Neosho Madtom

(Noturus placidus)

5-Year Review:

Summary and Evaluation

Photo by Daniel Fenner, USFWS

U.S. Fish and Wildlife Service Kansas

Ecological Services Field Office

Manhattan, Kansas

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5-YEAR REVIEW
Species reviewed: Neosho madtom (*Noturus placidus*)

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5-YEAR REVIEW
Neosho madtom (*Noturus placidus*)

1. General Information

1.1. Purpose of 5-Year Reviews

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since the time it was listed or since the most recent 5-year review. Based on the outcome of the 5-year review, we recommend whether the species should: 1) be removed from the list of endangered and threatened species; 2) be changed in status from endangered to threatened; 3) be changed in status from threatened to endangered; or 4) remain unchanged in its current status. Our original decision to list a species as endangered or threatened is based on the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and we review new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process that includes public review and comment.

1.2. Reviewers

Lead Regional Office: Mountain-Prairie Region (Region 6)
Mike Thabault, ARD Ecological Services, 303/236-4210
Bridget Fahey, Chief of Endangered Species, 303/236-4258
Seth Willey, Regional Recovery Coordinator, 303/236-4257
Kathy Konishi, Assistant Recovery Coordinator, 303/236-4212

Lead Field Office:
Kansas Ecological Services Field Office
Daniel Mulhern, Acting Field Supervisor, 785/539-3474

Cooperating Field Office(s):
Columbia Ecological Services Field Office
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Dixie Porter, Field Supervisor, 918/382-4501

Cooperating Regional Office(s):
Midwest Region Regional Office (Region 3)
Lynn Lewis, ARD Ecological Services, 612/713-5345
T.J. Miller, Chief of Endangered Species, 612/713-5334

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Michelle Shaughnessy, ARD Ecological Services, 505/248-6671
Susan Jacobsen, Chief of Endangered Species, 505/248-6641
Wendy Brown, Regional Recovery Coordinator, 505/248-6664

1.3. Methodology used to complete the review

On June 20, 2011, we published a Notice of Review in the *Federal Register* (76 FR 35906) soliciting any new information on the Neosho madtom that may have a bearing on its classification as endangered or threatened. We did not receive any comments in response to the Federal Register notice. This 5-year review was primarily written by the Kansas Ecological Services Field Office with substantive contributions and review by cooperating field and regional offices. It summarizes and evaluates information provided in the recovery plan, current scientific research, and surveys related to the species. All pertinent literature and documents on file at the Kansas Ecological Services Field Office were used for this review (See References section below for a list of cited documents). We interviewed individuals familiar with the Neosho madtom as needed to clarify or obtain specific information.

1.4. Background

1.4.1. Federal Register Notice citation announcing initiation of this review

76 FR 35906; June 20, 2011

1.4.2. Listing history

<u>Original Listing</u>
Federal Register notice: 55 FR 21148**;** May 22, 1990
Entity listed: Species
Classification: Threatened rangewide

1.4.3. Review History

On November 6, 1991, we initiated a 5-year review of all species listed prior to 1991 (56 FR 56882). This national notice summarized the status of all Threatened and Endangered species listed under the ESA prior to January 1, 1991, but did not further discuss species status nor did it propose or change the status of any species, including the Neosho madtom. The species' status was also considered in the September 30, 1991 Recovery Plan (USFWS 1991).

1.4.4. Species' Recovery Priority Number at start of 5-year review

At the start of the 5-year review, the Recovery Priority Number for the Neosho madtom was 8C. This number indicated that: (1) the Neosho madtom was listed as a full species; (2) populations face a moderate degree of threat; (3) recovery potential is high; and (4) recovery of the Neosho madtom may be in conflict with construction or other development projects (see Table 1).

Table 1. The below ranking system for determining Recovery Priority Numbers was established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	**High**	Monotypic Genus	7	7C
		Species	8	**8C**
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

1.4.5. Recovery Plan

Name of plan: Neosho Madtom Recovery Plan
Date approved: September 30, 1991
Dates of previous revisions, if applicable: N/A

2. REVIEW ANALYSIS

2.1. Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1. Is the species under review a vertebrate?

☒ Yes
☐ No

2.1.2. Is the species under review listed as a DPS?

☐ Yes
☒ No

2.1.3. Is there relevant new information for this species regarding the application of the DPS policy?

☐ Yes
☒ No

2.2. Recovery Planning and Implementation[1]

2.2.1. Does the species have a final, approved recovery plan?

☒ Yes
☐ No

2.2.2. Adequacy of recovery plan

The Neosho Madtom Recovery Plan was approved in September 1991. It addressed the species' status and distribution at that time. Information on habitat, life history, threats, regulation, biological research needs, and conservation measures were included. In the plan's recovery section, objective and measurable "interim" delisting criteria were included in narrative and step-down format. The plan states that when more information and knowledge is acquired, the criteria may need to be adjusted for each specific population segment. The plan provided excellent guidance directing research needs for the species. The plan addressed the full list of known threats to the species and recovery actions believed needed to mitigate, lessen, or remove those threats at the time of approval; however, it does not address this in the "5-factor format". The Neosho Madtom Recovery Plan has been generally adequate to guide recovery actions for the species, particularly for the time span immediately following listing (approximately 10 - 15 years).

[1] Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species, and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently, and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

There is now much new information concerning the species' populations, status, range extension, reproductive ecology, habitat, and threats available. A new 5-factor analysis of threats needs to be updated (see Section 2.3.2. Five Factor Analysis), and the "interim" delisting criteria needs to be changed, based on the new species information collected since the time of listing. The 1991 recovery plan is now generally inadequate to guide recovery actions into the future, and a revised plan should be created.

2.2.3. Progress toward recovery

The Neosho Madtom Recovery Plan set objective and measurable "interim" criteria for the delisting of the species. These criteria include having three self-sustaining populations (which was the number known at the time), each having a minimum of 500 sexually mature individuals occupying suitable habitat at minimum densities of three per 100 m^2 (1076 ft^2). These numbers were based on the initial work completed on the species' ecology (Moss 1981; Moss 1983). The recovery plan also includes caveats for changes to the "interim" criteria once additional information concerning population boundaries/genetics, population numbers (densities), habitat suitability in the different riverine reaches, and the species' reproductive ecology became known. The plan suggests that up to 19 individual population groups may exist, and that varying recovery thresholds, based on these groups, and their varying habitat quantity and quality, may be required as "final" criteria.

The recovery plan outlines six general actions to be completed to determine appropriate recovery criteria and to assist in species recovery. The first directs several tasks, including: biological studies to determine population size and boundaries; mobility between riffles; to assess interspecific competition with other riffle dwelling fishes; document spawning and recruitment rates in the wild; identify limiting factors such as habitat attributes and water quality; and the feasibility of artificial propagation.

The second general action simply directs the development of "final" delisting criteria using the new information obtained from the previous action requirement. Action three is to implement routine population monitoring across the species' range. Action four directs development of reintroduction plans, implementation of reintroduction efforts, and to develop an emergency response plan. Action five directs enhancing state statutes and regulation, enforcing existing regulation, ensuring compliance with ESA section 7, and developing information and education programs. Action six calls for intensive surveys in the Spring River, the Neosho River in Oklahoma, and appropriate tributaries.

Many of the tasks directed by the six recovery actions are complete. Some tasks are now recognized as unattainable and several are incomplete. The new information collected on the species is discussed in section 2.3 (Updated Information and Current Species Status) below.

2.3. Updated Information and Current Species Status

2.3.1. Background on the Species

The Neosho madtom is a small member of the catfish family (Ictaluridae) that reaches a maximum length in the wild of approximately three inches (75 mm). It typically occurs on riffles and gravel bars with shallow flowing water. It occurs primarily in the Cottonwood, Neosho, and Spring Rivers in Kansas, but its range minimally extends into Oklahoma and Missouri. The Neosho madtom is a very short lived species, typically living one to two years, and feeds primarily on aquatic insect larvae in the interstices of its gravel habitat (Moss 1981; Moss 1983; Cross and Collins 1995; Pflieger 1997).

Habitat modification and mainstem dams, both existing and potential, were cited as the primary threats responsible for the listing of the Neosho madtom (USFWS 1990), and remain as the primary threats. Deacon (1961) recognized the species as threatened due to various threats to its habitat or range. Habitat modifications include: impoundment, channelization, flood control, water pollution, gravel removal, and others. The species has not been captured in reservoirs, and inundation of habitat is presumed to have caused localized extirpation in the pools of reservoirs (Moss 1981; Moss 1983; Wagner et al. 1984; USFWS 1990). Flow reductions and discharges of pollutants were also recognized as threats to the species (USFWS 1990). A large portion of the species' current range in the Spring River remains within an area of historically intense mining for lead, zinc, and coal, which have resulted in elevated levels of metals in stream water (Spruill 1984; Wildhaber et al. 2000b). This area is currently acknowledged as the Environmental Protection Agency's Tri-State Superfund Site.

2.3.1.1. Biology and life history

Habitat

The Neosho madtom is a benthic species (lives on the stream bottom) of catfish that primarily inhabits shallow gravel substrates. It is insectivorous and feeds nocturnally. The species remains primarily inactive and hidden in bottom substrate during the day, and comes out at night to forage for aquatic invertebrates (Moss 1981). The majority of Neosho madtom collections are from areas with gravel substrates, primarily gravel in the size range of 0.5 to 2.5 inches (12 – 64 mm) in diameter. Most collections are made in the Spring and Neosho Rivers in shallow water, generally less than three feet deep (<1 m). Within these systems, no significant differences in madtom preferences for depth, velocity, and substrate size were found but gravel riffles with currents of one to four feet per second (<1.25 m/sec.) are preferred by adults (Moss 1981; Fuselier and Edds 1994; Wildhaber et al. 2000a).

In 1992, an artificial riffle was constructed on the Cottonwood River to determine if artificially created habitat could mitigate or compensate for overall habitat loss. This riffle was placed in an area of historical instream gravel mining and in proximity to existing riffles both up and downstream. A Neosho madtom was captured from the artificial riffle within six days following construction. The artificial riffle was found to hold a lower density of the species than the adjacent natural riffles, but not of statistical significant difference, which indicates that these structures could be pursued as a possible option to mitigate for lost habitat if needed and constructed correctly (Fuselier and Edds 1994; Fuselier and Edds 1995).

The mining of river gravel is a recognized threat to the Neosho madtom (USFWS 1990; USFWS 1991), and is a potential factor limiting recovery due to habitat degradation and direct habitat removal. Due to the nearly exclusive association of Neosho madtoms with gravel substrates for refugia, feeding, and recruitment, the Kansas Department of Wildlife and Parks from 1991-1995 placed a moratorium on the issuance of all gravel mining permits on the Neosho and Cottonwood Rivers, using their authority under state statute (Davis and Paukert 2008).

At the time of listing, historic dredging activity in the Neosho River resulted in destruction of Neosho madtom habitat (Moss 1981; Fuselier and Edds 1995) and negative effects to fish communities elsewhere (Forshage and Carter 1973; Kanehl and Lyons 1992); however, these data remained anecdotal toward gravel bar scalping (removal of gravel deposits above the water level) in warmwater streams. In 1995 the Service, through section 7 consultation with the Corps of Engineers, and in conjunction with the Kansas Department of Wildlife and Parks and several local landowners who were requesting mining authority, issued a biological opinion that allowed limited gravel bar scalping. The biological opinion required monitoring to evaluate the effects of gravel bar scalping on the Neosho madtom (USFWS 1995). No significant difference in Neosho madtom densities between "scalped" and non-mined sites types was detected (Davis and Paukert 2008).

Reproductive Ecology

The Neosho madtom is a short-lived fish, possibly living to reproduce for only a single season, although propagated fish have lived five to eight years in a laboratory environment (Bryan et al. 2006; Wildhaber 2011). Therefore, population maintenance in the wild is highly dependent upon each year's recruitment. A poor reproductive year can result in a small year class and thus reduced overall populations. Several successive years of poor recruitment could exacerbate these effects on the remaining fragmented populations of the species.

Reproduction likely takes place during May and June high flow events (Moss 1981; Moss 1983; Wildhaber et al. 2000a). Gravid females are typically captured in May, with young-of-the-year fish first captured in late July to August. This, suggests reproduction coincides with the early summer peak flow events. However, this relationship has not been demonstrated conclusively, as flows of the magnitude believed necessary for reproduction, generally prohibit sampling and assessment. It has been hypothesized that spawning Neosho madtoms use the head or crest of gravel bars where larger substrate provides ample cavity spaces (Edds 1995; Edds and Wilkinson 1996). Evidence exists of cavity use by Neosho madtoms in laboratory settings (Wilkinson and Edds 1997; Bulger et al. 2002a; Bryan et al. 2006). In the field, Neosho madtoms did not have a significant tendency to move to any specific section of a gravel bar during the spawning season (Bulger and Edds 2001). No other information on reproductive behavior in nature has been collected due to high flows and turbidity during the assumed spawning period.

Since little was known of the specifics of the Neosho madtom's reproductive behavior when the recovery plan (USFWS 1991) was first published, it suggested further research. To date, much work has been completed concerning the species' reproductive ecology in the laboratory setting, including reproductive behavior and propagation. Pfingsten and Edds (1994) were able to induce one Neosho madtom to spawn in an aquarium under a cinder block. However, none of the 63 eggs hatched. They were also able to document secondary sexual characteristic development in the lab. In 1996, Bulger et al. (1998) successfully spawned a pair of Neosho madtom in an aquarium. The pair utilized longitudinally divided pieces of plastic pipe for spawning and rearing, where the male guarded the eggs for nine to ten days, and young for eight to ten days.

Recent studies have demonstrated the relationship between photoperiod, temperature, and presence of flowing water on reproductive behavior and success (Bulger et al. 2000; Albers and Wildhaber 2002; Bulger et al. 2002a; Bryan et al. 2005; Bryan et al. 2006), which resulted in 21 spawns. The initial study focus on reproductive behaviors were between male and female Neosho madtom pairs in their nests, included courtship activity, physical behaviors during the spawn itself, and movement of substrate to create the nest cavity. Bulger et al. (2002b) documented nocturnal activity and demonstrated the importance of photoperiod on spawning behavior. Longer daylight hours increased daytime activity, nest enhancement, and courtship behavior.

Bryan et al. (2005) used time-lapse infrared videography, underwater cameras, and simulated winter conditions to assess laboratory stimulation of reproductive development. Medical ultrasound instruments were used to validate gender, and to estimate fecundity (number of eggs) over several annual cycles. They also provided the first visual record of Neosho madtom spawning. Of note, the Neosho madtoms used in these experiments survived up to eight years under laboratory conditions (Wildhaber 2011). Since 2007, The Peoria Tribe of Indians of Oklahoma (Tribe) has been working in conjunction with the U.S. Geologic Survey's Columbia Environmental Research Center to collect and assess Neosho madtom broodstock for propagation. It is the Tribe's intent to develop a propagation and reintroduction plan for potential augmentation of the Spring River population. The Tribe is also working with the Neosho Madtom Recovery Team to assure any population augmentation is within the bounds of the existing recovery plan (Wildhaber 2011).

Competition

The Neosho Madtom Recovery Plan (USFWS 1991) identified the need for information on interspecific competition between the Neosho madtom and other riffle dwelling species, particularly the slender madtom (*Noturus exilis*), which inhabits the Spring River but only a very small portion of the upper Neosho system. The concern was the potential detrimental effects to Neosho madtom populations in the Neosho system if slender madtoms became established there. Several slender madtoms were captured from the upper Neosho in 1988 (Ernsting et al. 1989).

Several studies have assessed competition between Neosho madtoms and associated benthic species, including slender madtom. Competition was not a limiting factor for the species within the Neosho and Spring Rivers (Wildhaber et al. 1999) and in the upper Neosho River (Tiemann et al. 2004a; Tiemann et al. 2004b). Densities of fishes with similar habitat preferences to Neosho madtoms were positively correlated with Neosho madtom densities, whereas densities of fishes with different habitat preferences were negatively correlated (Wildhaber et al. 1999). Overall, the availability of suitable substrate, water quality (including toxic metals), and aquatic invertebrates (prey items), and not interspecific competition, are the major influences on Neosho madtom population distribution and numbers (Wildhaber et al. 2000a; Wildhaber et al. 2000b).

2.3.1.2. Distribution, abundance, and trends

Distribution and Range

Historically, the Neosho madtom range included the mainstem rivers of the Neosho and Spring River drainage system south to the Neosho's confluence with the Arkansas River in Oklahoma (the Neosho River is now referred to as the Grand River in Oklahoma). It was also known from the Illinois River in Oklahoma. The species is now limited to approximately two-thirds of its original range (Moss 1981; Wildhaber et al. 2000a). This loss is due to habitat alteration and/or fragmentation by seven large mainstem dams (4 in Oklahoma and 3 in Kansas), and approximately 16 low-head dams in the remainder of its range (USFWS 1991).

At the time the recovery plan (USFWS 1991) was published, the species was considered to be distributed discontinuously in Kansas and adjacent areas of Oklahoma and Missouri (USFWS 1990). Three populations of the species were generally recognized: the Cottonwood and Neosho River population upstream from John Redmond Dam; the Neosho River population downstream of John Redmond Dam to the backwaters of Lake O' the Cherokees, Ottawa County, Oklahoma; and the Spring River population from the confluence of the North Fork Spring River, Jasper County, Missouri, downstream to its confluence with Turkey Creek (USFWS, in litt. 2009; Wagner et al. 1984; Moss 1981).

The Spring River population is now isolated from its Neosho River source population by the Lake O' the Cherokees (Moss 1981; Branson et al. 1969; Moss 1981; Wilkinson et al. 1996). At the time of listing, the species had not been captured from the Spring River downstream of Empire Lake, Cherokee County, Kansas. In 1994, two separate surveys captured several specimens downstream of Empire Lake, near Baxter Springs, Kansas (Tabor 1994; Wilkinson et al. 1996). Additionally a single Neosho madtom was also captured farther downstream in the Spring River in Oklahoma in 2006 (Fenner 2007). Another single Neosho madtom was later captured near the same site in 2007 (Fenner 2007). The discovery of the species downstream of Empire Lake suggests that two separate populations likely exist in the Spring River (Wilkinson et al. 1996).

Additionally, the species was captured twice in 1996 from the South Fork of the Cottonwood River, Chase County, Kansas (Wilkinson and Fuselier 1997); and from Lightning Creek in 1987 in Labette County, Kansas (Ernsting et al. 1989). It should be noted that these represent the only small tributary collection sites known to date, and both were less than 2 miles (3.2 km) from the mainstem river.

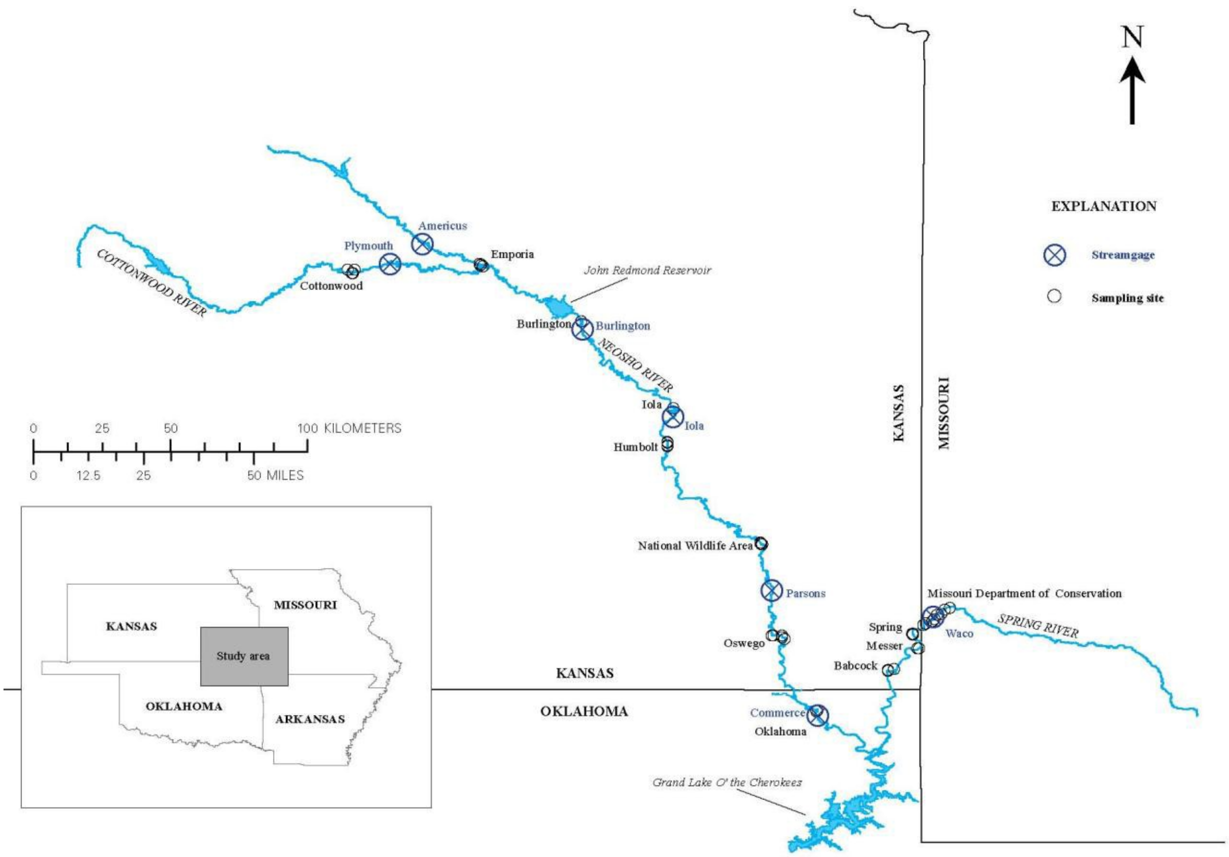


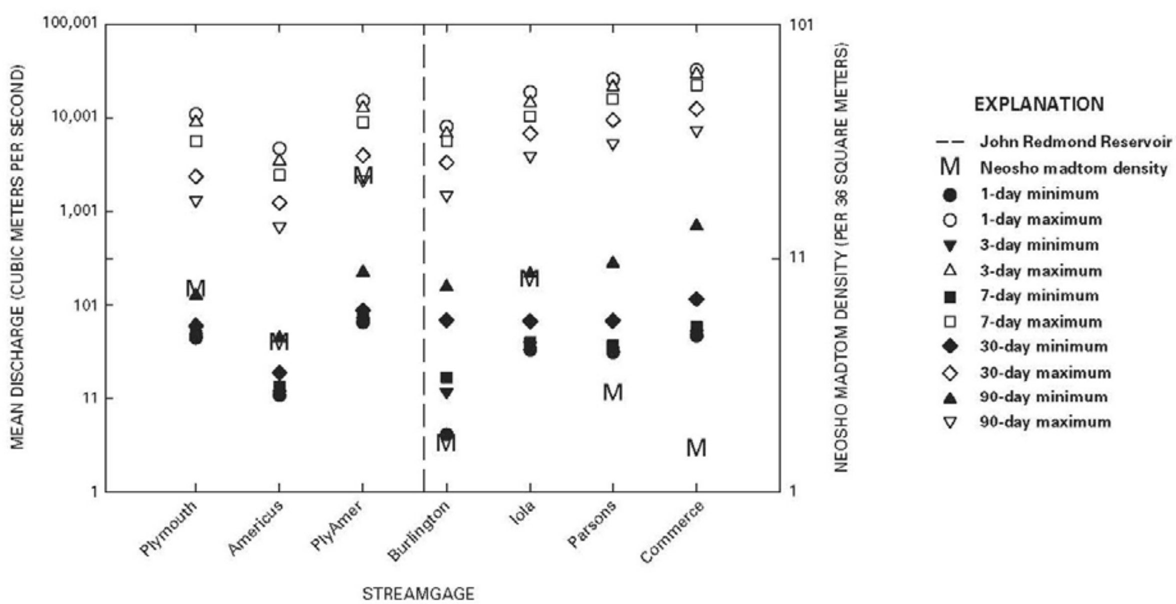
Figure 1. Present range of the Neosho madtom with USFWS and Missouri Department of Conservation sampling locations, and USGS gauging stations indicated. (Used with permission from Bryan et al. 2010, USGS).

Abundance and Trends

In 1991, the Service began annual monitoring of Neosho madtom populations in the Neosho, Cottonwood, and Spring Rivers. Data gathered included substrate composition, water velocity and depth, water quality, number and size of Neosho madtoms captured, and number and size of other benthic fishes present in the catch. The purpose of monitoring was whether reservoir releases, hydrologic characteristics, and if numbers and densities of Neosho madtom were affected by other benthic fishes sharing their gravel bar habitats. It also served to establish an environmental baseline for the species' abundance and its habitat conditions.

Two studies (Wildhaber et al. 2000a; Wildhaber et al. 2000b) were published analyzing the first eight years of this monitoring data, as well as data collected by the U.S. Geologic Survey's Columbia Environmental Research Center. They identified average Neosho madtom densities in the Neosho and Cottonwood upstream of Redmond Reservoir as 19.82 per 100 m² (1076 ft²); 5.64 per 100m² (1076 ft²) in the Neosho downstream of Redmond Dam; and 3.26 per 100m² (1076 ft²) in the Spring River upstream of its confluence with Turkey Creek, with none captured downstream from its confluence to Empire Lake. They also found a declining trend in density for Neosho madtom in the reach downstream of Redmond Dam, where its operation could be affecting water and habitat quality, particularly turbidity and substrate. A positive correlation between the Neosho madtom and other ictalurids (catfish), particularly juvenile channel catfish (*Ictalurus punctatus*) and stonecats (*Noturus flavus*) was identified, suggesting minimal or no interspecific competition. In the Spring River, habitat availability was the major limiting factor in density upstream of Turkey Creek (source of heavy metal contamination), and presence of contaminants the limiting factor downstream of Turkey Creek, either directly impacting the species' physiology or its benthic aquatic insect food base, or both.

Figure 2. The pattern of the Indicators of Hydrologic Alteration parameters and Neosho madtom density at the U. S. Geological Survey streamgages on the Cottonwood/Neosho Rivers. The streamgages are ordered downstream, left to right; the dashed line indicates the location of the John Redmond Reservoir; and the letter '**M**' indicates streamgage-level Neosho madtom density. (Used with permission from Bryan et al. 2010, USGS).



Bryan (et al. 2010) recently revisited the previous study (Wildhaber et al. 2000a) to update and identify any changes in trends and effects. They analyzed the data collected from 1991-1998 and 1999 to 2008. A continuing decline in density was detected for the reach of Neosho River downstream of Redmond Dam from 1999 to 2006 with a slight increase in densities to 2008. The location of the monitoring site relative to the reservoir explained a significant amount of variation in Neosho madtom densities when accounting for different flow regimes, both upstream and downstream from Redmond Reservoir. Significant, positive associations between Neosho madtoms and other ictalurids remains consistent with the previous study (Wildhaber et al. 2000a).

Table 2. Summary of the yearly mean values for Neosho madtom density per 36 square meters at each location and respective hydrologic stream-gauge used in the study (Used with permission from Bryan et al. 2010, USGS).

[Locations are ordered downstream, top to bottom: --, location was not sampled; a, standard protocol was not used and data were not included in analysis; NWA, Neosho Wildlife Area; MDC, Missouri Department of Conservation]

River	Site	Location	Streamgage	Year																		Mean value
				1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Upstream from John Redmond Reservoir																						
Cottonwood	Cottonwood	1	Plymouth	9.7	8.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.2
		2	Plymouth	8.8	10.7	--	1.4	--	1.3	4.0	6.3	3.1	0.7	--	--	--	1.4	--	--	--	--	4.2
		3	Plymouth	19.3	25.9	--	21.3	--	1.3	7.0	13.0	16.7	7.0	--	--	--	3.1	--	--	--	--	12.7
Neosho	Emporia	1	Americus	0	2.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2
		2	Americus	4.6	14.0	--	24.9	7.5	5.3	0	2.5	0	--	--	--	--	--	--	--	--	--	7.4
		3	Americus	6.4	.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.4
		4	Plymouth/Americus	--	--	--	72.7	19.8	2.9	20.9	45.7	--	--	--	--	--	--	--	--	--	--	32.4
Downstream from John Redmond Reservoir																						
Neosho	Burlington	1	Burlington	--	--	--	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6
	Iola	1	Iola	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	a	7.4	7.4
	Humbolt	1	Iola	4.9	40.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22.4
		2	Iola	2.9	29.1	--	4.5	--	--	--	--	--	0.3	--	--	--	1.6	2.2	--	--	--	6.8
		3	Iola	5.9	38.0	--	3.7	--	--	--	21.1	39.7	5.1	--	--	1.0	6.4	1.3	--	a	22.0	14.4
	NWA	1	Parsons	--	--	--	4.3	14.9	--	4.2	5.8	16.4	5.8	3.8	--	0	4.2	1.0	0	--	11.2	6.0
		2	Parsons	--	--	--	0	1.0	--	.3	4.2	1.3	0	--	--	0	1.3	.3	--	--	--	.9
	Oswego	1	Parsons	2.2	2.7	--	1.3	1.6	--	--	--	--	--	--	--	--	--	--	--	a	--	1.9
		2	Parsons	0	.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.3
		3	Parsons	0	--	--	.6	1.0	--	.3	.6	0	0	0	1.0	0	.3	0	a	a	--	.3
		4	Parsons	--	--	--	--	--	--	.3	1.7	1.5	--	--	--	--	--	--	--	--	--	1.2
	Oklahoma	1	Commerce	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	0
		2	Commerce	--	--	--	--	--	--	.4	1.3	1.0	.3	0	a	--	--	--	--	--	--	.6
		3	Commerce	--	--	--	--	--	--	--	1.0	5.1	1.3	0	0	0	1.9	0	a	a	--	1.2
Spring	MDC	20	Waco	--	--	--	1.1	--	--	--	--	--	--	--	--	.7	.7	1.0	0	0.3	3.0	1.0
		30	Waco	--	--	--	4.8	--	--	--	--	--	--	--	--	1.3	0	0	0	0	.7	1.0
		40	Waco	--	--	--	--	--	--	--	--	--	--	--	--	0	0	0	0	0	.3	.1
		50	Waco	--	--	--	--	--	--	--	--	--	--	--	--	2.0	1.7	0	0	0	1.3	.8
		60	Waco	--	--	--	--	--	--	--	--	--	--	--	--	1.3	1.0	1.7	.7	0	3.0	1.3
		70	Waco	--	--	--	--	--	--	--	--	--	--	--	--	1.0	1.7	0	.7	0	1.0	.7
		80	Waco	--	--	--	--	--	--	--	--	--	--	--	--	0	0	0	0	0	0	0
		90	Waco	--	--	--	--	0	--	--	--	--	--	--	--	0	0	.3	0	0	.3	.1
	Spring	1	Waco	--	--	--	.5	5.3	--	0	0	1.7	0	0	0	0	.4	0	0	--	--	.7
		2	Waco	--	--	--	.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.8
		3	Waco	--	--	--	0	--	--	0	0	0	0	0	.6	0	.3	.3	0	--	--	.1
	Messer	1	Waco	--	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
		2	Waco	--	--	--	0	--	--	--	--	--	--	--	--	--	--	0	a	--	--	0
	Babcock	1	Waco	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	0
		2	Waco	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	0	--	--	0
		3	Waco	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0

While overall population numbers throughout the Neosho madtom's range are difficult to quantify, we now know that numbers and densities can be highly variable between individual sample sites and years. We also know that densities vary between the major riverine reaches studied. The limited geographic distribution of the species in hydrologically altered and fragmented riverine habitat provides the possibility for localized and widespread adverse effects and population variations.

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

No genetic evaluation or analysis has been completed on the Neosho madtom since its listing. A study being conducted by the U.S. Geologic Survey's Columbia Environmental Research Center is in its early phases. Specimens used in several reproductive ecology studies (Bulger et al. 2002; Bryan et al. 2006) are being held for pending genetic analysis.

2.3.1.4. Taxonomic classification or changes in nomenclature

There have been no changes in the taxonomic classification of the Neosho madtom since its listing in 1990. The species was formally described by Taylor (1969), but had been recognized as a distinct species since the 1950s (Cross 1967). Prior to that, it was usually identified as brindled madtom (*Noturus miurus*), which also occurs in the Spring River, or mountain madtom (*Noturus eleutherus*), which is not found in the Neosho or Spring River drainages. The original specimens used to describe the Neosho madtom are from the Neosho River, Lyon County, Kansas, and are located at the University of Michigan, Museum of Natural History and the Museum of Natural History at the University of Kansas (USFWS 1991).

2.3.2. Five-Factor Analysis - threats, conservation measures, and regulatory mechanisms

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

The final rule listing the Neosho madtom as a threatened species indicated that existing and potential habitat modification comprises the major threat to the survival of the species. Modifications include: stream impoundment; hydrologic changes due to reservoir operations; water quality, including agricultural and mine waste contamination; water diversion and allocation; and instream gravel mining (USFWS 1990). Additional threats have been identified since the time of listing, including potential over-appropriation of water rights and long-term climate change.

Impoundments

The decline and imperilment of the Neosho madtom has been directly attributed to construction of numerous impoundments (Deacon 1961; Moss 1981; USFWS 1990; Wildhaber et al. 2000a). Dams eliminate river flow, trap silt, and increase sediment deposition within and upstream of the impounded areas. They alter water quality, increase bank and bed erosion, change hydrology and channel geomorphology, decrease habitat heterogeneity, affect normal flood patterns downstream, as well as block upstream and downstream movement of fishes (USFWS 1990; Cross and Collins 1995; Tiemann et al. 2004a; Gillette et al. 2005).

Within impounded waters, loss of fish diversity is directly attributed to loss of supporting habitat, sedimentation, decreased dissolved oxygen, temperature levels, and alteration in resident fish populations (USFWS 1990; Cross and Collins 1995). Downstream of dams, declines in some species are associated with changes and fluctuation in flow regime, channel scouring and bank erosion, reduced dissolved oxygen levels and water temperatures, and changes in resident fish assemblages (Moss 1981; USFWS 1990; Wildhaber et al. 2000a; Bryan et al. 2010). Small lowhead or mill dams can have similar effects, particularly reducing species richness, evenness, and fish movements (Tiemann et al. 2004a; Tiemann et al. 2004b; Gillette et al. 2005; Gillette et al. 2006).

Dam construction has a secondary effect of fragmenting the ranges of fish species, leaving habitats and populations isolated upstream or between structures as well as creating extensive areas of deep, uninhabitable impounded waters. These isolated populations thus become unable to naturally recolonize suitable habitat from downstream effectively isolating populations and reducing genetic heterozygocity (Allendorf and Luikart 2007), making the species more prone to further extirpation from stochastic events, such as severe drought, accidental chemical spills, or unauthorized discharges (Moss 1981; USFWS 1991; Wildhaber 2011).

Population losses due to impoundments have likely contributed more to the decline and imperilment of the Neosho madtom than any other factor. Significant stretches of riverine habitat throughout the range of the Neosho madtom has been impounded, leaving short, isolated patches of suitable habitat (USFWS 1991). The Neosho madtom does not occur in reservoirs, and it is unable to successfully reproduce and recruit under these conditions (Moss 1981; Moss 1983).

The Neosho madtom is presently impacted by four major impoundments in the Neosho and Cottonwood River systems and two impoundments on the Spring River. Grand Lake O' the Cherokees' (impounded in 1941) backwaters effectively delineates the downstream distribution of the species in the Neosho and Spring Rivers. John Redmond Reservoir (impounded in 1963) divides the Neosho River distribution into two recognized populations, one downstream of John Redmond Reservoir and one upstream in the Neosho and Cottonwood Rivers (Moss 1981; USFWS 1990; Wildhaber et al. 2000a). Two reservoirs also exist upstream of known Neosho madtom locations on the Neosho and Cottonwood Rivers, Council Grove and Marion Reservoirs. Additionally, the Neosho and Cottonwood Rivers have been further subdivided by 16 lowhead dams (USFWS 1991; Wildhaber 2011) that typically impound one to five miles (1.6-8 km.) of stream channel. These further spatial constraints provide for the possibility that up to 19 potentially isolated populations exist (Bryan et al. 2004).

These dams, by segmenting the species' riverine habitat, may impact the genetic variability in the species. Loss of genetic diversity in fragmented populations can impact species fitness, including fecundity and recruitment over time (Allendorf and Luikart 2007). The recovery plan (USFWS 1991) suggests that known concentrations of Neosho madtoms in the Neosho and Cottonwood Rivers are large enough to provide adequate genetic variation, but also suggest that the Spring River population (only one was known at that time) may be too small to provide adequate genetic variation. The plan also called for population genetics studies to identify possible genetic loss and differentiation of populations. At this time, no genetics studies on the species have been completed, and there is very little information available concerning migration or dispersion of the species within their fragmented habitat (Fuselier and Edds 1995; Fuselier and Edds 1996). These will need to be completed and the varying populations defined before the level of threat to the species' population genetics are known and recovery actions implemented.

These impoundments also inundate gravel riffle habitat, directly impacting habitat availability and quality (Gillette et al. 2005). John Redmond Reservoir inundated approximately 20 miles (31 km.) of river channel, and the lowhead dams in the system impact an approximate additional 45 stream miles (72 km.) (USFWS 1991). Lowhead dams on the Neosho River have detrimental effects to the Neosho madtom as well as the aquatic ecosystem within the study reaches (Tiemann et al. 2004a; Tiemann et al. 2004b; Gillette et al. 2005; Gillette et al. 2006). The dams significantly altered stream habitat upstream by creating increased depth, increased siltation, and lower velocities; and shallower depths, increased velocities, and larger, more embedded substrate downstream. Neosho madtom densities and aquatic invertebrate numbers were significantly lower across the study sites when compared to reference sites not impacted by lowhead dams (Tiemann et al. 2004a), suggesting that food availability and substrate composition may be limiting factors for the species in these areas. Since that time, negotiation and planning for the removal of Correl Dam, one of their study sites, has occurred. A proposal for the demolition and post monitoring is being prepared (Johnson, 2012 pers. comm). If removed, it would not only open habitat inundated behind the dam, but would allow emigration of Neosho madtoms upstream approximately 20 river miles (31 km.) into areas of suitable habitat not presently known to be occupied by the species.

The loss of habitat due to past inundation will continue into the future, particularly in the case of the large mainstem dams. However, removal of unneeded lowhead dams in the system could result in restoration of previously lost habitat for the species, and reduce the level of existing population fragmentation, diminishing the overall threat to the species.

Reservoir Operations and Hydrologic Changes

The final rule listing the Neosho madtom (USFWS 1990) and the recovery plan identified that determining minimum flow needs for the species' reproduction and survival was needed for recovery, and speculated that flood control operations of John Redmond Reservoir could be affecting the species and its habitat. Wildhaber et al. (2000a) investigated the relationship between ictalurid (catfishes) densities, including the Neosho madtom, substrate size composition, and water quality with changes in flow regime. Their analysis showed the Neosho River downstream of John Redmond Dam now has lower minimum flows, and lower short term and higher long-term flows than it would have without the dam. These flow changes limit available suitable habitat for the species, increase consolidation of gravels on bars and riffles (decreasing their suitability as habitat for the Neosho madtom), and alter the substrate composition in the stream reach nearest the dam to sizes not typically used by the species. Concurrently, average densities of Neosho madtom were significantly lower downstream of the dam than upstream, 5.62 and 19.82 per $100m^2$ ($1076 ft^2$), respectively (Wildhaber et al. 2000b), possibly reflecting the more natural hydrographs of the Neosho and Cottonwood Rivers upstream of John Redmond Reservoir. Also, a positive relationship between annual minimum flow date and Neosho madtom densities was found, suggesting that delaying minimum flows until after species recruitment may enhance population numbers downstream of the dam. Additionally, positive correlation exists between densities of Neosho madtoms and other ictalurids, also suggesting that dam releases that benefit the Neosho madtom will also benefit channel catfish (*Ictalurus punctatus*) and other riffle dwelling species (Wildhaber et al. 1999; Wildhaber et al 2000a).

Another study examined channel stability of the Neosho River downstream of John Redmond Dam as related to pre-dam and post-dam flow regimes thought to impact habitat availability and quality for the Neosho madtom (Juracek 1999). No significant post-dam bank-full-width channel widening was identified that attributed to the substantial reduction in the magnitude of post-dam annual peak flows. Even so, the operation of John Redmond Dam appears to impact the species in abundance, habitat quality, and quantity. These threats are expected to continue to impact the species downstream of the reservoir into the near future.

Gravel Mining

River gravel mining is a recognized threat to the Neosho madtom (USFWS 1990; USFWS 1991), and is a potential factor limiting recovery potential. Past gravel mining activity on the Neosho system included the removal of gravel deposits above the waterline (scalping), typically located on inside river bends; and mechanical excavation within and adjacent to the active, flowing stream channel. Mining within and adjacent to the flowing channel can directly remove occupied fish habitat; remove all temporally used habitat (habitat used at higher water levels) at a given location; as well as release large plumes of silt and other sediment downstream, degrading habitat quality; encourage increased erosion and head-cutting upstream; and directly cause mortality to fishes and other aquatic organisms by operation of heavy equipment in channel (Brown et al. 1998). Gravel bar scalping removes a volume of temporally available habitat, but does leave a dry gravel bar in place following excavation that is available to the species as river levels rise.

Davis and Paukert (2008) suggest that gravel bar scalping does not significantly influence mean Neosho madtom density; and that a more in-depth study should be completed to determine how the increase in scalping activities on the rivers effect bedload transport of gravel. This would identify if upstream mining is leading to lower volumes of gravel in downstream areas that constitute Neosho madtom habitat and if decreased bedload transport is resulting in higher rates of stream bank erosion downstream of mining activities. At this time, threat to the Neosho madtom from gravel mining is likely lower than at the time of listing; however, as unregulated scalping of gravel bars increase over time, the level of threat from decreased availability of gravel which encompasses the species' habitat will likely increase as well.

Water Quality

The Neosho Madtom Recovery Plan (1991) recognized several specific threats to water quality potentially impacting the species, including feedlot pollution, non-point source pollution, mine waste contamination, and operation of the Wolf Creek Nuclear Power Generating Station. Confined animal feeding operations (CAFOs) can accidentally release of large volumes of animal waste from sewage lagoons, threatening the Neosho madtom by severely impacting ammonia and oxygen levels in streams.

Three releases severely impacted the Neosho madtom in the Cottonwood and Neosho watersheds upstream of John Redmond Reservoir in 1966 and 1967 (Cross and Braasch 1969). The resulting fish kills impacted 10-25 miles (16-40 km.) of streams, and killed an estimated 225,000 to 425,000 fish (USFWS 1991). Additionally, between 1973 and 1986, three fish kills were also associated to lagoon spills in the same area, but were of much lower magnitude.

While continuing threats exist from CAFOs, the large industrial feeding operations that caused the major problems in the past have relocated out of the region, leaving predominantly smaller (<200 cattle), largely unregulated CAFOs. These operations are mainly seasonal (winter livestock feeding) and are typically located on tributaries, where large precipitation events wash the wastes into streams. As a result, the increased nutrient load can cause blooms of algae in shallow water over gravel bar habitat, decreasing supportive habitat and water quality for the Neosho madtom (USFWS 1991). Cattle in some areas also use the rivers as a source of drinking water. Increased erosion through trampling by cattle of stream-side vegetation and increased nutrient load through defecation create localized impacts on Neosho madtom. New regulations have reduced the magnitude of threat to the species from livestock feeding over the last 35 years, but local effects remain.

Non-point source pollution from land surface runoff can originate from virtually any land use activity. Across the Neosho madtom's range, typical sources are row-crop agriculture, road and bridge construction, urban and rural development, and removal of riparian vegetation. Pollutants entering the Neosho and Spring Rivers include sediments, fertilizers, herbicides, pesticides, animal wastes, pharmaceuticals, solid wastes, septic tank leakage, and petroleum products. The most significant of these impacts basin-wide is sedimentation and siltation (Kansas Water Office 2009). Activities that contribute sediment discharges into a stream system change the erosion or sedimentation pattern, which can lead to the destruction of riparian vegetation, stream bank failure, excessive instream sediment deposition, and increased water turbidity and temperatures (Waters 1995).

Sediment has been shown to damage 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. In addition, madtoms, which are heavily dependent on chemoreception (detection of chemicals) for survival, might be susceptible to human-induced disturbances, such as chemical and sediment inputs, because the smells they produce could interfere with a madtom's ability to obtain food and otherwise monitor its environment (Etnier and Jenkins 1980).

The Neosho madtom recovery plan (USFWS 1991) identified the need to assess the impacts of mine wastes entering the Spring River through land surface runoff. The species' range in the Spring River watershed is coincident with historical lead and zinc mining, and is partially encompassed by EPA's Tri-State Superfund site (Allen et al. 2001; Kiner et al. 1997). Contaminant concentrations, primarily lead and zinc, in the Neosho River were much lower than those found in Center and Turkey Creeks, tributaries to the Spring River that receive runoff from mining areas (Smith 1988; Allen et al. 2001). Fishes of the Spring River, including the Neosho madtom, are limited by lead, zinc, and cadmium in water and benthic invertebrate food sources downstream of the confluence of Turkey Creek (Allert et al. 1997; Wildhaber et al. 2000b). This threat limits the species' range in the Spring River and may contribute to the mortality of individual Neosho madtoms as they attempt to emigrate, or get displaced downstream during high water events.

Wolf Creek Nuclear Power Generating Station (Wolf Creek) near Burlington, Kansas, draws water from the Neosho River to fill its 5,090 acre (2060 hectare) cooling lake. The lake does not normally discharge water, losing water only to evaporation. However, it occasionally spills water following large precipitation events which discharges into a tributary to the Neosho River. The possible effects of accidental releases of thermal or radioactive water on the Neosho madtom and other forms of aquatic life are uncertain, and the likelihood of such an accident is small (USFWS 1991).

The Wolf Creek nuclear power plant began operating in 1985, prior to the species being listed, so effects to the Neosho madtom from the ongoing power plant operations were not subject to section 7 consultation. The plant withdraws water from either John Redmond Reservoir or the Neosho River. However, Nuclear Regulatory Commission (NRC) and the Service recently concluded section 7 consultation relicensing the Wolf Creek facility to be effective in 2022. The main threat from plant operations is the timing of the withdrawals of water from the Neosho River for plant cooling operations, and their combined effects with possible future drought conditions (U.S. Army Corps of Engineers 2011). As a result of the consultation, the plant operator and the NRC have agreed to withdraw water during periods of high stream flow and maintain the plant's cooling lake at high levels to avoid withdrawing water during low flow or drought conditions.

During a severe drought in the 1950s, the Neosho River ceased flowing during several periods, forcing riffle dwelling species, such as the Neosho madtom, into less favorable habitat. Riffle dwelling fishes were the slowest to recover following resumption of continuous flow (Deacon 1961). Neosho madtom was uncommon at the sites following the drought until the third summer of continuous flow (Deacon 1961; USFWS 1991). During this period of drought, water quality was also highly degraded at times due to lack of flow, as municipal sewage effluent was often released back into the river without being diluted (Cross 1967).

Droughts can be expected to recur, and the impact of droughts comparable to that of the 1950s will worsen as demands for water consumption increase. Surface water demand for industrial, agricultural, and municipal uses in the Neosho basin (inclusive of the Neosho, Cottonwood, and Spring Rivers) is projected to increase 25 percent between 1984 and 2040, which makes the overall surface water supply inadequate in the event of a severe drought (Kansas Water Office 1987; U.S. Army Corps of Engineers 2011). Public water demand in the Neosho basin is forecast to increase by 12,816 acre-feet per year by 2050 (Kansas Division of Water Resources 2006; Kansas Water Office 2006).

Minimum desirable stream flows were established by Kansas Statute in 1980 (K.S.A. 82a-703 & 82a-928) to help maintain surface flows in designated streams, and to protect them from over-appropriation of water rights. In developing these streamflow standards, consideration was given to consumptive use (municipal, industrial, and agricultural), fish and wildlife requirements, and water quality (Kansas Division of Water Resources 2006; Kansas Water Office 2006). Minimum desirable stream flows have been established for two sites on the Cottonwood River and three sites on the Neosho River (K.S.A. 82a-950; Kansas Water Office 1988). Given this scenario, water would be released from Marion, Council Grove, and John Redmond Reservoirs to provide the minimum flows needed in these streams. An assessment of transit losses for drought conditions was conducted by the USGS, and under none of their models would enough water be available in the reservoirs to meet the minimum desirable stream flows for the lower Neosho River in Kansas (Carswell and Hart 1985). The adverse effects of a drought on aquatic wildlife could be lessened, but not prevented, by these minimum stream flows during a prolonged drought (Kansas Water Office 1988; U.S. Army Corps of Engineers 2011). Threats from instream water shortages remain high, but not immediate.

Summary

The operation of John Redmond Dam appears to impact species abundance, as well as habitat quality and quantity. This impact, in combination with unregulated activities that result in impacts such as stream bank erosion and sedimentation, further threatens the species and its habitat. These threats are likely to continue into the near future. The threat to the Neosho madtom from instream gravel mining is now likely lower than at the time of listing due to regulations prohibiting gravel extraction from below the waterline. However, if unregulated scalping of gravel bars increase over time, the level of threat resulting from decreased availability of gravel habitat will likely increase as well. Threats from decreased water quality are believed similar to the time of listing, as most activities that contribute to degradations continue and are unregulated. Threats from decreased flows due to allocation of stream water continue, but are not immediate, and will likely only result in combination with a period of prolonged drought.

2.3.2.2. Overutilization for commercial, recreational, scientific, or educational purposes

Overutilization is not known to be a factor in the decline of the Neosho madtom.

2.3.2.3. Disease or predation

Disease and predation are not known to be factors in the decline of the Neosho madtom. However, migration of introduced piscivorous fishes from reservoirs into the species' riverine habitat could have some localized, temporary impacts through predation. Impacts of this nature have not been documented for the Neosho madtom.

2.3.2.4. Inadequacy of existing regulatory mechanisms

Several federal and state laws and regulations are pertinent to the Neosho madtom. These different statutes contribute in varying degrees to the conservation of the species.

Federal Endangered Species Act

The Endangered Species Act (ESA) is the primary federal law that provides protections for the Neosho madtom. The ESA provides several tools that are regularly used to help conserve the species. Section 7(a)(2) requires federal agencies to consult with the USFWS to ensure any project funded, authorized, or carried out by such agency does not jeopardize the continuing existence of a listed species, or result in the destruction or adverse modification of designated critical habitat for the species. In the case of the Neosho madtom, there is no federally designated critical habitat, so the second provision does not apply.

Section 9 of the ESA provides for direct protection of a federally listed species by prohibiting “take” (i.e., to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct). Section 10(a)(1)(B) allows us to permit incidental take where a Habitat Conservation Plan (HCP) minimizes and mitigates the effects of authorized incidental take. To date, there are no USFWS authorized HCPs finalized for the Neosho madtom. Section 6 of the ESA allows for cooperation between the USFWS and states in the management and funding of projects designed to enhance the conservation of federally-listed species. To date, numerous research and conservation projects involving Neosho madtom have been funded through section 6, including captive propagation, status surveys, environmental contaminants studies, and habitat and life history research. In the absence of the ESA’s protections, federal protections for the species or consideration for the species’ biological needs would be limited, as described below.

Other Federal Regulatory Mechanisms

The Federal Clean Water Act affords some protections for the Neosho madtom. The U.S. Army Corps of Engineers (Corps) issues permits for the discharge of dredged or fill materials into “Waters of the United States.” They interpret this phrase to include not only navigable waters, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters. The basic premise of the program is that no discharge of dredged or fill material may be permitted into such waters if: (1) a practicable alternative exists that is less damaging to the aquatic environment; or (2) the nation’s waters would be significantly degraded. In other words, permittees must show that they have, to the extent practicable: taken steps to avoid wetland impacts; minimized potential impacts on wetlands; and provided compensation for any remaining unavoidable impacts. Because of the Neosho madtom’s listed status, the Corps is required under section 7 of the ESA to consult with the USFWS before issuing a 404 permit to a project applicant that may affect the species. If the ESA’s protections were removed, section 404 of the Clean Water Act protections involving the conservation of the Neosho madtom would likely decrease significantly. Examples of projects that may affect the species and would be likely to occur if ESA protections were removed include: excavation and placement of fill, such as riprap, directly in the active, flowing channel; and work occurring in the active channel during the species’ spawning period. These actions could increase erosion and sedimentation resulting in decreased habitat quality and reproductive success; and possibly result in direct mortality by burying or crushing due to fill being placed or equipment operation in the channel.

Gravel bar scalping is presently not a regulated activity under section 404 because it occurs above the waterline. All gravel mining in the waters of the Neosho basin was regulated by the Corps under section 404 until 2007. In that year, National Association of Homebuilders vs. Corps overturned the Corps' definition of "incidental fallback" of fill in a wetland (U.S. Environmental Protection Agency 2008a; U.S. Environmental Protection Agency 2008b). As related to the Neosho madtom, this decision resulted in the scalping of gravel bars becoming an unregulated action under section 404, as long as all excavated (scalped) gravel is immediately loaded and removed from the streambed. This reduction of regulatory authority for the Corps resulted in inadequate protection for the madtom from gravel scalping activities.

Section 402 of the Clean Water Act governs National Pollution Discharge Elimination System permits for point sources, such as large confined animal feeding operations. While this system is managed by the Environmental Protection Agency most states, including Oklahoma, Kansas, and Missouri, are authorized to implement the program in their State. These permits require the use of best management practices to reduce pollutants to the "maximum extent practicable." Programs delegated to the states are not required to consult with the USFWS, nor are they required to specifically consider the impact of permitted actions to the Neosho madtom. If the ESA's protections were removed, there would be no impact to the National Pollution Discharge Elimination System permitting process. With or without the ESA's protections, the standards put in place through this permitting process likely benefit the species by providing protection to water quality.

The National Environmental Policy Act (NEPA) (42 U.S.C. 4371 *et seq*.) provides some protections for listed species that may be affected by activities untaken, authorized, or funded by federal agencies. Prior to the implementation of such projects with a federal nexus, NEPA requires an agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where the analysis reveals significant environmental effects, the federal agency must discuss mitigation that could offset those effects (40 C.F.R. 1502.16). Although implemented mitigation usually provides some protection for listed species, NEPA does not require that adverse impacts be mitigated, only that the impacts be assessed and the analysis disclosed to the public. In the absence of the ESA's protections, it is unclear what level of consideration and protection federal agencies would provide through the NEPA process.

State Implemented Regulatory Mechanisms

In Kansas, the Neosho madtom is listed as threatened under the Kansas Nongame and Endangered Species Act of 1975. This status gives the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) considerable authority to protect the species (K.A.R. 115-15-3). Persons undertaking or sponsoring any project involving public money, assistance from a public agency, or requiring a state or federal permit must obtain a permit from the KDWPT if their project is likely to destroy individuals of a protected species or their state designated critical habitats. These projects include roads and bridges, stream channel alterations, dams, landfills, sewer plants, power plants, airports, etc. The KDWPT can issue the permit if the project sponsor agrees to mitigate and compensate using measures to minimize the loss of animals or habitat; however, the KDWPT can refuse to issue a permit if the resource loss is determined to be unacceptable. Persons undertaking or sponsoring projects that are not funded from public sources and are not required to have a state or federal permit, such as housing developments, must obtain a permit from the KDWPT only if the action will destroy threatened or endangered species; habitat is not protected.

The Oklahoma Department of Wildlife Conservation, under state statute, prohibits the killing, possession, and harassment of state and federally listed species (OK. ST. T. 29 Sec. 5-402, 412, 412.1). The Neosho madtom is not state listed, but is protected from "take" under state law due to its federal status. Oklahoma has no legal provisions for review of state or private actions that may affect listed species' habitat.

The Missouri Department of Conservation lists the Neosho madtom as an endangered species by state statute (MO. CSR 10-4.110). This law prohibits the killing, possession, harassment, transport, and altering or destroying occupied habitat. There is no review or permit requirements concerning state or private actions that may affect a listed species or its habitat. Federal listing status provides more consistent protections than are afforded by the combination of individual state and enforcement capabilities across the species' three state range.

In Kansas, the Kansas Department of Health and Environment (KDHE) list standards for surface water quality that affords a level of protection for the Neosho madtom. The Cottonwood and Neosho Rivers are classified as "special aquatic life use waters" (waters that contain either unique habitat types and biota, or species that are listed under state statute). These streams have specific criteria for several environmental parameters (K.A.R. 28-16-28e), and further, if these criteria are determined to be underprotective, the KDHE can develop more appropriate site-specific standards. Although these standards are in place, they are often exceeded for extended periods of time until corrective measures can be implemented. Water quality standards for Missouri and Oklahoma have no provisions that recognize the special needs of state listed threatened or endangered species. Thus, the threat of impaired water quality is not currently addressed by any state regulatory mechanism in Missouri and Oklahoma; and only partially addressed in the species' Kansas range. federal listing under the ESA provides more consistent range-wide protections than state regulations.

Summary

Prior to listing, the Neosho madtom had no significant state or federal protections. Listing enabled the USFWS to provide some oversight of Federal actions potentially impacting the species, particularly through section 7 consultation and section 9 take prohibitions. Through the section 7 function, many impacts affecting the species have been lessened or avoided. These actions include several long-term and ongoing impacts (i.e., road and bridge construction, gravel mining below the waterline, bank stabilization projects). Without protections afforded by the ESA, these actions would likely occur without federal review of impacts to the species. However, the majority of habitat occupied by the Neosho madtom is under private ownership, and long-term and ongoing impacts resulting from private actions involving land-use and land-cover changes continue. Most private actions impacting the species are not included under the venue of existing federal and state regulatory mechanisms, including removal of riparian vegetation, row crop production, livestock grazing, small confined animal feeding operations, gravel mining above the waterline, and urban/suburban development. However, landowner knowledge of the species' presence and the associated take provisions of the ESA have reduced the occurrence of some detrimental actions, particularly the mining of gravel from beneath the water surface.

In summary, the current federal regulatory oversight has minimized many impacts across the range of the Neosho madtom. However, current regulatory authority has not been sufficient to prevent the species' continued, slow decline in a portion of its range. The decline has largely been limited to the lower Neosho River where threats appear more severe and habitat appears more susceptible to detrimental changes. In the absence of the ESA's protections, we believe the species' decline in the lower Neosho River would have been expedited as other regulatory mechanisms appear limited. It is also likely that the ESA's protections have benefitted the species in the remainder of its range where threats appear less immediate and severe.

2.3.2.5. Other natural or manmade factors affecting its continued existence

Drought

Drought in the prairie landscape is a natural phenomenon historically tolerated by the Neosho madtom in unaltered habitat. Drought has an increasing impact on the species as water demands increase and watershed development and land-use changes occur. These impacts have resulted in decreased connectivity and increased isolation of existing populations as surface flows decrease or cease. In its natural environment, the Neosho madtom was able to disperse to suitable, although likely less than optimal, habitat during dry periods. Presently, the numerous major and lowhead dams in the system greatly decrease this ability. Much of the species' remaining range is fragmented under ideal flow conditions, and the occurrence of drought exacerbates this threat.

Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC) (2007, p. 72) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

Since the release of the IPCC report, new evidence that our planet is experiencing significant and potentially irreversible changes has underscored reasons for concern (Smith et al. 2009 as cited by Glick et al. 2011). In the United States, we are seeing a multitude of changes consistent with a rapidly warming climate. Climate change impacts in the United States summarized by the U.S. Global Change Research Program in Global Change Impacts in the United States (Karl et al. 2009) include:

- U.S. average temperature has risen more than 2 degrees Fahrenheit over the past 50 years and is projected to rise more in the future; how much more depends primarily on the amount of heat-trapping gases emitted globally and how sensitive the climate is to those emissions.
- Precipitation has increased an average of about 5 percent over the past 50 years. Projections of future precipitation generally indicate that northern areas will become wetter, and southern areas, particularly in the West, will become drier.
- The amount of rain falling in the heaviest downpours has increased approximately 20 percent on average in the past century, and this trend is very likely to continue, with the largest increases in the wettest places.
- Many types of extreme weather events, such as heat waves and

regional droughts, have become more frequent and intense during the past 40 to 50 years.

These changes are already having a considerable impact on species and natural systems, including changes in the timing of biological events (i.e., phenological changes), such as the onset and end of breeding seasons, migration, and flowering; shifts in geographic ranges; and changes in community dynamics and populations. (Glick et al. 2011)

The ecological impacts associated with climate change do not exist in isolation, but combine with and exacerbate existing stresses on our natural systems. Vulnerability to climate change has three principle components: sensitivity, exposure, and adaptive capacity (Glick et al. 2011; Dawson et al. 2011). Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli (U.S. CCSP 2008 as cited by Glick et al. 2011). Exposure is the nature and degree to which a system is exposed to significant climate variations (IPCC 2001b as cited by Glick et al. 2011). Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC 2001 as cited by Glick et al. 2011).

If these climate change models prove accurate, the long-term impacts to the Neosho madtom could be substantial. Impacts in summer are of particular concern. Increased air temperatures will lead to higher water temperatures, especially during low-flow periods. Reduced summer precipitation and increased evaporation is likely to reduce flows. Such conditions cause increased stress to fish. The timing and amount of precipitation will also impact groundwater recharge rates. Finally, substantially hotter summers would likely increase municipal and agricultural demand for surface-water and ground-water resources. Thus, the available information indicates climate change is a substantial long-term risk factor which could meaningfully impact water quantity and the suitability of stream habitat. However, due to the lack of climate change projections and modeling specific to this region, it is too speculative to know the extent to which climate change will threaten the species. More study of this issue is recommended.

2.4. Synthesis

The Neosho madtom was listed as a threatened species in May 1990. At the time of listing three populations were known, and their status was assumed to be stable. Habitat loss for the species had been extensive due to construction of reservoirs. Known threats to the Neosho madtom include gravel bar removal, drought, chemical pollution, sedimentation, alteration of flow regimes, and interspecific competition. Knowledge of the species' reproductive ecology and population biology was lacking.

Since the Neosho madtom was listed, four generalized populations have been recognized. The population in the Neosho and Cottonwood Rivers upstream of John Redmond Reservoir appears stable, and is characterized by high numbers of individuals per unit area. This stream reach has a relatively natural hydrograph and generally moderate to high quality habitat with a low magnitude and immediacy of threat. The Neosho River population downstream of John Redmond Reservoir is generally low in abundance, and has exhibited a slow decline in numbers since monitoring began in 1991. The species in this reach is subject to rapid increases and decreases in flows due to dam releases; unnatural periods of high attenuated flows that may impact reproduction and recruitment; and has a mix of low to high quality habitat, with quality generally increasing as the stream flows south. This population has a moderate magnitude of threat of an ongoing nature. The Spring River population upstream from the confluence of Turkey Creek appears stable, but is characterized by low numbers, likely resulting from minimal amounts of suitable habitat present. Threats to species in this reach are believed low in magnitude and non-imminent. The population in the Spring River downstream of Empire Lake was not known to exist until 1994, and the species has only been captured five times in this reach. Little work has been completed in this section of river to document habitat availability and quality, and the species' distribution. However, it is likely impacted to some degree by lead and zinc contamination resulting from past mining activity.

The likely most severe impacts to the Neosho madtom since listing affect the population downstream of John Redmond Reservoir. Hydrological changes involving flow levels, timing, and periodicity likely impacts habitat quality and quantity, reproductive activity, recruitment, and the aquatic invertebrate fauna (food source). Initiation of section 7 consultation with the U.S. Army Corps of Engineers concerning dam operations and their impact to the species should occur in the near future to try to remediate some of the project's negative effects. Gravel bar removal (gravel mining) is still a threat, particularly in the Neosho and Cottonwood Rivers. However, the magnitude of threat from this activity has decreased substantially due to regulations prohibiting mining beneath the waterline. The occurrence of drought, in combination with appropriation of water rights, continues as a moderate, non-imminent threat to the species. Chemical pollution and sedimentation continue to impact the Neosho madtom and its habitat at similar levels to when listed, with most resulting from non-point source runoff from agricultural and urban activities. Interspecific competition between the Neosho madtom and other fishes, originally believed to be a threat, has been disproven by recent research.

The Neosho madtom's present status appears stable in the Neosho and Cottonwood Rivers upstream of John Redmond Reservoir; and in the Spring River upstream of the confluence with Turkey Creek (upstream population), albeit low abundance. The lower Spring River population is largely undocumented, and persists in extremely low abundance, however due to its recent discovery, not enough information exists to determine population trends and magnitude and imminence of threat. The Neosho River population downstream of John Redmond dam to the Lake O' the Cherokees in Oklahoma is experiencing a very slow decrease in abundance, likely being influenced by

John Redmond Dam operations and the presence of many lowhead dams. Overall threats to the species have remained similar, or have minimally decreased, since the time of listing. Generally, we believe the species as a whole has a low-moderate magnitude of threat, of a non-imminent basis, with the exception of the decreasing population downstream of John Redmond Reservoir whose threat is higher in magnitude and of a more imminent nature. However, due to the slow nature of the decline, and the possibility of threat reduction through future section 7 consultation with the Corps concerning John Redmond Dam operations, the Neosho madtom should remain listed as a threatened species.

Following the listing of the Neosho madtom in 1991, a strong degree of conflict arose concerning commercial gravel mining operations in relation to the species' habitat and income losses to several regional businesses. The level of conflict has been reduced in recent years due to changes in regulations. However, public water demand has also increased during this time and is forecast to increase further in the coming years, likely increasing the level of conflict (U.S. Army Corps of Engineers 2011; Kansas Division of Water Resources 2006; Kansas Water Office 2006). Due to this fact, we believe the current classification is still correct and should not be changed.

3. RESULTS

3.1. Recommended Classification:

☒ No change is needed

4. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Communicate and coordinate with the U.S. Army Corps of Engineers concerning possible detrimental impacts to the Neosho madtom by operations of John Redmond Dam; and to encourage initiation of section 7 consultation under the ESA resulting in changes in dam operations.

2. Continue to develop and fund a population genetics studies to identify possible genetic loss and differentiation of populations pertinent to a new draft recovery plan and its implementation.

3. Develop a new draft and final recovery plan for the Neosho madtom, including objective, measureable recovery criteria.

4. Continue to implement standardized annual monitoring for the species and its habitat, resulting in information to track changes in abundance, distribution, and trends.

5. Continue efforts and coordination with other agencies, municipalities, and landowners to encourage removal of lowhead dams in the species' watersheds.

6. Continue to use existing legislation and regulations (federal and state endangered species laws, water quality requirements, stream alteration regulations, etc.) to protect the species and its habitat.

7. Continue efforts to reduce non-point source pollution by working through the Partners for Fish and Wildlife Program, the Farm Bill, the Watershed Restoration and Protection Strategy (WRAPS), and other incentive programs to implement best management practices.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Neosho madtom (*Noturus placidus*)

Current Classification: Threatened rangewide

Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change needed

Review Conducted By: Kansas Ecological Services Field Office

LEAD FIELD OFFICE:

Mountain-Prairie Region (Region 6)

Signature Daniel W Mulhern Date 12/14/12
Acting **Field Supervisor, Field Ecological Services**

LEAD REGIONAL OFFICE:

Mountain-Prairie Region (Region 6)

Signature [signature] Date 3/25/13
Acting **Assistant Regional Director – Ecological Services**

COOPERATING REGIONAL OFFICE(S):

Southwest Region (Region 2)

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Acting **Assistant Regional Director – Ecological Services**

Midwest Region (Region3)

Signature Lynn M. Lewis Date 3/19/13
Assistant Regional Director – Ecological Services