Recovery Implementation Strategy

Chucky Madtom (*Noturus crypticus*)

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This Recovery Implementation Strategy describes the activities to implement the recovery actions identified in the Draft Recovery Plan for the Chucky Madtom (*Noturus crypticus*) (Service 2016). The strategy provides a narrative and the implementation schedule for the chucky madtom recovery activities. The implementation schedule estimates the cost for implementing recovery activities for reclassification from endangered to threatened (downlisting). Additionally, this strategy document restates the criteria for determining when the chucky madtom should be considered for reclassification from endangered to threatened status. A Species Biological Report, which provides information on the species' biology and status and a brief discussion of factors limiting its populations, is available at http://www.fws.gov/cookeville. The Recovery Implementation Strategy and Species Biological Report will be updated on a routine basis.

Recovery Strategy

The initial strategy for recovery for chucky madtom is to prevent the extinction of this fish by locating individuals and working with partners and the community of Greeneville, Tennessee to protect and enhance the existing habitat along Little Chucky Creek.

Conservation and recovery of this fish will require human intervention and participation. When we are successful at finding individuals, our recovery strategy will develop to work towards increasing madtom numbers through hatchery propagation and augmentation/reintroduction; enhanced restoration and protection of habitat in Little Chucky Creek and in those streams targeted for reintroduction as we learn more about this fish; addressing possible threats such as fish and crayfish species that feed on or compete with chucky madtoms; and monitoring success of recovery of the chucky madtom population and its habitat in Little Chucky Creek. To fully recover this species, we intend to strengthen our partnerships in this drainage with the community of Greeneville, Tennessee; Middle Nolichucky Watershed Alliance; Natural Resources Conservation Service; Greene County Soil Conservation District; Tennessee Valley Authority; non-governmental organizations; universities; and Tennessee Wildlife Resources Agency to help improved habitat conditions by implementing best management practices related to agriculture(e.g., control runoff of pollutants, reduce erosion). We also will need to find or establish new populations outside of the main stem of Little Chucky Creek. We will learn more on developing our recovery strategy as we implement recovery, especially research on life history as individuals are found and studied.

Recovery Objectives (Service 2016, Recovery Plan)

The recovery objectives over the next 30 years are to reduce threats in order to downlist the chucky madtom to threatened status. Defining reasonable delisting criteria is not possible at this time given the current low number of individuals, extreme curtailment of the species' range, extensive modification and fragmentation of habitat within the species historical range, lack of information about the species' biology, and magnitude of other existing threats. Therefore, this recovery plan establishes downlisting criteria for this catfish. Criteria will be reevaluated as new information becomes available.

Criteria for Classification to Threatened Status (Service 2016, Recovery Plan)

1. Suitable instream and riparian habitat, flows, and water quality for chucky madtom as defined by best available science, exist in occupied streams (addresses Factor A; recovery tasks 3.1, 3.2, and 3.3 will refine habitat needs).

2. Population studies show that a viable[1] chucky madtom population in Little Chucky Creek and at least 1 other stream (Dunn Creek, Jackson Branch; e.g., the only known stream representing the historical range of the species) are naturally recruiting (consisting of two year classes in the fall months) and sustainable over a period of 20-30 years (10 generations) (addresses Factors A, C, and E).

Recovery Actions Narrative with Stepped-down Activities

1 Capture chucky madtom and maintain broodstock (addresses Factor E threats)**.** The primary threat to the chucky madtom is its single extant population with few individuals and its apparent inability to offset mortality with its current recruitment rate. Survival and recovery of the chucky madtom requires the development of a propagation program to 1) create an ark (captive) population to ensure survival of the species while habitat restoration is ongoing, 2) augment any existing population in Little Chucky Creek or reintroduce chucky madtoms to Little Chucky Creek once habitat restoration provides the basic needs for all life history stages, and 3) reintroduce chucky madtoms in historical sites with appropriate protected habitat. Population genetic structure using microsatellites or other markers on broodfish and any progeny are important to understand the genetic health of an ark population and the effect of augmenting an existing population within Little Chucky Creek.

1.1 Conduct annual collection efforts in Little Chucky Creek. Chucky madtom captures by biologists working in its range have declined over the years. Increased efforts to collect broodstock are therefore vitally important to the implementation of recovery. Environmental DNA (eDNA) sampling techniques should be employed to monitor the Chucky madtom and to target traditional sampling locations. Sampling efforts should be conducted in all seasons in Little Chucky Creek, Greene County, TN.

1.2 Develop captive propagation protocols for chucky madtom. CFI has successfully propagated the closely related pygmy madtom (one mating pair) (CFI

[1] We define "viable" to be a population that is stable or increasing, of no less than 500 individuals that is showing natural reproduction, no longer requires augmentation, and is able to maintain itself and offset mortality. It has been estimated that effective population sizes may range from 500 individuals (Franklin and Frankham 1998) to avoid deleterious effects of genetic drift over several generations, up to 5,000 individuals (Lande 1995) for long-term survival. Populations will be considered to have sufficient genetic variation to be viable if measurements of observed number of alleles and estimates of heterozygosity and effective population size have remained stable or increased during the ten generations used to establish demographic viability.

2000) and has raised embryos of the closely related smoky madtom harvested from nests in a natural setting (Dinkins and Shute 1996), both endangered species. Protocols should be developed and strengthened by using mating pairs of more common closely related species as surrogates (saddled, elegant, and least madtoms), and by raising progeny from successful spawns to adults.

1.3 **Investigate the potential to use cryopreservation to conduct artificial spawning of chucky madtoms through surrogates.** Due to the low numbers of chucky madtoms (14 specimens) collected in Little Chucky Creek since 1991, every effort must be made to produce progeny and increase the genetic diversity of any ark population. Given its rarity, it is unlikely that a male and female chucky madtom will be in captivity at the same time; therefore, techniques to cryopreserving sperm and strip eggs from future broodstock should be investigated. Techniques have been developed for channel and blue catfish (*Ictalurus punctatus* and *I. furcatus*) (Christensen and Tiersch 2005, Hu *et al.* 2011, Quintero *et al.* 2011). Unfortunately, sperm cannot be stripped from *Ictalurus* males, males must be sacrificed and testes removed and crushed. Therefore, cryopreservation of sperm in chucky madtoms may be restricted to very old or moribund individuals. Protocols should be developed using common closely related species as surrogates (saddled, elegant, and least madtoms).

1.4 **Develop (and implement when broodstock are found) a genetic conservation plan for chucky madtom.** Genetic samples will be collected from all chucky madtom broodstock and a subsample of progeny. A genetic conservation plan will be developed to ensure that the proper genetic variability will be attained and maintained in the propagation program for both the ark population and for any progeny released into Little Chucky Creek or historical sites.

1.5 **Develop (and implement when broodstock are found and habitat tasks are completed under action 2) an augmentation or reintroduction (propagation) plan as warranted for chucky madtom.** This task would only be implemented if a captive ark population is successfully established and the population genetics are deemed appropriate for augmentation or reintroduction of chucky madtoms into Little Chucky Creek or historical sites.

1.6 **Develop (and implement when broodstock are found and task 1.5 is complete) a monitoring plan for propagated chucky madtoms released into Little Chucky Creek or historical sites.** This monitoring plan will include monitoring survival, health, movement, and genetic variation of released chucky madtoms.

2 **Protect and enhance existing habitat for the chucky madtom in the Little Chucky Creek.** Habitat loss through sedimentation and other non-point source pollutants is a primary cause of imperilment for the chucky madtom. Preserving and enhancing habitat in Little Chucky Creek is essential to the conservation of this species. As we find chucky madtoms and learn more about their habitat use, we will reevaluate habitat protection

priorities. For example, based on recent evidence that crayfishes occupied almost all of the artificial nesting structures placed in Little Chucky Creek and prey on madtom embryos, we believe we need to approach tasks 2.4 and 2.5

2.1 **Work with landowners, agencies, and NGOs to protect existing riparian and instream habitats.** Continue to work with the MNWA and all partners to abate agricultural and other sources of sedimentation, physical habitat disturbance, and contaminants in Little Chucky Creek. Determine extent of farming practices, especially livestock, within the Little Chucky Creek watershed. Characterize standard practices for fertilizing and managing pests for various cropping systems and identify best management practices for reducing threats associated with erosion, sedimentation, and contamination from fertilizer or pesticide application.

2.2 **Protect and enhance habitat using available mechanisms like land acquisition programs, conservation agreements, management agreements, etc**. Working in partnership with States agencies like TWRA, TDEC and other land conservation NGOs, we can approach using programs like section 6 Recovery Land Acquisition, state land acquisition pathways to acquire or protect land. Use data from land use characterization and monitoring (see task 5.2) to prioritize parcels and work cooperatively with land owners to protect or restore native riparian and upland forest or implement best management practices for agriculture to reduce input of sediment and chemical pollutants into Little Chucky Creek.

2.3 **Monitor habitat conditions in Little Chucky Creek and habitat associations of any chucky madtoms collected.** In the short term, all chucky madtoms collected in Little Chucky Creek will be used for captive propagation. Once a population is reestablished in Little Chucky Creek through habitat restoration, it should be monitored carefully.

2.4 **Begin a trapping program in Little Chucky Creek to remove all exotic crayfishes.** Based on existing data and evidence that crayfish are known to prey on madtom embryos, we believe we need to trap this creek watershed and fully evaluate the impact of crayfish.

2.5 **Conduct diet studies on potential chucky madtom predators (basses and crayfishes) to determine if interactions are competitive and / or predatory.**

3 **Conduct life history studies on chucky madtoms and/or surrogates.** Little is known about the life history of chucky madtoms, with only 14 specimens collected since 1991, all within a single creek system. Spawning behavior, recruitment, growth, longevity, food habits, and mobility are all inferred from other closely related madtoms or madtoms in general. More detailed information on all aspects of chucky madtom life history is needed to determine which life history and ecological traits influence the vulnerability of chucky madtoms to various threats. If an ark population is established, some information can be obtained, but many life history attributes will only be realized if a wild population

becomes established in Little Chucky Creek or is established or discovered in some other stream in the upper Tennessee River system. Therefore, the use of common closely related surrogate species (saddled, elegant, and least madtoms) may be the best short-term approach to understanding life history characteristics of chucky madtoms.

3.1 **Use surrogate species to determine life history traits of chucky madtoms.** Surrogate species will be used until chucky madtoms are considered viable in Little Chucky Creek (criteria 2 has been met).

3.2 **Use surrogate species to evaluate potential toxicity to chucky madtoms from commonly-used pesticides and herbicides in the Little Chucky Creek watershed.** Knowing which chemicals are most toxic to chucky madtoms will allow appropriate agencies to work with landowners and partners to restrict the use of these chemicals in the Little Chucky Creek watershed.

3.3 **Determine if surrogate species utilize large-river habitat for part of their life history.** Given that chucky madtoms are known from two creeks in different watersheds (Little Pigeon and Nolichucky rivers) they must have historically used mainstem habitat, at least for movement between smaller creeks in the upper Tennessee River drainage. Determine to what extent the surrogate species that are mostly restricted to smaller streams (saddled and elegant madtoms) use large river habitat.

4 **Promote voluntary stewardship as a practical means of reducing nonpoint source pollution from private land use and improving habitat.**

5 **Develop models to identify potential chucky madtom habitat and potentially find new populations.** While surveys have covered many Upper Tennessee River streams to search for additional populations of chucky madtoms (Burr and Eisenhour 1994, Shute *et al.* 1997, Rakes and Shute 2004, Lang *et al*. 2005), there could be additional undiscovered populations that have not been sampled. Predictive GIS models, such as MaxEnt, should be used to identify streams in the upper Tennessee River system with characteristics similar to those in Little Chucky Creek. Locality data for the other closely related Tennessee River madtoms that occupies small-streams (saddled madtoms) may be utilized to create a more robust data set for the model. In addition, modeling software can allow for characterization of the chucky madtom’s response to changes in land uses or from climate change.

5.1 **Predict other suitable habitat (using GIS modeling tools) in the upper Tennessee River system where chucky madtoms may occur.**

5.2 **Conduct surveys based on the habitat identified in task 5.1.**

5.3 **Use GIS modeling tools to predict responses of chucky madtoms to threats like changes in land use from development.**

6 Develop and implement programs and materials to help inform the public on the chucky madtom, and to involve them in watershed stewardship to protect this listed species.

7 Coordinate all recovery activities, evaluate success, and revise recovery plan as appropriate.

Summary of threats, criteria, actions, and activities

Listing factor	Threat	Criteria	Action	Activity
A	Water and habitat quality	1	2, 3, 4, 5	2.1-2.3, 3.1-3.3, 4.0
C	Predation	2	2	2.4, 2.5
D	Inadequacy of existing regulatory mechanisms	1	4	2.1
E	Small fragmented populations	2	1, 2, 3, 5	1.1-1.6, 2.1-2.4, 3.1, 3.3, 5.1-5.3

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IMPLEMENTATION SCHEDULE

Recovery schedules are intended to assist the Service and other stakeholders in planning and implementing actions and activities to recover and/or protect endangered and threatened species. The following Implementation Schedule indicates activity numbers; activity descriptions; activity duration; potential stakeholders and responsible agencies; and estimated costs. It is a guide for planning and meeting the objectives discussed in this strategy. The Implementation Schedule outlines recovery activities, and their estimated costs for the first 5 years of this recovery program, and the total cost to reach the goal of downlisting. Date and cost to delisting cannot be estimated at this time for the chucky madtom. **Actual expenditures by agencies and other partners is contingent upon appropriations and other budgetary constraints**.

While the ESA assigns a strong leadership role to the Service for the recovery of listed species, it also recognizes the importance of other Federal agencies, States, and other stakeholders in the recovery process. The "Responsible Agency" column of the Implementation Schedule identifies partners who can make significant contributions to specific recovery tasks. **The identification of agencies and other stakeholders within the Implementation Schedule does not constitute any additional legal responsibilities beyond existing authorities (e.g., ESA, CWA, etc.).**

Key to acronyms used in the Implementation Schedule

CFI	Conservation Fisheries, Inc.
ES	U.S. Fish and Wildlife Service, Ecological Services
MNWA	Middle Nolichucky Water Alliance
TWRA	Tennessee Wildlife Resources Agency
TVA	Tennessee Valley Authority
TNACI	Tennessee Aquarium Conservation Institute

CHUCKY MADTOM IMPLEMENTATION SCHEDULE											
ACTIVITY #	ACTIVITY DESCRIPTION	DURATION	RESPONSIBLE PARTY		COST ESTIMATES ($K)						COMMENTS
			R4 FWS	Other	FY17	FY18	FY19	FY20	FY21	Total cost to downlisting	
1.1	Conduct annual collection efforts in Little Chucky Creek, Greene County, TN.	Continuous (10+ years)	ES	TWRA, TVA, CFI, TNACI	15	15	15	15	10	320	15 for the first 4 years, then 10 each year for 30 years
1.2	Develop captive propagation protocols for chucky madtom.	3 years	ES	CFI, TNACI		10	10			30	This task will depend on success of task 1.1. and will require an additional year
1.3	Investigate the potential to use cryopreservation to conduct artificial spawning of chucky madtoms through surrogates.	6 years	ES	TWRA, CFI, TNACI			20	20	20	120	This task will require 3 additional years at 20/year.
1.4	Develop (and implement when broodstock are found) a genetic conservation plan for chucky madtom.	Continuous	ES	TNACI			10	5	5	145	
1.5	Develop (and implement when broodstock are found and habitat tasks are completed under action 2) an augmentation or reintroduction (propagation) plan as warranted for chucky madtom.	Continuous	ES	CFI, TNACI				10	10	270	This task will depend on success of task 1.1 and the habitat protection activities of tasks 2.1 – 2.5

1.6	Develop (and implement when broodstock are found and task 1.5 is complete) a monitoring plan for propagated chucky madtoms released into Little Chucky Creek or historical sites.	25	ES	TWRA, TVA, CFI, TNACI						250	This task will depend on task 1.1, 1.5 and tasks 2.1-2.5. $10/year for 25 years.
2.1	Work with landowners, agencies, and NGOS to protect existing riparian and instream habitats.	Continuous	ES	MNWA, TWRA, NRC	50	50	50	50	50	750	
2.2	Protect habitat using available mechanisms like land acquisition programs, conservation agreements, management agreements, etc.	Continuous	ES	TWRA, TDEC, MNWA, NGOs	75	75	75	75	75	1125	
2.3	Monitor habitat conditions in Little Chucky Creek and habitat associations of any chucky madtoms collected.	6	ES	TWRA, TVA, CFI, TNACI					25	150	This task will require an additional 5 years at $25/year.
2.4	Begin a trapping program in Little Chucky Creek to remove all exotic crayfishes.	Continuous	ES	TWRA, TVA, CFI, TNACI	5	5	5	5	5	150	
2.5	Conduct diet studies on potential chucky madtom predators (basses and crayfishes)	3	ES	TWRA, TVA, CFI, TNACI			5	5	5	15	

	to determine if interactions are competitive and predatory.										
3.1	Use surrogate species to determine life history traits of chucky madtoms.	5 years	ES	TWRA, TNACI, CFI			20			100	This task will require an additional 4 years at $20/year.
3.2	Use surrogate species to evaluate potential toxicity to chucky madtoms from commonly-used pesticides and herbicides in the Little Chucky Creek watershed.	3 years	ES	TWRA, TNACI, CFI				40	30	100	This task will require an additional year at $30/year.
3.3	Determine if surrogate species utilize large-river habitat for part of their life history.	5 years	ES	TWRA, TNACI, CFI			10	10	10	50	This task will require an additional 2 years at 10/year.
4.0	Promote voluntary stewardship as a practical means of reducing nonpoint source pollution from private land use and improving habitat.	Continuous	ES	TWRA, TNACI, CFI	3	3	3	3	3	90	
5.1	Predict other suitable habitat (using GIS modeling tools) in the upper Tennessee River system where chucky madtoms may occur.	5+ years	ES	TWRA, TVA, CFI, TNACI					15	75	This task will require a minimum of an additional 4 years at 15/year.
5.2	Conduct surveys based on the results of task 5.1.	Continuous	ES	TWRA, TVA, CFI	7	7	7	7	7	210	

5.3	Use GIS modeling tools to predict responses of chucky madtoms to threats like changes in land use from development.	2 years	ES	TNACI, TWRA					10	20	This task will require an additional year at 10/year.
6.0	Develop and implement programs and materials to help inform the public on the chucky madtom, and to involve them in watershed stewardship to protect this listed species.	Continuous	ES	TWRA, TNACI	3	3	3	3	3	90	
7.0	Coordinate all recovery activities, evaluate success, and revise recovery plan as appropriate.	Continuous	ES							NA	Costs absorbed under existing programs

<u>Estimated costs of downlisting</u>: The estimated costs associated with implementing recovery activities are $1,090,000 over a 5-year period. Recovery criteria for downlisting is expected to take 30 years (approximately 10 generations; 2047) for a total estimated cost is $4,060,000.

APPENDIX 1

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