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Survey of factors affecting the success of Clemson beaver pond levelers installed in Mississippi by Wildlife Services

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Abstract: Clemson beaver pond levelers were developed as a tool to enable land managers to manipulate water flow past beaver (*Castor canadensis*) dams. Wildlife Services has installed several of these devices in collaboration with landowners. We conducted a survey to determine if we could identify factors that impacted whether the devices were meeting landowner objectives. Fifty percent of the 40 levelers surveyed were still operating and regarded as successful. Factors considered in the survey included management objectives, time since the leveler was installed, watershed characteristics, physical attributes of the stream and of the beaver dam where the leveler was installed, and beaver activity. Management objectives closely correlated with owner satisfaction; devices installed to manage wetlands (primarily waterfowl habitat) were generally considered successful, while devices installed to provide water relief through perpetual flow were deemed less successful. Time elapsed since installation was not a factor, however, maintenance of the levelers was a factor. Seventy percent of the operating levelers had received some form of post installation maintenance. Levelers placed in sites with high beaver activity without implementing population control measures frequently failed. Ninety-five percent of the sites with successful levelers had received some population control measure either before, or after, or before and after installing the leveler. Physical attributes of the site or characteristics of the beaver dam were not closely correlated with success of the levelers.

Key words: beaver, *Castor canadensis*, Clemson pond levelers, Mississippi, survey, Wildlife Services

Beavers (*Castor canadensis*) occur almost everywhere there is a continuous source of water throughout North America (Hill 1982). They often build dams modifying their environment and enhancing their habitat. Therefore, the only aquatic habitats unsuitable for beaver are those systems lacking acceptable foods, denning sites, or suitable dam sites. As a keystone species, beavers affect geomorphology, bio-geochemical pathways, and community productivity through dam building and feeding behaviors

(Ingel-Sidorowicz 1982, Naiman and Melillo 1984, Naiman et al. 1986). Ponds and deep pools created by beaver remain even through intermittent stream flow providing critical habitat for fish and other wildlife (Harris and Aldous 1946, Gard 1961, Hanson and Campbell 1963, Ringelman 1991, Nickelson et al. 1992). Their excrement and fallen wood or leaves resulting from their activity also increases the energy flow by adding organic matter and nutrients to the water (Ingel-Sidorowicz 1982, Johnston and Naiman 1987). However, flooding or reduced water flow can negatively impact other species (Johnston and Naiman 1990, Miller and Yarrow 1994). High beaver populations concentrated in some areas can reduce native flora such that fauna survival may be jeopardized (DuBow 2000), particularly where disturbed sites are invaded by highly competitive non-native plants (Apfelbaum and Sams 1987).

Beavers inflict severe damage to agricultural crops and infrastructure, such as roads and culverts. Economic losses due to beaver probably continue to increase but were estimated by Arner and Dubose (1982) to have exceeded 4 billion dollars during the preceding 40 years in the southeastern United States. Annual timber losses through water impoundment or direct cutting were estimated at 38 million dollars in Mississippi alone (Arner and Dubose, 1978).

Wildlife Services provides assistance to reduce beaver induced problems through technical advice or through direct measures. Installing Clemson beaver pond levelers to reduce flood damage has been one of the measures employed. Mississippi Wildlife Services installed 40 levelers between May 1995 and August 1999 in cooperation with the Mississippi Fish and Wildlife Foundation to assist landowners wanting to reduce flooding while maintaining benefits of beaver impoundments for waterfowl and other wetland wildlife.

The Clemson beaver pond leveler was developed at Clemson University under the premise that beaver will not build dams if they do not detect water movement. A schematic and detailed description of the device are provided in a leaflet available through the Cooperative Extension Service of Clemson University, Clemson, South Carolina. Briefly, the device consists of an upstream intake component made from a PVC pipe (25 cm dia.) with numerous openings (150 to 180; 5 cm dia.) surrounded by a galvanized weld wire cage. The holes allow water to flow into the pipe while the wire cage prohibits debris from plugging the holes. The outlet is a smaller PVC pipe (20 cm dia.) extended through the dam. Reducing the diameter of the outlet pipe slows water movement minimizing potential for water noise. The farther the outlet pipe extends below the dam the lower the risk for beaver detecting and subsequently plugging the opening. A standpipe riser is used to maintain water at a desirable level. The riser needs to extend above the intake component as it is essential that this pipe remains submerged.

We conducted a survey to determine if we could identify factors that impacted whether the devices were meeting landowner objectives. Factors considered in the survey included management objectives, time since the leveler was installed, watershed characteristics, physical attributes of the stream and of the beaver dam where the leveler was installed, and beaver activity.

Survey

Three sources were used to gather information for the survey. A site visit was conducted. We usually were accompanied by a Wildlife Service specialist who had been involved in the initial installation. During this visit, we determined status of the Clemson beaver pond leveler and collected general data on watershed characteristics and physical attributes of the stream and beaver dam. Watershed characteristics broadly defined the area, such as a slough or hardwood bottom, the spatial scale of area flooded if the dam remained intact, and the purpose of the drainage system (e.g., drain agricultural fields after heavy rain, continuous flowing stream). Stream attributes included stream width below the dam and frequency of water flow; sediment load was judged as low, medium, or high. We measured the height and width of the dam, and determined whether other dams occurred up or down stream from the dam where the device had been installed. Wildlife Services' operational records were used to determine when the devices were installed and whether population control measures had been practiced. An interview with the landowner enabled us to determine whether individuals other than a Wildlife Service specialist had trapped beaver on these sites and identified any efforts extended by the landowner toward maintaining the devices.

Results and discussion

Twenty of the 40 Clemson beaver pond levelers evaluated were operating and regarded as successful by the landowner. The landowners' original management objectives correlated with the operational status and owner satisfaction of the device. Devices installed to manage wetlands (primarily waterfowl habitat) were generally considered successful, while devices installed to provide water relief through perpetual flow were deemed less successful. At least 6 of the unsuccessful devices had been removed by the landowner, most often because the owner wanted greater water flow.

Most factors considered in the survey were not repeated consistently among sites, confounding comparisons and rendering our results more reflective of a series of case studies than a replicated experiment. However, general patterns or trends can be deduced from the survey. Successful devices tended to have been installed more recently than unsuccessful devices ($P = 0.0178$). The mean elapsed times for devices regarded as successful and unsuccessful were 21.5 and 32 months, respectively. However, this difference was primarily because of a few levelers installed within the past 6 months; all considered successful. Several devices that had been installed for over 48 months remained in good condition. There was no apparent relationship between success and measured characteristics of the beaver dam. Watershed characteristics and stream attributes also were not related to owner satisfaction, although these attributes often were tied to management objectives. For example, both failed and successful devices were often located on small intermittent flowing drainages, but these devices were not necessarily installed for the same reason. However, devices installed to achieve wildlife management objectives invariably were placed on a small intermittent flowing drainage.

Post-installation maintenance had been performed on 70% of the 20 operating Clemson beaver pond levelers installed by Wildlife Services. This effort generally

consisted of adjusting the riser to manipulate water levels. Owners had adjusted risers on 11 of the 20 successful devices, while only 4 attempts had been made to adjust risers on unsuccessful devices. Vegetation was cleared and secondary dams removed near 2 and 3 of the successful devices, respectively. Contrarily, secondary dams were attributed to the failure of 9 devices regarded by landowners as unsuccessful. However, it is difficult to assess whether removal of dams, additional devices, population reduction, or a combination of these measures would have improved the landowners perceptions.

Population control measures appeared to increase the success of Clemson beaver pond levelers. Population control measures were practiced on 95% of the sites considered successful. The actual density of beaver on these sites before and after control measures is unknown. Therefore, it is impossible to interpret a beaver density "optimum" for successful operation of the devices. Regardless, this "optimum" would fluctuate between and within sites depending on beaver status and environmental conditions. However, these data suggest that a density threshold probably does exist, which when exceeded, contributes to the failure for achieving a landowner's objectives. Reducing beaver populations, however, does not ensure successful operations. Population reduction measures also were practiced on 50% of the sites where landowners were not satisfied with the results, possibly because beaver densities remained too high. Although other factors also need to be considered, 6 devices were removed by landowners to increase water flow regardless if they were plugged or impeded by beaver activity.

Management implications

Our survey shows the Clemson beaver pond leveler as used by Wildlife Services in Mississippi has been an effective tool to solve some problems caused by beavers. However, these devices should not be considered "magic" for solving flooding problems caused by beavers. Levelers installed by Wildlife Services in Mississippi were most effective when installed to manage wetlands and less effective when used to provide water relief through perpetual flow. Maintenance increased continued effectiveness, but several devices remained effective after 5 years in service without maintenance. Beaver population control measures increased the successful operation of the devises, but the devices eliminated the need to remove all beaver.

These findings are similar to other descriptions for using the Clemson beaver pond leveler. The Clemson University Cooperative Extension Service leaflet comments 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 pamphlet rating the use of water flow devices produced by the Massachusetts Department of Fisheries, Wildlife & Environmental Law Enforcement, considered the Clemson beaver pond leveler as "an effective tool in situations where water input to a pond is from a small stream or spring" "suitable only for small watersheds" and "During periods of unusually high rainfall, problems related to the inability of the device to handle large amounts of water may occur." The situation must be such that occasional flooding is acceptable. A Minnesota

Department of Natural Resources pamphlet states the device is an effective tool to resolve problems incurred by a dam being built at a critical location rather than those caused by the presence of beaver in general. 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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