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Notes and Discussion Piece: Status of the Topeka Shiner in Iowa

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Notes and Discussion Piece

Status of the Topeka Shiner in Iowa

Abstract.–The Topeka shiner *Notropis topeka* is native to Iowa, Kansas, Minnesota, Missouri, Nebraska, and South Dakota and has been federally listed as endangered since 1998. Our goals were to determine the present distribution and qualitative status of Topeka shiners throughout its current range in Iowa and characterize the extent of decline in relation to its historic distribution. We compared the current (2016–2017) distribution to distributions portrayed in three earlier time periods. In 2016–2017 Topeka shiners were found in 12 of 20 HUC10 watersheds where they occurred historically. Their status was classified as stable in 21% of the HUC10 watersheds, possibly stable in 25%, possibly recovering in 8%, at risk in 33%, and possibly extirpated in 13% of the watersheds. The increasing trend in percent decline evident in earlier time periods reversed, going from 68% in 2010–11 to 40% in the most recent surveys. Following decades of decline, the status of Topeka shiners in Iowa appears to be improving. One potential reason for the reversal in the distributional decline of Topeka shiners in Iowa is the increasing number of oxbow restorations. Until a standardized monitoring program is established for Iowa, periodic status assessments such as this will be necessary to chronicle progress toward conserving this endangered fish species.

Introduction

The Topeka shiner *Notropis topeka* is native to Iowa, Kansas, Minnesota, Missouri, Nebraska, and South Dakota (Lee *et al.*, 1980) and has been federally listed as endangered for two decades (Tabor, 1998). Since being listed interest in Topeka shiners has resulted in numerous studies of their physiology (Adams *et al.*, 2000; Koehle and Adelman, 2007), ecology and natural history (Kerns and Bonneau, 2002; Mammoliti, 2002; Stark *et al.*, 2002; Witte *et al.*, 2009; Campbell *et al.*, 2016; Mosey, 2017), genetics (Bergstrom *et al.*, 1999; Michaels, 2000; Anderson and Sarver, 2008), habitat relationships (Schrank *et al.*, 2001; Wall *et al.*, 2004; Gerken and Paukert, 2013; Bakevich *et al.*, 2013; Fischer *et al.*, 2018), and distributional status (Dahle, 2001; Blausey, 2001; Pasbrig and Lucchesi, 2012; Nagle and Larson, 2014; Bakevich *et al.*, 2015). A recent synthesis of published research and unpublished distributional data for the purposes of characterizing the Topeka shiner's range-wide biological status, referred to as a "species status assessment" or "SSA" (U.S. Fish and Wildlife Service, 2018a), was used to inform a Recovery Plan (U.S. Fish and Wildlife Service, 2018b), and proposes four future scenarios, ranging from continued decline to significant conservation gains, depending on the intensity and geographic extent of conservation actions taken.

Although the SSA identified the lack of standardized monitoring as an impediment to conservation of Topeka shiners in Iowa, increased interest in Topeka shiner conservation is evidenced by publication of several recent reports (Bybel *et al.*, 2018; 2019), peer-reviewed articles (Bakevich *et al.*, 2013; 2015; Fischer *et al.*, 2018), and accelerated habitat restoration activities (Kenney, 2013; 2014; Boone River Watershed, 2018) in Iowa. A recent status assessment (Bakevich *et al.*, 2015) documented a substantial decline in Topeka shiner distribution in Iowa and suggested a pathway toward reversing this decline could be increasing the number of off-channel habitat (oxbow) restorations. Oxbow restoration involves excavation of accumulated silt and soil from locations of former stream meanders down to the original stream bed level, allowing the restored oxbows to hold water and support aquatic life for longer periods of time than unrestored former oxbow locations (Kenney, 2013). Since the publication of Bakevich *et al.* (2015), the number of oxbow restorations in Iowa has roughly tripled (A. Kenney, U.S. Fish and Wildlife Service, pers. comm.; K. Wilke, The Nature Conservancy, pers. comm.) and an extensive survey of Topeka shiner occupancy in streams and oxbows in most of the Iowa watersheds potentially harboring Topeka shiners has been completed (Simpson, 2018). Therefore, an updated assessment of the status of Topeka shiners in Iowa is warranted. Our goals were to: (1) determine the present distribution and qualitative status of Topeka shiners throughout its current range in Iowa, (2) characterize the extent of decline in relation to its historic distribution, and (3) compare our status assessment with that of the recent SSA in Iowa (U.S. Fish and Wildlife Service, 2018a).

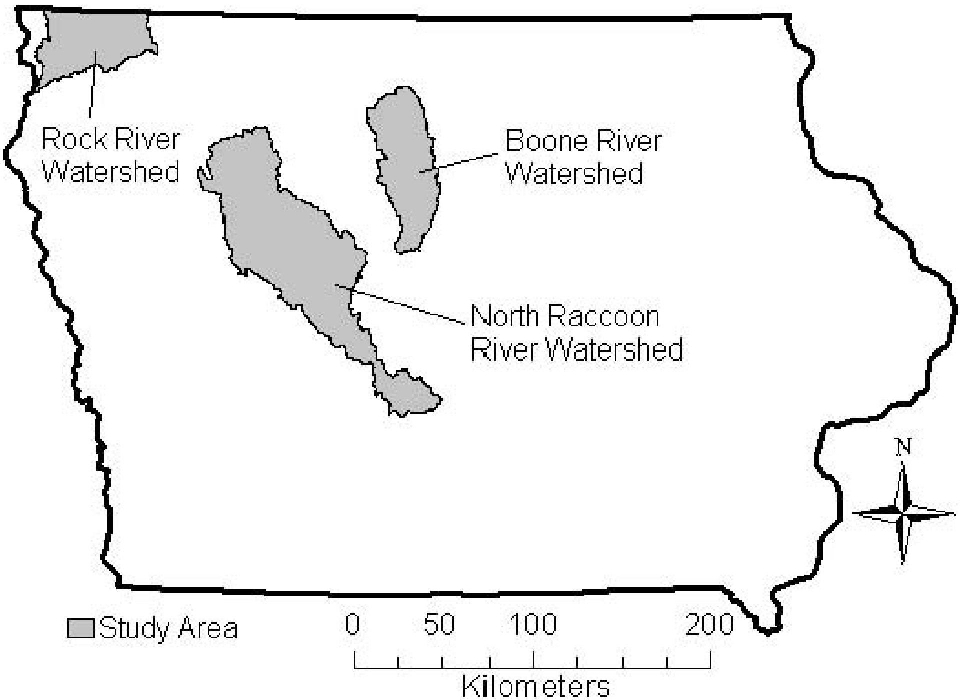

FIG. 1.—Locations of 8-digit hydrologic unit code (HUC8) study watersheds in Iowa. The smallest rectangle encompassing the three HUC8 watersheds is bounded by parallels to the north and south at 44° 8′ 17″ N and 41° 29′ 3″ N and meridians to the west and east at 96° 26′ 39″ W and 93° 37′ 55″ W, respectively

METHODS

The study encompassed the currently known extent of the Topeka shiner distribution in Iowa, which includes the Boone, North Raccoon, and Rock eight-digit hydrologic unit code (HUC8) watersheds. These watersheds are located in West-Central and Northwest Iowa (Fig. 1) and lie within the Des Moines Lobe and Northwest Iowa Loess Prairie subecoregions (Griffith *et al.*, 1994), which are characterized by level to gently rolling terrain and predominantly agricultural land use. These three watersheds are believed to be the only remnants of a larger historical Topeka shiner distribution in Iowa that included additional HUC8 watersheds in West-Central and Northwest Iowa, as well as North-Central, Central, and Southeast Iowa watersheds (Iowa Aquatic Gap Fish Atlas, 2005).

Ninety-four stream sites and 90 oxbow sites were sampled between May and October of 2016 and 2017 (Simpson, 2018). Selection of sites was nonrandom and based on stakeholder requests (Kenney, 2013; Boone River Watershed, 2018), needs of concurrent studies using the same set of samples (Bybel *et al.*, 2018; 2019), and landowner permission. Roughly two thirds of the oxbows sampled were restored (Kenney, 2013; Boone River Watershed, 2018).

Fish were sampled in streams using methods similar to the Iowa Department of Natural Resources wadeable streams procedure (Iowa Department of Natural Resources, 2015) and described in Simpson (2018). Reaches approximately 20 times the mean wetted width were sampled on one occasion with single-pass, daytime electrofishing (upstream direction) followed by a variable number of hauls with a seine (6.0 × 1.5 m, 6-mm mesh). Fish were sampled in oxbows using methods similar to those used by Bakevich *et al.* (2015) and described in Simpson (2018). Oxbows were sampled with one, two, or three hauls using bag seines (10.7m x 1.8m or 17.1m x 1.8m, 6-mm mesh), the number of hauls depending on sampling conditions and temperature. Efforts were made to minimize mortality of Topeka shiners and other fishes by holding captured fish in mesh cages in the sampled waterbody or in aerated tubs. All captured fish were identified to species, enumerated, and released alive.

Following the approach of Bakevich *et al.* (2015), the status of Topeka shiners in Iowa at the level of 10 digit hydrologic unit code watersheds (HUC10) was qualitatively determined by comparing the current (2016–2017) distribution to distributions generated by three data sets from earlier time periods: (1) a historical database including collections dating back to the 1890s using a variety of sampling methods (Loan-Wilsey *et al.*, 2005), (2) data collected nearly two decades earlier during 1997–2000 using similar sampling methods (electrofishing and seining) as in our collections (Clark, 2000; Menzel and Clark, 2002), and (3) data collected less than a decade earlier during 2010–11 (Bakevich *et al.*, 2015) using similar sampling methods. Occurrence of one or more Topeka shiners in collections from a time period in a HUC10 watershed indicated presence. Status for all HUC10 watersheds within the Boone, North Raccoon, and Rock HUC8 watersheds was qualitatively classified as stable, possibly stable, possibly recovering, at risk, or possibly extirpated. If a HUC10 watershed was occupied by Topeka shiners in all four time periods it was considered stable. If a watershed was occupied in three time periods including the most recently sampled period, it was considered possibly stable. If it was occupied during two periods including the most recent period, it was considered possibly recovering. If it was occupied during the first two time periods, but not detected during the last two periods, or was sampled in fewer than four time periods if it was not detected during the last sampling period, then it was considered to be at risk. If the HUC10 watershed was within the historic distribution of Topeka shiners, but they were not found during the last three time periods, Topeka shiners were classified as possibly extirpated. Status was considered uncertain in HUC10 watersheds sampled in fewer than all four time periods. Data were considered insufficient to classify status in HUC10s that were not sampled during the last two time periods.

Lastly, our status classifications were qualitatively compared with the status assessments for HUC10 watersheds in Iowa generated by the U.S. Fish and Wildlife Service (2018a) in their range-wide SSA. The centerpiece of the SSA is a resiliency model that ranks Topeka shiner populations in HUC10 watersheds based on consistency of presence, habitat availability/complexity, habitat condition/quality, and habitat connectivity. The ranking scale ranged from one (most resilient) to seven (least resilient). HUC10 watershed resiliency ranks from the SSA were tabulated within our status categories and presented as a box plot for visual comparison.

Results

Based on 184 individual stream and oxbow sites sampled in 2016–17, Topeka shiners were found in 12 of 20 HUC10 watersheds where they occurred historically (Table 1; Fig. 2). Topeka shiner status was classified as stable in 21% (five) of the HUC10 watersheds, possibly stable in 25% (six), possibly recovering in 8% (two), at risk in 33% (eight), and possibly extirpated in 13% (three) of the watersheds. The increasing trend in percent decline evident in earlier time periods reversed in 2016–17, going from 68% in 2010–11 to 40% in 2016–17 (Table 1).

The status of HUC10 watersheds as expressed by our classifications were in general agreement with resiliency rankings from the U.S. Fish and Wildlife Service's range-wide resiliency model analysis (Fig. 3). HUC10 watersheds we classified as either stable or possibly stable generally had the highest resiliency rankings (three to five), watersheds we classified as at risk had the lowest resiliency rankings (five to six), and watersheds we classified as possibly recovering had intermediate resiliency rankings (four to five). None of the HUC10s we classified as possibly extirpated received resiliency rankings in the SSA.

Discussion

Historically, Topeka shiners occupied areas in six states (Lee *et al.*, 1980; U.S. Fish and Wildlife Service, 2009). The Kansas Topeka shiner distribution has been the bright spot among the three southern states (Kansas, Missouri, and Nebraska), with 17 HUC10 watersheds occupied and several ranking relatively high on the resiliency scale (U.S. Fish and Wildlife Service, 2018a). In Missouri the Topeka shiner distribution declined rapidly in the last half-century and currently consists of only two

TABLE 1.—Historic, 1997–2000, 2010–2011, and 2016–2017 collections of Topeka shiners in 10-digit (HUC10) and eight-digit (HUC8) hydrologic units in Iowa. Historic data (pre-1997) are from Loan-Wilsey *et al.* (2005), 1997–2000 data are from Clark (2000) and Menzel and Clark (2002), 2010–2011 data are from Bakevich *et al.* (2015), and 2016–2017 data are from the present study. Status classification described in text. Percent decline for a time period is the proportion of the number HUC10's where Topeka shiners were not found to the total number of HUC10's in their historic range

			Topeka shiners collected[2]				
HUC10	HUC10 label[1]	HUC8	Historic	1997–2000	2010–2011	2016–2017	Status[3, 4]
Lower Boone River	g	Boone	Yes	Yes	No	No	At Risk
Middle Boone River	d	Boone	Yes	Yes	No	Yes	Possibly Stable
White Fox Creek	f	Boone	Yes	No	No	No	Possibly Extirpated
Eagle Creek	e	Boone	Yes	Yes	Yes	Yes	Stable
Otter Creek	c	Boone	Yes	No	No	Yes	Possibly Recovering
Prairie Creek	a	Boone	Yes	Yes	No	Yes	Possibly Stable
Upper Boone River	b	Boone	Yes	No	–	Yes	Possibly Recovering ?
Cedar Creek - Upper North Raccoon River	j	North Raccoon	Yes	No	No	No	Possibly Extirpated
Camp Creek	m	North Raccoon	Yes	Yes	No	No	At Risk
Buttrick Creek	s	North Raccoon	Yes	Yes	Yes	Yes	Stable
East Buttrick Creek	t	North Raccoon	Yes	Yes	Yes	Yes	Stable
Upper North Raccoon River	l	North Raccoon	Yes	Yes	No	No	At Risk
Lake Creek	n	North Raccoon	Yes	Yes	No	Yes	Possibly Stable
Purgatory Creek	o	North Raccoon	Yes	Yes	Yes	Yes	Stable
Cedar Creek - Middle North Raccoon River	p	North Raccoon	Yes	Yes	Yes	Yes	Stable
Middle North Raccoon River	q	North Raccoon	Yes	Yes	No	–	At Risk ?
Lower North Raccoon River	v	North Raccoon	Yes	Yes	No	–	At Risk ?
Hardin Creek	r	North Raccoon	Yes	Yes	Yes	–	Possibly Stable ?
Indian Creek	k	North Raccoon	Yes	Yes	No	–	At Risk ?
Little Cedar Creek	i	North Raccoon	Yes	No	–	–	—
Greenbrier Creek	u	North Raccoon	Yes	No	–	–	—
Raccoon River	x	North Raccoon	Yes	No	–	–	—
Walnut Creek	w	North Raccoon	Yes	–	–	–	—
Champepadan Creek	y	Rock	Yes	Yes	–	Yes	Possibly Stable ?
Little Rock River	cc	Rock	Yes	Yes	–	Yes	Possibly Stable ?
Otter Creek	dd	Rock	Yes	–	–	No	At Risk ?
Lower Rock River	ee	Rock	Yes	–	–	No	At Risk ?
Rock River	bb	Rock	Yes	No	–	–	—
Kanaranzi Creek	z	Rock	Yes	–	–	–	—
Mud Creek	aa	Rock	Yes	–	–	–	—
Percent Decline				35%	68%	40%	

[1] See Fig. 2 for HUC10 locations
[2] – indicates HUC10 not sampled during time period
[3] ? indicates uncertainty in status due to time period(s) not sampled
[4] — indicates status not classified due to no samples in two most recent time periods

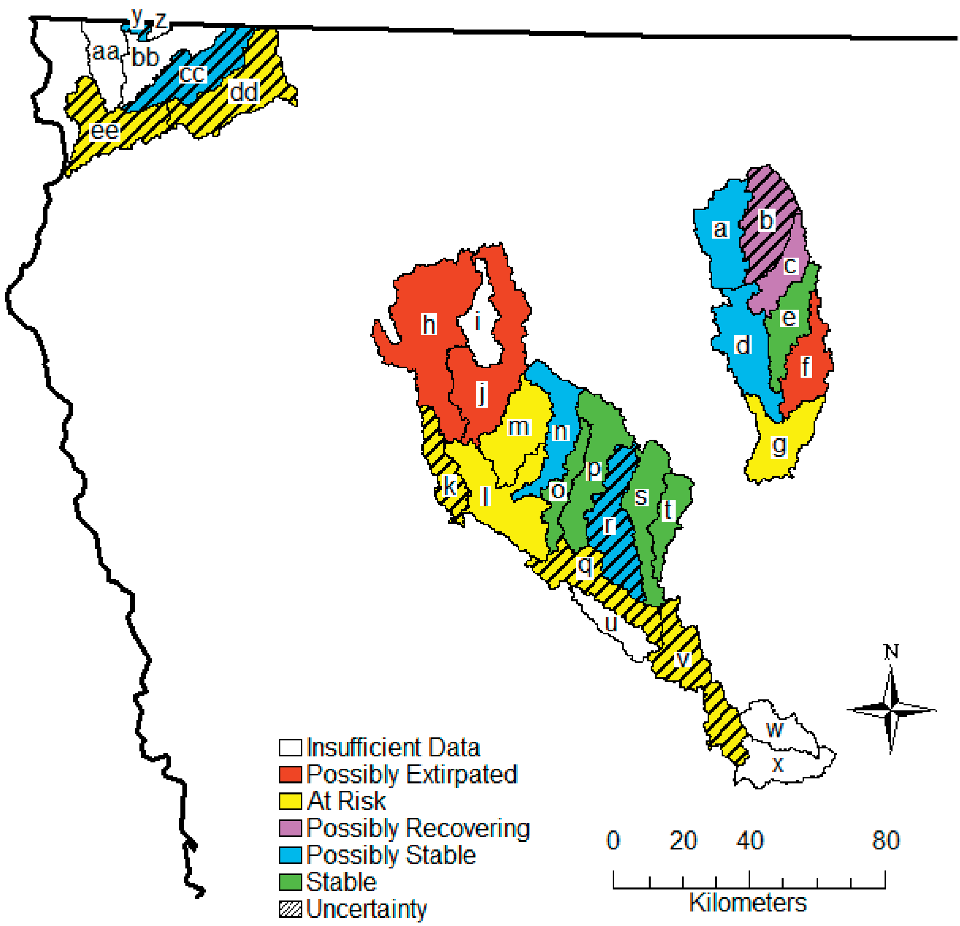

FIG. 2.—Status of Topeka shiners in HUC10 watersheds in Iowa. Status classification described in text. Lowercase letters identify HUC10 watersheds listed in Table 1

HUC10 watersheds with intermediate resiliency rankings, although re- introductions in the last 5 y have been promising (U.S. Fish and Wildlife Service, 2018b). Like Missouri, Topeka shiners in Nebraska are believed to only occur in two HUC10 watersheds presently, and there are currently no conservation actions underway in Nebraska to recover their former distribution (U.S. Fish and Wildlife Service, 2018a). Among the three northern states, South Dakota is a bright spot with records of recent Topeka shiner occurrence in 39 HUC10 watersheds, many with intermediate or high resiliency rankings (U.S. Fish and Wildlife Service, 2018a). Minnesota does not have as many occupied HUC10 watersheds (five) as South Dakota, but four of the five have high resiliency rankings (U.S. Fish and Wildlife Service, 2018a). There has also been an active oxbow restoration program in Minnesota since 2015 (Utrup, 2015) that has been successful in providing additional off-channel habitats that are frequently occupied by Topeka shiners (N. Utrup and S. Ralston, U.S. Fish and Wildlife Service, pers. comm.). In Iowa the historic range of Topeka shiners included most of Northwest, North Central, and West Central Iowa, with extensions into Central and Southeast Iowa (Iowa Aquatic Gap Fish Atlas, 2005). By the time of

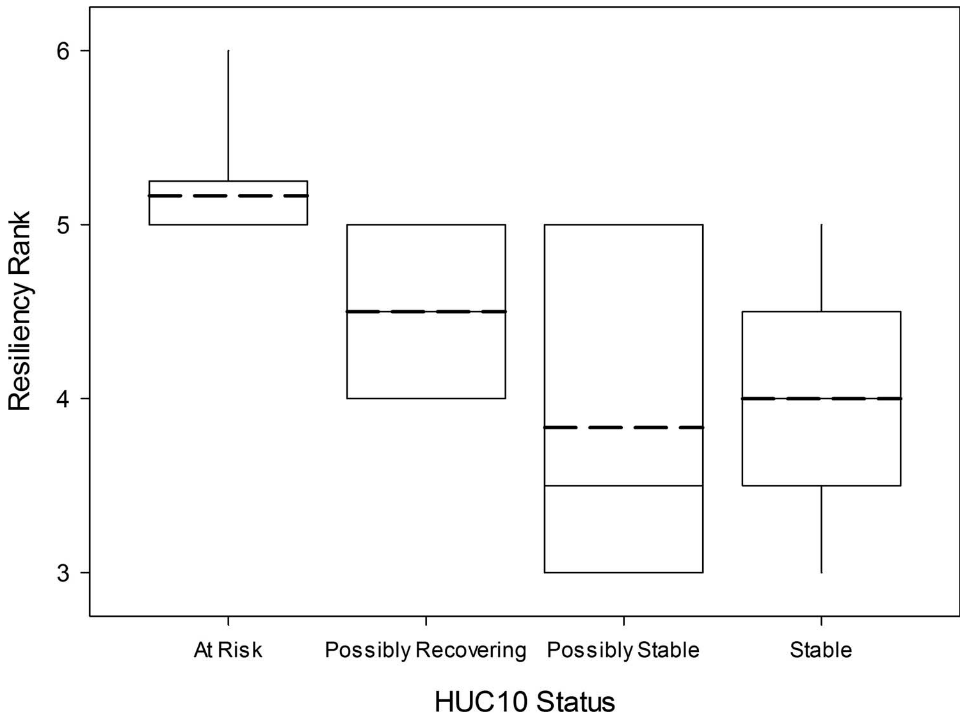

FIG. 3.—Box plot of Topeka shiner resiliency ranks of HUC10 watersheds by status classification. Resiliency ranks from U.S. Fish and Wildlife Service's Species Status Assessment for Topeka shiners (U.S. Fish and Wildlife Service, 2018a). Boxes encompass interquartile ranges, horizontal solid lines inside boxes are medians, horizontal dashed lines are means, and vertical lines denote ranges

their federal listing as endangered (Tabor, 1998) and continuing for the next decade through the previous status assessment (Bakevich *et al.*, 2015), Topeka shiners had experienced an estimated 73% decline in their distribution in Iowa.

Following decades of decline, our recent sampling suggests the status of Topeka shiners in Iowa is improving. After documented declines of 35% in 1997–2000 and 68% in 2010–11, the percentage of HUC10 watersheds where Topeka shiners were collected rebounded in 2016–2017 to a 40% reduction from their historical distribution. In addition only 27% of HUC10 watersheds were classified positively ("stable") by Bakevich *et al.* (2015), whereas over half of the HUC10 watersheds were classified positively ("stable", "possibly stable", or "possibly recovering") in the current analysis. Although their distribution is still significantly reduced from historic levels and threats to their long-term viability still clearly exist, this apparent reversal in the trend of distributional decline is reason for optimism. One potential reason for the reversal in the distributional decline of Topeka shiners in Iowa is the steadily increasing number of oxbow restorations, a process that began in 2002 and continues today (Kenney, 2013; 2014; Boone River Watershed, 2018). Between the previous time period and the most recent time period, the number of oxbow restorations roughly tripled (A. Kenney, U.S. Fish and Wildlife Service, pers. comm.; K. Wilke, The Nature Conservancy, pers. comm.). A recent study (Simpson, 2018) of Topeka shiner occupancy in oxbows documented a higher percentage of occupancy in restored (45%) versus unrestored (34%) oxbows. Many of the restored oxbows in Simpson's analysis were dry most of the time before they were restored and largely unavailable as Topeka shiner habitat before restoration. Therefore, it is plausible the continued efforts to improve and create new oxbow habitat for Topeka shiners in Iowa are now playing a role in reversing their long-term distributional decline. This conclusion supports the SSA's independent recommendation for creation of more restored oxbows in the northern portions of the species' range (U.S. Fish and Wildlife Service, 2018a).

Despite incorporating a broader range of components (the SSA resiliency model included habitat inputs), the SSA resiliency rankings for HUC10 watersheds were in rough agreement with our status classifications – watersheds that received higher resiliency rankings tended to be classified more favorably by our status assessment, and vice versa. The majority of resiliency rankings fell in the intermediate range of the one through seven scale, as were the majority of our status classifications intermediate (possibly stable, possibly recovering, at risk). The rough agreement between these two assessments bolsters the notion that, while still greatly reduced from their original distribution, the status of Topeka shiners in Iowa is improving. Furthermore, improvements in the last decade appear to be coincident with the steady increase in restored oxbows, which other research has implicated as beneficial to Topeka shiners. In the four future scenarios proposed in the SSA (U.S. Fish and Wildlife Service, 2018a) as encompassing the range of possible future conservation outcomes, maintaining the current level of oxbow restoration activity is considered necessary for maintaining the status quo, whereas accelerating oxbow restorations in addition to other activities is considered necessary for improving status.

Until a standardized monitoring program is established for Iowa (another recommendation of the SSA), periodic status assessments such as this will be necessary to chronicle progress toward conserving one of our endangered fish species. Because Topeka shiner detection probability is high (>90%) for the types of sampling methods used in the studies we qualitatively analyzed (Fischer *et al.*, 2018), we are confident in our overall conclusions. However, a future standardized monitoring program, as recommended by the SSA, would benefit from a rigorous occupancy analysis that would take into account the potential influence of sample size and perhaps other factors, such as habitat type and sampling gear/effort in individual collections.

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