



Understanding and Managing

Beavers

in Vancouver

August 2016

Report for the Vancouver Park Board and City of Vancouver by Jennifer Rae Pierce

Understanding and Managing Beavers in Vancouver has been created as a result of the Greenest City (GC) Scholars program.



The GC Scholars program is a partnership between the University of British Columbia (UBC) and the City of Vancouver (CoV). It offers select UBC graduate students a part-time summer internship with a CoV mentor.

Each GC Scholar researches a topic identified by their mentor that contributes towards a specific goal of Vancouver's Greenest City 2020 Action Plan.

This report is part of the final deliverable for GC Scholar Jennifer Rae Pierce, a PhD student at the School of Community and Regional Planning at UBC, along with the companion report, *Understanding and Managing Canada Geese in Vancouver*.

The goal of these reports is to improve management of beavers and Canada Geese in the city through more informed decision-making.

Particular thanks go to Nick Page, biologist at the Vancouver Park Board, who dedicated his time to mentoring Jennifer through this project.

cover page photo credit: Jennifer Rae Pierce

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MANAGEMENT OF BEAVERS

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SUMMARY

As a crucial species in the landscape, a primary character in local stories, and a foundational economic resource during colonial times, beavers are a cherished part of Canadian and First Nations' wildlife and culture. After reaching a population low due to over-harvesting from the fur trade, beavers have now made a strong comeback across North America, including the city of Vancouver.



*Beaver in Stanley Park
photo credit: Thomas Walker*

Status

In Vancouver parks and golf courses, approximately 45 beavers live in 9 or more active lodge sites along freshwater lakes, streams, and wetlands. It is not known how healthy the population of beavers currently is, though beaver kits have been found along beaches, exhausted in their unsuccessful search for suitable habitat. Along with a high activity rate in lodge sites, this suggests that the beaver population may be reaching a saturation point in the city and may lack habitat to accommodate population expansion. Surrounding areas have also seen an increase in beaver populations and many no longer allow beaver relocation in the area as beavers are territorial and cannot build lodges in proximity.

The city environment reduces predation pressures, including trapping by humans, further applying pressure on habitat availability. Further studies are needed to confirm food and habitat availability for existing and future generations of beavers.

Impacts

Beavers actively engineer their environment, building dams and dredging water bodies to maintain and increase wetland areas. They are a keystone species for freshwater ecosystems, increasing habitat availability for a number of species. They are generally viewed as a positive addition to the landscape by the public, though they can create a flooding nuisance and damage trees as a result of their work.

Beavers stay in their lodges during the day, emerging at dusk and dawn for feeding and dam building. When threatened, they will escape into the water for safety. Thus, they do not often interact with humans and do not present any substantial risk to human health.

Management

Relocation permits for beavers are extremely difficult to acquire and offer only a temporary solution because another beaver will inevitably move into the now-vacant habitat. Thus, contemporary management strategies usually address beavers in place. City workers install wire enclosures to protect



*Beaver in Stanley Park
photo credit: Mark T. White
and Doug Marks*

select trees and build water flow devices to reduce the capacity for beavers to dam watercourses. These techniques are seemingly straightforward though each comes with its own difficulties.

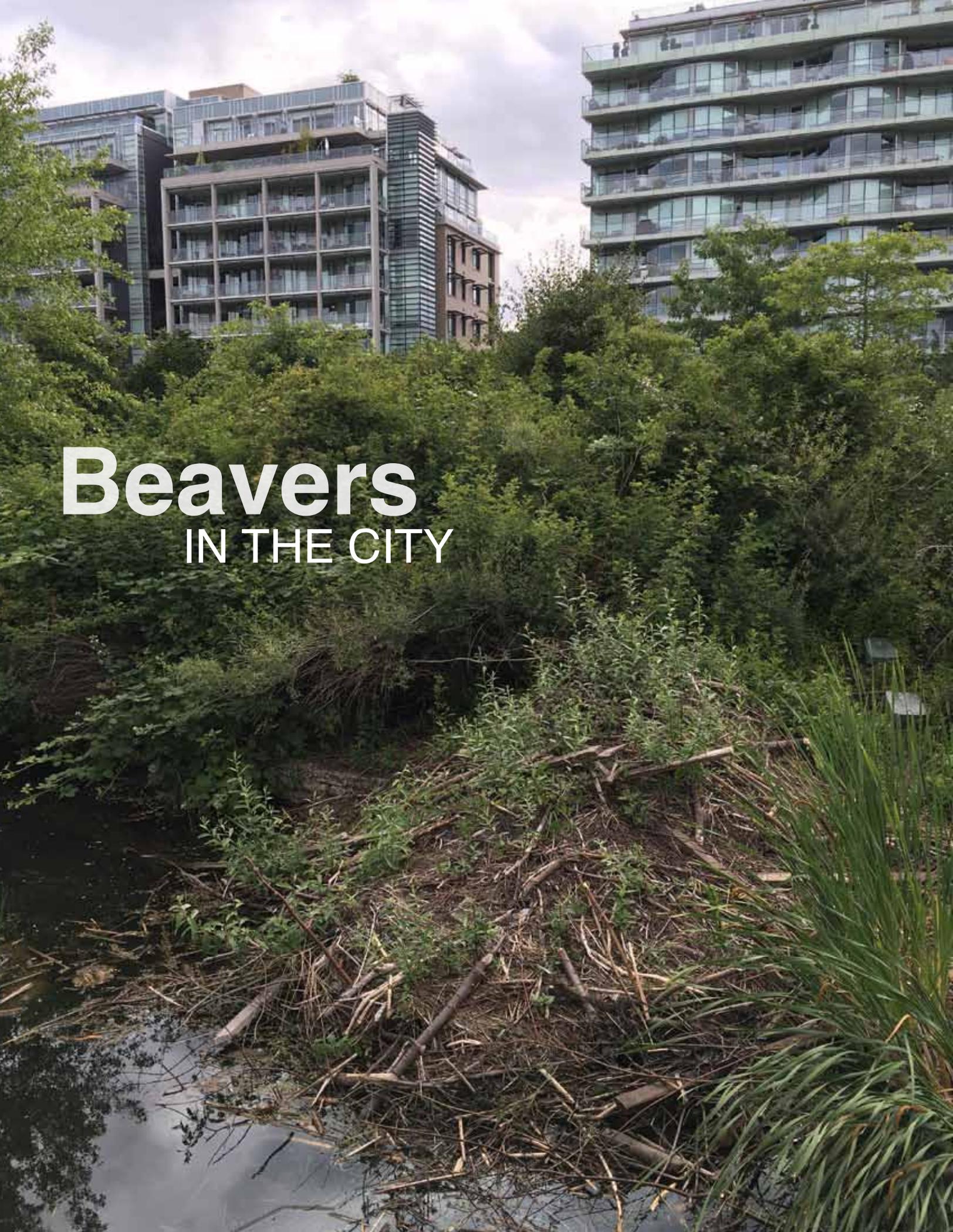
Wire enclosures around trees are highly effective at stopping gnawing and aesthetically unobtrusive. But, there is debate around which trees should be saved versus which ones left as food for the beavers. Willow trees have adapted to coexist with beavers, and can grow back from a stump. They are also the preferred diet of beavers, and so would make a good candidate to leave for the beavers. However, they are also an important part of park and golf course landscaping, generating conflict over the best strategy for tree protection. Public awareness therefore is a part of beaver management. As the beaver's preferred deciduous tree species are protected, beavers will expand their diet to include new species of trees, even including conifers. This means that regular surveys are needed to identify trees for protection before they are badly damaged.

Water flow devices to reduce flooding are challenging to build and maintain properly. Improperly designed or installed, the devices do not stop the beaver from clogging water drainage. And some water bodies are too small to allow for installation of the device. As a result, city workers must devote daily labor to check the dam sites and remove mud and sticks installed by the beavers who are very diligent in their work. Even with consistent effort by city workers, beavers can still cause flooding and erosion damage. Thus, management of beavers requires careful attention to detail and even then presents an ongoing cost to the city.

Opportunities

Beavers also bring a lot of positive opportunities to the city. Their activities support biodiversity and keep wetlands healthy. They can keep invasive water plants from clogging up water bodies. The high visibility of their lodges, dams, and gnawing activities present a novel environmental education opportunity for the public.





Beavers

IN THE CITY

POPULATION STATUS

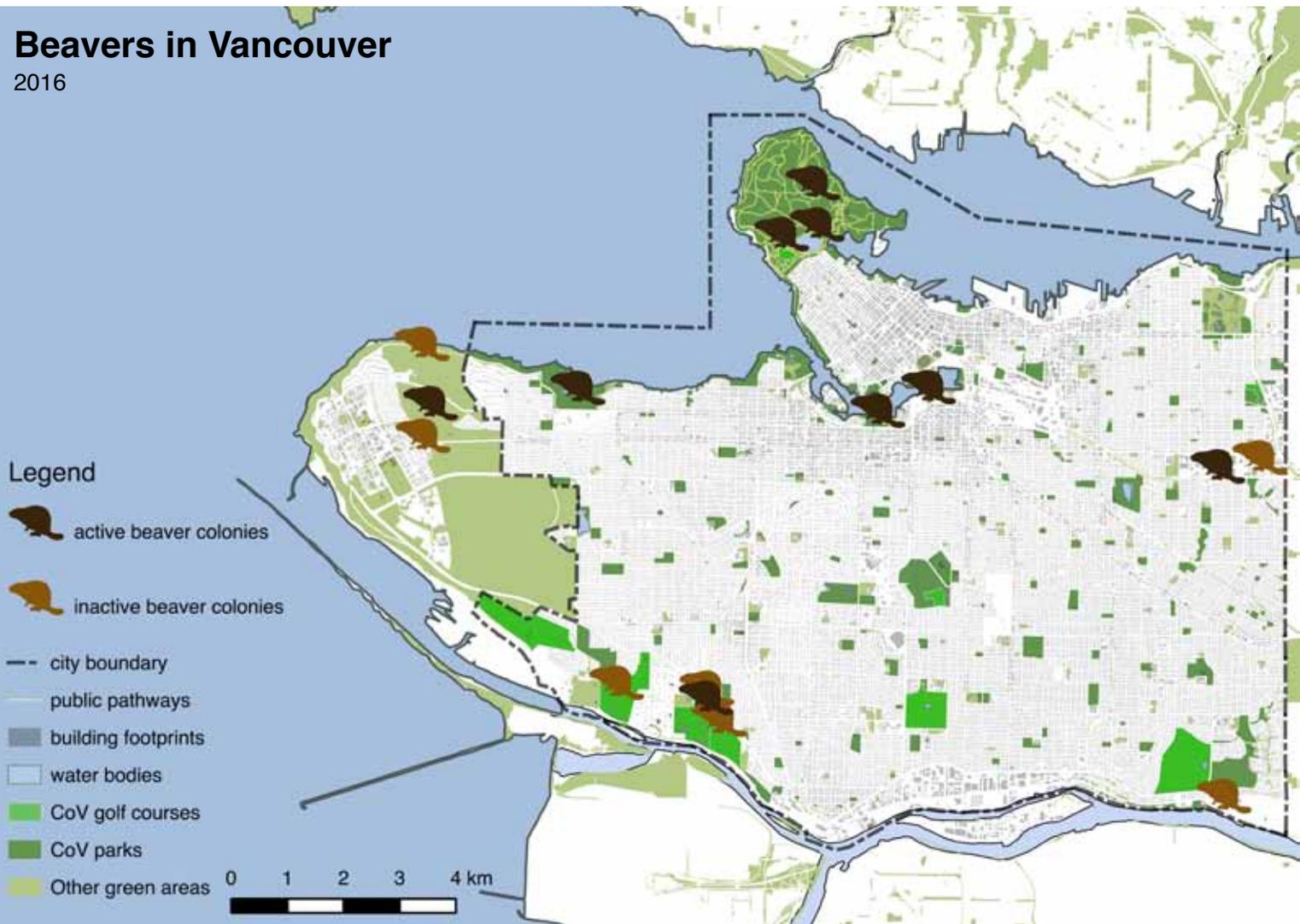
The North American Beaver (*Castor canadensis*) is found throughout BC and is considered to be healthy and stable in Canada (Hatler and Beal 2003). Beavers have been making a comeback to Metro Vancouver in the last decade, in some cases re-occupying sites that had been empty for several decades.

The Vancouver Beaver Population

In the summer of 2016, parks and golf courses in Vancouver contained 9-10 active colony sites, for an estimated population size of 45-50.¹ Four additional sites have lodges, but it has not been confirmed whether they are

Beavers in Vancouver

2016



¹ Populations are estimated by multiplying the number of colonies by the average number in a colony, usually five (Hatler and Beal 2003).



active at this time.

It is not known whether or not the current population size is sustainable.

The health of the beaver population in Vancouver is not known, though a 72% rate of habitat occupation is slightly higher than is recommended to allow for food supply regeneration.²[2] Some colony sites may have an insufficient food sources due to small habitat size and the low quality of parks as habitat.

2016 photograph of Beaver Lake showing a beaver lodge, water filtration device protecting the drain intake, and damming activity by the beavers to clog the device. The lake is nearly overgrown and filled in, but the beavers help keep this area of the water open. photo credit: Jennifer Rae Pierce

LOCATION

In past decades, young beavers would come to Vancouver down the Fraser and other streams seeking habitat. Beavers still wash up on the shores exhausted from their efforts to find habitat; one year 4 washed up on Stanley Park's shores alone (M. Mackintosh, pers. communication).

In the last decade, beavers had occupied many of the potential habitats available for them in the city. New colonies are now sometimes quite close to the parent colony, such as in Lost Lagoon where two colonies with breeding pairs are only 500 meters apart. This is less than half the expected distance.

Sixteen lodge sites have been identified in the city as of summer 2016, and

² The rate of habitat occupation is calculated by dividing active colony sites (8) by the total number of colony sites, active and inactive (11). A maximum colony occupation rate of 60-70% of potential lodge sites per year is recommended to allow regeneration of food supplies (Hatler and Beal 2003).

Active beaver colonies in Vancouver and adjacent areas.

Location	Active Lodges	Flooding	History
McCleery Golf Course	up to 3	yes	beavers present for at least 3 years, likely longer
Jericho Beach Park	1	yes	beavers present since the 80s
Charleston Park	up to 1	yes	2 adult beavers onsite, though it may be a shared colony with Hinge Park due to insufficient food supply for 2 colonies. Beavers left during the drought due to insufficient water after the artificial supply was shut off in 2015.
Hinge Park	1	no	beavers first spotted in April 2013; lodge built in January 2016. Up to 3 kits spotted in July 2016 (CBC News 2013; Chan 2016)
Stanley Park, Lost Lagoon	2	no	2 adults, 3 juveniles and 3 kits suspected in one lodge, plus a second breeding pair in the other. Possible offspring of the Beaver Lake colony. In place since a captive breakout in the 80s.
Stanley Park, Beaver Lake	1	yes	Arrived in 2008 after an absence of about 80 years.
Still Creek	1	unknown	has likely had beavers continuously; waterway connects to Burnaby Lake
Other Areas			
Pacific Spirit Regional Park	2	some	beavers present for at least 7 years
Coquitlam's Town Center Park	1	yes	believed to have 6 beavers currently
New Westminster	unknown	unknown	active populations along Fraser river and Brunetter river
Surrey	unknown	unknown	active beaver populations are common in parks and farmlands
Burnaby	unknown	unknown	Burnaby Lake Park and Still Creek host beavers

ten of these are known to be active. The table below describes the conditions at each site in Vancouver, as well as some surrounding sites.

PLANNING AND REGULATIONS

Beaver management activities are regulated at the provincial and federal levels. The City of Vancouver has several plans that offer strategic guidance for selecting the preferred approach to beaver management.

Regulations

British Columbia regulates and issues permits for activities related to beavers, including relocation, hunting, and disturbance of dams or lodges.

The BC Ministry of Environment (MoE) classifies the beaver as a Class 1 fur-bearing animal. They have issued individual trap line licenses for beavers since 1926. They approximate a 25% annual trapping rate to be sustainable.

The BC *Wildlife Act* forbids disturbance of beaver lodges or dams without authorization. The BC MoE issue permits for beaver dam/lodge removal,³ but only after alternatives have been exhausted and if removal is not deemed harmful to fish according to the *Fisheries Act*. Any changes around the stream such as dam removal also trigger compliance with the *Water Sus-*

³ For more information on dam removal, see <http://www.frontcounterbc.gov.bc.ca/guides/fish-wildlife/general-permit/what-you-need-to-apply/>

*This pond at McCleery Golf Course has a beaver lodge with plenty of parrotfeather milfoil, an invasive water plant, for the beavers to eat.
photo credit: Jennifer Rae Pierce*





This gnawed willow tree at Lost Lagoon is still growing. photo credit: Jennifer Rae Pierce

tainability Act. This requires a notification submittal to the Regional Ministry of Environment at least 45 days in advance of any activity. The province also provides best practice guidelines for dam removal.⁴

Municipal Plans

Vancouver's Greenest City Action Plan calls for increased access to nature by the public, and the 2015/2016 update calls for habitat restoration that focuses on wetlands and streams. The Vancouver Biodiversity Strategy supports these goals. The Stanley Park Ecological Action Plan specifically identifies beavers as one of two crucial keystone species for the park, alongside woodpeckers. They define a keystone species as "one whose very presence contributes to a diversity of life and whose extinction would consequently lead to the extinction of other forms of life" (SPES 2011, p. 23).

HABITAT

The beaver's preferred habitat is a muddy-bottomed, slow-moving, stable freshwater body with deciduous trees nearby (Hatler and Beal 2003). Beavers do not occupy one habitat long-term, as they typically exhaust the food in a location and move on within a decade. Typical colony density is one per 1-3 km of shoreline.

DIET

Aquatic plants such as pond lilies and the cambium layer in the bark of deciduous trees are the foundation of beaver diets. Beavers also consume shrub leaves, forbs (herbaceous flowering plants other than grass), deciduous twigs. They most prefer poplar (aspen and cottonwood) and willow. Tree materials are used for damming, lodge-building, and stored for later consumption, though a new colony will waste up to up to 65% of the material harvested. July to October is the most active time of year for wood harvesting (Hatler and Beal 2003). Beavers store their food in an underwater cache if winter is harsh. They will harvest up to 800 m upstream of their food cache, and 300 m downstream.

MORTALITY

Beaver predators⁵ are less common in cities than in more rural areas. With

⁴ The guidelines can be found here <http://www.env.gov.bc.ca/wld/instreamworks/beaver-damremoval.htm>

⁵ Predators of adult beavers include coyotes, wolves, bears, lynx, and wolverines. Minks,

lower predation rates, urban beavers, especially juveniles, are more likely to suffer from starvation due to lack of suitable habitat rather than predation or disease.⁶ Juvenile beavers sometimes wash up on the beaches in Spring, unable to find suitable habitat to settle down after leaving home.⁷ Vehicular collisions also present a mortal danger to beavers.

SOCIAL LIFE

Beavers mate in pairs and have 3-4 kits per year. They live in colonies, each in their own lodge, with family units of 6-15 individuals: paired adults, singles, new kits, and yearlings. Only the dominant pair of a colony will breed in a season. Two-year old juveniles leave the colony around May and will travel upstream and downstream in search of habitat. Scent mounds topped with castoreum keep other beavers away (Hatler and Beal 2003).

ENVIRONMENTAL IMPACT

Beavers are keystone species whose presence is vital to the health of ecosystems. They are called “ecosystem engineers” for their ability to manage their environment (SPES 2011). Beavers create and maintain wetland habitats, stabilize watersheds, aid in nutrient distribution and sediment filtration (Hatler and Beal 2003; Worcester 2010). They build water channels and deepen water bodies by building dams and removing sediment. They have a strong impact on the flow and spread of water bodies as well as on the survival and size of nearby deciduous trees and shrubs. In Stanley Park’s Beaver Lake, the beavers are responsible for removing invasive water lilies, keeping some of the lake visible (Worcester 2010).

There is concern regarding the impact of beaver dams on fish migration. Many fish are not impeded by the dams, but for those that are, dam management methods to ease fish movement during migration seasons can be compatible with the dam.⁸ Overall, beavers create conditions that benefit aquatic life, including fish populations.



*Adult beaver and kit in Hinge Park
photo credit: Olympic Village
Beaver @Vancouver Beaver*

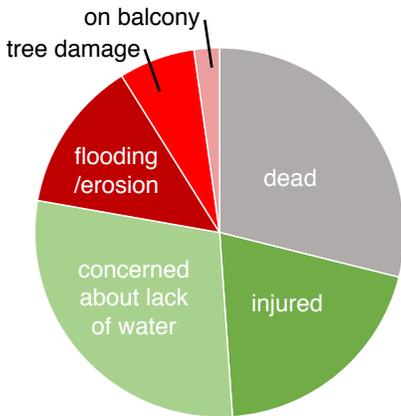
hawks, and owls will occasionally take kits. They are well protected in the lodge for the first year.

6 Beavers can live to be 12 years old. Beavers do not commonly die from disease (Hatler and Beal 2003).

7 These beavers are sent to a wildlife rehabilitation facility if found in a public area.

8 For tips on managing dams for fish migration, see <http://www.pskf.ca/publications/beavers.htm>

Topics of 3-1-1 Calls to Vancouver Regarding Beavers



Analysis of 3-1-1 calls since 2010 regarding beavers in the city supports the idea that the public generally supports beavers. Green wedges represent calls with a positive view of the beaver, red shaded wedges represent calls with a negative view of the beaver, and the grey wedge represents neutral calls.

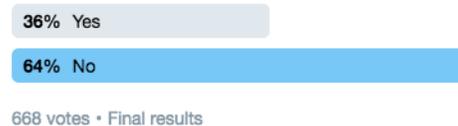
PUBLIC OPINION

The beaver is a cultural icon for Canada⁹ with historical significance and legendary status for Canadian colonial culture as well as indigenous peoples. There is generally positive feedback from locals when they detect beavers in the parks. Some local beavers even have their own twitter account!¹⁰ Beavers are politically popular and generally supported by the public as an adorable and ecologically significant part of the landscape.¹¹

There was public outcry with the City of Surrey in 2008 over the violent death of a beaver who was accidentally crushed in a live trap, spearheaded in part by the Fur Bearer Defenders. The city decided to trap the beaver after persistent flooding problems over the last two years threatened residences. This beaver’s death drew attention to beaver management by the city, who reported killing 40 beavers that winter. Public outcry, and strong mayoral support, resulted in an immediate change of policy away from killing (Baron 2008). Surrey now supports trapping only when necessary.¹²

A Global News poll on twitter demonstrated majority public support for beavers, despite referencing tree damage in the question (Judd 2016).

Beavers in Stanley Park have felled a number of trees. Should animal control step in to prevent more damage?



The twitter poll results are supported by data from Vancouver’s 3-1-1 records. Since 2010, 45 calls regarding beavers were made. Of these, over half (23) were calling in support of beavers, and a quarter (9) were calling about a beaver nuisance. Thirteen calls in 2015 alone were from different individuals who were concerned about the water levels in Charleson Park getting too low for the beavers during the drought restrictions. See the pie chart at right for more details.

The Expert/Public Interface

Wildlife management experts vary in their approach, but most are of the opinion that we must find ways to coexist with beavers. Others believe that

9 Officially recognized in the National Symbol of Canada Act

10 See the Olympic Village beaver’s tweets at <https://twitter.com/VancouverBeaver>

11 Outside of urban areas, they are also valued economically for their pelt and castoreum. Beaver pelts were valued at \$27 each in 2003 (Hatler and Beal 2003).

12 Surrey’s beaver policy can be found here <http://www.surrey.ca/community/3651.aspx>



*Stanley Park Ecology Society volunteers staff a table at Beaver Lake (left) where they share information with the public on beavers. Beaver educational materials (center and right) are available at the Nature House in Stanley Park:
photo credit: Jennifer Rae Pierce*

beavers are not compatible with urban parks because of reduced tree availability and habitat sites compared to less urban areas. These managers are more likely to actively discourage the establishment of a beaver colony. Generally, experts will take a more population-oriented approach compared to the individual attention that the public gives particular highly visible beavers.

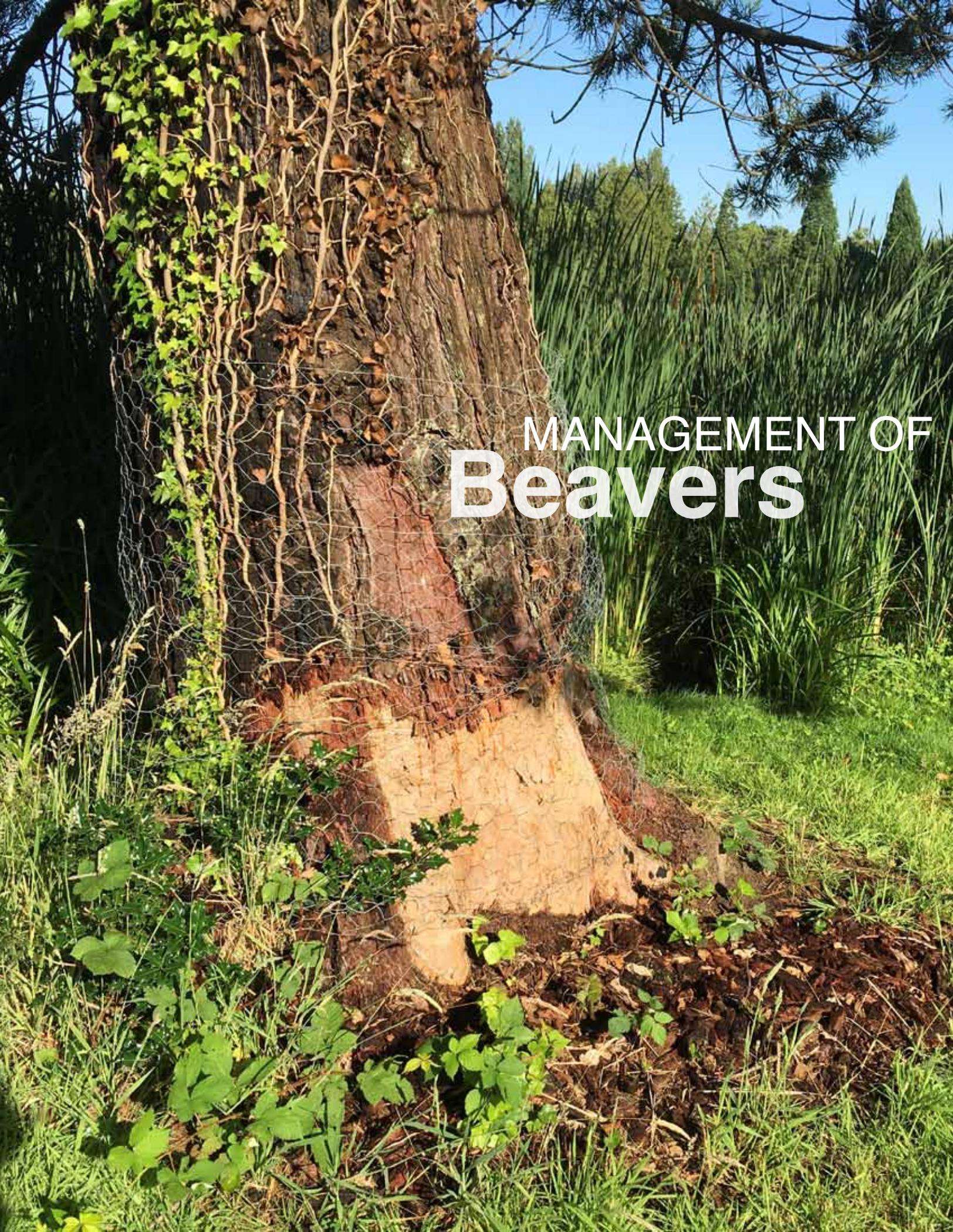
Experts are concerned about public interference with beavers, especially when public empathy is confronted with the harsh realities of the young unable to find habitat. If beavers wash up on shores in public areas, a trip to wildlife rescue is necessary, whereas no such aid is feasible in more remote areas, even in the Metro region. Even after rehabilitation, the problem of finding a suitable habitat for the youngster remains.

The Stanley Park Ecology Society has environmental outreach and education programs in Stanley Park specific to beavers. They set up an information booth about beavers at Beaver Lake, and have material in their Nature House at Lost Lagoon.

HUMAN HEALTH RISK

Giardia and tularemia are transmittable from beavers to humans through ingesting water contaminated with beaver feces (Hatler and Beal 2003). Both are treatable and can also be carried by livestock, rabbits, cats, and dogs. Beavers do not present a high health risk to people. Beavers do not attack, and are most likely to run to the safety of water when frightened but can bite if cornered.



A photograph of a tree trunk in a natural setting. The tree trunk is the central focus, showing a large section of bark that has been removed, revealing the lighter-colored inner wood. The remaining bark is dark and textured. To the left of the tree trunk, there is a wire mesh fence. The ground around the tree is covered with green grass and various plants. In the background, there are tall green reeds or grasses and a clear blue sky. The overall scene suggests a natural habitat where a tree has been damaged, possibly by a beaver.

MANAGEMENT OF **Beavers**



MANAGEMENT IN VANCOUVER

Management of beavers in Vancouver began in the 1980s when wildlife managers would live trap and relocate beavers from parks or golf courses to Pitt Lake under permit. Acquiring relocation permits became increasingly more difficult as beaver populations filled in surrounding areas, leaving nowhere to relocate the beavers that wasn't already occupied.

By the 1990s, wildlife managers sought ways to deal with beavers in place. The first baffler device in Beaver Lake was installed to prevent damming of the culvert. The device is intended to spread out water flow such that the beavers cannot find the leak and therefore do not dam around it. Unfortunately, this baffler has not been successful and the beavers dam around the baffler itself. Workers must remove the beaver's mud and stick debris daily to prevent flooding. A huge pile of debris stands nearby as a testament to their labors and the beaver's perseverance. The baffler's failure is due to its original construction. Poor coordination between the consultant who originally designed the feature and the engineers with the city resulted in a foreshortened pipe. This shorter pipe increases the flow rate of the water, allowing the beaver to detect the flow and clog it.

The lack of success from the baffler at Beaver Lake resulted in a renewed interest in relocation. Relocations have been justified by infrastructure damage or perceived blockage of fish migration by dams. Beavers are relocated by first trapping them using baited live clamshell traps or breaking apart the lodges and netting the animals as they swim out. Between 2001 and 2013, 18 beavers were trapped and relocated by EBB Environmental Consulting from Jericho Beach, Stanley Park, False Creek and many golf courses. Trapping beavers live is not an easy task. For example, flooding at Jericho Beach Park, prompted the city to hire EBB Consulting to coordinate live trapping of the beavers in the pond. Underwater restriction fencing and an underwater clam trap are used to trap the beavers for relocation.

With the exception of Rupert Park Pitch and Putt, all of the areas from which beavers have been relocated in Vancouver have since been repopulated by beavers, illustrating the futility of relocation efforts. In recent years, the city has stopped attempting to relocate and has focused instead on damage mitigation and management in place. City staff protect trees with wire mesh and regularly break up dams that could cause flooding to pathways or roads.

Beaver Lake's beavers were not baffled by the baffler shown at left. They surrounded it with a dam of mud and sticks, which the staff remove daily. The piles of debris in the photo at right stand as a testament to their struggle.

*photo credit:
Jennifer Rae Pierce*



Spotlight: Beaver Management at McCleery Golf Course

Management of beaver activity at McCleery has presented particular challenges. The golf course has a series of ponds interlinked by underground pipes that maintain rainwater drainage and a desired aesthetic. The course has been home to beavers for several years, and now hosts three lodges.

While the beavers do help out by eating parrotfeather millfoil, an invasive plant that has nearly covered some of the ponds, they also gnaw trees and clog drainage, resulting in flooding.

Laborers devote time every day to clearing out drains to keep water flowing and wire-wrapping trees. Beavers have even gnawed cedar trees (see the photo at the beginning of the beaver management section). Their efforts add up throughout the year to about 40 hours of labor. Despite this constant effort, the beavers can manage to gain the upper hand, and have clogged the drainage pipes such that trucks must come and blast the debris out of the pipes for a fee of \$2,000.

Last year, the course obtained a relocation quote for the beavers of about \$9,000, but this plan was not carried out due to the difficulty of obtaining permits and the inevitable return of beavers to the site anyway.

Installation of bafflers, if designed and installed properly, could help in some ponds, but would bring their own aesthetic impacts to the golf course.



The pump at left is a stopgap solution to prevent flooding while waiting for a debris blasting service. The drain at right is not protected and requires daily clearing of debris to prevent clogging. photo credit: Jennifer Rae Pierce



Planned and coordinated management strategies by the city are challenged by the beaver's perseverance and adaptability. Most management methods are carried out by groundskeepers who are trying to prevent flooding and protect cherished trees. Beavers have wandered further from shore than expected, gnawed on unusual tree species, and established new lodges in closer quarters than is typical. A beaver can establish a dam and flood a new area overnight. Beavers don't wait for bureaucratic decision-making before carrying out their plans, so the city often finds itself in a reactive rather than a proactive position with regards to beaver management.

MANAGEMENT TECHNIQUES

Beaver management efforts typically include plant protection, trapping and relocation,¹³ and flood prevention. Staff also repair erosion damage, unclog drainage pipes and remove dams to mitigate flooding and other damage. Management is largely reactionary.

Plant Protection

Cylindrical wire enclosures can be installed around the base of trees as needed and is highly effective at protecting trees. Protection should be a welded metal wire mesh, 1" or smaller, wrapped and overlapping itself around the base of the tree and extending 1 m above the ground (Page 2006). The wrap should be loose around the tree, allowing 6" space between the wire and the tree all the way around. The wire can be secured to itself with plastic ties or other means, allowing for adjustment as the trees grow over time. It should also be secured to the ground with stakes (BWW 2016).

Alternately, trees that need protection can be painted with a sand mixture extending from the base and at least four feet high (HSUS 2012; BWW 2016). The mixture should only be applied to trees that are at least six feet tall. The mix should consist of 8 ounces fine sand to a quart of latex or oil paint in any color (BWW 2016).

Entire areas can be protected with a 1 m high wire fence (Page 2006). In some cases, only the side nearest the water needs fencing as the beavers will not want to wander far from the water's edge (BWW 2016).

Plants can be protected with a spray repellent that has a taste that beavers dislike. The product called Ropel® by Nixalite is one such spray, though it is only offered in Canada for use on other species.

Another approach, espoused by Wildlife 2000, a long-standing beaver management organization in Colorado, is to plant willows and other fast-growing trees along the edge of the river specifically for the beavers (Prendergast

¹³ Beaver trapping and relocating has not occurred in the last few years.



A failed wire enclosure above was too short, allowing the beaver to gnaw above it. A successful one is pictured below which also includes public education and contact information for the biologist at the Park Board. Both are from Stanley Park. Photo credit: above by Kari Pocock, below by Jennifer Rae Pierce.

2011). This can reduce pressure on other plantings as the beaver prefer trees close to the water. Metro Vancouver is considering willow plantings around beaver wetlands in Pacific Spirit Regional Park to enhance beaver habitat as well. Wildlife 2000 have also provided beavers with tree branches from tree trimming companies to reduce pressure on existing trees (Willis 2013).

Trapping and Relocation

Relocation of beavers is costly and an often impermanent solution. Trapping and relocation of beavers from undesirable sites has a re-occupation rate of 80% within two years (HSUS 2012). Acquiring the proper permit from the Province requires identifying a suitable relocation site, and having permission from the landowner to relocate a beaver there. Suitable relocation sites can be difficult to find, sometimes even preventing a relocation. Trapping carries risks to domestic pets and other wildlife, and also the risk of separating kits from their parents. It is also expensive, as a labor-intensive and skilled activity.

Beavers can potentially be lured to new sites by placing otter or dog feces at the current site, and tempting the beavers with apples or willow branches at the new site (BWW 2016).

Trapping of beavers can provide the opportunity to outfit them with contraceptives. Norplant, a contraceptive implant for females that lasts five years in humans, has been used in Colorado on beavers and skunks, though success rates have not been recorded (Time 1992).

Flood Prevention

Installation and maintenance of water flow devices have a lower cost than retroactively repairing flood and erosion damage caused by flooding.¹⁴ The details of the water flow device need to be appropriate in order to function properly. The device must maintain at least three to five feet of water depth at the beaver lodge, and must spread out the water flow sufficiently that the beaver cannot detect it and clog it back up again.

Several companies offer design and installation services, often with a guarantee. The Clemson Leveler, BeaverStop, and Beaver Deceiver are three such products. Studies of such devices installed by the manufacturer have shown a marked increase in effectiveness since the 2000s, from less than 10% to 83%. Most (75%) of recent failures are due to downstream dam construction because the flow devices kept water levels too low for the beaver. The devices have an initial cost around \$1000, a lifespan of 10 years and an average maintenance input of 0.5 -1 hour per year (Callahan 2003; 2005). Annualized costs average around \$300 per device (Callahan 2005).

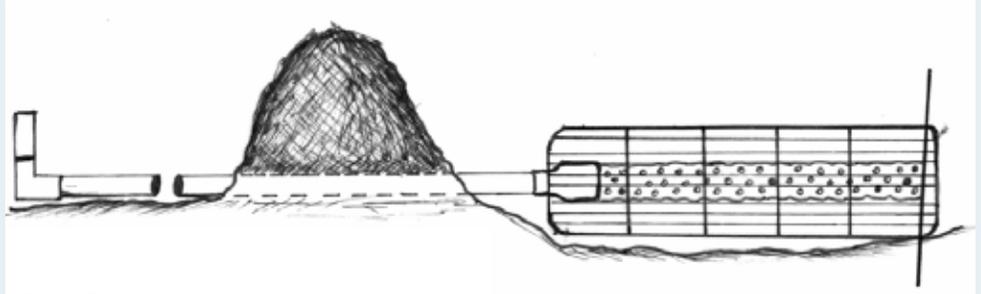
¹⁴ Beavers can also be kept further away from culverts using fencing (HSUS 2012).



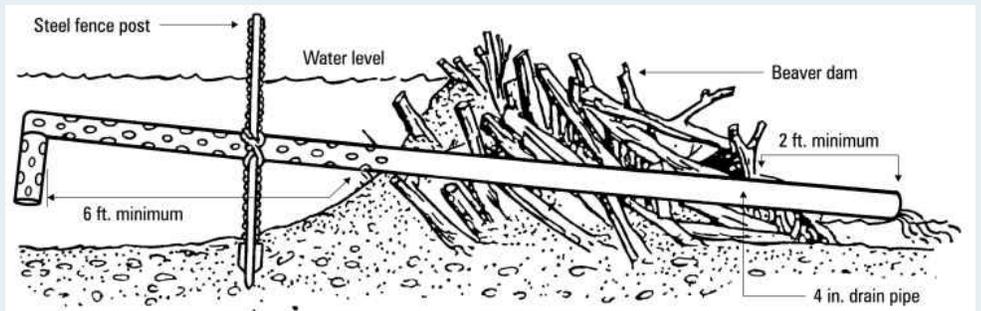
The clam trap used by EBB for beaver trapping is pictured above. Below and center is a kenneled beaver being released into a new location outside the city. Photo credit: John Gray

Spotlight: Water Flow Devices to Reduce Beaver-induced Flooding

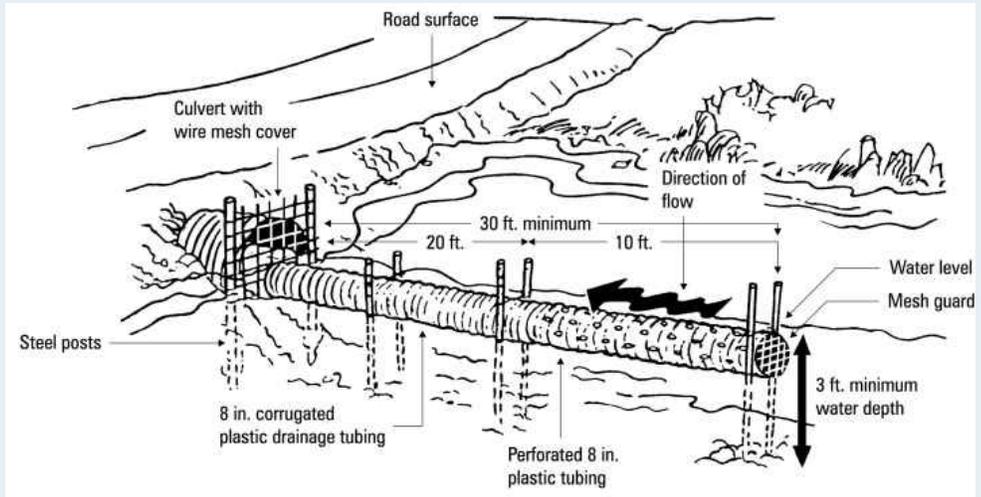
There is a high degree of variety in water flow device recommendations, even though these details can be crucial for proper function.



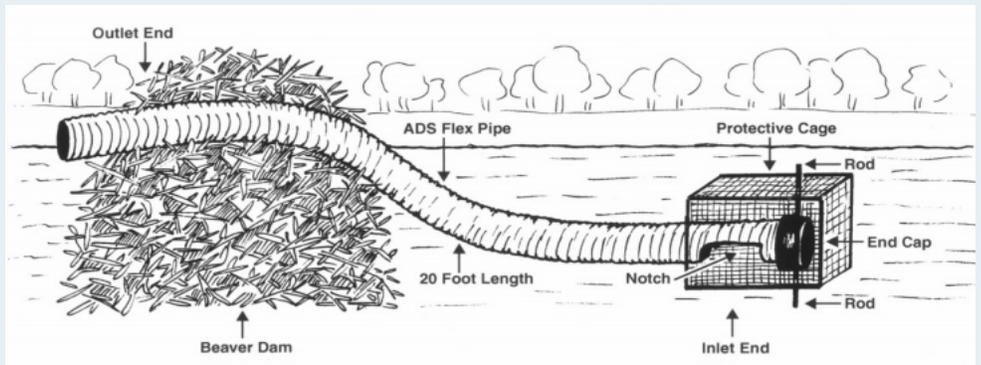
The Clemson Beaver Pond Leveler. Drawn by Dr. Jeanne Jones (Nolte et al. 2005).



Source: Nature-track.com



Culvert protector. Source: Nature-track.com



Flow leveler. Source: Human Society of the U.S.

Water flow device installation examples.



Beaver baffler (WRAP 2001).



Clemson Leveler (WRAP 2001).



Beaver Deceiver (WRAP 2001).



Beaver Deceiver (Boyles 2006).

Effectiveness decreases drastically when installation details are not followed properly.

Flow levelers use a flexible pipe with many holes and a larger 4-gauge mesh enclosure to connect two water bodies and regulate water levels. These devices can aid in fish travel since their openings can be much wider. They can also be used under beaver dams without destroying the dam itself (Beaversprite 2010).

Around culverts, a diversion dam made of wire mesh can make the damming of the culvert more time consuming for the beaver, giving workers more time to react before the path above is flooded. Unlike the deception devices described above, these devices merely slow the beaver rather than eliminate damming activities.(BWW 2016).

RECOMMENDATIONS

Short-term

1. Standard guidelines for water flow device construction can be developed and followed in order to reduce labor spent battling beavers in flood-sensitive areas. Drains at the McCleery Golf Club, and the beaver dam at Ceperly Creek in Stanley Park could benefit from water flow device installation. Nonfunctional water flow devices, such as at Beaver Lake, can be modified to increase effectiveness. Specifications for a sample device, the “Clemson Leveler,” tested for effectiveness can be found at <http://www.clemson.edu/psapublishing/PAGES/AFW/AFW1.PDF> Other commercial devices include the CulverClear(TM) and Beaver Deceivers(TM).
2. Signage near visible lodge sites, such as at Hinge Park, can be added to enhance public awareness and education.

Medium-Term

1. Population monitoring of the beavers could be accomplished without much additional cost. Groundskeepers can report lodge sites, management practices, damages, and ecosystem shifts annually to a central contact at the Park Board. This person could also observe each site annually. This data will help the city with mangement decisions.
2. A beaver population health assessment can determine if overpopulation and starvation is common.¹⁵ If overpopulation is occurring, consider supplementing their diet with cuttings from offsite, enhancing existing habitats, or reducing population size to minimize suffering and starvation.
3. Areas where the beaver is unwelcome can be made less suitable by putting rocks or gravel along the bottom of the water, fluctuating the water levels, using brackish water or saltwater, or minimizing deciduous trees. Otter or dog feces, or castoreum can help keep beavers away.

Long-Term

1. Paths near active beaver areas can be converted to raised boardwalks to allow for variable water levels and reduce disturbance by beaver activities.
2. Willows are the most beaver-adapted tree. Their fast growth resists dying from beaver harvest. These trees can be planted in beaver habitat where lodges are welcome.



*photo credit: Olympic Village
Beaver @Vancouver Beaver*



¹⁵ Individual health can be measured by the fatness of the tail, which thickens when healthy (Hatler and Beal 2003).

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ACKNOWLEDGEMENTS

Contributions from the following people made this report possible:

Mike Brisco

Trades Gardener, Board of Parks & Recreation

Oliver Busby

Principal, EBB Consulting

Maria Egerton

Conservation Projects Manager, Stanley Park Ecology Society

Lanny Englund

Urban Forestry & Park Services Manager, Parks, Recreation & Culture, City of Coquitlam

John Gray

Manager of Animal Control, City of Vancouver (CoV) Community Services

Ziggy Jones

Animal Attendant, Board of Parks & Recreation

Elizabeth Lau

Office Support Clerk, Board of Parks & Recreation

Dennis Luick

Superintendent, McCleery Golf Course, Board of Parks & Recreation

Mike Mackintosh

Park Ranger, Board of Parks & Recreation

Mehran Malek

Graphics Technician, Board of Parks & Recreation

Michael Mather

General Manager, University Golf Club

Jeff Mclean

Superintendent at Langara Golf Course, Board of Parks & Recreation

Jarrold Oliver

Assistant Links Superintendent, Marine Drive Golf Club

Henry Pahl

Superintendent, Musqueam Golf and Learning Academy

Nick Page

Biologist, Board of Parks & Recreation

Beverly Ramey

Director at Large, BC Nature (Federation of BC Naturalists)

Winson Tang

Team Lead, CoV HR, Digital Strategy & IT

Karen Taylor

Program Manager, UBC Sustainability Initiative

Frank Vargas

Superintendent, Point Grey Golf & Country Club

Jennifer Wahl

Policy Analyst, CoV Office of the City Manager

Robyn Worcester

Natural Resource Management Specialist, Metro Vancouver



*Understanding and Managing
Beavers in Vancouver*

August 2016

Vancouver Park Board
and City of Vancouver

Suggested citation:

Pierce, Jennifer Rae. Understanding and Managing
Beavers in Vancouver. Vancouver Park Board
and City of Vancouver, Aug 2016. pdf.

This report was produced as part of the Greenest City Scholars (GCS) Program, a partnership between the City of Vancouver and The University of British Columbia, in support of the Greenest City Action Plan.

This GCS project was conducted under the mentorship of City staff. The opinions and recommendations in this report, and any errors, are those of the author, and do not necessarily reflect the views of the City of Vancouver or The University of British Columbia.

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