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Advancing Research in the Field of Non-Lethal Beaver Damage Management

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ABSTRACT: Beavers serve critical ecological functions and play the role of keystone species in wetland ecosystems. Yet, their ecological engineering can sometimes cause flooding or other damage to human infrastructure and agriculture necessitating management action. In an effort to preserve the ecological benefits of beavers while mitigating damages, many stakeholders increasingly seek non-lethal solutions that are part of the USDA Wildlife Services (WS) Integrated Wildlife Damage Management approach. Research at the Wildlife Services National Wildlife Research Center aims to expand this portfolio by investigating drivers of beaver damage and developing, evaluating, and refining effective tools for non-lethal beaver management. In this paper we provide an overview of non-lethal beaver management tools showing promise in field operations, including: 1) physically excluding beaver from key areas; 2) managing water flow around beaver impoundments; 3) translocating beaver colonies from damaging to desired areas; 4) novel developments such as eDNA, drone surveys, and fertility control. We hope to generate discussions in the wildlife damage management community to better understand needs and knowledge gaps requiring additional research effort.

KEY WORDS: animal damage control, beaver, *Castor canadensis*, mammals, non-lethal methods, rodents

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INTRODUCTION

Beavers (*Castor canadensis*) serve critical ecological functions and play the role of keystone wetland species. Yet, the ecology and behavior of beavers can lead to several sorts of damage to agriculture, property, infrastructure and human health and safety (Taylor et al. 2017). The quintessential beaver behavior of dam-building is perhaps the most frequent cause of damage, flooding farm and timber lands, roads, airports, runways, and other properties. Each culvert obstructed by beaver activity can cost state transportation departments several to tens of thousands of dollars in annual maintenance or repair (Jensen et al. 1999, Boyles and Savitzky 2008). Forest damage from inundation in Mississippi alone has been estimated at 2-7 million dollars annually (in 2009 dollars; Shwiff et al. 2011). In areas where they don't build dams or lodges, beavers may burrow in stream or lake banks leading to erosion or destabilization. Additionally, beaver's reliance on woody vegetation as both a food and building material can cause damage to timber, orchards or other tree crops. Tree damage from herbivory and girdling cost millions in timber losses each year in Mississippi (Bullock and Arner 1985).

In an effort to preserve the ecological benefits of beavers while mitigating damages, many stakeholders increasingly seek non-lethal solutions that are part of the USDA Wildlife Services (WS) Integrated Wildlife Damage Management approach (WS Directive 2.105, 2004). Research at the USDA WS National Wildlife Research Center (NWRC) aims to expand this portfolio by investigating drivers of beaver damage and developing, evaluating, and refining effective tools for non-lethal beaver management. In this article we describe some of the common nonlethal approaches to beaver damage management and present opportunities for further research studies (Figure 1). We hope to generate discussions in the wildlife damage management community to better understand needs and knowledge gaps requiring additional research.

EXCLUSION

Tree damage can be mitigated by excluding beavers from individual trees or larger wooded areas. High value trees can be protected by wrapping individual (or small groups of) trees with heavy-gauge wire. Wrapping individual trees has been shown to be more effective than painting with sanded paint or using commercial wildlife frightening devices (Nolte et al. 2003). Wire must be sufficiently strong to exclude beavers. Six gauge welded mesh (with hole sizes from 2 to 6 inches, 5-15 cm) has been an effective barrier, while lightweight hexagon mesh (e.g., chicken wire) has been too weak to withstand beavers (Campbell-Palmer et al. 2016, Westbrook and England 2022). It is important that the tree wrap be of larger diameter than the trunk to allow for growth and to ensure that the beaver's teeth cannot reach the tree through the mesh (Westbrook and England 2022). The mesh should be placed at least three feet (0.9 m) above the ground or expected snow line (Westbrook and England 2022).

Wooded areas, such as orchards or timber plantings, can be protected by electrical or traditional fencing. Rigid fencing (e.g., chain link or welded wire) should be at least three feet (0.9 m) above the ground or expected snow line, and the bottom should either include a skirt or be buried enough to avoid burrowing (Hecht 2009). Electric fences should comprise at least three strands placed low enough to ensure beaver encounters (about 8-10 inches, 20-25 cm, off the ground) and should have caution signs for human safety (Hecht 2009).

While several exclusion methods have proven successful, there are still valuable areas for research. Tracking trends in use and routinely updating best practices can help to improve techniques. In addition to evaluating fencing types, metrics of cost effectiveness would help managers and property owners select the right method for their situation. Future developments may yield more effective frightening devices or chemical deterrents that could provide additional tools for excluding beaver from desired wooded areas.

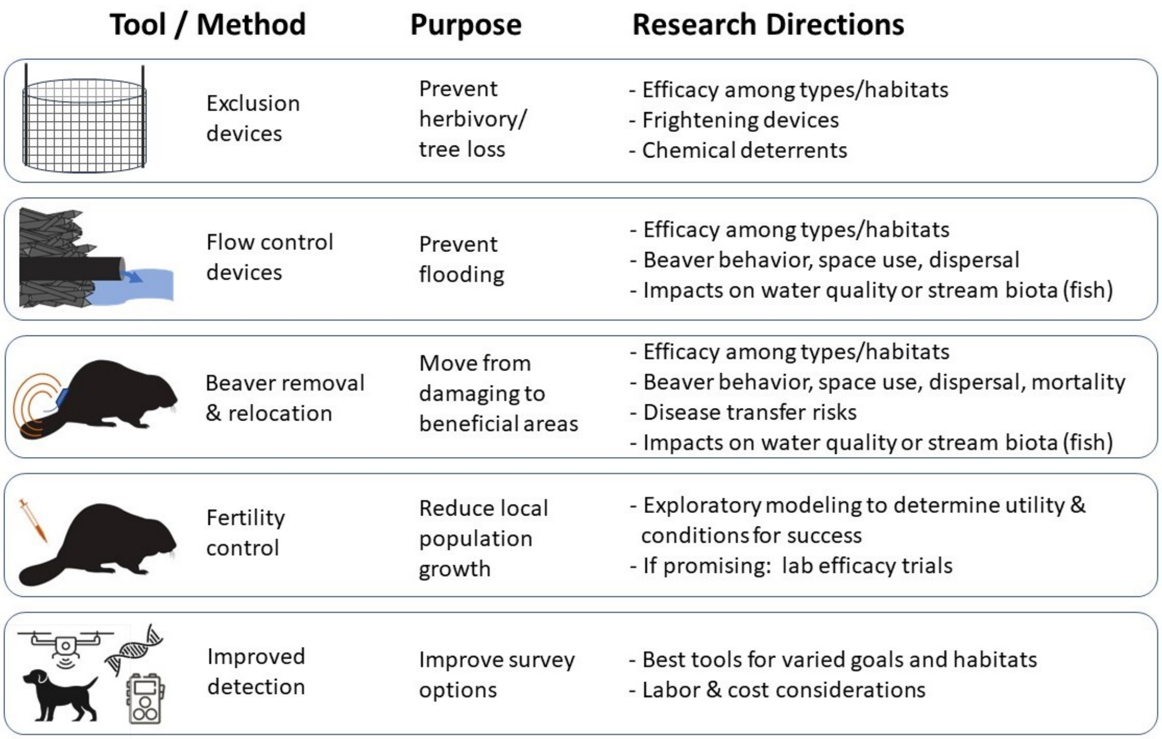

Figure 1. This diagram shows key tools for nonlethal beaver damage management and describes areas of research focus at the USDA Wildlife Services National Wildlife Research Center.

WATER FLOW CONTROL

Devices to control water flow ("flow devices") have become a popular solution to flood damage associated with beaver dams (Taylor and Singleton 2014). There are several commercial and DIY styles that are widely marketed, and each device is typically modified to suit the unique characteristics of each site. Generally, flow devices are designed to incorporate aspects of deception (keeping the beaver from detecting the source of water flow) and exclusion (keeping the beaver from blocking the flow pipe) to limit dam building behavior and manipulate water levels to control flooding while allowing the dam and beaver to remain in place (Taylor and Singleton 2014). Typically, a corrugated pipe (≥8 in, 20 cm, diameter) is placed through the beaver dam with the outflow (downstream) set at the desired water level such that excess water can be siphoned below the dam. Heavy-gauge wire mesh is used to exclude the beaver from the inflow so that it cannot clog the flow device pipe.

Flow devices have been shown to be cost-effective methods to mitigate beaver-associated flooding (Nolte et al. 2000, Simon 2006, Boyles and Savitzky 2008). Yet, there has been little quantitative data to assess the degree of water level control provided by flow devices. These data will help managers and property owners weigh the costs and benefits this option for beaver management. Flow devices sometimes fail, and one of the most reported reasons for failure has been the beaver building new dams (Nolte et al. 2000, Simon 2006). Flow devices can be most effective over the long term if they control water levels while the beaver colony continues their regular activity, avoiding dispersal or territorial shifts that could simply move the flooding problem to an unmitigated area. Thus, more research is needed to understand how the presence of a flow device might alter beaver behavior or space use. Additionally, some agencies have expressed concerns about fish passage in the presence of flow devices, particularly the potential for large fish to swim upstream through piping and become trapped in the caging at the pipe intake. More research is needed to determine how fish or other aquatic species interact with flow devices and to develop best practices that maintain fish and wildlife passage.

COLONY TRANSLOCATION

In recent years beavers have been increasingly incorporated into wetland restoration practices in hopes of leveraging the landscape engineering of these animals without causing additional conflict with humans (Law et al. 2017, Pilliod et al. 2018, Dittbrenner 2019). Translocating beavers from areas of conflict or damage to areas where they are desired for restoration efforts has become a favored solution in some areas (though prohibited in some states). Few translocation efforts have included post-release monitoring (~20% reported in Pilliod et al. 2018). Studies that have tracked beavers after translocation have shown high mortality (30-70%) and emigration (50-100%) in the months immediately after release (McKinstry and Anderson 2003, Petro et al. 2015, Doden et al. 2023). Long-term monitoring is even more difficult. Some studies have suggested successful establishment of translocated colonies based on presence of beaver dams seasons or years after translocation (Pollock et al. 2017). However, there has been no effort to verify whether the activity was indeed associated with the translocated colony, other beavers that may have been attracted by the translocation activity, or other beavers that naturally colonized a suitable stream reach regardless of human intervention. Tools such as telemetry can provide added insights to beaver initial reaction after translocation, while non-invasive genetic methods may be useful when revisiting sites for longer term monitoring.

With any translocation activity, there is the potential that one will inadvertently move pathogens or invasive species along with the host animal that is the target of management action (Kock et al. 2010, Warne and Chaber 2023). Chytrid fungus (*Batrachochytrium dendrobatidis* or *Bd*) is a pathogen of special concern in wetland ecology, causing devastation to amphibian populations worldwide (Fisher and Garner 2020) including in the U.S. (Russell et al. 2019). Past research has demonstrated that *Bd* can be adhered to and grow on secondary hosts including waterfowl (Garmyn et al. 2012). This has led to concern that aquatic mammals may also act as transport hosts for the pathogen. Recent research in Washington has shown that, indeed, *Bd* can be carried on beaver fur (based on eDNA samples from animals tranlocated as part of the Methow Beaver Project; Burgher et al. 2022). These recent findings have increased concern that beaver translocated from nuisance sites (often in the lower and more impacted areas of a watershed) could carry this damaging fungus to their release sites (potentially more pristine remote areas). Risk assessment for *Bd* and other pathogens will be an important area of research to safeguard other species and ecosystems as beavers are moved across watersheds.

NOVEL APPROACHES

Wildlife damage management is an ever-evolving field in which professionals must constantly innovate to overcome challenges as animals learn to circumvent established methods. To stay one step ahead, wildlife professionals apply tools from many disciplines to find novel solutions to age-old and emerging wildlife damage issues.

Given their aquatic and nocturnal habits, beavers can be difficult to survey. Aerial surveys are often effective at detecting dams, lodges, or food caches (Ribic et al. 2017, Thompson et al. 2022) but beavers denning in bank burrows can be much harder to detect visually. Environmental DNA (eDNA) techniques offer promise to detect animals through their genetic signatures shed into the environment. Sampling eDNA by filtering water has been shown to be especially effective for semi-aquatic species (Harper et al. 2019), and has been successfully applied to beavers (Duke 2021). Additionally, detector dogs can be a highly efficient at finding cryptic wildlife (Harrison 2006). Detector dogs have even been used to identify individual beavers in Europe (Rosell 2020).

Fertility control (often through immunocontraceptives) can help to curb population growth by lowering birth rates. This method has shown promise for helping to control rodent populations (Jacoblinnert et al. 2022). Scientists at the NWRC have recently expanded the utility of one immunocontraceptive, Gonacon, to additional rodent species (Shiels et al. 2024). Substantial testing would be required before such a treatment could be developed to control beaver populations. Preliminary population modeling could provide important information on the potential effectiveness of such a treatment, allowing scientists to weigh the costs and benefits of future trials.

CONCLUSIONS

As wildlife damage management tools are developed and refined, research plays a crucial role in assessing risks, measuring efficacy, and evaluating costs vs benefits. The USDA WS NWRC is working with practitioners and other stakeholders to initiate several lines of research aimed at mitigating beaver damage to agriculture, natural resources, property, and people.

LITERATURE CITED

Boyles, S. L., and B. A. Savitzky. 2008. An analysis of the efficacy and comparative costs of using flow devices to resolve conflicts with North American beavers along roadways in the coastal plain of Virginia. Procedings of Vertebrate Pest Conference 23:47-52.

Bullock, J. F., and D. H. Arner. 1985. Beaver damage to nonimpounded timber in Mississippi. Southern Journal of Applied Forestry 9:137-140.

Burgher, J., A. Duke, C. Goldberg, and J. Piovia-Scott. 2022. Using eDNA to monitor beaver relocations and associated transmission of aquatic pathogens and invasive species. Washington State University Final Project Report to Washington Dept. of Fish and Wildlife.

Campbell-Palmer, R., D. Gow, G. Schwab, D. Halley, J. Gurnell, S. Girling, S. Lisle, R. Campbell, H. Dickinson, and S. Jones. 2016. The Eurasian beaver handbook: ecology and management of *Castor fiber*. Pelagic Publishing Ltd, London, U.K.

Dittbrenner, B. J. 2019. Restoration potential of beaver for hydrological resilience in a changing climate. University of Washington, Seattle, WA.

Doden, E., P. Budy, M. Conner, and J. Young. 2023. Comparing translocated beavers used as passive restoration tools to resident beavers in degraded desert rivers. Animal Conservation 26:573-586.

Duke, A. C. K. 2021. Smooth-coated otter and North American beaver detection with environmental DNA: informing sampling design for conservation and management. Washington State University, Seattle, WA.

Fisher, M. C., and T. W. Garner. 2020. Chytrid fungi and global amphibian declines. Nature Reviews Microbiology 18:332-343.

Garmyn, A., P. Van Rooij, F. Pasmans, T. Hellebuyck, W. Van Den Broeck, F. Haesebrouck, and A. Martel. 2012. Waterfowl: potential environmental reservoirs of the chytrid fungus *Batrachochytrium dendrobatidis*. PLoS One 7:e35038.

Harper, L. R., L. L. Handley, A. I. Carpenter, M. Ghazali, C. Di Muri, C. J. Macgregor, T. W. Logan, A. Law, T. Breithaupt, and D. S. Read. 2019. Environmental DNA (eDNA) metabarcoding of pond water as a tool to survey conservation and management priority mammals. Biological Conservation 238:108225.

Harrison, R. 2006. A comparison of detector dogs, hair snares, cameras, and scent stations for detection of bobcats. Cat News 44:20-22.

Hecht, A. 2009. Managing wildlife damage: American beaver (*Castor canadensis*). Pages 1-5 *in* Wildlife Damage Publication Series. University of Georgia, Athen, GA.

Jacoblinnert, K., J. Jacob, Z. Zhang, and L. A. Hinds. 2022. The status of fertility control for rodents: recent achievements and future directions. Integrative Zoology 17:964-980.

Jensen, P. G., P. D. Curtis, and D. L. Hamelin. 1999. Managing nuisance beavers along roadsides. A guide for highway departments. Department of Natural Resources and the Environment, Cornell Cooperative Extension Publications, Ithaca, NY.

Kock, R., M. Woodford, and P. Rossiter. 2010. Disease risks associated with the translocation of wildlife. Revue Scientifique et Technique 29:329.

Law, A., M. J. Gaywood, K. C. Jones, P. Ramsay, and N. J. Willby. 2017. Using ecosystem engineers as tools in habitat restoration and rewilding: beaver and wetlands. Science of the Total Environment 605:1021-1030.

McKinstry, M. C., and S. H. Anderson. 2003. Survival, fates, and success of transplanted beavers (*Castor canadensis*) in Wyoming. Canadian Field-Naturalist 116(1):60-68.

Nolte, D. L., M. W. Lutman, D. L. Bergman, W. M. Arjo, and K. R. Perry. 2003. Feasibility of non-lethal approaches to protect riparian plants from foraging beavers in North America. Staff Publication 256, USDA National Wildlife Research Center, Fort Collins, CO.

Nolte, D. L., S. R. Swafford, and C. A. Sloan. 2000. Survey of factors affecting the success of Clemson beaver pond levelers installed in Mississippi by Wildlife Services. Wildlife Damage Management Conference Proceedings 21:120-125.

Petro, V. M., J. D. Taylor, and D. M. Sanchez. 2015. Evaluating landowner-based beaver relocation as a tool to restore salmon habitat. Global Ecology and Conservation 3:477-486.

Pilliod, D. S., A. T. Rohde, S. Charnley, R. R. Davee, J. B. Dunham, H. Gosnell, G. E. Grant, M. B. Hausner, J. L. Huntington, and C. Nash. 2018. Survey of beaver-related restoration practices in rangeland streams of the western USA. Environmental Management 61:58-68.

Pollock, M. M., G. M. Lewallen, K. Woodruff, C. E. Jordan, and J. M. Castro. 2017. The beaver restoration guidebook: working with beaver to restore streams, wetlands, and floodplains. United States Fish and Wildlife Service, Portland, OR.

Ribic, C. A., D. M. Donner, A. J. Beck, D. J. Rugg, S. Reinecke, and D. Eklund. 2017. Beaver colony density trends on the Chequamegon-Nicolet National Forest, 1987-2013. PLoS One 12:e0170099.

Rosell, F., D. Kniha, and M. Haviar. 2020. Dogs can scent-match individual Eurasian beavers from their anal gland secretion. Wildlife Biology 2020(2):1-7. https://doi.org/10.2981/wlb.00658

Russell, R. E., B. J. Halstead, B. A. Mosher, E. Muths, M. J. Adams, E. H. Grant, R. N. Fisher, P. M. Kleeman, A. R. Backlin, and C. A. Pearl. 2019. Effect of amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) on apparent survival of frogs and toads in the western USA. Biological Conservation 236:296-304.

Shiels, A. B., J. Runte, E. W. Ruell, D. C. Eckery, G. W. Witmer, and D. J. Salkeld. 2024. Treatment with the immunocontraceptive vaccine, GonaCon, induces temporary fertility control in free-ranging prairie dog populations in Colorado, USA. Wildlife Research 51:WR22135.

Shwiff, S. A., K. N. Kirkpatrick, and K. Godwin. 2011. Economic evaluation of beaver management to protect timber resources in Mississippi. Human-Wildlife Interactions 5:306-314.

Simon, L. J. 2006. Solving beaver flooding problems through the use of water flow control devices. Proceedings of Vertebrate Pest Conference 22:174-180.

Taylor, J. D., and R. D. Singleton. 2014. The evolution of flow devices used to reduce flooding by beavers: a review. Wildlife Society Bulletin 38:127-133.

Taylor, J. D., G. K. Yarrow, and J. E. Miller. 2017. Beavers. Wildlife Damage Management Technical Series, USDA APHIS Wildlife Services National Wildlife Research Center, Fort Collins, CO.

Thompson, C. A., J. F. Benson, and B. R. Patterson. 2022. A novel survey design for modeling species distribution of beavers in Algonquin Park, Canada. Wildlife Society Bulletin 46:e1322.

Warne, R. K., and A.-L. Chaber. 2023. Assessing disease risks in wildlife translocation projects: a comprehensive review of disease incidents. Animals 13:3379.

Westbrook, C. J., and K. England. 2022. Relative effectiveness of four different guards in preventing beaver cutting of urban trees. Environmental Management 70:97-104.