BEAVER REOCCUPATION AND AN ANALYSIS OF THE OTTER NICHE IN GREAT SMOKY MOUNTAINS NATIONAL PARK

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ABSTRACT

Beaver (Castor canadensis) reoccupied Great Smoky Mountains National Park in 1966 after an absence of 100 to 200 years. Beaver inhabit only streams with gradients less than 3.4%, and even in these situations, waters are not dammable, and beaver are bank dwellers. Beaver will have little impact in the park since few dam sites occur and their utilization rates on streamside vegetation is low. Beaver may increase marshy habitat in the park and ultimately benefit several threatened and endangered plants. Otter (Lutra canadensis) disappeared from the park the same year it was created in 1936. Only 144 kilometers of potential otter waterway exists near the park periphery in four disjunct locations, suggesting that the park alone could not support a self-sustaining otter population.

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INTRODUCTION

A number of large and medium-sized mammals were extirpated from the area now encompassing Great Smoky Mountains National Park prior to its establishment in 1936. Beaver (Castor canadensis), otter (Lutra canadensis), grey wolf (Canis lupis), and mountain lions (Felis concolor) were all common in the area when white man first arrived in the late 1700's (Kellogg 1939, Williams 1927). A limited number of fisher (Martes pennati) and elk (Cervus canadensis) also occurred during this period at the southern extremity of their former ranges. All were gone by the 1930's and, in addition, white-tailed deer (Odocoileus virginianus) and black bear (Ursus americanus) were greatly reduced by uncontrolled hunting and trapping and restricted to the remote central portions of the park. Beaver later expanded their ranges in Tennessee and North Carolina due to protection and stockings. They reentered Great Smoky Mountains National Park in 1966. This paper describes the beaver reoccupation, their utilization of stream habitats and woody plants, and the integrity of the otter niche in the park.

STUDY AREA

Precipitation in Great Smoky Mountains National Park exceeds 200 centimeters per year at the higher elevations, and flowing water is abundant in steep, narrow valleys. A total of 333 streams occur in the park. The majority originate near the central ridgeline of the park between 1,219 and 1,524 meters and flow toward the boundaries, leaving the park at 259 to 701 meters. Stream gradients are high; many bottoms are scoured bedrock; falls and cascades are common; and nutrient concentrations are low.

Only at elevations below about 760 meters are pools and riffles common and bottoms more developed. The park is part of the eastern deciduous forest biome. The drainages flow through a variety of cove forests, pine stands, and also successional forests that were once logged. The diversity of vegetation species and forest types in the park is high (Whittaker 1956).

METHODS

We searched for historical records of beaver and otter in park files, publications, and old journals. We also interviewed local residents and state or federal officials concerning present distributions. The extent of the beaver range was inspected through field surveys. Woody species utilization by beaver was studied in five drainages by recording the species of each tree barked, girdled, or felled. In addition, the availability and preference of woody vegetation by beaver was studied on an 0.83 kilometer section of Hazel Creek. All woody stems within easy access of beaver (four meters from the creek bank) were tabulated. Percent abundance and percent utilization of each plant species was calculated and then combined to yield a value index following Chabreck (1958). We recorded all woody stems as utilized, regardless of their ultimate disposition for dams, lodges, or food (Aldous 1938). The otter niche was evaluated through a review of parkwide fish surveys conducted from 1930 to 1959 (Hazard and King 1932, Hubbs 1940, Lennon 1961), calculation of stream gradients (reported as percent slope), and field inspections.

RESULTS AND DISCUSSION

History and Status of Beaver

Beaver were well distributed over the entire state of Tennessee in the 1700's (Kellogg 1939). Because of uncontrolled trapping, however, the species was extirpated in the eastern half of the state by 1880 and at that time was found in only Hardin, Wayne, and Lake Counties in western Tennessee (Rhoads 1896, Ganier 1928, Salyer 1946, Shultz 1954). We found no documentation of beaver in the area now encompassing the park; however, in 1762 it was reported to be common in the Little Tennessee River just three kilometers from the present park boundaries (Williams 1927), and it may have occurred in the park at that time.

Beaver have increased tremendously in both Tennessee and North Carolina from 1940 to the present due to a series of transplants and greater protection of the remaining individuals. Beaver were reintroduced to the Sandhills National Wildlife Management Area in North Carolina in 1940; and in 1950-53, releases were made in Nash, Person, and Henderson Counties (Taylor 1953). In Tennessee, beaver were reintroduced into Union and Carter Counties in 1952 and to Campbell County in 1978. In 1966 beaver reoccupied Great Smoky Mountains National Park from western North Carolina. The source of these animals is not clear. Expanding beaver populations now exist only 35 kilometers west and 58 kilometers north of the park in Tennessee. Scattered beaver sign and one dam have occurred recently on the Tennessee side of the park (Metcalf Bottoms in 1970, Little River in 1975, Greenbrier in 1978, Panther Creek in 1979), and reoccupation of that side of the park is imminent.

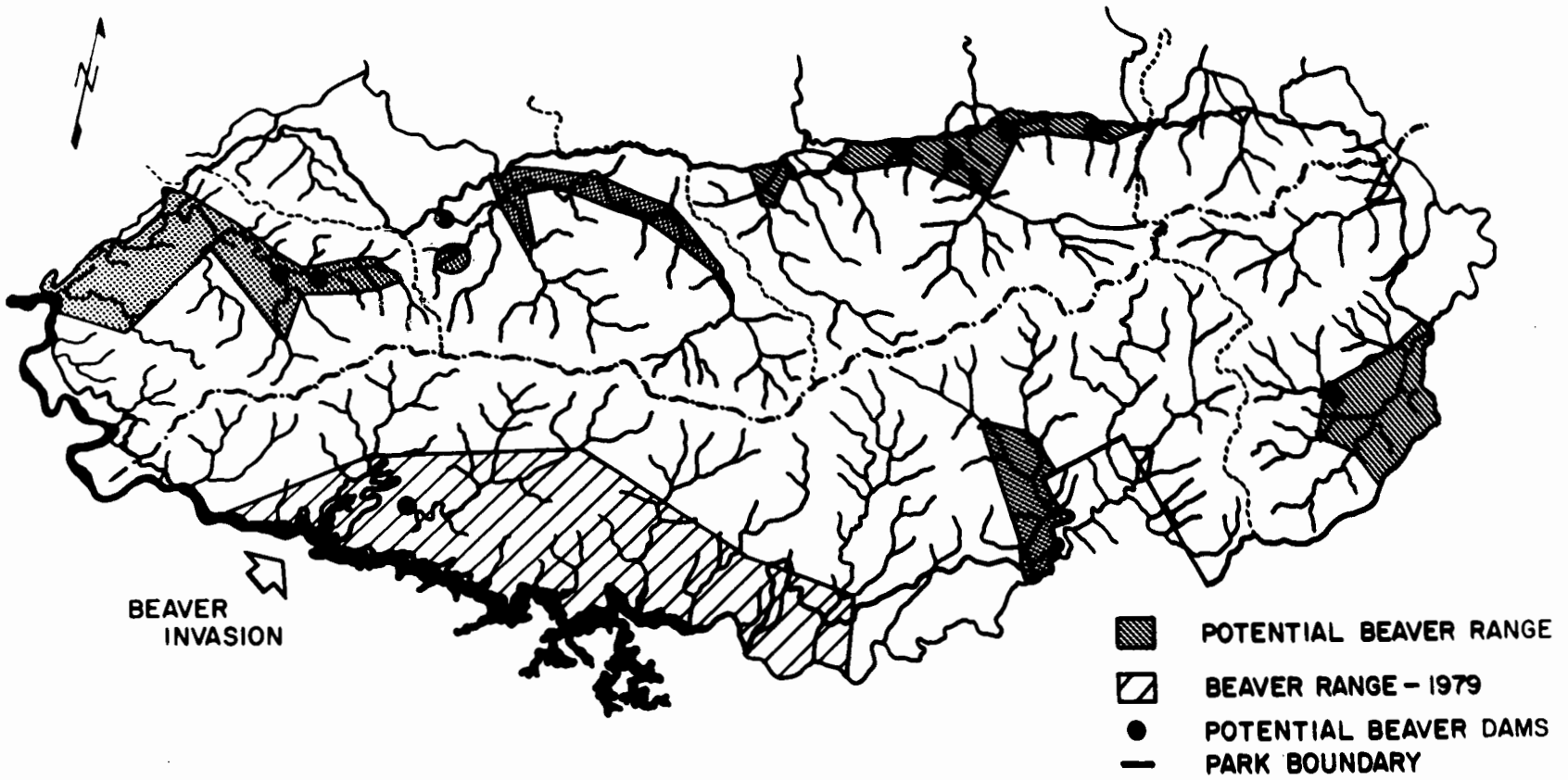

Fig. 1. Beaver range in Great Smoky Mountains National Park in 1979 and potential beaver range and dam sites.

In 1979, beaver occupied 31 kilometers of five major drainages on the North Carolina side of Great Smoky Mountains National Park. Their reoccupation averaged 0.4 drainages and 2.4 kilometers of waterway per year. Another 113 kilometers of potentially habitable waterways exist for beaver, 17.4 in the North Carolina portions and 95.8 in the Tennessee portions of Great Smoky Mountains National Park (Fig. 1). The major limitation for beaver range in the park is the steep gradients of the streams. Within the five occupied drainages, resident populations occur where the average percent slope of the stream is 2.2% (range 1.5 - 3.0, SD = 0.7), and transient use occurs where the average slope is 3.4% (range 3.1 - 4.0, SD = 0.4). Even in the range of 2%, the streams are too fast for dams, and except in occasional slow side tributaries (Fig. 1), all beaver live in bank dens or burrows.

Woody Plant Utilization by Beaver

Beaver utilized 28% of 951 woody stems available in the intensive study site, including 17 of the 27 plant species present (Table 1). The highest preference was shown for black birch (Betula lenta) and dogwood (Cornus florida). The value index was also highest for dogwood, and high (over 50 - Chabreck 1958) for yellow poplar (Liriodendron tulipifera), black birch, yellow birch (Betula lutea), oaks (Quercuss spp.), sycamore (Platanus occidentalis), ironwood (Carpinus caroliniana), beech (Fagus grandifolia), witch (hamamelis virginiana), hemlock (Tsuga canadensis), and alder (Alnus serrulata).

Beaver food habits vary greatly between areas, depending upon the plant species available (Northcott 1971, Jenkins 1975). A great diversity of

Table 1. Utilization of woody species by beaver in six drainages in Great Smoky Mountains National Park and a comparison of use and availability in one site.

Species	Use in Six Drainages		Intensive Study Site				
	Aggregate Average (of all species) Utilization	Percent of Streams	Percent Available	X	Percent of Individual Species Utilized	=	Value Index
Dogwood (*Cornus florida*)	11.8	50	17.6		61		1074
Poplar (*Liriodendron tulipifera*)	11.4	83	8.4		43		361
Black birch (*Betula lenta*)	4.4	50	4.5		79		355
Yellow birch (*Betula lutea*)	6.1	50	6.2		35		217
Oaks (*Quercus* spp.)	6.1	67	8.2		20		164
Sycamore (*Platanus occidentalis*)	2.7	67	4.7		33		155
Ironwood (*Carpinus caroliniana*)	12.2	50	2.0		47		94
Beech (*Fagus grandifolia*)	3.75	33	22.6		36		94
Witch Hazel (*Hamamelis virginiana*)	--	--	5.3		14		74
Hemlock (*Tsuga canadensis*)	1.7	33	5.5		11		61
Alder (*Alnus serrulata*)	2.8	50	5.8		9		52
Magnolia (*Magnolia acuminata*)	--	--	1.5		21		32
Pepperbush (*Clethra acuminata*)	--	--	3.4		9		31
Ash (*Fraxinus* spp.)	--	--	1.5		7		11
Sassafras (*Sassafras albidum*)	--	--	1.3		8		10

Table 1. (Continued)

Species	Use in Six Drainages		Intensive Study Site				
	Aggregate Average (of all species) Utilization	Percent of Streams	Percent Available	X	Percent of Individual Species Utilized	=	Value Index
Red maple (*Acer rubrum*)	1.6	33	11.0		1		10
Cherry (*Prunus* spp.)	1.8	33	.9		11		10
Willow (*Salix* spp.)	14.8	33	--		--		--
Silverbell (*Halesia carolina*)	5.6	50	--		--		--
Rhododendron (*Rhododendron* spp.)	3.7	33	--		--		--
Wild hydrangea (*Hydrangea arborescens*)	3.3	17	--		--		--
Hickory (*Carya* spp.)	2.8	33	--		--		--
Grape (*Vitus* spp.)	1.0	17	--		--		--
Miscellaneous	2.4	--	tr		0		0
Virburnum spp.	--	--	3.6		0		0
Locust (*Robinia pseudocacia*)	--	--	2.5		0		0
White pine (*Pinus strobus*)	--	--	2.5		0		0
TOTAL STEMS	492		951		270		

deciduous trees and shrubs were important to beaver in the park, a trend that is also found in some other beaver areas in the East (Crawford et al. 1976, Jenkins 1975). The utilization rate for preferred species was considerably lower than the 100% reported in other studies (Brenner 1962, Hall 1960, Northcott 1971, Crawford et al. 1976), apparently because of the fast water and resultant low density of beavers.

Ecological Impact of Beaver

The ecological impacts of beaver reoccupying Great Smoky Mountains National Park will be minimal. Only nine sites in the park appear to be dammable by beaver, and most of the aquatic effects of beaver, such as warming water during summer (Reid 1952, Adams 1953) and silting (Gard 1961) are restricted to their ponds. Present stream densities of beaver are apparently low, and woody utilization rates of streamside vegetation are relatively low. Beaver will not affect the park's threatened brook trout (Salvelinus fontinalis) populations since they are now restricted to streams with gradients greater than 15%, and beaver are found only below 3.4%.

Wetland habitats are very restricted in Great Smoky Mountains National Park, occurring mostly along Abrams Creek in Cades Cove. In this area, beaver dams will very likely be built. On a parkwide basis, 40 plant species are primarily restricted to wet habitats in Cades Cove, and of those, five species (Campanula aparahoides, Agrostis borealis, Carex trisperma, Woodwardia virginica, and Habenaria peramoena) are on either the Tennessee or North Carolina or both state lists of endangered plants.

Beaver dams will ultimately increase marsh land habitat in this area, but a single beaver dam could initially inundate and destroy isolated plant populations.

Beaver occupation of the park should improve conditions for otter. The changes in bottom organisms and fish populations that occur with beaver dams (Gard 1961) often benefit otter, and otter inhabit old beaver dens or houses. Otter are often caught in beaver sets (Lagler and Ostenson 1942, Ryder 1955, Bottorff et al. 1976), indicating their association, and otter populations increase when beaver do (Bottoroff et al. 1976). In addition, beaver dams often contribute to habitat and wildlife diversity (Rutherford 1955, Gard 1961, Reese and Hair 1976) and beavers were apparently part of the original native fauna of the park.

History of Otter

River otter were reported common in the rivers of East Tennessee, including the Tellico River only 3.2 kilometers from the park, by Lt. Henry Timberlake in 1762 (Williams 1927). In the late 1800's, Rhoads (1896) still considered the otter a rare but constant inhabitant of all the larger watercourses of Tennessee. By the 1930's, however, when the park was established, uncontrolled trapping had nearly eliminated the otter. Within the park area in 1927, a group of three otter were observed in Cataloochee; one was trapped on Cataloochee Creek in 1930; a pair was seen near Mount Sterling in 1931; one was seen several different times at the same location near Elkmont in 1934; and one was sighted in Cataloochee Creek in 1936 (A. Stupka and W. King

journals, park files). The last reliable sighting was made the same year the park was established.

The otter has continued to decline in Tennessee (Shultz 1954). In 1978, less than 100 otter, a state endangered species, inhabited portions of the Sequatchie, Hatchie, Tuscumbia, Buffalo, and Duck Rivers of Tennessee (Bill Yambert and Don Hammer, personal correspondence). The nearest Tennessee otter are 370 kilometers west of Great Smoky Mountains National Park. In North Carolina, viable otter populations inhabit the Piedmont and coastal areas, beginning about 240 kilometers east of the park. Otter are legally trapped east of Highway No. 1 in North Carolina.

The Otter Niche

A total of approximately 144 kilometers of stream in 18 drainages could potentially be occupied by otter in the park. This presumes that all waters habitable by beaver (< 3.4% slope) are also habitable by otter (Fig. 1). Otter are found in slow water along rivers, streams, lakes, and marshes where water quality is high and fish and aquatic life abundant (Bottorff et al. 1976). In rivers and streams, deep pools with slow-moving water and soft bottoms are important. The slower park waters meet these criteria and they do not freeze over in the winter.

The aquatic life available to otter in low elevation park streams is listed in Table 2, along with their instance of use by otter in other areas. All the food habits studies consulted listed fish as the most important food, with crayfish (Crustaceans) and amphibians usually being important. Six studies found forage fish to be the most important fish

Table 2. Frequency and abundance of potential aquatic foods for otter at low elevations in Great Smoky Mountains National Park (Hazard and King 1932, Hubbs 1940, Lennon 1961). Only fish collected at 5 or more of the 67 collection sites are listed. The eight sources for otter food habits are listed in the text.
Abundance of fish at low elevations in the park are: 1 = rare, 2 = sporadic, 3 = common, 4 = abundant.
Importance in otter diets: tr = trace, 1 = 1 - 25% of diet, 2 = 26 - 50% of diet.

	Abundance in park	% Frequency at 67 sites	Relative importance in otter diets	No. studies reporting as a food item
SALMONIDAE - Sport fish			1	5
Rainbow trout (*Salmo gairdneri*)	4	31		
Brook trout (*Salvelinus fontinalis*)	2	9		3
Brown trout (*Salmo trutta*)	2	0		2
CENTRARCHIDAE - Pan fish			2	6
Small-mouth bass (*Micropterus dolomieuii*)	4	40		1
Rock bass (*Ambloplites rupestris*)	3	27		2
Bluegill (*Lepomis macrochirus*)	1	9		1
Longear sunfish (*Lepomis megaletis*)	1	9		4
CATOSTOMIDAE - Forage fish			2	6
Northern hog sucker (*Hypentelium nigricana*)	4	64		
Red horses (*Moxostoma* spp.) 2 spp.	1-3	37		1
White sucker (*Catastoma commersoni*)	3	16		4

Table 2. (Continued)

	Abundance in park	% Frequency at 67 sites	Relative importance in otter diets	No. studies reporting as a food item
CYPRINIDAE				
Shiners (*Notropis* spp.) 4 spp.	1-4	84		4
Stone roller (*Campostoma anomalum*)	4	57		
River chub (*Nocomis micropogon*)	4	55		
Daces (*Rhinichthys* spp.) 2 spp.	4	54		3
Chubs (*Hybopsis* spp.) 3 spp.	3	18		
Creek chub (*Semotilus atromaculatus*)	3	10		2
PERCIDAE			1	5
Darters (*Etheostoma* spp.) 5 spp.	1-3	43		
COTTIDAE			1	3
Sculpins (*Cottus* spp.) 2 spp.	3-4	34		
CRUSTACEANS, esp. crayfish	4	Localized	2	8
AMPHIBIA, esp. frogs and large salamanders	4	Widespread	1	8
BIRDS, esp. waterfowl	2	Localized	tr	5
GASTEROPODA (mollusks)	1	?	tr	2
INSECTS	3	Widespread	1	5

Table 2. (Continued)

	Abundance in park	% Frequency at 67 sites	Relative importance in otter diets	No. studies reporting as a food item
Not found in park:				
ICTALURIDAE			1	6
UMBRIDAE			1	3
ESOCIDAE			1	4
CYPERINODONTIDAE			1	2

to otter (Lagler and Ostenson 1942, Wilson 1954, Hamilton 1961, McDaniel 1963, Sheldon and Toll 1964, Knudson and Hale 1968); one found panfish (Centrachidae) (Greer 1955), and another author found trout to be the most important fish group (Toweill 1974). In Great Smoky Mountains National Park, forage fish are the most abundant group, followed by Centrachids and then by trout (Table 2). The only significant otter foods not present are the fish families Ictaluridae, Umbridae, Cyperinodontidae, and Esocidae. Waterfowl are not common in the park, and crayfish, a very frequent otter food, are more common in slower, silty waters near the park boundary.

All otter foods become more frequent and more abundant near the boundary of the park, where stream gradients are reduced. Here, deep pools and marshes form and bottoms are silty instead of gravel or bedrock. Densities of otter in similar, cold-water mountain waters in Idaho were one otter per 3.6 kilometers of waterway (Melquist and Hornocker 1977), suggesting that the park might support less than 37 otter in four disjunct areas. Otter often remained in small areas: however, long movements of 31 and 35 kilometers were recorded (Melquist and Hornocker 1977), suggesting that, in the park, only Abrams Creek (32 kilometers), the longest slow stream, could provide any security for otter. The park alone, without the benefit of waterways adjoining the park that are suitable otter habitat, could not sustain a self-perpetuating otter population. The park could, however, be important to an otter comeback on a regional basis, due to the protection from all trapping and hunting within its boundaries and its high water quality. We speculate that habitat about three times again what the park offers, or

a total of about 430 kilometers of suitable waterways, would be required for a successful return of otter to this area.

Potential Impacts of Otter

If otter returned to the park ecosystem, they would probably take a greater proportion of the most abundant and slower fishes (Ryder 1955, Erlinge 1968)--forage fishes, followed by Centrarchids and then by trout. Some fish population changes have probably occurred since the last parkwide fish survey of 1959, listed in Table 2. In particular, exotic rainbow trout have greatly increased their range to the detriment of some other species, such as the brook trout. Otter might prey more heavily on the abundant rainbow trout, since they prefer active fish prey to less motile crustaceans and amphibians and prefer larger fish (15 - 17 centimeters) to smaller fish (< 15 centimeters) (Erlinge 1968). Otter are very unlikely to prey upon the park's threatened brook trout populations since they now occur only in the upper watersheds above 15% slope and often above natural waterfall barriers. This is a situation unattractive to otter. In addition, otter take less trout than are available to them (Greer 1955, Sheldon and Toll 1964), and their normal densities are so low that their predation on trout is apparently insignificant (Ryder 1964, Sheldon and Toll 1964, Toweill 1974).

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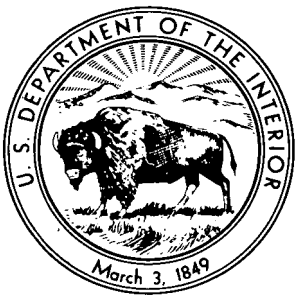

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