

Yellowfin Madtom
(Noturus flavipinnis)

**5-Year Review:
Summary and Evaluation**



(Photo courtesy of Conservation Fisheries, Inc.)

**U.S. Fish and Wildlife Service
Southeast Region
Tennessee Ecological Services Field Office
Cookeville, Tennessee**

5-YEAR REVIEW

Yellowfin Madtom (*Noturus flavipinnis*)

I. GENERAL INFORMATION

A. Methods Used to Complete the Review

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 et seq.). The public notice for this review was published in the *Federal Register* on May 7, 2018 (83 FR 20092) with a 60-day public comment period. In the notice, the Service requested new information regarding the Yellowfin Madtom that has become available since the last review of this species. The Service evaluated and incorporated the comments received from peer reviewers as appropriate (see Appendix A).

In conducting this 5-year review, we relied on available information pertaining to historic and current distributions, life history, and habitat of this species. Our sources include the final listing rule for the species, the Yellowfin Madtom Recovery Plan (Service 1983); the 2012 5-year review for this fish (Service 2012), the draft Species Status Assessment Report for the Yellowfin Madtom (Service 2019), peer-reviewed scientific publications; unpublished field observations by Service, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. Warren Stiles and Santiago Martín, Fish and Wildlife Biologists with the Tennessee Ecological Services Field Office (TNFO), completed the review.

B. Reviewers

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

Cooperating Region – Northeast: Martin Miller, 413-253-8615

Lead Field Office – Cookeville, Tennessee (TN), Ecological Services: Warren Stiles, 931-525-4977

Cooperating Field Office – Abingdon, Virginia (VA), Ecological Services: Rose Agbalog, 276-623-1233, ext. 25

C. Background

1. Federal Register Notice citation announcing initiation of this review:

May 7, 2018; 83 FR 20092

2. Species Status:

Stable. The Yellowfin Madtom probably occurred in many of the lower gradient streams of the Tennessee River basin (Jenkins 1975) and has been extirpated from known locations in Chickamauga Creek, Georgia, and Hines Creek, Tennessee (Service 1977). Since the Service listed Yellowfin Madtom under the ESA, the range of the species has expanded through rediscoveries and reintroduction efforts in the upper

Tennessee River drainage. The species was rediscovered in Citico Creek in the Little Tennessee River system, Tennessee, and Copper Creek in the Clinch River system, Virginia (Rakes and Shute 2006; Service 1983). In addition, reintroduction efforts helped bring back the Yellowfin Madtom to Abrams Creek and the Tellico River in the Little Tennessee River system, Tennessee, and the North Fork Holston River, Virginia.

3. Recovery Status

2 (2 = 26-50% species' recovery objectives achieved). The Service based this assessment on the implementation of a successful reintroduction and augmentation program. The Yellowfin Madtom has been reintroduced successfully to Abrams Creek in the Great Smoky Mountains National Park (GSMNP), and additional population augmentation efforts are ongoing in the Tellico River and the North Fork Holston River. After rediscovery of the Citico Creek population in the Cherokee National Forest (CNF), augmentation efforts focused in downstream reaches (P. Shute per. comm. 2020).

4. Listing History:

Original Listing

FR notice: 42 FR 45526

Date listed: September 9, 1977

Entity listed: Species

Classification: Threatened, Entire Range

5. Associated Rulemakings:

September 13, 2007. Establishment of Nonessential Experimental Population Status for 15 Freshwater Mussels, 1 Freshwater Snail, and 5 Fishes in the Lower French Broad River and in the Lower Holston River, Tennessee; 72 FR 52434.

August 12, 2002. Establishment of Nonessential Experimental Population Status and Reintroduction of Four Fishes in the Tellico River; 67 FR 52420.

August 4, 1988. Determination of Nonessential Experimental Population Status for Introduced Population of Yellowfin Madtom in VA & TN; 53 FR 29335.

6. Review History:

Recovery Plan: 1983

Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we performed recovery data calls including status recommendations such as "Stable" for this fish. We continue to show a "Stable" recommendation as part of our 5-year reviews. The most recent evaluation to inform the Recovery Report to Congress was completed in 2019.

5-year reviews:

A 5-year review for this species was noticed on November 6, 1991 (56 FR 56882). In this review, the Service evaluated the statuses of many species simultaneously with no in-depth assessment of the five factors as they pertained to the individual species. The notice summarily addressed these species and stated that no changes in their designations were warranted at that time.

In a second 5-year review for this species, the Service evaluated the status of Smoky Madtom and Yellowfin Madtom (*Noturus flavipinnis*) simultaneously. The Service completed the 5-year review on February 28, 2012, and no change to the Yellowfin Madtom listing status was recommended.

7. Species' Recovery Priority Number at start of 5-year review (48 FR 43098):
8, indicating that the Yellowfin Madtom is categorized as a species, has a moderate degree of threat, and a high recovery potential.

8. Recovery Plan:

Name of plan: Recovery Plan Yellowfin Madtom (*Noturus flavipinnis*)

Date issued: June 23, 1983

II. REVIEW ANALYSIS

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

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

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

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes

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? 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.

The Service will consider the Yellowfin Madtom (*Noturus flavipinnis*) for delisting when the following criteria are met:

(1) Through protection of existing populations and/or by introductions and/or discoveries of new populations there exist viable populations¹ in the Powell River, Copper Creek, and Citico Creek of the following magnitude:

¹ A viable population consists of ten years of population monitoring (biannual sampling) indicating that the species is reproducing and that the population is either stable or expanding. Due to the difficulty of sampling Yellowfin Madtoms in the Powell River, the collection of one individual at each of the five population centers on three occasions over ten years would constitute viability for the Powell River population.

a) Powell River (Claiborne and Hancock Counties, Tennessee; Lee County, Virginia) – A minimum of five population centers² exist from the backwaters of Norris Reservoir upstream to approximately river kilometer (rkm) 189.3 (118 miles (mi)). These populations are dispersed throughout this river reach so that it is unlikely that a single event would cause the loss of the entire population.

(b) Copper Creek (Scott County, Virginia) – The species is widely distributed from the creek’s mouth to rkm 50 (31.1 mi).

(c) Citico Creek (Monroe County, Tennessee) – The species is widely distributed throughout its preferred habitat within the creek.

Status:

Powell River – This criterion has not been fully met; we do not have collections of one individual at five population centers on three occasions over a ten-year period (see definition of viable populations for the Powell River above). However, the number of viable populations has increased since the last 5-year review. Data reported in Table 1 show that the Powell River currently has four viable population centers^{1,2}.

Table 1: Powell River “population center” monitoring results. Adapted from data presented in Rakes and Shute 2003, 2007, and 2007 to 2014 field notes.

Location	Date	No. Observed	No. Released
Buchanan Ford PRM 99.2	2000	1	
	2001	1	
	2006	1	
Above Buchanan Ford PRM 99.3	2006	9	
Brooks Bridge PRM 95.1	2001	1	
	2002	2	
Above Brooks Bridge PRM 95.3	2006	10	
Mulberry Creek PRM 103.3	2001	2	
Co Rd 833 PRM 120.3	2002	1	
	2006	1	
	2009	18	
Above VA 833 Bridge PRM 120.7	2006/07	13	
	2006/07	5	
	2012	8	
Hall Ford PRM 128.4	2006	11	
	2007	16	
	2011	8	
	2014	7	
VA 783 Bridge PRM 146.7	2006	1	206
	2007		77

² A population center consists of a single or grouping of sites which contain Yellowfin Madtoms in such close proximity that the individual fish can be considered as belonging to a single breeding unit.

	2009	2	102
	2012		99
	2014	1	
Above Laurel Branch PRM 147.1	2009		107
	2012		120
	2014	4	

Copper Creek – This criterion has not been met. Currently, Yellowfin Madtoms only reproduce in approximately 8.5 km (5 mi) in the lower reaches of the creek. Copper Creek currently struggles from the effects of agricultural run-off, direct agricultural impacts (e.g., cattle access to creek), and general poor water quality, especially upstream. There is moderate sedimentation, but it is only coming from certain tributaries and is, therefore, distributed unevenly throughout the range. Overall habitat quality for Copper Creek is “Low” (Service 2019). Yellowfin Madtoms were being stocked through 2018, but as of 2019, the upriver areas of Copper Creek are no longer being stocked due to lack of success (Pinder per. comm. 2019)

Citico Creek – This criterion has been met. The distribution of Yellowfin Madtom has remained in 6 km (3.7 mi) of Citico Creek since the last 5-year review. Average annual abundance indices for 30 years of monitoring data show an increasing trend for the species in Citico Creek, with successful reproduction reported on most years since 2000, as demonstrated by the presence of wild spawned individuals outside of stocked locations (Appendix B)

(2) Through introductions and/or discoveries of new populations, there exist viable populations in two other rivers within the species’ historic range. These populations should be at least as large as the smallest population in the aforementioned rivers.

Status: This criterion has not been met; however, we are working with partners to expand the range of the species in Abrams Creek, Tellico River, Clinch River, and North Fork Holston River. Please see section II.C.1.a of this 5-year review for more detailed information on population trends.

(3) Noticeable improvements in coal-related problems and substrate quality have occurred in the Powell River.

Status: This criterion has not been met. In response to increasing concern over impacts to freshwater mussels from coal mining in the Clinch River watershed, Regions III and IV of the U.S. Environmental Protection Agency (USEPA), the Tennessee Department of Environment and Conservation (TDEC), the Virginia Department of Environmental Quality (VDEQ), and the Virginia Department of Mines, Minerals, and Energy (VDMME) signed a Memorandum of Understanding (MOU) to establish a working group for improving communications and coordinating efforts to protect and restore the Clinch and Powell Rivers. These agencies and others have demonstrated an interest in working together to accomplish common goals of reducing human impacts associated with coal mining and processing, agriculture, urbanization, and the development of transportation corridors.

In 2008, a Clinch-Powell Science Plan Work Group was developed to prepare a preliminary and draft “Biodiversity Conservation Science Plan for the Clinch-Powell River System, Virginia – Tennessee, USA” for the Clinch-Powell Symposium Steering Committee and the Clinch-Powell MOU Working Group. The plan (Clinch-Powell RCDC and TNC 2015) would generate scientific information to aid biodiversity conservation in the Clinch-Powell system. Specifically, the plan includes proposals to (1) develop a GIS model to identify priority habitat zones and agricultural restoration areas, (2) organize project partners, (3) develop priority Natural Resources Conservation Services (NRCS) conservation practices, (4) prioritize and fund agriculture best management practices (BMP) projects, and (5) coordinate efforts to monitor agriculture BMPs impacts on water quality in priority areas (Clinch-Powell RCDC and TNC 2015).

(4) The species and its habitat in all five rivers are protected from present and foreseeable human related and natural threats that may adversely affect essential habitat or the survival of any of the populations.

Status: This criterion has not been met. The primary threat to the Yellowfin Madtom is water quality degradation from coal mining in the Clinch and Powell Rivers, and agriculture in Copper Creek. Impacts from these threats are anticipated to continue in the foreseeable future, as defined in the Yellowfin Madtom Species Status Assessment (Service 2019).

Currently, the only populations with substantial protections are those found wholly inside GSMNP (i.e., population in Abrams Creek) and CNF (i.e., populations in Citico Creek and the Tellico River).

C. Updated Information and Current Species Status

1. Biology and Habitat:

a. Abundance, population trends, demographic features or demographic trends: Powell River

Natural reproduction has been observed most years since 2012. This population occurs exclusively in private land and sedimentation continues to be a problem for this population (Appendix B). From 2012 to 2018, 625 juvenile Yellowfin Madtoms were released in this river for population augmentation purposes (Appendix B).

Copper Creek

Survey results at augmentation sites in the upper portions of Copper Creek (above the VA 682 Bridge) in 2015 and 2016 were disappointing, with only one tagged madtom observed (Petty and Rakes 2016). However, Yellowfin Madtoms continue to persist in the lower and middle portions of the creek (below the VA 72 Bridge) (Petty and Rakes 2016). As of 2019, the upper portions of Copper Creek are no longer being stocked with Yellowfin Madtoms due to a lack of success with those augmentation efforts (Pinder per. comm. 2019). Agricultural run-off, direct agricultural impacts (e.g., cattle access to creek), and general poor water quality, especially in the upper portions, continue to affect Copper Creek (Service 2019). From 2012 to 2018, 372 juvenile Yellowfin Madtoms were released in this stream (Appendix B).

Citico Creek

Observations of Yellowfin Madtoms have remained low in Citico Creek, but natural reproduction has been observed consistently (Appendix B). From 2012 to 2018, 42 adult Yellowfin Madtoms have been released in Citico Creek; four of these were moved from Abrams Creek in 2015 and 2017 to improve genetic diversity, while 38 were released in 2015 to augment the population (Appendix B)

Clinch River

There is little data from the northern Clinch River because surveys only began in 2012 after the population was rediscovered in 2004 (Rakes and Shute 2006). No Yellowfin Madtom stocking has occurred to date in the Clinch River. Therefore, this population has sustained itself through natural reproduction. The current limited amount of survey data indicates a somewhat higher detection rate than in other populations (Appendix B).

Abrams Creek

Observations of Yellowfin Madtoms have remained low in Abrams Creek, but natural reproduction has been observed consistently (Appendix B). In 2015, two adult Yellowfin Madtoms were moved from Citico Creek to Abrams Creek to improve genetic diversity (Appendix B).

Tellico River

Observations of Yellowfin Madtoms in the Tellico River are currently low despite intense stocking efforts (1,832 juveniles stocked from 2012 to 2018; Appendix B). Based on results to-date, it is unclear if this population can sustain itself without stocking efforts (Appendix B).

North Fork Holston River

The planned reintroduction mentioned in the 2012 5-year review began in 2016 with the release of Yellowfin Madtoms reared from nests collected in the Powell River (Petty et al. 2016). From 2016 to 2019, 1,217 Yellowfin Madtoms were stocked in the North Fork Holston River and detections so far remain low (Appendix B); eggs from a nest observed in 2018 were collected for propagation (Petty et al. 2019).

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

The genetic studies discussed in the 2012 5-year review have been completed. The study (Moyer and Williams 2012) compared genetic diversity of Yellowfin Madtoms in Abrams Creek and Citico Creek and had these key findings: 1) overall genetic diversity was low; 2) genetic diversity was different between the Citico Creek and Abrams Creek populations; 3) these differences were likely a result of variation in the reproductive success of individuals introduced in Abrams Creek, and not a result of having used too few individuals for the reintroduction program; and 4) at least four effective migrants (i.e., individuals that survive and reproduce) per generation are needed to minimize genetic differences between the Citico Creek and Abrams Creek populations.

Based on the genetic study conducted by Moyer and William (2012), Kulp et al. (2015) designed and started the implementation of a gene exchange and monitoring program in Abrams Creek and Citico Creek. The purpose of the program is to reduce the influence of genetic drift (i.e., random variation in the number of gene variants in a population

over time) on the genetic diversity of these populations over the course of 100 to 150 years. The plan consists of reciprocal translocation of one adult Yellowfin Madtom between Citico Creek to Abrams Creek every year simulating a 5% migration rate per generation as recommended by Moyer and William (2012). To date, two Yellowfin Madtoms were translocated to and from Citico Creek and Abrams Creek in 2015, 2017, and 2019 (Rakes et al. 2020). The Tellico River population will be incorporated into the gene exchange and monitoring program in the near future (Rakes et al. 2020).

Another genetic study completed by Moyer and Williams (2013) focused on finding the most appropriate source population for the reintroduction of Yellowfin Madtoms in the North Fork Holston River. Moyer and Williams (2013) concluded that there are three genetically distinct source populations of Yellowfin Madtoms (Powell River, Clinch/Copper Creek, and Abrams/Citico Creek) and that the Powell River source population was the most appropriate for reintroduction efforts in the North Fork Holston River, which was supported by similar findings in Lang and Mayden (2019).

c. Taxonomic classification or changes in nomenclature:

No changes to taxonomic classification or nomenclature have occurred since this species was listed. Nomenclature is consistent and follows that in Page et al. (2013).

d. Spatial distribution, trends in spatial distribution, or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

The Yellowfin Madtom is known from three tributaries of the Little Tennessee River in Tennessee (Abrams Creek, Citico Creek, and the Tellico River), the Powell River in Tennessee and Virginia, the Clinch River and Copper Creek in Virginia, and the North Fork Holston River in Virginia (Table 2).

On October 2, 2019, we received information from the Virginia Department of Game and Inland Fisheries indicating that a student at Virginia Tech had found at least one Yellowfin Madtom near a family campground on the Clinch River (approximately 8 miles downstream of the Copper Creek confluence). Surveys during the next field season will target this area to determine if the range of Yellowfin Madtoms in the Clinch River is larger than previously thought (J.R. Shute per. comm. 2019).

Table 2: Extent of yellowfin madtom distribution. “Current Extent” is based on the draft Species Status Assessment Report for the Yellowfin Madtom (Service 2019); “Previous Extent” is the distribution from the 2012 5-year review (Service 2012).

Population	Trend	Current Extent	Previous Extent
Powell River (TN, VA)	Expanding	65.1 km (40.5 mi)	40 km (25 mi)
Copper Creek (VA)	Declining	8 km (5 mi)	62 km (39 mi)
Clinch River (VA)	Expanding	65.7 km (40.7mi)	45 km (28 mi)
Citico Creek (TN)	Stable	6 km (3.7 mi)	6 km (3.7 mi)
Abrams Creek (TN)	Expanding	13.2 km (8.2 mi)	8 km (5 mi)
Tellico River (TN)	Expanding	7.5 km (4.7 mi)	N/A
North Fork Holston River (VA)	Establishment efforts are ongoing	N/A	N/A

The planned reintroduction of Yellowfin Madtoms in the North Fork Holston River began in 2016 with the release Yellowfin Madtoms propagated from nests collected in the Powell River in Tennessee and Virginia (Petty et al. 2016). At this time, the Yellowfin Madtom is not considered established, but population augmentation efforts are ongoing (Petty et al. 2019).

e. Habitat conditions:

Yellowfin Madtoms are known to occupy small-to-medium size warmwater streams with moderate current, often occurring in pools or backwaters (Service 1983). Gibbs et al. (2014) studied the summer habitat use of Yellowfin Madtoms in Abrams Creeks at the macrohabitat scale (e.g., habitat type, stream width, stream depth, dominant substrate, etc.) and microhabitat scale (e.g., habitat type, distance to nearest bank and riffle, stream depth, current velocity, etc. within a 0.25 m² area of locations occupied by the species). Results from this study confirmed our previous understanding of the habitat preferred by Yellowfin Madtoms at the macrohabitat level. Gibbs et al. (2014) also stated that the ideal stream velocity for Yellowfin Madtom occupancy may fall between 0.05 m/s and 0.43 m/s.

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

Physical habitat destruction resulting from a variety of human-induced impacts such as siltation, disturbance of riparian corridors, and changes in channel morphology continues to plague the Tennessee River watershed. The most significant of these impacts is siltation caused by excessive releases of sediment from activities such as agriculture, resource extraction (e.g., coal mining, silviculture), road construction, and urban development (Waters 1995). Activities that contribute sediment discharges into a stream system change the erosion or sedimentation pattern, which can lead to the destruction of riparian vegetation, bank collapse, excessive instream sediment deposition, and increased water turbidity and temperatures.

Sediment has been shown to abrade and or suffocate bottom-dwelling organisms by clogging gills; reducing aquatic insect diversity and abundance; impairing fish feeding behavior by altering prey base and reducing visibility of prey; impairing reproduction due to burial of nests; and, ultimately, negatively impacting fish growth, survival, and reproduction (Waters 1995). Wood and Armitage (1997) identified at least five impacts of sedimentation on fish, including (1) reduction of growth rate, disease tolerance, and gill function; (2) reduction of spawning habitat and egg, larvae, and juvenile development; (3) modification of migration patterns; (4) reduction of food availability through the blockage of primary production; and (5) reduction of foraging efficiency.

Non-point source pollution from land surface runoff can originate from virtually any land use activity (such as coal mining and agricultural activities) and may be correlated with impervious surfaces and storm water runoff from urban areas. Pollutants entering the Tennessee River watershed may include sediments, fertilizers, herbicides, pesticides, animal wastes, pharmaceuticals, septic tank and gray water leakage, and petroleum

products. These pollutants tend to increase concentrations of nutrients and toxins in the water and alter the chemistry of affected streams such that the habitat and food sources for species like the Yellowfin Madtom are negatively impacted. Common land uses within the Clinch-Powell watershed include urban, industrial, commercial, and residential development; livestock production; agricultural cropping including tobacco and corn; coal mining, reclaimed coal mined lands, and “abandoned” coal mined lands (i.e., lands affected by mining prior to the federal law that were not reclaimed properly); road and railroad networks; and silvicultural practices (USEPA 2002). These land use activities act as sources of stress to the Yellowfin Madtom by contributing sediment and contaminants into the watershed.

As indicated in the recovery plan, the Yellowfin Madtom is still affected by coal mining activities in the Powell River (Service 1983). Although coal fines can still be found in the river, the Powell River population is expanding. Coal mining activity has increased in the Clinch River watershed in recent years, and coal fines in the upper river are moving downstream into Tennessee. The 2012 5-year review mentioned the planned development of a 585-megawatt coal powered electric generation facility along the Clinch River in Virginia City, Wise County, Virginia. This facility has been built and began operation in July 2012; effluent discharge, run-off from fly ash storage, and other sources related to the operation of this facility represent new threats, which may result in further impacts to the Yellowfin Madtom populations in northern Tennessee and Virginia (Service 2019).

Agriculture continues to threaten the Yellowfin Madtom in the Clinch and Powell rivers and Copper Creek. Cattle, in particular, continue to threaten Yellowfin Madtom habitat in Copper Creek (Petty and Rakes 2016). Agricultural livestock and other unconfined animals often have direct access to waterbodies and can provide a concentrated source of coliform bacteria loads that can directly enter a stream and destroy riparian by trampling vegetation that holds streambanks in place. The Service along with The Nature Conservancy, local Soil Conservation Districts, the Natural Resources Conservation Service, Farm Service Agency, Clinch-Powell Resource Conservation and Development Council, and many State agencies and local partners are working together to protect aquatic biodiversity in the Clinch and Powell watersheds. These conservation efforts consist of cost-share programs to protect and restore riparian corridors and to reduce and prevent non-point source pollution on private lands.

GSMNP visitors using the Abrams Creek Campground continue to build small dams using stream rocks (Service 2019). During recreational activities, visitors may cause nests to be abandoned by the guardian madtom, which may result in the loss of eggs to predation. Egg masses may also be lost when they dislodge and float away from the rocks used to build the small dams (Service 2019). To reduce this threat, NPS has created exhibits and streamside signs to alert visitors of the presence of federally listed fish and to encourage them to stop moving stream rocks (Kulp per. comm. 2019).

More recently, disturbance from recreational activities have been observed in Citico Creek at the CNF’s Young Branch Horse Campground. Horse riders at this campground are known to allow their horses to swim in Citico Creek to cool off in an area where Yellow Madtoms may occur (P. Shute per. comm. 2014), potentially causing the loss of

egg masses, and trampling of individual madtoms. In an effort to reduce threats from horse riders, CNF issued order #08-04-04-15-408 on February 19, 2016, which prohibits the “watering, entering, or being in the critical habitat portion of Citico Creek proper for the protection of endangered and threatened species in Citico Creek proper.” Violations of the prohibition may result in fines.

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

The Yellowfin Madtom is not believed to be utilized for commercial, recreational, or educational purposes. However, this species is collected periodically for scientific purposes associated with conservation actions. For example, wild nests are collected periodically for propagation and stocking purposes.

Eggs reared in a hatchery may experience artificial selection outside their natural environment and may result in reduced fitness when the reared juveniles are returned to a natural environment (Trushenski et al. 2015). However, the effects of this phenomenon have not been assessed for this species.

c. Disease or predation:

Disease

We have no data indicating that disease is a factor affecting the yellowfin madtom.

Predation

Miller (2011) assessed the predation risk of three fishes in Abrams Creek, including the Yellowfin Madtom. Miller (2011) did not observe evidence of predation upon Yellowfin Madtoms through the examination of stomach contents of piscivorous (fish eating) fishes or underwater observation surveys.

d. Inadequacy of existing regulatory mechanisms:

The Yellowfin Madtom and its habitats are afforded limited protection from water quality degradation under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.), Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1234 – 1328), and state laws, such as Tennessee’s Water Quality Control Act of 1977 (T.C.A. 69-3-101) and Virginia’s State Water Control Act (§ 62.1). These laws focus on point-source discharges; however, while they have resulted in some improvements in water quality and stream habitat for aquatic life, many water quality problems are generated by non-point source discharges. Therefore, these laws and corresponding regulations have been inadequate to reverse population declines and habitat degradation for the species.

In response to increasing concern over impacts to freshwater mussels from coal mining in the Clinch River watershed, Regions III and IV of the USEPA, TDEC, VDEQ, and VDMME signed an MOU to establish a working group for improving communications and coordinating efforts to protect and restore the Clinch and Powell Rivers. These agencies and others have demonstrated an interest in working together to accomplish common goals of reducing human impacts associated with coal mining and processing, agriculture, urbanization, and the development of transportation corridors.

Yellowfin Madtom is listed as Threatened by the State of Tennessee. Under the

Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974 (Tennessee Code Annotated §§ 70-8-101-112), "...it is unlawful for any person to take, attempt to take, possess, transport, export, process, sell or offer for sale or ship nongame wildlife, or for any common or contract carrier knowingly to transport or receive for shipment nongame wildlife." Further, regulations included in the Tennessee Wildlife Resources Commission Proclamation 00-15 Endangered Or Threatened Species state the following: "except as provided for in Tennessee Code Annotated, Section 70-8-106 (d) and (e), it shall be unlawful for any person to take, harass, or destroy wildlife listed as threatened or endangered or otherwise to violate terms of Section 70-8-105 (c) or to destroy knowingly the habitat of such species without due consideration of alternatives for the welfare of the species listed in (1) of this proclamation, or (2) the United States list of Endangered fauna." This regulation is inadequate for the protection of the Yellowfin Madtom, as it only requires parties to consider alternatives before knowingly altering the habitat of it or other species listed by the State of Tennessee as threatened or endangered.

In Virginia, the Yellowfin Madtom is listed as Threatened and is protected under State law (4VAC15-20-130). It is unlawful to "...take, transport, process, sell, or offer for sell within the Commonwealth any threatened or endangered species of fish or wildlife except as authorized by law" (§ 29.1-566). A State permit is required for the taking, exportation, or possession of any threatened or endangered species of fish or wildlife for zoological, educational, or scientific purposes, and for propagation of such fish and wildlife in captivity for preservation purposes (§ 29.1-568). Though this designation prohibits the collection of the species without a state collection permit, this regulation does not provide any protection from habitat loss.

Two of seven streams with extant Yellowfin Madtom populations are located on the CNF and receive management and protection through the National Forest Management Act of 1976 (16 U.S.C. 1600 et seq.) and CNF's land and resource management plan (LRMP) (USFS 2004). The LRMP is implemented through a series of project-level decisions based on appropriate site-specific analysis and disclosure. It does not contain a commitment to select any specific project; rather, it sets up a framework of desired future conditions with goals, objectives, and standards to guide project proposals. Projects are proposed to solve resource management problems, move the forest environment toward desired future conditions, and supply goods and services to the public (USFS 2004). The LRMP contains protective standards that are designed to avoid and minimize potential adverse effects to the Yellowfin Madtom and other sensitive species; however, the CNF continues to consult with the Service when their activities may adversely affect streams supporting the species. The CNF's management under the LRMP contributes substantially to the conservation of the species, and we expect the CNF to continue to implement management actions that benefit the species.

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

Small Population Size

The Yellowfin Madtom is vulnerable to loss of genetic diversity and fitness due to small population sizes. Species that are restricted in range and population size are more likely to suffer loss of genetic diversity due to genetic drift, potentially increasing their

susceptibility to inbreeding depression and decreasing their ability to adapt to environmental changes (Allendorf and Luikart 2007). However, the effects of this threat are expected to be reduced through the gene exchange and monitoring program discussed in Section II.C.1.b.

Climate Change

Climate change has the potential to increase vulnerability of Yellowfin Madtom populations to random catastrophic events or alter habitat suitability within the species' range. By the end of 2100, it is virtually certain that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales, and it is very likely that heat waves and extreme precipitation events will occur with a higher frequency and intensity (IPCC 2014). Projections for future precipitation trends in the southeastern U.S. are less certain than temperature projections; however, it is expected that there will be reduced water availability due to the increased evaporative losses (from increased transpiration from plants and evaporation from soils and water bodies) from rising temperatures alone (Carter et al. 2014). Warmer temperatures and decreased water availability will increase water temperatures, change runoff regimes, and increase the frequency, duration, and intensity of droughts in the southeastern United States (Kunkel et al. 2013).

Reduced water availability may be a significant threat to the Yellowfin Madtom in the long term. In 2016, flows and water levels were exceptionally low for most of the late summer, with extreme drought conditions extending into November. Approximately a third to half of the Citico Creek channel was dry in late August (CFI 2017).

Invasive crayfish

In aquatic ecosystems, invasive crayfishes may cause biodiversity loss through competition for resources, reproductive interference, and predation (Gherardi 2010). TWRA and other biologists sampled the Clinch and Powell rivers in 2011 to document distribution of the Kentucky River crayfish (*Faxonius juvenilis*), a non-native crayfish in these watersheds (Bart Carter, per. comm. 2020). In that year, the species was not found upstream of the Hwy. 25E bridge (36.401980, -83.459170) in the Clinch River. However, the distribution of the Kentucky River crayfish has expanded since then. In 2019, Jeff Simmons collected the crayfish at Swan Island (Clinch River upstream of Swan Island, CRM 172.4. Hancock Co., 36.4779, -83.2895), which represents a significant expansion (Bart Carter, per. comm. 2020). TWRA and other biologists also documented a range expansion in the Powell River in 2019 from Kings Bend (36.500882, -83.648925) to the Hwy 25E bridge (36.540610, -83.631411) (Bart Carter, per. comm. 2020).

Currently, there is no direct evidence indicating that the Kentucky River crayfish is adversely impacting Yellowfin Madtoms, but the Service will take this potential threat into consideration if there are sudden changes in the Yellowfin Madtom's distribution, observed abundance, or reproduction.

D. Synthesis

The Yellowfin Madtom is currently present in three tributaries of the Little Tennessee River in Tennessee (Abrams Creek, Citico Creek, and the Tellico River), the Powell River, the

Clinch River, Copper Creek (a tributary of the Clinch River), and the North Fork Holston River.

Yellowfin Madtom populations in Copper Creek, Clinch River, and Powell River continue to experience threats from habitat degradation. In particular, the Yellowfin Madtom's range in Copper Creek has seen a precipitous decline since the last 5-year review, from a range of 62 km to 8 km (Table 2), as impacts from agriculture have hampered population augmentation efforts in the upper reaches. The Service is also uncertain about the population trends in the Clinch River and Powell River because monitoring efforts have been inconsistent, partially due to the difficulties in properly sampling these large rivers.

Populations in Abrams Creek and Citico Creek experience reduced levels of threat, compared to other populations, and are protected through management of their watershed by GSMNP and CNF, respectively (Service 2019). While the population in the Tellico River is protected by CNF, population indices have remained low despite intensive stocking efforts (Appendix B), and it is unclear if the population would be able to sustain itself if stocking efforts are discontinued (Service 2019).

Since the last 5-year review, the Service and its partners started a propagation and reintroduction program in the North Fork Holston River; initial monitoring results for this population are encouraging, but more time and monitoring data are needed to assess the success of this effort.

Based on our analysis, Yellowfin Madtom is threatened by Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) and Factor E (other natural or manmade factors affecting its continued existence). Most of the species' distribution occurs outside protected areas (i.e., GSMNP and CNF), where threats are likely to persist in the foreseeable future (Service 2019). Therefore, given the limited distribution of the species and the continued level of threats, the Yellowfin Madtom is likely to become endangered within the foreseeable future throughout its range. Therefore, the "threatened" status of the Yellowfin Madtom remains appropriate. The recovery priority number for the Yellowfin Madtom should remain at 8, as the degree of threat remains moderate and potential for recovery remains high.

III. RESULTS

A. Recommended Classification:

Threatened, no change is needed.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- A.** Continue population augmentation activities in the Tellico River and North Fork Holston River.
- B.** Conduct surveys in the Clinch and Powell Rivers to determine range extent in these systems.

- C. Continue to monitor population levels and habitat conditions of presently established populations as well as introduced and expanding populations.
- D. Determine if qualitative night-time surveys would improve current population assessment methods.
- E. Conduct projects that replicate the Moyer and Williams (2012) study and assess the efficacy of the genetic exchange and monitoring program.
- F. Continue efforts to reduce non-point pollution from agricultural activities by working through Partners for Fish and Wildlife, Farm Bill, and other landowner incentive programs to implement best management practices.
- G. Continue planning and survey efforts to find better population augmentation locations in Copper Creek
- H. Continue to utilize existing legislation and regulations (Federal and state endangered species laws, water quality requirements, stream alteration regulations, etc.) to protect the species and its habitat.

V. REFERENCES

- Allendorf, F. W. and G. Luikart. 2007. Conservation and the genetics of populations. Malden, Massachusetts, Blackwell Publishing. 642 pp.
- Carter, B. 2020. Personal communication. email to Warren Stiles, Service Biologist, update species information for 5-year review. Tennessee Wildlife Resources Agency.
- Carter, L. M., J. W. Jones, L. Berry, V. Burkett, J. F. Murley, J. Obeysekera, P. J. Schramm, and D. Wear. 2014. Chapter 17: Southeastern and the Caribbean in Climate change impacts in the United States: the third national climate assessment, J. M. Melillo, T. C. Richmond, and G. W Yohe, Eds. U.S. Global Change Research Program. pp. 396-417.
- Clinch-Powell Resource Conservation and Development Council and The Nature Conservancy. 2015. Clinch and Powell Rivers Watershed Restoration Plan (Hancock and Claiborne Counties, TN). 29 pp.
- Conservation Fisheries, Inc. (CFI). 2017. Rare fish reintroduction and population monitoring in the Little Tennessee River System: 2016. Annual report per Federal Energy Regulatory Commission. 5 pp.
- Dinkins, G. R., and P. W. Shute. 1996. Life histories of *Noturus baileyi* and *N. flavipinnis* (Pisces: Ictaluridae), two rare madtom catfishes in Citico Creek, Monroe County, Tennessee. Bulletin of the Alabama Museum of Natural History 18: 43-69.

- Etnier, D. A. and R. E. Jenkins. 1980. *Noturus stanauli*, a new madtom catfish from the Clinch and Duck rivers, Tennessee. *Bulletin of the Alabama Museum of Natural History* 5:17-22.
- Gherardi, F. 2010. Invasive crayfish and freshwater fishes of the world. *Rev. sci. tech. Off. int. Epiz.* 29(2): 241-254.
- Gibbs, W. K., J. E. Miller, J. K. Throneberry, S. B. Cook, and M. A. Kulp. 2014. Summer habitat use and partitioning by two reintroduced rare madtom species. *Journal of Freshwater Ecology* 29:243-258.
- Jenkins, R. E. 1975. Status of the yellowfin madtom, *Noturus flavipinnis*. U.S. Off. Endang. Spec. Internat. Activities, Washington. 11 pp.
- IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
- Kulp, M. A. 2019. Personal communication – email to Santiago Martín, Service Biologist, Tennessee stream mitigation briefing statement and rock dam signs/posters. National Park Service, Great Smoky Mountains National Park.
- Kulp, M. A., S. E. Moore, M. Cantrell, S. Chance, and G. Moyer. 2015. Threatened and endangered fish translocation to and from Abrams Creek, Citico Creek, and Tellico River, Great Smoky Mountain National Park and Cherokee National Forest: implementation and genetic monitoring plan. Natural Resource Report NPS/GRSM/NRR—2015/930. National Park Service, Fort Collins, CO. 88 pp.
- Kunkel, K. E., T. R. Karl, D. R. Easterling, K. Redmond, J. Young, X. Yin, and P. Hennon. 2013. Probable maximum precipitation and climate change. *Geophysical Research Letters* 40:1402-1408.
- Lang, N. J. and R. L. Mayden. 2019. Identifying conservation units within the yellowfin madtom, *Noturus flavipinnis* (Teleostei: Ictaluridae). Unpublished manuscript, St. Louis, MO. 14 pp.
- Miller, J. E. 2011. Summer microhabitat, dispersal, and predation risk of three rare fishes in Abrams Creek, Great Smoky Mountains National Park. A thesis presented to the Faculty of the Graduate School Tennessee Technological University, Cookeville, TN. 149 pp.
- Moyer, G. R. and A. S. Williams. 2012. Genetic assessment of Abrams Creek reintroduction program for the federally threatened yellowfin madtom (*Noturus flavipinnis*, and endangered smoky madtom (*Noturus baileyi*) and Citico darter (*Etheostoma sitikuense*). U. S. Fish and Wildlife Service Conservation Genetics Lab, Warm Springs, VA. 43 pp.
- . 2013. Assessment of genetic diversity within and among populations of yellowfin madtom (*Noturus flavipinnis*). U.S. Fish and Wildlife Service Conservation Genetics

Lab. Warm Springs, VA. 25 pp.

- Page, L. M., H. Espinosa-Pérez, L. T. Finley, C. R. Gilbert, R. N. Lea, N. E. Mandrak, and R. L. Mayden. 2013. New Seventh Edition of Common and Scientific Names of Fishes: Changes include capitalization of common names. *Fisheries* 38 (4): 188-189.
- Petty, M. A., J. R. Shute, and C. L. Ruble. 2016. Restoration and assessment of the yellowfin madtom in the North Fork Holston River, Virginia. Report to Virginia Department of Game and Inland Fisheries 8 pp.
- . 2018. Restoration and assessment of the yellowfin madtom in the North Fork Holston River, Virginia. Report to Virginia Department of Game and Inland Fisheries 6 pp.
- Petty, M. A., and P. L. Rakes. 2016. Yellowfin madtom augmentation in Copper Creek. Report to the Virginia Department of Game and Inland Fisheries. Contract Number 2012-13449. 3 pp.
- Petty, M. A., P. L. Rakes, J. R. Shute, and C. L. Ruble. 2011. Captive propagation and population monitoring of rare southeastern fishes in Tennessee: 2010. Final Report for 2010 field season and second quarter report for fiscal year 2010 to the Tennessee Wildlife Resources Agency, U.S. Fish and Wildlife Service, Cookeville and Asheville Field Offices, and Cherokee National Forest. 39 pp.
- Petty, M. A., P. L. Rakes, J. R. Shute, and C. L. Ruble. 2019. Restoration and assessment of the yellowfin madtom in the North Fork Holston River, Virginia. Report to Virginia Department of Game and Inland Fisheries. Contract Number EP2489073. 11 pp.
- Pinder, M. 2019. Personal communication - email to Kathryn N. Smith, Texas A&M University-Natural Resources Institute, re: Yellowfin madtom in Copper Creek. Virginia Department of Game and Inland Fisheries, Blacksburg, Virginia.
- Rakes, P. L., and J. R. Shute. 2003. Surveys and habitat assays for the yellowfin madtom, *Noturus flavipinnis*, and the slender chub, *Erimystax cahni*, in the Clinch and Powell rivers of Tennessee and Virginia. Final Report to the U.S. Fish and Wildlife Service. 35 pp.
- . 2006. Surveys to delineate a new population of the yellowfin madtom, *Noturus flavipinnis*, in the Clinch River System in Virginia. Final Report to the Virginia Department of Game and Inland Fisheries. 21 pp.
- Rakes, P. L., M. A. Petty, J. R. Shute, and C. L. Ruble. 2020. Captive propagation and population monitoring of rare southeastern fishes in Tennessee: 2019. Report of Conservation Fisheries, Inc. to U.S. Fish and Wildlife Service, Cookeville, TN. Contract #F18AP00121.
- Shute, J. R. 2011. Personal communication – email to Stephanie Chance, Service Biologist, updated species information for 5-year review. Conservation Fisheries, Inc. Knoxville, TN.

- Shute, J. R. 2019. Personal communication – phone call with Warren Stiles, Service Biologist, update species information for 5-year review. Conservation Fisheries, Inc. Knoxville, Tennessee.
- Shute, P. 2014. Personal communication – email to Stephanie Chance, Service Biologist, Smoky madtom incident. Service. Cookeville, Tennessee.
- Shute, P. 2020. Personal communication – email to Warren Stiles, Service Biologist, update species information for 5-year review. Conservation Fisheries, Inc. Knoxville, TN.
- Throneberry, J. K. 2009. Reintroduction success of smoky madtom *Noturus baileyi* and yellowfin madtom *Noturus flavipinnis* in Abrams Creek, Great Smoky Mountains National Park. A thesis presented to the Faculty of the Graduate School Tennessee Technological University, Cookeville, Tennessee. 67 pp.
- Trushenski, J. T., H. L. Blankenship, J. D. Bowker, T. A. Flagg, J. A. Hesse, K. M. Leber, D. D. MacKinlay, D. J. Maynard, C. M. Moffitt, V. A. Mudrak, K. T. Scribner, S. F. Stuewe, J. A. Sweka, G. E. Whelan, and C. Young-Dubovsky. 2015. Introduction to a Special Section: Hatcheries and Management of Aquatic Resources (HaMAR)—Considerations for Use of Hatcheries and Hatchery-Origin Fish, North American Journal of Aquaculture 77 (3): 327-342.
- U.S. Environmental Protection Agency. 2002. Clinch and Powell Valley watershed ecological risk assessment. National Center for Environmental Assessment, Washington, D.C., EPA/600/R-01/050.
- U.S. Fish and Wildlife Service. 1977. Endangered and Threatened Wildlife and Plants. Final threatened status and critical habitat for five species of southeastern fishes. Federal Register 42:45526.
- . 1983. Yellowfin Madtom (*Noturus flavipinnis*) recovery plan. Atlanta, GA. 33 pp.
- . 2012. Yellowfin Madtom (*Noturus flavipinnis*) and Smoky Madtom (*Noturus baileyi*) 5-year review. Service Tennessee Ecological Services Field Office, Cookeville, TN. 27 pp.
- . 2019. Draft Species Status Assessment Report for the Yellowfin Madtom (*Noturus flavipinnis*), Version 1.0. August 2019. Atlanta, GA.
- U.S. Forest Service (USFS). 2004. Revised Land and Resource Management Plan – Cherokee National Forest. Cleveland, Tennessee 471 pp.
- Waters, T. F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Soc. Monograph 7, Bethesda, Maryland. 251 pp.
- Wood, P. J., and P. D. Armitage. 1997. Biological effects of fine sediment in the lotic environment. Environmental Management. 21:203-217.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Yellowfin Madtom (*Noturus flavipinnis*)

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Review conducted by: Warren Stiles and Santiago Martín, Tennessee Ecological Services Field Office, Cookeville, Tennessee

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service
Tennessee Field Office

Approve _____ Date 06/23/2020

OTHER REGIONAL OFFICE APPROVAL:

We emailed this 5-year review to the following regional and/or field offices for their concurrence prior to finalizing the document: Hadley Regional Office and Virginia Field Office. We will retain any comments that we received, as well as verification of concurrence from other regions, in the administrative record for this 5-year review.

**APPENDIX A: Summary of peer review for the 5-year review of Yellowfin Madtom
(*Noturus flavipinnis*)**

- A. Peer Review Method: On January 22, 2020, an email was sent to the following species experts for peer review of the draft Yellowfin Madtom 5-year review:

Bart Carter, Region IV Fisheries Program Coordinator
Tennessee Wildlife Resources Agency

Mike Pinder, Aquatic Biologist
Virginia Department of Game and Inland Fisheries

Peggy Shute, Aquatic Biologist
Conservation Fisheries

On June 8, 2020, an email was sent to Matt Kulp, Supervisory Fishery Biologist
Great Smoky Mountains National Park, to provide additional peer review of the draft.

- B. Peer Review Charge: Peer reviewers were not given detailed directions or forms to fill out for their review. They were asked for review of the science used in the document and not for review of the legal status determination.

- C. Summary of Peer Review Comments/Report:

Mike Pinder provided a 2019 report with updated information on the reintroduction efforts in the North Fork Holston River.

Bart Carter provided information about the past and present of the Kentucky River crayfish in the Clinch and Powell rivers. The crayfish is not native to these systems and may be a threat to the Yellowfin Madtom.

Peggy Shute made several comments suggesting need for improved survey efforts for this species. In particular, she indicated that night-time surveys during the non-reproductive period would be an efficient method for detecting presence and collecting more accurate abundance estimates. She also made the Service aware of a 2016 CNF order designed to limit detrimental effects to the Yellowfin or its critical habitat in Citico Creek from horses.

Peggy Shute and Matt Kulp clarified that the current translocation rate of Smoky Madtoms meets the goal of the gene exchange program.

All reviewers provided minor formatting edits and/or pointed out confusing wording or statements that needed clarification.

- D. Response to Peer Review: Peer reviewer comments were evaluated and incorporated into the revised document, as appropriate.

APPENDIX B: Yellowfin madtoms released, detected, observed reproducing (i.e., presence of young-of-year individuals or eggs), and number of effort hours by year and river/creek location. Detection rates are restricted to August, September, and October (Service 2019).

Year	Abrams Creek				Citico Creek				Tellico River			
	# Released	# fish/p-hr	Reproduction Observed	Hours of Effort	# Released	# fish/p-hr	Reproduction Observed	Hours of Effort	# Released	# fish/p-hr	Reproduction Observed	Hours of Effort
2005	56	0.45	No	26	0	2.39	Yes	14	186	0.13	No	15
2006	8	0.72	No	28	0	1.92	Yes	13	84	0.00	No	16
2007	0	0.20	Yes	20	0	8.46	Yes	3	419	0.00	No	7
2008	0	0.00	Yes	8	0	1.20	Yes	13	379	0.33	No	12
2009	100	0.13	Yes	38	0	0.00	No	6	413	0.38	No	11
2010	49	1.29	Yes	24	0	3.14	Yes	19	96	1.33	No	9
2011	0		Yes	0	0	4.10	Yes	10	156	0.54	No	20
2012	0	1.77	Yes	31	0	2.62	Yes	15	130	0.27	No	23
2013	0	3.18	Yes	20	0	1.38	Yes	16	195	0.03	Yes	39
2014	0	0.49	Yes	49	0	1.53	Yes	25	278	0.00	No	6
2015	2	0.70	Yes	44	40	0.55	Yes	18	235	0.18	No	22
2016	0	0.43	Yes	40	0	0.75	Yes	13	297	0.50	Yes	11
2017	0	0.48	Yes	27	2	0.50	Yes	28	297	0.14	Yes	28
2018	0	0.25	Yes	30	0	0.23	Yes	21	400	0.00	Yes	12

Year	Copper Creek				Clinch River				Powell River				North Fork Holston River			
	# Released	# fish/p-hr	Reproduction Observed	Hours of Effort	# Released	# fish/p-hr	Reproduction Observed	Hours of Effort	# Released	# fish/p-hr	Reproduction Observed	Hour of Effort	# Released	# fish/p-hr	Reproduction Observed	Hour of Effort
2005	0		No	0	0			0	0			0	0			0
2006	0		No	0	0			0	0			0	0			0
2007	0	1.75	No	4	0			0	0			0	0			0
2008	0	0.66	No	29	0			0	0			0	0			0
2009	127		No	0	0			0	0			0	0			0
2010	0		Yes	0	0			0	0		Yes	0	0			0
2011	141	1.83	No	6	0			0	0	0.05	Yes	22	0			0
2012	199	1.12	No	13	0	1.14	Yes	22	221			0	0			0
2013	66	0.67	No	5	0	0.29	No	24	154		Yes	0	0			0
2014	0		No	0	0			0	0		Yes	0	0			0
2015	53	0.27	Yes	37	0			0	250		Yes	0	0			0
2016	54	0.69	No	9	0	1.78	No	0	0		Yes	6	0	0.70	No	10
2017	0	4.00	No	2	0			0	0		Yes	0	349	0.38	No	8
2018	0		Yes	0	0	0.69	Yes	6	0		Yes	0	308		Yes	0