Recovery Plan for the Slenderclaw Crayfish (*Cambarus cracens*)

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PURPOSE AND DISCLAIMER

This document presents the U.S. Fish and Wildlife Service's (Service) plan for the conservation of slenderclaw crayfish. The recovery plan is the second part of the Service's 3-part recovery planning framework and includes the statutorily required elements pursuant to section 4(f) of the Endangered Species Act (Act). This recovery plan is informed by the first part of the framework, a Species Status Assessment (SSA). The SSA report delivers foundational science for informing decisions related to the Act and includes an analysis of the best available scientific and commercial information regarding a species' life history, biology, and current and future conditions that characterizes the species' viability (i.e., ability to sustain populations in the wild over time) and extinction risk. We have also prepared a Recovery Implementation Strategy (RIS), the third part of the framework. The RIS is an easily updateable operational plan that is separate and complimentary to the recovery plan that details the on-the-ground recovery activities needed to complete the recovery actions contained in the recovery plan.

Recovery plans describe the envisioned recovered state for a listed species (when it should no longer meet the Act's definitions of a threatened species or endangered species) and include a recovery strategy, recovery criteria, recovery actions, and the estimates of time and cost needed to achieve it. Plans are published by the Service and are often prepared with the assistance of recovery teams, contractors, State agencies, and others. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in plan formulation, other than the Service. They represent the official position of the Service only after they have been signed by the Regional Director as approved. Recovery plans are guiding and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and completion of recovery actions.

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RECOMMENDED CITATION AND ELECTRONIC AVAILABILITY

U.S. Fish and Wildlife Service. 2025. Recovery plan for the slenderclaw crayfish (*Cambarus cracens*). U.S. Fish and Wildlife Service, Southeast Region, Atlanta, Georgia, USA. 11 pp.

An electronic copy of this Recovery Plan will be made available at:
https://ecos.fws.gov/ecp/species/9792

1. INTRODUCTION

This recovery plan describes criteria for determining when the slenderclaw crayfish should be considered for delisting, lists site-specific actions that will be necessary to meet those criteria, and estimates the time and cost to achieve recovery. Additionally, a summary of the species' biology and status are included, along with a brief discussion of factors limiting its populations. A detailed discussion of these and other topics pertinent to the recovery of slenderclaw crayfish can be found in the Species Status Assessment (SSA) (Service 2019, entire). Detailed on-the-ground activities implementing recovery actions can be found in the Recovery Implementation Strategy (RIS). These supplemental documents are available online on the species' ECOS webpage. The RIS and SSA are finalized separately from the Recovery Plan and will be updated on a routine basis.

Current Species' Status

The slenderclaw crayfish was federally listed as an endangered species on October 8, 2021 (86 FR 50264). The Service also designated approximately 78 river miles (126 river kilometers) in DeKalb and Marshall counties, Alabama as critical habitat under the Act. This species was assigned a recovery priority number of 5, which indicates the species faces a high degree of threat and has low recovery potential. The degree of threat is considered high because the primary threat to slenderclaw crayfish is the invasion of the non-native virile crayfish (*Faxonius virilis*). Recovery potential is considered low because of a lack of understanding of the biological and ecological needs of the species, making it difficult to develop management techniques.

The slenderclaw crayfish is a cryptic (difficult to detect), stream-dwelling and burrowing crayfish endemic to two Tennessee River Basin watersheds along Sand Mountain in Alabama. Slenderclaw crayfish consists of two populations: Short Creek and Town Creek. The Short Creek population includes Shoal Creek, Scarham Creek, and Short Creek. The Town Creek population includes Town Creek and Bengis Creek (Figure 1). Historically, the slenderclaw crayfish was collected at five sites: one in Shoal Creek, one in Short Creek, two in Scarham Creek and one in Bengis Creek. Compared to now, the species is currently found at three sites in Shoal Creek, one site in Bengis Creek, and an additional site in Town Creek (Figure 1). Repeated survey efforts have attempted to collect the slenderclaw crayfish at the type locality on Short Creek and the other three historical sites on Scarham and Bengis creeks, but it has not been collected at these sites since the 1970s (Service 2019, pp. 9–12).

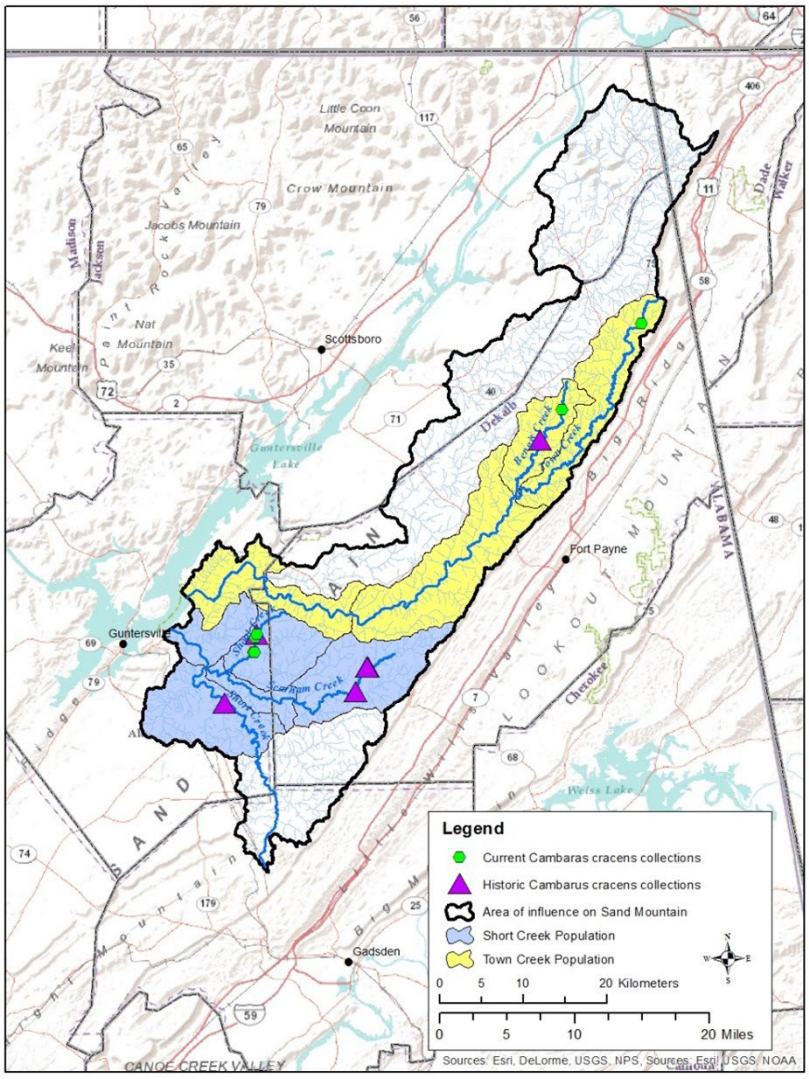

Figure 1. Slenderclaw crayfish (*Cambarus cracens*) range map with historic (purple triangles) and currently known (green dots) occupied sites. Two populations, Short Creek (shaded purple) and Town Creek (shaded yellow), are delineated based on HUC-12 watershed boundaries and tributaries flowing into Guntersville Lake on the Tennessee River. Larger tributaries (HUC-10s) likely to influence slenderclaw crayfish habitat watersheds are outlined in black (Service 2019, p. 11).

Habitat Requirements and Limiting Factors

The slenderclaw crayfish is a stream-dwelling crayfish and tertiary burrower, meaning it will burrow when necessary (e.g., in drying conditions or to hide from predators, Schuster et al. 2022, p. 51). It occupies small to medium flowing streams (20 feet/6 meters wide and 2.3 feet/0.7 meters deep or less) with minimal turbidity (Service 2019, pp. 4, 8). Within the Short Creek population, the habitat occupied by the species is predominately large boulders and fractured bedrock, and in the Town Creek population the occupied habitat is small substrate types with a mix of sand, gravel, and cobble. The species needs abundant interstitial space for sheltering,

sufficient water flow and water quality that maintains benthic habitats and macroinvertebrate prey, and stream connectivity (Service 2019, p. 8).

The primary threats to slenderclaw crayfish are invasion by non-native virile crayfish and degradation of stream habitats (Service 2019, pp. 14–20). Virile crayfish have spread from their native range through their use as fishing bait, as pets, and through commercial (human) consumption (Schwartz et al. 1963, p. 267; Service 2015, p. 4). They are extremely tolerant animals that feed as generalists, able to persist in a variety of habitats and environments and have a natural tendency to migrate and spread quickly in new areas (Loughman and Simon 2011, p. 50). Virile crayfish invasions have resulted in the extirpation and displacement of native crayfishes (Hubert 2010, p. 5; Loughman and Welsh 2010, p. 70; Larson et al. 2018, p. 180), and they are present within the range of slenderclaw crayfish (Service 2019, pp. 16–20). The specifics of how virile crayfish affects slenderclaw crayfish are to be determined; though body size, average chelae size, aggression levels, and growth rates have indicated that virile crayfish has an ecological advantage compared to several native crayfish species, including those in the *Cambarus* and *Procambarus* genera (Hale et al. 2016, p. 6). At this time, there are no reported areas were virile and slenderclaw crayfish co-occur (Service 2019, pp. 16–17).

Stream habitat degradation through pollution and eutrophication from nonpoint sources stemming from agriculture, animal production, and runoff from unimproved roads have been documented within the range of the slenderclaw crayfish (Bearden et al. 2017, pp. 18, 21–22; Service 2019, pp. 14–15). Town and Short creeks are currently on the §303(d) list of impaired watersheds, due to atmospheric deposition of metals (mercury) and excess nutrients, respectively, and two tributaries to Short Creek, Drum Creek and Cross Creek are listed due to pathogens (E. coli) and organic enrichment (ADEM 2024, pp. 15–16). Town and Short creek watersheds also contained toxic trace metals and pesticides in a 2017 water quality analysis, including measurements of lead in Bengis Creek that exceeded the acute and chronic aquatic life criteria set by the Environment Protection Agency (ADEM 2017, pp. 10–17; Bearden et al. 2017, p. 32). Uncertainty remains regarding specific water quality thresholds for many crayfish species, including the slenderclaw, but some crayfish densities have been shown to be limited by metal concentrations that exceed the chronic water quality criteria (Allert et al. 2008, p. 105). Further, diminished water quality from increased nutrients, ammonia, and other contaminants can be fatal to aquatic macroinvertebrates, which are the primary food source for juvenile crayfish (EPA 2024).

Droughts and flooding also impact water flows and quality, and manmade barriers such as dams and impoundments impede crayfish movement and population connectivity (Barnett and Adams 2021, pp. 4–5), both of which occur in the range of the slenderclaw crayfish. Additional information is needed to better understand slenderclaw dispersal patterns and barriers. Recovery actions identified in this plan therefore focus on the need to identify the range of the species, habitat and life history requirements, and potential impacts from the virile crayfish to better understand and address these threats and their impacts on slenderclaw crayfish viability.

2. RECOVERY STRATEGY

The recovery strategy provides a concise overview of the envisioned recovered state for slenderclaw crayfish, describes the Service's chosen approach to achieve it, and includes the rationale for why the approach was chosen. Specifically, the recovery strategy articulates how the plan's statutory elements (e.g., recovery criteria, recovery actions, and estimates of time and cost) will work together to achieve the slenderclaw crayfish's recovery.

Both identified slenderclaw crayfish populations have low resiliency, reduced representation, and limited redundancy (Service 2019, pp. 38–39). The recovery strategy is to implement actions and activities that enhance resiliency of the Short Creek and Town Creek slenderclaw populations to moderate and higher levels, as defined in the SSA using demographic and habitat metrics (Service 2019, p. 31). The limited range of this narrow endemic and its documented small abundances first necessitate additional research to better understand the species' biology, habitat requirements, dispersal patterns, population genetics, and responses to identified threats. These studies will inform subsequent management actions such as mitigating the threat of virile and other nonnative crayfish invasions, improving stream habitat quality to meet the species' needs, establishing additional occupied sites, and increasing overall abundance. These actions are needed across the known range of the Town and Short creek populations, and adaptive management and adjustments to recovery implementation will be necessary to respond to new information gained through this research. For example, understanding life history strategies of virile crayfish specific to this area and in comparison to slenderclaw crayfish may dictate which sampling and removal techniques are most effective (e.g., Rogowski et al. 2013, pp. 1286–1287; Tripp et al. 2024, p. 1102).

Establishing additional occupied sites in multiple branches of the stream networks throughout the known range will also improve redundancy and representation by adding abundance, diversity, and complexity to the crayfish's distribution. These may be achieved through captive propagation or headstarting, augmentations, reintroductions, as well as natural dispersal as a result from improved habitat conditions. The actions in this plan therefore prioritize research and the development of targeted management plans that reduce threats to the species and enhance resilience.

Collaboration and partnerships will also be necessary to implement recovery actions. The Service will work cooperatively with county, state, and federal agencies, academic institutions, community organizations, and private landowners to develop monitoring plans, enhance stream habitats, manage invasive species, conduct outreach, and carry out additional research as necessary to inform recovery actions.

3. RECOVERY CRITERIA

Recovery criteria are statutorily required objective, measurable descriptions of a recovered state for slenderclaw crayfish, as described in 4(f)(1)(b)(ii) of the Act. Recovery criteria describe the conditions of resiliency, redundancy, representation, and threat abatement that indicate when slenderclaw crayfish may no longer meet the Act's definitions of an endangered species or threatened species. Recovery criteria present our best estimate of a species' recovered condition at the time of recovery plan development. Changes in available information, technologies, and

our understanding of the species over time might mean that the recovered state envisioned by the recovery criteria differs from our assessment in a later status determination.

The following delisting criteria, when met collectively, may indicate that slenderclaw crayfish no longer meets the Act's definitions of either a threatened species or endangered species, and may be able to be the removed from the Federal Lists of Endangered and Threatened Wildlife and Plants:

Delisting Criterion 1
A minimum of two populations of slenderclaw crayfish maintain moderate or higher resiliency, as defined by the SSA (Service 2019, p. 31, or the most recent version) over a 10-year monitoring period (approximately 3 generations).

Justification: This criterion addresses the establishment of resilient slenderclaw crayfish populations and ensures effective adaptive capacity for the species. In the analysis of current and future conditions for the slenderclaw crayfish, population abundance, number of juveniles, presence of virile crayfish, and water quality conditions were used to determine population resiliency (Service 2019, pp. 29–31). To be resilient, populations need to exhibit sufficient abundance (at least 100 individuals) and successful recruitment (at least 30 juveniles found within last three years of monitoring) with sufficient stream habitat conditions to support viable food sources, continued reproduction, and survival (i.e., improved water quality conditions and lack of competition with virile crayfish)—or some combination thereof that ensures the continued survival of the species. Maintaining resiliency over a 10-year period which encompasses approximately three generations, would provide reasonable assurance that the current populations will be able to withstand future stochastic events. Based on studies of other systems, a 10-year timeframe is also the best available estimated time slenderclaw populations would witness negative displacement as a result from invasive virile crayfish cooccurrence (Service 2019, p. 46).

Delisting Criterion 2
Each population maintains at least 5 self-sustaining occupied sites spread among multiple stream branches and habitat types throughout the population's boundaries, with consistent evidence of natural recruitment over a 10-year monitoring period.

Justification: Representation and redundancy ensures that populations persist through catastrophic events and adjust to environmental changes (Wolf et al. 2015, p. 204). This criterion improves representation by ensuring that the species occupies both habitat types that it was historically found in, which is one of the two identified representation metrics used in the SSA (Service 2019, p. 32). This criterion also adds to the species' redundancy and resiliency by increasing population abundance and requiring a more complex, nonlinear distribution of occupied sites such that stochastic or catastrophic events in one tributary do not eliminate entire populations.

The term "sites" refers to segments of occupied streams approximately 200 meters (approximately 650 ft) in length that are within a population. The slenderclaw crayfish's dispersal patterns are unknown, and crayfish movement can vary widely between species

(Longshaw and Stebbing 2016, entire). Thus, there are varying distances between occupied sites, but they are separated by assumed natural or manmade barriers to crayfish movement (e.g., dams, road crossings, waterfalls). Given the number and distribution of currently and historically occupied sites of slenderclaw crayfish, each watershed should have appropriate habitat and be able to support at least five sites. Successful recruitment, indicated by the presence of multiple life stages observed at least every two years over a 10-year monitoring period, would indicate that sites are established and able to persist through environmental variations and potential threats such as presence of invasive crayfish (Service 2019, p. 46).

4. RECOVERY ACTIONS

Recovery actions are the statutorily required, site-specific management actions needed to achieve recovery criteria, as described in section 4(f)(1)(B)(i) of the Act. The Service assigns recovery action priority numbers (1-3) to rank recovery actions. The assignment of priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented.

Table 1. Recovery actions, their estimated cost, and their priority.

Recovery Action	Related Recovery Criterion	Priority	Estimated Cost
1. Assess and evaluate slenderclaw crayfish population abundances and distributions, genetic differences, habitat preferences, food requirements, reproductive requirements, and other life history traits across the species' range.	1, 2	1	503,000
2. Monitor slenderclaw crayfish populations across their range to assess trends over time.	1, 2	1	242,000
3. Assess the establishment and spread of virile and other nonnative, invasive crayfish species within the range of slenderclaw crayfish.	1	1	200,000
4. Conduct ecological and life history studies on virile and other nonnative crayfish, including competitive interactions, that occur in the range of slenderclaw crayfish.	1	1	228,000
5. Develop and implement management techniques to mitigate the threats of virile crayfish and other invasive species to slenderclaw populations as appropriate.	1	1	205,000
6. Develop a controlled propagation plan (in accordance with the USFWS Controlled Propagation Policy, 65 FR 56916) and carry	2	1	4,425,000

Recovery Action	Related Recovery Criterion	Priority	Estimated Cost
out captive rearing, reintroductions, and augmentations as necessary and appropriate.			
7. Evaluate stream habitat quality throughout the species' range and carry out restoration and enhancement activities to meet slenderclaw crayfish requirements for survival and reproduction.	1	2	3,685,000
8. Develop educational and outreach programs to raise awareness on the spread of nonnative crayfish, water quality issues, and conservation of native crayfish.	1	3	5,000
Total Estimated Cost of Recovery			9,493,000

Recovery action priority numbers are based on the following:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

5. ESTIMATED TIME AND COSTS TO ACHIEVE RECOVERY

We estimate that the full implementation of the recovery actions would improve the status of slenderclaw crayfish so that it could be delisted in 30 years following the adoption of this recovery plan and is estimated to cost $9,493,000. We note that the recovery program may change over time, or the timeframe estimated to implement the recovery actions to achieve recovery of the species may take longer than expected. The recovery of slenderclaw crayfish will depend largely on the commitment and the ability of the Service and partners to implement the recovery actions necessary to achieve the recovery criteria.

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