To the Graduate Council:

I am submitting herewith a thesis written by Mary C. Miller entitled "Reintroduction of river otters into Great Smoky Mountains National Park." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

Michael R. Pelton, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor
and Dean of The Graduate School

REINTRODUCTION OF RIVER OTTERS
INTO
GREAT SMOKY MOUNTAINS
NATIONAL PARK

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Mary C. Miller

May 1992

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ABSTRACT

Beginning in December 1988, 14 river otters were obtained from South Carolina and Louisiana, implanted with radio transmitters, and released on Little River in Great Smoky Mountains National Park (GSMNP). A total of 896 radio locations were obtained. There were four mortalities.

Five otters established home ranges in Little River. Four otters traveled out of Little River. Of those otters, three established home ranges on the North Carolina side of GSMNP. One otter established a home range in the French Broad River outside of GSMNP. The remaining otter has not been located since its release.

After a brief period of acclimation, otters became either crepuscular or nocturnal. They avoided people by denning and feeding in areas where people were not present.

A total of 75 scats were collected from Abrams Creek, Little River, Little Pigeon River, and Hazel Creek. Scats were analyzed to determine feeding habits. Crayfish and fish were the most utilized prey; northern hog suckers (Hypentelium nigricans) were the most abundant fish found.

Rock crevices, ground burrows, and a log jam were identified as resting sites. The sites were all in close proximity to feeding locations. Eight otters were found in association with other otters on at least one occasion. In 71% of the associations, the interactions took place between

a male and a female. No female to female associations were recorded.

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CHAPTER I

INTRODUCTION

River otters (Lutra canadensis) were once abundant throughout North America (Hamilton 1939). Early explorers found river otters in nearly all waterways (Hall 1981). Because otters were one of the more valuable furbearers, they were intensively harvested (Coues 1877, Hamilton 1939, Caras 1967, Toweill and Tabor 1982, VanGelder 1982). Harvest began in the 1500's in New England (Melquist and Dronkert 1987), and by the year 1700 trappers witnessed a decline in population densities in that region. Because of this decline, trappers shifted their efforts to other areas of the continent. Unregulated harvest throughout North America caused a severe decrease in the abundance of otters (Toweill and Tabor 1982, VanGelder 1982). In addition, human encroachment on otter habitat destroyed riparian areas and decreased the number of waterways suitable for otter existence (VanderWerf 1981, Toweill and Tabor 1982). Also, polluted food chains may have contributed to the extirpation of some populations (VanderWerf 1981, Toweill and Tabor 1982, VanGelder 1982). In the interior United States, where there are fewer wetland areas and thus fewer areas of otter habitat, populations were most severely affected (Polechla 1988).

In recent years, an increased awareness of the status

of endangered and threatened species has been shown by the public. River otter populations were more protected in the twentieth century than in the past, resulting in an increase in otter numbers (Melquist and Dronkert 1987). In the mid 1970s, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed river otters on Appendix II (Endangered Species Scientific Authority 1978). Export of species on Appendix II is permitted only if it is found to be non-detrimental to the species. Member nations of CITES, including the United States and Canada, were required to tag each river otter pelt and record the state or province of origin. Because little was known about river otter status and biology, the addition of lutrines to Appendix II caused a flurry of activity among governmental and educational organizations to study river otter populations (Polechla 1988). Many states in the United States, including Tennessee, found populations to be depleted and even extirpated (Toweill and Tabor 1982). As a result, reintroductions have taken place with varying degrees of success. All but five states in the United States and two Canadian provinces now have river otter populations (Melquist and Dronkert 1987).

River otters were historically found in the streams of what is now Great Smoky Mountains National Park (GSMNP) (Ganier 1928, Linzey and Linzey 1971). Habitat destruction and unregulated harvest caused the population to decline in

numbers (Linzey and Linzey 1971). The last reported sighting was in the Cataloochee area of GSMNP in the early 1900s (Linzey and Linzey 1971).

National Park Service policy allows for the reintroduction of native wildlife species (Wright and Thompson 1935). A study done by Singer et al. (1981) estimated that potential river otter habitat was present in GSMNP. Researchers determined there was ample habitat available for river otters, including forage fish and escape areas. In 1986, 11 river otters were released into Abrams Creek of GSMNP (Griess 1987). The success of that recovery attempt proved that otters from the coastal United States could survive and adapt to the colder streams of this region. Success of that initial effort prompted this study.

Researchers from the National Park Service and the University of Tennessee believed that for river otters to be successfully re-established in GSMNP, they would have to survive in areas of higher human visitation than is currently present around Abrams Creek. Little River was chosen as the second site for a reintroduction attempt. Little River flows from the upper elevations of GSMNP through Townsend, Tennessee, and finally joins the Tennessee River in Knox County. It is an accessible waterway to fisherman, kayakers, tubers and swimmers, as well as researchers. Researchers hoped the accessibility of Little River would facilitate data collection. In addition, the

adaptability of the otters to humans could be more closely evaluated.

The objectives of this study were to:

1. Reintroduce river otters into Little River in Great Smoky Mountains National Park,
2. Determine food habits of otters,
3. Determine home range of otters,
4. Describe resting sites of otters, and
5. Delineate otter-human interactions.

CHAPTER II

STUDY AREA

Great Smoky Mountains National Park

The Great Smoky Mountains are part of the Southern Appalachian Highlands. Within the Southern Appalachian Highlands lies the range of mountains known as the Unaka Mountain Range. This mountain range is part of the Blue Ridge Province (Fenneman 1938). The mountain range's main ridge forms the border of Tennessee and North Carolina and runs northeast to southwest. Great Smoky Mountains National Park is composed of 207,301 ha of steep ridges and narrow valleys, and there are 1,080 km of streams (King and Stupka 1950). Elevations range from 275.3 m at Chilhowee Lake to 2,059 m at Clingman's Dome.

The area now called Great Smoky Mountains National Park (Figure 1) was largely uninhabited in the 1700s. Cherokee Indians lived on the periphery of the Smokies but had little effect on the ecosystem. In the mid-to-late 1700s, settlers began to arrive in greater numbers, causing changes in the landscape. Many areas were cleared for homes and farming practices. In the nineteenth century, logging companies began to operate in the area; by 1935, when the park came under the protection of the federal government, two-thirds of the land had been cut (Pyle 1988).

The climate of GSMNP is warm-temperate rain forest

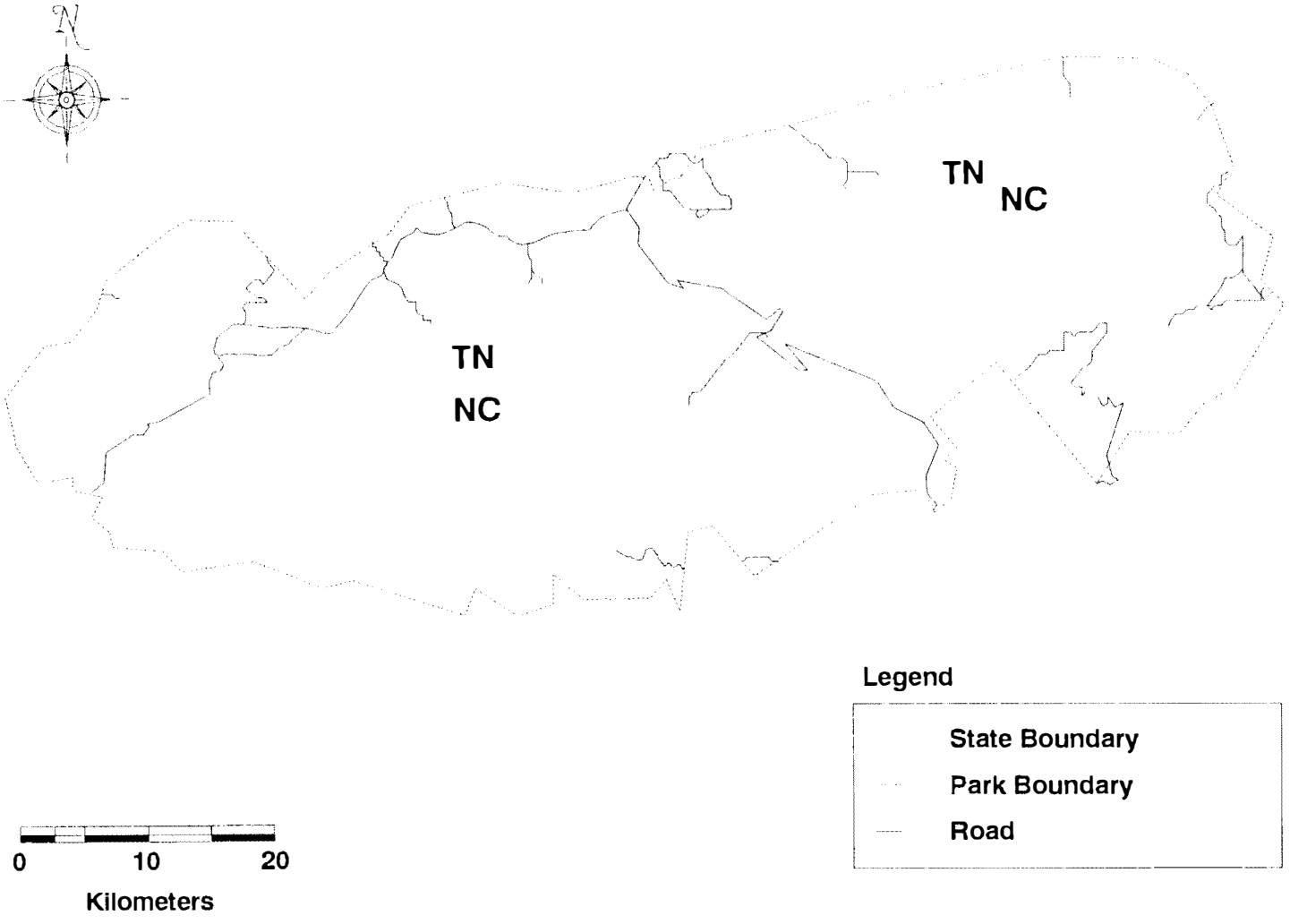


Figure 1. Study area, Great Smoky Mountains National Park.

(Thornnwaite 1948). Annual precipitation varies with elevation from 140 to 200 cm (Stephens 1969). Precipitation also varies through the seasons, with maximum rainfall usually occurring in the month of July and minimum rainfall occurring in September or October.

Most rocks in GSMNP are of sedimentary origin and lack any fossil remains. They are classified as Ocoee Series rocks (King and Stupka 1950).

The major soil types of the park are Ramsey Association soils. Ramsey soils have low water retention, moderate fertility, and medium-to-high acidity (King et al. 1968).

Ambient air temperatures vary with elevation. For example, with every 1,000 m of increased elevation, temperatures decrease approximately 4 C. Warmest weather normally occurs in July or August at 23.9 C, and coldest weather occurs in January or February at 3.3 C (Stephens 1969).

Spruce and fir forests are the dominant cover types at elevations over 1,524 m. More than half of the woody plants in these forests are northern species that reach their southernmost extension in GSMNP. Lower slopes are dominated by a variety of hardwoods. The change in vegetation accompanying the change in elevation is comparable to that seen when traveling northward into Canada (King and Stupka 1950).

The diversity of habitats afforded by GSMNP supports

numerous kinds of plant and animal life. More than 1,300 species of flowering plants are found in GSMNP (King and Stupka 1950). At least 2,400 species of non-flowering plants can be found in the area, including 50 ferns and allies, 230 lichens, 330 mosses and liverworts, and 1,800 fungi (King and Stupka 1950). Sixty mammalian species (including river otters), 130 reptilian species, 200 avian species, 39 amphibian species have been found in GSMNP (King and Stupka 1950). Simbeck (1990) reported 79 fish species have been collected within the Park's boundaries.

Little River Watershed

The East Prong of Little River is located in the middle portion of GSMNP on the Tennessee side. A major part of Little River flows adjacent to a two-lane road that encounters heavy motor traffic at various times of the year. The upper portions of Little River have foot trails adjacent to them.

The East Prong Little River watershed encompasses an area of 15,615 ha, and rises in elevation from 354 m to 2,025 m. The total length of streams in this watershed is 283.3 km. The total length of streams in the Abrams Creek watershed, used as the first otter reintroduction site, is 347.9 km (Parker and Pipes 1990).

The pre-park vegetation disturbance in the Little River watershed was due to corporate logging where mechanized equipment was used. Other disturbances were due to

concentrated settlements. Seventy-nine percent of the Little River watershed was corporately logged. Following logging, 33% of the watershed was burned. Around the time of park establishment, 6% of the watershed was affected by concentrated settlement (Pyle 1988).

CHAPTER III

METHODS

In 1988, a professional trapper in South Carolina was contracted by the University of Tennessee (UTK) to obtain 10 river otters for reintroduction into GSMNP. This trapper was chosen to obtain the otters because he was experienced in trapping and releasing them unharmed. In addition, he could provide the otters at a lower cost than other sources. The South Carolina Wildlife and Marine Resources Department allowed the trapper to obtain otters for UTK outside the normal trapping season. When difficulties resulted in a delay in obtaining the required otters from South Carolina, arrangements were made to purchase the remaining four otters from Louisiana.

Trapping began in December, 1988, in several locations of coastal South Carolina and also in the Great Pee Dee River of South Carolina. Body snares were set in areas where otter presence was obvious. Traps were checked at least once every 24 hours. River otters removed from traps were taken to a holding facility to await transport to Tennessee.

Ground vehicles transported all but four otters to Knoxville. The other four otters were transported by plane.

The trapper in South Carolina notified researchers when otters were available for transport to Knoxville. Surgery

to implant radio transmitters was scheduled at that time. After arriving in Knoxville, otters were held for 12 to 24 hours prior to surgery. In most cases, otters arrived in Knoxville in the evening and were taken directly to the University of Tennessee College of Veterinary Medicine to await surgery the next morning. The otters that were held before surgery were kept in a 3 x 4 m holding enclosure that was bedded with fresh straw. Transport cages were used as den boxes to facilitate removal of otters from the enclosure. The doors of transport cages were wired open to permit exit and entry by otters. To remove the otters from the holding pen, the doors of the transport cages were closed and secured after otters entered the cages.

Before surgery, all otters were visually examined by a veterinarian after being immobilized with ketamine hydrochloride (Ketaset, Bristol-Meyer Co., Syracuse, NY). Researchers recorded morphological measurements (Table 1) and a veterinarian collected blood samples. Most of the otters had no visible injuries or only slight skin abrasions; however, one female had more serious injuries. The injured otter had two broken digits that needed to be amputated.

The approximate age of each otter was identified. The otter's size and the wear of its teeth were the primary methods used in aging; baculum length was used to help age males (Stephenson 1977), and uterine characteristics were

Table 1. Morphological measurements of river otters released in Little River, GSMNP, 1988, 1989, and 1990.

Animal no.	Sex	Weight (kg)	Total length (cm)	Tail length (cm)	Hind foot (cm)	Ear (cm)	Skull length (cm)	Skull width (cm)
550	F	6.8	110.0	40.0	6.1	2.2	11.2	8.3
560	M	5.2	103.5	40.7	6.7	2.2	12.8	8.7
561	M	5.9	106.5	45.0	6.9	2.3	11.8	8.4
580	M	4.6	97.7	38.0	6.4	1.0	13.5	10.4
600	F	4.7	105.6	40.9	5.5	2.1	9.6	10.0
620	M	8.5	122.3	46.0	6.0	2.3	13.9	7.6
601	F	4.4	99.4	37.1	6.4	1.8	10.1	10.4
610	M	7.6	112.2	44.3	6.1	1.8	11.8	10.2
630	F	5.8	106.0	38.0	7.3	1.7	13.0	11.5
640	F	5.7	105.3	37.8	8.0	1.7	12.1	10.0
602	F	6.4	106.0	41.7	7.5	1.9	12.1	8.5
631	M	8.6	121.4	45.0	8.0	2.0	12.9	10.5
780	M	6.6	105.0	37.0	8.8	1.6	12.4	10.4
790	M	6.8	110.0	43.0	8.3	1.7	14.0	9.8
Range	Min	4.4	97.7	37.0	5.5	1.0	9.6	7.6
	Max	8.6	122.3	46.0	8.8	2.3	14.0	11.5
Mean		5.9	107.0	41.1	6.4	1.9	12.0	9.5

used to aid in aging females (Toweill and Tabor 1982). Two females were pregnant when surgery was performed. Fetal measurements were taken to age the fetuses. An embryo approximately 10 days old was found during surgery in one female, and two nearly full-term fetuses were found during surgery in the other female. The fetuses were not removed during surgery to allow normal parturition.

River otters are vaccinated against diseases in many reintroduction attempts. The otters obtained from South Carolina did not receive any vaccinations because it was important to find out whether or not the presence of diseases in GSMNP wildlife would prevent a successful reintroduction of otters. The otters purchased from Louisiana had been given vaccinations for canine and feline distemper and canine rabies before arriving in Knoxville.

Intraperitoneal transmitters (150-151 Mhz, Telonics, Inc., Mesa, AZ) were surgically implanted in all otters using procedures described by Melquist and Hornocker (1979). To avoid any additional stress, the otters were released as soon as possible after surgery. Five otters were released within four hours of surgery. The others were held from 12 hours to five days.

Radio Telemetry

Otters were released at various sites on Little River, and daily radio-tracking was done until the otters appeared to establish home ranges. At this point, tracking was

curtailed to five times per week. A TR-2/150-152 Mhz receiver was used in conjunction with a TS-1 Scanner/Programmer (Telonics, Mesa, AZ) to locate radio equipped otters. The otters located along portions of water where roads are present were found from the ground using a vehicle-mounted whip antenna. Other otters were located by aerial tracking and also by using a two-element H antenna (Springer 1979, Melquist and Hornocker 1983). In most cases, when the otters were found in or near water, it was possible to get accurate locations without triangulation. Ground-to-ground range of transmitters varied due to: (1) topography, (2) whether or not the animal was in a den, and (3) whether or not the animal was in or out of the water.

Dispersal

The farthest distance traveled from the release site was calculated for each otter. This distance was determined by measuring from the release site to the farthest location that each otter traveled. When an otter traveled overland, straight line distance was measured between streams.

Home Range

Length of home range was calculated for each otter. This calculation was made by measuring the length of stream travelled by an otter within the boundaries of its home range. Boundaries were defined by the consistent use of one area by an otter. A test for significant differences

between sexes was done using a t-Test.

Food Habits

Searches for otter scats were made in areas where otters had been located in this study and in the previous GSMNP reintroduction study on Abrams Creek. When scats were found, they were collected for later analysis to determine food habits. Information that was obtained about the scat included location, substrate, distance to water, type of overstory and understory, and season of the year.

Prior to examination, scats were air-dried, then washed through sieves and sorted. Any fragments of bone, scale, or other material that could be identified as a food item was retained. The remaining scat material also was retained in a separate container. Individual food items from otter scats were compared to specimens in the zooarcheological collection housed in UTK's Anthropology Department to determine the species of prey eaten.

Percentage of occurrence was used to calculate food items. The number of scats was divided into the number of occurrences of a food item. Minimum number of individuals for each food item was calculated by adding the elements that were representative of different specimens.

Resting Sites

Dens and resting sites were examined and the following information recorded: the type of resting site, the location, the size of the den entrance, and the distance

from the opening to the water. The overstory and understory also were recorded, as well as the distance to the nearest road or foot trail.

Social Interactions

Interactions between otters were recorded. If otters were within 500 m of each other, they were considered to be in association. The sex of each otter, the date, and the time of day were recorded for each observation.

Otter-Human Interactions

Interactions between otters and humans were delineated by recording when humans were near an otter and if the otter was active or inactive at that time. Activity patterns of otters were useful in determining if any interactions occurred.

CHAPTER IV

RESULTS AND DISCUSSION

Radio Telemetry

Nine river otters obtained from South Carolina were released into GSMNP in 1988 and 1989. Five otters, one from South Carolina and four from Louisiana, were released in 1990. The fates of 13 of the 14 otters in this study were determined (Figure 2); the location of the remaining otter, no. M610, is not known. A total of 896 telemetry locations was recorded (Table 2). Nine otters successfully established home ranges.

The first otters (an adult female no. F550, and an adult male no. M560) were released on 27 December 1988 in the Elkmont area of Little River. Both otters had slight skin abrasions and were treated with antibiotics. Otter no. F550 was pregnant at the time of surgery. For four days, the male was located repeatedly upstream within 2.0 km of the release site within 2 km. He was not located again until 10 January 1989 (10-day interval). At that time, he was found dead on a ridge in the Little Pigeon River drainage which is adjacent to the Little River drainage (Figure 3). He had traveled at least 0.8 km overland, and the nearest water was Flint Rock Branch 0.7 km away. A necropsy performed on no. M560 at the University of Tennessee College of Veterinary Medicine found no

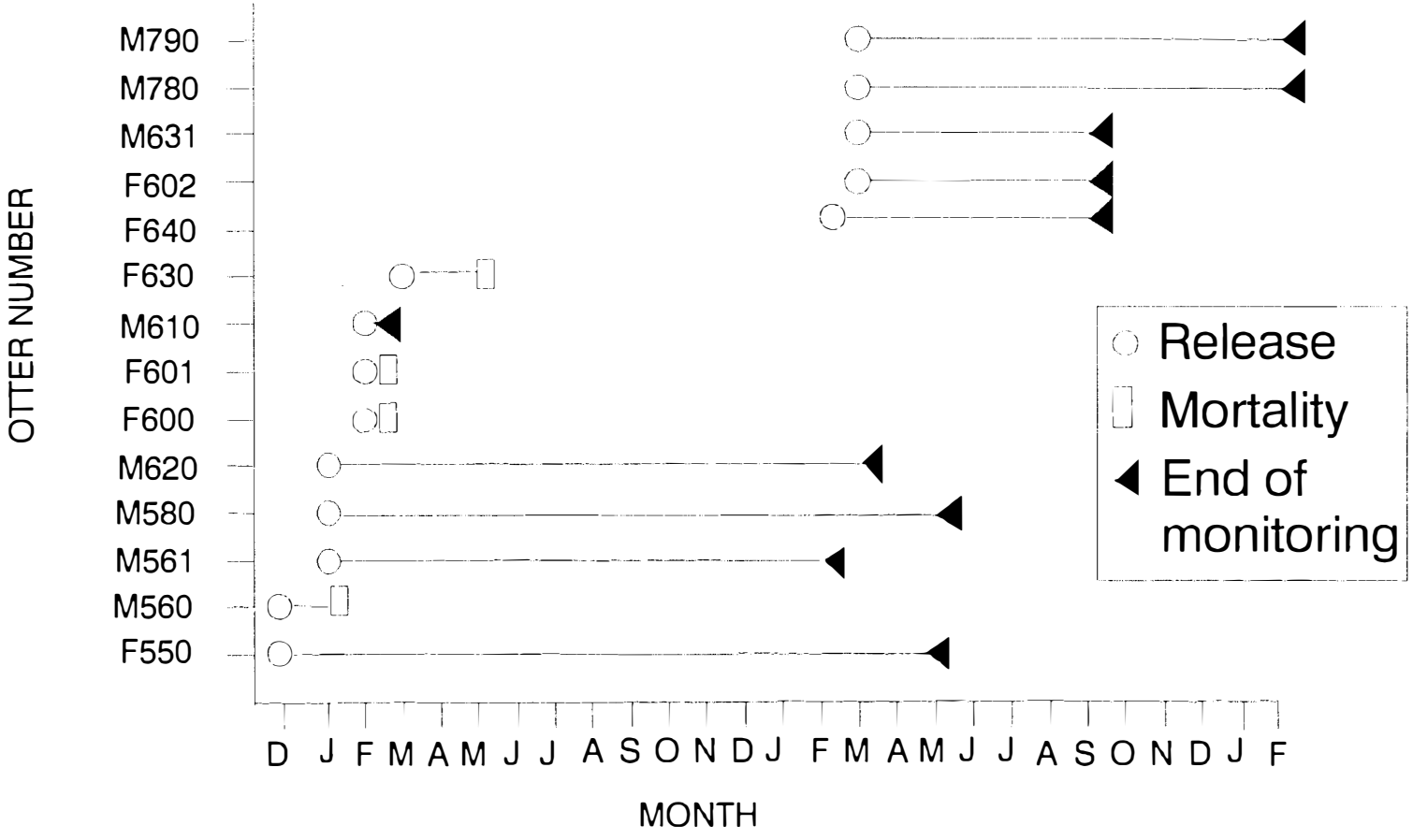


Figure 2. Summary of radio telemetry locations for river otters released in Little River, GSMNP, December 1988 to February 1991.

Table 2. Summary of telemetry locations for river otters released on Little River in GSMNP between 28 December 1988 and 23 March 1990.

Animal no.	Sex	No. of locations	Date released	Last location date	Total tracking days
550	F	86	12/28/88	4/02/90	460
560	M	10	12/28/88	1/10/89	13
561	M	181	01/21/89	2/09/90	389
580	M	117	01/21/89	5/01/90	465
620	M	76	01/31/89	4/17/90	441
600	F	6	02/02/89	02/03/89	2
601	F	9	02/16/89	03/15/89	27
610	M	4	02/16/89	02/16/89	1
630	F	23	03/02/89	03/22/89	10
640	F	23	02/05/89	09/07/90	556
602	F	81	03/23/90	09/07/90	168
631	M	94	03/23/90	09/07/90	168
780	M	134	03/23/90	02/09/91	315
790	M	52	03/23/90	02/02/91	308



Figure 3. Locations and probable overland travel route of otter no. M560.

significant lesions but did observe a lack of body fat. Otter no M560 was estimated to be a subadult. Juvenile dispersal was reported to be the reason for many cases of overland travel by otters (Melquist and Hornocker 1983). Inexperience combined with the stress of capture, transportation, and surgery probably led to the rapid dispersal of M560 out of Little River. In addition, no acclimation time was allowed. It was hoped a shorter confinement period would reduce stress, however, the rapid release may have had an opposite effect.

For 19 days, female otter no. F550 moved downstream, staying within 7.7 km of the release site. She then traveled up Laurel Branch and overland 0.7 km into the Little Pigeon River (Figure 4). For 23 days, she was located in the vicinity of Gatlinburg, Tennessee when radio contact was lost. On 16 March 1989 (39 days later) and again on 31 May 1989 she was located via an aerial search 6.1 km from Fontana Lake in Hazel Creek, GSMNP, North Carolina, 33 km from the original release site. This otter was repeatedly located in Hazel Creek over the next 11 months, and was last located 2 April 1990 in the same area. Heavy rainfall caused high water levels in Little River just prior to no. F550's movement out of that watershed. High water in addition to the stress of capture and transport may have caused no. F550 to move out of Little River. Otter no. F550's dispersal out of Little Pigeon River may have been

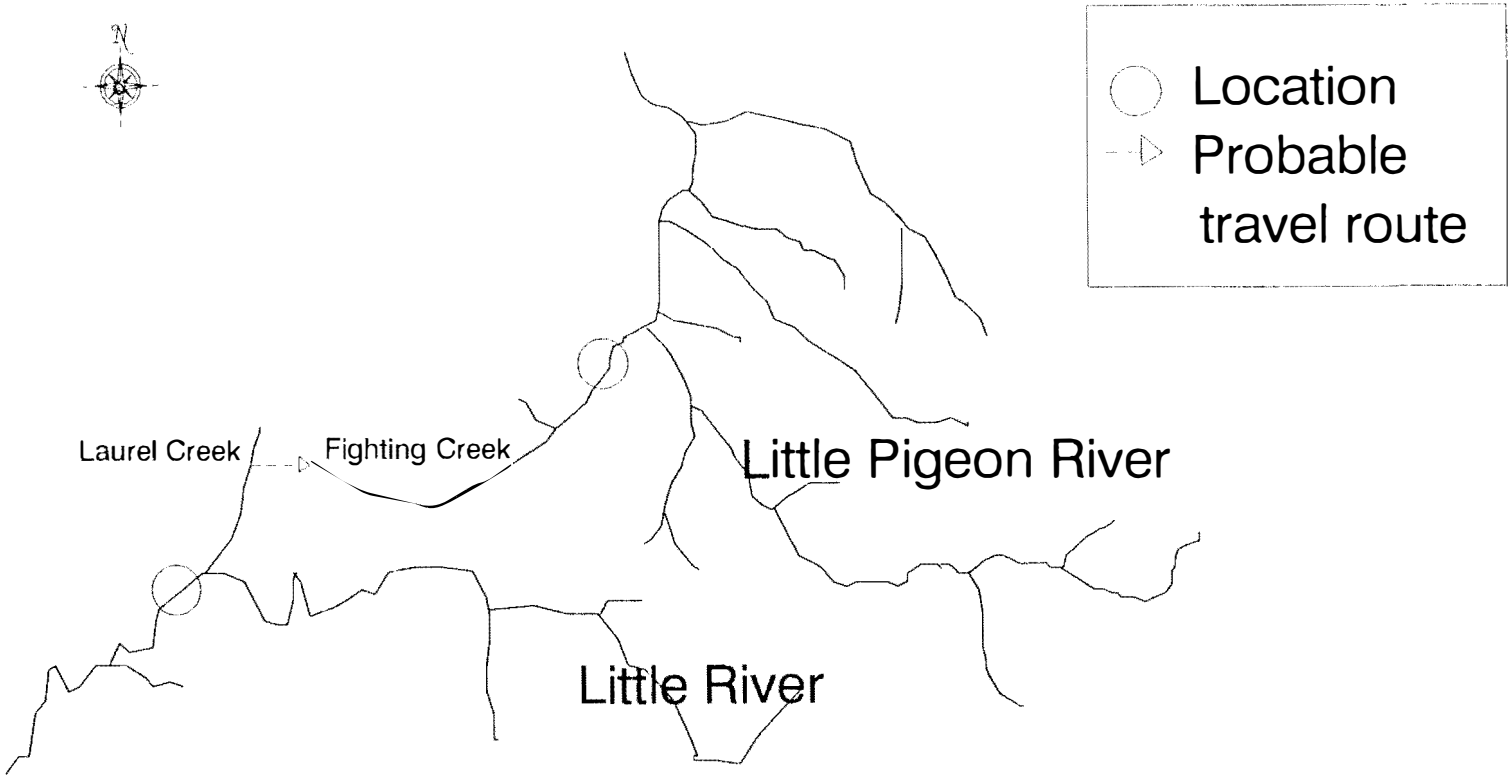


Figure 4. Locations and probable overland travel route of otter no. F550.

initiated by a search for a secluded natal den. However, her extreme movements during what would have been the time of parturition make successful birth unlikely.

Two adult males were obtained in January 1989. No injuries were observed at the time of surgery and they were released on 21 January 1989 at the same site as the previous two otters. Otter no. M561 immediately moved downstream and crossed into the Little Pigeon River drainage by the same route as otter no. F550 (Figure 5). The male returned to Little River after two days and established a home range within 20.5 km downstream of the release site. During the following winter months, no. M561 continued downstream and established a home range in the lower elevations of Little River. He was last located 9 February 1990 in Little River below the Sinks. The other male, no. M580, remained in Little River for six months and established a home range within 13.4 km of the release site. At that time, he began to travel up Little River. Male no. M580 was located 12 July 1989 (19 days after the last Little River location) in Hazel Creek, 31.7 km from the release site. He was found in the same den with female no. F550 on 22 September 1989. Otter no. M580 was located in Hazel Creek and adjacent Eagle Creek, GSMNP. He was last located 1 May 1990 in Eagle Creek.

The next two animals obtained were an adult male and an adult female. The male (no. M620) was missing two digits on

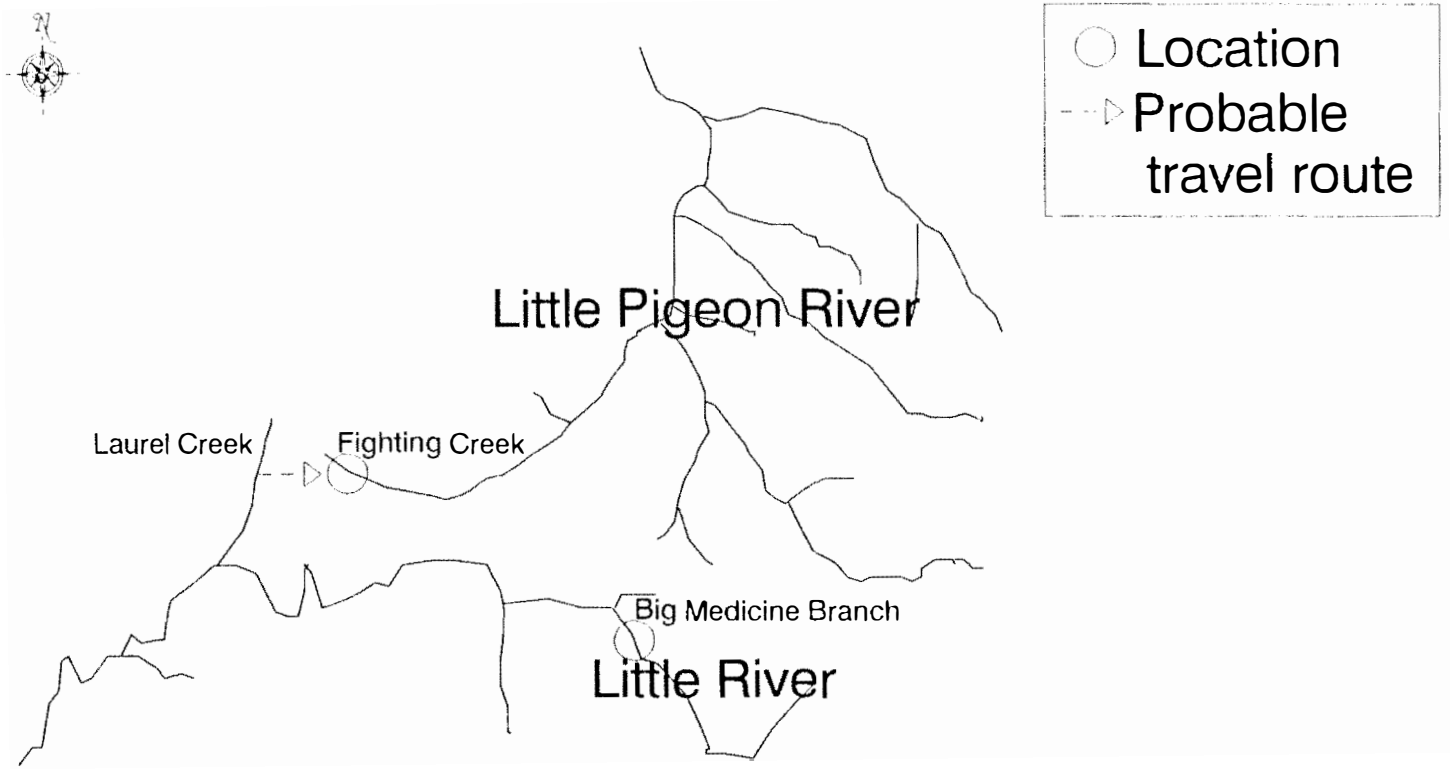


Figure 5. Locations and probable overland travel route of otter no. M561.

his left hind foot, but the foot had already healed. He was released on 31 January 1989 at Metcalf Bottoms in Little River. He was located the fourth day after release in Little Pigeon River 2.4 km from female no. F550. Radio contact was lost on 14 February 1989. He was located by aerial search on 16 March 1989 in Deep Creek, GSMNP (Figure 6). Deep Creek flows into the Tuckaseegee River at Bryson City, North Carolina. For two days, no. M620 was located by ground telemetry in the Tuckaseegee River in Bryson City before he moved out of the area. He established a home range in the Little Tennessee River in the vicinity of Twenty-mile Creek, GSMNP. Otter no. M620 was last located in the Little Tennessee River on 17 April 1990. The adult female otter (no. F600) obtained at the same time as no. M620 had some injuries. She had two broken toes on her left rear foot, several broken incisors and canines, and an abscessed lower mandible. In addition, very little body fat was present. The broken toes were amputated. Two nearly full-term fetuses were found when surgery was performed. The female was treated with antibiotics and held for three days before being released into the Little River at Elkmont on 2 February 1989. She survived only two days and did not move far from the release area.

The fifth release was conducted on 16 February 1989, when a pair of adults was released at Metcalf Bottoms. Both the male (no. M610) and the female (no. F601) were in good

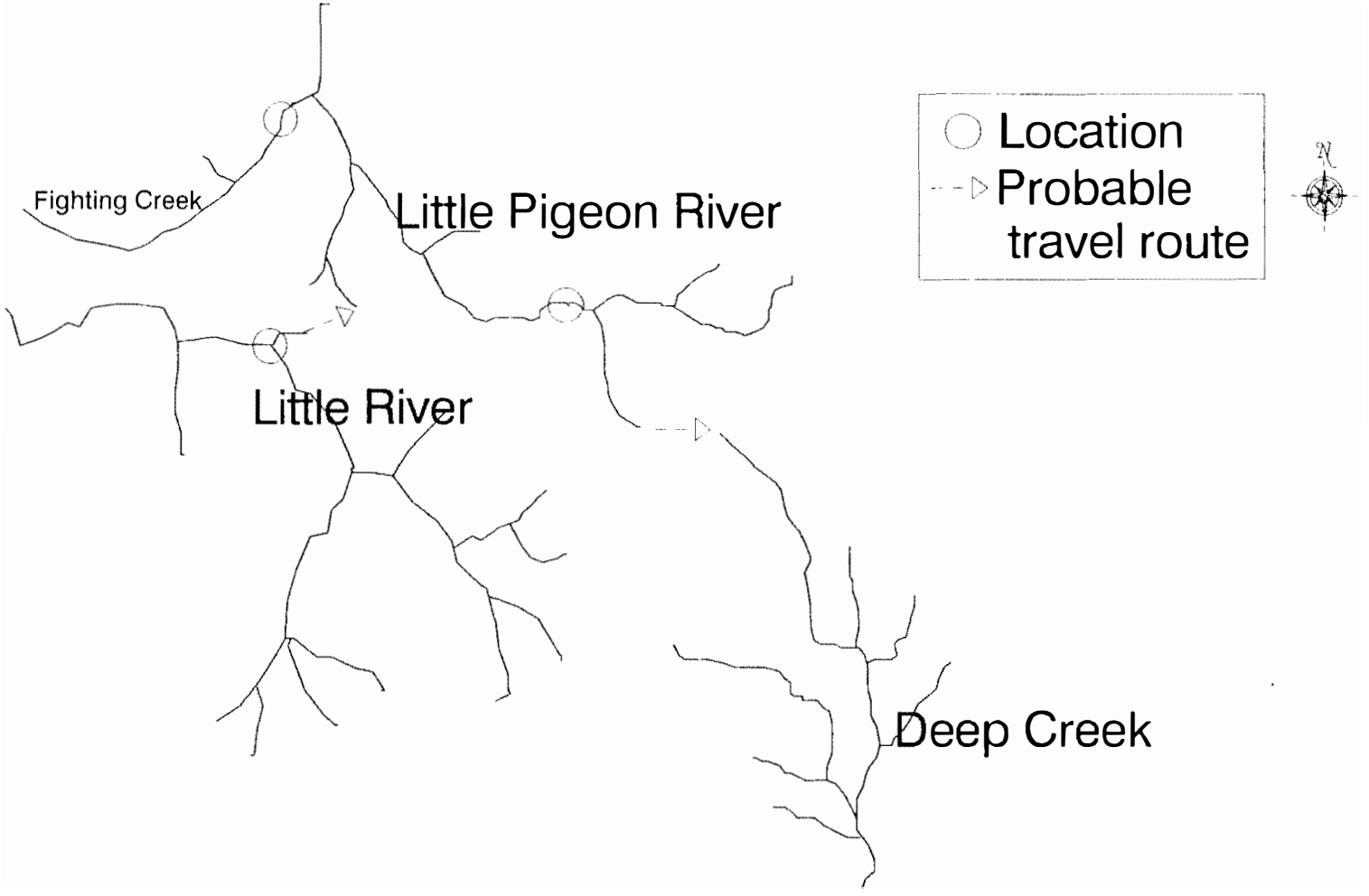


Figure 6. Locations and probable overland travel routes of otter no. M620.

physical condition when they were examined prior to release at the time of surgery. Otter no. M610 has not been located since the day of release. The female was found near the release area for two days. She was not located again until 15 March 1989 (25 days later) when her carcass was recovered in the Tremont area of the Middle Prong of Little River. No body fat was present when a necropsy was performed, and her weight had decreased by 1.0 kg. As with otter no. M560, the inexperience of otter no. F601 in addition to the stress of capture likely led her to leave the area.

A female otter (no. F630) was released on 2 March 1989 at Elkmont in Little River. The otter was an adult in excellent physical condition. She left the Little River drainage the same day of her release and moved into the Little Pigeon River. She arrived there by way of Sugarlands Branch after traveling overland for at least 620 m. Over a period of seven days, no. F630 went down Little Pigeon River 36.7 km into Sevierville, Tennessee, where radio contact was lost. The otter was again located on 16 March 1989 in the Little River drainage at Walland, Tennessee. She was traveling down Reed Creek from Bates Mountain. The distance no. F630 traveled is at least 45.4 km streamline distance from her previous location in Sevierville. Walden Creek is the most likely route the otter followed from the Little Pigeon River to the Little River. Walden Creek flows down Bates Mountain into the Little Pigeon River at the town of

Pigeon Forge. No. F630 descended Little River 29.3 km before moving back upstream 17.5 km. The last telemetry location was in the Wildwood, Tennessee, area on 22 March 1989.

A dead otter was reported to the Tennessee Wildlife Resources Agency during the week of 9 April 1989. The animal was found in the Lane Hollow area of Sevier County, Tennessee approximately 2 km from Douglas Lake. The carcass was recovered along with a transmitter on 9 May 1989. The transmitter was identified as the one implanted in otter no. F630. She had apparently been shot because the otter skull found at the site had a hole 1.7 cm in diameter on the right side of the parietal section. Otter no. F630 likely moved from Wildwood back to the Little Pigeon River by way of Reed Creek and Walden Creek. She probably traveled down to the east fork of the Little Pigeon River to where Lane Hollow Branch enters. She then moved up the branch into the field where her carcass was recovered. The total distance moved was 60.5 km.

Five river otters were released in 1990. One female otter was acquired from South Carolina in January. A physical examination of female otter no. F640 indicated she was a healthy, young adult. She was released 5 February 1990 in Little River at Elkmont. Otter no. F640 immediately moved downstream and was found three days later by ground telemetry in the Middle Prong of Little River near the

Tremont Ranger Station. She ascended Middle Prong and established a home range in the upper sections.

Four additional otters, three males and one female, were obtained in March 1990 from the Bayou Otter Farm in Louisiana. By examining the otters at the time of surgery to implant radio transmitters, researchers discovered all were adults in good health.

The four otters were released on 23 March 1990 into Little River at Elkmont. Two of the male otters, nos. M780 and M790, and the female otter, no. F602, established home ranges in Little River within 11 km of the release site. They were found in the Elkmont area on a regular basis, often in close proximity to each other.

The remaining male, no. M631, left the Little River drainage within a week after his release. He crossed into Little Pigeon River and remained in that drainage. Over the course of three months, no. M631 moved downstream out of GSMNP and established a home range in the Boyds Creek area of the French Broad River.

The farthest distances traveled from the release sites were calculated for each otter (Table 3). Seven otters moved out of the watersheds into which they were released (Table 4). Extreme dispersals are not unusual in river otter reintroduction studies. In a study on Abrams Creek (GSMNP), the farthest distance traveled by an otter

Table 3. Farthest distance traveled from the release site by river otters released in Little River, GSMNP, 1988, 1989, and 1990.

Animal no.	No. of days from release to farthest distance	Distance (km)
F550	79	171.2
M560	14	4.4
M561	375	28.9
M580	465	31.7
F600	2	0.6
M620	170	185.2
F601	27	19.0
M610	1	0.5
F630	16	189.4
F602	18	6.8
F640	42	37.7
M631	140	50.0
M780	317	15.5
M790	39	8.5

Table 4. Identification of river otters that traveled out of Little River, GSMNP.

Animal no.	Number of times animal crossed out of a watershed
M560	1
F550	2
M561	2
M580	1
M620	1
F630	3
M631	1

was 39.2 km by a male. A female otter in that study did move out of Abrams Creek and into Little River where she established a home range. Transmitter signals also were "lost" or apparently ceased prematurely. It is possible those otters dispersed out of the area (Griess 1987). In Illinois, an otter moved 114 km from the release site (Anderson and Woolf 1984), while an otter in a Missouri study moved 320 km from the release site (Erickson 1984). Four male otters moved more than 100 km in an Ohio reintroduction study (McDonald 1989). Long-range movements in this study are thought to be exploratory or involve searching for mates. More males moved greater distances than females, although the sample size of females was not large enough to make any determinations regarding sex.

Home Range

Home ranges were calculated for six male and three female otters. Five otters (M561, F602, F640, M780, M790) established home ranges on Little River. The home range of F602 overlapped that of M780 and M790. One female (F550) established a home range on Hazel Creek. One male (M580) established a home range on Eagle Creek. Another male (M620) established his home range in the Little Tennessee River. The remaining male (M631) established a home range in the French Broad River. Seven of these home ranges were within GSMNP (Figures 7, 8, 9).

The average home range length for the nine otters was

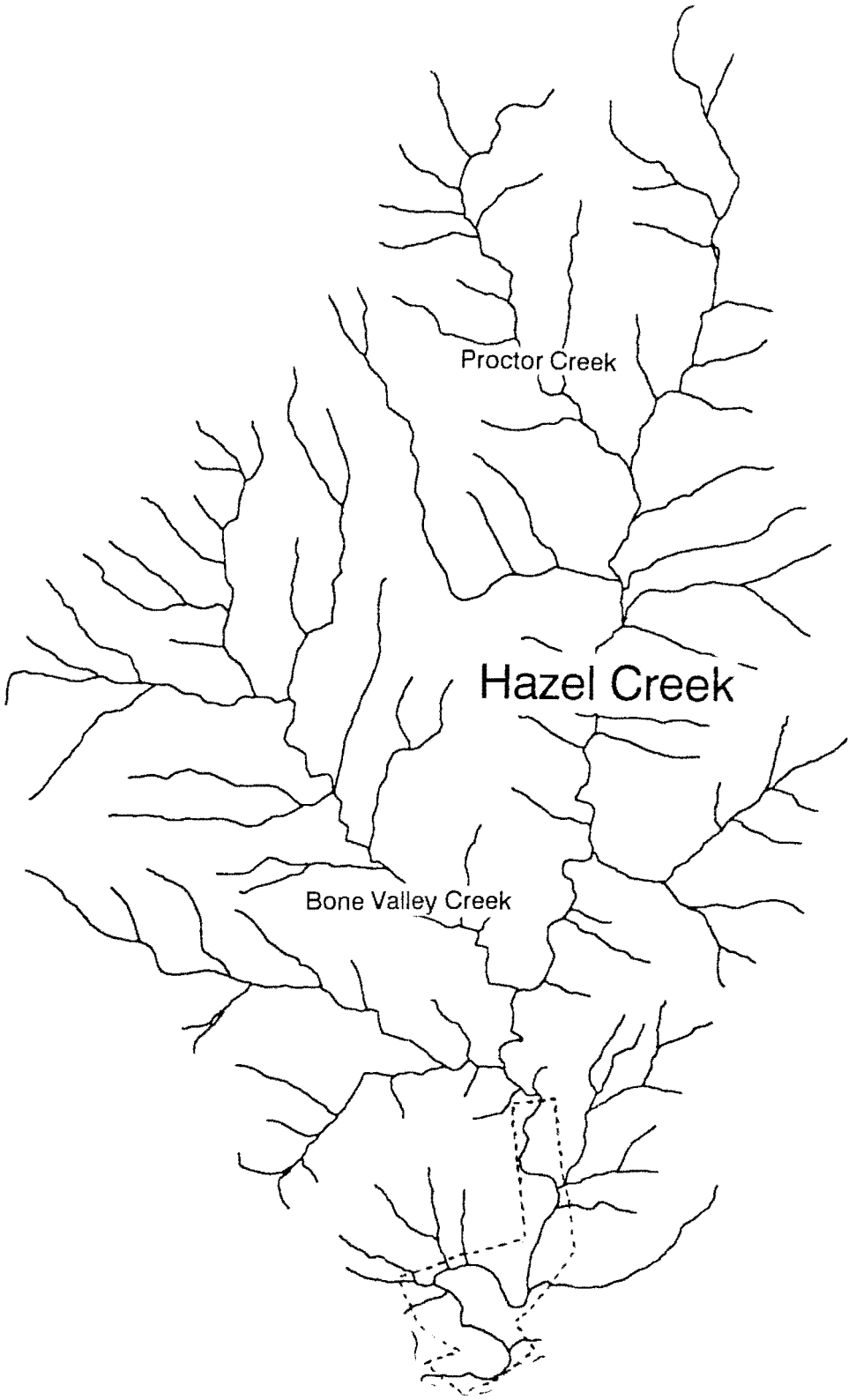


Figure 7. Home range (dotted area) of otter no. F550 released into Little River, GSMNP.

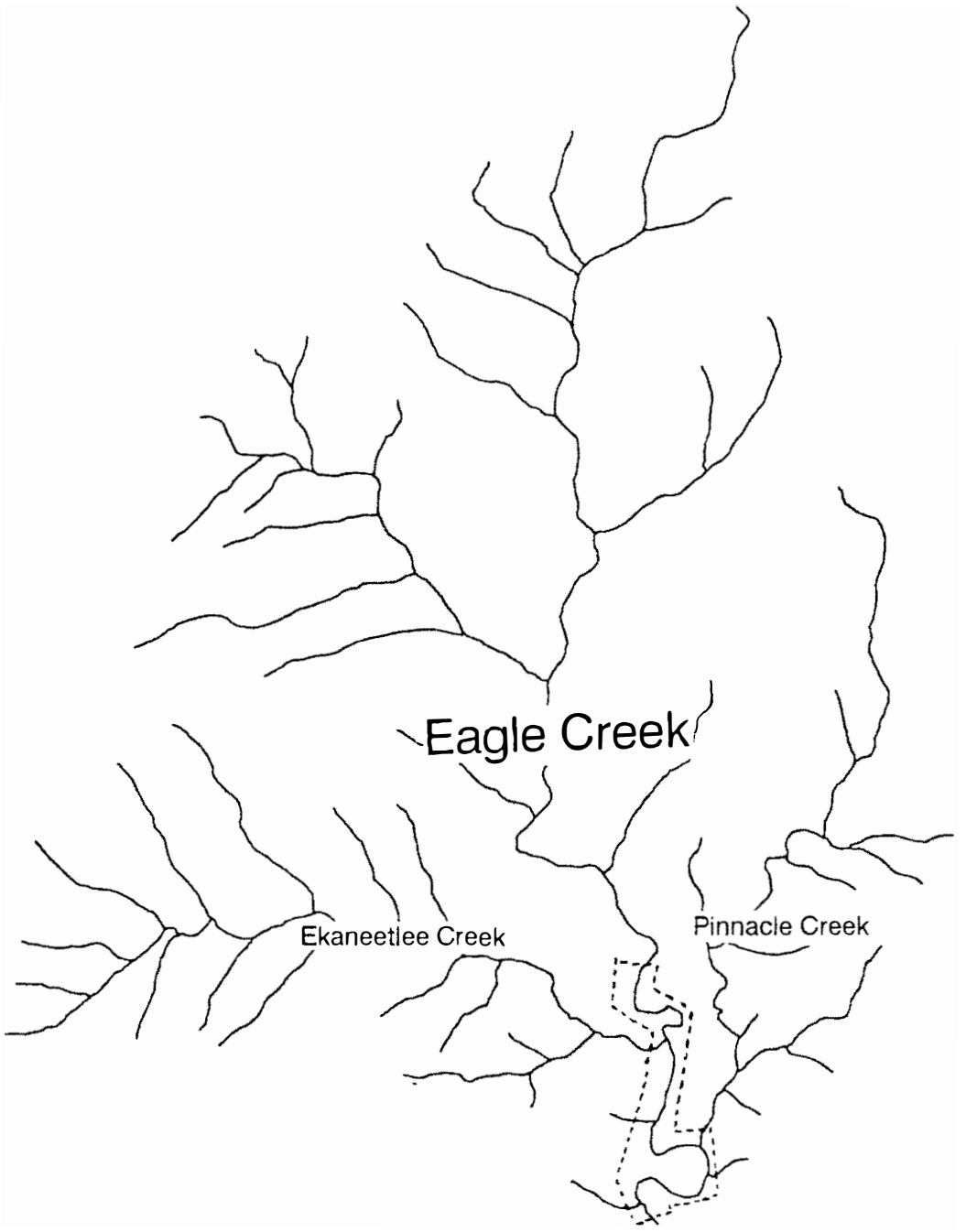


Figure 8. Home range (dotted area) of otter no. M580 released into Little River, GSMNP.

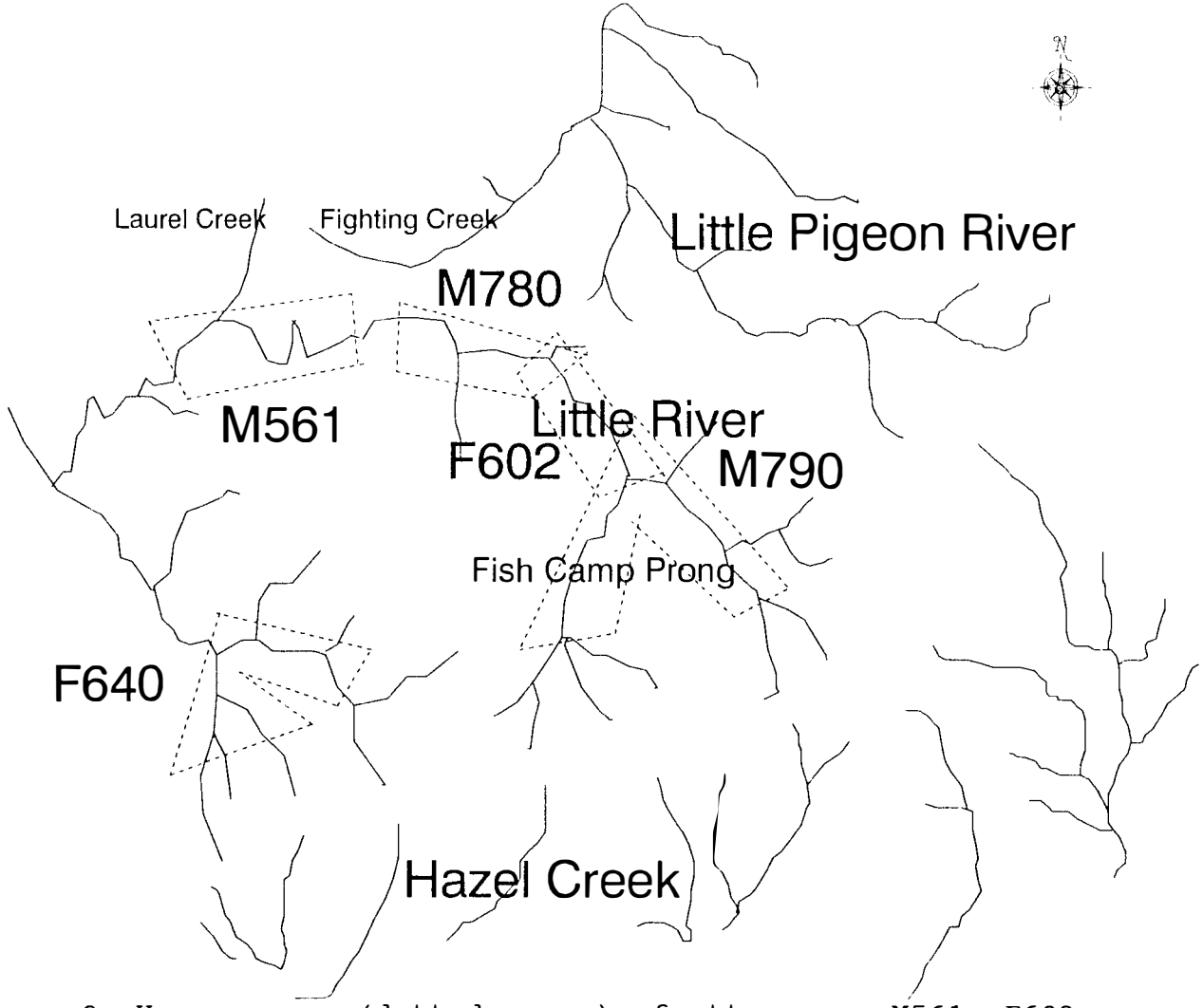


Figure 9. Home ranges (dotted areas) of otter nos. M561, F602, F640, M780, and M790 released into Little River, GSMNP.

13.3 km (range = 7.1 to 23.4 km). The average home range length for females was 16.6 km (range = 11.1 to 23.4 km), and the average home range length for males was 11.6 km (range = 7.1 to 20.3 km) (Table 5). There were no significant differences in home range size between sexes ($p > 0.05$). These sizes are comparable to the home range sizes found for 11 otters released in Abrams Creek, GSMNP. Lengths of female home ranges in Abrams Creek averaged 15.9 km (range = 9.2 to 23.5 km), and male home range lengths averaged 14.1 km (range = 8.8 to 17.7 km) (Griess 1987). Again no significant differences were found between sexes in that study. The home range lengths found in GSMNP are smaller than those found in other studies of river otters. However, home range size of otters is dependent on several variables including prey availability, weather conditions, and topography (Melquist and Hornocker 1983). In Idaho, males had home ranges averaging 50 km and females had home ranges averaging 44.3 km (Melquist and Hornocker 1983). Missouri otters also exhibited larger home ranges with males averaging lengths of 40.3 km and females averaging lengths of 24.0 km (Erickson 1984).

Food Habits

Searches for scat were conducted where otters had been located, including Abrams Creek, Little River, Little Pigeon River, and Hazel Creek. A total of 75 scats was recovered. The majority of scats (51%) was found on Little River,

Table 5. Home range lengths for river otters released into Little River, GSMNP in 1988, 1989, and 1990.

Animal no.	Home range length (km)
F550	11.1
M580	9.2
M561	8.1
F602	23.4
M620	9.7
M631	7.1
F640	15.4
M780	20.3
M790	15.2

while 30 were collected in the vicinity of Abrams Creek, 1 was found on Little Pigeon River, and 4 were collected on Hazel Creek (Figures 10, 11, 12, 13, 14). All scats were found on creek or river banks within 3 m of water.

Crayfish were the most abundant food item found. Eighty-three percent of all scats collected contained crayfish remains. Fish were the next most abundant prey; fish remains were found in 81% of all scats. However, fish were found in 91% of scats collected in winter, whereas crayfish were only found in 62% of winter-collected scats. In summer, crayfish were found in 100% of scats, while fish remains comprised only 64% (Table 6).

Three fish families were represented in scats collected for analysis (Table 7). Northern hog suckers (Hypentelium nigricans) made up 30% of the number of fish found, followed by stonerollers (Campostoma anomalum) at 23%. The only game species identified was bluegill (Lepomis macrochirus) at 3%.

The results of this study are similar to other studies of river otter. Otters released in Abrams Creek also consumed fish and crayfish (Griess 1987). Crayfish appeared to be the most important food item in that study. Griess (1987) found the most frequently eaten fish were white suckers (Catostomus commersoni) and stonerollers at 57% and 50%, respectively. A seasonal comparison cannot be made as scats were only collected during summer months in the previous release. Other river otter food habits studies

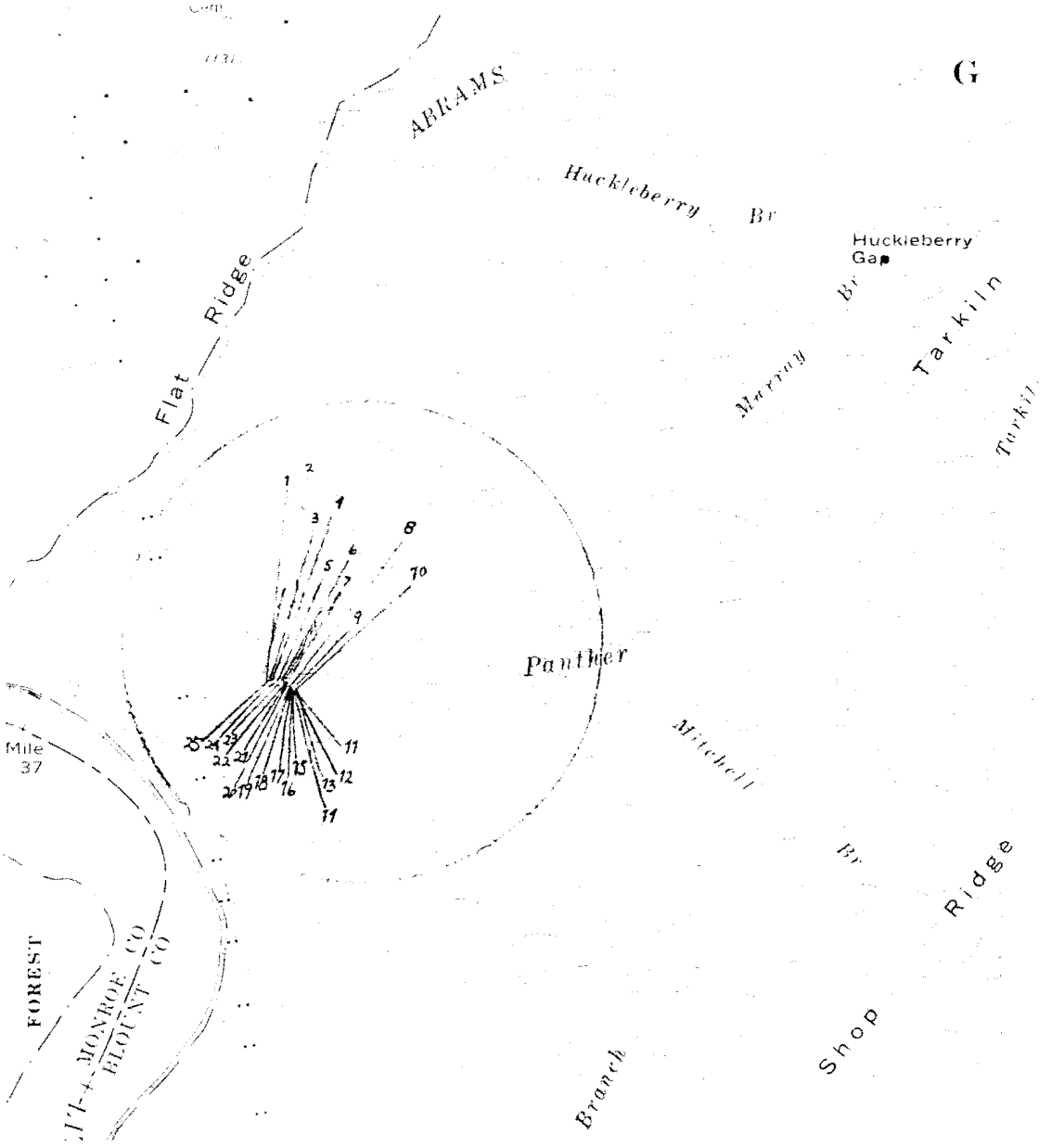


Figure 10. Locations (circled) of 25 scats found on lower Abrams Creek since December 1988.

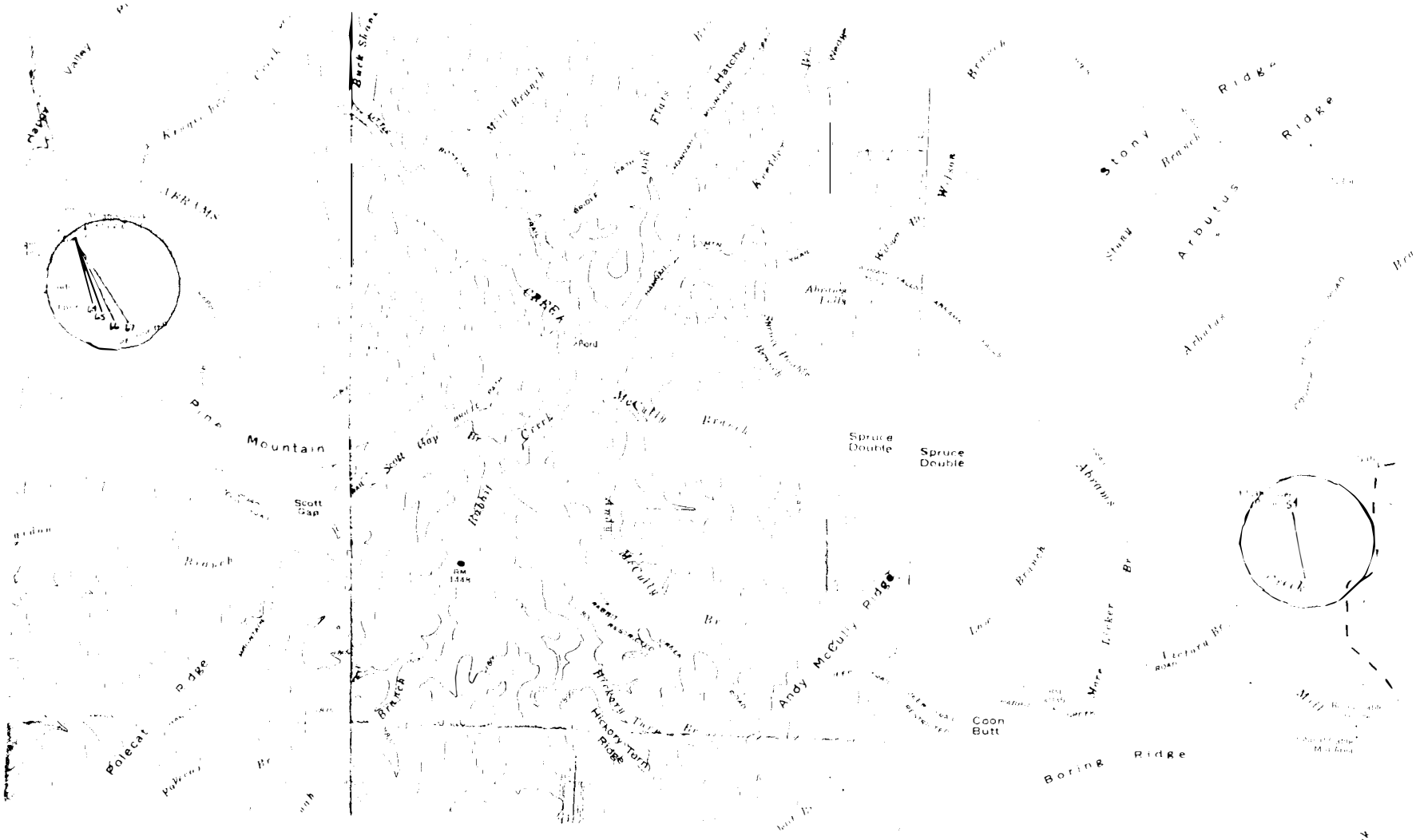


Figure 11. Locations (circled) of 5 scats found on upper Abrams Creek since December 1988.

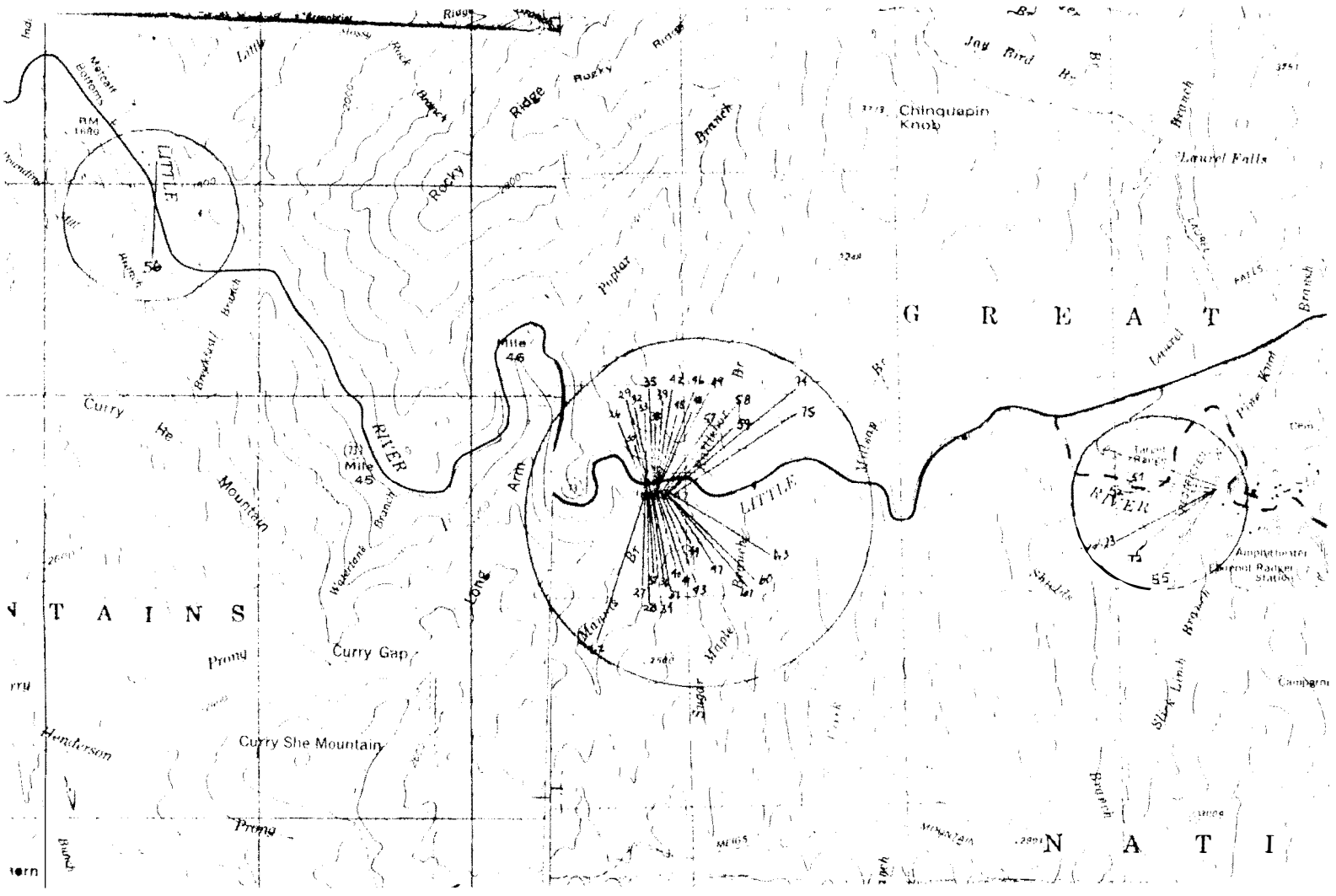


Figure 12. Locations (circled) of 40 scats found on Little River since December 1988.

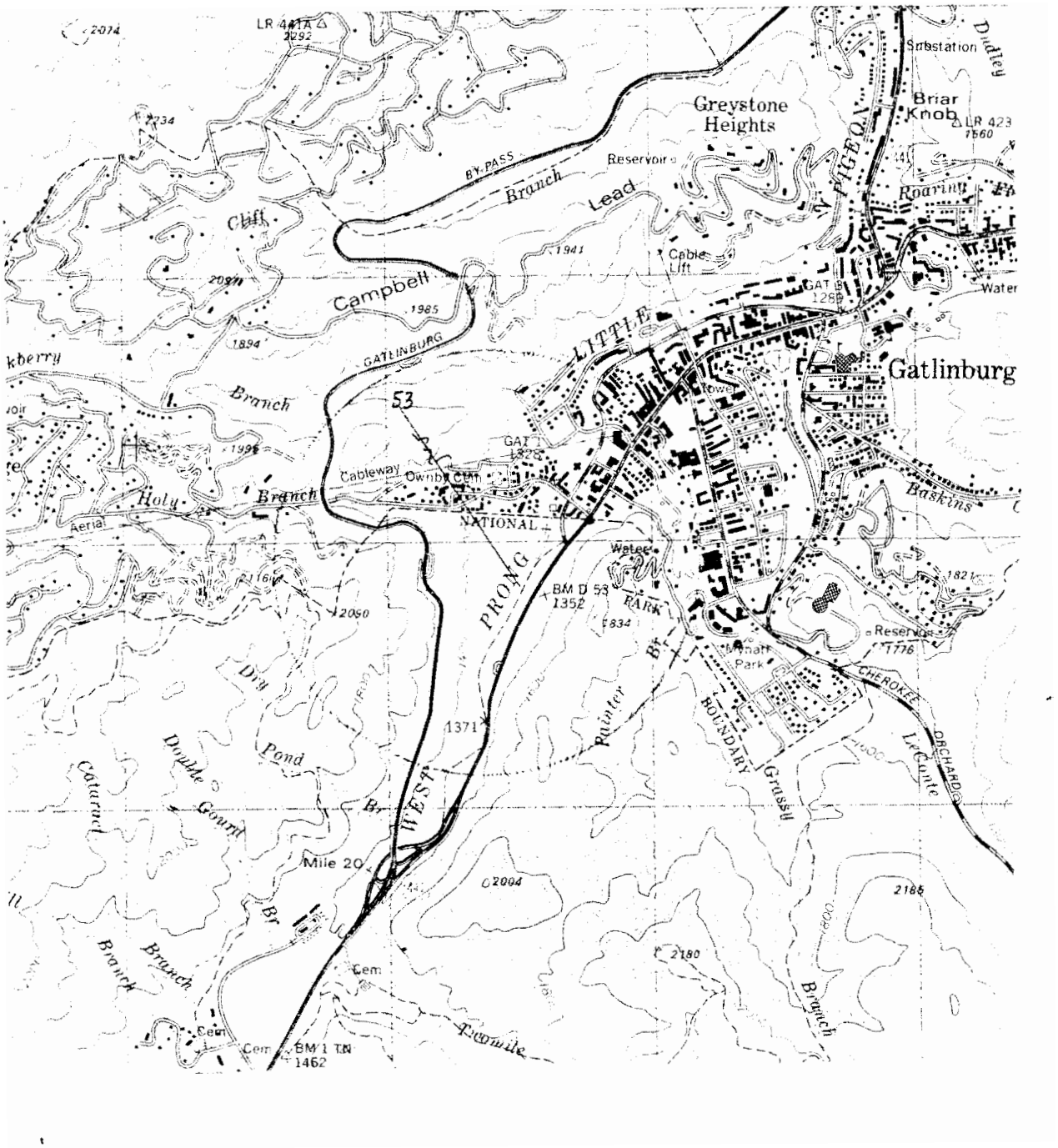


Figure 13. Location (circled) of 1 scat found on Little Pigeon River since December 1988.

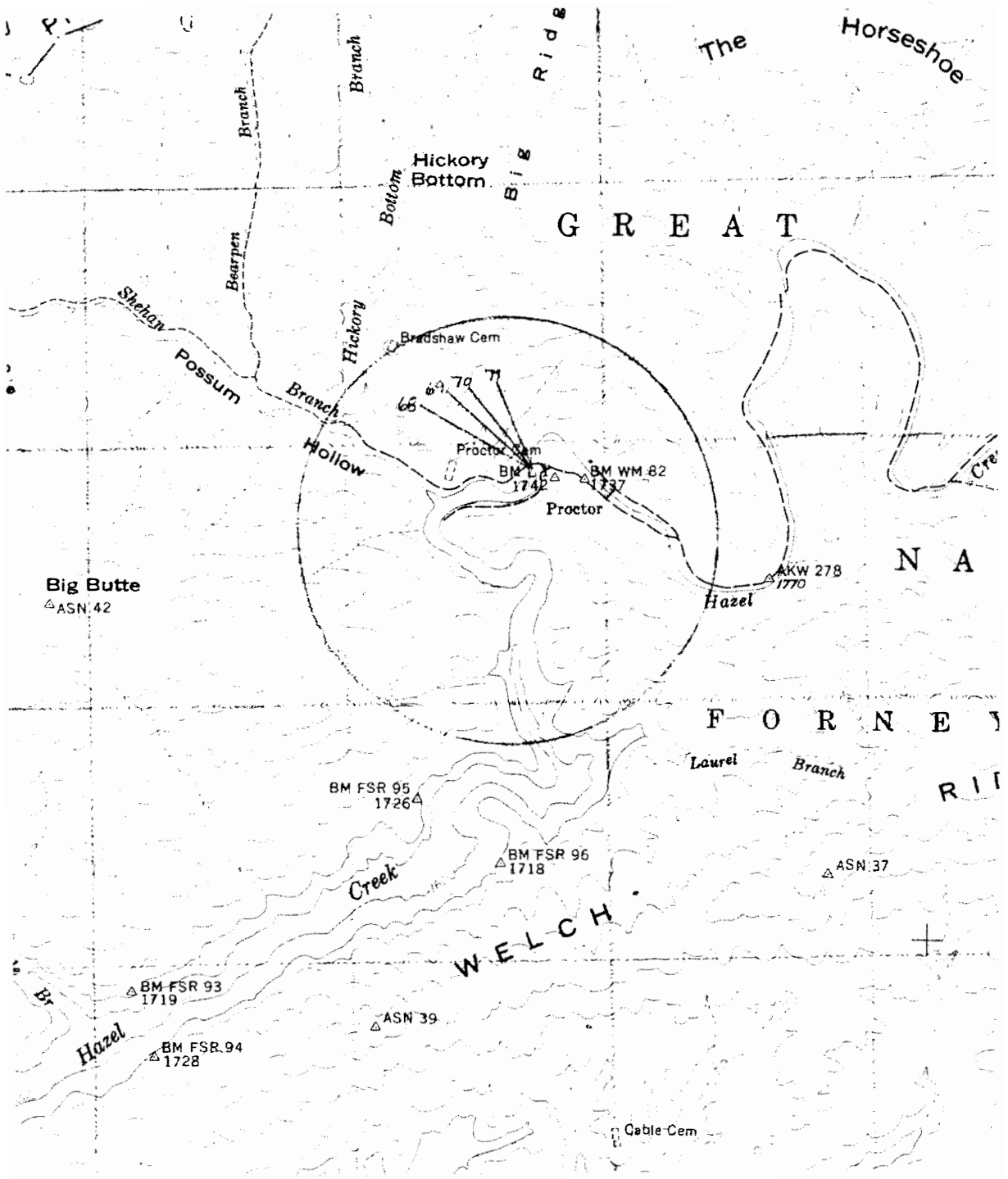


Figure 14. Locations (circled) of 4 scats found on Hazel Creek since December 1988.

Table 6. Percentage of crayfish and fish, by season, identified in river otter scats collected in GSMNP between 15 July 1988 and 22 September 1989.

	Frequency of occurrence (%)
Summer	
Crayfish	100
Fish	64
Winter	
Crayfish	62
Fish	91
Summer and Winter	
Crayfish	83
Fish	81

Table 7. Fish species identified in river otter scats collected in GSMNP between 15 July 1988 and 22 September 1989.

Fish family and species	Number	Frequency of occurrence (%)
Cyprinidae		
Campostoma anomalum	18	23
Cyprinella galactura	1	1
Luxilus coccogenis	1	1
Nocomis micropogon	3	4
Rhinichthys atratulus	1	1
Catostomidae		
Catostomus commersoni	5	6
Hypentelium nigricans	23	30
Moxostoma duquesnei	8	10
Moxostoma erythrurum	2	3
Centrarchidae		
Lepomis macrochirus	2	3

found frequently eaten fish species in the families Cyprinidae, Centrarchidae, and Catostomidae (Lagler and Ostenson 1942, Hamilton 1961, Loranger 1980, Serfass 1984).

Resting Sites

Day rest site data also were collected on radio-instrumented otters. Since December 1988, data were collected on 14 rest sites, including eight rock crevices, five ground burrows, and one log jam. While the rock crevices and ground burrows were secure resting sites, the log jam was probably being used as a temporary hiding place. Twelve of these rest sites were located at pools where prey was readily available and used repeatedly by more than one otter. All rest sites were within 5.0 m of water with entrance holes above the water.

Nine of the sites were located in moderately dense rhododendron. Two were groundhog burrows located along creek banks where trees or brush were absent. One site was found in a stand of moderately dense hemlock, and the other was among a thick growth of honeysuckle.

Social Interactions

Eight otters were found in association with other otters on at least one occasion (Table 8). On two occasions, a female was found with three male otters. Three males were found at the same location on one occasion. One female, no. F602, was located with the same male, no. M780, on four separate occasions. A female was located with with

Table 8. Summary of social interactions between river otters released into Little River, GSMNP, in 1988, 1989, and 1990.

Animal no.	In association with	No. of times together
F550	M580, M560	1, 1
M561	M580	1
F602	M631, M780, M790	2, 4, 3
M631	M780, M790	1, 1
M780	M790	2

the same male three times, and with another male twice.

In 71% of the associations, the interactions were between males and females; the other interactions took place between males. On one occasion, three males were found together. No female associations were recorded. The lack of female interactions is probably due to the distance between females in this study.

The results found in this reintroduction are similar to those of other reintroductions into river systems. In Missouri, otters were only found in association 19% of the time, and male otters were found to be more social than female otters (Erickson 1984).

Otter-Human Interactions

Otters were located within 100 m of humans on 12 occasions. However, otters were not active on 11 of those occasions. The only time an otter was active it was moving in the opposite direction of the people. On one occasion, an otter immediately became active when the person left the area.

Daily activity data suggest otters adjust their feeding patterns and avoid people. More heavily visited rivers such as Little River produced patterns in otters indicating they shifted feeding times from initial diurnal patterns to crepuscular and nocturnal patterns. Only one otter, no. F640, was found to be more active during the day.

CHAPTER V

SUMMARY AND CONCLUSIONS

A total of 14 river otters was released in Little River, GSMNP, between 28 December 1988 and 23 March 1990. Of these, eight were males and six were females. Four mortalities, one male and three females, occurred during this study. The nine otters that established home ranges appeared to be able to adapt and survive well in their transplanted location.

Some river otters in this release did travel extensively from the release site. There were no differences in these movements between sexes, however, there were differences between individuals. The shortest distance (6.8 km) and the farthest distance (189.4 km) travelled from the release site were both by females.

There were no differences found between sexes in home range size. However, individual home range sizes did vary. The average home range size for all otters was 12 km.

Activity patterns varied depending on the location of each otter. Otters located in areas of high human use, lower Little River for example, exhibited more nocturnal movements than otters located in areas of little human use. Otters in areas receiving less human recreational pressure exhibited more diurnal or crepuscular activity patterns. These data suggest otters are capable of adapting to areas

where humans are prevalent, given that habitat is available. They seem to prefer areas of low human density as illustrated by the movements of male no. M580 from Little River to Hazel Creek.

Some seasonal movement was noted in addition to daily home range patterns. Otters located in upper portions of Little River during the summer months tended to move into lower elevations during winter months.

Otters adapted to the prey supply within their home ranges. Crayfish remains were the most commonly found prey in scats collected for analysis. Fish remains also were found in scats. Three fish families were identified: Cyprinidae, Catostomidae, and Centrarchidae. Northern hog suckers (Hypentelium nigricans) were the most frequently found fish species.

Otters used resting sites and dens available within their home ranges. They appeared to find suitable sites for escape cover when needed. Most of these areas were near abundant food sources, such as deep pools. The resting sites located were natural formations including rock crevices and vegetative debris or dens excavated by other animals.

Otters in this study were mainly solitary. However, otters have been located near other otters. These associations have been predominantly between males and females. Females were never located near another female.

Humans had some impact on otters, mainly through a change in activity patterns of otters. Few sightings of otters by humans in Little River were reported. However, otters often were located in areas where humans frequent at times of the day when people were around. Roads found close to the river did not appear to hamper otters in their day-to-day existence.

The results of this study are comparable to other reintroduction studies. Otters released in Little River exhibited more overland travel to other watersheds than the otters released in the first reintroduction attempt in GSMNP. These movements were probably due to the accessibility of Little River to people. Other possible factors include high water levels, inexperience of individual otters, and the lack of an acclimation period. Home range sizes were similar to those found in other mountainous regions.

Although reproduction was not verified in this study, the proximity of males and females to each other makes reproduction probable. Several sightings of adults and juveniles have occurred in Abrams Creek, the site of the previous release in GSMNP. These reports give some degree of optimism for fully reestablishing a population in this area. However, in the author's opinion, the existence of a river otter population in GSMNP would be better ensured with the release of additional otters. Females are especially

needed to increase the reproductive potential of the population. As the otter population expands beyond the boundaries of GSMNP, law enforcement along with public education will be necessary to prevent undue losses.

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