The Return of Beavers to Southern Piedmont Streams: Stream Restoration or Disruption?

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The return of beaver to streams in Guilford County, North Carolina has encountered widely different responses in rural and urban landscape contexts. We found that beaver were viewed as positive agents of stream restoration in a project intended to rank potential riparian conservation easements in rural Guilford County. The response to beaver in two urban neighborhoods was to demand their eradication as a public nuisance. A primary goal of stream restoration in environmental planning is the recreation of natural conditions in streams altered by human action. Successful implementation of that goal will require clear definitions of what constitutes natural form and function, and human accommodations to the changes reintroduced species may bring to local environments.

Introduction

After being gone for over a century, beaver (*Castor canadensis)* have returned to the North Carolina Piedmont, a landscape significantly altered by human actions during their absence. Opportunistic by nature, the beaver are reoccupying both rural and urban riparian settings, transforming and restoring stream valleys to conditions more like those prior to European contact. The transformation is meeting with a mixed reaction from people living in the affected areas. While some welcome the beaver's work as a low-cost means of restoring natural functions and spatial forms to degraded riparian landscapes, others see the animals as a disruptive nuisance and are calling for their eradication. The purpose of this paper is to examine those conflicting responses in the rural and urban contexts of Guilford County, North Carolina, and discuss their implications for environmental restoration efforts in human altered landscapes.

Beaver were common throughout North Carolina before European contact, but their numbers declined rapidly throughout the 18th century because of heavy trapping for the fur trade with Europe. Trapping was following by extensive land conversion, wetland drainage, and stream alteration to accommodate agricultural and urban land uses, until the animal was extirpated from the state sometime around the end of the 19th century. In 1939, the North Carolina Department of Conservation re-introduced 29 beaver from Pennsylvania into the North Carolina Coastal Plain (Woodward and Hazel 1991). The animals quickly took hold in their old niche and since then have spread westward across the state, following the rivers and stream corridors upstream to the Piedmont.

Geomorphic and Ecologic Influences

Beaver obviously alter the geomorphic and ecologic character of landscapes. Butler (1995) asserted that humans are the only animals that have done more to alter the landscape characteristics and functions of North American streams, and Shepard (1986) referred to the beaver as the original Soil Conservation Service because of the sediment detainment functions of their dams and ponds. Large woody debris dams, mud-and-stick lodges, bank burrows, excavated canals, and food caches are some of the more common structures placed in, across, or along stream channels by the work of active beaver. Such activity alters the hydrology of affected streams and produces a variety of geomorphic changes, particularly in upland Piedmont streams impacted by erosional incision

accelerated by agricultural and construction practices of the past and present. Other effects of beaver impoundments include modification of bank erosion and mass wasting processes, and altered temporal and spatial stormwater runoff and flooding patterns. Reduced rates of stormwater runoff may also raise local groundwater tables, and expand the transitional wetland zone between the open water channel and adjacent uplands (Gurnell 1998; Butler and Malanson 1994; Naiman and colleagues 1988).

Not all beaver construct large dams or lodges. On smaller streams they may construct shelters by simply burrowing into stream banks. Meetemeyer and his colleagues (1998) reported on the erosional effects of stream bank burrowing and tunneling in a North Carolina Piedmont stream where beaver dams were generally lacking, finding that such activities actually contributed to bank mass wasting and erosion.

In their ecological role, palustrine wetlands formed by the work of beaver may modify the species abundance and diversity of riparian vegetation, setting in motion successional vegetation dynamics as ponds fill with sediment or dams are abandoned (Malanson 1993). Old and abandoned beaver ponds fill to become wet "beaver meadows" in some instances. Similar to other wetland environments, beaver created wetlands function as biogeochemical filters and sinks, which can be important in the environmental management of pollutant loads. They also provide habitat for a variety of wetland plants and animals, including other aquatic mammals, amphibians, fish, and a host of benthic invertebrates.

A common result of urban development or agricultural drainage schemes is the transformation of perennial flow regimes to "flashy" ephemeral flow that can decimate aquatic ecology. Beaver activity can return a measure of stability to stream flow, allowing high order predators such as fish and amphibians to move upstream and feed on insect larvae or other food. During droughts the deep water provided in beaver ponds can also serve as a refuge for fish and amphibians. Contrary to popular belief, such relationships between beaver and aquatic life may actually serve to reduce mosquito populations (Shepard 1986; Johnston 1994).

The stream altering work of beaver sometimes presents natural hazards to human land use. Dams may function to hold back minor floods for decades or even centuries before finally being silted in. In other cases Southern beaver dams have been known to burst during major storm events, sending flash floods downstream (Butler 1989). Beaver activity in the South has had negative impacts on highway and railroad drainage structures as well (Butler 1991; Federal Interagency Working Group 1998).

What most often puts beaver at odds with people, particularly in urban settings or intensively managed forests, is their ability to take down trees. In wildland landscapes where preservation of natural functions is a stated policy goal, use of trees and shrubs by beaver may be viewed as an element of the natural landscape dynamics of an area, but in urban settings where "urban forestry" has reached the city planning agenda, trees are being promoted as valuable assets. Anything that results in reducing the inventory of trees may be viewed as a negative event requiring interdiction by city officials.

A single adult beaver can chew through a tree 6 inches in diameter in about 15 minutes, and larger trees pose only minor challenges to a determined beaver (Butler 1995). Sharply chiseled stumps adjacent to fallen or missing trees are often noticed before the animals themselves are actually seen in a new area. Beaver prefer to gather food and building material near the water, and favor some tree species over others, but they generally do not discriminate between horticultural trees in a residential yard or native trees in a natural setting. It is particularly in instances where horticultural trees are taken down that the animals quickly run afoul of homeowners and urban foresters (Gray 1990).

Beaver as Agents of Rural Landscape Change

We first encountered North Carolina beavers as agents of landscape change through a riparian land acquisition project. A consortium of non-profit groups interested in restoring streams within

the Upper Cape Fear River basin enlisted our help in assessing the condition of a stream flowing through rural areas of northern Guilford County. Their goal was to identify potential sites for acquisition by the North Carolina Clean Water Trust Fund. The Clean Water Trust Fund was set up to protect and restore riparian areas and wetlands along the state's major rivers as part of efforts to improve water quality. The consortium selected Mears Fork of the Haw River, a 3rd order stream near the headwaters of the Cape Fear River, with a drainage area of approximately 18 square miles. They chose Mears Fork because the Guilford County Natural Heritage Inventory listed it as the highest quality stream in the county (Bates 2001). That ranking was based on the critical habitat provided by the mature hardwood forests and wetlands found along the stream. Neotropical migrant birds, river otter, beaver, wild turkey, and deer are just some of the wildlife utilizing the riparian habitat. The diverse and rare riparian plant assemblages in the area are also notable, including the purple fringeless orchid (*Platanthera peramoena)*, a species considered significantly rare and peripheral by the North Carolina Natural Heritage Program and discovered along Mears Fork during fieldwork for the inventory (Amoroso 2002, Bates 2001).

Our task was to assemble a spatial database of the Mears Fork drainage basin that could be used to analyze and prioritize land parcels for potential acquisition of conservation easements or fee simple title by the state. We utilized digital ortho-photography and hydrologic data sets, in addition to color infra-red (CIR) aerial photography, zoning maps, and property tax maps obtained from Guilford County to create a digital spatial database of land use, land cover, and property divisions. A variety of habitat quality indices are available for stream classification, but we limited our project to illustrating how the database could be queried to identify potential parcels based on criteria specified by the Clean Water Management Trust Fund (Tricot 2001). McQuaid and Norfleet (1999) provide a review and assessment of other stream habitat quality indices that have been applied in North Carolina.

Two criteria we examined were related to the activity of beaver: 1) the proportion of an ownership parcel within a forested riparian buffer, and 2) the presence of open bodies of water in a parcel. The forested riparian buffer was defined as the proportion of the land extending 300 feet from the centerline of the stream. It was estimated using aerial photographs. The buffer was found to be consistently wider wherever beaver were active.

Open bodies of water were shown without regards to origin in the spatial hydrology data set we obtained from the county, but field observations indicated we were dealing with two very different forms of detained water. The first was sediment detention ponds located on the upper tributaries of the Mears Fork drainage network. Many of the ponds were constructed several decades ago as cooperative erosion control efforts between agricultural landowners and the federal Natural Resource Conservation Service (then known as the Soil Conservation Service). The ponds were typically accessible to livestock, vegetative buffers were minimal, and signs of life in the water were scarce. Trampling and bank erosion, as well as pollutant loading by livestock were evident. Ponds managed specifically for private recreational fishing were an exception.

The work of beaver was the principle origin of open water bodies and wetlands within the narrow floodplain of Mears Fork. Outside of reaches with beaver, much of Mears Fork resembles other Piedmont streams in that the channel is deeply incised with undercut banks subject to mass wasting. There is a narrow transition from channel to upland vegetation and the floodway is poorly developed. Stream reaches where beaver are present are distinctly different. They include a wider and wetter transition from channel to upland, with standing dead tree snags being used by cavity nesting birds, or as roosts for wading water birds. Emergent wetland vegetation, woody shrubs, and bottomland hardwood trees are found on the wider sediment-rich floodway. Fish and other vertebrates,

as well as macro-invertebrates, are readily observed in the shallows and muds of the impounded water.

Local naturalists commonly observe beaver and other wildlife along the wider sections of the floodway during evening hours (Bates 2001). Indirect signs of active beaver are further indicated by felled trees and sharp woody stakes, dam sites and food caches, bank dens, canals cut through wet meadows, and trampled runs through the marshy areas. Wet meadows formed by the siltation of former beaver ponds were of particular interest in our assessment. Such wetlands are uncommon on the Piedmont and are habitat for many of the rare or endangered plant species of Guilford County, including the purple fringeless orchid. Because of their role in restoring the habitat of the orchid and in adding to the limited stock of wetland environments on the Piedmont, we recommended that areas with active beaver be considered for higher ranking than those with sediment detention ponds constructed by landowners. Our recommendations were favorably received by the consortium and contributed to acquisition of three conservation easements totaling 51 acres of riparian land.

In summary, our work in rural Guilford County showed that beaver can be viewed as agents of stream restoration. Their work contributed to increased landscape diversity and species richness along Mears Fork, and met the criteria for funding by the Clean Water Management Trust Fund.

Beaver as a Public Nuisance

Observations and interviews with urban residents and city foresters in Pinecroft Lakes and Hamilton Lakes, two urban Greensboro neighborhoods, reveal a different reaction to stream environments modified by beaver. Both neighborhoods are outside the Mears Fork drainage and were not part of that study. However, similar to the case of Mears Fork, beaver moved into each area by natural dispersal and modified the pre-existing stream conditions. Here we review the neighborhood reactions to those modifications.

Pinecroft Lakes began as a private hunting and fishing club set up outside of the city's limits in the 1920s. The neighborhood takes its name from three dams constructed across a stream running through the property in the 1930s. Sedimentation associated with urban construction and assimilation of the neighborhood into the city of Greensboro has altered the three lakes. The one furthest downstream remains an open lake, siltation of the middle lake has created a shallow wetland, and the upper most lake is silted in completely and grown up in bottomland hardwoods.

The area was annexed into the city following sale of the land to a developer in 1953. A residential neighborhood was built and the hunting lodge and outlying cabins were converted into year-round residences. Most of the older homes were constructed on large lots far back from the water's edge, but more recent construction on subdivided lots has reached into the wet margins of the middle lake.

In the early 1990s the City of Greensboro and the T. Gilbert Pearson Chapter of the Audubon Society cooperated with the neighborhood in the establishment of an educational boardwalk with interpretive signs describing the wetland functions and character of the middle lake, as well as the dynamic history of siltation in the area. Audubon hoped to highlight the wildlife habitat values of urban wetlands, including the role of an active beaver colony that had been using the area for some time. In addition, the City of Greensboro Stormwater Services Division wanted to increase public acceptance of created wetlands as an effective management practice for reducing stormwater sediment and pollutant loadings into the city's streams.

Trouble started when new homeowners on the lots reaching back into the wetland discovered that beaver were in the area. The newcomers called the city expressing alarm and complaining that their trees were at risk. Some property owners responded by placing wire fencing around their most valued trees to discourage the beaver, just as

homeowners on older properties had been doing for years with good results. Others demanded the city get rid of the beavers, citing a fear of more mosquitoes and the potential for flooded streets if the beaver were allowed to remain in the area.

The Stormwater Management Division of the Greensboro Environmental Services Department conducted a survey of neighborhood residents and found them about evenly split between those who were accustomed to the presence of beaver and willing to work towards an accommodation of the animals, and those who wanted the city to do something more decisive about the perceived beaver problem. Finally, under pressure from the most vocal neighbors, the city hired a trapper to capture and kill the beavers. He then blew out their dams to lower the water in the wetland to a level acceptable to homeowners with backyards reaching to the water's edge (Phlegar 2001).

Recent field observations at the site show signs of renewed beaver activity in the form of fresh mud and stick placement in dams blown out by the trapper. The last several years have been a period of marked dryness and low stream flows in Greensboro, however, so water levels at Pinecroft Lakes have remained low. The returning beaver are also being more discrete about taking down trees and the city has not received any recent complaints. What will happen when normal rainfall runoff patterns return, or if a nocturnal beaver is discovered gnawing on a backyard tree late one night, remains to be seen.

A similar story is playing out across town at Hamilton Lakes. That neighborhood was formed when a dam was constructed in 1920 across a wooded stream corridor. The resulting lake became the focal point of a private, upscale neighborhood noted for its leafy character and lots with views of the lake. Beaver recently moved into the area after an extensive area of wooded rural land upstream from Hamilton Lake was cleared for development. The newly arrived beaver felled several trees along the stream, including a prized cherry tree in a homeowner's yard. They also placed a low dam above the stream's inlet to Hamilton Lake and backed up a shallow pool.

Meetings of the local neighborhood association were called to discuss the "beaver problem." As in the case of Pinecroft Lakes, battle lines were drawn between opponents and proponents of the beaver. The governing board of the neighborhood association hired a man who described himself as an animal control consultant who had given up trapping beaver for their pelts because of the low price, finding a better income could be made trapping nuisance animals. During one heated meeting of the neighborhood association he declared, "if the beaver population is left alone, they'll cut down all the trees, I'll promise you that." He added that beaver would expose residents to rabies and to an intestinal parasite that causes extreme diarrhea in humans, claiming that merely touching the water a beaver inhabits can spread the disease (Perkins 2001a)[1].

As debate continued, a sort of guerilla war was staged in the woods around Hamilton Lake by defenders of the beaver who viewed killing the animals as inhumane. At one point a dead beaver was found hung from a tree with a sign around its neck (reports of what was written on the sign conflicted and could not be verified). Defenders of the beaver responded by vandalizing traps set to capture the animals. Finally, after months of claims and counter-claims, the owner of a private wildlife preserve in rural Rockingham County offered to accept the beaver if they were live trapped and brought to his property for release. This solution seemed to appease all parties to the issue and the beaver were trapped and moved (Perkins 2001b).

Field reconnaissance in the area soon after the beaver were removed showed that they had in fact felled some wild tulip poplars and a good number of smaller alders, willows, and mulberries. Their overall affect on the wooded character of the neighborhood was minimal, however, and none of the felled trees or shrubs could be seen from the streets of the neighborhood. The tree canopy remained mostly closed along the stream corridor. The greatest damage to canopy trees resulted from

wind and ice storms, rather than beaver activity. Stumps and woody spikes left by the beaver were vigorously sprouting new stems, creating a denser understory and more potential food for the absent beavers in the form of abundant tender bark.

Within a few months of the removal of the beaver, I returned to the site and found fresh tracks in the mud, confirming that either all the beaver had not been trapped or a new group of beaver had noticed the vacant habitat and food supply and were moving in to take the place of the former occupants. As in the case of Pinecroft Lakes, trapping and removal of the animals proved to be a temporary measure that satisfied local residents in the short term, but did not eradicate the animals in the long term.

Discussion

Environmental restoration has been defined as the holistic reestablishment of natural landscape functions made nonviable by human disruption (National Research Council 1992). Restoration ecologists recognize that no restoration is likely to be perfect, and all will be exercises in approximation. The principal goal is to recreate naturalistic functions as well as spatial forms. Specifically, the National Research Council Committee on Restoration of Aquatic Ecosystems stated (1992, pgs 17-18):

> Merely recreating a form without the functions, or the functions in an artificial configuration bearing little resemblance to a natural form, does not constitute restoration. The objective is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs. Often, restoration requires one of more of the following processes: reconstruction of antecedent physical conditions, chemical adjustment of the soil and water; and biological manipulation, including the reintroduction of native flora and fauna, or of those made nonviable by ecological disturbances.

Our observations in rural Guilford County and urban Greensboro suggest that a fundamental obstacle to the ideal described by the committee may be variations in public perception of what constitutes natural form and function from one landscape context to another. No reference streams remain to serve as models for what North Carolina's Piedmont streams looked like during the period when beaver were a common component of the landscape and Native Americans were the only human residents of the region. Instead, several generations of people have never known a stream that was not heavily impacted by agricultural and urban development practices. What is experienced over the long term may subsequently be considered natural when no other point of reference exists. And when animals that are part of the dynamic functions and forms that were once truly natural begin to reassert themselves they are labeled as disruptive and a "nuisance" under the pretext of protecting a degraded natural landscape.

We found less public resistance to the reestablishment of beaver in rural Guilford County, though the question remains open for further study. Shepard (1986) reported that farmers in Virginia were experiencing conflicts with beavers because of loss of land for grazing and crop depredations. Along the Mears Fork, the activity of beaver is generally limited to a narrow riparian corridor whose restoration rural residents appear willing to accept, given that the dynamics of beaver activity do not directly infringe on agricultural production. Urban residents live in closer spatial contact with the landscape changes brought about by the work of beaver, particularly when homes are situated in or near streams and wetlands, and that may contribute to the greater opposition to beaver we experienced in Greensboro.

Rural and urban landowners may also differ in fundamental attitudes of mind and human perceptions of natural landscapes. In the anecdotal cases reviewed here, urban property owners appear to consider natural form to imply trees undisturbed or unmodified by the actions

of animals. Urban forestry in its most spatially static silvicultural form is the goal. Streams that have been straightened, dredged, and cleared of woody debris are considered restored to their natural function simply by allowing vegetation to grow up along the banks. Benign wildlife, such as songbirds, are acceptable and even desirable, so long as their natural history does not interfere with the perceived naturalness of the trees. But when an animal such as the beaver introduces change to the stream form, and dynamics to the vegetative composition and structure, the action is considered destructive and unacceptable. People who view themselves as protecting the trees see removal of the animals as the only viable solution. Where there was urban opposition to removal of the beaver it was grounded more in a moralistic objection to killing animals than a desire to include beaver in a policy of restoring natural functions. Removal by live trapping was an acceptable compromise for such people.

A political dimension may increasingly affect the issue as cities continue to refine the set of best management practices implemented in stormwater management plans mandated by the National Pollution Discharge Elimination System (NPDES). NPDES is a series of federal mandates requiring cities to reduce pollutant loading of streams by runoff from dispersed sources. Phase I of NPDES was first implemented in the 1990s in larger cities, and is now entering Phase II, which will include smaller towns and municipalities. Constructing stormwater detention ponds has been among the most common best management practice required of new property developments in many plans, and urban ponds now dot the Piedmont landscape in much the same way sediment detention ponds were constructed to control rural agricultural runoff in a previous generation. The ponds can be expensive to install and carry ongoing maintenance costs, leading stormwater planners to search for alternate practices, including those which incorporate natural processes and functions (Broughton and Apfelbaum 1999; Lewis and colleagues 1994).

One approach has been to encourage developers to set aside riparian corridors in development plans and receive credit for stormwater mitigation without the need for building detention ponds. That approach most often involves considering topography and natural drainage in the clustering of building lots. A common example is the case of naturally vegetated buffers along stream corridors being set aside as common property of planned unit developments. Another variation includes preservation or construction of wetland basins rather than open water ponds.

Either scenario creates a setting that invites the work of beaver in their roles of natural stormwater detention engineers, soil conservationists, and restoration ecologists. The major difference is that the fees charged by the beaver are much less than their human counterparts. If water levels rise too high, or interfere with roads or local infrastructure, human engineering can be selectively utilized to alter the situation. For example, perforated pipes inserted through a beaver dam well below water level have been used to lower water levels without eliminating the pond or the beaver (Federal Interagency Stream Working Group 1998; Shepard 1986). Desirable trees can likewise be protected with various armoring devices, or by manipulating plantings to provide more favorable food species to decoy the beaver away from trees designated for protection.

Conclusions

Beaver are dispersing throughout both rural and urban landscapes of the North Carolina Piedmont, returning streams to conditions more like those before European contact. Natural predation is light and human trapping for furs or food lacks economic incentive, so as suitable habitat becomes available it appears likely that the beaver will continue to expand their range. Adaptable and opportunistic by nature, beaver often return to areas to rebuild when previous animals are removed or killed.

The question of when and whether beaver activity is a public nuisance or beneficial ecological restoration has much to do with attitudes of mind and the social goals of environmental restoration. The abundant geomorphic and ecologic literature on the natural functions of beaver activity seem to have been generally overlooked in the formulation

of public policy. Stormwater management planning may provide an avenue for changes in the public perception of beaver activity, but for now urban homeowners in Greensboro have generally shown themselves to view beavers as nuisance animals requiring removal rather than accommodation. Rural landowners in Guilford County appear to be less strident in opposition to the impact of beaver on streams, but their specific attitudes and perceptions remain open to further study.

End Notes

[1]According to the U.S. Center for Disease Control *Giardia* is found worldwide and infects both domestic and wild animals, including dogs, cats, deer, and beaver. *Giardiasis,* the illness caused by *Giardia,* occurs when cysts of the parasite are ingested through person-to-person transmission or ingestion of fecally contaminated food or water. Waterborne outbreaks are caused by drinking water contaminated by *Giardia cysts.* North Carolina law does not require reporting of cases of *Giardiasis* to the CDC so the prevalence of the illness could not be determined. Hamilton Lake is closed to all recreational use and does not serve as a drinking water supply. **(http://www.ede.gov/epo/mmwr/preview/mmwrhtml/ss4907al).**

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