



### Three-Log Drains

This simple drain is made from three or more hardwood logs. Beavers rarely chew through hardwood logs (such as oak logs) when they are underwater. The structure is placed perpendicularly through the dam as described for the pipe drain. Two logs are laid on top of a board or sheet of iron with their upstream ends slightly apart. A third log is placed on top. Water runs through the funnel formed by the logs and seeps along their edges.

A similar approach might be used to prevent beavers from damming a stream. A blind drain constructed from stones, logs, tiling, perforated drain pipe, or similar materials laid along a streambed will allow water to flow beneath a dam. If beavers build a dam, the streambed below the dam will remain permeable, preventing water from collecting behind it. Generally, beavers will move to a more suitable site.

Another adaptation of the three-log drain reduces opportunities for beavers to plug openings created by uneven logs

(figure 16). Sheet metal (30 inches wide and 6 to 8 feet long) is laid along the bottom of an opening cut through the dam. Two green or waterlogged poles, 6 to 9 inches in diameter and 10 to 16 feet long, are placed on top of the sheet metal. The upstream end of these logs needs to be at least a foot lower than the downstream end. Green sticks (1 to 2 inches in diameter) are placed across these logs to support a third log, which is laid across the sticks and centered above the bottom logs.

Sheet metal, about the size of the sheet placed on the bottom, is wrapped over the top log and along the sides of both bottom logs. The sheet metal is nailed along the sides of both bottom logs and the top of the top log to hold the drain together. The intake end of the drain can be anchored by driving a forked stick into the pond bottom with the fork hooking the top log to hold it down.

**Forest Service Experience**—No respondent had used this method.

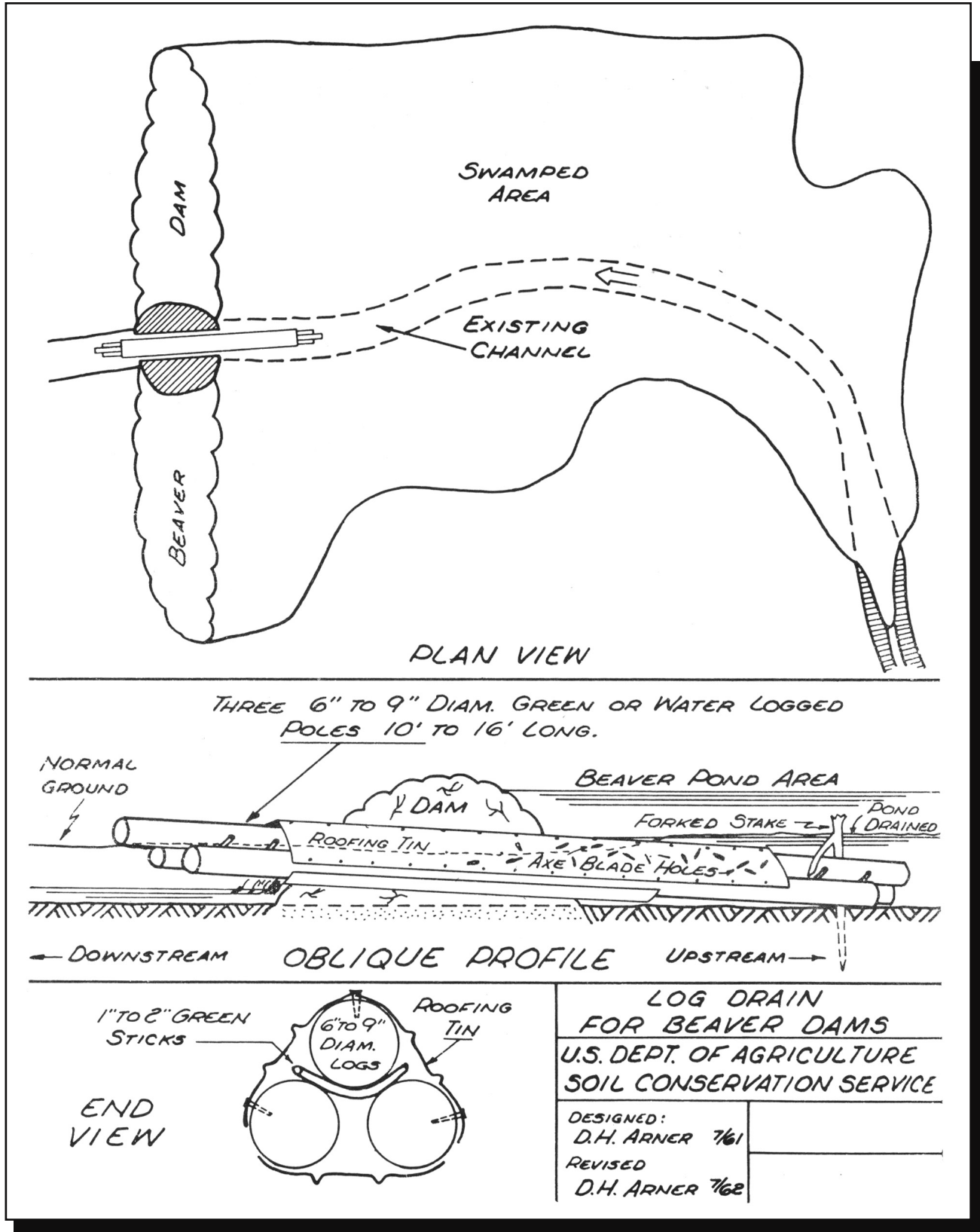


Figure 16—This drawing shows a modified three-log drain could be used to partially drain ponds impounded by beavers.



## Comparing the Different Methods of Protecting Culverts

Table 2 shows the advantages and disadvantages of five methods to prevent beavers from plugging culverts.

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### DRAIN PIPES

**Advantages:** Inexpensive; maintain a set water level.

**Disadvantages:** Require installation; regular cleaning and maintenance; success varies.

### CULVERT PIPES

**Advantages:** Inexpensive; easy to construct and install.

**Disadvantages:** Must be set deep enough to keep the intake fully submerged; require regular maintenance; reduce waterflow through the culvert; may hinder fish passage; success varies.

### CLEMSON BEAVER POND LEVELERS

**Advantages:** Low maintenance; maintain set water levels; several levelers can be used in heavy flow areas.

**Disadvantages:** High initial investment to build and install; intake must be fully submerged to work optimally; single sets are inadequate to handle high volumes or fast flowing water; levelers may reduce waterflow and hinder fish passage.

### CULVERT GUARDS

**Advantages:** Inexpensive; easy to install; success is good when the guards are cleaned regularly.

**Disadvantages:** Require frequent cleaning; may reduce the culvert's discharge capacity; susceptible to ice damage; may block fish passage.

### CULVERT FENCES

**Advantages:** Keep culverts clear; allow high-waterflows to spill over any blockage and drain through the culvert; maintain constant water level; can be regulated when fences are combined with pipes.

**Disadvantages:** Expensive, especially if an extended area needs to be enclosed; require regular maintenance; may create an impoundment that affects roads or railroad grades; beavers may build dams high enough to flood the road; fences may reduce waterflow and block fish passage.





## Trapping

**T**rapping can be an effective, practical, and environmentally safe method to trap or remove beavers from areas where they are causing problems. The objectives of the trapping program and the trapper's experience generally determine which types of traps are used. Several factors that need to be considered when you are developing a trapping program include:

- The behavioral and biological characteristics of the target animal
- Access to the target site
- The experience and skill of the trapper
- Nontarget animals in the vicinity
- Cost effectiveness of trapping
- State and Federal laws and regulations
- Other site-specific considerations

Trap-and-release programs can be effective when specific beavers need to be relocated. Release sites should be identified before beavers are captured to prevent releasing animals in areas without appropriate resources or where other beavers already have established territories.

Check local regulations before releasing animals to new sites. State and Federal laws and regulations govern trapping and the treatment and movement of wildlife. Generally, the State Department of Wildlife is the place to contact for information and guidance on trapping regulations.

Most traps pose a minimum danger to humans. However, exercise special caution if children may encounter trap sets. Trapped animals can become agitated. Depending on their size, beavers can be dangerous. Trappers need to exercise caution to avoid injuries while setting some types of traps (such as body-grip and foot-hold traps) and when handling captured animals.

The tech tip, *Using Traps and Snares to Capture Beavers* (0577-2344-MTDC, <http://www.fs.fed.us/eng/t-d.php>) describes various types of traps and some of the techniques used to set them.

### Forest Service Experience

Forest Service employees have had mixed results with trapping. Many respondents said that after they tried a variety of nonlethal methods without success, trapping was successful. Some described trapping as a good short-term solution, but said that repeated trapping may be necessary if the site is good beaver habitat. Others thought trapping was not cost effective, because beavers returned to the site and it was difficult to trap entire families. Some respondents felt that relocating beavers is not effective because it just transfers the problem to another site.



## Shooting

Spotlighting beavers and shooting them at night may take time, but this technique can be effective. Shotguns (12 gauge) loaded with BB or No. 4 buckshot or small-caliber rifles (.22, .22 magnum, .222 and similar calibers) are used. The shooter sits quietly behind a breach or break at

a dam with the best time period being 1 hour before dark. Check with the State Department of Wildlife before using this approach. Generally, shooting is legal only when State authorities do the shooting or issue a permit to do so.



## Devices To Frighten Beavers

Animals generally avoid areas that appear threatening. In remote areas, beavers may be hard to see unless noise and movement are kept to a minimum, but beavers in urban areas may frequent lakes even when people are active along the shore. Visual displays or noises that alarm the animal will discourage its visits. Although animals are generally wary of unfamiliar sounds or sights, they become less wary with time unless the noise or vision is paired with negative reinforcement. Most devices used to frighten beavers (such as artificial lights, propane cannons, or cracker shells) rarely work for more than a few days or a week.

The possibility that wildlife will become accustomed to devices intended to frighten them can be minimized by installing or operating the devices only when they are needed the most. It is important to begin using these devices immediately after the onset of damage. Established movements and behaviors are much more difficult to disrupt than behaviors that are just forming. Devices that operate sporadically or are activated by an animal's presence are more effective than permanent or routine displays.

Visual displays combined with noisemakers generally are more effective than either technique would be if implemented alone. For example, sirens and strobe lights activated at irregular intervals are likely to be more effective than a constant visual display or loud noises emitted at fixed intervals.

Supplementing these techniques with other measures occasionally can increase their effectiveness. For example, beavers will grow accustomed to noise from a radio next to a break in a dam and will ignore it over time, but if someone occasionally jumps out from behind the dam when a beaver

approaches, the radio will do a better job of frightening the beaver.

Several commercial devices can be used to frighten beavers. When these devices are combined with homemade devices, endless combinations are possible. One such device can be created by attaching a *Critter Gitter* (AMTEK, San Diego, CA) on each side of a 4- by 4-inch post that is 12 inches long. The Critter Gitters are attached a couple of inches from the bottom of the post and a flashing light (Enhancer Model EH/ST-1) is attached just above each Critter Gitter. A 2-inch hole bored through the core of the post allows the device to be installed over a metal T-post. The device is then secured to a flotation platform that keeps the motion detectors a few centimeters above the water level.

Trials showed that this device did deter beavers, but not for extended periods. Anecdotal evidence suggests that the device may discourage beavers from repairing dams for a few days if it is installed in a stream channel after a dam has been breached. Those few days might allow the pond to drain temporarily.

### Forest Service Experience

Several respondents said they had tried using a white flag attached to a post near the entrance to a culvert or a white bed sheet stretched across the stream channel at the entrance of the culvert. One respondent had success with this method. Another respondent placed a white flag at a culvert entrance after demolishing a beaver dam. The dam was rebuilt within weeks. The second time the dam was demolished, the road maintenance crew found the white flag inside the dam.



## Electric Barriers

**E**lectric fence material can be used to shock beavers approaching culverts. One approach used a device that created a mild electric current between electrodes placed in the water when it was activated by movement on the water's surface. When this device was installed properly, it created an electric field in front of a culvert, discouraging beavers from entering the area.

Another approach incorporated a series of wire loops that dangled from a wire electrified with a fence energizer (figure 17). Any animal that touched these loops received a shock. Although these devices can deter beaver activity, they



Figure 17—The Beaverhead-Deerlodge National Forest has used electric fences to frighten beaver.

should be used with extreme caution. The combination of water and electricity could endanger people as well as wildlife. Moving one electrode out of the water could increase the potential hazard. Changing water levels may submerge wires that were intended to dangle above the water.

Although these devices may be applied safely under certain conditions, the potential risks should be considered thoroughly before they are used.

## Forest Service Experience

Several respondents said they had used electric fences or hot wires near culvert openings successfully, although one respondent was concerned the device could shock someone. Another problem for that respondent was vandalism of the charger.

Bob Duhamel, who works for the Beaverhead-Deerlodge National Forest used the dangling electrode technique successfully. First, he strings a strand of electric fence wire across the channel about 18 inches above the water's surface in front of the culvert or bridge. Then he uses alligator clips to attach strands of wire with loops at one end. These loops are placed 2 to 3 inches apart and 2 inches above the water. The installation is left in place for about 7 to 10 days. The cost of such an installation is about \$320. It can be reused indefinitely.



## Repellants

Repellants are not effective in reducing culvert problems, but may be used to protect riparian areas.

Effective repellants render a plant less attractive to foraging animals. The likelihood that a particular plant will be eaten depends on its own palatability and the availability and desirability of alternative foods. Although beavers tend to avoid plants treated with predator odors, during studies beavers have damaged some of the treated trees.

Beavers readily gnawed through trees treated with deer repellants (Deer Away—Big Game Repellent Powder, Thiuram, and Ro-Pel; NWRC unpublished data). Beaver also chewed branches treated with 100 times the recommended concentration of hot sauce (capsaicin). These studies suggest that the usefulness of commonly available repellants is probably limited.

Chemical repellants did reduce damage when they were applied directly to foliage consumed by beavers. Beavers clipped substantially fewer cottonwood and willow seedlings treated with Deer Away—Big Game Repellent Powder and Plantskydd than they untreated seedlings. These products are among the most effective repellants to reduce deer browsing. These products are not registered for beaver. Future label restrictions may restrict the application of chemical repellants in riparian zones.

Textural repellants (for instance, paint with sand) may offer an alternative. During tests, cottonwood stems that were painted with a textural repellant were damaged less than stems that were not. A few treated trees were cut and others were stripped of bark, but untreated stems or stems painted with untreated paint were damaged severely during this 2-

week trial. Eight of ten beavers completely avoided stems treated with 30-millimeter sand, and gnawing by the other two beavers was very limited. Painting cottonwood stems in this study did not adversely affect the vigor of the stems. Buds sprouted through the paint and new foliage appeared.

Another approach to reducing damage is to convince beavers that unoccupied sites are occupied. During tests, unoccupied sites treated with a mixture of beaver castoreum anal gland secretion were colonized less often than untreated sites. This study indicated that dispersing beaver probably avoid areas with odors indicating they are occupied. However, the feasibility of using such an approach in the field is largely unknown. No product on the market is effective in deterring beaver from settling unoccupied sites. Beavers did not reduce their use of treated areas during experiments with deer repellants.

Although chemical repellants may deter beavers from clipping seedlings and textural repellants may reduce gnawing, site considerations will determine whether these techniques can be used. Plants such as willow that are preferred by beavers are more difficult to protect than plants that are not preferred, such as cascara.

After certain plants have been treated, an animal's foraging choices will depend on the size of the area being protected and the percentage of plants that have been treated relative to all the plants in the beaver's territory. Beavers in sparsely occupied wetlands can expand their territory, but beavers in densely populated areas or in areas with drier climates may not have that option. Competition with other beavers may cause beavers to be less selective in their choice of foods, rendering repellants less effective.





## Fences

Fences that could exclude beavers from large areas generally are cost prohibitive. Fences do not need to be high (just 24 to 30 inches), because beavers do not jump or climb well. Beavers will dig or crawl through openings, so the bottoms of fences should be tight against the ground or buried a few inches. Woven wire (4 by 4 inches) will deter beaver, but heavier gauge wire may be needed to protect a highly desirable resource. A 3-foot-high chain link fence (woodland-green, vinyl coated, 2-inch mesh, 0.095-inch core, 9 gauge) kept beavers from harming vegetation in a park. Similar fencing materials or rocks laid along banks can prevent beavers from undermining banks. Generally, a

fence that crosses a small stream and extends 500 feet on either side will stop beavers from traveling along the stream.

Barriers can protect individual trees. Barriers do not have to be more than 30 inches high. Smooth surfaces work best, because if beavers can grasp the barrier's lips or flaps, they may pull or chew on them until they get to the tree.

The best type of barrier depends on the desirability of the protected forage and the availability of alternative foods.

Chicken wire and plastic tree wraps may deter beavers, but beavers can chew through these barriers easily if they really want to.



## Conclusions

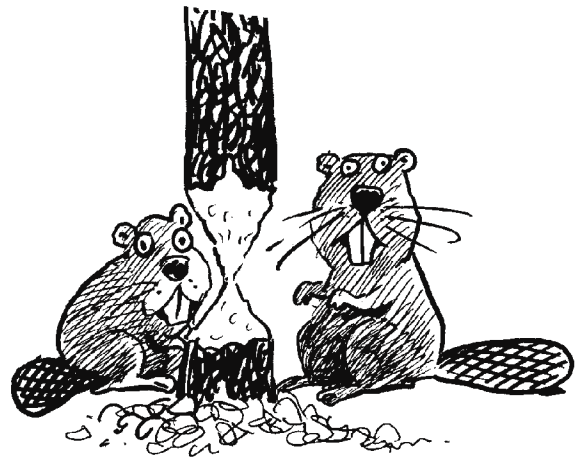
As beaver populations continue to increase, beavers are expanding into new areas and the problems they cause are increasing. The best solution to the problem of beavers damming culverts is to redesign and replace the culverts that beavers have dammed. Oversized culverts help prevent beavers from building dams. The culvert's location is another factor. Replacing culverts is expensive and is not an option in most cases. When replacing culverts is not an option, managers can consider:

- Installing devices that keep beavers from damming culverts. These devices can be grates or rebar installed in the culvert entrance, small wire mesh fences placed in front of the culvert, or wire mesh culvert extensions. Sometimes beaver will leave the area when these devices are installed. In other cases, they will build dams against them. Periodic maintenance can keep the culvert free of material. These techniques, especially the culvert fence, have been used successfully in almost all regions.
- Installing devices that allow water to flow through the culvert. These devices may keep beavers from building dams or they may limit the size of the dams. Many designs exist, but the main idea is to keep water flowing slowly and quietly through the pipe so beavers don't hear the sounds of rushing water that arouse their instincts to build dams. Devices using perforated tubing, the Clemson Beaver Pond Leveler, T-culverts, culvert blocks, and simple log drains can be effective. Routine maintenance is required to keep the systems from being clogged by debris.
- Trapping or shooting. Trapping or shooting can be an effective, relatively low-cost method of reducing beaver problems. Beavers can be trapped and relocated if suitable relocation sites exist. Trapping is prohibited in some States. All programs must be conducted in accordance with applicable regulations. Trapping and shooting may provide no

more than a short-term solution because other beavers probably will show up if the habitat is good. Usually, systematic annual trapping or shooting programs are required.

- Using devices that frighten beavers. These devices attempt to make an area appear threatening. While most methods do not work for more than a few days, an electric fence with dangling loops was effective in one instance.
- Using repellants. Repellants are not effective in reducing culvert problems, but can be used to protect riparian areas. Commercial repellants do not offer much protection to larger trees, but can protect willow or cottonwood seedlings from beavers. Grit added to paint and applied to the base of trees was more effective than standard repellants.
- Installing fences. Fences up to 500 feet long can be placed in an area to effectively exclude beavers. The coated mesh or chain link fence does not need to be more than 2 feet high. The fence must be tight against the ground or buried a few inches to keep beavers from digging or crawling underneath it. This method is fairly expensive, but could be used to protect small areas.

Site conditions, habitat, and beaver populations will play a large role in determining whether any particular method will be successful.





## Appendix—The Clemson Beaver Pond Leveler

**W**ildlife Services in Mississippi conducted a survey to determine whether Clemson Beaver Pond Levelers they had installed were meeting landowners' objectives. Wildlife Services is a program in the U.S. Department of Agriculture Animal and Plant Health Inspection Service. The survey considered:

- Management objectives
- The length of time since the leveler was installed
- Watershed characteristics
- Physical attributes of the stream and the beaver dam
- Beaver activity

Twenty of the forty Clemson Beaver Pond Levelers evaluated were operating and regarded as successful by the landowner. The landowners' original management objectives correlated with the operational status of the device and the owner's satisfaction with it. Devices installed to manage wetlands (primarily waterfowl habitat) generally were considered successful, while devices installed to provide perpetual waterflow were deemed less successful. At least six of the unsuccessful devices had been removed by the landowner, usually because the owner wanted more waterflow.

Most factors considered in the survey were not repeated consistently among sites, confounding comparisons and

making the results more like a series of case studies than a replicated experiment. However, general patterns or trends could be deduced. Successful devices tended to have been installed more recently (21.5 months) than unsuccessful devices (32 months). A few levelers had been installed within the past 6 months. All of those were considered successful. But several devices that had been installed for longer than 48 months were still in good condition.

There was no apparent relationship between the likelihood that a device would be successful and the characteristics of the beaver dam. Watershed characteristics and stream attributes also were unrelated to owner satisfaction, although these attributes often were tied to management objectives. For example, both successful and unsuccessful devices often were located on small drainages with intermittent flow, but the successful and unsuccessful devices were not necessarily installed for the same reason. Devices installed for wildlife management objectives invariably were placed on small drainages with intermittent flow.

Maintenance had been performed on 70 percent of the 20 operating Clemson Beaver Pond Levelers installed by Wildlife Services. Usually, maintenance involved adjusting the riser to manipulate water levels. Owners had adjusted

risers on 11 of the 20 successful devices, while only four attempts were made to adjust risers on the 20 unsuccessful devices. Vegetation was cleared near two of the successful devices and secondary dams were removed near three of the successful devices. The failure of nine devices regarded by landowners as unsuccessful was attributed to secondary dams. It is difficult to assess whether removal of dams, additional devices, population reduction, or a combination of these measures would have improved landowner's perceptions of the device's performance.

Population control measures appeared to increase the success of Clemson Beaver Pond Levelers. Population control measures were practiced on 95 percent of the sites considered successful. The actual density of beavers on these sites before and after control measures is unknown. It is impossible to determine an optimum density of beavers for successful operation of these devices. However, these data suggest that a density threshold probably does exist. When the beaver population exceeds that threshold, a device is less likely to meet a landowner's objectives.

Population control measures alone do not ensure successful operations. Population reduction measures were practiced on 50 percent of the sites where landowners were not satisfied with the results. Perhaps beaver densities remained too high at those sites. Six devices were removed by landowners to

increase waterflow without regard to whether they were plugged.

These findings reflect the recommendations for using the Clemson Beaver Pond Leveler. The Clemson University Cooperative Extension Service says that "the leveler is not a panacea for eliminating all beaver problems" and "the leveler does not negate the need for direct control of beaver populations where problems are both extensive and severe; however, it may reduce this need."

A Massachusetts pamphlet considered the Clemson Beaver Pond Leveler to be:

- "An effective tool in situations where water input to a pond is from a small stream or spring"
- "Suitable only for small watersheds"
- "Susceptible to problems related to the inability of the device to handle large amounts of water during periods of unusually high rainfall"

A Minnesota Department of Natural Resources pamphlet says that the device is an effective tool to resolve problems created when a dam is built at a critical location but not problems caused by beavers elsewhere. This pamphlet recommends that "in most beaver flooding situations, the most effective way to reduce flooding is to remove beaver and then the dam or culvert plug."



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## Notes

## About the Authors

**Dr. Dale Nolte** is the Mammal Research Program Manager for the USDA/APHIS Wildlife Services National Wildlife Research Center. Dr. Nolte has conducted research over the past several years to assess the efficacy of nonlethal devices to deter beaver from building dams or gnawing on trees. He earned a Ph.D. in foraging ecology from Utah State University.

**Dr. Dale H. Arner** is a retired Professor from Mississippi State University. Dr. Arner is recognized as one of the premier experts on beaver ecology and management, contributing significantly to the literature available on beaver in the south and providing practical strategies to manage beaver. He earned a Ph.D. in Wildlife Management from Auburn University.

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**Andy Trent** is a project engineer at MTDC. He received his bachelor's degree in mechanical engineering from Montana State University in 1989. Before coming to MTDC in 1996, he worked as a civilian engineer for the U.S. Navy. Andy works on projects in the nurseries and reforestation, forest health protection, and watershed, soil, and air programs.

## Library Card

Nolte, Dale; Arner, Dale H.; Paulson, John; Jones, Jeanne C.; Trent, Andy. 2005. How to keep beavers from plugging culverts. Tech. Rep. 0571-2830-MTDC. Missoula, MT: U.S. Department of Agriculture Forest Service, Missoula Technology and Development Center. 30 p.

Describes ways to address the problems caused by beavers that dam culverts. This problem has become more serious as beaver populations have recovered from unregulated trapping during the 19th century. The rapid flow of water through culverts and noise of running water trigger beavers' instincts to build a dam. If the speed of flow and the noise of running water can be reduced, beavers may leave culverts alone. Often, the best solution is to replace the culvert

with one that is oversized or to move it to a more suitable location. Either choice is expensive. When existing culverts can't be replaced or relocated, options include:

- Installing devices that keep beavers from damming culverts
- Installing waterflow devices that control the speed and noise of the water
- Using devices to frighten the beavers (short-term solution)
- Trapping or shooting the beavers (they could be replaced by others living nearby)
- Fencing the area to keep beavers out

Keywords: animal damage control, dams, fencing, flooding, repellants, Wildlife Services

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**For additional information about how to keep beavers from plugging culverts, contact Andy Trent at MTDC.**

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**Electronic copies of MTDC's documents are available on the Internet at:** <http://www.fs.fed.us/eng/t-d.php>

**Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer networks at:** <http://fsweb.mtdc.wo.fs.fed.us/search>