November 1995

BEAVER IMPACTS ON TIMBER ON THE CHAUGA RIVER DRAINAGE IN SOUTH CAROLINA

J. Rickie Dams
Department of Forest Resources, Clemson University, Clemson, SC

Judy A. Barnes
South Carolina Department of Natural Resources, Columbia, SC

George E. Ward
Department of Forest Resources, Clemson University, Clemson, SC

David van Leak
Department of Forest Resources, Clemson University, Clemson, SC

David C. Guynn Jr.
Department of Forest Resources, Clemson University, Clemson, SC

See next page for additional authors

BEAVER IMPACTS ON TIMBER ON THE CHAUGA RIVER DRAINAGE IN SOUTH CAROLINA.

J. RICKIE DAMS, Department of Forest Resources, Clemson University, Clemson, SC 29634.

JUDY A. BARNES, South Carolina Department of Natural Resources, Columbia, SC 29202.

GEORGE E. WARD, DAVID VAN LEAK, and DAVID C. GUYNN JR, Department of Forest Resources, Clemson University, Clemson, SC 29634.

C. ANDY DOLLOFF, Southeastern Forest Experiment Station, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

MARK HIJDY, George Washington National Forest, U.S. Forest Service, Harrisburg, VA 51037.

ABSTRACT: Even though beavers (*Castor canadensis carolinensis*) occur over most of the southeastern United States, the impacts of increasing beaver populations on riparian forests within the southern Appalachian mountains are. not been well documented. Long-tenor browsing and inundation by beaver may alter the composition and structure of riparian forests. A survey of 62 streams (74 mi) within the Chauga River drainage in the mountains of South Carolina was conducted during 1991-1992 to determine the level of beaver activity within the drainage and the amount of timber damaged by beaver activities. Thirty-six streams had evidence of significant beaver activity with a total of 5.3 mi (7.2%) affected by beaver. Twenty-six streams (17.3 mi), primarily those with steep gradients and no flood plains, had no evidence of beaver activity. On beaver impacted areas, values of beaver damaged timber averaged $781.27/ac for sawtimber and $36.01/ac for pulpwood While high in terms of volume/acre within impacted riparian areas, timber damage was relatively minor for the entire drainage because of the small area (49.2 ac) affected.

Proc. East. Wild]. Damage Mgmt. Conf. 7:177-186. 1997.

Beavers occupied the entire state of South Carolina prior to European settlement, but populations were eliminated from South Carolina by the early 1800s (Salyer 1946, Golley 1966). In 1940 and 1950, beaver were reintroduced into South Carolina in Chesterfield County in the upper coastal plain on the North Carolina border and in Aiken County in the lower Piedmont on the Georgia border, respectively. During the 1950s, beaver probably migrated into South Carolina from Georgia. By 1966, 12 of the state's 46 counties were inhabited by beaver (Golley 1966); 26 counties had established beaver colonies by 1974 (Hair and Woodward 1974). Presently, beaver occur in all counties of South Carolina (J. Witt, South Carolina Wildlife Marine Resources Department, pets. comet.).

Although impacts of beaver activities on coastal plain and piedmont habitats are well documented (Goodbee and Price 1975, Hill 1976, Woodward 1977, Amer et al. 1969), effects of beaver impact on riparian forests in the Southern Appalachians water sheds are lacking. Therefore, a survey of streams in the Chauga drainage was initiated to:

1. inventory beaver impacts on streams within the Chauga River drainage;
2. determine the timber damage caused by beaver activities along these streams.

The objective of this paper is to report the results of that inventory.

METHODS

Study Area

The Chauga River drainage is located in Oconee County in northwestern South Carolina. The area has a temperate climate, with warm summers and mild winters. Temperatures range from an average maximum temperature of approximately 97° F in mid-summer to an average minimum midwinter temperature of 7° F. The average mean annual temperature is 58° F. Precipitation averages 63 in, with slight peaks in midsummer and winter months (U.S.D.C. Weather Bureau 1955-1987).

The study area included all streams within the upper Chauga River drainage including the Chauga river, from the uppermost headwaters (1900 ft elevation) downslope to the southern boundary of the Sumter National Forest at Cobb's Bridge (820 ft elevation). Topography includes steep mountainous ridges and low rolling hills. Stream gradients are generally gradual with occasional waterfalls, cascades and steep gradients. Overstories of the riparian forests are dominated by yellow poplar (Liriodendron tuli pifera , hemlock k (Tsuga canadensis , shortleaf pine **(Emus** echinata , white oak

ercus albs , and red maple (Acer rubrum) Understories are predominately dogwood Cornus florida and rhododendron (Rhododendron maximum (Ward 1993).

Oconee County was 1 of the 12 counties reported by Golley (1966) to have beavers in 1966. In 1962, beaver were reported in Franklin County, Georgia, located across the Chattooga River from Oconee County, and it is likely that beaver moved into Oconee County during the early to mid sixties from this area. A 1974 survey of 25 landowners in Oconee County reported beavers had been on their property for a period of approximately 10 years (Woodward 1977). From these reports, it is assumed that beavers have been on the study site for 30-35 years.

Stream Inventory and Damage Assessment

From July 1991 through May 1992, an on. ground survey of all streams within the Chauga River drainage was conducted to document beaver activity (Barnes 1993). Streams were surveyed from mouth to headwaters >_ 3 ft wide. Distances were measured with a Topometric hip chain. Dams and ponds were tallied and mapped as well as lengths, widths, and heights of dams and lengths, widths, and areas of ponds. Beaver dam and pond frequencies were calculated for each stream. Signs of beaver activities, including gnawed, girdled, felled trees, slides, tracks, and burrows and their locations, were noted. The Chauga River, because of its relatively large size, was surveyed from helicopter.

Timber damaged by beaver was estimated on dam sites randomly chosen from the total number of dam sites identified in the initial beaver activity survey (Ward 1993). Two types impoundments (Hair et al. 1978) were identified and sampled: (1) floodplain impoundments which had impoundments wider than the stream channel, and (2) stream channel impoundments which contained dams but no visible impoundments larger than the normal stream width. These 2 types of study sites were located on 26 different tributaries within the upper Chauga River drainage. All beaver-damaged trees within a 66 ft by 6.6 ft strip line positioned perpendicular to the impoundment were tallied. Strip lines were located on both sides of impoundments and ran lengthwise upslope from the impoundment edge. Damaged timber within impoundments were tallied using strip lines which ran perpendicular and across the impounded area of the stream. The first strip lines were located directly behind the dam. Subsequent lines were spaced 33 ft apart. The number of strip lines varied on different sites and was dependent on the distance behind the dam where visible damage stopped.

Within cruise lines, all trees above 1-in dbh (diameter breast high) were recorded. The dbh, merchantable height (bolts or logs) and total height were recorded for trees in the merchantable size class(? 5-in dbh). In the unmerrchantable size class (1-4-in dbh), dbh and total height were recorded.

Minimum requirements for sawtimber were 10-in dbh for pine and 12-in dbh for hardwoods, with minimum top diameters of 8-in and 10-in, respectively. At least 1 log (16 ft of limb-free bole) was required for a tree to be counted as sawtimber. Pulpwood size classes were 5-9-in dbh for pine and 5-11-in dbh for hardwoods, with minimum top diameters of 4-in. Sawtimber and pulpwood volumes of damaged trees for each species were multiplied by stumpage prices to calculate per acre dollar values. Prices were based on recent timber sales on the Sumter National Forest (J. Abercrombie, U.S. Forest Service, pens. comet.). Beaver preferences for certain species, based on value indexes, were determined for all species present (Chabreck 1958).

RESULTS

Stream Survey

Impacted Streams.-

From 199.1-1992, 62 first and second order tributaries (74 mi) within the drainage were inventoried. Streams varied in length from 0.2 to 5.7 mi. Four hundred and thirteen dams and 222 impoundments were recorded on 36 streams (58%) impacted by beaver. Eleven streams (18%) were heavily to severely impacted (17-35 . dams and ponds/mi); 9 streams (15%) were moderately impacted (10-16 dams and ponds/mi) and 16 streams (26%) were slightly impacted (1-9 dams and pondslmi). Twenty-six streams (42%) were not impacted by beaver.

The swiftness and high volume of water flowing in the Chauga river prevented the establishment of dams and ponds on the river. However, there were felled or gnawed trees, slides, tracks and burrows all along the river's banks with the highest activity centered around the mouth of tributaries.

Dams were constructed from a variety of materials. Smaller dams, those less than 1 ft in height, were most often constructed of mud and debris pushed up from stream channels and were located in the narrow headwaters. Larger dams were primarily constructed of woody stems up to 6-in in diameter and 4-6 ft in length. Dams ranged from 3 to 200 ft in length and 0.5 to 6.6 ft in height averaging 21.7 ft in length, 2.6 ft in height, and 4.9 ft in width.

Dam frequencies ranged from 1-29 dams/mi with an average of 7.4 dams/mi. Seven streams had > 16.1 darns/mi. There was a 1.9 dam to pond ratio as not all dams produced ponds. Some dams were too small to create impoundments, some were breached or leaking, and in some cases, dams may have been built to slow water current, but not actually store water (Naiman et al. 198$).

Floodplain impoundments were located behind 222 dams. The rest (n=19I) contained no visible impoundments larger than the normal stream width (stream channel impoundments). Dams without impoundments resulted from washouts, inactivity, or small dams.

Ponds averaged 85.3 ft long, 25.6 ft wide and covered an average of 0.07 ac. They ranged in length from 3 to 394 ft and in width from 3-249 ft. The largest pond covered 0.57 ac. Depths ranged from 0.7-6.9 ft with an average of 2.6 ft. Ponds tended to be smaller during the warmer months due to lower water levels and reduction in dam construction and maintenance by beaver. A pond's zone of influence in winter was usually larger and was evident in spring and summer by visible water lines, exposed mud flats, and hydrophytic vegetation. Beaver impacted streams averaged 3.9 ponds/mi with a range of 0-20.9 ponds/mi. The highest pond frequency (20.9 ponds/mi) occurred on 2 streams.

Assuming a riparian zone width of 66 ft, areas of the riparian forest for stream channel impoundments ranged from 0.065 to 0.248 ac and averaged 0.125 ac (n=15). The riparian zone for floodplain impoundments averaged 0.245 ac (n=21) with a range of 0.084 ac to 0.583 ac.

Thirty-four woody species were identified within the riparian forest. Red maple, dogwood, hemlock, and rhododendron were most numerous with > 10% of total stems represented by each of these species. Tree basal area averaged 154.6 ftzlac. Yellow poplar and hemlock had the highest basal areas with 46.4 and 21.2 ft/ac, respectively, while shortleaf pine, white oak, and red maple had basal areas > 10 ft Jac. Tree diameters ranged from 1-32 in dbh Trees >_ 20 in dbh were recorded for yellow poplar, hemlock, shortleaf pine, and several oak species

Quercus sp).

Non-Impacted Streams.-

Twenty-six tributaries (42%) showed no evidence of beaver activity. These streams generally had steeper gradients and narrow stream channels. Mean average slope, as determined from topographic maps, of these 26 streams was 6.5%, while mean average slope for the 36 impacted streams was 4.3%. Gradients, where impact was heaviest, were _<_2% (Taylor 1993). Steep gradients are major deterrents to beaver occupancy, regardless of the quantity of the food available (Reid 1952, Rutherford 1955, Retzer et al. 1956, Naiman et al. 1986).

Areas of Beaver Damage

Within the assumed riparian forest width of floodplain impoundments, areas with beaver damage averaged 0.165 ac with a range of 0.012 ac to 0.551 ac. Areas of beaver influence for stream channel impoundments averaged 0.065 ac and ranged from 0.005 ac to 0.099 ac. Average distance of beaver damage was 76 ft (both sides of stream).

The total area of actual beaver influence for the entire Chauga River drainage was 49.21 ac, about 3.8% of the riparian forest area (assuming a 66 ft wide riparian zone) along the 62 tributaries. Areas with relatively wide floodplain impoundments accounted for ?5% of impacted areas. Most beaver damage on the Chauga drainage occurred in low gradient, wide floodplain areas where the number dams sometimes exceeded 20/mi (Barnes 1993 Taylor 1993). Total length of tributary streams impacted by beaver in the Chauga drainage w 5.34 miles, about 7.2% of the total length of the 62 streams in the Chauga River drainage (Barnes' 1993).

Timber Damage

Sawtirnber volumes (damaged and undamaged timber) in beaver-impacted areas averaged 9,229 board Chirac for hardwoods and 3,235 board ftlac for pines. Beaver damaged 43% (4,029 board ft/ac) of the hardwood volume and 5% (157 board ft/ac) of the pine volume. Yellow poplar was the dominant sawtimber species (5,836 board ft/ac) and suffered the greatest damage (3,376 board ft/ac) (Table 1). Cherry Prunus serotina and sweetgum (Liquidambarr aciflua were the hardwood species with the greatest relative damage (100 and 77%, respectively), but had relatively small total volumes. Shortleaf pine was the only coniferous species having sawtimber trees damaged by beaver; however, sawtimber-size pines were not common. Shortleaf pine averaged 2,201 board ft/ac but only 157 board ft/ac (7.1%) were damaged.

Pulpwood volumes averaged 7.33 cords/ac for hardwoods and 5.14 cords/ac for conifers. Beaver damaged 45% (3.27 cords/ac) of hardwood pulpwood and 28% { 1.44 cords/ac) of conifer pulpwood Yellow poplar had the highest amount of pulpwood damage with 1.52 cords/ac (Table 2), although hemlock had the greatest total pulpwood volume (damaged and undamaged timber) of any species. Hemlock often formed dense stands of pulpwood-size trees in the understory within the riparian zone. Hemlock is generally included with pine when timber sales are conducted in this region.

Volumes, both total and damaged/ac, varied widely, as indicated by large standard errors. Small numbers of sample trees for some species and varying site conditions contributed to this high variability.

Presence and Use of Species

Twenty-one of 34 woody species inventoried (62%) in impacted areas were damaged by beaver. Beaver preference, based on value indexes (VI), revealed that dogwood was the most preferred species (VI=647) (Table 3). Yellow poplar was second (VI=492), and the most preferred of commercially important species. Over half of yellow poplar steins were damaged by beaver. Rhododendron, hazel alder Alnus serrulata , and red maple ranked third, fourth and fifth, respectively. Species not utilized by beaver were sparsely distributed and occurred in small numbers.

Diameter Class Distribution of Beaver Damage

Twenty-six percent of all tree stems in impacted areas were damaged by beaver activities. Most damage was due to felling (42.1%), while girdling accounted for the lowest frequency (7.4%). Of the total basal area of damaged trees, 46.8% was caused by gnawing. Felled trees accounted for only 10.6% of the basal area of damaged trees, while flooding accounted for 25.4% of the basal area of damaged trees.

Approximately 50% of all beaver-damaged trees were in the 1-3-in diameter class, and > 83% were _< 10-in dbh. From an economic standpoint, most damage occurred in pulpwood-size trees. Other studies have found similar results (Chabreck 1958, Bullock and Amer 1985). The largest tree damaged by beaver was a 27-in hemlock killed by flooding.

Over 77% of trees felled by beaver were <3-in in diameter, and 99 percent were _<10-in in diameter. The largest felled tree was a 16-in white oak. Seventy-seven percent of trees gnawed by beaver were <10-in diameter, and evenly distributed among the 1-3 and 4-10-in classes. Trees gnawed by beaver decreased as diameter increased > 10-in. The majority of girdled trees (52.4%) were 4 to 10in diameter. The largest girdled tree was 20-in dbh.

Flood-damaged trees exhibited a bellshaped diameter distribution pattern, slightly skewed toward smaller trees (Figure 5). This trend was expected because all trees in a given area were flooded regardless of diameter, so the diameter distribution of flood-damaged trees mimicked that of the original stand.

Economic Analysis

The value of beaver-damaged sawtimber in impacted areas averaged $781.27/ac, with yellow poplar comprising >86% of the total value (Table 4). Pulpwood damage averaged $36.01/ac (Table 2). Yellow poplar and hemlock had the highest pulpwood losses with $11.79/ac and $10.63/ac, respectively.

Total value of beaver-damaged timber on the entire Chauga River drainage was estimated at $61,048.44 for sawtimber and $2,813.82 for pulpwood. These estimates of timber damage should be viewed as potential losses and not as actual mortality. Damaged figures included trees which had been gnawed, girdled, felled or flooded by beaver activity. Felling, girdling and flooding all result in tree mortality, but gnawing damage may or may not result in tree mortality.

Stumpage prices were specific to the local market in the spring of 1993 and may not be applicable to other regions of the Southern Appalachians. Prices for yellow poplar and oak were high because trees within the riparian zone tend to be of exceptional size and quality. Pine and hardwood pulpwood prices were low ($7.75/cord) due to difficult logging conditions and the set- aside policy of the U. S. Forest Service, which required 80% of timber be sold to local buyers (J. Abercrombie, U.S. Forest Service, pers. comet.). Prices for timber were also lowered by policies requiring buyers to pay for road maintenance and erosion control on logging sites.

DISCUSSION

Most beaver impacts were located in flatter sections of streams (stream gradients of 1-2%) which had relatively wide flood plains. Large areas of beaver influence usually consisted of numerous smaller dams along the stream instead of one large dam, possibly the result of a need for slowing streamflow in these relatively fast flowing mountain streams. Steep gradients and lack of flood plains may have restricted beaver activity on nonimpacted streams.

Average acreage for stream channel and floodplain impoundments were extremely small (0.065 and 0.165 ac), much smaller than those reported by researchers in other regions. For instance, in Mississippi the average beaver impoundment was almost 25 ac (Amer et al. 1969).

Beaver typically reduce dam construction and dam maintenance activities during warmer months (Davis 1984). Many of these streams were surveyed during spring and summer months, so impoundments probably were neither as numerous or extensive as in cooler months. Therefore, dam and pond counts reported here conservatively estimate the actual number that occurred on the site during the entire year.

Dogwood, yellow poplar, rhododendron, alder, and red maple preferred by beaver in this area. *Although s*weetgum is highly preferred by beaver in regions where it occurs frequently (Chabreck 1958, Woodward 1977, Bullock and Amer 1985,), in the Chauga River drainage, sweetgum occurred in small numbers which resulted in a low value index. However, 50% of sweetgum stems had been damaged by beaver. ,

Long term usage of species with the highest value indexes may alter the composition of future stands. In this study, value lost as a result of beaver activity did not include any decreases in land expectation value from species reduction or conversion. Although species alterations may occur on some sites, most impoundments on the Chauga River drainage were not of a permanent nature. Field observations confirmed the temporary status of many beaver impoundments. Similar observations of the cyclical nature of beaver activity have been noted by others (Naiman et al. 1988, Barnes 1993, Taylor 1993).

Value estimates for timber are based on assumption that all trees are harvestable. M timber damage occurred within the prim streamside management area as described in
Mana ement Practices for South Carolina's For
Wetlands, where only selective cutting ' recommended. At present, the U.S. Forest Service does not harvest within this zone. Trees in the riparian zone benefit streams through shading, erosion control, and large organic debris production, functions which may be more valuable on public' lands than timber production. Periodic and selective salvage cuts to remove beaver-damaged timber may be used, while maintaining adequate stocking to ensure that ecological functions of riparian zones are not impaired. This procedure was recommended in other studies (Toole and Krinard 1967, Bullock and Amer 1985).

Valuation of beaver-damaged timber was straight forward because market values were readily attainable. However, beaver also produce nonmarket benefits and losses which are difficult to quantify economically. For example, beaver impoundments convert riparian forests to wetland habitat, resulting in more diverse herpetofauna, avifauna and hydrophytic vegetation, (Edwards 1983, Reese and Hair 1976, Hill 1982) while degrading trout habitat (Taylor 1993, Barnes 1993).

SUMMARY

The Chauga River drainage has been heavily impacted by beaver over the past three decades. Thirty-six of 62 streams had evidence of beaver activity ranging from slight to severe. Heaviest impacts were in streams with low gradients and substantial floodplains. Twenty-six streams were not affected by beaver, primarily because of their steep gradients.

Only a relatively small area (49.21 ac) of the Chauga River drainage suffered timber impacts. Impacted areas averaged 0.065 ac for stream channel impoundments and 0.165 ac for floodplain impoundments. Although Barnes (1993) documented 413 beaver dams in the Chauga River drainage, the small impoundments in this mountainous terrain accounted for relatively minor timber damage.

Dogwood, yellow poplar, and rhododendron were the species most preferred by beaver. Beaver on Chauga River drainage, as in other regions, have a preference for trees in the lower diameter classes. Over 80% of all trees utilized by beaver were _< I O-in in diameter.

Hardwood sawtimber and pulpwood damage exceeded that of conifers on beaver impacted areas, with 4,000 board f)/ac of hardwood damaged by beaver compared to 157 board ft/ac for conifers. Hardwoods suffered more than twice the pulpwood damage of conifers. Yellow poplar had the greatest damage (3,376 board ft/ac of sawtimber and 1.52 cords/ac of pulpwood).

The value of damaged timber in beaver impacted areas averaged $781.27/ac for sawtirnber and $36.01/ac for pulpwood Total value of beaverdamaged timber in the entire Chauga River drainage was $61,048 for sawtimber and $2,813 for pulpwood. Over 84% of economic losses were associated with damage to yellow poplar. Pines suffered negligible amounts of damage.

Potential damage to timber in mountainous terrain is much less than in flatter physiographic regions. Beaver impoundments on the Chauga River drainage were far smaller than those reported in other studies, primarily because of differences in terrain. Timber damaged by beaver, while relatively high in terms of volume/ac, was minor for the entire drainage because of the small area impacted.

LITERATURE CITED

Amer, D. H., J. S. Baker, D. Wesley, and B. Herring. 1969. An inventory and study of beaver impounded water in Mississippi. Proc. SE Assoc. Game and Fish Comm. 23:110-I28.

G. T. Hepp, L. M. Luckett, K. P. Reese, and D. K. Woodward. 1978. Beaver pond ecosystems and their relationships to multiuse natural resource management. In National Symp. on Strategies for the Protection and Management of Floodplain Wetlands and other Riparian Ecosystems. Callaway Gardens, GA.

Barnes, J. A. 1993. Impact of beaver Castor <u>canadensis carolinensis)</u> on trout habitat on the Chauga River Drainage in South Carolina. M. S. Thesis. Clemson Univ., Clemson, SC. 76 p.

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

Chabreck, R H. 1958. Beaver-forest relationship in St. Tammy Parish, Louisiana. J. Wildl. Manage. 22:179-183.

Davis, J. R 1984. Movement and behavior patterns of beaver in the Piedmont of South Carolina. M. S. Thesis. Clemson Univ., Clemson, SC. 83 p.

Edwards, J. K. 1983. Utilization of beaver ponds by small mammals, reptiles and amphibians in the Piedmont of South Carolina. M.S. Thesis. Clemson Univ., Clemson, SC. 38 p.

Golley, F. B. 1966. South Carolina mammals. Univ. Georgia Press. Athens, GA. 181 p.

Goodbee, J. and T. Price. 1975. Beaver damage survey. Georgia For. Comm, 24 p.

Hair, J. D. and D. K. Woodward. 1974. Status of beaver in South Carolina. Presented to South Carolina Forestry Study Committee. 5 p.

Hill, E. P. 1976. Control measures for nuisance beaver in the southeastern United States. Proc. 7th Vertbr. Pest Control Conf. Univ. California, Davis. 13 p.

. 1982. Beaver Castor canadensis pp. 256-281.1n Wild mammals of North America _ Biology, Management and Economics. J. A. Chapman and G.A. Feldhamer (eds.). John Hopkins Univ. Press. NY. 1147 p.

Naiman, R J., J. M. Melillo, and J. E. Hobbie. 1986. Eco-system alteration of boreal forest streams by beaver Castor canadensis). Ecology 67:1254-1269.

C. A. Johnston, and J. C. Kelley. 1988. Alteration of North American streams by beaver. BioScience 38:753-762.

Reese, K. P. and J. D. Hair. 1976. Avian species diversity in relation to beaver pond habitats in the Piedmont region of South Carolina. Proc. S.E. Assoc. Fish and Wildl. Agencies Conf: 30:437-447.

Reid, K. A. 1952. Effects of beaver on trout waters. Penn. Angler. 21:6-7.

Retzer, J. L., H. M. Swope, J. D. Remington, and W. H. Rutherford. 1956. Suitability of physical factors for beaver management in the Rocky Mountains of Colorado. Colorado Dept. Game, Fish and Parks, Tech. Bull. 2:1-32.

Rutherford, W. H. 1955. Wildlife and environmental relationships of beavers in Colorado forests. J. For. 53:803-806.

Salyer, J. C. 1946. The Carolina beaver: a vanishing species? J. Mamm. 27:331-335.

Taylor, G. B. 1993. Impacts of beaver Castor canadensis carolinensis) on riparian ecosystems in the Chauga River drainage. M. S. Thesis. Clemson Univ., Clemson, 5C. 79 p.

Toole, E. R and R M. Krinard. 1967. Decay in beaver-damaged southern hardwoods. For. Sci. 13:316-318.

United States Department of Commerce. Weather Bureau, South Carolina Section. 19551987. Vols. 58-90. Ashville, NC.

Ward, G. E. 1993. Impacts of beaver on timber damage of riparian zones in the Chauga river drainage. M. S. Theses. Clemson Univ., Clemson, SC. 48 p.

Woodward, D. K 1977. The status and ecology of the beaver Castor canadensis carolinensis) in South Carolina with emphasis on the Piedmont region. M.S. Thesis. Clemson Univ., Clemson, SC. 208 p.

Table 1. Total and beaver-damaged sawtimber volumes/ac by species on the Chauga River drainage in the mountains of South Carolina (1992).

Species	Total volume (bd ft Int 1/4)	Damaged volume (bd ft Int 1/4)	Percent Damage
Yellow Poplar	5836	3376	57.8
White Oak	1592	160	10.1
Scarlet Oak (Q. coccinea	580	0	0.0
Northern Red Oak (Q. rubra322		0	0.0
Sweetgum	434	333	76.7
Beech (Fagus andifolia	374	69	18.4
Black Cherry	91	91	100.0
Shortleaf Pine	2201	157	7.1
White Pine (P_. strobus	399	0	0.0
Hemlock	635	0	0.0
Hardwood Total	9229	4029	43.7
Conifer Total	3235	157	4.9

Table 2. Total and beaver-damaged pulpwood volumes/ac by species on the Chauga River drainage in the mountains of South Carolina (1992).

	Total volume Percent		Damaged volume
Yellow Poplar	2.37	1.52	64.2
Red Maple	1.67	0.94	56.4
Sourwood	0.65	0.05	8.3
White Oak	0.59	. 0.17	28.3
Beech	0.48	0.06	11.6
Sweetgum	0.28	0.00	0.0
Dogwood	0.24	0.16	67.5
River Birch	0.22	0.22	100.0
Hickory	0.20	0.10	49.3
Hemlock	3.97	1.37	34.5
Shortleaf Pine	0.59	0.06	10.0
Virginia Pine	0.40	0.00	0.0
White Pine	0.19	0.00	0.0

"Nine species with < 0.15 cords/ac total. volume are not listed.

Table 3. The 10 woody species most preferred by beaver based on value indexes within the Chauga River drainage in the mountains of South Carolina (1992).

Species°	Percentage of total	Percentage used	Value index
Dogwood	11.5	56.3	647
Yellow Poplar	9.2	53.5	492
Rhododendron	11.2	19.5	218
Alder	4.8	37.7	181
Red Maple	13.2	11.0	145
Hemlock	10.8	7.6	82
Sweetgum	1.1	50.0	55
Shortleaf Pine	2.3	20.0	46
White Oak	2.6	14.3	37
Sourwood	7.4	4.9	36

Table 4. Average value/ac of timber damaged by beaver for the Chauga River drainage in the mountains of South Carolina (1992).

Species	Sawtimber value/ac	Pulpwood values/ac
Yellow Poplar	675.20	11.79
White Oak	32.00	1.29
Sweetgum	39.36	
Beech	3.93	0.43
Black Cherry	5.19	
Shortleaf Pine	25.59	
Sourwood		0.42
Red Maple		7.30
Dogwood		1,26
River Birch		1.67
Hickory		0.78
Northern red oak		0.20
American Holly		0.24
Hemlock		10.63
Total	781.27	36.01