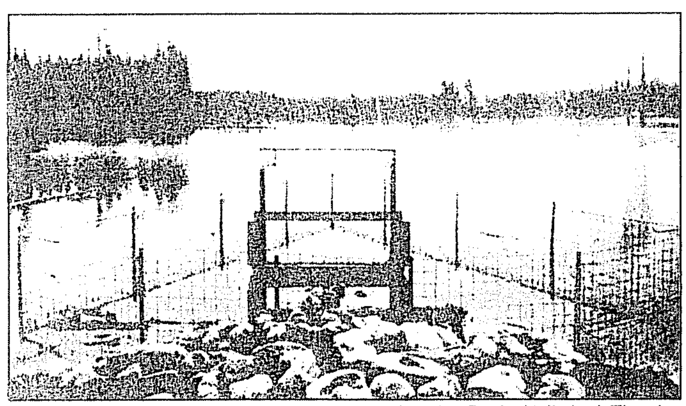
The product has just recently become available in eastern Canada. Several respondents to our survey indicated very good results with Beaver Stop in Ontario.

For more information including promotional material and a video, contact:

D.C.P. Consulting Ltd.
3219 Coleman Road N.W.
Calgary, Alberta T2L 1G6
Tel: (403) 282-2506
Fax: (403) 220-9591
Toll Free: 1-800-565-1152

Beaver Fences and Weirs

Another means of preventing beavers from entering culverts is the use of wire fences to cordon off the entrance to a culvert (**Photo**). These fences are usually horseshoe or semi-circular shaped and placed around the upstream side of the culvert (**Diagram 4**). They must be constructed to ensure beavers cannot go around or under the fence.



Doug Brooks, Ducks Unlimited, Timmins

This installation of the beaver fence by Ducks Unlimited shows how the immediate area in front of the inlet is kept clean of debris.

Survey respondents indicated that regular maintenance is required to keep beaver fences operating optimally. Swinging gates and removable sections can be used to make cleaning and maintenance easier.

Beavers will use the fencing as a framework upon which to build a dam (**Diagram 5**). It is much easier and safer to clean out this material than a blockage inside a culvert. A big advantage to beaver fences is that at times of high water flow, water will spill over the dam and flow through the culvert which is clear and intact.

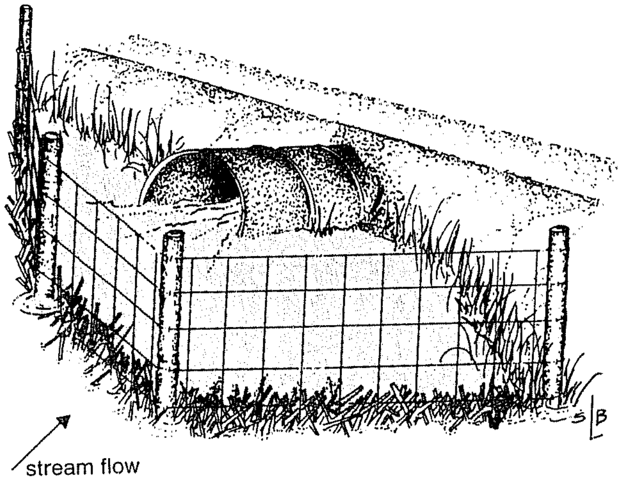


Diagram 4 - Beaver fence
Constructed on upstream side of culvert; keeps culvert clear and allows high water to flow over dam and through the culvert.

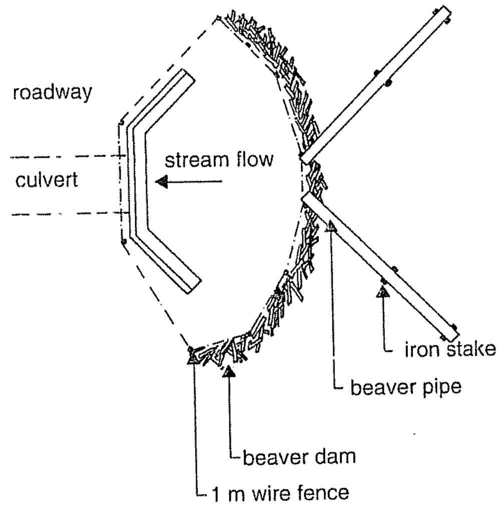


Diagram 5 - Beaver fence
In conjunction with beaver fences. Two or more beaver pipes can be placed in a fan shape to control water levels and water flow into culvert; refer to page 44 for discussion of beaver pipes.

A variation to this idea is to use a concrete, rock or wooden weir in place of wire fencing. This is a more permanent structure and can be built up to the desired water level. Rock weirs are easily constructed if rocks are available on site. Keeping the crest width of a weir narrow (10 to 15 cm), will make it difficult for the beaver to build a dam.

Beaver fences can be used in conjunction with beaver pipes (**Diagram 5**). This arrangement not only maintains a culvert clear and intact, but allows specific water levels to be maintained.

Beaver Fences and Weirs
Pros (+) and Cons (–)

+ Maintains culvert clear and intact
+ High water flows will spill over dam and through culvert
+ Maintains constant water level
+ In conjunction with beaver pipes, can regulate water levels
– Can be expensive, especially if area to be fenced is large
– Usually requires regular maintenance
– Can create impoundment which will affect road or railbed characteristics
– Beavers may build dam higher than roadbed which could flood out road on sides of impoundment
– May reduce water flow and fish passage

CULVERT PIPES

Generally, a culvert pipe is a pipe running through a culvert that extends out into the water at either end of the culvert (**Diagram 6**). The working principle is that beavers may dam up the culvert, but will have difficulty finding and blocking the intake to the pipe, thus allowing some water passage.

Numerous variations to this idea have been developed and tried. The major challenge in these situations is in keeping the intake clear. If beavers can detect where water is entering the pipe, they will usually be able to plug it. To work best, the intake must be completely submerged.

Pipes are usually rigid but perforated drainage pipe (**Diagram 6**) or weeping tile can be successful in deterring beavers from detecting water flow. In most cases, beavers will eventually detect where the water is flowing and regular cleaning will be required.

Wire mesh tubes have also been used in place of solid piping. The advantage with this method is the increased water intake area. Beavers will typically try to block water flow at the entrance to the culvert and may avoid blocking off the entire length of mesh.

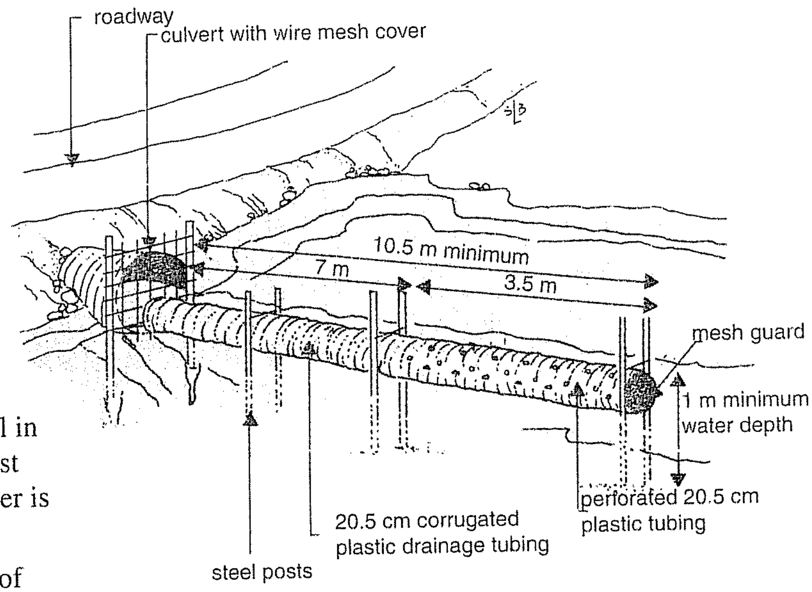


Diagram 6 - Basic culvert pipe setup.

The end of the culvert should also be fitted with a screen mesh (**Diagram 6**) to deter beavers from entering the culvert and building up material inside.

Survey respondents suggest that inlets and outlets on culvert pipes should be extended about six to ten metres out from the culvert and in positions that minimizes the sound of rushing water. This will help in deterring beavers from detecting water flow. Water depth should be sufficient to have the intake portion completely submerged to be most effective. Respondents indicated that success is hampered if the stream is too shallow.

An important point to consider when using culvert pipes is the reduction in water flow. Culverts are designed and installed based on their size and calculated discharge capacity (water flow). Blocked culverts with water flowing only through the smaller culvert pipe, may seriously affect the surrounding roadbed and other structures if they are not adequately protected.

Culvert Pipes
Pros (+) and Cons (–)

- \+ Relatively inexpensive
- \+ Easy construction and installation
- – Must be deep enough to keep intake fully submerged
- – Usually requires regular maintenance
- – Variable success
- – Reduces amount of water passage from original culvert design
- – May reduce fish passage

The Clemson Beaver Pond Leveler

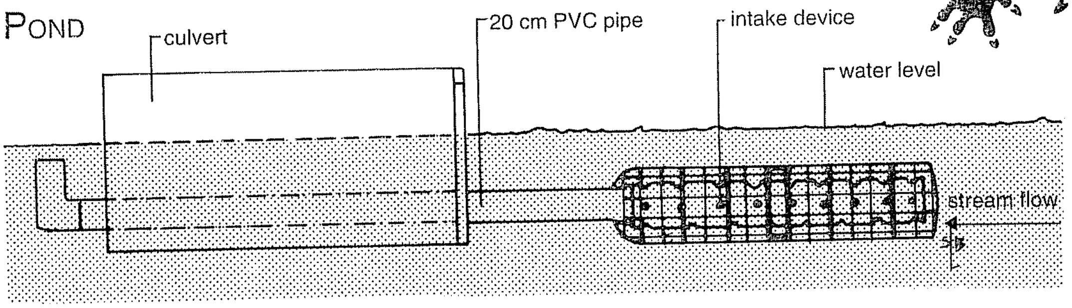


Diagram 7 - Clemson Beaver Pond Leveler in culvert situation

The Clemson Beaver Pond Leveler is a variation of the culvert pipe principle (see also page 47 for use in dam situations) but has several unique characteristics.

The Leveler was designed by Dr. Gene Wood at Clemson University in South Carolina in 1987. Through the university, it was tested over several years at over 50 sites. During these tests, it worked each time and was never clogged by beaver activity. Since then it has been in widespread use across 40 States. Our survey results indicate that it is popular among government agencies and has been very effective in controlling beaver-problem situations.

The Clemson Beaver Pond Leveler is a length of 20 cm PVC tubing that runs through the length of a culvert (**Diagram 7**) and is fitted with an intake device. The unique intake device is a 3 m length of perforated PVC tubing surrounded by a cylinder of galvanized welded wire (**Diagram 8**). This intake device is designed to spread water intake flow over a large area and reduce the probability that the water flow or the sound of flowing water will be detected by beavers. The outlet is extended 6 m from the end of the culvert and can be fitted with an elbow and stand pipe to control water levels.

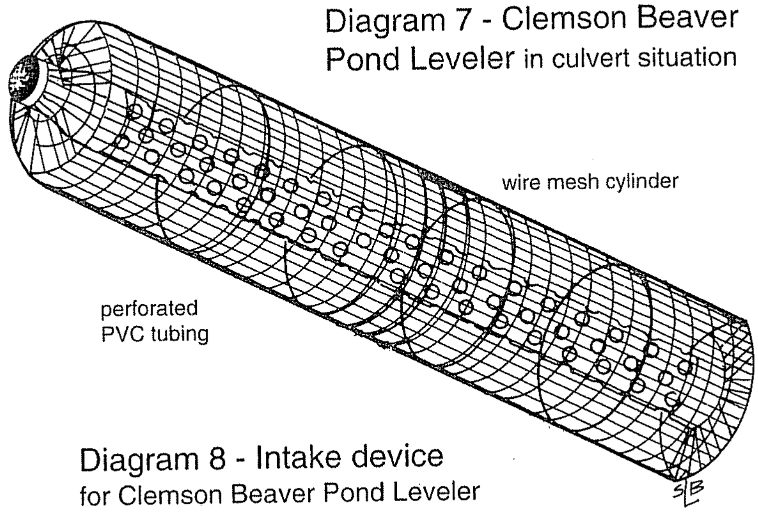


Diagram 8 - Intake device for Clemson Beaver Pond Leveler

All materials needed to construct the Leveler can be obtained at local building and plumbing supply stores and farm co-ops for approximately $400. Two people can construct a leveler in two to three hours and install the device at the site within two hours.

Required maintenance for the device is relatively low. It can operate effectively for several years before the intake device requires cleaning due to floating debris in the water.

For detailed plans including an instructional leaflet and video, contact Dr. Gene W. Wood, Mr. Larry A. Woodward, or Dr. Greg Yarrow at:

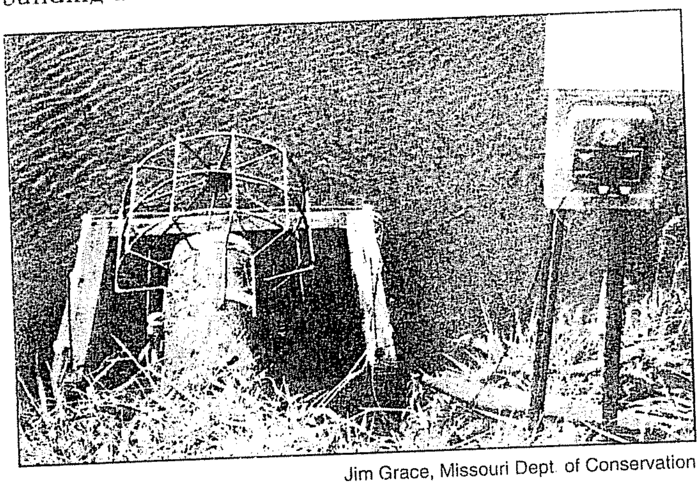
Department of Aquaculture, Fisheries and Wildlife
G08 Lehotsky Hall, Clemson University
Clemson, South Carolina 29634
Tel: (803) 656-3117

Clemson Beaver Pond Leveler
Pros (+) and Cons (–)

- \+ Low maintenance
- \+ Has been used with excellent success elsewhere
- \+ Can control water levels
- \+ Can combine several levelers together in heavy flow areas
- \+ Much information available on construction and use
- – Requires initial investment of time and money to build and install
- – Intake device must be submerged to work optimally
- – Not designed for fast flowing water
- – May reduce water flow and fish passage

Electric Fences

Electric fences can be used effectively in deterring beavers from entering or building upon culverts and other water control structures (**Photo**). Beavers coming in contact with the fence will be shocked and will avoid building at the site.



Jim Grace, Missouri Dept. of Conservation

Electric fence set-up at culvert entrance. Notice single strand wire mounted on floating wooden apparatus. This culvert has also been fitted with a metal grill for additional protection.

Usually a single strand of electric fencing strung approximately 10 cm above the water surface can be effective. Fluctuating water levels can inhibit their use as this can place the fence in an ineffective height either above or below the water surface. Battery packs or solar generators can be used as power sources.

Although effective, many survey respondents stated the biggest problem with electric fence systems is vandalism (e.g. theft of battery packs). For this reason, many suggested they be used only in remote locations or on private land.

Electric Fences
Pros (+) and Cons (–)

- \+ Relatively inexpensive
- \+ Easy installation
- – Battery packs and solar generators often stolen or vandalized
- – Fluctuating water levels can result in fence at ineffective height from water surface

The Millette Culvert

This device is a modified culvert and can be used in place of standard corrugated steel pipe designs. It is designed to deter beavers from detecting water flow at water crossings.

This culvert is usually constructed from wood but can be made of metal. It can be built to varying sizes depending on the amount of water flow. On a large stream, a typical size may be 3 m high by 2 m wide and constructed with large beams. The culvert should extend at least 1 m from the roadbank on each side of the roadway, so total length will vary depending on road width.

What sets this device apart from a standard culvert is that the upstream end of this culvert is closed. A square opening (size varies depending on size of culvert) on the bottom side at each end allows water to pass through the culvert.

This helps to prevent beavers from detecting water flow and blocking the culvert. A small trap door can be built into the top side of the culvert to assist with cleaning.

Millette Culvert
Pros (+) and Cons (–)

- \+ Does not require additional device such as culvert pipe
- \+ Has been used successfully in northeastern Ontario
- \+ Low maintenance
- – Requires installation prior to road construction or must reconstruct water crossing
- – Can be relatively expensive

This culvert has been used repeatedly with success in northeastern Ontario. In one example, this culvert has been operating effectively for 15 years, where previously beaver problems persisted. For additional information, contact:

Paul Millette
Box 1172
Hearst, Ontario P0L 1N0
Tel: (705) 362-8685

Beaver Dams

Beaver pipes

A beaver pipe or syphon is a pipe (usually plastic) running through a beaver dam that maintains water levels at desirable or tolerable heights, while preserving the impoundment and its beneficial effects (**Diagram 9**). They provide an alternative to the usually short-term solution of destroying a dam and draining the associated impoundment.

Here again, the major challenge is in keeping the intake clear. If beavers can detect where water is entering a pipe, they will attempt (and usually succeed) to plug it. Various success rates have been experienced and depends largely on the individual circumstances.

Numerous adaptations and variations of beaver pipes exist. Most of the adaptations centre around the intake portion and trying to deter beavers from detecting water flow by spreading out the intake surface area. A very frequent comment from survey respondents was the importance of eliminating or reducing the sound and flow of running water.

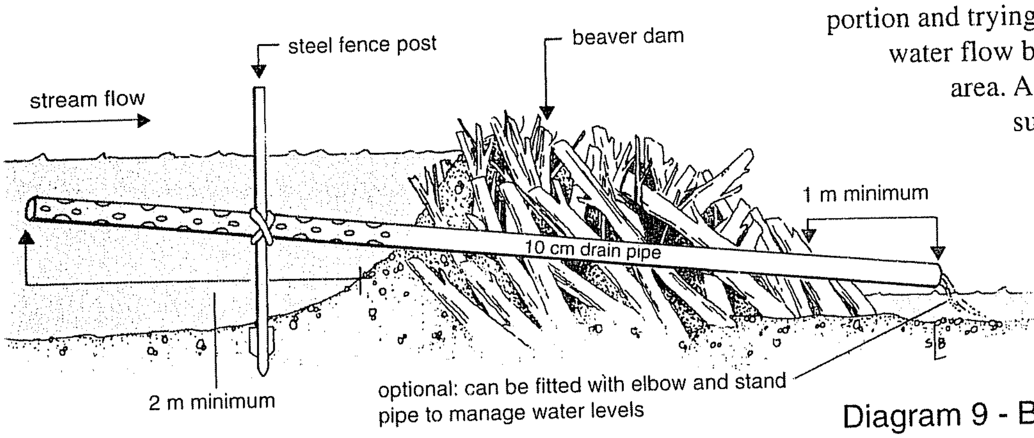


Diagram 9 - Basic beaver pipe set-up
Outflow should be positioned to minimize sound of flowing water; pipe diameter can vary or more than one pipe can be installed.

In deep impoundments, submerged perforated buckets or barrels flipped upside down and covering the intake spout, may work in preventing beavers from detecting water flow (**Diagram 10**). Other simpler designs such as perforated pipes, screens and mesh intake tubes have been used with varying degrees of success.

Another type of intake device can be constructed by attaching a perforated pipe at 90° to the mouth of the pipe going through the dam (**Diagram 11**). This device is an another attempt to spread out water intake sufficiently to make it more difficult for beavers to detect water flow.

Wire mesh formed into long cylinders can be used in place of plastic pipes and placed through beaver dams in a similar fashion. The wire mesh will create more intake area and may prevent beavers from completely blocking water flow.

Installation of beaver pipes requires making a hole or trough somewhere in the dam down to the level where the pipe will be placed. The height of the pipe will determine the water level.

The intake section of the pipe should extend at least 10 m into the impoundment and may be secured with posts. Once the pipe is in place, beavers will quickly rebuild the dam around the pipe. The outlet should be placed in a position that minimizes the sound of rushing water, which will help in deterring beavers from detecting water flow.

In large impoundments with large dams, it may be more effective to install several beaver pipes spaced at regular intervals or at critical high-volume areas.

Beaver pipes usually require regular seasonal cleaning and maintenance.

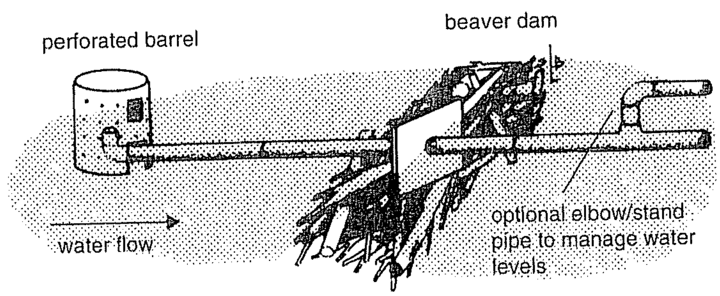


Diagram 10 - Perforated barrel intake
For use with beaver pipe to deter beavers from detecting water flow into pipe.

Beaver Pipes
Pros (+) and Cons (–)

+ Relatively inexpensive
+ Can set constant water level in beaver impoundments
+ Preserves impoundment
– Requires initial construction and installation
– Usually requires regular cleaning and maintenance
– Variable success rates

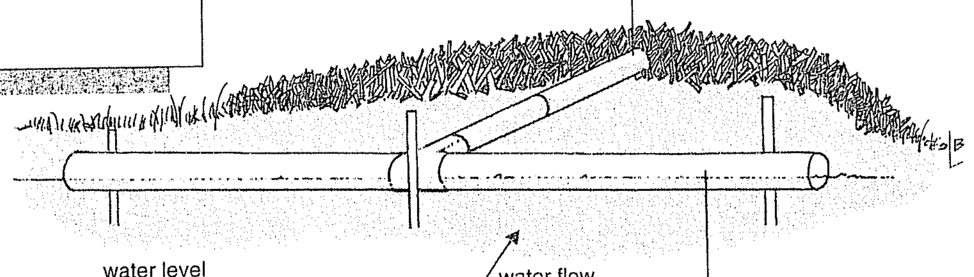


Diagram 11 - "T" intake device
For use with beaver pipe; perforated intake pipe is designed to spread water intake over large area and deter beavers from detecting water flow.

The Clemson Beaver Pond Leveler

The Clemson Beaver Pond Leveler is described in detail on page 40. In addition to being effective in culvert situations, it is also very effective in controlling water levels in beaver dam situations.

The leveler in a dam situation is exactly the same device as described previously, but is placed through a dam (**Diagram 12**). Again, the intake device is designed to deter beavers from detecting water flow. Through the use of an elbow joint and stand pipe at the outlet, water levels in impoundments can be regulated.

This device has had widespread use in the southeast U.S. with very good success. Many survey respondents indicated it can operate effectively for many years without cleaning or maintenance.

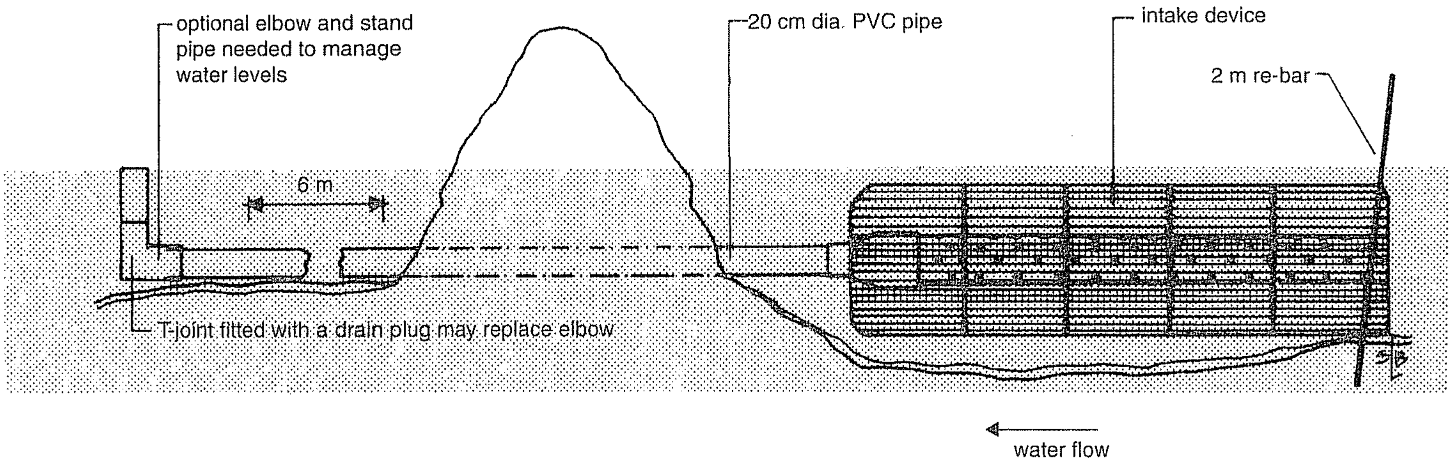


Diagram 12 - Clemson Beaver Pond Leveler
in dam situation

Clemson Beaver Pond Leveler
Pros (+) and Cons (–)

- \+ Low maintenance
- \+ Has been used with excellent success elsewhere
- \+ Can control water levels
- \+ Can combine several levelers together in heavy flow areas
- \+ Much information available on construction and use
- – Requires initial investment of time and money to build and install
- – Intake device must be submerged to work optimally

Ross Hall, Nova Scotia Dept. of Natural Resources

A section of the Clemson Beaver Pond Leveler is being transported across the beaver pond to a nearby beaver dam where it will be installed to control the pond's water level.

3-LOG DRAIN

An early adaptation to the idea of beaver pipes is one constructed of 3-logs bound together with a piece of sheet metal (**Diagram 13**). This simple design works under the same principle as other beaver pipes by draining water through a dam at a given height.

Installation is generally similar to installing other beaver pipes, except that the three-log apparatus replaces other forms of tubing. Spaces between the logs must be maintained to ensure water passage between the logs. Regular maintenance and cleaning is usually required to keep water passages clear.

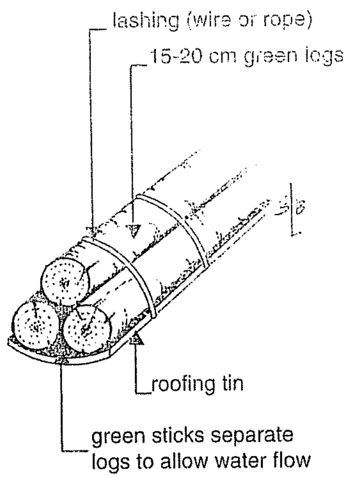


Diagram 13 - 3-log drain
For use as a beaver pipe in a dam situation.

Comments from survey respondents indicates the 3-log drain has been used frequently in areas of the U.S. and is still prescribed by some resource managers.

3-log Drain
Pros (+) and Cons (–)

- \+ Relatively inexpensive (logs can be obtained on site)
- – Logs will deteriorate much quicker than plastic tubing
- – Variable success rate
- – Requires regular cleaning and maintenance

Electric Fences

In some situations, electric fencing can be used effectively at dam sites. A hole or trough made in a dam can be surrounded by a single strand of electric fencing. Beavers attempting to repair the hole will contact the fence and get shocked, thereby preventing them from successfully repairing the dam. Power can be supplied by battery packs and solar powered devices.

Electric fencing has been used in many situations and has experienced various success rates (also see page 42).

> **Electric Fences**
> **Pros (+) and Cons (–)**
>
> \+ Relatively inexpensive
> \+ Easy installation
> – Theft and vandalism of battery packs and solar power devices
> – Variable success rate

Road Design Considerations At Water Crossings

One of the most frequent comments from survey respondents was that beaver activity considerations should be included in road design and planning. Unfortunately, most roads and water crossings are designed and built without thought to potential beaver activity.

Beaver activity can drastically diminish the effectiveness of water crossings. Road structures designed to anticipate beaver problems will reduce long-term maintenance costs. Structure types available include bridges, round culverts, pipe-arch culverts, horizontal ellipse culverts, and arches.

When planning the route a road will take and where it will cross the stream, if possible, avoid areas where food supply such as Aspen, Willow or Balsam Poplar is in abundance.

Locating a structure (e.g. bridge or arch) at rapids or riffles with gradients over six percent (slope of 16.7H:1V) will avoid most beaver problems. However, this location may impact fish habitat. Check with the local MNR for approval. Note that since culverts should be installed with zero or minimal gradient, culverts are not recommended for use at rapids or riffles.

Knowing beaver behavior can improve structure design. Since the sound of water flowing over rocks, logs or rippling through a culvert will stimulate a beaver to build a dam, the road designer may select a new structure with a large opening area to accommodate the natural channel and minimize water flow noise.

Road structures designed to anticipate beaver problems will reduce long-term maintenance costs.

At existing structures the water channel at the outlet can be altered. Adding rip rap across the channel downstream of the structure will cause ponding water to back up into the structure. Use steps (several shallow ponds) to provide for fish passage. This flooding will raise the water level in the structure, effectively slowing the water flow velocity and reducing the noise.

Metal tends to amplify sound. Noise can be reduced by utilizing other materials in place of steel culverts such as wooden bridges or concrete structures.

Eliminating noise can also be achieved by locating a new road in an existing beaver pond. The water level in the pond will be constant and the beaver will not build more dams. Generally, a culvert in a pond location may be set so it is submerged up to one half of its opening height without impairing its capacity to pass water. If the culvert will be submerged more than one-half of its opening height then, generally, a larger more costly structure will be required.

Designers should check water velocities in a structure, to reduce noise, and to compare velocities against fish swimming speeds over the length of the structure. If fish passage is a requirement, water velocities, generally, should be less than 1.5 metres per second at the anticipated time of fish migration. Design for fish passage may "beaver-proof" the structure automatically.

Once a structure is sized and installed, it is important to remember that future installation of beaver control devices (e.g. simple screens at the inlet and outlet), may reduce the structure's capacity to pass flood flows. Devices that diminish flow should be removed during flood periods and in the autumn prior to freeze up. Often these devices become clogged with debris and must be cleaned.

To minimize road maintenance where beaver problems are anticipated on lower standard roads, designers can provide a dip or shallow spillway on the road itself to pass flooding caused by beavers. This is known as a low water crossing or a wet crossing.

If designers recognize that there may be a future beaver problem and choose to accept the occasional flooding of the road, then the entire section of road that is expected to be flooded over can be reinforced with rip rap (**Diagram 14**). The surface of the spillway would be course gravel or rip rap sized to stay in place against flood water velocities, with smaller stones on the road and larger boulders on the downstream road side slope where water velocities would be greatest. In some cases, logs have been used at the edge to provide for uniform overflow and to resist erosion. This will minimize road washouts.

Another consideration during the planning stages of a road, is how the road, and, specifically, how the water crossings will be abandoned when they are no longer required. This is particularly true in areas of beaver activity since the water crossings will no longer be maintained. For environmental reasons, it is now becoming common practice to remove the crossings and stabilize the stream banks to prevent long-term erosion. To find out more about abandoning roads, you should check with the local road authority.

Good planning, design and construction will save money over the long-term.

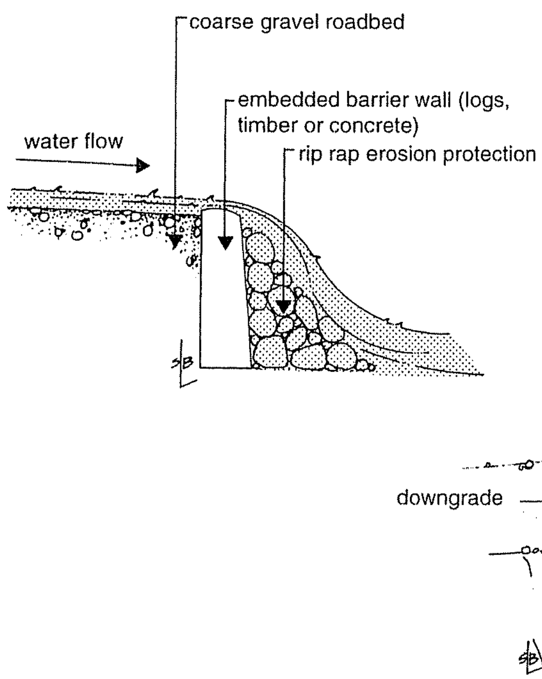
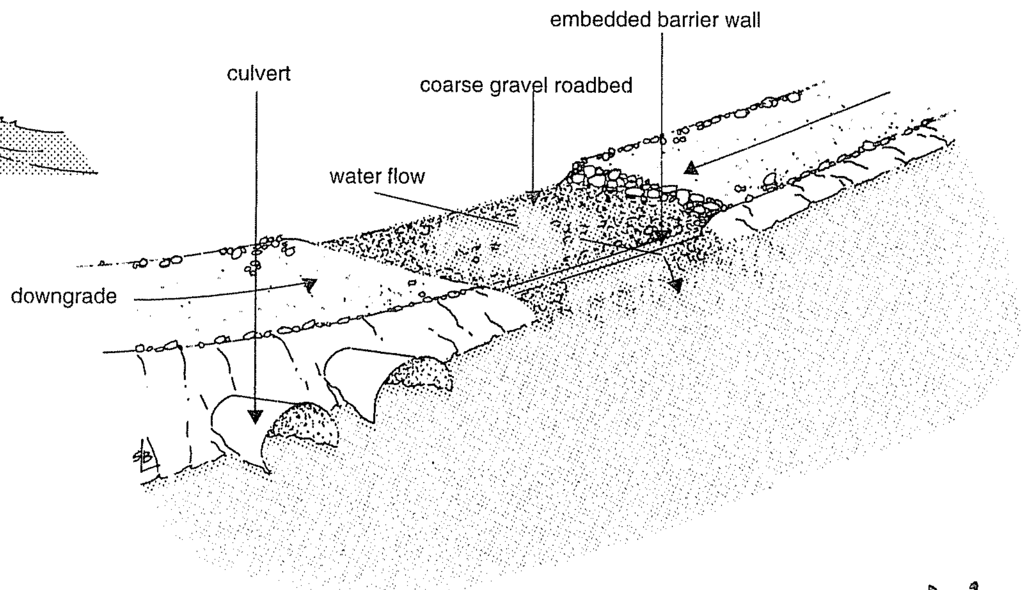


Diagram 14 - Low Water Crossing

If we can accept the fact that a road will experience periodic flooding, then the road can be designed to receive the flowing water with minimal or no damage.



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Closing Thoughts

Not all the ideas we received from survey respondents made it into this handbook, but we have tried to present a range of alternatives. It is also important to understand that many of the ideas presented have not been rigorously tested. We encourage all users of the handbook to do so. If you are aware of any beaver management devices or practices that differ from those included in this handbook, or if you have other comments or suggestions, please send them to:

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