THE BEAVER—A SOUTHERN NATIVE RETURNING HOME

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ABSTRACT: Beaver populations, extirpated in the previous century, have returned to the South often causing severe damage to timber and other resources. Many landowners perceive trapping programs as being ineffectual, perhaps because most programs are overwhelmed with immigrant beavers. To quantify immigration patterns, from November 1984 to May 1985, resident beaver were removed from a 1,619 ha study area in west Tennessee and for the next 40 months immigrants were captured within one month of immigration. Removal patterns of the resident population (169 beavers) suggest that bounty systems may be ineffectual to protect natural resources. Immigration was low (5.5 beavers) June to September and significantly ($P \leq 0.05$) higher (46.4 beavers) October to May.

KEY WORDS: beaver, *Castor canadensis*, damage, trapping, control, immigration, bounty

Proc. 18th Vertebr. Pest Conf. (R.O. Baker & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. 1998.

INTRODUCTION

It would be difficult to trace the course of American history without including the beaver (*Castor canadensis*). However, it is a story, especially a southern story, best told in three parts. Prior to European settlement, North American beaver populations are speculated as ranging between 60 to 400 million individuals (Naiman et al. 1986). Insatiable European demand for beaver pelts provided a powerful incentive for pioneer trappers. Annually, from 1620 to 1630, more than 10,000 beavers were taken from Connecticut and Massachusetts. In the decade following 1630 an estimated 800,000 were trapped from the Hudson River watershed in western New York (Naiman et al. 1986).

As eastern beaver populations declined, early 19th century expeditions were outfitted by speculators and sent westward to exploit new territories. The fur industry was so pervasive that in many areas beaver pelts as expressed by the "beaver standard" became a basic unit of exchange (Wesley 1978).

Trapping continued unabated during the 1800s and early 1900s, extirpating populations from many parts of their native range (Wesley 1978; Jenkins and Busher 1979). Beaver habitat also was lost as an expanding rural population practiced open range grazing which destroyed small trees, grasses and forbs along the watercourses (Milne and Milne 1960). And, since 1834, an estimated 195,000 to 260,000 square kilometers of wetlands have been converted primarily to farmland (Naiman et al. 1986).

Although scattered, remnant populations continued to exist over most of the beaver's southern range (Shultz 1954), beavers were virtually nonexistent in Alabama (Barkalow 1949; Moore and Martin 1949), South Carolina (Penny 1949), Virginia and West Virginia (Swank 1949), Tennessee (Shultz 1954), and Mississippi (Cook 1965) by the late 1800s. The first part of the story was made complete as several human generations lived out their lives on the southern landscape, laboring under the supposition that the bottomland systems were—and for all they knew—always had been, complete without the beaver.

ACT TWO OF THE BEAVER'S STORY

Restocking programs were initiated in many states by the mid 1900s (Saylor 1946; Shultz 1954; Cook 1965; Beshears 1967; Wigley 1986). Decreased trapping pressure along with an increasingly urban society enabled rapid expansion of native and reintroduced beaver. The South's innumerable streams provided superb travel lanes to an expanding beaver population and it would have been an ecological mystery if the beaver had not eventually reoccupied its old haunts. Inadvertently, like a welcoming party thrown for the wrong person, much had been done to prepare for its return.

During the beaver's absence, tremendous hardwood forests developed along many southern watercourses. These forests had remained unmolested, except by axe and chainsaw—shovel and dozer—prior to living memory. Roadways and railways crossed the bottomlands atop earthen dikes, allowing rivers to squeeze through under the bridges. Channelized streams were lined with soil depositions along both banks, except where the tributaries entered. To the beaver these were ready-made dams with holes that could be plugged. Many farmlands that were habitually too wet had been abandoned to grow up in thick stands of willow and birch saplings. These lands provided excellent food sources for the beaver.

By the mid-1970s, on many watersheds within the region, beavers were perceived as an "exotic" nuisance species whose dam-building and girdling activities heavily damaged forests. Bullock and Arner (1985) estimated that the beaver-induced loss to Mississippi's economy from 1975 to 1985 approached $2.4 billion. Miller (1986) concluded that "the beaver is the vertebrate animal causing the most damage to Southern forests at the present time."

Wigley (1986) surveyed 3,369 rural, noncorporate landowners owning more than 2 ha of land in Arkansas to estimate the impact of beaver populations in that state. Responses from 1,716 individuals holding 312,006 ha, or 2.3% of the land base, indicated that beaver activity had negatively impacted 342,105 ha statewide. Some form of beaver damage was reported by 32% of all respondents with 50% describing damage as substantial or severe.

About a quarter of all landowners reporting damage stated a willingness to pay for beaver removal. Although trapping could be demonstrated as the primary force in reducing populations prior to the 1800s, trapping was largely perceived as ineffectual by many respondents.

Part two of the beaver's story was complete. The southern native had returned home in force and it was necessary for land managers to learn about this "new" threat to the resources under their care.

BEAVER BIOLOGY

A beaver colony is the basic unit defining populations on the landscape. A typical colony consists of five to eight beavers with two adults (parents), the kits of the current year, and yearlings from the previous year (Busher et al. 1983), occupying a pond or stretch of stream, utilizing a common food supply and maintaining a common dam or dams (Bradt 1938).

Beavers are generally monogamous (Kleiman 1977; Svendsen 1989). Pair bonds can be formed throughout the year, but most commonly in late summer and fall (Svendsen 1989). The breeding season generally occurs from January to March in colder climates (Svendson 1980), but may occur in December or January in the South (Hill 1982). Gestation is approximately 100 days (Bergerud and Miller 1977). Kits weigh approximately 0.5 kg and average 38 cm long including a 9 cm tail. Litter size ranges from 1 to 9, averaging 3.7 (Svendsen 1980). First parturition normally occurs at age three, but can occur as early as age two depending on habitat or social structure of the colony.

Beavers could not persist over a large part of their native range without adequate supplies of woody vegetation to support them during fall and winter months. Over time, a colony's foraging activities will decrease the amount of woody vegetation around their impoundment. Beavers can react to a reduction in forage by moving to another colony site (Svendsen 1989) or by adding to pre-existing dams and backing water closer to new food supplies. Beavers are capable of building large dams. One dam in Montana was 650 m long, another in New Hampshire 1,213 m long (Rue 1969), and one in Wyoming was 5.4 feet high (Rue 1969).

Four types of beaver movements have been listed (Bergerud and Miller 1977): 1) movement of an entire colony; 2) wandering of yearlings; 3) dispersal of two-year-olds away from the natal territory; and 4) movement of adults who have lost a mate. Young beaver generally disperse from the natal colony during the season of their second birthday, coinciding with parturition of the adult female (Bradt 1947; Townsend 1953; Beer 1955; Libby 1957; Brooks et al. 1980). Although there seems to be an inherent tendency to leave, there is also indirect evidence that two-year-olds are driven from the colony by dominant adults (Hodgson and Larson 1973).

A number of beaver control methods have been examined over the years, including poisons (Hill 1976), chemosterilants (Arner 1964; Hill et al. 1977), surgical sterilization (Brooks et al. 1980) and introduction of alligators (*Alligator mississippiensis*) (Hill 1976). All of these are incomplete, impracticable or are contrary to public acceptance.

Trapping, the method by which beaver populations were once extirpated, remains as the best means available to produce measurable success. Yet, as was demonstrated by Wigley's (1986) survey, many landowners have no faith in trapping.

OBJECTIVES

The objectives of the Ames study were to: 1) record removal rates of a resident beaver population subjected to an intense trapping regime; 2) determine if immigrant beavers attempted to re-colonize the trapped-out area; and 3) quantify immigration patterns in a reasonable manner.

STUDY AREA AND METHODS

This study was conducted largely on the Ames Plantation, a 7,500 ha landholding administered cooperatively by the Hobart Ames Foundation and the University of Tennessee Agricultural Experiment Station (Houston et al. 1995). Ames Plantation is in the upper headwater basin of the North Fork of the Wolf River, located in the Mississippi Embayment section of the Gulf Coastal Plain physiographic province, 80 km east of Memphis, Tennessee, and 80 km southwest of Jackson, Tennessee.

A 1,619-hectare study area was defined in the floodplain of the North Fork Wolf River beginning at the downstream departure of the river from Ames Plantation property and continuing upstream approximately 12.8 kilometers until the river became intermittent. There were numerous small tributaries along this length. At the lowermost point of the study area the North Fork Wolf River averaged 0.5 to 1.0 m deep and 5 to 7 m wide.

Beginning in November 1984 and continuing through May 1985, intensive trapping removed all beavers from the 22 active colonies in the study area. Individual locations were considered trapped-out if beaver activity (e.g., dam repair, tracks, cuttings) was not observed during repeated visits (spanning several days) to the site (Peterson and Payne 1986). No attempt was made during this period to distinguish initial populations from immigrants.

From June 1, 1985 through September 30, 1988, all colony sites remained under surveillance and beaver attempting to recolonize were removed within one month of immigration to the site. During this time all captures were considered to be immigrants.

Trapping was accomplished primarily with the Conibear 330 (about 90%) and limited use of the wire snare (Hill 1976 and 1982; Weaver et al. 1985). The most productive technique was to create a small break or series of breaks with hand tools in the major dam and place one or several Conibears in or near the breach. Escaping water stimulated colony members to attempt repair. Other common sets included those on runways across the top of dams or sets in association with well worn feeding runs.

If scavaging did not prevent acquisition, the lower mandible of each specimen was extracted for age determinations (van Nostrand and Stephenson 1964; Larson and van Nostrand 1968).

It was assumed that the study site was readily available to immigrants. Based on aerial surveillance

during the course of the study by Tennessee Division of Forestry personnel, beaver populations remained consistently high on downstream portions of the river (Charles Riddell, pers. comm. 1987). The number of beavers caught from June 1985 through September 1988 was summed by four-month periods. February through May was viewed as the time when two-year-olds dispersed from natal colonies, representing a high probability period for immigration. The other two periods (October to January and June to September) were fixed by choosing this period.

To maintain the assumptions necessary for analysis of variance, the total number caught by individual four-month periods were transformed to log (sum + 1) and trapability was assumed equal for each time period. Analysis of variance was conducted on transformed data to determine if immigration was significantly different among four-month time periods.

RESULTS AND DISCUSSION

During the first seven months of the study, 169 beavers were captured; however, monthly capture totals were not uniform. Generally, fewer beavers were captured each month and, by the end of the seven-month period, pre-study resident populations were judged to have been removed (Figure 1).

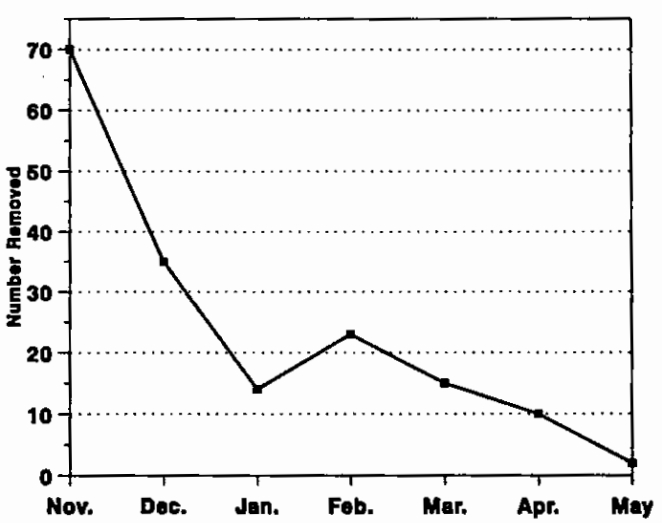

Figure 1. Removal of initial beaver populations from the Ames Plantation Study Area, Fayette County, West Tennessee, November 1984 through May 1985.

From June 1985 through September 1988, 162 beavers attempting to recolonize original or new sites were removed. Recolonization attempts were relatively low during the period June to September averaging 5.5 immigrants, significantly less than the periods October to January (22.7 immigrants) and February to May (23.7 immigrants), which did not differ significantly (Figure 2). The interval from the first of October through the end of May accounted for 89.6% of all average yearly immigration.

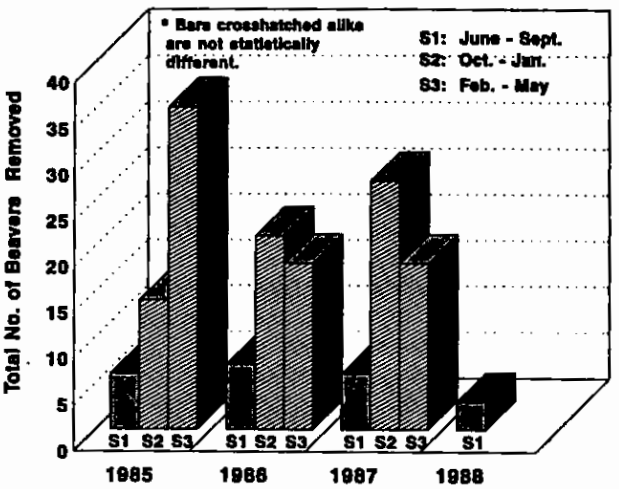

Figure 2. Total number of immigrating beavers removed from Ames Plantation Study Area, Fayette County, West Tennessee, June 1, 1985 through September 30, 1988, by four-month trapping period.

In this study 89.4% of all beaver on which age could be determined were four years old or less (Table 1). Immigrants in the one to two year age class were prominent throughout the year. This age class made up 46.3% of all immigrants during the February to May period. Beaver in the zero to one age class made up 22.5% of all captures, being especially prevalent October to January (34.8%). Only three individuals were estimated older than eight years of age, with the oldest a 34.2 kg, 12-year-old female that was carrying four near term fetuses.

THE QUESTION OF BOUNTY SYSTEMS

These results suggest that the use of "bounty systems" to control beavers on a small watershed may be ineffectual. During the first month of the study 70 beavers were caught. Under a bounty system, this might represent adequate economic reward to a trapper. However, catch totals were halved during the following month and halved again the next. Quickly diminishing returns likely would force abandonment of control efforts.

Also, the authors noticed that the older beavers at each colony site tended to be caught first (Houston et al. 1995). The removal of either or both adults has been suggested to stimulate sexual activity in remaining yearlings (Brooks et al. 1980). Potentially increased recruitment within the residual population, along with immigration, could replenish beaver populations quickly.

Generally, the control "domain," an ownership, watershed or county, will be surrounded by high beaver populations. As catch rates and monetary returns diminish within this domain, the bounty trapper is forced to: 1) quit; 2) move to more productive trapping sites within the domain; or 3) move to more productive trapping areas outside the control domain. Although bounties may cause impressive numbers of beavers to be

Table 1. Total number of beavers immigrating into the Ames Plantation study area, Fayette County, West Tennessee, June 1, 1985 through September 30, 1988, by month and age class.

	Age Class (years)								
Month	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8+
January	3	2	-	3	-	-	-	-	-
February	4	3	2	3	-	-	-	-	1
March	2	13	4	-	-	-	-	-	1
April	2	13	4	3	-	-	-	2	-
May	2	2	3	2	1	-	-	-	-
June	1	3	3	-	1	-	-	-	-
July	-	3	1	2	-	-	-	-	-
August	1	1	1	-	-	-	-	-	-
September	1	-	2	1	-	-	-	-	1
October	7	2	2	2	-	-	-	-	-
November	10	3	8	-	-	1	1	-	-
December	3	4	4	8	1	-	-	-	-
Totals	36	49	34	24	3	1	1	2	3

caught quickly, little would be accomplished to protect a specific resource at a specific site. A remnant population probably would remain to continue the threat.

However, this study also suggests that persistent trapping can extirpate beaver populations. In the face of sustained and sufficient economic pressures applied over large regions (e.g., greatly inflated pelt prices) beaver populations will require careful management to prevent over exploitation.

IMMIGRATION

Beaver immigration into the 1,619 ha study area began quickly and persisted throughout the duration of the study. Beavers repeatedly recolonized idle colony sites, likely because these sites possessed favored habitat features (Houston et al. 1995). The preponderance of immigration was expected to occur February through May, when young adult beaver disperse from natal territories in search of mates and suitable habitat. Unexpectedly, immigration totals from October through January were equally high and not statistically different from February through May.

Working in Montana, Townsend (1953) noted that September was the month of greatest dam building and was the time when two-year-olds "settled down" into their new home. Svendsen (1989), determined that pair bonds in an Ohio study were formed predominately in the late summer and early fall. In west Tennessee the period of greatest dam building and "settling in" may occur later in the year, perhaps October to December. First frost usually occurs during late October at Ames Plantation as opposed to a normally earlier onset of harsh weather in Montana and Ohio. Needing a dependable, woody food source, young adult beaver apparently attempt to "settle down" as the weather grows colder and herbaceous food supplies dwindle. Also, in Tennessee, October through November represents a time when deciduous leaves are in their greatest abundance in streams, representing an excellent source of dam building materials.

Summer immigration (June to September) was significantly lower than the remaining two periods. Where beaver populations are high, and colony sites difficult to locate, the beaver's ability to subsist on relatively abundant herbaceous food supplies may delay the urgency of finding a suitable permanent home. After dispersal from natal sites, a proportion of young beavers may remain "at large," representing a surplus population available to fill suitable habitat or replace lost mates in the fall (Beer 1955; Peterson and Payne 1986; Svendson 1989). In the authors' study, June through September encompassed the majority of the growing season; and timber innundated for any significant duration during this timeframe likely would die. Therefore, while immigration may be relatively low, any dam repair by immigrants during this period would represent significant peril to growing stock.

More than 89% of all immigrants into the control domain were four years old or younger. This was expected because most wildlife populations are heavily skewed toward younger classes and young adult beaver are more likely to move (Beer 1995; Leege 1968). It was unexpected that 22.5% of all immigrants would be less than one year old, an age class presumed to remain near familiar natal surroundings.

In this study kits often were removed from colony sites where adult immigrants, presumably the parents, also were present. Likely, pregnant females gave birth onsite or arrived with kits in tow (Bergerud and Miller 1977). Kits caught from July to December frequently were unaccompanied by adults and sometimes attempted to repair the dams in rudimentary fashion. The erratic fashion of these episodes, with regular abandonment of the site, left the impression that these young beaver came from outside the study area and were caught while simply "exploring" (Bergerud and Miller 1977).

SUMMARY

A survey of landowner attitudes toward beaver damage and control in Arkansas reported that respondents often perceived control measures such as trapping to be largely ineffective (Wigley 1986), despite having been demonstrated successfully elsewhere (Hill 1976). Such responses probably represent unfamiliarity with successful trapping techniques and that the average landowner likely cannot differentiate between initial populations and immigrants. The Ames study suggests that effective beaver control will seldom be a "one shot deal." By removing a colony from a specific site, beaver habitat is made available. It is likely that immigrants will discover the available habitat and attempt recolonization.

Yet, unfocused control programs that are "aimed at all beaver" and lack the sustained economic incentive to greatly reduce populations over large regions, is only a partial solution and will generally fail to protect specific resources. Furthermore, extirpation of any species from major portions of its range is socially unacceptable.

A successful control program must first define the resource that it is designed to protect (Houston et al. 1992). This establishes a domain that focuses control efforts. There must be a determination of the specific beaver activity that places the resource at risk. This, along with an understanding of beaver biology, can lead to the development of a successful control strategy.

For example, a landowner may have no desire to remove a beaver colony from a farm pond, but cannot tolerate girdling of the surrounding ornamental trees. If the ornamental trees are not damaged, then control can be judged successful. Barriers around individual trees may provide sufficient protection and the control program would be a success.

However, if beaver-caused inundation poses a threat to a large timber tract, then a control program should not be judged by the number of beaver removed, but by the absence of water and survival of the timber. The water can be removed by breaching the dams. To maintain the breaches, a trapping program would be required to catch resident beaver and subsequent immigrants. However, this would not require removal of beaver outside the control domain.

Perhaps, in this case, resident beaver populations could be removed by the first of the growing season. If summer trapping is legal, removal of immigrants would require relatively little effort during the growing season when immigration rates are expected to be lower. In the fall, when the timber becomes dormant, inundation might pose little threat and recolonization could be allowed. Beavers are territorial (Bergerud and Miller 1977) and immigrants might effectively obstruct further immigration per site, lowering the effort needed to remove populations prior to the onset of the next growing season (Houston et al. 1995). However, trapping during the growing season is a physically demanding endeavor, and within the geographical range of the cottonmouth moccasin (*Agkistrodon pisivorous*) requires extreme wariness on the part of workers.

PART THREE—AN ONGOING STORY

The third part of the beaver's story is a work in progress and involves the ongoing drama of a native whose return home has been met with concern by those whose land the beaver shares. And, because much has changed while the beaver was in exile, it will be a story of learning to control the beaver's genuinely negative impacts while recognizing and capitalizing on the equally genuine positive factors. Likely, the beaver is home to stay. As such, control programs will be executed within relatively small domains surrounded by beaver populations. Potential immigration into these domains makes it probable that control programs, or at least vigilance and a preparedness to begin control measures, will be as perpetual as the resource they are designed to protect.

ACKNOWLEDGMENTS

This research was enabled by support from the Hobart Ames Foundation and the University of Tennessee Agricultural Experiment Station. Appreciation is expressed to the landowners adjoining Ames Plantation that allowed their property to be included in the study.

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