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Note and Discussion Piece

Status of the Topeka Shiner in West-Central Iowa

ABSTRACT.—The Topeka shiner *Notropis topeka* is a federally endangered fish species that is estimated to occupy only 20% of its historic range. In Iowa Topeka shiners have been in decline for decades. Our goal was to determine the present distribution of Topeka shiners in the west-central portion of their range in Iowa and to characterize the extent of its decline. We compared the current distribution to distributions generated from earlier collections. We found Topeka shiners in six of 22 watersheds where they occurred historically. Status of Topeka shiners was judged to be stable in 27% of the watersheds, at risk in 45% of the watersheds, and possibly extirpated in 27% of the watersheds. None were classified as increasing. Based on comparison of the historical distribution with more recent ones, Topeka shiners in west-central Iowa showed a 27% decline a decade ago and currently exhibits a 73% decline in their distribution. The collective evidence from four of five other states in the species' range reveals similar declines. This study provides further information on the local distribution and extent of decline for this federally endangered species with a greatly reduced and fragmented overall distribution.

INTRODUCTION

The Topeka shiner *Notropis topeka* is a federally endangered fish species (Tabor, 1998; Wall and Berry, 2004) native to portions of six states in the Midwest and Great Plains regions - Minnesota, Iowa, Missouri, South Dakota, Nebraska and Kansas (Lee *et al.*, 1980). At the time of listing, Topeka shiners were believed to have been reduced to roughly 20% of their historic range due to negative impacts of a variety of land use, habitat, and biotic factors (Tabor, 1998). Since the time of listing, studies in the six states have increased knowledge of Topeka shiner distribution, habitat preferences, and environmental relationships, but significant concerns remain for the long-term conservation of the species (USFWS, 2009). Topeka shiners are nearly always found in very low abundance (Lee *et al.*, 1980; Loan-Wilsey *et al.*, 2005; USFWS, 2009), although infrequent large collections (in the 100s) have been reported in South Dakota (USFWS, 2009), Minnesota (Ceas and Larson, 2010), and Iowa (Bakevich, 2012; A. Kenney, USFWS, pers comm.). These rare large populations are usually found in off-channel habitats (OCH) such as oxbows or other standing bodies of water near streams, although a few large in-stream collections have been observed in South Dakota (Paukert *et al.*, 2007) and Minnesota (Ceas and Larson, 2010).

In Iowa Topeka shiners have been in decline for decades (Meek, 1892; Menzel, 1987). By the 1990s the Topeka shiner distribution in Iowa was limited mainly to the Boone and North Raccoon watersheds in west-central Iowa and a few locations in far northwest Iowa (Clark, 2000). Populations formerly known to occur in the Des Moines and Iowa River watersheds in west-central Iowa were apparently extirpated by the 1990s (Clark, 2000). A statewide survey of fish assemblages in wadeable streams based on randomly selected locations revealed 82 species but no Topeka shiners (Rowe *et al.*, 2009a). Our goal was to determine the present distribution of Topeka shiners in the west-central portion of its range in Iowa and to characterize the extent of its decline.

METHODS

The study area was confined to the North Raccoon, Boone, middle Des Moines, and upper Iowa 8-digit hydrologic unit code (HUC8) watersheds located in the Des Moines Lobe subecoregion (Griffith *et al.*, 1994) of west-central Iowa (42°13′48.0″N 94°27′00.0″W) (Fig. 1). This landscape is characterized by gently rolling terrain and is dominated by row crop agriculture. Although Topeka shiners historically occurred in all of these watersheds (IAGFA, 2005), surveys from over a decade ago indicated that significant populations only remain in the North Raccoon and Boone River watersheds (Clark, 2000). These two basins contain the only known Topeka shiner population in west-central Iowa.

Based on prior knowledge of Topeka shiner habitat use, we chose to sample both stream and OCH sites. Stream sites were typical of west-central Iowa with low gradients and riparian areas of grasses, row crops, or pasture. Many streams were channelized and had low habitat complexity. OCH sites were

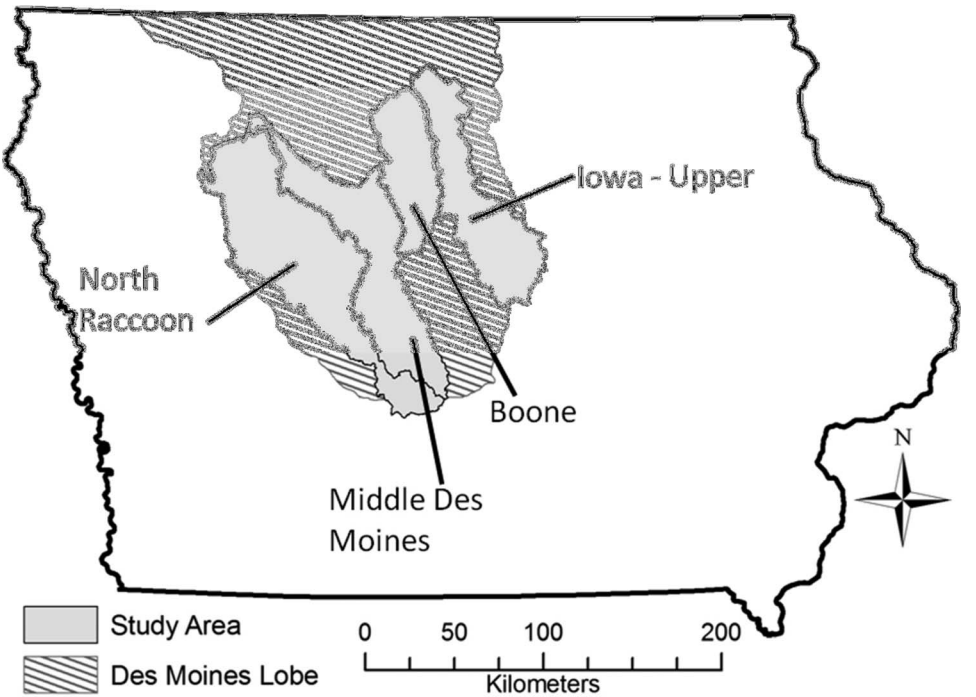

FIG. 1.—Locations of 8-digit hydrologic unit code (HUC8) study watersheds in the Des Moines Lobe subecoregion of west-central Iowa

pond-like bodies of water within the stream floodplain that remained disconnected from the stream channel during base flow conditions. OCH were characterized by silt substrate, aquatic macrophytes, and moderate turbidity. Several OCH sites were used to store water for livestock resulting in trampled areas within and around the site. Many of the sites were unrestored OCH, but several OCH restored by the U.S. Fish and Wildlife Service (Kenney, 2013) occurred in the study area and were sampled. Because stream and OCH sites differed physically, they were sampled using different protocols.

Because Topeka shiners are rare in Iowa, sample sites that had an increased likelihood of their occurrence were chosen for this study. We used three criteria to select sample sites. First, we selected sites where Topeka shiners were predicted to occur based on two occurrence models. One model was developed by Clark (2000) and Menzel and Clark (2002) and the other was the Iowa Aquatic GAP model (IAGFA, 2005; Loan-Wilsey *et al.*, 2005). Both models used landscape-scale variables (*e.g.*, land cover type, stream gradient) to predict Topeka shiner occurrence. Second, we selected stream sites where Topeka shiners had been previously documented (IAGFA, 2005; Loan-Wilsey *et al.*, 2005). Third, we selected OCH sites that could be identified from aerial photographs taken during 2009 and 2010.

Stream sites were sampled once during the study. Sampling was conducted in May through August 2010 and 2011, following standard Iowa Department of Natural Resources protocols for wadeable streams (IDNR, 2001) but with some modifications to increase the likelihood of Topeka shiner detection. Each stream site was at least 100 m in length and did not exceed 400 m. First, the site was sampled by upstream single-pass pulsed-DC electrofishing, applying sufficient power to immobilize small-bodied fishes. For small streams a battery-powered backpack LR-20 electrofishing unit (Smith Root Inc., Vancouver, Washington, U.S.A.) was used. For larger streams a generator-powered barge-mounted VVP-15B electrofishing unit (Smith-Root Inc., Vancouver, Washington, U.S.A.) was used. After

the site was sampled with electrofishing, the wetted width of the site was sampled with a bag seine (6.0 × 1.5 m, 6-mm mesh). All fish were identified to species, enumerated, and released alive.

OCH sites were sampled once during the study. Sampling was conducted in May through August, 2010 and 2011, using a single haul with a bag seine (6.0 × 1.5m, 6-mm mesh) only. Standard sampling protocols are not available for these habitats, but our methods were similar to those of other studies of fish in small OCH (*e.g.,* Thomson and Berry, 2009). All fish were identified to species, enumerated, and released alive.

To determine the status of Topeka shiners in central Iowa we compared the current distribution to distributions generated by two data sets from earlier collections: (1) a historical database including collections dating back to the 1890s using a variety of sampling methods (Loan-Wilsey *et al.*, 2005), and (2) data collected roughly a decade earlier during 1997–2000 using similar sampling methods (electrofishing and seining) as in our collections (Clark, 2000; Menzel and Clark, 2002). Topeka shiner status for all HUC10 watersheds within its historic range in west-central Iowa (as indicated by presence in the historic database) was classified as increasing, stable, at risk, or possibly extirpated. If the watershed was not occupied by Topeka shiners during 1997–2000 but they were found during 2010–2011, it was considered increasing. If the watershed was occupied by Topeka shiners during 1997–2000 and during 2010–2011, it was considered stable. If it was occupied by Topeka shiners from1997–2000, but they were not found from 2010–2011, it was considered to be at risk. Lastly, if the HUC10 watershed was within the historic distribution of Topeka shiners but they were not found from 1997–2011, it was determined Topeka shiners were possibly extirpated. Another study (Bakevich *et al.*, 2013) focusing on habitat and biotic relationships with Topeka shiner presence in west-central Iowa was conducted simultaneously with the present study.

RESULTS

Ninety four sites, representing 67 stream and 27 OCH sites, were sampled in 2010 and 2011 (Fig. 2B). Topeka shiners were collected in 52% (14) of the OCH sites but only 9% (6) of the stream sites.

Topeka shiners were found in six out of 22 HUC10 watersheds where they occurred historically (Table 1). East Buttrick, West Buttrick, Hardin, Cedar, and Purgatory creeks and associated OCH sites in the North Raccoon River watershed, and Eagle Creek and associated OCH sites in the Boone River watershed included at least one site where Topeka shiners were collected. Status of Topeka shiners was judged to be stable in 27% (6) of the HUC10 watersheds, at risk in 45% (10) of the watersheds, and possibly extirpated in 27% (6) of the watersheds. None was classified as increasing. Four of the HUC10 watersheds classified as stable - Purgatory, Hardin, West Buttrick and Eagle creeks - showed evidence of reproduction in the form of young-of-year Topeka shiners. Based on reductions in the number of HUC10 watersheds in which Topeka shiners were found in the 1997–2000 and 2010–2011 studies, it is estimated that shiners experienced a 27% decline in their distribution a decade ago and currently endured a decline of 73% relative to their historical distribution in west-central Iowa (Table 1). The spatial difference in Topeka shiner collections between 1997–2000 and our study in 2010–2011 illustrates where the decline has occurred in the last decade (Fig. 2).

DISCUSSION

The historic range of Topeka shiners occupied portions of six states in the Midwest and Great Plains regions - Minnesota, Iowa, Missouri, South Dakota, Nebraska and Kansas (Lee *et al.*, 1980). Range-wide, Topeka shiners are estimated to occupy only 20% of their historic range, leading to their listing as a federally endangered species in 1999 (Tabor, 1998). Nebraska and Missouri have very small distributions of Topeka shiners remaining (USFWS, 2009). Nebraska's remaining distribution is limited to two widely separated locations and is estimated to consist of as few as 200 individuals (Panella, 2012). Missouri once had a sizeable Topeka shiner range in the central part of the state with smaller distributions in northwest and north-central Missouri (Pflieger, 1997) but only small remnants of two of these historic ranges remain (USFWS, 2009) and re- introductions are now underway to repopulate some of the extirpated locations (Parham and McKenzie, 2013). Kansas formerly had populations of Topeka shiners occurring over a large portion of the state, but most of these are presumed extirpated and the current distribution is limited to a few locations in the Flint Hills of eastern Kansas (USFWS,

2009). Topeka shiners were once distributed over much of eastern South Dakota and the species can still be found throughout much of its historic South Dakota range (USFWS, 2009). Recent surveys indicate a much larger distribution of Topeka shiners in South Dakota than was known at the time of listing (Wall and Thomson, 2007). Thousands of OCH, referred to in South Dakota as "dugouts" and used for watering cattle, have been found to frequently harbor Topeka shiners and are believed to be an important habitat and perhaps partially responsible for the species' apparent resilience in South Dakota (Thomson and Berry, 2009). Topeka shiners also currently occupy a sizeable portion of their historic range in southwestern Minnesota (USFWS, 2009), and although their distribution was considered stable in Minnesota following federal listing (Dahle, 2001; Hatch, 2001), a recent study suggests Minnesota populations have declined in the last decade (Nagle, 2014). OCH are important Topeka shiner habitats in Minnesota (Dahle, 2001; Ceas and Larson, 2010).

The historic range of Topeka shiners in Iowa covered much of the state (IAGFA, 2005; USFWS, 2009) with concentrations in the Des Moines, Boone, Iowa, Rock, and especially the North Raccoon watershed (Harlan *et al.*, 1987; IAGFA, 2005). Historic portions of the Iowa range outside of these watersheds were represented by only a few collections and are believed to have been very sparse originally and currently all are presumed extirpated (Clark, 2000). By the 1990s Topeka shiner collections in Iowa were limited primarily to the Boone, Rock, and North Raccoon watersheds (Clark, 2000) and as shown in our study, a decade later the remaining center of the state's distribution in west-central Iowa has experienced a 73% decline. A statewide survey of fish assemblages in wadeable streams based on randomly selected locations revealed 82 species but no Topeka shiners (Rowe *et al.*, 2009a). Currently, the only places in Iowa known to support Topeka shiners are a few locations in the Rock (M. Hawkins, Iowa Dept. Natural Resources, pers. comm.) and Boone watersheds and a larger number of sites in the North Raccoon watershed. Topeka shiner populations in nearly three quarters of the HUC10 watersheds examined in this study were judged to be either possibly extirpated or at risk of extirpation.

A trend evident in the documented declines of Topeka shiner distributions in several states is the eventual loss of isolated populations. Significant contraction of the original ranges through loss of small, isolated, outlying populations has occurred not only in Iowa but also in Missouri, Kansas, and Nebraska (Lee *et al.*, 1980; Harlan *et al.*, 1987; USFWS, 2009). Loss of these small, isolated populations is a reminder of the vulnerability of such populations to extirpation (Meffe, 1986; Frankham, 1996; Hallerman, 2003). The steepness of the probability of extirpation relationships with population size below 1000 individuals in Hallerman (2003, Fig. 18.1) illustrates the peril facing these populations and does not bode well for their long term persistence. In addition to the documented negative effects of widespread land use and habitat changes, fish kills resulting from various types of pollution represent another significant threat to a species found only in a few small isolated locations. From 1995 to 2011, 202 major fish kills (>1000 fish each) occurred in streams throughout Iowa (IDNR, 2012). So far there is no evidence a fish kill has been responsible for extirpating a Topeka shiner population, but the potential threat is certainly real.

Like in South Dakota, OCH have been shown to be important Topeka shiner habitats in west-central Iowa (Clark, 2000; Bakevich *et al.*, 2013) and an ambitious program is underway in Iowa to restore degraded oxbow OCH near streams that historically or currently support Topeka shiners (Kenney, 2013). Early accounts of preferred stream habitats describe still or slow moving, clear, vegetated areas of streams with sandy or gravelly substrates (Pflieger, 1997; Harlan *et al.*, 1987). This combination of characteristics is rare in Iowa streams following more than a century of profound changes to the land cover and hydrology of Iowa (Bishop, 1981; Smith, 1981; Bogue, 1994; Rowe *et al.* 2009a, b). Oxbow OCH may be a surrogate for what was once a far more common habitat in Iowa stream systems, and as such, restoration and even creation of oxbows may now represent the best strategy for Topeka shiner recovery.

Like all field studies, ours has shortcomings that are worthy of note and are reminders that conclusions should be viewed with caution. First, our knowledge of the ecology and original distribution of Topeka shiners is limited by the simple fact that they are seldom encountered in routine surveys given they are a rare species (*e.g.*, Rowe *et al.*, 2009a). Although recent research (Wall *et al.*, 2004; Witte *et al.*, 2009; Koehle and Adelman, 2007; Bakevich *et al.*, 2013; Gerken and Paukert, 2013) has begun to fill the gaps, a better understanding of Topeka shiner ecological and physiological needs in relation to current

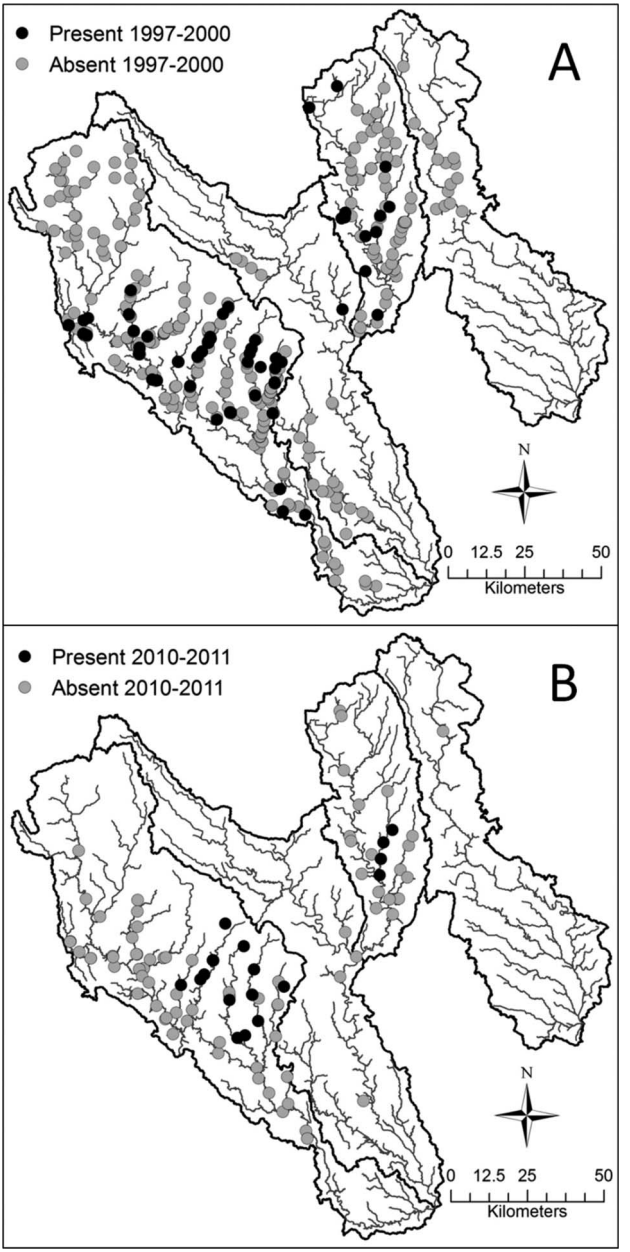

FIG. 2.—Presence and absence of Topeka shiners from collections in 1997–2000 (**A**) and 2010–2011 (**B**) in west-central Iowa. 1997–2000 data are from Clark (2000) and Menzel and Clark (2002)

TABLE 1.—Historic, 1997–2000, and 2010–2011 collections of Topeka shiners in 10-digit (HUC10) and 8-digit (HUC8) hydrologic units in west-central Iowa. Historic data (pre-1997) are from Loan-Wilsey *et al.* (2005), 1997–2000 data are from Clark (2000) and Menzel and Clark (2002), and 2010–2011 data are from the present study. Topeka shiner status for each HUC10 was determined to be stable (detected during 1997–2000 and during 2010–2011), at risk (detected during 1997–2000 and not detected during 2010–2011), or possibly extirpated (not detected during 1997–2000 or during 2010–2011). 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

HUC10[1]	HUC8	Topeka Shiners Collected			Status
		Historic	1997–2000	2010–2011	
Headwaters	North Raccoon	Yes	No	No	Possibly Extirpated
Cedar Cr. – Upper N. Rac.	North Raccoon	Yes	No	No	Possibly Extirpated
Camp Creek	North Raccoon	Yes	Yes	No	At Risk
Indian Creek	North Raccoon	Yes	Yes	No	At Risk
Upper North Raccoon R.	North Raccoon	Yes	Yes	No	At Risk
Lake Creek	North Raccoon	Yes	Yes	No	At Risk
Purgatory Creek	North Raccoon	Yes	Yes	Yes[2]	Stable
Cedar Cr. - Middle N. Rac.	North Raccoon	Yes	Yes	Yes	Stable
Middle North Raccoon R.	North Raccoon	Yes	Yes	No	At Risk
Hardin Creek	North Raccoon	Yes	Yes	Yes[2]	Stable
West Buttrick Creek	North Raccoon	Yes	Yes	Yes[2]	Stable
East Buttrick Creek	North Raccoon	Yes	Yes	Yes	Stable
Lower North Raccoon R.	North Raccoon	Yes	Yes	No	At Risk
Lower Boone River	Boone	Yes	Yes	No	At Risk
Middle Boone River	Boone	Yes	Yes	No	At Risk
White Fox Creek	Boone	Yes	No	No	Possibly Extirpated
Eagle Creek	Boone	Yes	Yes	Yes[2]	Stable
Otter Creek	Boone	Yes	No	No	Possibly Extirpated
Prairie Creek	Boone	Yes	Yes	No	At Risk
Bluff Creek	Middle Des Moines	Yes	No	No	Possibly Extirpated
Brushy Creek	Middle Des Moines	Yes	Yes	No	At Risk
East Branch Iowa River	Upper – Iowa	Yes	No	No	Possibly Extirpated
Percent Decline			27%	73%	

[1] Abbreviations: Cr.=Creek, N.=North, Rac.=Raccoon, R.=River.

[2] Evidence of reproduction noted during sampling – presence of young-of-year Topeka shiners.

and future habitats and their attendant biological assemblages would shed light on whether our results and the current overall state of understanding about Topeka shiner distributional status are accurate. Finally, future studies incorporating repeated site sampling visits which would enable estimation of detection probability would heighten confidence in occupancy assessments and temporal comparisons from which status assessments like the one presented here are obtained.

The current distribution of Topeka shiners in west-central Iowa is significantly reduced from what it was just a decade ago and sharply reduced from its historic distribution. The collective evidence from four of the other five states in the species' range reveals similar declines. Quantitative studies of landscape, habitat, and biotic community characteristics associated with Topeka shiner presence are beginning to reveal desirable stream and OCH characteristics for the persistence of remaining populations and to guide restoration of sites which may be able to support Topeka shiners in the future (Clark, 2000; Shrank *et al.*, 2001; Winston, 2002; Menzel and Clark, 2002; Wall *et al.*, 2004; Bakevich *et al.*, 2013; Gerken and Paukert, 2013). Actively restoring and creating new OCH sites has had success in South Dakota (USDA, 2010) and Iowa (Kenney, 2013). Re- introduction of Topeka shiners into formerly occupied portions of its range, as is currently underway in Missouri (Parham and McKenzie, 2013), may also play an important role in the recovery of this federally endangered species.

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