Ringed map turtle
(*Graptemys oculifera*)

5-Year Review:
Summary and Evaluation

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

† Please see Addendum 1 at the end of this, our original 5-year review document. The Addendum provides the limited new information we have gathered for our second 5-year review for this threatened turtle that was initiated in the Federal Register (May 7, 2018, 83 FR 20092) and the analysis we have shared to explain the basis for continuing to recommend no change in status for this species.

5-YEAR REVIEW
Ringed map turtle / *Graptemys oculifera*

I. GENERAL INFORMATION

A. Methodology used to complete the review:
This review was accomplished using available information pertaining to historic and current distributions, life histories, and habitats of these species. Our sources include the final rule listing these species under the Act; the Recovery Plan; peer reviewed scientific publications; unpublished field observations by Service, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts.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 forwarded to three peer reviewers and their comments were incorporated into the final document as appropriate (see Appendix A). We announced initiation of this review and requested information in a published *Federal Register* notice on June 14, 2005 (70 FR34492)

B. Reviewers
Lead Region: Southeast Region: Kelly Bibb, 404-679-7132

Lead Field Office: Jackson, Mississippi, Ecological Services: Linda LaClaire, 601-321-1126

Cooperating Field Office: Lafayette, Louisiana, Ecological Services: Deborah Fuller, 337-291-3124

C. Background

1. FR Notice citation announcing initiation of this review: June 14, 2005. (70 FR 34492)

2. Species status: 2010 Recovery Data Call Declining. Results from recent survey work have demonstrated that two of five ringed map turtle populations on the Pearl River have declined since the 1980's.

3. Recovery achieved: 2 (26-50% recovery objectives achieved); see section II.B.3 for details on recovery criteria and how each criterion has or has not been met

4. Listing history
Original Listing
FR notice: 51 FR 45907
Date listed: December 23, 1986
Entity listed: Species
Classification: Threatened

5. Associated rulemakings:
Not applicable

6. Review History:
Final Recovery Plan: 1988
Recovery Data Call: 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, 2000, and 1999

7. Species' Recovery Priority Number at start of review (48 FR 43098): 14
Degree of Threat: Low
Recovery Potential: High
Taxonomy: Species

8. Recovery Plan
Name of plan: Ringed Sawback Turtle Recovery Plan, U.S. Fish and Wildlife Service, Atlanta, GA 28 pp.
Date issued: April 8, 1988

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 re-consider the classification of this species with regard to designation of DPSs? No

B. Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes. The ringed sawback (or map) turtle has an approved recovery plan with objective measurable criteria.

2. **Adequacy of recovery criteria.**

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and there is no new information to consider regarding existing or new threats)? Yes

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.

<u>Criteria for removal of the ringed map turtle from the list of threatened species</u>:

1. Protection of a total of 150 miles of the turtle's habitat in two reaches of the Pearl River. These reaches must be on opposite ends of the Ross Barnett Reservoir at Jackson. The smaller of the two reaches must contain a minimum of 30 river miles.

Status: A ringed map turtle sanctuary has been designated north of the Ross Barnett Reservoir at Jackson. The Pearl River Valley Water Supply District (District) set aside approximately 12 river miles north from Ratliff Ferry to Lowhead Dam on the Pearl River as a sanctuary area, effective July 1990. Within the sanctuary, the District is required to maintain informational signs to facilitate public awareness of the sanctuary and of the importance of the area to the species, conduct channel maintenance by methods which do not hinder the propagation of the species, and record a notation on the deed of the property comprising the sanctuary area that will in perpetuity notify transferees that the sanctuary must be maintained in accordance with these provisions.

No areas have been formally protected south of the Ross Barnett Reservoir. Only 12 miles in one Pearl River reach north of the Ross Barnett Reservoir have been protected. Therefore, this criterion has not been met.

Criterion 1. addresses Factor A., B., D., and E.

2. Evidence of a stable or increasing population over at least a ten year period in the two Pearl River reaches.

Status: Personnel with the Mississippi Museum of Natural Science/Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), the Louisiana Department of Wildlife and Fisheries (LDWF), and the Corps of Engineers have conducted periodic surveys of ringed map turtle populations in their respective states (Jones and Hartfield 1995; Dickerson and Reine 1996; Shively 1999; Jones 2009; LDWF 2009). Additional surveys have been conducted by an individual researcher (Lindeman 1998). Only the MDWFP surveys provide data that can be used to judge the status of populations over time. The four MDWFP surveys were conducted over a 20-year period during 1988/1989, 1994, 2002, and 2008/2009 at the same five sites (Jones 2009). Comparisons between the sites over this time period indicate that three of the studied populations are relatively stable and one of the populations is declining. Survey data from 2008/2009 indicate that the remaining population may also be in decline (Jones 2009).

Two of the stable ringed map turtle populations (Carthage and Ratliff Ferry study sites) occur north of the Ross Barnett Reservoir and one (Lakeland study site) occurs south of the reservoir. The Ratliff Ferry population occurs within the sanctuary designated by the Pearl River Valley Water Supply District.

Twenty-two ringed map turtles, which had been marked during earlier surveys, were recaptured during the 2008/2009 study (Jones 2009). Minimum age estimates of 23.5 years for males and 30 to 36 years for females were made for these recaptured turtles (Jones 2009). Although the 20-year study of selected sites on the Pearl River by MDWFP indicated the presence of three relatively stable populations, the duration of the study was less than that of a single generation of the ringed map turtle (Jones 2009). Therefore, although this criterion has partially been met, further monitoring over at least another 10 to 15 years will be necessary before a final determination can be made concerning the stability of these populations.

Criterion 2. addresses Factor B., C., and D.

3. **An established, continuing plan of periodic monitoring of population trends and habitat to ensure a stable population in these river reaches.**

There is no formal population and habitat monitoring plan for the ringed map turtle. However survey/monitoring studies have been

conducted at regular intervals, as described above, and as a result this criterion has been partially met.

Criterion 3. addresses Factor A., B., C., D., and E.

C. Updated Information and Current Species Status

1. Biology and Habitat:

a. Abundance, population trends

Dr. Robert Jones of the Mississippi Museum of Natural Science has studied the ringed map turtle at selected sites in Mississippi, over a period of 20 years (summary in Jones 2009). Population estimates at the five study sites varied, sometimes considerably, during this time period. Two of these study sites are located north of the Ross Barnett Reservoir (Reservoir) at Jackson, Mississippi, and three sites are located south of the Reservoir. Data from the two sites north of the Reservoir, and the northernmost site south of the Reservoir, indicate that populations in these localities have been relatively stable for the last 20 years. However, the two additional sites south of the Reservoir appear to be in decline. The number of ringed map turtles captured during the 2009 study of the population near Columbia, Mississippi, was significantly smaller than any of the estimates from the previous three surveys during the 20-year period. Jones (2009) suggested that further surveys at this site should be made to determine is this is the beginning of a long-term trend. However, population estimates at the site near Monticello, Mississippi, demonstrated a consistent downward trend throughout the study and may indicate that this population is in decline (Jones 2009).

Less information on the status of the ringed map turtle is available for portions of the Pearl River and its tributaries in Louisiana. In 1999, a study was completed along portions of the Bogue Chitto River located within Louisiana (Shively 1999). In 2009, a survey was initiated to re-visit these same sections of river. This study will be completed in the summer of 2010. The final results will be compared to findings from the 1999 survey to provide current population status and a 10-year trend for the ringed map turtle in this area of its distribution (LDWF 2009).

b. Genetics, genetic variation, or trends in genetic variation:
In initial studies of the molecular systematics of map turtles (genus *Graptemys*), mitochondrial DNA (mtDNA) were used to estimate the levels of variation between species. The results of these studies revealed relatively low levels of variation between species in this group when compared to other vertebrate genera (Lamb *et al.* 1994). However, results from more recent work using nuclear DNA (nucDNA) strongly support the traditional sawback clade (yellow-blotched map turtle (*G.*

flavimaculata), black-knobbed map turtle (*G. nigrinoda*), and the ringed map turtle) and the species-level relationships within it (Wiens *et al.* 2010). This is important because the almost identical mtDNA sequences of these species might lead to the mistaken assertion that they were not, in fact, distinct species (Wiens *et al.* 2010).

Levels of genetic variation between ringed map turtle populations have not been studied.

c. Taxonomic classification or changes in nomenclature:

Kingdom: Animalia
Division: Chordata
Class: Reptilia
Order: Testudines
Family: Emydidae
Genus: *Graptemys*
Species: *oculifera*
Common name: Ringed map turtle [as currently accepted (Crother 2008); however common name, ringed sawback turtle, was used in the listing of the species]

d. Spatial distribution, trends in spatial distribution or historic range: The ringed map turtle is restricted to the Pearl River and its major tributaries in Mississippi and Louisiana. It is not found in the tidally influenced section of the lower West Pearl River. This species' distribution has been monitored periodically since the late 1970's (McCoy and Vogt 1980; Jones and Hartfield 1995; Dickerson and Reine 1996; Lindeman 1998; Shively 1999; Jones 2009; LDWF 2009). The spatial distribution of the ringed map turtle throughout the Pearl River drainage has not changed based on these studies.

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): The decline of the ringed map turtle has been attributed to habitat modification and water quality deterioration, reservoir construction, channelization, desnagging for navigation, siltation, and the subsequent loss of invertebrate food sources (U.S. Fish and Wildlife Service 1988). Little information is available on any improvements that have been made in quality and quantity of ringed map turtle habitat. However, the designation of a 12-mile reach of the Pearl River as a sanctuary has reduced some threats to ringed map turtle habitat in this area (see discussion under Criteria 1. for removal of the ringed map turtle from the list of threatened species).

In the Bogue Chitto River in Louisiana, a study of the long-term trends in the river fish assemblage indicated a decline in the relative abundance or possible extirpation of over twenty species during the 27-year study period

(Stewart *et al.* 2005). The authors of this study speculated that increased siltation contributed to the decline in the local fish assemblage (Stewart *et al.* 2005). Increased siltation may also be having negative effects on ringed map turtle populations in this area. More data are needed on the comparison of specific water quality conditions in areas occupied by stable ringed map turtle populations versus areas occupied by populations that are declining (see discussion under Five Listing Factors, Factor D).

2. The Five Listing Factors and a Summary of their Application to the Ringed Map Turtle

Factor A: ***The present or threatened destruction, modification, or curtailment of its habitat or range.*** The ringed map turtle requires structures (logs, snags, etc.) on which it can safely bask protected from predation and suitable nesting habitat (large, high, sandbars adjacent to the river). These habitat features are threatened by habitat modification conducted for flood control (impoundments) and navigation, as well as sand and gravel mining.

An impoundment for flood control of the Pearl River within ringed map turtle habitat at Jackson, Mississippi, south of the existing Ross Barnett Reservoir, has been considered. A feasibility study was conducted by the Corps of Engineers on the formation of this impoundment; however, the future of the project is unclear. If the proposed reservoir is completed, it would likely result in the extirpation of the known ringed map turtle population at this location. The population at this location represents the best known population on the Pearl River south of the Ross Barnett Reservoir.

River channel erosion is continuing to change the structural dynamics of the river system, especially south of the reservoir at Jackson, Mississippi. Sand and gravel mining and the removal of logs in streams are contributing to river channel erosion in Louisiana (Shively 1999). Erosion results in a wider and shallower channel due to stream bank destabilization. River channel erosion may have negative effects on the basking sites of the ringed map turtle. This is important because *Graptemys* are the most habitual baskers among aquatic turtles and rely on basking logs and branches for temperature regulation, feeding and nocturnal resting sites (summarized in Lindeman 1998 and 1999) (see additional discussion under Factor E regarding basking). Results of a study conducted by Dickerson and Reine (1996) in Louisiana indicated that ringed map turtles prefer basking sites which are partially submerged in those areas with the deepest water and swiftest current. As the river channel widens, the number of these sites will decrease. In a survey of the Bogue Chitto River in Louisiana, ringed map turtle numbers were lower near sand and gravel mining operations than in similar areas of the stream elsewhere (Shively 1999). Near sand and gravel mining operations, the channel was shallower and appeared scoured; the substrate was loose and in-steam logs were few.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes. Shooting of basking turtles for recreation and collecting turtles for commercial purposes posed a threat to the ringed map turtle at the time of listing. Direct take by humans is a continuing threat. Shooting of ringed map turtles has been documented since the time of listing the species (Shively 1999). There is evidence that collecting for commercial purposes also continues.

Factor C: ***Disease or predation.*** There was no known threat from disease at the time of listing and disease does not appear to be a current threat.

Predation, however, is a current threat. During a study of the largest population of ringed map turtles, Jones (2006) found that the turtles endured a very high level of nest predation from both vertebrate and invertebrate predators. Approximately 86 percent of the ringed map turtle nests in the study were attacked by vertebrates and approximately 24 percent of the remaining eggs were destroyed by invertebrates (Jones 2006). Armadillos (*Dasypus novemcinctus*) and raccoons (*Procyon lotor*) were the most frequent nest predators; fish crows (*Corvus ossifragus*) were also significant nest predators (Jones 2006). Invertebrate predators included *Solenopsis molesta*, a native species of fire ant, and larvae of the dipteran *Tripanurga importuna*, a sarcophagid fly (Jones 2006). The increase in predation may be a result of increased predator populations due to human-induced habitat deterioration in the vicinity of the river. This particular suite of vertebrate predators is of particular concern since armadillos are a recently arrived component of the fauna, raccoons have increased substantially in Mississippi over the last few years, and fish crows are expanding both their range and numbers (Jones 2006). Since turtles, and *Graptemys* in particular, are long-lived animals (Snider and Bowler 1992), they are extremely limited in their ability to respond to increased mortality of any life-history stage (Congdon *et al.* 1993) (see additional discussion under Factor E.).

Factor D: ***The inadequacy of existing regulatory mechanisms.*** Prior to federal listing, the ringed map turtle was listed as endangered under Mississippi Department of Wildlife Conservation Public Notice 2408 and as a result, the Federal Lacey Act applied to the taking and transportation of the ringed map turtle from Mississippi. Louisiana did not recognize the turtle as a protected species prior to listing. Listing under the Endangered Species Act added restrictions against take and against transportation of the ringed map turtle from Louisiana.

Neither Louisiana nor Mississippi has regulations to protect the ringed map turtle against the loss or alteration of its habitat. However, monitoring of water quality is conducted by states under Section 305(b) of the Clean Water Act (CWA). Monitoring results indicate that water quality and quantity are not fully supporting a minimum designated use of fishing or fish and wildlife habitat in many of the river reaches where the ringed map turtle occurs. The Mississippi and Louisiana

Departments of Environmental Quality have developed lists of impaired waters in their respective states to satisfy the requirements with respect to Section 303(d) of the CWA (Louisiana Department of Environmental Quality 2004; Mississippi Department of Environmental Quality 2006). Reaches of the Pearl River in both states, and reaches of the Bogue Chitto River in Louisiana, are included on these lists. Also identified on the lists are the pollutants causing or potentially causing impairment of designated uses. Pollutants include excessive nutrients, organic enrichment/low dissolved oxygen, pesticides, sedimentation/siltation, mercury and other toxics, and pathogens. One of these pollutants, increased siltation, has been implicated in the decline of diversity in the fish fauna of the Bogue Chitto River in Louisiana where the ringed map turtle also occurs (Stewart *et al.* 2005).

Additional research is needed to determine sensitivities of the ringed map turtle to known pollutants. This lack of data may prevent agencies from exercising their existing regulatory authorities.

Factor E: ***Other natural or manmade factors affecting its continued existence.*** In the final listing rule, water quality degradation was described as a serious threat under this factor. Although direct effects on the ringed map turtle had not been determined, the negative effects on their primary food sources were well documented. Water quality degradation was assumed to reduce or eliminate the turtle's food supply.

Boating and other recreational uses of the Pearl and Bogue Chitto Rivers during the summer months are threats to basking turtles and turtle nests. Ringed map turtles usually abandon their perches when people boat or float by their sites and may not re-emerge to bask for up to an hour (Shively 1999). A study has been conducted on the impacts of boating on basking by the yellow-blotched map turtle in the Pascagoula River. In order to reduce the negative impacts to basking behavior that they documented, the authors of the study suggested that a limit be enacted on the size of boats allowed to access the river (Selman *et al.* 2010). *Graptemys* species bask with a greater frequency than many other turtles (Lindemann 1998). Alterations in basking frequencies may affect the general health of ringed map turtles, and because basking may be integral to the maturation of eggs, lower basking frequencies may reduce the ability of females to mature their clutches of eggs. In addition, large numbers of people party and camp on the same open, high sandbars favored by nesting ringed map turtles (Jones 2006). This use of sandbars by humans can limit turtle nesting habitat when turtles avoid these otherwise quality nesting sites (Jones 2006) or nests may be destroyed inadvertently by human activities on the sandbars.

A reproductive study of the ringed map turtle indicated that this turtle apparently has a low annual reproductive potential (Jones 2006). Females mature at the relatively late age of 10 years (Jones and Hartfield 1995). They likely nest only once during the year and some female ringed map turtles apparently skip

reproduction in certain years (Jones 2006). Since *Graptemys* are long-lived turtles, these may be demographic traits that evolved with longevity. However, data collected during studies of other *Graptemys* species have documented alterations in reproductive parameters that likely result from chemical stressors in the environment (Shelby and Mendonca 2001; Selman and Qualls 2005). In either case, this low reproductive potential which limits the species' ability to adapt to increases in mortality, combined with the known high levels of predation in ringed map turtles, represents a serious threat.

D. **Synthesis** – Existing data comparing surveys of five sites over a period of 20 years indicate that three of the Pearl River ringed map turtle populations are stable, while the remaining two Pearl River populations are likely declining. A study on the Bogue Chitto River, replicating previous surveys from the late 1990's, will be completed during the summer of 2010. Studies monitoring known populations will need to be continued for 10 to 15 more years to give an adequate picture of population trends due to the long life span of the ringed map turtle.

A measure of protection has been achieved for the ringed map turtle by the establishment of a ringed map turtle sanctuary at Ratliff Ferry on the Pearl River north of Jackson, Mississippi. However, this section of river represents only 12 river miles of the total 150 river miles suggested as a benchmark in the recovery criteria. In addition, many of the threats present at the time of listing still remain. River channel erosion with subsequent habitat loss, a potential impoundment, water quality degradation, "recreational" shooting, and commercial collecting continue to be problems. Not addressed specifically in the final rule, but a current threat, is the increasing amount of human use of the Pearl and Bogue Chitto Rivers for boating and other recreational uses which have direct and indirect effects on ringed map turtle populations. Low reproductive potential is a newly documented threat to the species.

In summary, threats to the species are continuing. Although there has been some progress towards achieving recovery goals for the ringed map turtle, the recovery criteria have not been met and this species continues to meet the definition of a threatened species under the Act.

III. RESULTS

A. **Recommended Classification:** No change is needed.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Conduct an analysis of potential effects to the ringed map turtle from a proposed impoundment of the Pearl River at Jackson, Mississippi.
2. Enforce protection against commercial collecting of ringed map turtles.

3. Educate the public about the protected status of the ringed map turtle in order to reduce the direct take of turtles by shooting and encourage support of limiting public use of nesting sandbars.
4. Study effects of high nest predation on selected populations.
5. Pursue land acquisition of selected river reaches in order to achieve further protection of critical ringed map turtle populations.
6. Investigate the endocrine system of the ringed map turtle to determine if its apparent low reproductive frequency might result from a disruption of the hormonal system due to chemical effects.
7. Conduct research to determine sensitivities of ringed map turtle to known pollutants.
8. Compare water quality data from habitat occupied by stable ringed map turtle populations with data from habitat occupied by declining populations.
9. Enforce TMDLs once they have been developed.
10. Monitor selected populations of ringed map turtles and their habitats on a regular basis.
11. Work with partners to limit other threats to the ringed map turtle such as restricting sand mining at potential nest sites and restricting the size of boats that access occupied river reaches.
12. Implement all other tasks identified in the recovery plan.

V. REFERENCES

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of *Graptemys oculifera* (Ringed map turtle)

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

__x__ No change is needed

The review was completed by Linda LaClaire, Jackson, Mississippi Field Office.

FIELD OFFICE APPROVAL:

fw Lead Field Supervisor, Fish and Wildlife Service

Approve Cary Wright Date 7-31-10

REGIONAL OFFICE APPROVAL:

for Lead Regional Director, Fish and Wildlife Service

Approve Aaron L Valdez Date 8-17-10

APPENDIX A
Summary of peer review for the 5-year review of
Ringed map turtle / *Graptemys oculifera*

A. Peer Review Method:

The document was peer-reviewed internally by Cary Norquist, Jackson, Mississippi Field Office and by Debbie Fuller, Lafayette, Louisiana Field Office. Once the comments were added to the document, it was sent to three outside reviewers (see below). The outside peer reviewers were chosen based on their qualifications and knowledge of the species.

B. Peer Review Charge: The below guidance was provided to the reviewers.

1. Review all materials provided by the Service.
2. Identify, review, and provide other relevant data that appears not to have been used by the Service.
3. Do 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 those potential implications of uncertainties for the technical conclusions drawn are clear.
   - Strengths and limitation of the overall product.
5. All peer reviews and comments will be public documents, and portions may be incorporated verbatim into our final document with appropriate credit given to the author of the review.

C. Summary of Peer Review Comments/Report

Dr. Bob Jones
Mississippi Museum of Natural Science
Mississippi Department of Wildlife, Fisheries, and Parks
2148 Riverside Drive
Jackson, MS 39202-1353

Dr. Jones supplied recent research reports and concurred with the completed review.

Gary Lester
Louisiana Natural Heritage Program
Louisiana Department of Wildlife and Fisheries
P.O. Box 98000

Baton Rouge, LA 70898

Mr. Lester did not respond directly to my request for comments. However, other personnel in the Heritage Program supplied recent reports of on-going survey work on the Bogue Chitto River.

Dr. Peter Lindeman
Edinboro University of Pennsylvania
Department of Biology and Health Services
150 Cooper Hall
Edinboro, PA 16444

Dr. Lindeman supplied recent research reports on *Graptemys* species and made specific comments on the review based on his recent research.

D. Response to Peer Review

Peer reviewers' comments were evaluated and incorporated into the document, as appropriate.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the
Ringed Map Turtle (*Graptemys oculifera*)

Addendum 1. Summary of new information obtained since the 2010 5-year review.

The *Federal Register* notice announcing the initiation of this 5-year review was published on May 7, 2018 (83 FR 20092). The following information updates the referenced sections of the 2010 5-year review (USFWS 2010). Sections of the 2010 5-year review not referenced herein, do not contain new information related to this addendum.

I. GENERAL INFORMATION

C. Background

2. Species Status:
Declining. Four of the five well-studied ringed map turtle populations have declined since the 1980s and only one population is considered stable. Although recent survey work has resulted in some slight expansion of the ringed map turtle's range, the species as a whole is in decline.

II. Review Analysis:

C. Updated Information and Current Species Status

1. Biology and Habitat:
a. Abundance, population trends
Since the last five-year review (U.S. Fish and Wildlife Service 2010), multiple surveys have been conducted throughout the range of the ringed map turtle. At the southern edge of the species' range in the lower Pearl River of Mississippi, Buhlmann (2014, 2017) assessed the distribution of the ringed map turtle within the Stennis Western Maneuver Area (SWMA) of the East Pearl River within the Stennis Wildlife Management Area and found ringed map turtles of both sexes and juveniles. Deadwood was abundant within the SWMA, but nesting habitat on sandbars was limited. Buhlmann (2014) suggested management recommendations for sandbars, such as adding sand and removing overstory and shrubby vegetation, to improve their quality as nesting sites. Buhlmann (2017) summarized data from basking surveys within the SWMA and found numbers of ringed map turtles to be on the low end of the range of densities reported in Selman and Jones (2017). He also used wildlife cameras on sandbars to monitor ringed map turtle nesting and found nest predation, primarily by crows and raccoons, to be very high.

Additional surveys were conducted in the lower Pearl River in Louisiana. Landry and Gregory (2010) reported on surveys in the Bogue Chitto River in Washington and St. Tammany Parishes, and Landry (2012) reported on surveys in the Pearl River in Washington Parish. The number of ringed map turtles found during the Bogue Chitto River survey was lower than that reported in a 1999 survey of the same area (Landry and Gregory 2010). The reason for the reduction in turtle numbers is unclear. In areas of the Bogue Chitto heavily used by recreational tubing and canoeing, basking turtles appeared to be acclimated to the disturbance (Landry and Gregory 2010), but some other aspect of the activity may be contributing to reduced numbers by limiting nesting success. Habitat data were collected but not analyzed for the report, and while no evidence of reproduction was observed, there was little effort given to nest searching during the study (Landry and Gregory 2010). During the ringed map turtle survey in the Pearl River located in Washington Parish, six river kilometers (km) north of Bogalusa and four river km south of Bogalusa, a small population was documented with 77 percent of captures being adults and a 1:1 sex ratio (Landry 2012). Additional survey work in the area is needed to determine the status of this ringed map turtle population. Terrell (2015) reported finding a fresh dead hatchling ringed map turtle during an amphibian and reptile study of the Bogue Chitto National Wildlife Refuge (NWR) that encompasses part of the lower Pearl River. Lindeman (2018a) also conducted surveys for map turtles on the Bogue Chitto NWR. He surveyed eight river reaches over four days in areas of the East and West Pearl River and documented presence of ringed map turtles in the Pearl Navigation Canal and higher densities of ringed map turtles in the West Pearl than in the East Pearl River.

Selman (2018) conducted several recent surveys for the ringed map turtle and the unlisted Pearl River map turtle (*G. pearlensis*) in the Pearl River at Jackson, Mississippi. These surveys were conducted in the reach of the Pearl River that may be altered into an impoundment by the proposed flood reduction project for the Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Hinds and Rankin Counties, Mississippi (One Lake Project; see further discussion of this project under **"2. a. Present or threatened destruction, modification or curtailment of its habitat or range"**). Although ringed map turtle habitat in this area had previously been degraded due to channelization, both turtle species were observed within this reach during the surveys and a significant number of the observed ringed map turtles (27 percent) were juveniles. This level of recruitment is much higher than the Monticello and Ratliff Ferry sites in the long-term data set summarized by Jones (2017), below (Selman pers. comm. 2018).

Jones (2017) summarized trends in his 25-year dataset comparing five Pearl River population segments in Mississippi. When these data are taken together, one population demonstrated stability, one population declined, and three populations appeared to be in the initial stages of decline. Most population estimates and basking counts trended downward through time with a proportionate decline in males and greater declines occurring in the number of juveniles captured (Jones

2017). Jones (2017) hypothesized that the decline in males, which are smaller than female ringed map turtles, may be the result of increased predation, possibly by American alligators (*Alligator mississippensis*) whose populations were observed to increase in the Pearl River over the study period. Predation could also be reducing numbers of smaller females and juveniles, however the decline in juveniles probably also relates to the documented increase in nest predation (Jones 2017). In two of the five populations, both males and females trapped after 2000 are significantly larger than those trapped before that date implying that the population is composed of older individuals and there is a lack of recruitment into the sub-adult age class (Jones 2017). Trends in long-term capture success were negative at all five study sites and declines have occurred in populations both upstream and downstream of the Ross Barnett Reservoir at Jackson (Selman and Jones 2017). Jones (2017) concluded that although the ringed map turtle remains relatively abundant, the species is slowly declining over much of its range in the Pearl River.

Since the 2010 five-year review, Lindeman (2013) completed a book on all species of *Graptemys* that included a species account for the ringed map turtle summarizing all the literature available for the species at the time of its publication.

b. Genetics, genetic variation, or trends in genetic variation

Gaillard *et al.* (2015) used six polymorphic microsatellite loci to analyze the population genetics of the ringed map turtle at eight sites in the Pearl River drainage. Although the Ross Barnett Reservoir is assumed to function as a barrier to turtle movements, the study did not identify genetic changes that would reflect this (Gaillard *et al.* 2015). The lack of data supporting the reservoir as a barrier to gene flow is presumably due to the long generation time of the turtle (the reservoir was completed in the mid-1960s) since in over 25 years of sampling, no marked ringed map turtles were ever found to make cross-reservoir movements (Jones unpublished data). Additional studies using mark-recapture or radio telemetry were recommended to further study the potential for cross-reservoir movements (Gaillard *et al.* 2015). Analysis of the study's data indicated that only subtle genetic differences occurred between populations at sample sites, reflecting a stepping stone model of gene flow and a pattern of isolation by distance (Gaillard *et al.* 2015). There were no detections of bottlenecks in any of the populations analyzed.

Thomson *et al.* (2018) found support for the current taxonomic phylogeny of *Graptemys* species in their recent review. They indicated that substantial lineage-level diversity exists between *Graptemys* species largely structured by recent and rapid divergence of populations among adjacent river systems.

d. Spatial distribution, trends in spatial distribution or historic range

Recent survey efforts at both the north and south extreme edges of the known ringed map turtle distribution resulted in some small range extensions for the species, new

localities, and two new county records in Mississippi (Pike and Walthall) (Lindeman 2014, 2015, 2016, 2017, 2018b). In the lower Pearl River, Lindeman (2014) reported a new Pike County, Mississippi record representing a range extension in the Bogue Chitto River east of McComb; this record is 30 river km north of the previous upstream Bogue Chitto River record from Walthall County, Mississippi (Lindeman 2014). In the upper half of the Pearl River drainage, Lindeman (2015) reported new tributary records and an upstream range extension of 24-river km in the Strong River.

2. Five-Factor Analysis

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

The ringed map turtle continues to lose habitat within its restricted range of approximately 875 km of the Pearl and Bogue Chitto rivers (Jones and Selman 2009). The flow of the Pearl River is regulated primarily by releases from the Ross Barnett Reservoir spillway (Selman and Jones 2017). The Pearl River Water Management District attempts to maintain relatively stable water levels in the reservoir through-out the year, thus during periods of low river flow (usually during the summer months), the volume of water released is very low and the hydrology of the river is affected. At other times, water releases may occur rapidly and stopped quickly when the target reservoir level is achieved (Selman and Jones 2017). The effect of these rapid and variable water level changes is that the banks of the Pearl River downstream of the reservoir become waterlogged and collapse under their own weight with resulting channel filling and ringed map turtle habitat degradation.

As mentioned above and in the 2010 five-year review (U.S. Fish and Wildlife Service 2010), an impoundment for Pearl River flood control at Jackson, Mississippi, several kilometers south of the existing spillway at the Ross Barnett Reservoir, is being considered. A biological opinion on the effects of the project on the ringed map turtle has been completed (USFWS 2019). Although this analysis of the potential effects of the proposed project included an estimated loss of two percent of the population occupying the project area or an estimated mortality of 1,306 turtles, the conclusion reached in the biological opinion was that the project would not jeopardize the continued existence of the ringed map turtle. The project proposes removal of 33 million cubic meters of soil from the floodplain, over an area of approximately 15.2 river-kilometers, to create a 3,707-hectare pool (USFWS 2019). Conversion of riverine habitat to predominantly lake habitat will result in loss of riverine dependent species, localized downstream bank and river bottom instability, and segregation of aquatic animal populations (USFWS 2019). The

project will decrease flow velocities through the impoundment and the river engineering used to create the impoundment will result in a loss of river bends. The existing river functions to create habitat for the ringed map turtle whereby faster currents occurring on the outer bend of the river cause erosion on the outer bank and result in deposition of sediments on the inner bank. Deadwood from tree falls is deposited as the outer bank collapses and flat sandbars form from the sediments on the inner bank. The formation of the impoundment will stop this habitat creation, alter hydrology, and further fragment ringed map turtle habitat such that the best remaining ringed map turtle population will be isolated between the new impoundment and the Ross Barnett Reservoir.

b. Overutilization for commercial, recreational, scientific, or education purposes.

International trade in turtles is a major threat to many species, especially those with unique markings and limited ranges (Sung and Fong 2018). Historically, exports of wild turtles were largest in the Asian region, but recently growth in exports of wild turtles has increased substantially in the Nearctic region that includes the United States (Luiselli *et al.* 2016). Although online searches of U.S. sites with available ringed map turtles for purchase indicate specimens are captive-bred and contain banners indicating what states prohibit imports, it can be very difficult to document whether or not a particular turtle is wild-captured or if trade is a current threat to the ringed map turtle (see further discussion under **"Factor d. The inadequacy of existing regulatory mechanisms"**).

c. Disease or predation.

Disease

Although there was no known threat from disease at the time of listing or identified in the previous five-year review, recent research indicates that threats from disease may be an emerging issue.

Shell lesions on freshwater aquatic turtles caused by a newly identified fungus (*Emydomyces testavorans*) have been recently described (Woodburn *et al.* 2019). This ulcerative shell disease was found in both captive aquatic turtles and in wild pond turtles. A sample taken from a shell lesion on a captive ringed map turtle was incorporated into this study, however, the causative agent for the lesion was not identified (Woodburn *et al.* 2019).

Ranaviruses are capable of infecting turtles. Aquatic turtles share habitat with susceptible fish and amphibian populations and as a result may be more at risk of infection than terrestrial turtles (Wirth *et al.* 2018). Susceptibility to disease may be increased by immunosuppressive effects

to immune systems of aquatic turtles due to stressors such as pesticides, herbicides, and heavy metals that enter aquatic systems (Wirth *et al.* 2018). Ranaviruses are likely underreported in turtles due to lack of awareness, few long-term studies on the pathology of disease in turtles, and minimal population monitoring (Wirth *et al.* 2018). Few data are available for ranaviruses in *Graptemys* species; however, Mississippi map turtles (*G. pseudogeographica kohni*) have been infected under experimental conditions (Brenes *et al.* 2014).

Predation

Predation continues to be a threat to ringed map turtle adults, juveniles, hatchlings, and nests, especially by human-subsidized predators such as raccoons and fish crows. As described above, Jones (2017) hypothesized that an increase in populations of the American alligator on the Pearl River may be negatively affecting the sex ratios of ringed map turtles by predating on smaller male turtles.

d. The inadequacy of existing regulatory mechanisms.

All species of *Graptemys* are currently listed on CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendix III (Lindeman 2013) which requires export permits from the listing countries or certificates of origin from the non-listing countries to allow exports. The intention of this designation is to make it possible to track international trade of the species. Nevertheless, a recent assessment of consumer trends and illegal activity in online international wildlife trade indicated that many of the turtles for sale online and listed in CITES appendices were likely illegally traded as they lacked the appropriate documentation (Sung and Fong 2018). In addition, turtles with the highest prices tended to be critically endangered species, wild-caught turtles, or those with special morphological forms (Sung and Fong 2018). The Southeastern United State is an emerging global hotspot of Threatened (IUCN category; see IUCN 2012) species (Rhodin *et al.* 2018). The Florida Fish and Wildlife Conservation Commission released information in a 2019 press release on the poaching and selling of over four thousand native Florida turtles for overseas markets, including the Asian pet trade (Southeastern Cooperative Wildlife Disease Study Briefs 2019). There are no current data on impacts to the ringed map turtle from the international turtle trade; however, take of ringed map turtles is occurring. In 2019, law enforcement confiscated a ringed map turtle in Illinois that had been transported there from Louisiana (K. Lejeune, pers. comm. 2019).

Ringed map turtles occur within the Stennis Western Maneuver Area, Stennis Space Center, Mississippi, near the southern limit to their range in the Pearl River (Buhrmann 2014, 2017). An Integrated Natural Resources

Management Plan (INRMP) has been prepared for the site (U.S. Navy 2011). The INRMP covers a 10-year period and includes measures to protect habitat for the turtle by controlling quantity and quality of stormwater runoff. Other conservation measures included in the INRMP are conducting regular surveys for ringed map turtles and identifying areas that provide suitable habitat for them; developing tools to educate installation personnel regarding the species; and controlling invasive species that may negatively affect ringed map turtle habitat (U.S. Navy 2011).

The Bogue Chitto River, Louisiana, has been designated a Natural and Scenic River under the Louisiana Department of Wildlife and Fisheries Scenic Rivers Program and thus is protected from clearing or de-snagging. Nevertheless, recent surveys indicated a decline in the ringed map turtle population that occurs there (Landry and Gregory 2010).

The future of the One Lake Project, discussed in more detail above, is unclear. However, the Service recently completed a Biological Opinion on the impacts of the proposed project to threatened and endangered species and concluded that the project would not jeopardize the continued existence of the ringed map turtle (U.S. Fish and Wildlife Service 2019). Nevertheless, if the proposed reservoir is completed, it would isolate the best remaining and only stable ringed map turtle population between the impoundment and the Ross Barnett reservoir. The genetic isolation of these turtles would likely result in the decline of their population such that it would no longer contribute to the recovery of the species.

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

Human disturbance

Heppard and Buchholz (2018) compared the level of disturbance to basking turtles resulting from boating in "Wake" and "No Wake" zones and factors such as increased boat traffic, boat type and speed. They concluded that disturbance is likely to decrease mean daily turtle body temperature, especially at high disturbance levels, and in May when air temperatures have not reached their peak (Heppard and Buchholz 2018). Basking has been theorized to play a role in clutch development (Moore and Seigel 2006) and reduced basking frequencies may limit the ability of females to complete development of their egg clutches. The work of Heppard and Buchholz provides a possible explanation for reduced clutch development and the contribution this could make to observed population declines (Jones 2017).

Ringed map turtles nest on sandbars from May to July. Unfortunately, heavy recreational use of sandbars, which disturbs nesting turtles, coincides with the ringed map turtle-nesting period (Jones 2017). In addition, garbage left by

humans on the sandbars provides food for predators and increases their population numbers. This contributes to high nest predation with approximately 86 percent of nests destroyed by vertebrate predators (Jones and Selman 2009).

Non-native species

The non-native Mississippi map turtle has been found in the Pearl River and appears to be established within the range of the ringed map turtle (Selman 2018). The impact of this turtle to survival and recovery of ringed map turtle populations is unknown.

Climate change

In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the Earth's climate system is unequivocal (IPCC 2014). Numerous long-term climate changes have been observed including changes in arctic temperatures and ice; widespread changes in precipitation, ocean salinity, and wind patterns; and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (IPCC 2014). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change; however, while continued change is certain, the magnitude and rate of change is unknown in many cases.

Climate change has the potential to affect aquatic species, including the ringed map turtle, through disruption to their physiology (such as temperature tolerance), life history (such as timing of reproduction, growth rate), and distribution (range shifts, migration of new predators and/or competitors) (Heino *et al.* 2009, Strayer and Dudgeon 2010). Lindeman (2013) estimated that approximately 15 to 20 km of ringed map turtle habitat in the lower Pearl River would disappear as the result of a 5-m sea level rise. Increased air temperatures due to climate change will increase temperatures of ringed map turtle nesting substrate, as weather is the primary determinant of temperature in reptile nests (Mitchell and Janzen 2019). A study of nest substrate type indicated that nest temperature and soil moisture affected incubation duration and offspring sex ratios (Mitchell and Janzen 2019). Since the ringed map turtle has temperature-dependent sex determination with female hatchlings dominating at higher temperatures, nesting females will need to mediate the effects of weather through microhabitat selection of their nest sites to avoid embryo death or populations with sex ratios skewed towards females (Valenzuela *et al.* 2019). In addition, increased soil temperatures could alter the seasonal timing of emergence of hatchlings that overwinter in the nest (Gibbons and Lovich 2019).

The increased temperatures predicted to result from climate change will be associated with increases in frequency, intensity, and duration of extreme heat events (U.S. Geological Survey 2017). Species with limited ranges, fragmented

distributions, and small population size are likely especially vulnerable to the resulting effects of climate change. Although there is uncertainty about the specific effects of climate change (and their magnitude) on the ringed map turtle, climate change is almost certain to affect its aquatic habitats, terrestrial nesting habitats, and physiology. Thus, we consider climate change to be a potential threat to the ringed map turtle.

D. Synthesis

A recent comparison of long-term data on ringed map turtle populations at five sites on the Pearl River indicated that only one population is stable; however, this population may face extirpation from the proposed construction of an impoundment in the Jackson metropolitan area. Habitat within the range of the ringed map turtle continues to be degraded and lost due to anthropogenic factors. The international turtle trade has become a growing threat to turtles in the southeastern United States and may affect the ringed map turtle in the future. Disease may be an emerging threat as new research has documented fungal and viral disease in other *Graptemys* species. Predation is an ongoing threat and predation pressure appears to be increasing, especially due to human-subsidized predation and the re-establishment of American alligator in the Pearl River. Human disturbance of basking and nesting turtles is continuing in heavily used areas of the Pearl River and remains a threat. Currently, existing regulatory mechanisms have not been effective in stopping the decline in ringed map turtle populations and enforcement efforts need to be increased. The effect of climate change represents a threat to the ringed map turtle that is not fully understood. The protection of habitat from ongoing and new threats, in addition to long-term monitoring of populations, will be needed to ensure this species' viability into the future. Based on the above analysis of new information available since the last five-year review, the ringed map turtle continues to meet the definition of a threatened species under the Act.

III. RESULTS

A. Recommended Classification:

_X_ No change is needed.

B. New Recovery Priority Number: No change.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

The previous 5-year review included a list of recommendations to improve recovery of the ringed map turtle. Accomplishments toward these recommended actions, and future actions needed, are summarized below.

- An analysis of potential effects to the ringed map turtle from the proposed impoundment of the Pearl River at Jackson, Mississippi, has been conducted by an independent researcher (Selman 2018) and by the Service in the form of a biological opinion (USFWS 2019). In the biological opinion, the Service made a determination that the effects of the proposed impoundment on the ringed map turtle did not rise to the level of jeopardy. However, the completed project as currently proposed would isolate the best remaining population of the species between two impoundments causing its decline due to habitat degradation and genetic isolation, and remove it from contributing to the recovery of the species.
- At this time, the extent of commercial and/or illegal collecting of ringed map turtles is unknown, but pressure on native freshwater turtles in the southeastern United States is increasing due to the illegal international turtle trade. The Service will continue to monitor the potential for this threat to affect ringed map turtle populations.
- Efforts to educate the public about the protected status of the ringed map turtle have occurred resulting from publicity surrounding the One Lake Project. The success of these outreach efforts is unknown. Further public outreach of this type, including the importance of deadwood management and restoration in the Pearl River basin, would be worthwhile.
- Nest predation is a verified threat across the range of the ringed map turtle. Further study is needed to determine how to reduce this threat.
- Land acquisition of selected river reaches is being proposed to partially mitigate the effects of the One Lake Project impoundment and protect essential ringed map turtle populations. The outcome of this effort is currently unknown.
- The possibility that disruption of the ringed map turtle hormonal system has been negatively affected by pollution and is resulting in low reproductive frequency or hatchling survival has not been investigated. A study of this potential threat has value and such a study could be combined with a more general assessment of the species sensitivities to known pollutants as suggested in the 2010 five-year review.
- A comparison of water quality data from the area of the Pearl River supporting the Lakeland population with the other four populations that are known to be declining has not been done. This study and the development and enforcement of TMDLs would contribute to the recovery of the species.
- The five populations described in Jones (2017) have been monitored on a regular basis and these populations need to be monitored into the foreseeable future.
- The status of ringed map turtles in Louisiana is not well known. There is a need to complete comprehensive surveys of appropriate habitat in the lower Pearl River and Bogue Chitto River to better understand the distribution and abundance of the turtles in the state.
- Sand mining at potential ringed map turtle nesting sites is not known to be a current threat. However, boat use and the increasing size and speed of boats within ringed map

turtle habitat is a current threat to the turtles and their habitat. Partnerships need to be established to work on defining limits to the size and speed of boats accessing occupied river reaches, as well as defining limits to public use of sandbars used as nesting sites. Pursuing this effort is especially important in the heavily used area occupied by the Ratliff Ferry population where the ringed map turtle is in known to be in decline.

- In order to maximize comparisons of population data in future monitoring studies, a standardized basking survey protocol is needed. The protocol could be developed in junction with similar efforts to standardize surveys for the closely related yellow-blotched map turtle (*Graptemys flavimaculata*).
- The Service continues to work towards implementing all of the tasks identified in the recovery plan.

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Addendum 1. Summary of new information

FY 2020 APPROVAL*

Lead Field Office Supervisor, U.S. Fish and Wildlife Service

Approve Cary Wright Date 11/10/2020

*In 2014, Southeast Region Field Supervisors were delegated authority to approve 5-year reviews that do not recommend a status change.

Field Supervisor signature on this document reflects:

1. ____We have no new information received, no new public comments, and the original five-factor analysis remains an accurate reflection of the species' current status.

2. __X__We have obtained a small amount of new information that we have summarized in Addendum 1, received no new public comments, and the original five-factor analysis remains an accurate reflection of the species' current status.