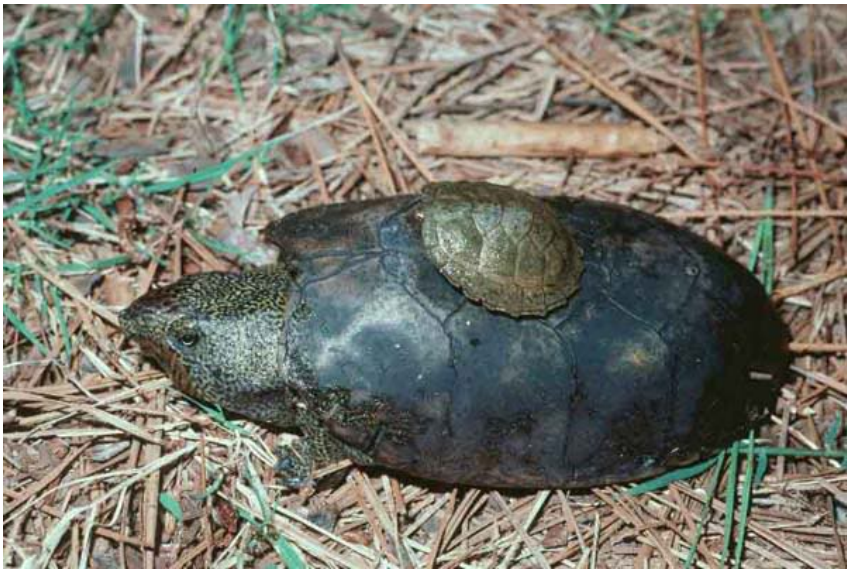
Flattened Musk Turtle
(*Sternotherus depressus*)

5-Year Review:
Summary and Evaluation



Photograph of an adult and juvenile flattened musk turtle (United States Geological Survey).

U.S. Fish and Wildlife Service
Southeast Region
Mississippi Ecological Services Field Office
Jackson, Mississippi

5-YEAR REVIEW

Flattened musk turtle (*Sternotherus depressus*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to historic and current distributions, life history, and habitats of this species. We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period (74 FR 31972). We conducted an internet search, reviewed all information in our files, and solicited information from all knowledgeable individuals including those associated with academia and State conservation programs. Our sources include the final rule listing for this species under the Act; the recovery plan; peer reviewed scientific publications; unpublished field observations by Service, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. The completed draft was sent to the other cooperating Service office and three peer reviewers for review. Comments were evaluated and incorporated into this final document as appropriate (see Appendix A). We did not receive any public comments during the 60-day open comment period.

B. Reviewers

Lead Region – Southeast Region: Kelly Bibb, 404-679-7132

Lead Field Office –Mississippi, Ecological Services: Daniel J. Drennen, 601-321-1127

Cooperating Field Office - Alabama, Ecological Services: Jeff Powell, 251-441-5858

C. Background

1. **Federal Register Notice citation announcing initiation of this review:** July 6, 2009 (74 FR 31972)

2. **Species status:** Declining. Population numbers have declined in various reaches in between historical sample sites. Data from those same sites in 2012 indicated a 32-56% chance of extinction in the historical sites (Rissler and Scott 2014). Coal mining and non-sustainable land management practices with related water quality and quantity threats continue to escalate. Species is long lived and adults are sporadically found but population age/size metrics, especially of juveniles and hatchlings, are not well known. No population viability analysis (PVA) has been completed and known populations lack temporal population metrics.

3. **Recovery achieved: 1** (0-25% recovery objective achieved)
Known population estimates within the current range are incomplete. Recent information suggests declines in the juvenile cohort of the populations, and/or

inadequacy of trapping methods (Marion 2014 pers. comm., Ernst *et al.* 1989). Significant gaps in known data of the flattened musk turtle (FMT) population structure exists.

4. **Listing history**
   Original Listing
   FR notice: 52 FR 22418
   Date listed: June 11, 1987
   Entity listed: species
   Classification: Threatened

5. **Associated rulemakings:**
   Not applicable

6. **Review History**:
   Recovery Plan: 1990
   Recovery Data Call: 2013, 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, and 2000
   Five Year Review: November 6, 1991
   In this review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in- depth assessment of the five factors as they pertained to the different species' recovery. In particular, no changes were proposed for the status of this animal in the review.

7. **Species' Recovery Priority Number at start of review: 14**
   Degree of Threat: Low
   Recovery Potential: High
   Taxonomy: Species

8. **Recovery Plan:**
   Name of plan: Flattened Musk Turtle (*Sternotherus depressus*) Recovery Plan
   Date issued: February 26, 1990

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. **Is the species under review listed as a DPS?** No

2. **Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy?** No

B. Recovery Plan and Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes, there is a final approved Recovery Plan (1990).

2. **Adequacy of recovery criteria.**

Do the recovery criteria reflect the best available (i.e., most up-to date) information on the biology of the species and its habitat? No. The recovery criteria are based on data that is 24 years old (1990 Recovery Plan) and are not specific to conservation actions necessary to recover specific populations in various reaches within the species range. Snap shots since the early 1980's of population dynamic metrics indicate declines, especially in adult males, even at non-impacted sites, and there appears to be a steady decline in capture rates, and sex and age ratios.

The recovery objectives are vague and are difficult to measure. For example, a minimum viable population (the lowest population below which growth in the population is negative) is not defined nor are metrics for PVA (Patterson and Murray 2008; Ralls *et al.* 2002) such as age/sex ratios, age classes, collection numbers, mortality and natality. There is no statistical basis to propose the 12 protected viable populations of the species (as stated in recovery plan) as a benchmark (with reliable confidence intervals) indicating the health of the species. There are no inclusion of factors for persistence in populations and no taking into account stochastic factors (demographic, environmental and genetic) and deterministic factors (habitat loss based on land management and water quality and water quantity threats).

No mention of sustainability of the species populations is considered. Sustainability is the use of resources so that the resource is not depleted or permanently damaged (Lacy 2012). Maximum sustainable yield population is the population size that yields the maximum growth. The quality of habitat determined for the species by gradient/sediment comparisons of stream reaches (Guthrie 1986) as stated in the FMT Recovery Plan (1990), is inadequate and needs clarification or to be replaced.

Thus, recovery criteria for the flattened musk turtle (FMT) are inadequate and should be revised to better address population viability including the collection of metrics for PVA and an estimate of minimum and maximum sustainable yield of the populations over time. These statistics are needed in order to make decisions concerning the species and habitat management.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Not entirely.

All recent threats (see Five Factor Analysis), along with those listed in the FMT Recovery Plan (U.S. Fish and Wildlife Service 1990), are not sufficiently

addressed by the recovery criteria. It is not known how completion of recovery criteria, as described in the recovery plan, will impact FMT populations, in light of no definition or overall conservation strategy for the management of viable (Patterson and Murray 2008; Ralls *et al.* 2002) and sustainable populations of this species (Lacy 2012). Measured species populations' statistics inside significant and reliable confidence intervals are not addressed in the recovery plan.

The recovery criterion does take into account the 5 listing factors. Since the 1990 FMT Recovery Plan, there has been important new information. However, this information addressed some metrics of FMT biology, natural history, status, and threats (Melancon *et al*. 2013, Holmes 2005, Rogers and Marion 2004 a., b., Bailey and Guyer 1998, Schnuelle 1997, Dodd 1990, Dodd *et al*. 1988) and should be incorporated into the species recovery plan.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The criterion for delisting the FMT is:

> The demonstration of viable populations of the species over a 10-year period in at least 12 streams.

Status: Criteria have not been met.

Rissler and Scott (2014, 2012) found the species within 12 reaches of the Sipsey Fork, Upper Black Warrior River and Mulberry Fork; persisting in the Sipsey Fork, especially in the Bankhead National Forest; to be nearly extirpated or extirpated from the Mulberry and Locust Forks of the Black Warrior River basin; and new populations in Lost Creek and Lake Nicol (Mulberry drainage below the confluence with the Sipsey Fork and Upper Warrior River drainage). However, only four of the 12 reaches (Sipsey Fork, Brushy Creek, Blackwater Creek, and Blackburn Fork) appear to have characteristics consistent with a viable population (i.e. adequate size and age class structure). Nonetheless, there has been no long-term monitoring over a 10-year period to document viability in these locations.

Incorporated in the FMT recovery plan (U.S. Fish and Wildlife Service 1990) as the basis for minimum recovery of the species, as reflected in the criteria, was the use of Guthrie's (1986) proposed modifications of a regulatory formula (Mount 1981) to estimate the presence and health of FMT populations (expressed as species number collected per unit effort) related to geomorphic characters, silt and habitat quality within 10 known habitat reaches. This method does not relate the species populations to a minimum viable population (the lowest population below which growth in the population is negative) with defined statistical metrics (Patterson and Murray 2008; Ralls *et al.* 2002), and is inadequate to use as a basis for both designating and protecting the 12 streams identified in the recovery criteria.

C. Updated Information and Current Species Status

1. Taxonomy

Sternotherus depressus was originally described as a full species (Tingle and Webb 1955); relegated to a subspecies of *S. Minor* (loggerhead musk) (Wermuth and Mertens 1977, 1961); later thought to be an intermediate of two species (Estridge 1970, Mount 1975); and returned to its status as a distinct species in 1991 (Seidel and Lucchino 1988, Iverson 1991, Walker and Advise 1998). Pauly and Shaffer's (2010) and Rissler and Scott (2014) phylogenetic analysis of the species involving gene sequencing indicates that the species is a unique, strongly differentiated lineage with a sturdy species specification.

2. Species Range

Historically, the FMT range was found in the upper Black Warrior River drainage above the Fall Line in north-central Alabama, encompassing portions of Blount, Cullman, Fayette, Jefferson, Tuscaloosa, Walker and Winston counties. According to Dodd (1990), the species disappeared from more than 50% of its estimated historic range, and most remaining populations are fragmented by degraded habitat. At the time of listing in 1987, the FMT was known from less than one-half of the approximately 125 sites in the Black Warrior River upstream of the Bankhead Dam (52 FR 22418).

Most population monitoring has focused within the William Bankhead National Forest (Sipsey Fork and Brushy Creek in the Sipsey drainage) which encompasses about 11% (161 km; 100 mi) of the species' range (Melancon *et al*. 2013). Rissler and Scott (2014, 2012) found the species within 12 reaches of the Sipsey Fork, Upper Black Warrior River and Mulberry Fork; to be nearly extirpated or extirpated from the Mulberry and Locust Forks of the Black Warrior River basin; persisting in the Sipsey Fork, especially in the Bankhead National Forest; and new populations in Lost Creek and Lake Nicol (Mulberry drainage below the confluence with the Sipsey Fork and Upper Warrior River drainage). However only four streams (Sipsey Fork, Brushy Creek, Blackwater Creek, Blackburn Fork) may have basic characteristics of viability.

Unpublished capture and survey accounts include Pauly's (2009 pers. comm.) finding of three individuals at Blackburn Fork of the Little Warrior River (Blount County) in August 2009 and two individuals from the North River and Blue Creek (Tuscaloosa County) (Pauly 2009 pers. comm.). Ernst (*et al.*1989) reported low densities of FMT in upper Turkey Creek (Jefferson County) and moderate density in the lower section. Recently an anecdotal observation of a solitary FMT (Stiles 2006 pers. comm.) may indicate low population numbers or remnant individuals existing. However, Rissler and Scott (2012) did not find FMTs in Turkey Creek. The species is found above and below the Lewis Smith Lake

Reservoir (Rogers and Marion 2004a) and at some reservoir sites that have good water quality and habitat. Reproducing FMT populations of low to moderate densities were reported at these sites by Marion and Bailey (2004).

The species is limited throughout its current range to areas minimally impacted by pollution, sedimentation and impoundments (Dodd 2008). Collection data from Ernst *et al*. (1989) and K. Bailey (2010 pers. comm.), suggests that the upper more northerly distribution limit of the species is within the Sipsey Fork at the Sipsey River Recreation Area and Granal Road.

3. Habitat

The FMT prefers clear and shallow water (to 1.5 m (4.9 ft.)), rocky bottom substrates with rock crevices, alternating shallows, deeper pools, pools with some current, low silt, minimal nutrients and pollution, and a moderate temperature (Ernst and Lovich 2009, Dodd 2008). The species are poor swimmers and usually depend on sinking to the bottom and crawling along the substrate (Ernst and Lovich 2009). The FMT prefers large streams of order >3 (summarized in Dodd 2008). Streams of the >3 order, are larger than those of order 1 and 2 (Zaimes and Emanuel 2006). The FMT probably occurred in most >3 order stream and river reaches (Dodd 2008) with appropriate habitat (Ernst and Lovich, 2009).

More than 15 years ago, Schnuelle (1997) compared some demographic characteristics of FMTs in non-impacted to impacted sites and documented a continued decline in the species' population demographics in all impacted and in some non- impacted sites. Dodd (1990) estimated that only 6.9% of historically suitable habitat contained turtle populations unaffected by severe habitat degradation. The remaining 93% was either severely degraded or was no longer suitable for the FMT (Dodd 1990).

4. Population Biology

In all studies throughout the species range, population age and size classes seemed to be skewed heavily toward adults, although there is no significant difference in the abundance of FMT between Lewis Smith Lake Reservoir and stream locations sampled by Melancon *et al.* (2013). However the population-size /age class structure of the species is different and heavily slanted towards larger and presumably older individuals (Melancon *et al.* 2013).

Most FMT trapped and marked for baseline population metric studies were done so at sites common to the researchers projects (Dodd 2008), and were a side note to other aspects of the species natural history or ecology. Because of this random analysis of various populations, current baseline population data is dissimilar, both spatially and temporally, throughout the species known range. Associated with this dissimilarity, Rissler and Scott (2014) related historically sampled sites (Ernst *et al.*1983, and Mount 1981) from the 1970's and 1980's to 2012 sampled

data, and found that the current populations to have a 32-56% chance of major decline or having gone extinct since the original historical studies.

a. FMT Populations in Lentic (impoundment) Habitat

Within the Lewis Smith Lake Reservoir, remnant populations of FMTs at the confluence of tributaries to the reservoir may have advanced into appropriate lake habitats, adding to the existing isolated surviving FMT population (Alabama Power Company 2013). Previous studies have shown that these isolated populations persist in the reservoir primarily in the impounded arms of the major inflowing streams (Bailey and Bailey 2003, Ernst *et al*.1989, Mount 1981). These populations are separated from each other by extensive reaches of deep water with steep, often near vertical shorelines that turtles cannot ascend to leave the water (Melancon *et al*. 2013). This relief effectively fragments the reservoir populations due to the unsuitable habitat, and the poor swimming ability of the species (Ernst *et al.* 1989). It is possible that FMT are not migrating into Lewis Smith Lake Reservoir; but are reproducing within the reservoir area (Cochran pers. comm. 2014).

The factors limiting nesting habitat and rearing habitat are unknown but may be related to reservoir level changes especially during winter where overwintering turtles may freeze due to winter water drawdowns (Cochran pers. comm. 2014). Alabama Power Company (2013) ranked FMT aquatic habitat suitability along the margins of Lewis Smith Lake Reservoir (from the normal full-pool shoreline to the normal full-pool depth of 4.6 m (15 ft.) and identified stretches of shoreline unavailable for nesting. As expected, the species were found in good and moderate habitat as to poor habitat. Some female individuals were radio tagged and were noted to move in June-July from 6.1 m (20ft.) to 184 m (603 ft.), from steep rocky habitat to more gently sloping sandy banks and possibly suitable nesting habitat. Reproducing populations of low to moderate densities are above and below Lewis Smith Lake Reservoir (Rogers and Marion 2004a) and at some reservoir sites that have good water quality and habitat (Marion and Bailey 2004). Melancon (*et al*. 2013) found no significant differences in the abundance of FMTs between the reservoir and stream locations sampled. However, significant differences were found in population-size and structure between habitat types, indicating little or no reproduction and /or recruitment in the reservoir populations based on carapace (shell growth) length. Melancon *et al*. (2011) found that FMT grew slower than most kinosternids, and based on the von Bertalanffy growth-curve analysis, reached an age of 40-60 years. The larger reservoir individual FMT likely began life as stream residents. Recruitment and survival of younger FMT individuals is low in reservoir populations and may be based on the lack of food for juveniles and reservoir management (Melancon *et al*.2013). The remaining adult populations may not be sustainable and may likely decline in abundance over the long term.

b. FMTs Populations in Lotic (stream and river) Habitat

In stream and river habitat, the species tend to be smaller size classes from those found in lentic or impoundment habitat. Gravid females and some nests were reported by Holmes and Marion (2002) and others within the last 15 years. Moran (2010) reported a juvenile FMT and its habitat as shallow water <=60 cm (23.6 in) and a predominately sandy substrate in Brushy Creek. An overall decrease in juveniles noted in studies from pre-1970's until present suggests that recruitment is not sufficient to maintain long term viability of FMT (Melancon *et al.* 2011). Rissler and Scott (2012) sampled portions of the North River, Blue Creek, and Yellow Creek from the North Black Warrior drainage, and Lost and Blackwater Creek of the Mulberry drainage and reported that these reaches contained viable populations, but no definitive definition of viable populations were given. Without recruitment information based on size intervals of juveniles it is impossible to determine the viability of any of the populations within a reliable statistical confidence interval (Patterson and Murray 2008; Ralls *et al.* 2002).

Melancon (*et al*. 2011) used the von Bertalanffy growth equation curve, comparing age and size, to look at some metrics of the population of the species in the Sipsey Fork and Brushy Creek (Winston County) populations. The von Bertalanffy growth curve or function describes the change in body size in the form of length and weight over time to derive various life-history and population parameters (Pardo *et al* 2013). Melancon (*et al*.2011) found that female FMTs grow faster in early life than males possibly indicating that the early accelerated female growth rate may represent an adaptive strategy to reach egg-bearing size and minimize risk of female mortality. The male growth rate is steady through life. Melancon (*et al.* 2011) believed the males use more energy searching for mates rather than in growth.

c. Population Metrics

No status survey has adequately analyzed population viability (PVA) and sustainability (Hays and McBee 2010, Marchand and Litvaitis 2004, Reed *et al.* 2003, Bodie 2001). Some metrics and population parameters have been identified but insufficiently sampled within reservoir populations (Alabama Power Company 2013, 2012, 2011; Melancon *et al.* 2013, 2011; Holmes 2005) but no long term PAV has occurred.

Older survey and capture records for FMTs include Dodd *et al.* (1988) population size estimate of 600 FMTs within four major non-impacted stream habitats (Sipsey Fork, Brushy Creek, Blackwater Creek and Blackburn Fork). Dodd *et al.* (1988) considered these populations to be viable and the remaining populations at impacted sites to be non-viable (Dodd 1990). However, these conclusions were based on one year of collections, with no reliable statistical confidence intervals and may not adequately reflect the true definition of population viability that considers minimum viable adult population size, among other parameters and can

predict population growth rate per generation (Reed *et al.* 2003). Ten years later, Schnuelle (1997) and Bailey and Guyer (1998) affirmed a decline in the historical populations since 1981 and predicted that the species would eventually be extirpated within certain degraded sites

Recently information from studies over an 18-year period concerning the growth of the species was summarized and used to develop growth curves for both sexes (Melancon, *et al.* 2011). Demographic comparisons between reservoir-dwelling and stream-dwelling populations of the species, focusing on shell length as an indicator of age and recruitment within the reservoir population and impoundment habitats in general (Melancon *et al.* 2013), have highlighted some long term sustainability problems in impoundment populations but a long term PAV is necessary in order to refine the threats to specific aspects of the populations.

In summary, even though there have been numerous studies touching on various aspects of the natural history and population dynamics of the FMT, population viability has not been adequately determined for any of the species populations. Long-term monitoring over a minimum of a 10-year period is needed before the viability of any of the populations can be assessed. Research is needed to gather information on population status, numbers and structure along with geomorphic and water quality/quantity changes to ensure that populations are secure from any foreseeable threats. Additionally, other means of assessing habitat quality for the species (Hays and McBee 2010, Marchand and Litvaitis 2004, Holmes and Marion 2002, Bodie 2001) may be more appropriate than what was suggested by Guthrie (1986) in the FMT Recovery Plan (1990).

2. Five-Factor Analysis

a. Present or threatened destruction, modification or curtailment of its habitat or range:

Habitat degradation is the primary factor that has reduced the distribution of populations of the FMT in the upper Black Warrior system (U.S. Fish and Wildlife Service 1990). Specifically the habitat of the FMT has been highly degraded and fragmented by dams, reservoirs (Bankhead and Lewis Smith Lake Reservoir; Alabama Power Company 2006), smaller impoundments, industrial pollution, silviculture (USDA Forest Service 2007), agriculture, mining and urbanization (U.S. Fish and Wildlife Service 1987). The formation of Lewis Smith Lake Reservoir in 1961, six years after the description of the species, inundated 8579 ha (21,200 acres) of both bottomland and stream habitat (56 km (35 mi) long)) (Rogers and Marion 2004a). The reservoir inundated very steep gradients (*i.e.* Clear Creek Falls at Falls City was 43 feet (13.1 m) high) (McCandless, no date) and eliminated habitat for the species. The maximum depth within the lake at the dam is 264 ft. (80.5 m)). Since the species prefers clear, shallow water (to 1.5 m (4.9 ft. (Ernst and Lovich 2009, Dodd 2008), the impoundment probably eliminated

much of existing habitat in that 56 km (35 mi) of river and stream reach that were inundated.

There are no historical records of the species being located within the area of inundation before the Lewis Smith Lake Reservoir was formed in 1961. However, it is likely that the species was there considering the habitat that was inundated.

Water Quality Decline

Declining water quality is the major threat to the existence of the FMT and other aquatic species (Shepard *et al*. 2004, Shepard *et al.* 2001). Deteriorating water quality may contribute to increased suspended sedimentation and impact all trophic levels of invertebrate and macrophytic flora and fauna, which are necessary to maintain a constant food supply for the species. Sediment has been shown to impact food supply to aquatic organisms by wearing away or suffocating periphyton (organisms that live attached to objects underwater), gastropods and bivalves, disrupting aquatic insect communities, and negatively impacting fish growth, physiology, behavior, reproduction and survivability (Knight and Welch 2001, Waters 1995).

Sediment is the most abundant pollutant in the Mobile River Basin (Alabama Department of Environmental Management 1996). Sedimentation in the upper Black Warrior River system has negatively affected the FMT with the following injurious effects: (1) reduction of mollusks and other invertebrates used as food; (2) physical alteration of rocky habitats where the species forage and take cover, and (3) accumulation of substrate in which chemicals toxic to FMTs and their prey persist (Dodd *et al*. 1988). Increased sediment clogs gills of invertebrates and fish while increased water velocities carry suspended sediment that act as scrubbers, removing algae, plants and aquatic life from substrate (Waters 1995).

Non-point source pollution from stormwater runoff contributes to the overall decline of water quality and increases water quantity within the species' range. Storm water runoff can originate from virtually any land use activity and may be correlated with impervious surfaces. Pollutants (i.e. fertilizers, pesticides, animal wastes, septic and gray water, and petroleum products) tend to increase concentrations of nutrients and toxins in the water and alter the water chemistry such that the habitat and food sources for the species are negatively impacted. Construction and road maintenance activities associated with mining, urban development, forestry and agriculture typically involve earth-moving activities that increase sediment loads into nearby aquatic systems through stormwater runoff during and after precipitation events.

Durflinger-Moreno *et al*. (2006) considered water quality degradation to be the primary reason for the extirpation of the Black Warrior waterdog

(*Necturus alabamensis*), a species preferring and sharing similar habitat to the FMT (Godwin 2013), over much of its historical range in the upper Black Warrior River system.

Creation of large impoundments in the upper Black Warrior River system (Bankhead, Lewis Smith, and Holt dams) flooded thousands of square acres of habitat previously considered appropriate for the FMT and other rare species. Hartfield (1990) summarized that over 272 km (170 miles) of the main channel and tributaries of the Black Warrior River had been affected by impoundments in the Black Warrior River Basin. Impoundments do not have adequate water quality and habitat for the FMT that includes clear, shallow water (to 1.5 m (4.9 ft.)), alternating pools and riffles, flowing water, crevices and large boulders. Where habitat is still available, Ernst *et al.* (1983) reported moderate to low density of FMT populations near the mouths of tributaries in the Lewis Smith Lake Reservoir. Dodd (1990) concluded that river impoundments contributed to the species fragmented distribution.

Coal Mining Activities

The Warrior Coal Basin lies underneath the majority of the Black Warrior River watershed. This basin is the southernmost coal deposit in Appalachia and the largest coal basin in Alabama, with approximately 94 active mines in the Black Warrior watershed (Southern Environmental Law Center 2009). Surface mining affects the distribution of the FMT (Ernst *et al.* 1989, Dodd *et al.* 1986, Mount 1981).

Strip mining for coal results in erosion, sedimentation, groundwater level decline, and general degradation of water quality that affects many aquatic organisms (U.S. Fish and Wildlife Service 2000). Runoff from coal surface mining generates pollution through acidification, increased mineralization, and sediment loading. Due to high demand for coal, the Black Warrior River continues to suffer from impaired water quality of heavy metals, acids, and sediments that run off from active and abandoned coal mines.

Impacts associated with past mining activities and abandoned mines include leakage of sediment ponds and mine tailing (Mathis 2007; Diehl *et al.* 2004). Presently only operating mines are required to employ environmental safeguards established by the Federal Surface Mining Control and Reclamation Act of 1977 and the Clean Water Act of 1972 (U.S. Fish and Wildlife Service 2000).

The recently proposed Rosa and Shepherd coal mines will have more than 60 pollution discharge points into the main stem or tributaries of the Locust Fork (Southern Environmental Law Center 2009). Many new mines or rehabilitated old mines within the Black Warrior River system and the FMT's habitat range have no meaningful mitigation plan or analysis. Nonetheless

permitting of such operations continues (Black Warrior Riverkeeper memo to US Fish and Wildlife Service 2014, 2012; Black Warrior Riverkeeper memo to Corps of Engineers 2012; Black Warrior Riverkeeper memo to Alabama Surface Mining Commission 2011).

Strip-mining, heavy benthic siltation, elevated metal concentrations and altered pH levels, have resulted in habitat fragmentation of the species. These actions increase the FMT vulnerability to disturbances by altering the populations' genetic compositions and increase the probability of extirpation (Dodd 1990, U.S. Fish and Wildlife Service 1990). Ernst (*et al.*1989) found an inverse correlation between the amount of sedimentation and FMT population density but no cause and effect relationship was established. FMT populations in close proximity to coal mining have low or zero recruitment and tend to be composed of predominately adults. Dodd *et al*. (1986) found a statistically significant absence of juveniles at mine affected sites when compared with populations at mine unaffected sites. The species may eventually be extirpated from these mine areas (Bailey and Guyer 1998).

In summary, the historical loss and fragmentation of FMT habitat has occurred and is projected to continue. The decline of this habitat has been observed and documented by others (Black Warrior Riverkeeper *in litt*. 2011, 2012, 2014). Habitat loss and fragmentation amplifies threats from stochastic events such as point and nonpoint source water and habitat quality degradation, accidental spills and violations of permitted mine discharges (Southern Environmental Law Center 2009; Mathis 2007; Diehl *et al.* 2004; Dodd 1988).

b. Overutilization for commercial, recreational, scientific, or educational purposes:

Scientific collecting is not considered a threat, due to control of scientific collecting by the State of Alabama through the issuance of collection permits. However, collection for the pet trade was identified as a threat at the time of listing and continues to be a concern. Reed and Gibbons (2004) in Linderman (2008) suggested that the high vulnerability of the razorback musk turtle, *S. carinatus*, makes the FMT desirable to the pet trade. Similarly, overexploitation of the FMT for the pet trade due to its rarity has in the past caused declines in populations (Ernst and Lovitch 2009).

c. Disease or predation: Mortality from disease since 1985 has led to a decline of the species in the Sipsey Fork population (Dodd 1985). Disease symptoms in Brushy Creek, Locust Fork, and Lost Creek along with heavy metal and bacteria counts, were reported and summarized by Dodd (2008) and Fonnesbeck and Dodd (2003). Although not very well understood, disease may be a significant threat to the species. There is a potential for demographic consequences of disease outbreaks and declining populations (Gibbs and

Amato 2000). Fonnesbeck and Dodd (2003), encountered diseased turtles with shell necrosis, emaciation, lesions and other symptoms during systematic sampling for the species in the Sipsey Fork. This resulted in substantial mortality and the FMT population at this site declined by 50%, based on Jolly-Seber population estimate statistics (Fonnesbeck and Dodd 2003). The cause of the disease is unknown.

d. Inadequacy of existing regulatory mechanisms:

In addition to its listed status as threatened under the ESA, the species has been designated as a freshwater turtle at high risk of extinction (Turtle Conservation Coalition 2011), and as a NatureServe and State-level Rank protection number two (Bailey *et al*. 2006).

The FMT and its habitats are afforded some protection through Section 7 and 9 of the ESA (1974), Alabama Statutes and Codes (Section 9-11-269 Protection of FMT; Acts 1984, No. 84-261, p. 1259) and from water quality and habitat degradation under the Clean Water Act of 1972 (33 U.S.C. 1251 et seq.) and the Alabama Water Pollution Control Act, as amended, 1975 (Code of Alabama, §§ 22-22-1 to 22-22-14). Alabama follows traditional common-law riparian doctrine which associates the right to use water with ownership of land abutting the water (Elliott 2012). Additionally 756 km (470 miles) of streams in the Black Warrior Basin either do not support or only partially support their designated uses as described (Alabama Department of Environmental Management 303(d)list; Alabama Department of Conservation and Natural Resources 2005; Alabama River Alliance 2003). Because of inconsistency in implementation of Clean Water Act regulations and other best management practices, which are voluntary for some activities and mandatory for others, existing regulatory mechanisms in Alabama are still inadequate. The Federal Surface Mining Control and Reclamation Act of 1977 has been ineffective in preventing the continued decline of many species in the Black Warrior Basin, including the FMT, fishes, and mussels (Mathis 2007, U.S. Fish and Wildlife Service 2000, Bailey and Guyer 1998, Hartfield 1990, Mettee *et al*. 1989, Dodd *et al*. 1988). Federal water projects, including the construction of Bankhead, Lewis Smith, and Holt dams, have historically contributed to the decline of the species. Surviving FMT populations are negatively affected by discharges, highway construction, mining (current and un-reclaimed sites), pesticides and activities with a Federal nexus such as: roadside and bridge replacement and maintenance (Daily Mountain Eagle Newspaper 2010; Romans and Selby 2008, AST 2008, Bailey and Bailey 1999, U.S. Fish and Wildlife Service 2010, 2005, 2004 memos to Federal Highway Administration); pipeline construction and Northern Beltline construction along with supporting infrastructure (Sirmans 2014a, 2014b; Jackson 2011; Birmingham Business Alliance 2010; U.S. Fish and Wildlife Service 2006-2010) and urbanization in general (Hill 2009).

Within the Bankhead National Forest, the FMT populations are protected. Management plans include timber harvest, road maintenance and other public usages that emphasize management strategies considering and implementing protection measures regarding all aspects of the FMT biology and conservation (Cochran, U.S. Forest Service. pers. comm. email 2013).

There is available information for landowners and governmental agencies concerning general habitat management guidelines for amphibian and reptiles (Bailey *et al.* 2006). If enforced and followed, the mentioned regulations and recommendations would help reduce sediment loading in rivers, streams and other aquatic habitats (Cochran, U.S. Forest Service. pers. comm. email 2013).

In summary, regulatory mechanisms are in place to protect aquatic species, but multiple stream reaches within the occupied habitat of the FMT (i.e. portions of the Sipsey Fork, Brushy Creek, Blackwater Creek and Blackburn Fork) fail to meet current State of Alabama regulatory standards. The lack of specific information on the sensitivity of the FMT to common industrial and municipal pollutants limits the application of these regulations. In two of these stream reaches (Brushy and Blackwater creeks), according to Rissler and Scott (2014), the populations of FMT do not have any indication of gene flow from *S. minor* (loggerhead musk turtle) and were not found to have *S. minor* alleles, thereby making these two reaches essential in preserving the true genetic genome of the FMT. Therefore, existing regulatory mechanisms, as currently applied, are inadequate for the FMT.

e. Other natural or manmade factors affecting its continued existence:

The species is vulnerable to catastrophic events such as chemical spills and other water quality and quantity alterations. Populations of FMT are isolated from each other by reaches of unsuitable habitat created by impoundments, pollution, or other factors. In some of the best localities, FMT densities are low (Dodd 2009). Low population densities combined with fragmentation of habitat renders populations extremely vulnerable to inbreeding depression (negative genetic effects of small populations), stochastic and catastrophic events such as flood, drought, or chemical spills. For example, documented nesting took place under the canoe launch on Sipsey Fork at Highway 33. A heavy rain event covered the nests and eggs with a load of sand leading to their mortality (Godwin 2013 pers. comm.). Mortality of females and males during nesting foray (nest exploratory behavior) (Anthonysamy 2012, Aresco 2003, Bailey and Bailey 2002) have been documented but it is not known to what extent this impacts the population.

Determination and maintenance of baseline instream flows (AWAWG 2012; Annear *et al*. 2004) are essential in providing the necessary water quantity during the species breeding seasons and foraging for food along with

wintering habitat. Ecologically significant instream flows is fundamental in safeguarding the FMT along with the species food source. In Brushy Creek, a juvenile FMT was found by Moron (2010) in shallow and clear water over a sandy substrate and associated with the Warrior pig toe mussel (*Pleurobema rubellum*) and orange nacre mucket (*Hamiota perovalis*). Maintaining a good flow in Brushy Creek is essential in maintaining prey sources for FMT adults such as mussels (Moran 2010). Juvenile and hatchling FMTs are insectivores and require food sources dependent on adequate water flow and good water quality (Marion, pers. comm., 2014; Dodd 2008, Mount 1981). Reduction of basking habitats and benthic cover (Reese and Walsh 1998a, b; Vandewalle and Christiansen 1996) and reductions of sandbars for nesting (Tucker *et al*.1997, Johnson 1992) can result when baseline flows are reduced or habitat is inundated artificially such as a reservoir. In *S. minor* elevation above mean water level is more important for nesting localities than distance from shoreline (Cox and Marion 1978).

More study is needed to understand the ongoing hybridization and historical gene flow between S. *depressus* and *S. minor* and the possibility of induced hybridization being caused by the formation of Lewis Smith Lake Reservoir (Pauly and Shaffer 2010). Mitochondrial analysis indicates that the ancestral FMT species has historically hybridized with *Sternotherus carinatus* (razor-backed musk turtle), spotlighting the importance of introgression within the species and a nearby species, *Sternotherus minor*. Iverson (1977) suggested that hybridization between the mentioned species may have been facilitated by construction of reservoirs that converted rocky, fast flowing stream habitat (FMT habitat) to habitat preferred by *Sternotherus minor*. Additionally, Rissler and Scott (2014) found that there is a strong indication of gene flow from *S. minor* into the current range of *S. depressus* and there are only three tributaries sampled (Lost Creek, Blackwater Creek and Brushy Creek) in their study containing individuals of *S. depressus* that were not found to have *S. minor* alleles.

Currently, the Alabama Natural Heritage Program (2012) is conducting surveys on the main stem of the Sipsey Fork and its major tributaries, along with portions of the upper end of Lewis Smith Lake Reservoir. Surveying of the species by using environmental DNA are ongoing and the primer genes are being determined for the species (J. Godwin, pers. comm., 2014). Physiochemical measurements and the relationship between biotic production, prey sources, and basin geology to population metrics are being collected. Nesting and overwintering aspects of habitats of the species including radio-telemetry of adult male and female turtles are ongoing (Alabama Natural Heritage Program 2012).

D. Synthesis

Over the last 30 years, there have been a variety of studies on the FMT. These studies have provided information to partially address threats to the species; however, the recovery criteria have not been met.

FMT basic species information is limited (Ernst and Lovich 2009, Dodd 2008, Marion and Bailey 2004). Due to the lack of consistent monitoring studies at specific temporal intervals, there has been no population viability analysis (PAV) or statistically significant estimate of the species populations. Most threats to the FMT that are identified in the final rule (52 FR 22418) still remain, although there is protection of the species habitat within the Sipsey Fork and tributaries of the Bankhead National Forest (Cochran, U.S. Forest Service, pers. comm., 2013). Federally listed species are evaluated to address any effects to them by forest management practices (Counts, pers. comm., 2008). With the ongoing deterioration of water quality, expansion of urbanization, fragmented distribution caused by impoundments, small populations of FMT, and reopened old coal mines and new coal mining sites; the individual numbers within the populations seem to be declining and all populations remain vulnerable to stochastic and anthropomorphic events. Studies to monitor known populations will need to continue for at least 10 years to give an adequate picture of population viability. Therefore, the recovery criteria have not been met and the FMT continues to meet the definition of a threatened species under the Act.

III. RESULTS

A. Recommended Classification: Recovery criteria have not been met. According to the FMT Recovery Plan (1990), recovery criteria are met when there are viable populations of the species in at least 12 streams over a 10-year period. This has not been demonstrated by long-term monitoring over the 10-year period. Currently, only four of the 12 reaches (Sipsey Fork, Brushy Creek, Blackwater Creek, and Blackburn Fork) may have basic characteristics of viability but there has been no long-term monitoring to document viability over the 10-year period. Ernst *et al.* (1989) emphasized the importance of maintaining the current status of the FMT within these four reaches and if declines were noted then appropriate protection would be necessary. However, a definition of viability of the FMT populations is needed to determine viability based on the PVA within a reliable standard confidence interval over time. Additional populations of sufficient size need to be located and appropriate protection of the habitat installed.

X__ No change is needed

B. New Recovery Priority Number __8__
This species continues to support placement under "high" for degree of recovery potential; however, based on this review, a change in the degree of threat from "low" to "moderate" appears to be more appropriate at this time. Even though

four of the stream reaches are afforded protection by their location on U.S. Forest Service lands, these sites, and all remaining sites, continue to be threatened by non-point pollution from outside U.S. Forest lands, in association with non-sustainable land management practices and increased coal mining. Overall, the species appears to be declining.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Revise recovery plan. The use of Guthrie (1986) in the recovery plan should be clarified or replaced with improved statistical means of determining habitat quality related to FMT population viability.
- Continue implementing pertinent recovery actions from the FMT Recovery Plan (U.S. Fish and Wildlife Service 1990).
- Reengage FMT Recovery Group.
- Define the species' current range by a range wide status survey of historically known range and any other possible stream reaches that have not been sampled.
- Develop range wide population and habitat monitoring plan.
- Establish collection metrics for PVA and minimum and maximum sustainable yield of the populations.
- Determine and maintain instream flows within the habitat of the species.
- Support the State of Alabama comprehensive conservation strategy efforts concerning the FMT (Alabama Department of Conservation and Natural Resources 2005).
- Support the Alabama Water Watch, Black Warrior River Keeper, Partners in amphibian and reptile conservation (Bailey *et al.* 2010) and other conservation efforts within the Black Warrior River Basin (Alabama River Alliance 2003; Alabama Water Watch 2002).
- Support actions for stream and riparian management for freshwater turtles as described by Bodie (2001) and Bailey *et al.* (2006)
- Continue partnering with stakeholders (e.g. Forest Service, landowners, non-governmental organizations) in protecting FMT habitat.
- Restore degraded habitat especially with regard to storm water runoff and other non-point source pollution.
- Develop protection and management plans for all watersheds sites as indicated by information acquired from habitat and population survey studies.
- Develop and initiate captive head start and husbandry program at Atlanta/Birmingham Zoos or equivalent facility (Hill 2011, pers. comm. to Drennen)
- Support conservation, outreach and management practices with the Lewis Smith Lake Reservoir Homeowners association and watershed management group.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
OF THE FLATTENED MUSK TURTLE

Current Classification: Threatened
Recommendation resulting from the 5-Year Review:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
__X__ **No change is needed**

Review Conducted By: Daniel Drennen, Mississippi Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service, Mississippi Field Office

Approve _____ Date 7-11-14

REGIONAL OFFICE APPROVAL:

For
Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 7/17/14

Appendix A. Summary of peer review for the 5-year review of flattened musk turtle (*Sternotherus depressus*)

A. Peer Review Method: The Service conducted peer review. Three peer reviewers were selected by the Service for their knowledge of and expertise with the flattened musk turtle. Individual responses were received from two of the peer reviewers.

Peer Reviewers: Dr. Ken Marion, University of Alabama, Birmingham, Al., Dr. Leslie Rissler, University of Alabama, Tuscaloosa, AL., and Allison Cochran, U.S.D.A., Forest Service, Bankhead National Forest, Double Springs, AL.

B. **Peer Review Charge:** See attached guidance.

C. **Summary of peer Review Comments:**

Overall, peer reviewer comments were supportive of the information and conclusions presented in this review. Dr. Leslie Rissler did not provide comments. Dr. Marion and Ms. Cochran noted several grammatical and typographic errors, various sentences requiring revision for clarity, topographic clarity of river names, and citations that needed updates. Also Ms. Cochran added some additional information concerning the possibility of the species surviving in the Lewis B. Smith Lake/ Reservoir and raised questions concerning the ability of the species to survive overwinter water drawdowns.

D. **Response to Peer Review:** Comments and concerns received from peer reviewers were addressed and incorporated into this 5-year review as appropriate, grammatical errors were corrected, various sentences were revised for clarity, localities were clarified and citations updated. Additional information was included concerning the winter drawdown of the Lewis B. Smith Lake/Reservoir.

Guidance for Peer Reviewers of Five-Year Status Reviews
U.S. Fish and Wildlife Service, Mississippi Field Office

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with U.S. Fish and Wildlife Service (Service) policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data apparently not used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.

4. Provide written comments on:
   - Validity of any models, data, or analyses used or relied on in the review.
   - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
   - Oversights, omissions, and inconsistencies.
   - Reasonableness of judgments made from the scientific evidence.
   - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implication of uncertainties for the technical conclusions drawn are clear.
   - Strengths and limitation of the overall product.

5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents and portions may be incorporated verbatim into the Service's final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance or the peer review process should be referred to Daniel J. Drennen, Recovery Biologist, Mississippi Ecological Services Field Office, at 601-321-1127, Daniel_drennen@fws.gov.