Beaver Management Plan
for the Village of Yellow Springs, Ohio

Glass Farm beaver- photo courtesy of Scott Stolsenberg

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Compiled by Vickie Hennessy

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After moving to Ohio in 1984, she served as a Professor of Biology at Sinclair Community College for 20 years where she taught a variety of biology courses including Ecology, Tropical Ecology, River Ecology, served on a number of college committees, and involved her students in several community environmental projects. Vickie served on the Yellow Springs Environmental Commission from 2008 to 2011, works as an environmental activist within the village, and has served as president of the Green Environmental Coalition- a local grassroots environmental organization- since 2008.

Introduction

This Beaver Management Plan for the Village of Yellow Springs was written as a guide to assist in managing the beaver population at the Glass Farm.

The document is divided into two parts. Part 1, provides information about beavers- their natural history, behavior, wetlands, benefits, and conflicts. Part 2 focuses directly on beaver management strategies that may be used for the Glass Farm beaver population.

Part 1 begins with a brief history of the Glass Farm in Yellow Springs, and the current situation there since beavers began inhabiting the area. There is discussion of the positive role that beavers play in the environment, especially in this time of climate change; a description of beaver natural history, behavior, and ecology because it is felt that understanding the animal that one is managing is a critical first step to success. Part 1 ends with a discussion of some of the conflicts that can arise between beavers and landowners and includes specific conflicts within the village-primarily concerns about over population, tree damage, flooding, and mosquitoes.

Part 2, begins with a description of the Beaver Management Tasks Force whose role it is to manage the Glass Farm beaver population in a manner that creates a sustainable wetland environment by minimizing conflict with beavers and maximizes their benefit. The remainder of the document focuses on proven Beaver Management Strategies that may be applied to situations at the Glass Farm- specifically protecting trees from damage, installing flow devices to keep water flowing through dams, and mosquito control.

The Appendix also provides specific information on methodology and construction of management tools.

It is hoped that these guidelines will serve to educate readers about the benefits that beavers provide to our environment and their role of mitigating climate change as well as creating a sustainable wetland with enhanced species diversity that can serve as a site for nature study and education for the community as well as primary, secondary schools, and colleges. By practicing this management plan, it is anticipated that conflicts between beavers and residents will be minimized allowing beavers to co-exist within the Village of Yellow Springs and to create a sustainable wetland that enhances water storage, filters sediment and toxins, provides a home for a wide diversity of species, and serves as a site for nature observation and scientific studies.

It is intended that this be a “living document” with changes and additions over time to best suit the needs of a dynamic beaver population within the boundaries of our village.

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PART 1

Glass Farm

In 1978, the Village of Yellow Springs purchased the 45-acre Glass Farm from Bob Baldwin Sr., for the purpose of having open space and land available for future development to support village growth. However, since this time, the land has remained undeveloped. Most of the land is rented to an area farmer (Flatter) who raises corn and soybeans. Given the need for increased housing stock, it seems inevitable that soon consideration for development will be given to of the western 2/3rd of that property for housing and possibly, mixed use development. The eastern 1/3 of the Glass Farm- about 14 acres- has a Conservation zoning designation that was strongly supported by neighbors in the area, and established in the new zoning code revision in 2013.

This 'conservation' area contains both community gardens and a detention basin that was constructed in 2005 for flood control. Water draining from western areas of the Village flows through underground pipes and empties under the north side of Dayton Street into a channel. The stream thereby created flows west of the Baptist Church and Thistle Creek, and then turns east on the Glass Farm. The detention area regulates the water flow so that flooding does not occur downstream at the north end of the village. This controlled headwater stream leaves the Glass Farm under King Street and eventually flows into Yellow Springs Creek, through Glen Helen, and then into the Wild and Scenic Little Miami River.

Beavers

By 2011, a couple of beavers found their way to the Glass Farm detention area and built several dams and a lodge. Presumably they came upstream from the Glen. Their presence created a wetland habitat that has attracted a diversity of wildlife species. The beaver dams also caused the water level to rise creating a potential conflict with the functioning of the detention area. The Village Crew cleared the dams constructed by beavers for several years, but their efforts increased during the spring of 2014 when beavers repeatedly dammed the culvert under King Street thus blocking flow out of the detention basin.

On May 21, 2014, the Village experienced a 'hundred-year' flood. Water levels rose throughout Yellow Springs to unprecedented levels, and the detention basin, which overflowed on to King Street, was no exception. Some residents called the beaver's effect on water levels into question. Kent Bristol, acting Village Manager, called a 'stakeholder's' meeting to remedy the situation. It was generally agreed that the beavers would not be trapped, removed, or killed until an alternative solution could be attempted on a trial basis.

At that time, Mike Callahan from Beaver Solutions in Massachusetts, was contacted for advice about installing a device known as a “Beaver Deceiver” or Pond Leveler that allows water to flow through a beaver dam in a way unknown to the beaver- therefore unaffected by the beaver’s need to stop the escaping water. After consultation with Mike Callahan, a flow device was tailor-designed to the Glass Farm detention basin by local engineer, John Eastman. Eastman calculated that a pond height of three feet at the culvert would protect the beavers from predators and still allow the detention basin to prevent downstream areas from flooding. According to Eastman, with the beaver dam in place, the detention basin volume is only reduced by about 6 percent of the total storage volume and that small amount will have very little impact on the frequency with which the downstream banks are flooded.

The “beaver deceiver” works by tricking beavers into believing their dam is working to fully back up the stream. But a pipe breaches the dam through a fence, allowing water to drain from the pond into the culvert. Meanwhile, the fences at both ends of the pipe keep the beavers from damming up the pipes themselves. After Eastman drew up the specifications, in September 2014, Jason Hamby, Village superintendent of streets, built and installed the device with his crew. By the next day, the beavers had built their dam along the fence, as the design intended. Once the water level rose high enough, the pipe began to drain the pond. The open water surface area of the pond, when full, is about one acre, with wetlands covering a larger area. Wetlands include what might appear to be dry ground, but is actually saturated just below the ground surface so that only wetland plants can grow there.

Because beaver are known as “Keystone Species”, their dam building activities greatly impact the surrounding area and create a wetland habitat that attracts a wide variety of other species- from algae, plants, invertebrates to reptiles, birds and other mammals. Without the beaver, this type of species diversity would not be possible. Further, over 43% of our endangered species rely on wetland habitats for their survival.

“The Glass Farm wetland is an example of beaver-led ecological restoration and a unique educational and recreational opportunity”. – *Marianne MacQueen, as quoted in the Yellow Springs News, November 2014.*

Rational for Beaver Wetlands: Effects Upon Climate and Water

Restoring beaver wetlands is one of the most effective and economical ways to minimize some potential impacts of climate change on wildlife habitat and the land's hydrology, and thus human communities.

The path to the future requires understanding the past and how current and historic human activities have defined our present situation. Before European settlement of North America, the continent's beaver population was between 60 to 400 million, according to estimates from historic trapping harvest data.[1] By the early 1900s, beaver populations in the continental U.S. and southern Canada were nearly eradicated. The current beaver population of North America is probably 10 percent, or less, of the original number.

The estimated loss of about 90 percent of these four-footed engineers, and the vital wetlands they once maintained has profoundly affected the continent's hydrology. Their systematic and widespread removal represents the first large-scale Euro-American alteration of watersheds. As beavers were removed, and their dams failed from lack of repairs or were destroyed, changes took place in how water was stored and routed from upper to lower watersheds. Channels eroded into the soft sediments once trapped behind the dams. Over time, valley bottoms shifted from landscapes dominated by ponds, multiple channels, wetlands, and wide riparian zones abundant in fish and wildlife, to landscapes defined by the simple, incised, overly wide, single-thread channels with narrow strips of riparian vegetation that we know today. In addition, widespread drainage of North American wetlands via outlet ditches lined with tiles occurred; over 50 million acres were drained for cropland in the U.S. Midwest alone.[2] Much of the drained acreage later proved unsuitable for agriculture, yet the land's water storage, flood mitigation capacity, and complex, extensive wildlife habitat was dramatically reduced.

Human activities, past and present, have systematically stripped watersheds of those features that once helped store and slowly release water, dampen flood peaks, and sustain stream flows during droughts. Now connected, incised river systems function essentially as pipelines, rapidly moving water from the upper to the lower watershed with little water storage, and wetlands are a fraction of their past extent. These changes have severely compromised the ability of human and wild communities to successfully deal with climate change and increased climate variability.

The potential contribution of beavers as partners in helping mitigate the impacts of climate change, and other environmental problems, such as the rising rate of species extinction, is considerable. Dam building by beavers naturally and economically restores freshwater wetlands, which have been rated as the world's most valuable terrestrial ecosystem in terms of natural services.[3]

The return of beavers, and recognition of their contribution, will lead to rapid increases in surface and groundwater storage, improved wildlife habitat, decreased regional flood damage, improved water quality, and increased water quantity within a few years.

Beavers will not make sense everywhere because of the extent and location of human development. However, certain private and public lands exist- even within a village boundary- where beavers would be a welcome addition. These areas would become water storage zones- complex ecosystem reservoirs that would provide huge benefits to many humans and wild communities [4].

Many communities across the nation are encouraging beaver wetlands and some- especially in the west- are even reintroducing beavers to assist with water storage in arid areas. In Ohio alone, there are several communities that are working to allow beavers to reside within their borders. In Mason, Ohio, beavers moved into a city park there and park staff were concerned about the destruction of many of the park's trees. The issue to remove the beavers was brought before the city council, but because of public support for the beavers, they were allowed to stay http://www.wcpo.com/news/local-news/warren-county/mason/mason-stumped-by-tree-damaging-beaver In Columbus, Ohio Metro Parks installed a Beaver Flow Device when beavers moved into Glacier Ridge Park in December 2014. http://www.beaversww.org/assets/PDFs/Columbus-OH.pdf And last year in Mt. Healthy, near Cincinnati, when beavers moved into a drainage pond within a highway cloverleaf, special training classes were held for ODOT workers to learn how to install flow devices to preserve beaver habitat. http://bronxriver.org/puma/images/usersubmitted/file/BeaverspriteSpring2013FE(1).pdf

http://www.martinezbeavers.org/wordpress/2015/06/15/

Proactively identifying suitable sites for beavers, and the acceptable limits of beaver-driven changes, allow communities to plan how to minimize beaver conflicts while maximizing their benefits [4].

See Appendix A- Climate Change Adaptation Imperatives of Beavers.

Excerpt taken from Brown, S.T. and S. Fouty, *Beaver Wetlands.* LakeLine Magazine. North American Lake Management Society. Spring 2011

Natural History of Beavers

Beaver in Urban Habitats
Beavers are very interesting creatures and they are now returning to this area after an absence of nearly 300 years. As beavers and people move into each others' backyards, many of us want to learn more about these wild animals -- either to enjoy watching them or to learn how to take preventive measures to protect property. The following information on the biology, life history, ecology, and behavior of *Castor canadensis* is provided so we can all gain a better understanding of this remarkable mammal.

Basic Life History
Beavers are the largest rodents in North America; adults typically weigh from 35 to 50 pounds, but there are numerous records of them exceeding 100 pounds! They are between two and three feet in length, with an additional 12 to 18 inches for the tail. Beavers vary in color from light to dark brown; in this area most are dark brown to reddish brown in color. The fur contains long, shiny guard hairs covering dense, soft underfur that traps air and helps protect them from the cold. It is the underfur that is of value in the fur industry. Beavers are widely distributed, living in every Canadian province below tree line and in every state except Hawaii.

Beavers have numerous morphological, physiological, and behavioral adaptations that enable them to thrive in semi-aquatic environments. Their body is "torpedo" shaped; that contributes to their agility in water, but on land it makes them a bit awkward and clumsy. They are muscular animals with large bones, and a massive skull that supports strong chewing muscles. Like all rodents, beaver teeth never stop growing, so they do not become too worn despite years of chewing hardwoods. Their four front teeth (incisors) are self-sharpening due to hard orange enamel on the front of the tooth and a softer dentin on the back. Therefore as beavers chew wood the softer backside of the tooth wears faster, creating a chisel-like cutting surface.

Beavers have a broad, horizontally flattened tail that is scaly in appearance. The tail is used for stability while sitting or standing upright on land, as a rudder and propulsion in water, as a warning device, and for both fat storage and thermal regulation. Their hind feet are large and webbed for propulsion; the toenail on the 2nd toe of each hind foot is split, forming a grooming claw that can be used to clean dirt and other debris out of their fur. [4] The front legs are short and the front paws have heavy toenails for digging. Beavers' eyes are near the top of their head so they can see above the water while keeping most of their body underwater, and they have a translucent membrane that covers their eyes when underwater. Both ears and the nose have valves that close when the animal submerges. The throat can be blocked by the back of the tongue, and the lips close behind their incisors to permit gnawing and carrying sticks underwater without choking.

Feeding
Beavers are vegetarians whose diet varies with changes in season. In spring and summer they feed on non-woody plants or plant parts such as water lilies, algae, grasses, sedges, herbs, ferns, and shrub leaves and shoots. In the fall and winter they favor twigs, roots, bark and inner bark (cambium layer) of woody plants. Aspen, birch, alder and willow are favored tree species, but beavers have been known to cut almost every kind of tree, including conifers. Bark and leaves may be eaten where they fall in the woods or dragged back to the water. Since they consume large amounts of cellulose, they have a specialized digestive tract with very long intestines. Also, beavers often are coprophagic and will ingest their feces to gain the undigested nutrients. 5

Beavers create a food cache each fall. The food cache is a stock of branches and twigs stored under the water near the lodge for a winter food supply. These are compiled from September to November. Beavers preferred tree species are notably aspens and willows, with other tree species eaten and used based on relative availability. In different studies beaver will cache many different species including aspens, willows, alders, witch hazel, red maple, sugar maple, red oak, white birch, yellow birch, and white pine. Any branches that have been stripped during feeding will often be used in dam or lodge construction in the spring. 6

Reproduction: Beavers form permanent, monogamous breeding pairs that continue between breeding seasons. Copulation takes place in the water mainly from December to January. The gestation period on average lasts 107 days. In May to July kits are born typically in litters of 3 to 4. Reproduction normally takes place only in the adult pair of a colony and most females do not reproduce until age two. In populations with heavy trapping, females may breed at a younger age. At age seven, 90% of females will reproduce and will continue to do so until death.

Both sexes look identical externally. Beavers have no external sex organs, except teats on nursing females, and they have a common urogenital opening near the base of the tail (a "cloaca" similar to waterfowl).

Development of kits is relatively rapid. Beavers are born fully furred and teethed weighing about 0.7- 1.4 lbs. Within several hours they will have full use of their eyes and show defensive behaviors. They may also enter the water on their first day of life. Beaver young remain in the nest during their first year. Young are able to swim by 9 days old. By 3 weeks young are able to groom themselves and are eating mainly vegetation. Young are normally fully weaned by week 10, even though lactation may continue. When weighing 7 – 8 lbs., kits begin to leave the lodge to explore and feed. Young normally remain in the lodge until their second year, at which time they will disperse to find a mate and build their own lodge. A yearling weighs 24 – 27 lbs.

If a member of a pair dies it will often be replaced with a 2-year old disperser. The average pairing lasts 2.5-3.1 years. The high replacement rate may be explained by the age discrepancies of repairing. On average a beaver lives to 10-12 years and up 19 years in captivity. 4

Ecology and Behavior

Lodge and dam building-

Beavers live in lodges or bank burrows. Bank burrows can be used in faster moving water, but most beavers live in lodges. Lodges can extend several feet out of the water and are made of sticks, mud, leaf materials, and sod. There are normally two underwater entrances and a main room, which may be 6-8 ft. diameter and is completely above water. Often, beavers will have a main lodge or the nursing lodge and one to several alternative lodges. The second lodge site is used heavily after the kits are born, at varying water levels, and in the summer months. During the winter and cold seasons the lodges maintain a warmer temperature inside than outside (in one study the lowest temperature inside was 0˚ C while out side it reached –6˚ C). The lodges are well ventilated with no seasonal variation in CO2 or O2. 7

The site selection for the lodge is influenced by many factors, which include population levels, territoriality, and habitat quality. Environmental factors that influence the site are percent canopy cover, slope of the riverbank, and water depth. Sites with greater slope and depth are normally chosen. The site of the lodge also tends to have more canopy cover then surrounding areas and is not harvested for building or food. 8

Beaver dams are initiated where water flows over obstructions in streams and at outlets to pools; audible stimuli are important in releasing and orienting construction behavior. Dams begin with beavers pushing pond or stream sediment and stones into a ridge. Ridge size depends upon stream velocity and when the ridge no longer holds back water, sticks and branches are added for support, followed by more mud. As a dam takes form, building behavior is oriented where water flows over or around the structure. Building behavior generally ceases when water no longer flows over or around the dam or when ice forms.
Dams are maintained throughout the year, but most material is added during periods of excess water. Mud and sediment from the pond bottom are carried in the forepaws against the upper chest and are pushed along the upstream side of the dam to or near the crest. Sticks are towed to the dam and, using teeth and forepaws, slid over the crest to the downstream side. Maintenance behavior increases with age and all family members participate.

Beavers frequently perform slow, close inspection of dams. This inspection appears to be visual, but sound detection of escaping water also may be important. About one-third

of all close inspections result in dam maintenance. All family members perform the behavior, and the frequency increases with age. Breaks in dams are rare, probably because of frequent inspections and maintenance. Materials selected for repairs follow a fixed sequence, similar to initial dam construction. Repaired crests often are higher than adjacent portions of a dam. [9]

Diving: Beavers can regulate their blood chemistry, heart rate, and circulation pattern to enable them to remain underwater for 15 or more minutes, although a normal dive lasts for 5-6 minutes. When diving blood is signaled to move to vital organs that could suffer from oxygen shortages. The heart rate and metabolism will also drop on a dive. The average resting heart rate of a beaver is 100 beats/minute and can drop to 50 beats/minute while diving. [4]

Mound Building: Beavers hold territories of 10-75 acres. Scent mounds built from pond sediment and are marked with castoreum form these territories. Castoreum is a urine based excretion that is stored in castor sacs. The adult male primarily does the scent marking, but other family members will also take part in this activity. Beavers will periodically remark the mounds. They are also able to distinguish between family and non-family members as well as neighbors and non-neighbors. The main mound building time is in late spring, early summer, during the time a dispersal of young. Reasons for marking scent on a mound include elevation of the point of odor release, intensify odor with moist substrate, and protection from flooding. [10]

Social organization: The beaver family social system is unique among rodents. Each family occupies a discrete, individual site. The adult pair bond is long-term and monogamous, although a lost adult may be replaced by a transient or an offspring. The family strategy is characterized by low birth rate, low young mortality, prolonged behavioral development, and high parental care. An age-class hierarchy exists and is maintained through close-range interactions where body orientations, vocalizations. postures, and gestures convey status; physical aggression is rare among family members. Adults dominate yearlings and yearlings dominate kits. Either adult may be dominant, or they may be co-dominant.
Offspring tend to stay with their parents until they are 2 and help with taking care of the young, building, food caching, and scent mound work. The male and female also allocate their time between many different roles or jobs. Both males and females spend about the same amount of time traveling to get food, but females spend more time on interactions, feeding and on food caching. Males on the other hand spend more time on lodge work and alarm displays. There is a shared responsibility in the care of young with both males and females.[11]

Activity Patterns: The normal activity pattern is a crepuscular (dawn and dusk)-nocturnal active period and a diurnal resting period. This pattern becomes much more irregular in the winter. [7] Beavers' activity during spring, summer, and fall is predominately dusk to dawn, with activity beginning later in spring and fall than in mid-summer. Active period length is 11-13 hours per night, but varies among individuals and

families. One beaver usually emerges first from the lodge or burrow more frequently than any other family member. This individual may be male or female, but typically is an adult. The adult male often patrols the pond perimeter after emerging.
In winter where ponds are frozen for several months, free-running circadian activity rhythms, with a period of 26-29 hours, probably are common. Activity above ice is correlated positively with air temperature. As temperature falls, above ice activity declines and at about 10-15 degrees F. it ceases. [7]

Summary

Beavers are extremely well adapted to their semi-aquatic life-style and their ability to dam streams, cut trees, and build lodges make their presence highly visible in the landscape. Beavers have played an active role in Ohio Valley ecology for thousands of years. Intensive trapping and deforestation that followed European colonization eliminated beavers from this region by the early 1800's. Today, the landscape beavers are returning to is very different than the one they occupied over 200 years ago. While trees and waterways are similar, transportation corridors and human developments now break them. Beavers were not considered in human development patterns because they were absent, so areas with a low or gradual gradient, often next to streams and rivers, were selected for roads, railroads, housing developments, and parks. Because beavers have a dramatic impact on the landscape in very urban areas, their return to a human- dominated environment has not been without conflict.

Benefits of Beavers- Summary

- **Biodiversity:** Beaver ponds create wetlands, which are among the most biologically productive ecosystems in the world [12]. This one species supports hundreds.

- **Create entire food chains:** Beavers open the tree canopy and the resultant sunlight causes an explosion of biological activity. Algae and aquatic plants grow in the sun drenched, nutrient rich water. This organic material supports microscopic organisms, which are eaten by a variety of invertebrates. These become food for fish, birds, and mammals.

- **Increase bushy growth of trees:** Tree cutting by beavers stimulates more growth in many trees, such as willow and poplar. For example, for each willow stem that is cut, three or four more will appear in the spring. These plants, plus the abundance of grasses, sedges, saplings growing on the pond perimeter, provide food, cover and nesting sites for foraging animals.

- **Elevate fish populations:** Beaver dams protect the downstream spawning areas from sedimentation, and create cool, deep pools, which increase salmon and trout populations.[13]

- **Improve water quality:** By functioning as natural sponges that store runoff water and slowly release it, beaver wetlands allow algae and plants in the pond to absorb dissolved nutrients, process organic wastes, and detoxify runoff toxins (e.g. heavy metals, pesticides, and fertilizers). These wetlands serve as the "Earth's Kidneys".[14]

- **Create fertile soils:** Even when beavers finally move on or are removed from an area, their drained ponds continue to provide important benefits. The exposed mudflats provide fertile soils for lush vegetation to promote diverse wildlife habitats.

- **Prevent flooding:** By building a series of dams across small watercourses, beaver help to control water levels, slow water flow, and reduce major floods downstream.

- **Slow erosion:** The running water that enters a beaver pond slows down and automatically drops its load of silt. Otherwise the fine silt suspended in running water would be carried far downstream. Water downstream of a beaver pond is typically clearer and cleaner (toxins filtered out) than the water entering.

- **Aid with Climate Change:** Beaver ponds restore our drinking water aquifers, stabilize the water table, and better maintain stream flow during drought. Beavers are even being reintroduced around the country to improve arid lands.

Conflicts with Beavers and Landowners

It is inevitable that conflicts will arise between the two species most adept at altering the natural world to suit their own needs. Both humans and beavers have built structures that can be seen from space, for example, the Great Wall of China and a half-mile long beaver dam in Alberta, Canada.[15] But we can resolve many of these problems and benefit from the essential natural services that beaver wetlands provide.

When problems arise, working with the beaver is the best solution. If beavers are removed from good habitat, many studies show that others tend to resettle the habitat. Survivors in the area often respond with larger litters, and beavers can migrate over tens of miles. Removing beavers, whether by killing, or live-trapping, rarely gives a lasting solution.

In addition, without beavers to keep up a dam, it will disintegrate. The subsequent loss of a vibrant pond often causes many lives to be lost and much environmental damage.

Is it a Real Problem?

Ignorance about beavers and their role in nature can cause alarm about having these medium-size animals in the neighborhood. Fear of the unknown can lead to exaggeration, such as saying dozens of beavers are present when there are only a few (it is not widely known that one family may have three lodges). In fact, overpopulation is rare, because beavers are territorial and one family typically defends a half- mile of streamside territory from strange beavers.

When a beaver fells a tree or floods a few trees alongside a stream, a landowner may panic, unaware that such change is part of nature's cycle. Tree cutting often stimulates more growth in many species, such as willows, aspen and cottonwoods. Willow stumps may sprout three or four new stems in the spring, and poplars re-sprout from the roots. Plus, there are ways to protect special trees.

Flooding may kill trees, but dead trees provide homes for wood ducks, owls, herons, woodpeckers, and flying squirrels. Such trees are just as important in nature as live ones. Remember, a newly flooded beaver site is apt to be a historic wetland, where trees invaded after it was drained for agriculture. Beaver flooding is limited by geography to a small percent of the landscape wetland, and there are ways to manage undesirable flooding.

Win-Win Solutions

Allowing the beavers to remain while solving the specific problem (for example, flooded roads or tree cutting), preserves the many beaver benefits. Wetlands are decreasing

worldwide, but freshwater wetlands have been rated in a study by over a dozen ecologists and economists as the world's most valuable terrestrial ecosystem in terms of natural services [3]. By installing flow devices, often most of the beaver wetlands can be saved, while ending the unwanted flooding. Problems with objectionable tree cutting can be solved with fencing or other methods (see Appendix B)

Proven, cost-effective devices, such as beaver pipes in dams, are installed to control objectionable flooding. Road flooding is a common beaver/human conflict that be solved with methods such as "enclosures," or beaver fences, for example, the Beaver Deceiver. Since beavers are quite adaptable, it is best to use proven techniques. (See Appendix C)

If beavers must be relocated, using Hancock or Bailey live traps is the best method.* Snares hold the victim helpless against predators and can cause death by drowning due to entanglement with the wires used. No kill trap that currently exists will reliably cause a fast death under field conditions, and drowning traps are especially inhumane for animals that can hold their breath for 10 minutes or more. Surviving beavers respond to persecution with larger litters. Because of this species' benefits in creating vital wetlands, and because removal is rarely a lasting solution, working with beavers gives the best results [16].

Primary Concerns re: Beaver at the Glass Farm

Various Yellow Springs' residents and landowners near the Glass Farm have concerns about beavers residing there. The primary concerns are: Overpopulation, dams and resultant flooding or water stagnation, mosquitoes, and tree damage.

Natural Population Control

Beavers rarely overpopulate because they breed only once a year, defend large streamside territories from strangers, and the two-year-olds leave home each spring to find mates. They are limited to a small fraction of the landscape that is close to waterways. Kits have many predators including hawks, owls and otters; dogs and coyotes will also take older beavers that are especially vulnerable when seeking new territories. Accidents are another frequent cause of mortality, including falls into abandoned wells, and especially traffic accidents. In general, trapping is the most common source of mortality [19].

Beavers are limited by the amount of available habitat and food. Like many wildlife species, beaver populations self-regulate by starting to decrease their rate of reproduction (fewer kits born per season and fewer reproductive pairs) when occupancy reaches a certain level. In areas where beavers are just returning to the ecosystem or where trapping or other unnatural human-caused mortality has recently ceased, populations may peak and then slowly drift down to a sustainable level.

Studies show that beaver populations follow a sigmoidal, or S-shaped pattern, meaning that populations rise and fall over time, with or without trapping - in New York's 62,000 acre Allegheny Park, trapping beaver has been prohibited for 25 years and occupancy rate in this park varied from 40% to 60% during these years, never reaching 100% occupancy – similar findings in California showed population expansion, decline and stabilization at 35% of maximum capacity. [17] One of the longest-term beaver studies in the Quabbin Reservation shows similar trends. Data gathered in 2006 shows a decrease from 2004 "continuing a downward trend that began in 2001. Massachusetts beaver population estimates, as reported in the media, have leveled off at about 70,000 since 2005. [18]

In all likelihood, the Glass Farm beavers initially migrated from Glen Helen and followed waterways upstream to the Glass Farm. It also seems likely that young beavers at the age of dispersal will follow the same route back to Glen Helen. Currently there are a number of beaver living in the Little Miami Watershed that includes John Bryan State Park and Glen Helen (in addition to many transient beaver traveling through these areas that stop primarily to feed.) As beaver populations spread throughout the state and the nation, most waterways will become hosts for dispersing beaver in travel or seeking a home. It is a natural cycle.

Dams- Flooding and Mosquitoes

Beavers at the Glass Farm have created two primary types of dams- each creating a different set of potential conflicts.

One dam, as previously mentioned in section on the Glass Farm, was built at the culvert that drains the detention basin under King Street. Because of potential flooding that could occur downstream if the beaver pond level got too high, a "Pond Leveler" flow device was installed which maintains the pond at a level not to exceed three feet. (See Appendix C)

Secondary dams have been built in the inlet channel that flows under Dayton Street into the detention basin area. These dams have functioned to elevate water levels, and slow water flow to a point of stagnation. There has been concern from the Baptist Church and other property owners along the channel, that the environment creates a breeding ground for mosquitoes.

Tree damage Some tree damage has been observed by property-owners primarily along the west side of the inlet channel. In most cases beavers removed small trees less than six inches in diameter. In a few cases, beaver girdled larger trees. To prevent further potential damage, some property owners installed wire fencing around trees felt to be at high risk for damage. (Appendix B: Trees and Plantings.)

PART 2

Beaver Management Task Force

The management of beavers at the Glass Farm will be under the direction of the Beaver Management Task Force in accordance with the policy set forth in this Beaver Management Plan.

Structure: The Beaver Management Task Force shall be composed of a director, a minimum of 5 stakeholders (residents potentially affected by conditions caused by the beaver's presence), a member of the Yellow Springs Village Crew, a member of the YS Environmental Commission, a YS Village Council member, a minimum of two teachers and/or faculty from YS Village Schools and Antioch College, and up to 3 Village residents with interest. The composition of the BMTF is designed to involve a diverse group of village residents with varied concerns related to the presence of a beaver colony residing at the Glass Farm- from Village government to stakeholders to environmental experts. All viewpoints will be considered in decision-making processes related to management strategies. The overall goal of the BMTF is to define the acceptable limits of beaver-driven changes, and to make plans to minimize beaver conflicts while maximizing their benefit to maintain a sustainable wetland ecosystem. All management strategies and procedures must have prior approval from Village government.

Duties: It shall be among the duties of the Beaver Management Task Force to implement a bi-weekly survey of the conservation area at the Glass Farm, and to note any adverse conditions created by beaver. Such conditions may include:

- new beaver dams which may create stagnant, slow moving water, or impaired drainage.
- trees that have been damaged or cut by beaver.
- stagnant water that creates a breeding ground for mosquitos.
- situations of flooding, including areas downstream from the Glass Farm.

It will be the charge of the BMTF to implement solutions to these situations by:

- Installing a flow device through a beaver dam that will allow water to flow through the dam preventing backed-up and stagnant water and thus maintaining appropriate water levels.
- Working with property owners to install wire fencing around tree trunks at risk, or to install fencing along the waterway.
- Contact with the GCCHD for the application of the larvicide, Bt, in waters with high amounts of mosquito larvae.

- Assuring that all beaver flow devices and pond levelers are functioning correctly.

Additionally, it shall be the task of the BMTF to assure that beaver have an adequate food source in the Fall. Willow trees should be planted and fenced off as needed. This will help maintain the beaver population and prevent damage to property owner's trees.

Meetings: The BMTF will meet, at minimum, quarterly, to assess the condition of the beaver population during each season. Additional meetings may be scheduled as necessary. Sub-committees may also be formed as needed (for example: mosquito eradication, tree-protection, dam breaching, etc). Before any sub-committee engages in a new management strategy or procedure, it must first be presented to the BMTF director. A new management strategy may only be initiated if it has the final approval of Village government.

Maintenance: Any manmade device exposed to the elements requires some maintenance. It is recommended that Beaver Flow Device pipes be inspected each spring for winter ice, beaver or other damage, or if the pond level ever rises unexpectedly. Culvert Protective Fences should be inspected three to four times a year to remove any accumulated debris from the fence. Typically this is done at the end of autumn, spring runoff, and any large debris-producing storm [21].

Signage: Signage will be placed near the entry to the conservation area off of King Street. The following types of messages will be used:

- This is a natural wetland area created by beavers. Please
- Stay on trail
- Keep pets on a leash
- Do not enter the water
- Do not collect plants or animals
- For further information about this area, please contact _____.

Additional interpretive signs may be used to describe beaver habitat, ecology, dams, lodges, and other features.

Education: It is anticipated that school groups will use this beaver wetland for educational purposes. It would best serve these groups if they notified the BMTF prior to their visit. The BMTF may be able to guide them to specific areas or species so that they may best obtain their goals. In situations of long-term, ongoing research, notification is essential to prevent routine maintenance from interfering with research plans.

Funding: In January 2016, Tecumseh Land Trust, working in conjunction with the Village Environmental Commission, was awarded a Clean Ohio grant valued at $68,868. Funds of approximately $10,000 were budgeted to cover the cost of beaver management and materials (flow devices and maintenance, fencing for trees, tree planting, signage, etc)

Beaver Management Task Force 2016

- Director- Vickie Hennessy, author of Beaver Management Plan
- Village Council member- Marianne MacQueen
- Environmental Commission / neighbor- Tom Dietrich
- Yellow Springs Village Crew- Jason Hamby
- Antioch College- Brian Kot
- Yellow Springs Schools / neighbor- Becca Eastman
- Village Residents / property owners/ neighbors-

  Rick Donahoe

  Bettina Stolsenberg

  Chad Runyon

,

Beaver Managing Strategies: Trees & Plantings

How to Protect Trees From Beavers

Beavers often prefer to eat seaweed, clover and other land and aquatic plants, instead of the green bark (cambium) of trees, during warm weather. But, in areas with harsh winters, they need to prepare an underwater food cache of branches - unless abundant water lily tubers are available. They will normally use the peeled stick leftovers to build their dams and lodges. Because one beaver family (colony) often makes several of these teepee-shaped dwellings, the number of lodges is not a reliable way to estimate the number of local beavers.

Beavers may fell a wide variety of trees, though they tend to cut fast-growing trees, such as poplar, willow, cottonwood and alder that have little commercial value. Although the felling of these trees may appear destructive, such culling often results in more, bushier growth next spring. For example, each willow stump may resprout three to four new stems, while poplars tend to regrow from their roots. If the beavers then use the branches from the old trees for a dam that creates a wetland, great benefits can result, such as water cleansing, erosion abatement, flood control and more biodiversity.

Those concerned about protecting trees from beavers, must consider that most cutting occurs within 50 feet of the shore. Although beavers may travel 200 feet from water, the likelihood of tree damage decreases as the distance from shore increases. While beavers prefer certain tree species, they do not necessarily take them in order of preference, so it's a good idea to protect special ones. Leave the trees that are already down, so the beavers are not driven to cut more, while you are protecting others. It may be possible to arrange with tree trimming companies to have branches dropped off to provide alternative food [21].

Recommendations for Preventing Tree Damage

1. Homeowners who live along the edge of the in-flowing stream to the Glass Farm wetland are strongly encouraged to protect their trees with inexpensive wire cylinder tree wraps or cages. These properties include Park Meadows, Thistle Creek, the properties of R. Donahoe, C. Runion, and R. Eastman.

2. Cylinder cages should be made of ½ inch-mesh hardware cloth or heavy wire 2” x 4” fencing. The cylinders should be 3 to 4 feet in height and well anchored to the ground to prevent beavers from crawling under. Encircle the trunk, leaving a space of about six inches between the tree and the fence. Cut every other horizontal wire to leave a long prong and bend these into hooks to attach with the other end. These cages can easily be removed to use on another tree. (See Appendix B)

3. Making a cylinder with a diameter of 12 inches greater than the tree's diameter will keep the fence the required 6 inches from the tree on all sides. To make the cylinder, cut the wire fence that comes 4-feet high to the length that you need and roll it into a cylinder. You can figure this out using the formula C = 3.14 x D; where C equals the circumference of the cylinder and D is the Diameter that you need, i.e. 12 inches greater than the tree diameter. (See Appendix A)

4. The Beaver Management Task Force will wrap selected trees, 6" in diameter and greater, on village property as described above, and will assist property owners protect their trees in the same manner.

5. Where wrapping of individual trees is impractical, low fences (3- or 4-feet high, depending upon the local snowfall) are used to protect groups of trees, and normally need not surround the entire stand, since beavers dislike being separated from the water. Have the fence fit tightly to the ground and trail each end toward the water. Monitor often in the beginning for burrowing. If digging occurs, two concrete blocks tied together can be used to block the tunnel. (See Appendix B for alternate suggestions.)

Tree Planting

Willow mutualism

The relationship between beaver and willow has been described as a mutualism where both species benefit from the interaction.[19] Although herbaceous plants are the preferred foods of beaver in summer, willows serve as the primary riparian zone source of food because the leaves and twigs are eaten in summer and the limbs and trunks are cut for food during winter. * However, beaver also benefit the willows. Beaver dams create situations that are favorable for growth of willow, which occurs through a number of mechanisms.

- Willow are more tolerant of flooding than most other trees- consequently when a pond is flooded, willow survive while other trees are killed.
- In forested areas, the cutting of trees and creation of ponds open the canopy, which allows light to penetrate- light fosters growth of willow.
- Beaver dams cause an expansion of the area of wetted soils and a rise in the ground water table, which facilitates the growth of willow- moist soil, is needed for seed germination and seedling survival.
- Sediments trapped by beaver dams enhance nutrient levels, which further facilitate growth of willows.
- Willows respond to beaver cutting with a burst of growth that increases stem production both in terms of numbers of stems per plant and rate of elongation.*

Under natural conditions beaver and willow are capable of coexisting on a stream reach indefinitely because beaver shift centers of foraging, which allows willow to recover in a continuing cycle.

Glass Farm Willow Planting
Currently, on the northeast side of the beaver pond a stand of small willow trees exists. Beaver have cut over 50% of these trees, but their regenerative, bushy growth in the spring provides food for beaver during summer and fall. Nonetheless, it would be advantageous for beaver to have more of their preferred food source available when constructing their food cache during the fall. This past fall season, they primarily depended on Bradford Pear trees, and occasionally, fell small trees of various species on private land.

With this and the condition of willow mutualism in mind, new willow sprigs will be planted on the northwest edge of the pond adjacent to the existing stand. These new plantings will be protected by fencing. By having an adequate supply of willow as food stored for the winter, it is expected that the beaver will cut fewer trees on neighboring properties during the winter months

Beaver Management Strategies: Dams

No other animal with the exception of man so significantly alters its habitat to suit its own needs and desires. The beaver's short legs and wide body made them slow and vulnerable to their enemies. However, unlike most of their historic predators, beaver are excellent swimmers. As a result, beavers evolved to have a strong preference to remain in or very close to the safety of the water. The need for safety is the primary reason beavers build dams to create ponds. Beavers predictably select sites to build their dams based primarily on topography and food supply. Beavers often situate their dams where there are constrictions in the stream flow (natural or manmade). This is why beavers have a strong propensity to dam culverts. For relatively little work, they can create a large dam and pond.

Glass Farm Dams

Over the years, beavers in the Glass Farm have created dams at several locations. There is a constructed inlet channel that flows from Dayton Street west of the Baptist Church and Thistle Creek, and then turns east on the Glass Farm to enter the detention basin. Several dams have been constructed along the inlet channel, and a few smaller dams have been located in the detention basin wetlands, which slow flow rate and raise the water level near their lodge. The most significant dam to alter the area was built at the culvert under King Street that drains the detention basin. This dam was repeatedly removed by the village crew in 2014, and consistently rebuilt by the beavers to raise the water level of their pond. After the flood in May 2014, efforts began to design a solution. As previously mentioned, by September of that year, a water level flow device-sometimes called a "beaver deceiver", or Pond Leveler-- was installed to allow water to flow through the dam and into the culvert.

Water Level Flow Device

If properly designed and built, a Pond Leveler will create a permanent leak through the beaver dam that the beavers cannot stop. In order for these pipe systems to work, they must be designed so that a beaver cannot detect the flow of water into the pipe. The Pond Leveler works by surrounding the submerged intake of the pipe with a large cylinder of fencing to prevent the beavers from getting close enough to the intake to detect water movement. As a result, the beavers do not try to clog the pipe, and maintenance is rarely needed. Usually a pond depth of at least three feet is required for the Pond Leveler to function properly. Generally, the height of the pipe in the dam determines the pond level. Water will flow through the pipe unless the pond level drops below the peak of the pipe. The pipe is set in the dam at the desired pond level, and can be adjusted up or down if desired. Pond Leveler pipes do not need to be sized like culverts to handle catastrophic storm events because heavy storm runoff will simply flow over the top of the dam. Following the storm, the pipe will return the pond to the normal level. Some mild pond fluctuations are possible following very wet periods, but since the pipe controls dam height, the pond size remains at a safe level. (**See Appendix C-1**)

The Pond Leveler installed at the Glass Farm generally followed this design, but was modified by John Eastman in August 2014 to accommodate the specific functions needed for the Glass Farm Detention Pond. (**See Appendix C-2**)

Secondary Dams

Several small dams in the detention basin area were built by beavers from 2012 to 2014, which caused the water level to rise near their lodge and feeding areas. Most of these were removed by the Village Crew during that time period. In April 2015, after days of heavy rain, water began to backup on the western side of the village. It was discovered that water in the inlet channel that originates from underground pipes draining this area, was backing up and preventing proper drainage. Two thought-to-be abandoned beaver dams were located in the channel. The largest was partially removed and the other, located upstream, was breached numerous times to allow water to flow through. Beavers continually repaired the dam following each breaching- thus stopping water flow and indicating that it was still an active dam. Plans are currently in place to install a Beaver Pond Leveler (See Appendix C-3) through this dam to allow water to continually flow through the channel into the detention basin area.

Continuous monitoring of this area will be required to detect any new dam building activity by beavers in the inlet channel.

Recommendations for Beaver Dam Management

1. In most cases, beaver lodges and dams should NOT BE DISTURBED, as this only encourages increased beaver activity. Lodges and dams should be disturbed only if a) they are causing a safety hazard, b) are causing water backup, flooding or otherwise threaten private or village property (including bridges). (See Appendix B)

2. Beaver dams will not be removed, but “deceiver” or bypass devices will be installed where (a) water backup, flooding or other threats to private or village property can be mitigated by such a device, **and** (b) where the water depth and shoreline height are sufficient to accommodate the device.

3. Beaver dams will be removed only if (a) dams are causing water backup, flooding or otherwise threaten private or village property **and** (b) such threats cannot be mitigated by a beaver flow device, **or** (c) it is too shallow or water flow is too great for the use of these devices.

Trapping

Beavers will not be trapped and killed because it is inhumane, unsafe, expensive, and doesn't permanently solve the problem. Beaver are territorial and when a niche is opened, other beaver will fill the niche usually within a year, often causing more damage by rebuilding lodges.

If beavers must be relocated, using Hancock or Bailey live traps is the best method. Snares hold the victim helpless against predators and can cause death by drowning due to entanglement with the wires used. No kill trap that currently exists will reliably cause a fast death under field conditions, and drowning traps are especially inhumane for animals that can hold their breath for 10 minutes or more. Surviving beavers respond to persecution with larger litters. Because of this species' benefits in creating vital wetlands, and because removal is rarely a lasting solution, working with beavers gives the best results [21].

Mosquito Management

Beaver dams slow current and increase deposition of sediment and organic material in water. These ponds play a key role in the development of complex
Insect life, which in turn, feed fish, birds and mammals. Beaver activity greatly affects both aquatic and non-aquatic insect life in response to increased sediment deposition and still water behind the dam. Lotic insects that prefer running water are replaced by lentic insects that prefer still water, and the variety and density of species has been shown to increase.

This of course leads to natural questions about mosquito larva, which are known to accumulate in still pools. However, mosquitoes have been shown to become less numerous in beaver ponds, and the species composition of their populations actually changes. There are nearly 3000 known species of mosquito but beaver ponds tend to shift composition of larvae- making conditions less desirable for some and ideal for others. All mosquitoes are not created equal, some are much more damaging to human populations. For example, one of the species most associated with West Nile Virus and Yellow-Fever (Aedes) cannot survive in the permanent water of a beaver pond. [20]
Continued involvement by Mosquito Abatement can monitor conditions and help control negative species.

Glass Farm Mosquitoes

Most complaints about mosquitoes come from the Baptist Church and residents of Park Meadows, both located along the inlet channel. Water in this channel tends to back up and flow very slowly due to a series of three beaver dams downstream as well as the presence of many fallen trees and branches blocking the channel.

In early June 2014, this area was found to have an extremely high number of mosquito larvae. At that time the GCCHD was called to treat the area with the larvicide Bt. After treatment, the larva numbers declined significantly.

Recommendations

- The channel must be cleared of fallen trees, limbs, and other debris.
- Abandoned beaver dams should be removed, and a flow device installed in active dams to keep water flowing through the channel.
- The beaver wetlands and especially the inlet channel should be continually monitored from May thru September for the presence of mosquito larvae.
- When larvae quantity is at high levels, the GCCHD will be called for treatment of the waterway with the ecologically safe larvicide, *Bacillus thuringiensis.*

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Appendix A

CLIMATE CHANGE ADAPTATION IMPERATIVE OF BEAVERS

Beaver promote dynamic and resilient systems that can better tolerate variation induced by climate change. The current absence of beaver from significant portions of their historical habitat significantly undermines the resilience of riparian/ aquatic ecosystems and therefore limits adaptation to climate change.

Because of the hydrological and ecological effects of beaver engineering (specifically, dam building), functional populations of beaver rapidly and significantly contribute to climate change adaptation. In summary:

- Beaver dams slow snowmelt runoff, which
  - Extends summertime stream flow
  - Restores perennial flow to some streams
- Beaver dams create ponds, which
  - Maintain and create wetlands
  - Provide nurseries for salmonids and other native fish
  - Provide critically needed amphibian habitat
  - Increase habitat for small mammals, cavity nesting birds (using drowned trees)
  - Contribute to establishment of deep-rooted sedges, rushes, native hydric grasses, and woody riparian vegetation
  - Improve downstream water quality by trapping and storing sediment
  - Create mesic meadows in sediment behind abandoned dams
- Water enters groundwater upstream of, beside, and downstream as cooler seeps, which
  - Sub-irrigates the valley
  - Allows water to re-enter creeks/ streams downstream as cooler seeps, which
    - Is critically important to cold-water fish, e.g. salmonids
    - Reduces evaporative loss
  - Expands and restores riparian vegetation, which
    - Shades creeks/ streams, which
      - Reduces water temperature
      - Provides hiding cover for fish
    - Buffers Banks against erosion during high flows
    - Provides critical fish and wildlife habitat
  - Restores and expands deep-rooted riparian vegetation, which
    - Increases bank integrity during high flows
    - Increases critical wildlife habitat
- A series of beaver dams can function as “speed bumps” during high water flows, which
  - Spreads water outward on the floodplain
  - Recharges groundwater near stream

- Locally reduces flood force and gouging
- Increases stream complexity, including creation of backwater and pools
- Expands the presence of water for riparian plant communities

- Beaver dams capture sediment, which
  - Raises incised streambeds
  - Provides soil for mesic meadows
  - Reduces losses of sediment from the forest and into water facilities
  - Reduces the conversion of complex stream and riparian habitat to straighted ditches
  - Heals headcuts
- Beaver increase large woody debris in creek, due to
  - Tree-cutting
  - Dam building
  - Existing dams and their remnants which
    - Increase complexity of streams
    - Increase bank integrity during high flow
    - Increase habitat for fish, amphibians, otter, and other species
  - Reduce expense of human construction/ maintenance/ repair of instream structures or placement of large, woody debris in streams
  - Prevents or reduces headcutting

Wild Earth Guardians. Beaver and Climate Change Adaptation in North America, A Simple Cost Effective Strategy, Wild Earth Guardians. September 2011.

Appendix B

How to Protect Trees

Cylindrical Cages

Cylindrical cages are the best way to protect individual trees. Make them of sturdy 2 x 4 inch welded wire fencing, about four feet high (three feet is adequate in areas without snow). Encircle the trunk, leaving a space of about six inches between the tree and the fence. Cut every other horizontal wire to leave a long prong and bend these into hooks to attach with the other end. Cages should be anchored to the ground with stakes.

SPECIFIC INSTRUCTIONS:

Making a cylinder with a diameter of 12 inches greater than the tree's diameter will keep the fence the required 6 inches from the tree on all sides. To make the cylinder, cut the wire fence that comes 4-feet high to the length that you need and roll it into a cylinder. You can figure this out using the formula C = 3.14 x D; where C equals the circumference of the cylinder and D is the Diameter that you need, i.e. 12 inches greater than the tree diameter.

To make a cylinder of this 4 ft. x C (as calculated above). You cut the horizontal wires on one side in order to attach to the other end once it's wrapped around the tree. Cutting the horizontal wires before you wrap it around the tree makes it easier.

Chicken wire is less reliable, but this is sometimes used as a temporary measure, or to protect many small trees as with mitigation plantings. If this weaker fencing is used, stake rather close to the trunk to prevent crushing by beavers.

Low Fences

Low fences (3- or 4-feet high, depending upon the local snowfall) are used to protect groups of trees, and normally need not surround the entire stand, since beavers dislike being separated from the water. Have the fence fit tightly to the ground and trail each end toward the water. Monitor often in the beginning for burrowing. If digging occurs, two concrete blocks tied together can be used to block the tunnel. If an electrified wire, such as those used for dog fences, is strung 4 - 6 inches off the ground, this serves the same purpose as a wire mesh fence.

Paint with Sand

Coating tree trunks with a sand and paint mixture may prevent beaver gnawing as they dislike the gritty feel of sand in their mouths. Use 8 ounces of fine sand (30 mil, 70 mil or masonry sand) to one quart of oil or latex paint. Stir often and paint trunks about four feet high. The paint can be clear or color-coded to match the trees. Avoid painting young trees less than six feet tall as this may harm them.

Young, restoration trees can be protected with a combination of "4 the Birds," or "Birds Away," and sand. Apply the sticky substance with a dedicated brush that has also been dipped in sand, and painted a strip about four feet high on the trunks of saplings. Avoid using this method on older trees, which might be used by trunk climbing birds.

Repellents and Other Methods

Repellents may protect saplings and foliage plants for a few months, but these work best when there's other food available. Ro-pel is the only deterrent currently registered as a beaver deterrent with U.S. EPA. Research indicates that repellents containing sulfur compounds, such as Deer Off and Big Game Repellent Powder, are effective as temporary deterrents, but they are not yet registered for this use with EPA. Growing Season Repellent from Nott Products is reported to protect plants for up to two months, will not clog sprayers and can be used around edibles.

Occasionally beavers can be lured from a problem area to a new location. Methods used range from leaving otter, or dog, scat at the old site to spraying almond extract on willows to attract beavers and placing favorite foods (such as fresh poplar branches or apples) at the new site.

Beavers, Wetlands and Wildlife. *Trees and Plantings: How to Protect Trees from Beaver.* http://www.beaversww.org/solving-problems/trees-and-plantings/

Appendix C

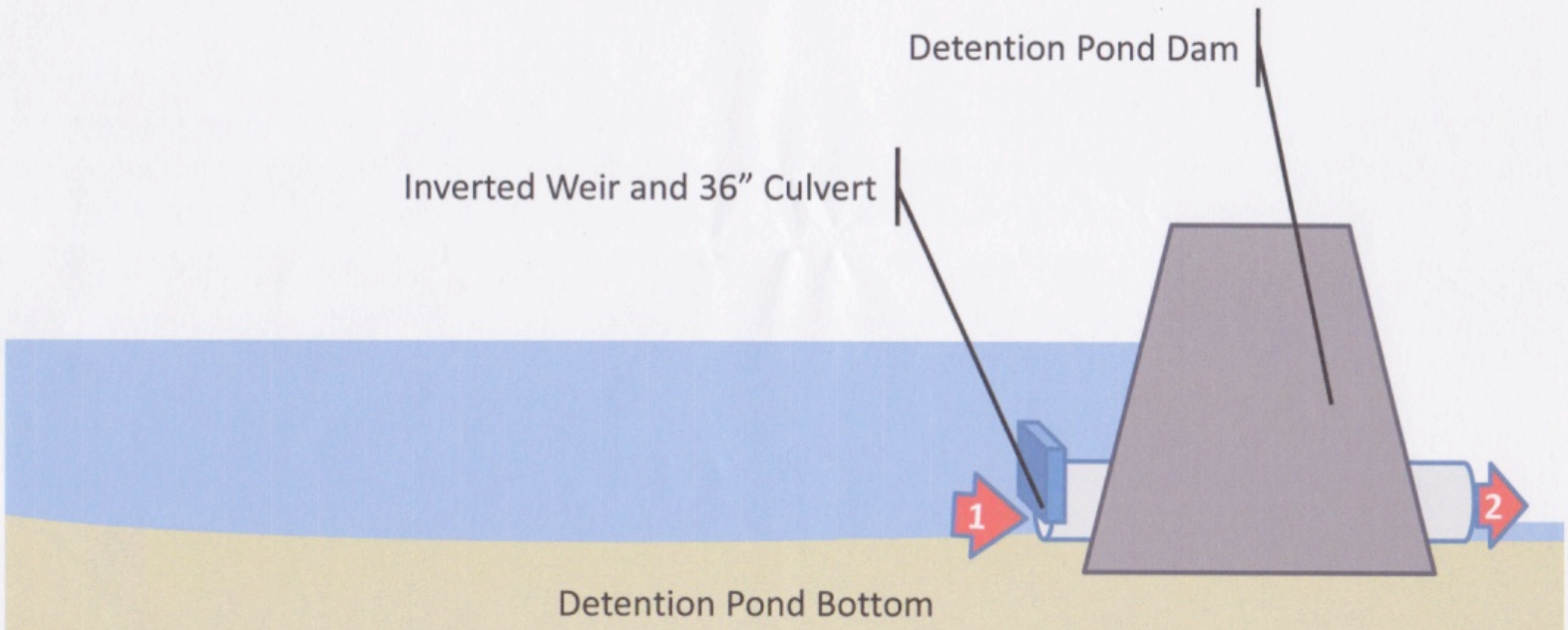
Pond Levelers and Flow Devices

1. **Beaver Flow Control Device at the Glass Farm**
   Conceptual drawings courtesy of Duard Headly
   - **Before beaver presence**
   - **After flow device installation**
   - **In high storm water event**

2. **Water Level Control and Culvert Protection**
   Glass Farm Detention Pond Village of Yellow Springs
   Provided by Environmental Engineer John Eastman in August 2014. 8 pgs.

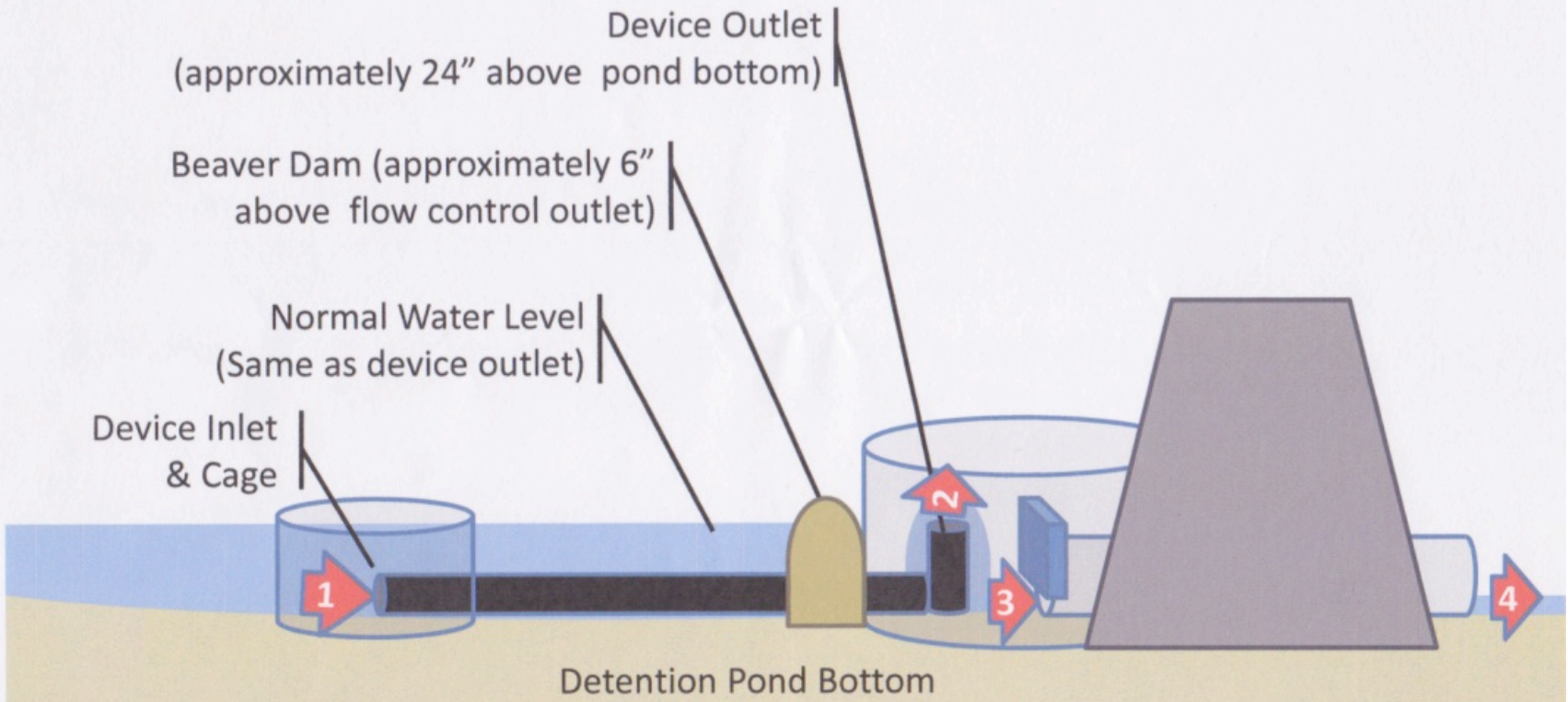
3. **Pond Leveler Flexpipe**
   - **Specifications**
   - **Installation, Jake Jacobson**

Detention Pond at the Glass Farm Prior to Beaver and Flow Control Device



Under High Water Flow Conditions water is detained by the dam. The water level slowly lowers by controlled release of water through the inverted weir preventing flooding downstream. All water flows through the Inverted Weir (1) into the 36" culvert to be expelled (2) on the other side of the dam.

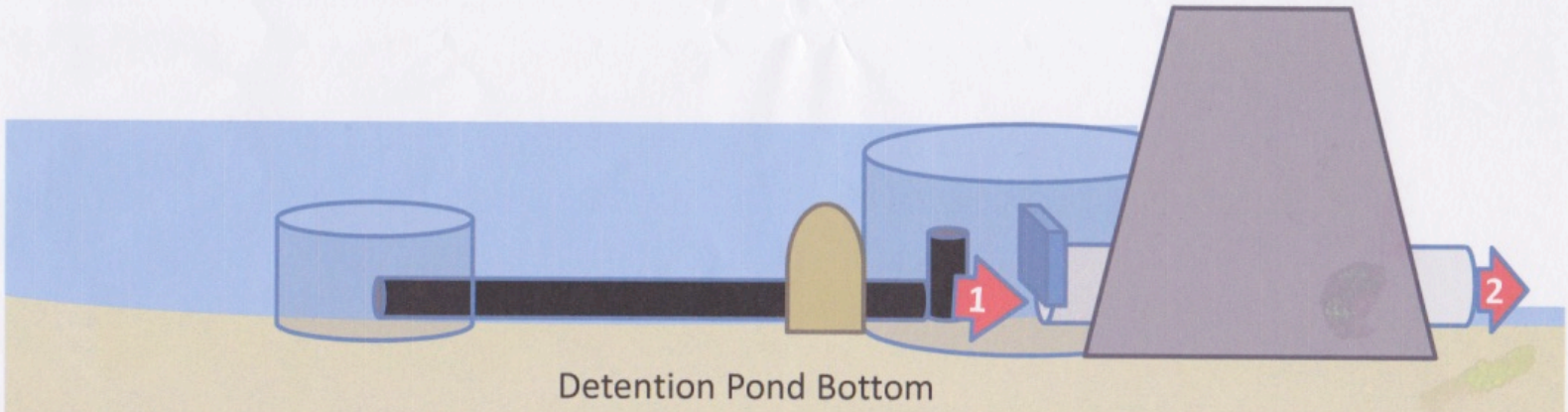
Beaver Flow Control Device at the Glass Farm



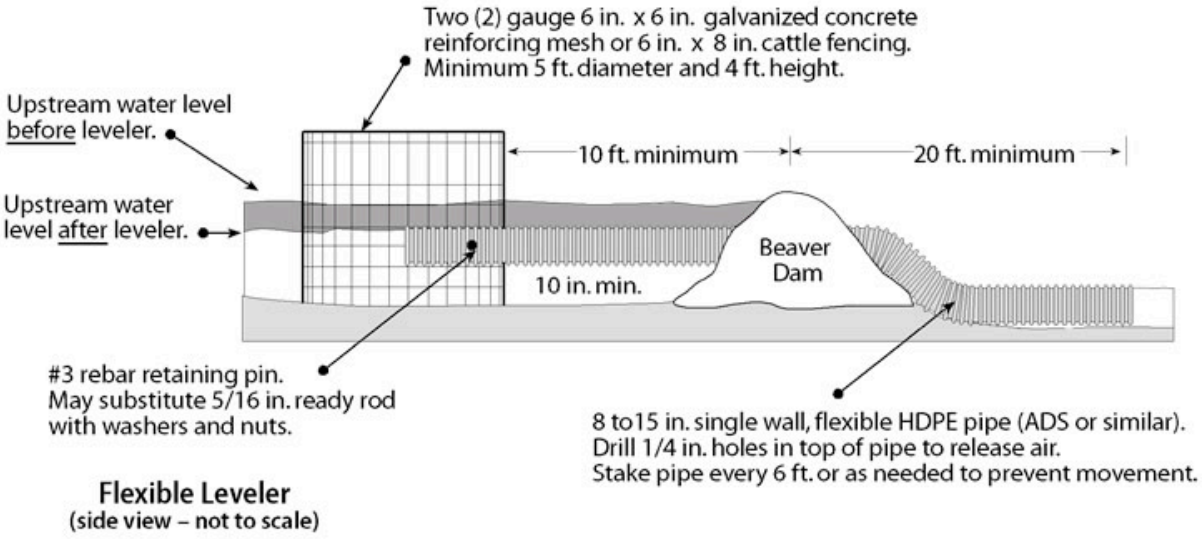
Under normal conditions the flow control device keeps the water level at the height of outlet. All water flows in the flow control device inlet (1), out the outlet (2) and through the Inverted Weir (3) into the 36" culvert to be expelled (4) on the other side of the dam.

Beaver Flow Control Device at the Glass Farm

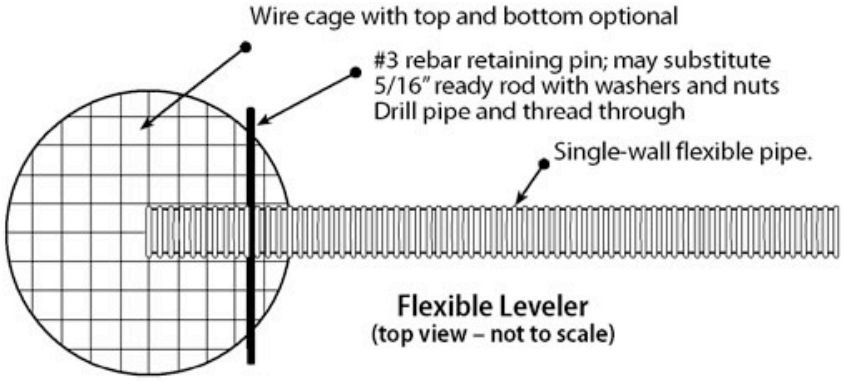
During storm events the water flows through the same path as it would if the flow Control device, beaver dam and beaver were not there.



Under High Flow Conditions the flow control device becomes irrelevant. The water level will exceed the height of the flow control device outlet and dam and all water will flow directly into the Inverted Weir (1) into the 36" culvert to be expelled (2) on the other side of the dam.



Flexible Leveler
(side view – not to scale)



Flexible Leveler
(top view – not to scale)

Construction notes:

1. Construct wire cage using hog rings or similar devices for fasteners. Overlap one section for cage wall.
2. Cut out hole for flexible pipe in cage wall.
3. Remove dam as needed to place flexible pipe. Replace dam after leveler is installed.
4. Stake single-wall HDPE pipe every 6 ft. To prevent it from floating or beavers from moving it, use two T-posts and wire between them and over the top of the pipe to secure the pipe.
5. Drill 3/8th in. hole in culvert for rebar to allow for friction fit. If ready rod is used, place washers next to pipe and secure with double nuts.
6. One (1) 16 foot section of fencing will construct a cage wall approximately 5 feet in diameter. An additional section is needed to construct the top and bottom of each cage.
7. Pipe diameter should be sized to pass the stream base flow.
8. Final layout of the pipe should allow for a shallow gradient to facilitate fish passage.

http://www.beaversww.org/assets/PDFs/How-to-build-a-Flexpipe.pdf

Appendix D-1

Yellow Springs Beaver Activity Timeline

(to be continually updated)

May 2014 The village experienced a "hundred year flood" during which water levels rose to unprecedented heights. Due to the beaver dam blocking drainage, the water in the detention basin overflowed onto King Street This provided the impetus for plans to install a beaver flow device to regulate and maintain water levels in the detention basin. (see section on Glass Farm).

September 2014 The Village crew installed a beaver flow device that allowed for drainage of the detention basin through the beaver dam and into the outflowing culvert. This device functioned well throughout the winter.

May 2015 The fence- surrounding the culvert that drains the pond under King Street and prevents beaver from entering or clogging the culvert outflow- began to collapse due to pressure from the surrounding beaver dam, debris, and heavy spring rains.

September 2015 The original fence was replaced by a very sturdy "box"- design fence that protects access to the culvert and completely encloses the elbow pipe outflow. It has no bottom or top but is extremely sturdy.

October 2015 Beaver began widening their dam that surrounds the new fence. Within two months, the dam was over 5 feet in width and extended within a few feet of the inlet pipe cage.

November 2015

- Beaver constructed a small dam approximately 15 ft. past the culvert in the outflowing stream between the culvert and King Street. This dam was removed several times and continually rebuilt by beavers, however this dam had little effect on water flow.
- Beaver began plugging inside the culvert with sticks and mud approximately 5 ft. from the culvert entrance. A fence was installed at the outflow end of the culvert to prevent beaver entry. The blockage was partially removed several times to allow water to flow into the culvert. With blockage in place, the pond level rose to top of the outflow elbow pipe.
- Unknown how beavers are entering the culvert.

December 2015

- A breach in the fence surrounding the outflow pipe in front of the culvert was discovered. Sign of beaver entering the culvert by burrowing under the fence at points where the fence is not flush with the substrate.
- The lower portion of the fence was sealed and reinforced using wire fencing material, sheet metal, wooden boards, and large boulders as a temporary fix.

January 2016 Beaver were maintained during the winter, spring, summer. The maximum number seen at one time is 4. They are beginning to spend more time dam building in the inlet channel. One dam is in the channel between village land and the Donahoe property, and another is behind Thistle Creek.

August 2016 Cameras were installed at various places along the channel at the Glass Farm and also at Ellis Pond.

October 2016 A large beaver dam was discovered at the Arboretum across the drainage ditch behind Ellis Pond. Trees at the arboretum began to be protected with wire fencing.

November 2016

- We completed covering all trees at Ellis Pond and the Arboretum with wire fencing.
- At the Glass Farm, two beaver flow-devices were installed through the two dams in the channel behind Thistle Creek to keep the water flowing.
- Within a week of installation, beavers had blocked the culvert in the ditch behind Thistle Creek with mud and sticks. These were removed on several occasions, but continually built back until a heavy wire fence was installed around the inlet end of the culvert.

December 2016

- A meeting occurred between several staff and government officials of Yellow Springs and a similar contingent from the Greene County Office of Soil and Water re: the presence of beaver in the ditch behind Ellis Pond. This ditch functions to drain the agricultural fields in the area and is under the authority of Greene County. Since the beaver presence prevents its function, the county plans to trap and kill the beaver. There is a family of 6 animals- an adult pair, two yearlings, and two young from this year.
- Once all the beaver had been trapped, the county removed the dam in the drainage ditch.

March 2017

- A dead beaver was discovered floating in the pond at the Glass Farm. It was a large adult, and was taken by Antioch professor, Brian Kot, for use as a study specimen.
- Since that time, all beaver are presumed to have left the area.
- The Glass Farm however, has been restored to a natural habitat with the support of a Clean Ohio Grant and the partnership of TLT. We are hopeful that with the restored wetland habitat, the beaver will return in the near future.

March 2018

- Because the beaver dam at the Glass Farm culvert that drains the pond was starting to deteriorate due to lack of beaver maintenance, a load of small rip–rap type rocks were installed adjacent to of original dam as reinforcement and to regulate the flow. Now the only drainage of the pond is through the flexpipe, (which is probably not a great idea).
- Completion of the Glass Farm restoration project created an 8-acre area of native habitat and wetland under a permanent conservation easement. This area was restored by removal of invasive species, planting native prairie and tree species, and adding benches and walking paths for the public to enjoy.
- Village Council, to permanently manage and maintain this region, established a new committee called the Glass Farm Conservation Area Management Committee. Its membership is composed primarily of the former Beaver Management Task Force and it operates under the joint auspices of the Village Manager and the Environmental Commission.

Appendix D-2

RESOLUTION 2018-
CREATING A PERMANENT GLASS FARM CONSERVATION AREA MANAGEMENT COMMITTEE

WHEREAS, the Village of Yellow Springs previously created a detention pond on the property known as the Glass Farm; and
WHEREAS, a colony of beaver arrived on the Glass Farm, making their home and creating a natural wetland and a serene location for all to enjoy; and
WHEREAS, the Village partnered with the Tecumseh Land Trust to obtain a grant to restore the area to its true natural habitat, removing invasive species, planting native species and placing the area under a permanent conservation easement; and
WHEREAS, many and varied species of plants and animals, including birds, have made this habitat their home; and
WHEREAS, the continued existence of the Glass Farm Wetland area is important to the citizens of the Village of Yellow Springs and also conforms with the general values of the Village regarding greenspace and conservation; and
WHEREAS, the continued maintenance of the Glass Farm Wetland is important to all concerned but requires a concerted effort over the years; and
WHEREAS, many residents have volunteered time and funding to create and maintain this area;
NOW, THEREFORE, BE IT RESOLVED that the Council of the Village of Yellow Springs does hereby
Section 1. Create a Glass Farm Conservation Area Management Committee, to be comprised as and operate in the manner described in Exhibit A hereto affixed.
Section 2. Said Management Committee shall manage the Glass Farm Conservation Area in accordance with direction provided by Council and in harmony with achieving all of Council's stated goals.

_____
Brian Housh, President of Council

Passed: 5-7-18

Attest: _____
Judy Kintner, Clerk of Council

ROLL CALL:

Brian Housh ____ Marianne MacQueen _____ Judith Hempfling ____

Kevin Stokes ____ Lisa Kreeger _____