Assessment of the Population Status of the Flattened Musk Turtle (*Sternotherus depressus*) in the Sipsey Fork and Brushy Creek Branches of Lewis Smith Lake, Alabama

Sherry R. H. Rogers
&
Ken R. Marion

University of Alabama at Birmingham

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Alabama Power Co.,
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&
The Nature Conservancy

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I. Introduction

Figure 1—a flattened musk turtle

The flattened musk turtle (figure 1) was described by Tinkle and Webb (1955) from specimens collected in the Mulberry Fork of the Black Warrior River in Alabama. It was designated as *Sternotherus depressus* (Tinkle and Webb, 1955). Tinkle later detailed the systematics and ecology of *S. depressus* and the rest of the *S. carinatus* complex (1958). The status of the species was accepted by Estridge (1970) and Iverson (1977), but not by Mount (1981) or by Ernst and Barbour (1972). Mount (1981) referred to the flattened musk turtle as "a very distinctive subspecies" of *S. minor.* Mount based his conclusions on the presence of intergrades between *S. minor peltifer* and *S. depressus* (Mount et al., 1991). In more recent years, there has been additional exploration into the taxonomic status of *S. depressus*. Seidel and Lucchino (1981) considered *S. depressus* a species based on analyses of allozymic and morphological variation. Ernst et al. (1988) considered it a separate species based on comparisons of shell morphology within the complex. In 1998, Walker et al. compared the mitochondrial DNA of *S. depressus* to that of all other mud and musk turtles and determined that that it is a well-supported monophyletic group. The U.S. Fish and Wildlife Service currently lists it as the species *Sternotherus depressus* (Recce, 1987).

S. depressus was declared to be a threatened species under the Endangered Species act in 1987 (Recce, 1987). Two reasons cited for the decline of *S. depressus* are loss of habitat and habitat fragmentation. Habitat has been lost to impoundments and siltation effects from agricultural, residential, and industrial activities (Recce, 1987). These factors also contribute to habitat fragmentation. According to Dodd (1990), habitat fragmentation can increase vulnerability to disturbance and open the door to demographic accidents and possible eventual extinction.

The largest impoundments found in the geographic range of *S. depressus* are Bankhead Lake and Lewis Smith Lake. The Lewis Smith Dam was completed in 1961 and the lake is approximately 35 miles long. Because it was built just six years after the species was described, there are no historical records of *S. depressus* in the area now covered by the lake; however, *S. depressus* is found both above and below the lake, and the habitat that the lake now covers was the type that *S. depressus* seems to prefer. Populations still exist in certain areas of Smith Lake.

According to Mount (1981), silt is the biggest threat to populations of *S. depressus*. The source of that siltation is primarily strip mining for coal, but runoff from agriculture, forestry and construction also contribute to the siltation problem (Mount, 1981).

A lack of recruitment and an age structure skewed heavily toward adults has been found in many impacted sites throughout the animal's range. Data from Mount's 1981 study revealed that there might have been a decrease in the proportion of juveniles as compared to pre-1970 data, but he also mentions that 1970 collecting methods were different, and that the large number of juveniles collected by Tinkle and Webb (1958) may have skewed the pre-1970 data. Juvenile numbers were low or absent at a substantial number of sites that were extensively sampled by Dodd (Dodd, 1986). Ernst et al. (1983) collected no juveniles at 37% of their waded locations. In addition to fragmentation and loss of habitat, illegal collection for the pet trade may have had a negative impact on the population size and structure of *S. depressus* (Schnuelle, 1997).

Figure 2—flattened musk turtle habitat in Smith Lake with shelf-like rocks underwater

Mount (1981) determined that optimal *S. depressus* habitat consisted of "a segment of a free flowing large creek or small river having the following characteristics: (1) drainage area between 50 and 500 mi^2, (2) depth averaging 2 ft, with vegetated shallows alternating with pools at least 3½-4 ft deep, (3) pools with detectable current, (4) an abundance of submerged rocks with crevices, overlapping flat rocks, or accumulations of boulders, (5) abundant molluscan fauna, (6) low silt load and minimal silt deposits, (7) relatively low nutrient content and bacterial count, (8) moderate temperatures (max. 85°), and (9) minimal pollution by synthetic chemicals and toxic inorganic materials." Ernst et al. (1989) generally agreed with Mount's assessment but found that habitats with high amounts of sand were also suitable as long as there was plenty of bedrock, boulder, and cobble substrate, and they also noted that food supply appeared to be linked to turtle abundance.

In the lacustrine environment of Smith Lake, flattened musk turtles are found in areas along the bank that have an abundance of shelf like rocks (figure 2). They are not found in areas that lack suitable cover, such as that seen in figure 3.

Figure 3—Smith Lake habitat without shelf-like hiding places—unsuitable for FMTs

Tinkle (1958) examined the stomach contents of several juvenile *S. depressus* and found insects to be the most abundant food items. Marion et al. (1991) did a more quantitative study and determined that gastropods, clams and mussels were the primary components of the adult *S. depressus* diet. Schnuelle (1997) quantified the prey of adult

and juvenile *S. depressus* and found the difference to be significant. Turtles of carapace length ≥70 mm showed an increased preference for gastropods and bivalves , while juveniles primarily prey on softer-bodied benthic macroinvertebrates (Schnuelle, 1997).

Close (1982) studied the reproductive cycle of *S. depressus* and found that females lay two clutches of eggs per year, with clutch sizes ranging from 1-3 eggs. Ovulation occurs for the first clutch in May, and for the second clutch in June (Close, 1982). The eggs in the first clutch are laid in May, those in the second clutch in mid June through early July (Close, 1982). Close (1982) dissected numerous specimens and determined that females as small as 70-75mm carapace length (CL) can have swollen follicles or eggs, while males as small as 60-65mm CL can have sperm in their epididymides. Close (1982) estimated that females reach sexual maturity at 6-8 years, while males require only 4-6 years.

It is believed that flattened musk turtles can live for at least 50 years. Preliminary growth curve data supports this. Ken Marion has a member of a closely related species, *Sternotherus minor peltifer*, in his care. It was captured in 1979 as an adult and is still living (personal communication, October 2004). It is probable that flattened musk turtles that were alive before Smith Lake was created are still living in the lake today.

Very little is known about the nesting preferences of *S. depressus*. Only one natural nest was documented prior to the Dodd et al. (1986) study. In that study, one nest was found. It was located on the north shore of the Sipsey River, 6.5 meters from water on a high sandy bank under slight vegetative cover, in a position that would allow the afternoon sun to reach it (Dodd et al., 1986). It was found on July 31 and it contained two freshly deposited eggs (Dodd et al., 1986). The eggs began hatching on September 14th and 16th after being incubated at 25° C (Dodd et al., 1986). Hatching took about two days (Dodd et al., 1986). Prior to that, in late May or early June of 1983, Ken Marion (personal communication) found a nest next to the Sipsey Fork just upstream from the Highway 33 bridge. He noticed a white egg sticking out of a sandy portion of the bank on a slope of 20 degrees, about three feet above the water line. The nest was likely eroded by rain or high water. The nest contained 5 or 6 eggs that were within a foot of each other. He brought them back to the lab and successfully incubated them in sand and vermiculite. The number of eggs indicates that there may have been more than one clutch of eggs in the nest.

Studies have indicated that the best populations of flattened musk turtles are found in Bankhead National Forest. Funds were allocated by Alabama Power and the U.S.D.A. Forest Service through the Nature Conservency to determine the status of these turtles in selected areas of Smith Lake and in specific areas affected by silvicultural improvements in the Bankhead National Forest. This report is an account of efforts in the Smith Lake study sites. A separate report was written detailing efforts in the stream sites of Bankhead National Forest.

II. Objectives

1) To determine the population status of *S. depressus* in the Sipsey Fork and Brushy Creek branches of Smith Lake.

2) To determine if nesting success and recruitment are limiting factors in the long term success of the populations of *S. depressus.*

III. Methods

1) Study Site Selection

The study sites were chosen on the Sipsey Fork and Brushy Creek branches of Smith Lake. The dominant criterion used in the selection was accessibility. Sites were either located near areas accessible by vehicle or in areas accessible by boat. The traps had to be set relatively close to a boat launch so that they could be set very close to sunset and checked at dawn to prevent possible drowning of turtles.

As part of this study, a survey of 26 stream sites in Bankhead National Forest was also done. The results of that portion of the study are in a separate report (Rogers and Marion, 2004).

2) Data Collection

a. Trapping—Wire-mesh funnel traps (Iverson, 1979) baited with sardines were placed near suitable cover and left overnight (figure 4). Traps were set as close to sundown as possible and checked at dawn the following morning. The number of traps deployed and number of nights sampled was determined by ease of access, weather conditions, and qualitative potential for presence of *S. depressus*. Trap-nights and trap-hours were recorded.

Figure 4--flattened musk turtles in a funnel trap

b. Meristic Measurements—Standard meristic measurements (carapace length, carapace width, plastron length, plastron width, shell height, body weight) were taken on each captured turtle. Adult turtles were sexed. Physical

anomalies, shell wear, presence of leeches, algal growth on shells, etc. were recorded. Any identification marks from previous studies were also recorded.

c. Identification of turtles—Each turtle was given an individual identification number by injecting an 11mm Biomark Inc. PIT tag (Figure 5) into the peritoneal cavity near the right rear leg (Buhlmann and Tuberville, 1998). The opening was then sealed with New Skin Liquid Bandage. PIT tagging allows population estimates to be made and individuals to be tracked in the future.

Figure 5--PIT tag injector, PIT tag, and Liquid Bandage

d. Biotelemetry—In an attempt to better define nest site parameters and locations, any gravid females were to be fitted with transmitters and followed. Unfortunately, due to intensive concentration on stream sites early in the year, most of the trapping done at Smith Lake was done post-nesting season and no gravid females were found there during the study.

IV. Results & Discussion

Traps were set from a boat and from land along the edges of the Sipsey Fork and Brushy Creek branches of the upper part of Smith Lake. Records were kept for each trap's location and number of turtles captured in it. Two sites readily accessible by land were trapped intensively: the Brushy Creek branch of Smith Lake at the Highway 63 Bridge and the Sipsey Fork Branch of Smith Lake in the cove immediately north of the Houston Campground swimming area. The turtles trapped by boat are discussed separately from those trapped in the land-accessible intensive sites.

1) Traps set by boat

a. Sipsey Fork Branch

Traps were set on the Sipsey Fork Branch by boat on four separate occasions. A total of 49 traps were set by boat along the Sipsey Fork Branch of Smith Lake. A total of 34 flattened musk turtles were captured. This is a success rate of 0.69 turtles per trap-night along selected areas and coves of the Sipsey Fork Branch. One turtle less than 70mm carapace length (CL) was captured here (3%), and four (12%) were between 70mm and 80mm CL. This shows that at least some recruitment has taken place here. The ratio of males to females was 1.13:1

On August 15, 2002, fourteen traps were set south of the Hwy 278 Bridge and a total of 9 turtles was captured. One trap had 1 turtle, two traps had 2 turtles, one trap had 4 turtles, and the remaining ten traps had no turtles. The success rate was 0.64 turtles per trap-night.

On August 23, 2003, fourteen traps were set south of the Hwy 278 Bridge and a total of 16 turtles was captured. Four traps had 1 turtle each, one trap had 2 turtles, one trap had 4 turtles, one trap had 6 turtles, and the remaining seven traps had no turtles. The success rate was 1.14 turtles per trap-night.

On August 24, 2003, thirteen traps were set north of the Hwy 278 Bridge in the inundation zone of the Sipsey Fork and a total of 6 turtles were captured. One trap had 2 turtles and four traps had 1 turtle. The remaining eight traps had no turtles. The success rate was 0.46 turtles per trap-night.. Conditions in the inundation zone generally were not favorable for habitation by flattened musk turtles. There was a high level of sedimentation and very few areas with suitable cover. Conditions were worse further upstream. The densest known stream population occurs several miles upstream, well past the zone of inundation, so it is reasonable to assume the conditions become more favorable beyond the influence of the reservoir.

On September 17, 2003, eight traps were set South of the Hwy 278 Bridge and 3 turtles were captured. One trap had 2 turtles, one trap had 1 turtle, and the remaining five traps had no turtles. The success rate was 0.62 turtles per trap-night.

Figure 6 shows a pin in the location of each of the traps set by boat along the Sipsey Fork Branch of Smith Lake and in the inundation zone of the Sipsey Fork. Figure 7 shows one dot for each turtle captured in those traps. Table 1 shows each individual capture and its associated meristic and demographic data.

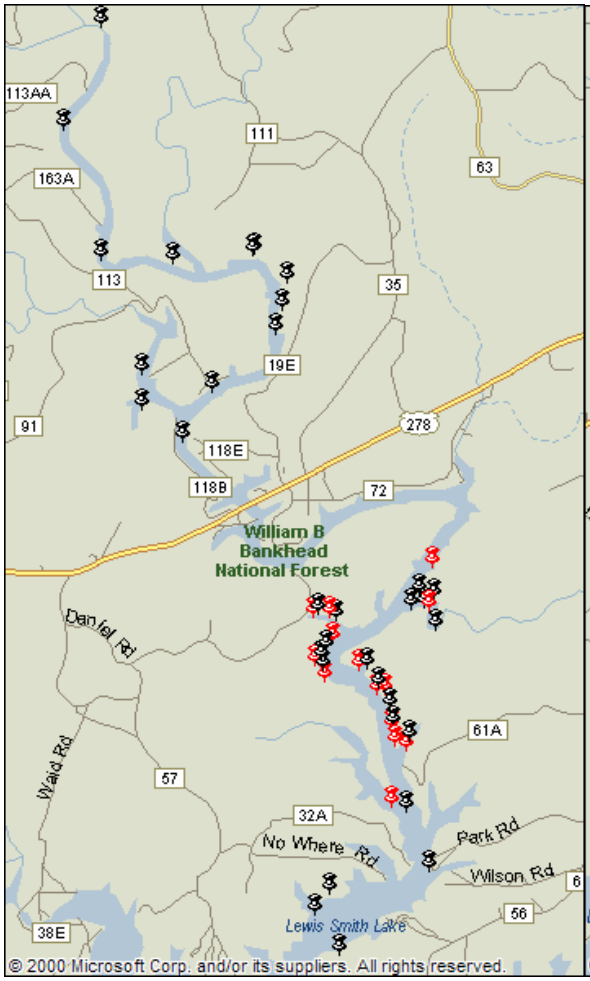

Figure 6—Traps set by boat--Sipsey Fork
Red = 2002; Black = 2003

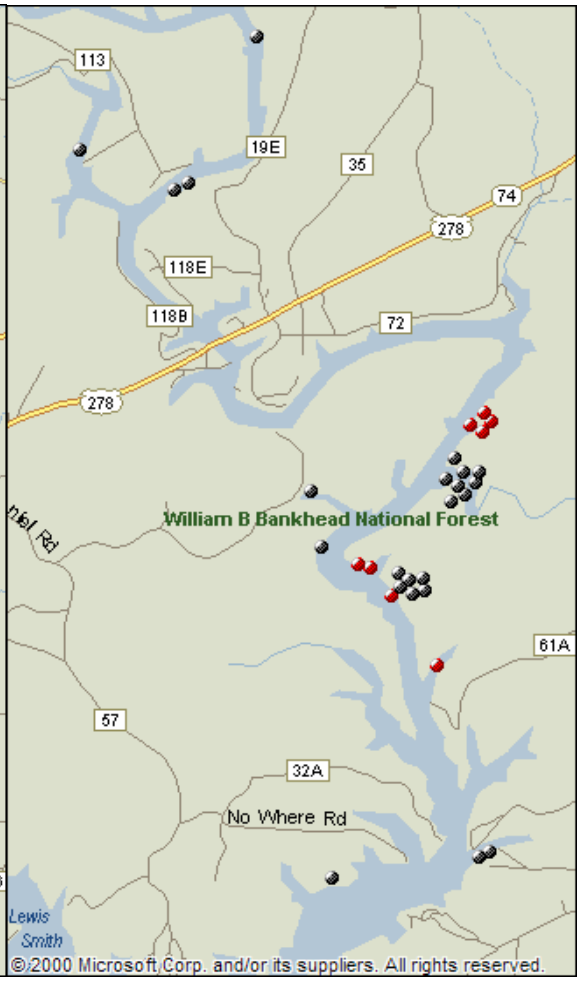

Figure 7—Turtles trapped by boat—Sipsey Fork
Red = 2002; Black = 2003

Table 1

TURTLES TRAPPED BY BOAT IN THE SIPSEY FORK BRANCH OF SMITH LAKE						
Specimen number	**Date**	**Sex**	**Carapace Length**	**Weight**	**Oviductal eggs**	**General Condition**
4349095345	8/15/02	FEMALE	93	104	No	Excellent
4369464016	8/15/02	FEMALE	92	106	No	Excellent
4369553623	8/15/02	FEMALE	96	98	No	Excellent
4369702E14	8/15/02	FEMALE	93	90	No	Good
43491C5331	8/15/02	FEMALE	94	91	No	Excellent
43697E2163	8/15/02	FEMALE	92	102	No	Good
NOT MARKED	8/15/02	FEMALE	91	100	No	Excellent

434A196347	8/15/02	MALE	86	78	N/A	Excellent
43674B0B50	8/15/02	MALE	87	85	N/A	Excellent
4348117414	8/23/03	FEMALE	90	88	No	Excellent
4369425901	8/23/03	FEMALE	97	108	No	Excellent
4369547E08	8/23/03	FEMALE	101	136	No	Excellent
434A325527	8/23/03	FEMALE	79	56	No	Excellent
436953164B	8/23/03	FEMALE	83	62	No	Excellent
43696B392F	8/23/03	FEMALE	93	unrecorded	No	Excellent
4369704B57	8/23/03	FEMALE	92	102	No	Excellent
434807134	8/23/03	MALE	78	unrecorded	N/A	Excellent
4369670E04	8/23/03	MALE	94	100	N/A	Excellent
43484E510B	8/23/03	MALE	74	50	N/A	Excellent
43491D5874	8/23/03	MALE	88	86	N/A	Excellent
43687B3458	8/23/03	MALE	82	68	N/A	Excellent
436909634B	8/23/03	MALE	60	26	N/A	Excellent
43691B2A5C	8/23/03	MALE	93	98	N/A	Excellent
4369472A0A	8/23/03	MALE	92	104	N/A	Excellent
43694E1800	8/23/03	MALE	86	72	No	Excellent
43485F3A58	8/24/03	FEMALE	101	142	No	Excellent
4348750D0F	8/24/03	FEMALE	83	62	No	Excellent
4367637271	8/24/03	MALE	80	57	N/A	Excellent
43476C2637	8/24/03	MALE	95	91	N/A	Excellent
436959002B	8/24/03	MALE	89	79	N/A	Excellent
43696D372C	8/24/03	MALE	99	111	N/A	Excellent
43477F0708	9/17/03	MALE	98	112	N/A	Excellent
4368781F79	9/17/03	MALE	84	68	N/A	Excellent
UNRECORDED	9/17/03	MALE	95	110	N/A	Excellent

b. Brushy Creek Branch

Traps were set by boat on the Brushy Creek Branch of Smith Lake on two separate occasions. A total of nineteen traps were set and a total of 10 turtles were captured. The success rate was 0.53 turtles per trap-night. One (10%) turtle was <70mm in CL and 2 (20%) were between 70mm and 80mm CL. This shows that at least some recruitment has taken place in this site. The ratio of males to females was 4:1 here.

Seven traps were set on August 22, 2002 and 2 turtles were captured in one trap. The success rate was 0.29 turtles per trap-night. On October 11 of the following year, twelve traps were set and 8 turtles were captured. Three traps had 2 turtles and two traps had 2 turtles in them. All seven of the traps that had no turtles were placed in one large cove south of the rest of the traps. The habitat in that cove looked very promising. It was surprising that no turtles were captured there.

Figures 8 shows a pin in the location of each of the traps set by boat along the Brushy Creek Branch of Smith Lake. Figure 9 shows one dot for each turtle captured in those traps. Table 2 shows each individual turtle captured and the associated meristic and demographic data.

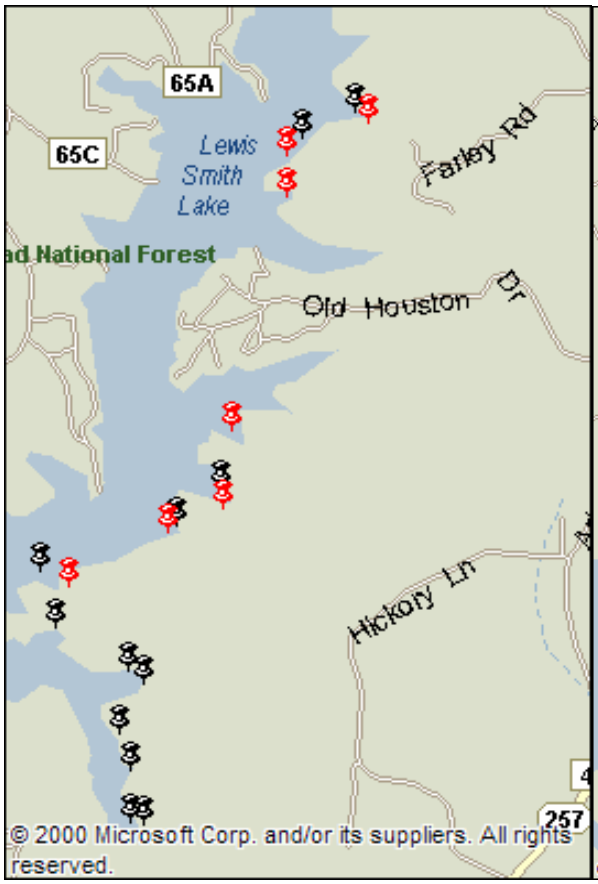

Figure 8—Traps set by boat—Brushy Creek
Red = 2002; Black = 2003

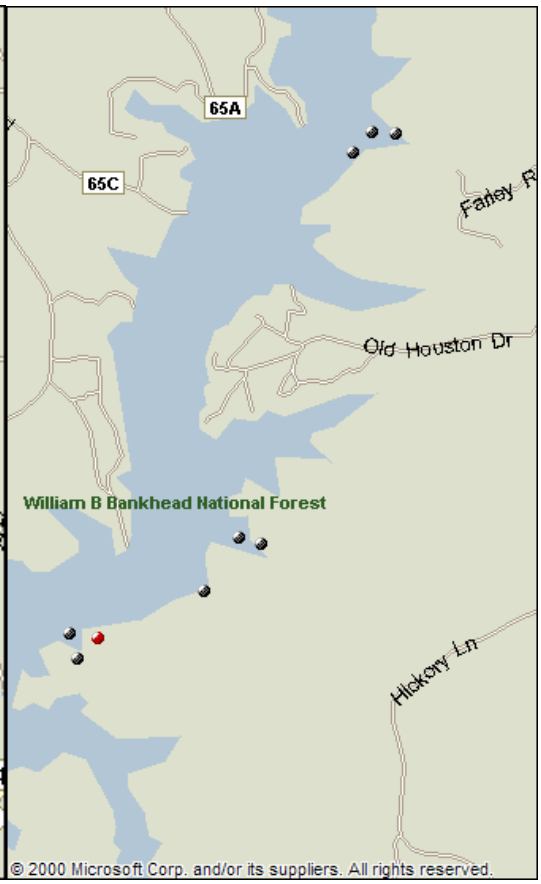

Figure 9—Turtles trapped by boat—Brushy Creek
Red = 2002; Black = 2003

Table 2

TURTLES TRAPPED BY BOAT IN THE BRUSHY CREEK BRANCH OF SMITH LAKE						
Specimen number	**Date**	**Sex**	**Carapace Length**	**Weight**	**Oviductal eggs**	**General Condition**
43491B017D	8/22/02	MALE	66	38	N/A	Excellent
43677E6636	8/22/02	MALE	79	63	N/A	Excellent
436955300D	10/11/03	FEMALE	94	99	No	Excellent
UNRECORDED	10/11/03	FEMALE	72	46	No	Excellent
4347544661	10/11/03	MALE	95	102	N/A	Excellent
43475A1E1C	10/11/03	MALE	95	95	N/A	Excellent
4349050A7C	10/11/03	MALE	101	112	N/A	Excellent
4369486F62	10/11/03	MALE	95	106	N/A	Excellent
4369490A35	10/11/03	MALE	85	66	N/A	Excellent
436969267D	10/11/03	MALE	94	98	N/A	Good

2) Traps set in land-accessible intensive sites

One site that was easily accessible by land was trapped intensively on both the Sipsey Fork and Brushy Creek branches of Smith Lake. The cove immediately north of the Houston Campground swimming area was chosen for the Sipsey Fork branch, and the area near the Hwy 63 Bridge was chosen for the Brushy Creek Branch.

a. Sipsey Fork branch near Houston Campground swimming area

This site was a deep cove that terminated in a small stream with a beaver dam on it. Beavers were occasionally seen swimming in the area. The edges of the cove had shelf-like rocks underwater which can provide suitable cover for flattened musk turtles. The banks were composed mostly of broken rocks and mud. The area was surrounded by mixed pine/hardwood forest. The cove was located approximately 100 meters north of the bathhouses and parking lot at the Houston Campground.

A total of twenty-seven traps were set in this site between August 12, 2003 and October 12, 2003. There were 5 turtles captured during this time, one of which was captured twice, for a total of 6 captures. Table 3 shows each of the turtles and the associated meristic and demographic data. The success rate at this site was 0.22 turtles per trap-night. One of the 6 turtles captured was a small (<60mm CL) juvenile. This shows evidence of recent recruitment in the area. There was a 4:1 ratio of males to females at this site.

Table 3

TURTLES TRAPPED IN THE COVE NORTH OF THE HOUSTON CAMPGROUND SWIMMING AREA IN THE SIPSEY FORK BRANCH OF SMITH LAKE						
Specimen number	**Date**	**Sex**	**Carapace Length**	**Weight**	**Oviductal eggs**	**General Condition**
4369770A72	8/13/03	FEMALE	88	86	No	Excellent
4369103911	8/13/03	MALE	88	90	N/A	Good
4369103911	8/14/03	MALE	88	90	N/A	Good
NOT TAGGED	9/30/03	JUVENILE	56	24	N/A	Excellent
434805790B	9/30/03	MALE	95	108	N/A	Excellent
4348554713	10/13/03	MALE	90	94	N/A	Excellent

b. Brushy Creek at Highway 63 Bridge

This site was accessible by a dirt road and seemed to be a popular place for teens to go swimming. This area was part of the main course of the lake, rather than a cove. The banks were composed entirely of large layered shelf-like rocks, both above and below the waterline. Housing developments are being built in the immediate area. Traps were set on the south bank to the east and west of the bridge.

Seven traps were set here in August of 2002 and 3 turtles were captured. An additional 40 traps were set between July 23 and September 30 of 2003. During that time, nine turtles were captured, one of which was captured twice. Table 4 below contains the associated meristic and demographic data. Overall, there were 13 captures in 47 trap-nights for a success rate of 0.28 turtles per trap-night. None of the turtles captured at this site were less than 80mm CL. The character of the banks here did not appear to be suitable for nest digging, though little is known about the nesting preferences of flattened musk turtles. The ratio of males to females at this site was 0.8:1.

Table 4

TURTLES TRAPPED NEAR THE HIGHWAY 63 BRIDGE OVER THE BRUSHY CREEK BRANCH OF SMITH LAKE						
Specimen number	**Date**	**Sex**	**Carapace Length**	**Weight**	**Oviductal eggs**	**General Condition**
43697C3677	8/22/02	FEMALE	102	143	No	Excellent
434A360F5E	8/22/02	MALE	82	60	N/A	Excellent
4369686C62	9/10/03	FEMALE	97	118	No	Excellent
4367542478	9/10/03	MALE	104	134	N/A	Fair

436971506C	9/10/03	MALE	99	unrecorded	N/A	Fair
43694C2A2E	9/11/03	FEMALE	91	96	No	Excellent
4369686C62	10/1/03	FEMALE	97	114	No	Excellent
43696F511F	10/1/03	FEMALE	97	104	No	Excellent
43675F2478	10/1/03	MALE	103	138	N/A	Good

3) Overall trap success in Smith Lake

During this two year study, a total of 142 traps were set in the Sipsey Fork and Brushy Creek branches of Smith Lake. A total of 59 flattened musk turtles were captured: 34 males, 24 females, and one juvenile too young to be sexed. The sex ratio was 1.42 males per female. The success rate was 0.42 turtles per trap-night. The overall success rates in the Sipsey Fork and Brushy Creek branches were 0.52 turtles per trap-night and 0.29 turtles per trap-night, respectively. The overall trap success is summarized in Table 5 below. Because the populations in Smith Lake are not homogenous and trap placement was not random, trap placement may have had an effect on success rates. The ratio of males to females in the Sipsey Fork branch was 1.3:1, and in the Brushy Creek Branch it was 1.7:1.

Table 5—Overall Trap Success at Smith Lake

Site	Males	Females	Juvenile/ Sex Unknown	Total Number Turtles	Trap-Nights	Turtles/ Trap-Night
Sipsey Fork Branch of Smith Lake	22	17	1	40	76	0.52
Brushy Creek Branch of Smith Lake	12	7	0	19	66	0.29
Smith Lake Totals	34	24	1	59	142	0.42

There are historical records of flattened musk turtles in both branches of Smith Lake. In 1981, Mount set twelve traps in the Sipsey Fork branch of Smith Lake and captured 9 flattened musk turtles (Mount, 1981). His success rate was 0.75 turtles per trap-night, which is higher than the 0.29 rate in this study. In 1983, Ernst et al. set eight traps in the Sipsey Fork Branch of Smith Lake and ten traps in the Brushy Creek Branch (1983). They captured 2 turtles in Sipsey Fork and 13 turtles in Brushy Creek (Ernst et al., 1983). The success rate in the Sipsey Fork was 0.25, which is less than the rate from this study; however, the success rate at the Brushy Creek branch was 1.3, which is higher than what we found in the current study. Because only a few traps were set in Smith Lake in each of these earlier studies, the success rates cannot be compared to those of the current study with a high degree of confidence.

In 2002, Karan and Mark Bailey set traps in 20 sites throughout Smith Lake (Bailey and Bailey, 2003). Turtles were only captured in 3 sites: 2 sites in the Ryan Creek branch and 1 site in the Rocky Creek Branch (Bailey and Bailey, 2003). In a total of 290 trap-nights, 8 turtles were captured (Bailey and Bailey, 2003). The overall success rate was 0.028 turtles per trap-night (Bailey and Bailey, 2003) One of the Ryan Creek branch sites had a success rate of 0.2 turtles per trap-night when considered alone (Bailey and Bailey). During the Bailey and Bailey study, traps were set in 5 sites in the Sipsey Fork Branch and in 2 sites in the Brushy Creek Branch; however, no flattened musk turtles were captured in these sites (2003).

4) Recruitment

Recruitment of juveniles into a population is essential to its long-term viability. Because most of the trapping was done post-breeding season, no flattened musk turtle nests were located during this study and no gravid females were captured. The size class distribution of the 49 turtles captured in Smith Lake during this study was compared to the size class distribution of the 120 turtles found in the oligotrophic stream areas of the Sipsey Fork and Brushy Creek upstream of Smith Lake in the Black Warrior Wildlife Management Area and at the Mimm's canoe access point of Sipsey Fork at Highway 33 (Rogers and Marion, 2004). Chi^2 analysis showed that the size class distribution of the 2 habitat types differed significantly ($p = 0.0000203$). Turtles less than 80mm in carapace length (CL) can be considered evidence of recruitment in the population, while those less than70mm in CL can be considered evidence of recent recruitment. These smaller size classes are represented by the purple, red, and pink in Figure 10. In Smith Lake, 87% of the turtles captured were in the larger size classes compared to 59% in the stream populations. More than 60 percent of the turtles captured in Smith Lake were over 99mm CL range, compared to 26% of the turtles captured in the stream habitat. Only 5% of the turtles captured in Smith Lake were less than 70mm CL, whereas in the stream habitat this size class comprised 19% of the population.

One third of the 9 turtles captured by Mount in 1981 in the Sipsey Fork Branch of Smith Lake were less than 75mm in CL, compared to 8% in the current study (Mount, 1981). The CL of the thirteen turtles captured in the Brushy Creek Branch of Smith Lake in 1983 ranged from 56 to 93mm CL (Ernst et al. 1983). The turtles captured by Bailey and Bailey in the Ryan Creek and Rock Creek branches of Smith Lake ranged from 43 to 93mm in CL; however only 1 turtle (13%) was under 75mm CL (Bailey and Bailey, 2003). The 43mm juvenile indicated recent recruitment in the Ryan Creek branch (Bailey and Bailey, 2003).

The data show that fewer turtles from smaller size classes were captured in Smith Lake than in nearby stream sites during this study. This could indicate that recruitment in Smith Lake does not compare favorably with recruitment in the stream habitat in which flattened musk turtles evolved. It is possible that recruitment in Smith Lake is not sufficient for the long term viability of populations in Smith Lake.

There are a number of possible reasons for the difference in size class ratios between the lake and stream populations. It is possible that while there is an abundance of *Corbicula* available for adults to prey on, the softer bodied prey of

juvenile flattened musk turtles is in limited supply in the reservoir. It is also possible that there are fewer favorable nesting sites in the lacustrine environment, or that there are more nest predators than in the stream environment in which flattened musk turtles evolved. Seasonal fluctuations in the water level of Smith Lake, such as low pool in the wintertime, could also have unforeseen effects on recruitment. Since very little is known about the nesting preferences of flattened musk turtles, work specifically designed to determine their nesting requirements is needed. Once the nesting preferences are known, it may be possible to determine what effect, if any, the lacustrine environment is having on nest success and juvenile recruitment.

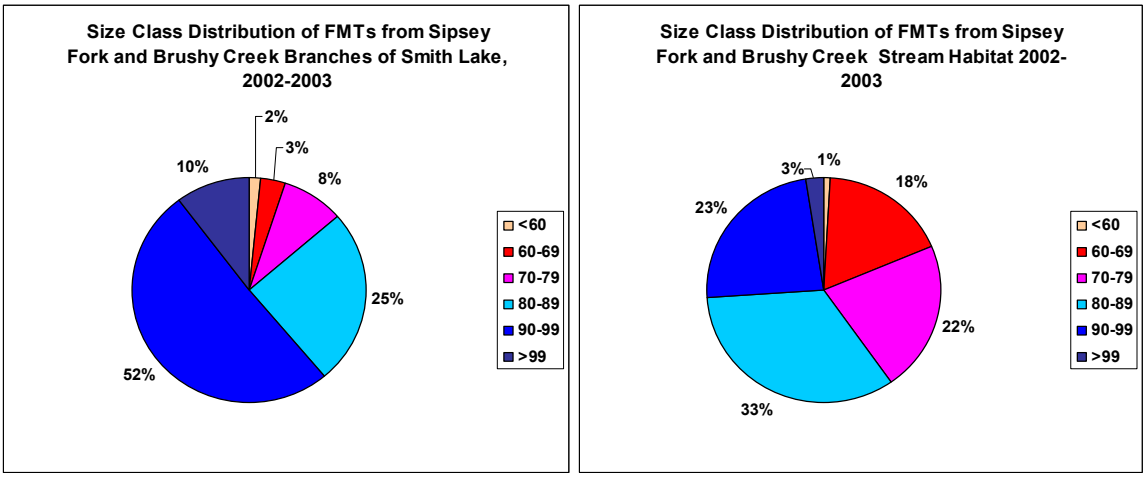

Figure 10—Comparison of size class distributions in lake vs. stream populations

Flattened musk turtles occur in Smith Lake in isolated coves and pockets with suitable cover such as the shelf-like rocks seen in Figure 2. There are records from previous studies of the species' occurrence in Smith Lake (Mount, 1981); (Ernst et al., 1983). They are not strong swimmers and it is unlikely that they are able to traverse the deep, cold areas of the lake between favorable coves. This fragmentation of the habitat may be causing population isolation. Flattened musk turtles can be notably absent from some coves that appear to have suitable characteristics, such as the southern-most cove that was trapped in the Brushy Creek Branch of Smith Lake (Figures 8 and 9). In summary, while some recruitment is occurring in the reservoir, it does not compare favorably with nearby stream populations (Figure 10). This could conceivably result in long-term viability problems. Studies in the near future should focus specifically on the nesting requirements of flattened musk turtles.

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