U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT
AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Faxonius hartfieldi*

COMMON NAME: Yazoo crayfish

LEAD REGION: Region 4

LEAD REGION CONTACT: Byron Hamilton, 773-848-4642, byron_hamilton@fws.gov

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DATE INFORMATION CURRENT AS OF: 5/1/2023

STATUS/ACTION

___Species petitioned for listing which we have determined is not a listable entity

_X__ Species petitioned for listing which we have determined does not warrant listing (does not meet the definition of a threatened or endangered species)

___Non-listed species for which we have not received a petition but for which we have undertaken a species status assessment on our own initiative and which we have determined does not warrant listing (does not meet the definition of a threatened or endangered species)

___Listed species petitioned for delisting which we have determined does not warrant delisting

___ Listed species petitioned for downlisting which we have determined does not warrant downlisting

___ Listed species petitioned for uplisting for which we have made a warranted-but-precluded finding for uplisting (this is part of the annual resubmitted-petition finding)

___ Listed species petitioned for uplisting which we have determined does not warrant uplisting

___ New candidate
___ Continuing candidate
Date when the species first became a candidate (as currently defined):

___ Listing priority number change
Former LPN: ___
New LPN: ___

___ Candidate removal: Former LPN: ___

- ___ Taxon does not meet the Act's definition of "endangered species" or "threatened species" because it is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
- ___Taxon does not meet the Act's definition of "endangered species" or "threatened species" because it is not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
- ___ Taxon does not meet the Act's definition of "species."
- ___ Taxon mistakenly included in past notice of review.
- ___ Taxon believed to be extinct.

Petition Information:
___ Non-petitioned
_X__ Petitioned; Date petition received: April 2010
90-day "substantial" finding: September 27, 2011 (76 FR 59836)

PREVIOUS FEDERAL ACTIONS:

The Yazoo crayfish was included in a listing petition from the Center for Biological Diversity et al. (CBD 2010, pp 792-793) in April 2010. The petition requested that the U.S. Fish and Wildlife Service (Service) list 404 aquatic, riparian, and wetland species as endangered or threatened under the Endangered Species Act of 1973, as amended. The Service found that this petition presented substantial scientific or commercial information indicating that listing may be warranted for 374 species, including the Yazoo crayfish in 2011. As a result, we conducted a Species Status Assessment (SSA) for the Yazoo crayfish to compile and synthesize the best available scientific and commercial data on the species life history and population biology as well as factors influencing likelihood of persistence through 2099.

ANIMAL GROUP AND FAMILY, ORDER AND FAMILY: Decapoda: Astacoidea and Parastacoidea

ANALYTICAL FRAMEWORK

To assess the Yazoo crayfish viability, we conducted a species status assessment (SSA) using the principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 306–311). Briefly, resiliency supports the ability of the species to withstand environmental and demographic stochasticity (for example, wet or dry, warm or cold years, variation in demographic rates); redundancy supports the ability of the species to withstand catastrophic events (for example, droughts, large pollution events); and, and representation supports the ability of the species to adapt to both near-term and long-term changes in its physical and biological environment (for example, climate change, disease). A species with a high degree of resiliency, representation, and redundancy is better able to adapt to novel changes and to tolerate environmental stochasticity and catastrophes. In general, species viability will increase with increases in resiliency, redundancy, and representation (Smith et al. 2018, p. 306). Using these principles, we identified the species' ecological requirements for survival and reproduction at the individual, population, and species levels, and described the beneficial and risk factors influencing the species' viability.

BIOLOGICAL INFORMATION

For additional information on the species description, taxonomy, habitat/life history, historical and current range/distribution, please refer to pp. [5-18] of the SSA Report.

Species Description

The Yazoo crayfish is a stream-dwelling species distributed among scattered locations in the Yazoo and Big Black River drainages in Mississippi. The species is small, growing to 50 to 70 millimeters (2 to 3 inches) total length (Fitzpatrick and Suttkus, 1992). Males with developed reproductive structures that are informative for identification (Form I) have been sampled from 10 August through 24 October and juveniles from 5 March through 13 April (Fitzpatrick and Suttkus 1992; Adams 2008a), but no ovigerous (bearing eggs) females or females carrying young have been observed (Jones 2013).

Photo credit: C. Lukhaup

Taxonomy

The Yazoo crayfish (*Orconectes hartfieldi*) (Fitzpatrick and Suttkus 1992 pp. 70-76) was reclassified as *Faxonius* Ortmann 1905 *hartfieldi* (Crandall and De Grave 2017, entire). However, the taxonomic status of the Yazoo crayfish is currently uncertain. The original description of the Yazoo crayfish (Fitzpatrick and Suttkus 1992, entire) may not include the full range of morphological variation found in the species (S.B. Adams, USFS, person. comm. 2021). Individuals in some streams of occurrence have characters representative of the Yazoo crayfish and *F. perfectus* (a species distributed in the disjunct Tombigbee River drainage to the east) rendering identification (and distribution) uncertain. It is unclear if these individuals represent undescribed morphological diversity within the Yazoo crayfish, a new taxon, or hybridization with another species (Adams 2020, pp.14-16). Phylogenetic relationships and morphological diversity within the Yazoo crayfish needs to be reassessed relative to other closely related species, particularly *F. perfectus*. We assess that all records of the Yazoo crayfish with uncertain identification are the Yazoo crayfish. We have chosen this option for two reasons: 1) among the reasons for uncertain identification of some individuals, undescribed biodiversity, appears the least likely; and 2) if there is undescribed diversity within Yazoo crayfish, this assessment will be available as a basis for future assessments.

Habitat/Life History

Little is known of the life history of the Yazoo crayfish or closely related species (Adams 2008a, b, c, all entire). Reproductive life history characteristics of the Yazoo crayfish are presumably similar to those of other *Faxonius* species, especially *F. perfectus* (Adams 2008a, b, both entire). The timing of previous collections suggests that mating occurs from fall to spring, females are ovigerous in spring, and juveniles are released in late spring or early summer (Adams 2008b, entire). This is consistent with data from other *Faxonius* species (Adams 2008c, entire). Fecundity is likely positively related to size in the Yazoo crayfish based on data from other *Faxonius* species (Adams 2008c, entire).

Historical and Current Range/Distribution

Historically, the Yazoo crayfish was known from the Yazoo to the Big Black River drainages. Distribution of the Yazoo crayfish has been significantly revised since a review for the species was completed in 2014 (USFWS 2014, entire). Individuals sampled from the Yocona (Potlockney Creek) and Tallahatchie (Bellamy Creek a tributary of Tillatoba Creek) River drainages were originally identified as Yazoo crayfish but were recently reexamined and identified as other species (Adams 2020, pp. 13-15). As a result, the Yazoo crayfish is not known to occur in these watersheds (Adams 2020, pp. 15-16). However, recent work has expanded the known distribution of the Yazoo crayfish in the Yalobusha, Yazoo, and Big Black River drainages. Unfortunately, some individuals in some sites cannot be confidently identified to species. Records for the Yazoo crayfish that have been confidently identified are located in 21 sites and 6 streams across 5 river drainages in Mississippi (Fig. 1). Uncertain records for the Yazoo crayfish occur in 7 sites and 5 streams across 2 drainages (Fig. 1).

Changes to the known distribution of the Yazoo crayfish may include extirpation from the Little Tallahatchie River drainage. The single record for the Yazoo crayfish in the Little Tallahatchie River drainage is a confidently identified Form I male collected in 1967, the only individual known to exist from that collection. Though habitat at the collection site (Orr Creek) appears suitable for the species today, the Yazoo crayfish has not been sampled again despite relatively high sampling effort there in recent years (Adams 2020, pp. 12-17). If the collection location for the 1967 record was accurate, it is possible that the Yazoo crayfish has been extirpated from the Little Tallahatchie River drainage in the last 50 years. Confidence in the locality data is not high because there was only a single specimen; the record was not cited until the species description >20 years later; and there is a likelihood of errors over the more than 5 decades.

The Yazoo crayfish currently occupies a wide range of stream sizes from small headwater streams, such as the first order (Strahler 1957, entire) Little Mouse Creek (watershed area: 11 km^2), to large streams such as Fourteenmile Creek (watershed area: 644 km^2) (SSA Report, Table 2.1, pg. 10, Service 2022). Occupied streams have moderate gradients and are located in the Lower and Upper Gulf Coastal Plain ecoregions. Yazoo crayfish have not been sampled from the adjacent Mississippi Alluvial Plain (hereafter the Delta) where streams are low gradient, turbid, and suffer from poor water quality. Individuals in the lower Big Black drainage are separated by the Mississippi River from all other known sites of occurrence. Individuals in tributaries of the Little Tallahatchie, Yalobusha, and Yazoo rivers are separated from each other by the apparently unsuitable habitat of the Delta.

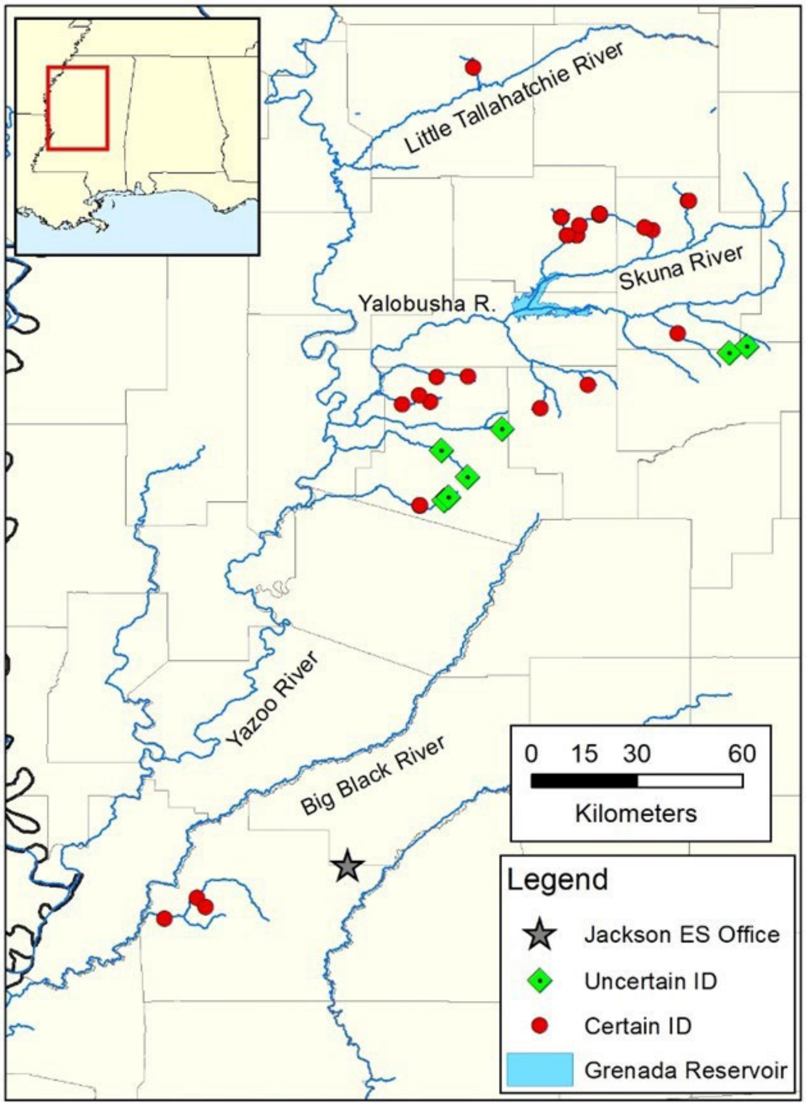

Figure 1. Distribution of Yazoo Crayfish (*Faxonius hartfieldi*). Map indicates sites of occurrence with confident (certain) and questionable (uncertain) specific identification in the Little Tallahatchie, Yalobusha, Yazoo, and Big Black River watersheds.

Species/Population Needs

The Yazoo crayfish needs enough suitable, connected habitat to support healthy metapopulation dynamics (Hanski and Ovaskeinen 2003, entire). Metapopulations with a relatively high number of occupied (Redundancy) or empty patches of suitable habitat will likely occur within a highly variable environment that will support evolutionary processes (Representation). However, connectivity among patches of suitable habitat is necessary to support metapopulation processes and gene flow. This is especially true for aquatic organisms because they are usually unable to move around barriers within their linear environments (Fagan 2003, entire), and this appears likely for stream-dwelling crayfishes as well (Barnett et al. 2020, pp. 768-785).

FACTORS INFLUENCING THE STATUS

The Act directs us to determine whether any species is an endangered species or a threatened species because of any factors (or threats) affecting its continued existence (i.e., whether it meets the definition of a threatened species or an endangered species). We use the term "threat" to refer in general to actions or conditions that are known to or are reasonably likely to negatively affect individuals of a species. The term "threat" includes actions or conditions that have a direct impact on individuals as well as those that affect individuals through alteration of their habitat or required resources. The term "threat" may encompass—either together or separately—the source of the action or condition or the action or condition itself.

However, the mere identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an "endangered species" or a "threatened species." In determining whether a species meets either definition, we must evaluate all identified threats by considering the expected response by the species and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species' level. We evaluate each threat and its expected effects on the species then analyze the cumulative effect of all of the threats on the species as a whole. We also consider the cumulative effect of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Secretary determines whether the species meets the definition of an "endangered species" or a "threatened species" only after conducting this cumulative analysis and describing the expected effect on the species now and (if evaluating whether a species is a threatened species) in the foreseeable future.

Threats, Conservation Measures, and Existing Regulatory Mechanisms

For additional information on threats to viability, please refer to pp. [18-30] of the SSA report. Our synthesis of factors that could potentially affect the viability of the species indicates that human population growth, contemporary land use and urban, agricultural, or infrastructure development across the species' largely rural distribution likely do not present an imminent threat. The greatest current threat to the species is habitat degradation and fragmentation due to legacy effects of past land use practices. Habitat fragmentation will likely interact with future climate change leading to potential reductions in viability of the species. Hence, the best available information indicates that habitat degradation and fragmentation have the greatest negative effect on current viability of the Yazoo crayfish.

Fragmentation has been cited as a leading potential cause of extirpation of crayfishes in the United States (Vorosmarty et al. 2010, entire). One of the leading crayfish experts in the country has indicated that habitat fragmentation and the small size of remaining suitable habitat are likely the greatest current threats to long term persistence of the Yazoo crayfish (Adams 2020, p. 17). There are two primary mechanisms of fragmentation within the distribution of the Yazoo crayfish: road crossings and impoundments. Additionally, it is possible that channelization over long distances may also form filters or barriers to dispersal.

Intact forests within catchments and along the riparian zone are crucial to healthy stream ecosystems (Warren 2012, pp. 221-264). Reductions in catchment canopy cover (forest cover within a catchment, which is one of the HUC levels), even if riparian cover remains intact, will likely have negative effects on stream habitat and Yazoo crayfish, especially for those streams running through agricultural fields and more urbanized areas (Service 2022, p. 24). Small impoundments directly destroy habitat and alter stream gradients and habitat upstream of the lake (Tullos et al. 2016, entire).

Sedimentation in streams is often a result of within channel erosion of banks, head cutting, and stream incisement, which are usually the result of past land cover and land use practices (e.g., channelization) (Neal and Anders 2015, entire). Increased sedimentation from a variety of sources (e.g., timber harvest that do not use best management practices, row crop agriculture, and urbanization) is detrimental to stream habitats for a variety of reasons (Lester and Boulton 2008, entire; Turunen et al. 2021, entire). Given our limited information for the Yazoo crayfish, perhaps the most potentially damaging effect of increased sedimentation is smothering of apparently suitable habitat in fine sediments. Smothering is often periodic in response to disturbance events in the watershed and variation in flows. When suitable habitat is buried, refugia from sudden flooding and predators, suitable sites for reproduction, and food resources may be reduced. Increased turbidity due to sedimentation may have multiple negative effects on fitness (e.g., suppressed feeding or foraging, decreased feeding efficiency, increased predation).

<u>Conservation Measures and Existing Regulatory Mechanisms</u>

The Yazoo crayfish is included in the Mississippi State Wildlife Action Plan (SWAP), a ten-year comprehensive update to the 2005 Comprehensive Wildlife Conservation Strategy. The original plan serves as the foundation for the SWAP and marked a major milestone in conservation planning in the U.S. It was the first time each state wildlife agency led a collaborative effort to design a conservation “blueprint” for all wildlife species in their jurisdictions. To accomplish this, each state worked with partners and experts to identify species of greatest conservation need (SGCN), describe their habitats and key threats, recommend conservation actions necessary to prevent more species from becoming threatened or endangered, spur recovery, and keep common species common (Mississippi Museum of Natural Science. 2015, p1). The Yazoo crayfish has a State Rank of S2 which indicates imperiled in Mississippi because of rarity (6 to 20 occurrences) or because of some factor(s) making it vulnerable to extirpation.

Increases in forested watershed cover through time and reductions in row crop agriculture (USDA NASS 2021a and b, entire) as well as better understanding and implementation of Best Management Practices (BMPs) in recent years for agriculture and timber plantations partly explains catchment erosion no longer being the main source of sediment inputs in lowland, agricultural streams (Neal and Anders 2015, entire; Auerswald and Geist 2018, entire, however, see Zaimes et al. 2019, p. 11:1343). Sediment inputs into streams today are mostly the result of past land use and land cover (Service 2022, p. 22).

Streams across most of the distribution of the species are also undergoing self-repair. One estimate of recovery from channelization in western Tennessee (Gulf Coastal Plain, very similar to streams occupied by the Yazoo crayfish) suggested that about 60 years were needed for bank erosion rates to return to natural rates (Hupp 1992, pp. 1209-1226). Therefore, stream repair in this system is likely occurring but may take many years to provide benefits to the species.

Cumulative Effects

Interactions between climate change and high levels of stream habitat fragmentation are likely the single greatest threat to the persistence of the Yazoo crayfish in the future. The increased occurrence, duration, and severity of extreme events such as heavy precipitation, extreme heat, droughts, and possibly forest fires (USGCRP 2018, entire) will likely result in additional direct mortality of aquatic species and reductions in fitness (Service 2022, p. 33). Because the Yazoo crayfish occur in highly fragmented streams with relatively small patches of available suitable habitat, access to refugia or new patches of suitable unoccupied habitat is likely rare but uncertain. Recolonization or demographic rescue by a subpopulation in another portion of the watershed is usually not possible. Isolated small populations likely suffer from a lack of genetic diversity and may suffer from the effects of past population bottlenecks and inbreeding depression (Reed 2008, pp. 16-34).

We note that, by using the SSA framework to guide our analysis of the scientific information documented in the SSA Report, we have analyzed the cumulative effects of identified threats and conservation actions on the species. To assess the current and future condition of the species, we evaluate the effects of all the relevant factors that may be influencing the species, including threats and conservation efforts. Because the SSA framework considers not just the presence of the factors but to what degree they collectively influence risk to the entire species, our assessment integrates the cumulative effects of the factors and replaces a stand-alone cumulative-effects analysis.

ANALYSIS

We assessed the Resiliency, Redundancy, and Representation of the Yazoo crayfish to determine current and future condition.

To determine current resiliency, we assessed the combined effects of forest cover, channelization, and fragmentation within each analytical unit. Each metric was scaled and provided a numerical score based on its condition. We summed the scores of each metric to assess overall resiliency within each analytical unit to determine low, moderate, or high resiliency. For additional details on current condition methods, please refer to pp. [34-38] of the SSA report.

Delineating Analytical Units

For all analyses, sites of occurrence within HUC 12 watersheds were grouped within streams to form analytical units (Figure 2). Given that distribution of the species is more or less undefined and because we have no dispersal information for the species, it is unlikely that these units form natural populations. We used the U.S. Environmental Protection Agency’s Level IV ecoregions to describe representation units (USEPA 2013, unpaginated, accessed Aug. 15 2022). We describe the distribution of analytical units within HUC 8 watersheds and level IV ecoregions

(Table 1).

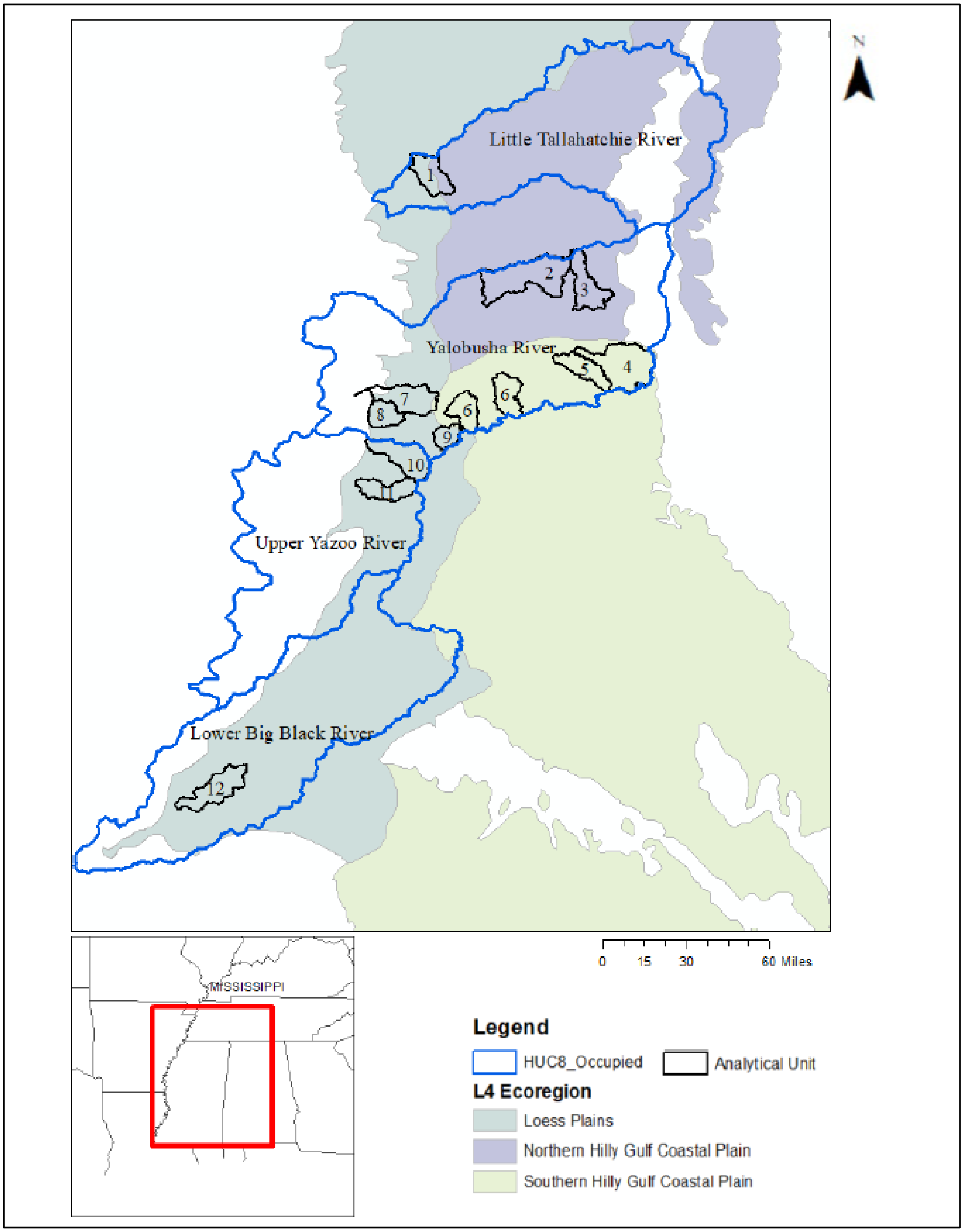

Figure 2. Map of analytical units distributed across HUC 8 watersheds and Level 4 eco-regions. Numbers correspond to analytical unit number.

Table 1. Analytical units locations and identification number.

HUC 8	Ecoregion	Analytical Unit Name	Analytical Unit Number
Little Tallahatchie River	Northern Hilly Gulf Coastal Plain/Loess Plain	**Orr Creek**	1
Yalobusha River	Northern Hilly Gulf Coastal Plain	**Turkey Creek**	2
	Northern Hilly Gulf Coastal Plain	**Skuna River**	3
	Southern Hilly Gulf Coastal Plain	**Topshaw Creek**	4
	Southern Hilly Gulf Coastal Plain	**Shutispear Creek**	5
	Southern Hilly Gulf Coastal Plain	**Batapan Bogue**	6
	Loess Plains	**Potococowa Creek**	7
	Loess Plains	**Teoc Creek**	8
	Loess Plains	**Big Sand Creek**	9
Upper Yazoo River	Loess Plains	**Pelucia Creek**	10
	Loess Plains	**Abiaca Creek**	11
Lower Big Black River	Loess Plains	**Fourteenmile Creek**	12

Forest Cover

We used the National Land Cover Database land cover dataset to assess land cover within the analytical units described in Table 4.1 of the SSA report (Jin et al. 2019, pp. 2971-3003). We assessed percentage of forest cover within each analytical unit. We considered forest cover of <50% as low, 50-75% forest cover as moderate, and >75% forest cover as high.

Channelization

We used GIS tools to measure total stream length and the length of channelized reaches in streams occupied by the Yazoo crayfish to estimate the proportion of stream length that is channelized. We considered a percent channelization of <33.34% as high resilience, 33.34-66.33 as moderate, and >66.33 as low.

Fragmentation

We used GIS to qualitatively assess fragmentation within streams of occurrence. We used the Southeast Aquatic Barrier Prioritization Tool (SARP 2021, online) to estimate the number of potential barriers (road crossings and impoundments) in each occupied HUC 12 watershed and divided the number of barriers (roads and dams) by HUC 12 watershed area. For our analysis, we determined a density of barriers <61.67 as high resilience, 61.67-123.33 as moderate, and >123.33 as low.

CURRENT CONDITION

Resiliency describes the ability of a population to withstand environmental or demographic stochastic disturbance. Based on our delineation for analyses, we delineated 12 analytical units across 20 HUC-12 watersheds in four HUC 8 watersheds and three level IV ecoregions (Figure 2). Five analytical units are considered high resiliency, 3 moderate resiliency, and 4 low resiliency. The highest resiliency analytical units are those with a higher number of occupied watersheds, lower channelization, lower fragmentation, and higher forest cover (Service 2022, pp. 36-38). Although threats are present on the landscape, our analysis of current condition indicates that the Yazoo crayfish has multiple high and moderate resilient populations distributed across the landscape.

Representation describes the ability of a species to adapt to both near-term and long-term changes in its physical (climate conditions, habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments. For the Yazoo crayfish, we do not have information on the genetic diversity within and among populations across the species' range. In the absence of genetic and ecological diversity information, representation can be assessed based on the extent and variability of habitat characteristics across the geographical range. The Yazoo crayfish occurs across different ecoregions that could influence its adaptive capacity to respond to environmental changes. We used the U.S. Environmental Protection Agency's Level IV ecoregions as representation units (USEPA 2013, unpaginated, accessed Aug. 15 2022). We report representation as the presence of moderate and high analytical units across ecoregions. Redundancy is the ability of a species to withstand catastrophes, which we define as disturbances that exceed the typical annual stochastic variation with the potential to extirpate populations of the species. We report redundancy as the number of moderate and high resiliency units distributed across the range of the Yazoo crayfish.

The Yazoo crayfish occupies 12 analytical units across 20 HUC 12 watersheds in four HUC 8 watersheds and three level IV ecoregions, which we consider adequate representation. There are multiple moderate and high resilient populations in each ecoregion and across the species' range providing the Yazoo crayfish with redundancy.

FUTURE CONDITION

We calculated future resiliency by assessing future land use change within each analytical unit. We used the USGS FOREcasting SCEnarios of Land-use Change (FORE-SCE)) (Sohl et al. 2018, data release). For more information on future condition, please refer to pp. [37-38] of the SSA report.

The FORE-SCE model develops future scenarios based on the IPCC Special Report on Emissions Scenarios (SRES) pathways. We developed two future scenarios, scenarios A and B, at 2040 and 2060. Scenario A uses the B1 SRES pathway, which is a lower development scenario similar to the RCP 4.5 emissions pathway (Sohl et al. p. 1021). Scenario B uses the A2

SRES pathway, which is a higher development pathway similar to the RCP 8.5 emissions pathway (Sohl et al. 2014, p. 1022).

We calculated resiliency scores for years 2040 and 2060 under scenarios B1 and A2. Negative impacts to streams from urban land cover in a watershed can be detected at about 10% and are severe at 25% (Paul and Meyer 2001, p. 352; Walsh et al. 2005, p. 715). We assumed that any analytical units with greater than 10% urban cover would experience a decrease in resiliency. In addition, we qualitatively described the possible impacts of legacy effects of channelization and fragmentation as well as changing water temperature due to climate change for each analytical unit.

We summarized resiliency for all analytical units across two future scenarios at 2040 and 2060 (Table 1). In 2040, four moderate and five high resiliency analytical units remain the same under scenarios B1 and A2. Three low analytical units remain the same in scenario A2, but one is reduced to very low under scenario B1. In 2060, the number of high resiliency units decreases from five units to three units under scenarios B1 and A2. In B1 2060, there are 4 moderate units and five low units, and in A2 2060, there are five moderate units, two low units, and two very low units.

Table 2. Summary of resiliency across all analytical units for current and future scenarios B1 and A2 at 2040 and 2060. Resiliency condition H=High, M= Moderate, L=Low, VL=Very Low.

		Resiliency				
Analytical Unit Number	**Analytical Unit**	**Current**	**B1 2040**	**B1 2060**	**A2 2040**	**A2 2060**
1	**Orr Creek**	L	L	L	L	L
2	**Fourteenmile Creek**	M	M	L	M	L
3	**Abiaca Creek**	M	M	M	M	M
4	**Pelucia Creek**	H	H	H	H	M
5	**Batapan Bogue**	L	VL	L	L	VL
6	**Big Sand Creek**	L	L	L	L	VL
7	**Potococowa Creek**	H	H	H	H	H
8	**Shutispear Creek**	H	H	M	H	H
9	**Skuna River**	M	M	L	M	M

10	**Teoc Creek**	H	H	H	H	H
11	**Topshaw Creek**	M	M	M	M	M
12	**Turkey Creek**	H	H	M	H	M

In 2040, the number of moderate and high resiliency analytical units remains the same under future scenarios B1 and A2 in maintaining redundancy and representation. In 2060, the number of moderate and high resilience units decreases under both scenarios, but redundancy is maintained by multiple moderate and high resiliency units distributed across the range while representation is maintained across the three occupied ecoregions.

FINDING

Regulatory Framework

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species is an “endangered species” or a “threatened species.” The Act defines an endangered species as a species that is “in danger of extinction throughout all or a significant portion of its range,” and a threatened species as a species that is “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” The Act requires that we determine whether any species is an “endangered species” or a “threatened species” because of any one or a combination of the following factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;
(B) Overutilization for commercial, recreational, scientific, or educational purposes;
(C) Disease or predation;
(D) The inadequacy of existing regulatory mechanisms; or
(E) Other natural or manmade factors affecting its continued existence.

These factors represent broad categories of natural or human-caused actions or conditions that could have an effect on a species’ continued existence. In evaluating these actions and conditions, we look for those that may have a negative effect on individuals of the species as well as other actions or conditions that may ameliorate any negative effects or may have positive effects.

The Act does not define the term “foreseeable future, which appears in the statutory definition of “threatened species.” Our implementing regulations at 50 CFR 424.11(d), as revised in 2019, set forth a framework for evaluating the foreseeable future on a case-by-case basis. The term “foreseeable future” extends only so far into the future as we can reasonably determine that both the future threats and the species’ responses to those threats are likely. In other words, the foreseeable future is the period of time in which we can make reliable predictions. “Reliable” does not mean “certain”; it means sufficient to provide a reasonable degree of confidence in the prediction. Thus, a prediction is reliable if it is reasonable to depend on it when making decisions.

It is not always possible or necessary to define the foreseeable future as a particular number of years. Analysis of the foreseeable future uses the best scientific and commercial data available and should consider the timeframes applicable to the relevant threats and to the species' likely responses to those threats in view of its life-history characteristics. Data that are typically relevant to assessing the species' biological response include species-specific factors such as lifespan, reproductive rates or productivity, certain behaviors and other demographic factors.

Status Assessment

Status Throughout All of Its Range

After evaluating threats to the species and assessing the cumulative effect of the threats under the section 4(a)(1) factors, we assessed the current status of the Yazoo crayfish to determine if it meets the definition of an endangered species. Currently, the species occupies 12 analytical units in four HUC 8 basins. Recent increases in sampling have expanded the distribution significantly and doubled the number of known locations. In general, current land use practices do not appear to have an appreciable negative impact on the species' resiliency, redundancy, and representation. Moreover, habitat conditions for the species have been improving over the past 10-20 years (reduction in agriculture, increase in forested habitat within occupied watersheds, decrease in developed landcover) (USDA NASS 2021a and b, entire). Lingering effects of prior land uses and management practices continue to impact the species, but there is evidence that streams are recovering from these uses and habitat may be improving. Although threats are present on the landscape, the Yazoo crayfish has multiple moderately and highly resilient populations distributed across the landscape providing the species with adequate redundancy and representation. Therefore, the threats appear to have low imminence and magnitude such that they currently are not significantly affecting the species' viability. The SSA Report describes some of the uncertainties in the species' occurrence, populations, and response to threats, but considering the available data, the risk of extinction is low due to the distribution of multiple high and moderate resiliency units across its range. Thus, after assessing the best available information, we conclude that the Yazoo crayfish is not in danger of extinction throughout all of its range. Therefore, we proceed with determining whether the species is likely to become endangered within the foreseeable future throughout all of its range.

In considering the foreseeable future as it relates to the status of the Yazoo crayfish, we considered the relevant risk factors (threats/stressors) acting on the species and whether we could draw reliable predictions about the species' response to these factors. We considered whether we could reliably assess the risk posed by the threats to the species while recognizing that our ability to assess risk is limited by the lack of available data about effects to the species and its response to those effects.

Land use patterns are projected to continue over the next 30 years. Human population density is low in most of the species' range so impacts related to urbanization and development are generally low and show minimal change under both future scenarios B1 and A2 in 2040. Future scenarios in 2060 demonstrate an increase in urbanization in some analytical units resulting in a decrease in resiliency of four analytical units under scenario B1 and five analytical units under scenario A2; however, seven analytical units remain in moderate or high condition in scenario

B1 while eight units remain in moderate or high condition in scenario A2. Although change is predicted to occur due to threats on the landscape, our analysis indicates that the magnitude of change under both scenarios and timesteps does not indicate a significant risk to future viability of the Yazoo crayfish. The species is expected to experience slight reductions in resiliency in 2060, but moderate and high resiliency populations are expected to remain across the range. In addition, recent increases in sampling efforts have resulted in significant expansion of the species' current range, and it is predicted that future increases in sampling efforts will produce similar results (Jones 2013, entire; Adams 2020, pp. 12-18). After assessing the best available information, we conclude that the Yazoo crayfish is not likely to become endangered within the foreseeable future throughout all of its range.

Status Throughout a Significant Portion of Its Range

Under the Act and our implementing regulations, a species may warrant listing if it is in danger of extinction or likely to become so in the foreseeable future throughout all or a significant portion of its range. Having determined that the Yazoo crayfish is not in danger of extinction or likely to become so in the foreseeable future throughout all of its range, we now consider whether it may be in danger of extinction or likely to become so in the foreseeable future in a significant portion of its range—that is, whether there is any portion of the species' range for which it is true that both (1) the portion is significant; and (2) the species is in danger of extinction now or likely to become so in the foreseeable future in that portion. Depending on the case, it might be more efficient for us to address the "significance" question or the "status" question first. We can choose to address either question first. Regardless of which question we address first, if we reach a negative answer with respect to the first question that we address, we do not need to evaluate the other question for that portion of the species' range.

In undertaking this analysis for Yazoo crayfish, we chose to address the status question first. We began by identifying portions of the range where the biological status of the species may be different from its biological status elsewhere in its range. For this purpose, we considered information pertaining to the geographic distribution of (a) individuals of the species, (b) the threats that the species faces, and (c) the resiliency condition of populations.

We evaluated the range of the Yazoo crayfish to determine if the species is in danger of extinction now or likely to become so in the foreseeable future in any portion of its range. The Yazoo crayfish is a range-limited stream-dwelling species that occurs within a small area distributed among scattered locations in the Yazoo and Big Black River drainages of Mississippi. The range of a species can theoretically be divided into portions in an infinite number of ways. We focused our analysis on portions of the species' range that could result in the species being designated as "endangered" or "threatened." We considered whether the threats or their effects on the Yazoo crayfish are greater in any biologically meaningful portion of the species' range than in other portions such that the species is in danger of extinction now or likely to become so in the foreseeable future in that portion. The primary threat identified for the Yazoo crayfish is habitat fragmentation, resulting from a number of factors such as stream channelization, road crossings, impoundments, and development. Based on the best available science, these factors are not concentrated within a specific portion of the range but are spread throughout the range of the species. Currently, in each ecoregion, moderate and high resiliency populations occur. In Northern Hilly Gulf Coastal Plain, there are two moderate resiliency populations and one of low resiliency. In Southern Hilly Gulf Coastal Plain, there are two low resiliency populations and one of high resiliency. In Loess Plain, there are two moderate and four high resiliency populations.

Although some populations may decline to low or very low resiliency in the future, at least one moderate and/or high resiliency population will occur in each ecoregion. In Northern Hilly Gulf Coastal Plain, there are two low resiliency populations and one of moderate resiliency. In Southern Hilly Gulf Coastal Plain, there are two very low resiliency populations and one of moderate resiliency. In Loess Plain, there are three moderate and three high resiliency populations. Despite the presence of low or very low populations, the presence of at least one moderate or high population within each eco-region, as well as multiple populations, reduces the risk of local extirpation in the future. The current and future condition analyses of the Yazoo crayfish indicate sufficient resiliency, representation, and redundancy in each ecoregion. As a result, there are no portions of the species' range where the species has a different biological status from its rangewide biological status. Therefore, we conclude that there are no portions of the species' range that warrant further consideration, and the species is not in danger of extinction or likely to become so in the foreseeable future in any significant portion of its range. This does not conflict with the courts' holdings in *Desert Survivors* v. *U.S. Department of the Interior*, 321 F. Supp. 3d 1011, 1070-74 (N.D. Cal. 2018), and *Center for Biological Diversity v. Jewell*, 248 F. Supp. 3d. 946, 959 (D. Ariz. 2017) because, in reaching this conclusion, we did not apply the aspects of the Final Policy on Interpretation of the Phrase "Significant Portion of Its Range" in the Endangered Species Act's Definitions of "Endangered Species" and "Threatened Species" (79 FR 37578; July 1, 2014), including the definition of "significant" that those court decisions held to be invalid.

Determination of Status

Our review of the best available scientific and commercial information indicates that the Yazoo crayfish does not meet the definition of an endangered species or a threatened species in accordance with sections 3(6) and 3(20) of the Act. Therefore, we find that listing the Yazoo crayfish is not warranted at this time.

COORDINATION WITH STATES

In preparing the finding for the Yazoo crayfish, we closely coordinated with State agencies in Mississippi throughout the SSA process. Specifically, we contacted all relevant State agencies (Mississippi Dept. of Wildlife, Fisheries and Parks; Mississippi Dept. of Transportation; and Mississippi Dept. of Environmental Quality) to request information and provide technical review of the threats assessment and analytical framework. We also included biologists with expertise in the species, its habitat, and relevant threats in our partner review of the SSA Report. The information, feedback, and comments received through these coordination efforts were incorporated in the SSA Report, where appropriate. We continue to coordinate with State agencies on conservation of the Yazoo crayfish.

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All SAFs supporting 12-month findings or candidate notices of review will be signed by the Director. SAFs should continue to be surnamed by Regional and Headquarters staff and leadership.

Date: 9/14/23

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