Topeka Shiner Monitoring in Minnesota: 2018

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TABLE OF CONTENTS

ABSTRACT

In response to a range-wide decline in abundance and distribution, the Topeka shiner (*Notropis topeka*) was designated as a federally endangered species in 1999. In 2004, the Minnesota Department of Natural Resources (MN DNR) began a presence/absence survey effort to monitor Minnesota populations of Topeka shiners at randomly selected sites within the federally designated critical habitat for the species. Averaged over the first fourteen years of monitoring from 2004-2017, Topeka shiners were present at 66.5% of randomly selected reaches of streams. During 2018, Topeka shiners were found at 70% of randomly selected one-mile segments. Results from 2018 and the previous three years may be indicative of Topeka shiner populations beginning to stabilize after the stark declines observed during 2012-2014.

INTRODUCTION

The Topeka shiner (*Notropis topeka*) was historically widespread and abundant in low order streams (1st through 3rd order) throughout the central plains region of the United States. Since the early 1970's, the species has exhibited significant declines across much of its range and is estimated to occur in only 10-15 percent of its historic geographic distribution (Tabor 2002). Habitat loss, predominately the mass conversion of tallgrass prairie for agricultural purposes, has been implicated as the primary driver in the rapid decline of Topeka Shiners across their range (Cross 1967; Eddy and Underhill 1974; Gelwicks and Bruenderman 1996; Berg et al. 2004). This conversion of tallgrass prairie with meandering stream channels connected to their floodplain to an agricultural landscape of ditched and straightened stream channels has led to a decrease in base flows, disruption of floodplain connectivity, elevated sedimentation, increased turbidity, higher water temperatures, and loss of aquatic vegetation; all of which are factors contributing to the degradation and loss of the Topeka shiner's preferred habitat (Tabor 1993). In response to the rapid and dramatic decline in abundance and distribution, the U.S. Fish and Wildlife Service designated the species as endangered under the Endangered Species Act of 1973 (Tabor 1998).

Surveys conducted during the late 1990s indicated that Minnesota harbored viable populations of Topeka shiners throughout its distribution in the state, and that compared with previous survey efforts in the 1970s and 80s, these populations appeared to be stable (Dahle 2001; Hatch 2001). These findings were in stark contrast to survey efforts in other portions of the Topeka shiner's historic range, where they were sampled at only 17% of historic localities in Kansas (Tabor 1998) and 15% of historic localities in Missouri (Gelwicks and Brunderman 1996). This discrepancy between presence/absence at historic sites in Minnesota versus the other 4 regions within the species' range led Dahle (2001) to conclude that "Minnesota populations may represent the largest and most stable population remaining in the species' range." In 2004, the Minnesota Department of Natural Resources began an effort to monitor populations of Topeka shiners within the state. A protocol was established (Ceas and Anderson 2004) to conduct a presence/absence survey of Topeka shiners at twenty randomly selected reaches (one-mile) of stream from within the federally-designated critical habitat in the Big Sioux and Rock River drainages in southwestern MN. Surveys were conducted annually from 2004 to 2010 and Topeka shiners were found at an average of 76.4% of sites over the seven year period (Ceas and Anderson 2004; Ceas and Monstad 2005, 2006; Ceas and Plain 2007; Ceas and Larson 2008, 2009, 2010). However, this percentage began to decline in 2010 (60%; Ceas and Larson) and declined further during 2012-2014 (40%, 30% and 45% respectively; Nagle and Larson 2012, 2013, 2014). Cunningham saw marked increases in sites where Topeka shiners were present during 2015, 2016 and 2017 (65%, 90% and 60% respectively; Cunningham 2015, 2016, 2017).

Although the annual percentage of sites where Topeka shiners were present was relatively stable for the first six years of monitoring (Figure 1), surveyors began to note a marked decline in relative abundance of the species (Ceas and Larson 2009, 2010). This percentage of sites where Topeka shiners were present was drastically more volatile over the next seven years (2011-2017), but the observed relative abundance of the species continued to decline. Results from monitoring surveys conducted in 2018 are detailed in this report and are consistent with a probable decline in the prevalence of Topeka shiners in Minnesota since the early 2000's.

METHODS

Methods for 2018 Topeka shiner monitoring follow Ceas and Anderson (2004) and are reproduced below with updated information.

Selection of Stream Segments

For each year of Topeka shiner monitoring, 20 one-mile reaches of stream were selected at random from the federally designated Topeka shiner critical habitat within Minnesota, employing an ArcView extension program developed by MN DNR (Appendix A, Map 21).

Landowner Contact

Given that a large percentage of the randomly-selected stream segments occur on privately-owned lands, permission was obtained from landowners to access those reaches of stream. Contact information for landowners was provided to the DNR by the County Auditor's offices of Pipestone and Nobles counties. Landowner contact information for Rock County was accessed online at http://rock.houstoneng.com. Additional online resources were also used for obtaining landowner information (White Pages, Nuwber, etc.). All landowners received a letter in the mail requesting access to their property to conduct aquatic surveys in March 2018. Each landowner received a follow up telephone call during April 2018. If landowners were not reached in some form, then we attempted to reach them at their primary residence the week of the surveys (May 21st-24th, 2018). When possible, stream segments were accessed at public right-of-ways at bridge crossings.

Selection and Reconnaissance of Sampling Sites

Based on habitat preferences characterized in the literature (Minckley and Cross 1959; Bailey and Allum 1962; Pflieger 1997; Berg et al. 2004; Eddy and Underhill 1974; Dahle 2001; Hatch 2001), sample sites were identified within each randomly-selected reach of stream using aerial photography viewed in ArcGIS ver 10.4.1. For each sample segment, a brief reconnaissance was conducted to prioritize sampling at potential Topeka shiner habitat. Basic habitat descriptions and locality information for each of the twenty stream segments sampled in 2018 are presented in Table 1 of Appendix B. Lists of fish species captured along each of the sample segments are presented in Table 2.

Fish Sampling

Presence/absence surveys were conducted for Topeka shiners using 10' x 5' x 1/8" pole seines from May 21st to 24th, 2018. Sampling efforts were focused on low-flow areas along the main channel boundary (MCB), backwaters, and off-channel ponds and oxbows. Seines were dragged along unobstructed reaches of substrate, and set-kicks were performed in vegetation or undercut banks. Due to substantial habitat and stream character heterogeneity across randomly selected sample segments, sampling efforts were not standardized between segments. Stream segments were sampled until either Topeka shiners were captured, or all suitable Topeka shiner habitat within the segment had been sampled. In the absence of Topeka shiners or suitable habitat, a minimum of ten sites were sampled within each segment.

The monitoring effort focuses on presence/absence of Topeka shiners, and no methodologies were employed to quantify population size or numbers of individuals within the sample reaches. However, within segments where Topeka shiners were sampled, a qualitative assessment of relative abundance was made based on the professional judgment of the surveyor (Ceas and Larson 2010). While these assessments are inherently subjective by nature, they are intended to provide a coarse characterization of Topeka shiner relative abundance at sites where they are present. Sites where Topeka shiners were sampled were categorized as either 'abundant' (Topeka shiner is most numerous species present, or >10 individuals collected in the initial seine haul at capture site), 'common' (Topeka shiner individuals appear in low numbers relative to other species, or 5-10 individuals captured in the initial seine haul), or 'present'(<5 individuals captured after substantial sampling effort).

RESULTS

2018 Monitoring Surveys

Topeka shiners were collected at 14 of the 20 one-mile stream segments: 261, 264, 265, 266, 267, 268, 269, 270, 271, 273, 274, 275, 279, and 280 (Appendix A, Map 22). See Figure 1 for yearly totals of segments with Topeka shiners from 2004-2018. In all 2018 instances, Topeka shiners were captured in areas of low flow, pool, or backwater habitat; no individuals were captured in free-flowing reaches of stream. Segments 264, 265, 270, 271, 273, 274, 275, and 285 were reaches of stream where Topeka shiners were captured at the first sample site. Habitat and voucher photographs for 2018 stream segments are presented in Appendix C.

Based on Ceas and Larson's abundance criteria, Topeka shiner abundance was slightly lower in 2018 than observed in 2017, but higher than the prior five years of surveys (2012-2016). Of the sites where Topeka shiners were captured, four yielded Topeka shiners in abundant numbers (estimated >50). This is an estimation because high ambient temperature forced us to release all remaining fish in these seine hauls after confirming Topeka Shiner presence to avoid any mortality. Topeka shiners were common or present at the remaining 11 sites where the species was found (n < 8 per segment, 2 sites = common, 9 sites = present). Segment 269 yielded four individuals on the 10 sampling effort at that site, going against the strong pattern seen over the years of rarely capturing Topeka shiners after sampling the first few 'good' sites within a segment. However, this does confirm the need for the minimum of 10 sampling sites per segment.

Nine sample segments contained off-channel pool habitat (segments 261, 262, 264, 266, 267, 269, 274, 279, and 280). Topeka Shiners were found in seven of these segments, but only found in the off-channel pools in four of them. The off-channel ponds along segment 269 (Rock River) appeared to have limited connectivity with the stream and only fathead minnows (*Pimephales promelas*) and brook stickleback (*Culaea inconstans*) were captured in these ponds. The artificial pond along the degraded reach of segment 262 (East Branch Flandreau Creek) contained only Iowa darters (E*theostoma exile*), johnny darters (*Etheostoma nigrum*), green sunfish (*Lepomis cyanellus*), and orangespotted sunfish (*Lepomis humilis*). It appeared that this pond had minimal connectivity even during high water events. A

complete list of 2018 segments, corresponding samplings sites, number of Topeka shiners captured, and brief habitat descriptions are presented in Table 1.

A total of 27 fish species were collected during the 2018 surveys. Plains topminnow (*Fundulus sciadicus*), a Threatened species in MN, were collected in five segments (267, 268, 269, 273, and 275). A complete list of fish species collected in each segment is presented in Table 2.

DISCUSSION

Monitoring surveys conducted in 2018 found Topeka shiners at 70% of the randomly selected segments (Figure 1). The 2018 results follow the pattern of increased occupancy observed by Cunningham during 2015-2017, and relative abundance was higher for the second consecutive year compared to the low abundance observed during 2012-2016 (Figure 2).

2018 Absence localities

The following section describes segments of streams that did not contain Topeka Shiners in 2018, but exhibited suitable habitat and/or contained historic records of the species. Refer to Table 1 for brief habitat descriptions and coordinates of sample sites within each segment. Refer to Appendix C for habitat photographs representative of the habitat along the one-mile segments.

Segment 262 (East Branch Flandreau Creek) exhibited suitable Topeka shiner habitat in the pools on both the upstream and downstream sides of the gravel road culvert on the eastern end of the segment. The excavated off channel pond offered suitable no flow habitat as well. Overall, this headwater stream's eroded banks and incised channel offered minimal potential Topeka shiner habitat. A segment just east on the East Branch Flandreau Creek was sampled in 2012; no Topeka shiners were present.

Segment 263 (North Branch Pipestone Creek) exhibited suitable Topeka shiner habitat in the pools just downstream of the road culvert as well as the culvert pools at the very southern end of the segment. However, these were heavily silted in. Overall, its incised banks and swift flows limited potential habitat. The eastern portion of this segment was sampled in 2008; Topeka shiners were present.

Segment 272 (Beaver Creek) had deeply incised banks with severe erosion that has led to siltation in many areas. This resulted in minimal suitable Topeka shiner habitat besides small slack water areas on the main channel border/bends. Sampling occurred in Beaver Creek north of this segment in 2006; Topeka shiners were present.

Segment 276 (Elk Creek) is a small headwater stream, partially channelized, with very few pools/off channel habitat for Topeka shiners. Elk Creek was surveyed just downstream in 2004; Topeka shiners were present.

Segment 277 (Kanaranzi Creek) was heavily channelized and fast flowing with steeply eroded banks. Very little suitable Topeka shiner habitat was present beyond small main channel border areas. However, more suitable off channel habitat may be available during lower flows. The northern portion

of this segment had been surveyed in 2010 and 2016; Topeka shiners were present during both of these surveys.

Segment 278 (Kanaranzi Creek) was high and fast flowing with steep eroded banks along much of the segment. Considerable Topeka shiner habitat was present in the form of two large off channel pools with both submergent and emergent macrophytes. However, the fish species present in these pools appeared to be recently deposited. It is likely that even more suitable Topeka shiner habitat would be present during lower flows. The western half of this segment was surveyed in 2005; Topeka shiners were present.

Plains Topminnow

The plains topminnow (*Fundulus sciadicus*) is a state threatened species that was first listed as special concern in 1984. While not a monitoring objective, plains topminnow presence/absence historically has been documented during Topeka shiner surveys. Since survey efforts focused on low-flow, off channels and pool habitats, also the preferred habitat of plains topminnows, both species can be sufficiently monitored simultaneously (Pflieger 1997). Despite the considerable survey effort in suitable plains topminnow habitat, we document plains topminnows at only 20% of the segments within the species' distribution in 2018. The low number of segments where plains topminnows were documented and low number of individuals observed suggests that this species is need of additional protection and monitoring as suggested by Nagel (2014).

Conclusions

Minnesota's Topeka shiner monitoring effort was designed to detect changes in the species' presence within the state (Ceas and Anderson 2004). Data collected over the past fourteen years of monitoring has shown a shift(s) in the prevalence of Topeka shiners in Minnesota. The first six years of monitoring found Topeka shiners at an average of 79% of segments. Beginning in 2010, occupancy began to fall steadily bottoming out in 2013 (30%), and averaging 44% from 2010-2014. These rates began to rebound with Cunningham (2015, 2016, 2017) observing Topeka shiners at 70% of segments from 2015-2017 (Figure 1). Higher occupancy rates observed in 2018 and the prior three years may be partially attributable to the random selection of stream segments sampled during these four years. Fewer headwater streams (segments 262 and 276 in 2018), which generally do not offer suitable Topeka shiner habitat and historically have had low occurrence rates, may have been randomly selected during these years and helped drive the higher occupancy rates observed compared to 2011-2014.

While Topeka shiner presence appears to be on the rise since the to-date low of 30% in 2010, relative abundance continues to be lower since peaking in 2008 when Topeka shiners were found to be "common" or "abundant" at 55% of segments. Following Ceas and Larson's qualitative assessment of abundance, common/abundant segments numbered ≤15% each year during 2010-2016, and may have been indicative of a population decline in Minnesota. However, relative abundance has increased during 2017 (40%) and 2018 (30%). It should be noted that the higher number of common/abundant sites observed in 2017 may have been due to a change in survey methodology and thus an increase in sampling intensity. This increase in sampling intensity was not continued in 2018. Increases in relative abundance during 2017-2018 could be in part due to hydrological patterns in Southwest Minnesota over the last several years. High water events in 2014, as well as sustained high flows from late 2015 to summer 2016 may have increased successful Topeka shiner recruitment in Minnesota. High water

conditions may have created favorable conditions for young of the year recruitment as well as winter survival of all age classes (Figure 3; Cunningham 2017).

Years of low occupancy and relative abundance may be linked back to hydrologic patterns as well, specifically low water regimes such as those experienced in 2012-2013. Lower flows during late fall through winter could dry off channel habitats and lower pool depths in main channels/channel borders creating potentially lethal overwintering conditions for Topeka shiners (Figure 3; Cunningham 2016). Extensive landscape changes, predominantly the conversion of grasslands to row crops continue to exacerbate these flashy hydrologic patterns. These landscape changes have and will continue to alter stream dynamics (sediment loads, flow regimes, channel morphology, off channel connectivity among others), all of which negatively affect Topeka shiner populations in Minnesota. Paired with an ever changing climate, landscape changes will continue to degrade critical Topeka shiner stream habitat in Minnesota.

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Figure 1. Percentage of randomly selected stream segments where Topeka shiners (*Notropis topeka*) were captured, 2004-2018.

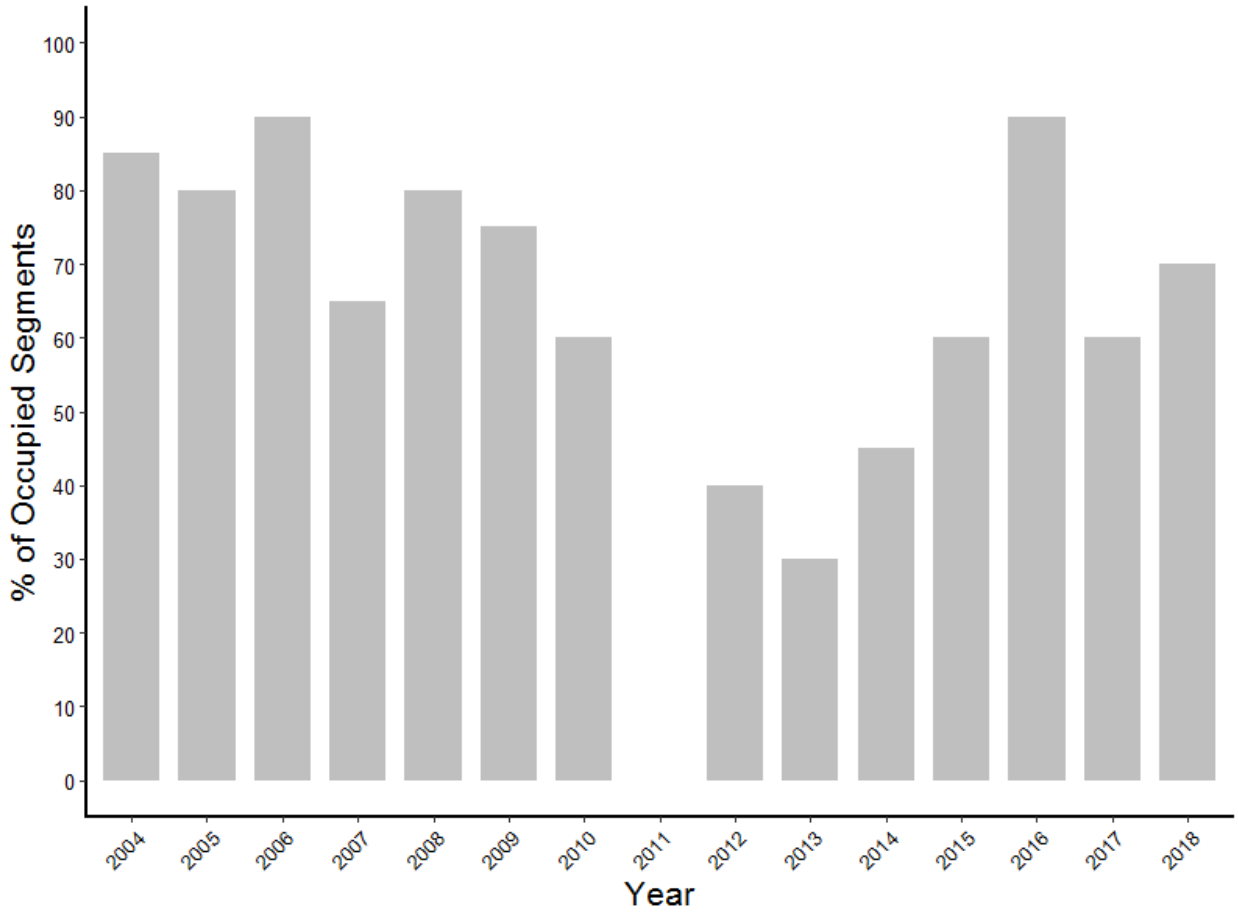


Figure 2. Number of sites where Topeka shiners (*Notropis topeka*) were considered 'common' or 'abundant', 2006-2018.

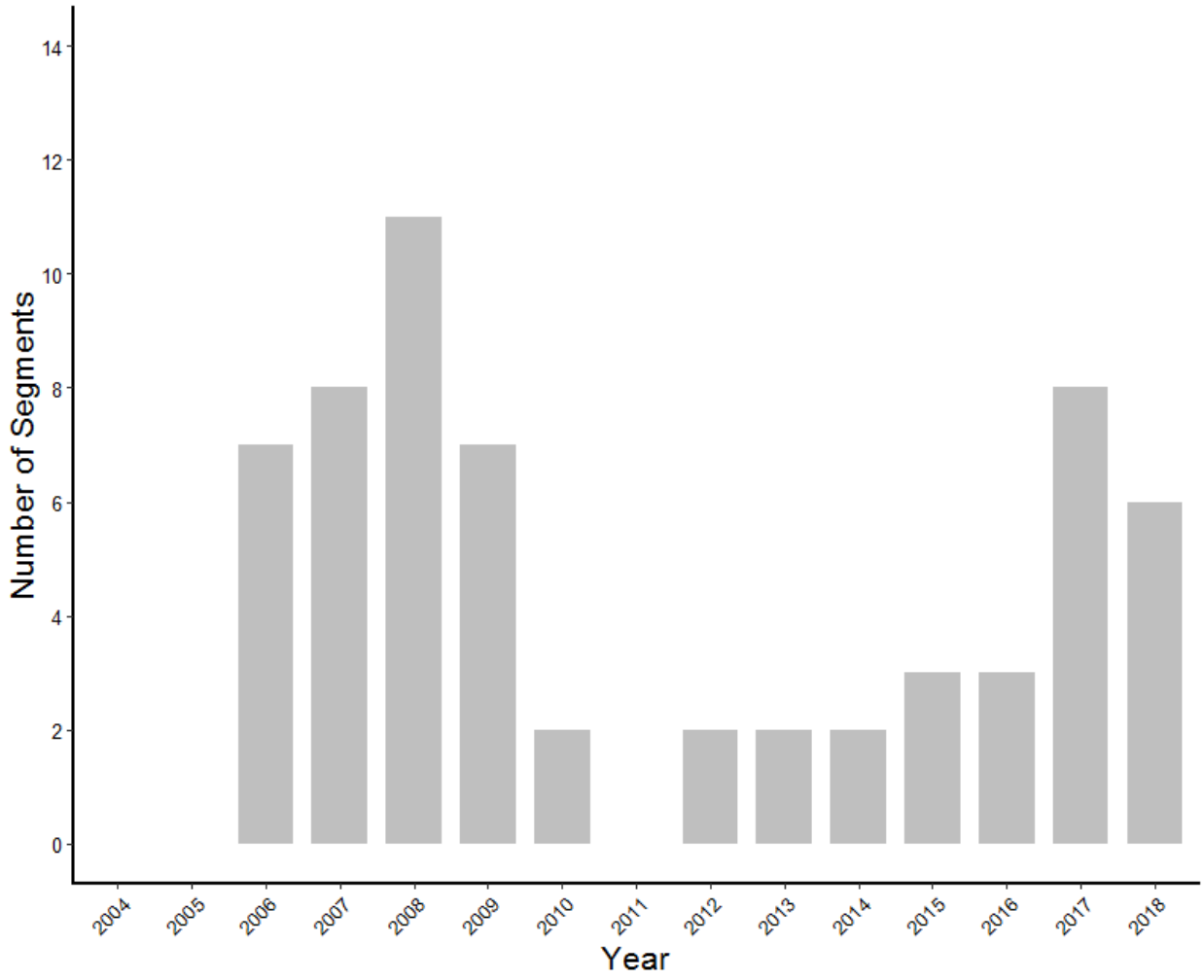
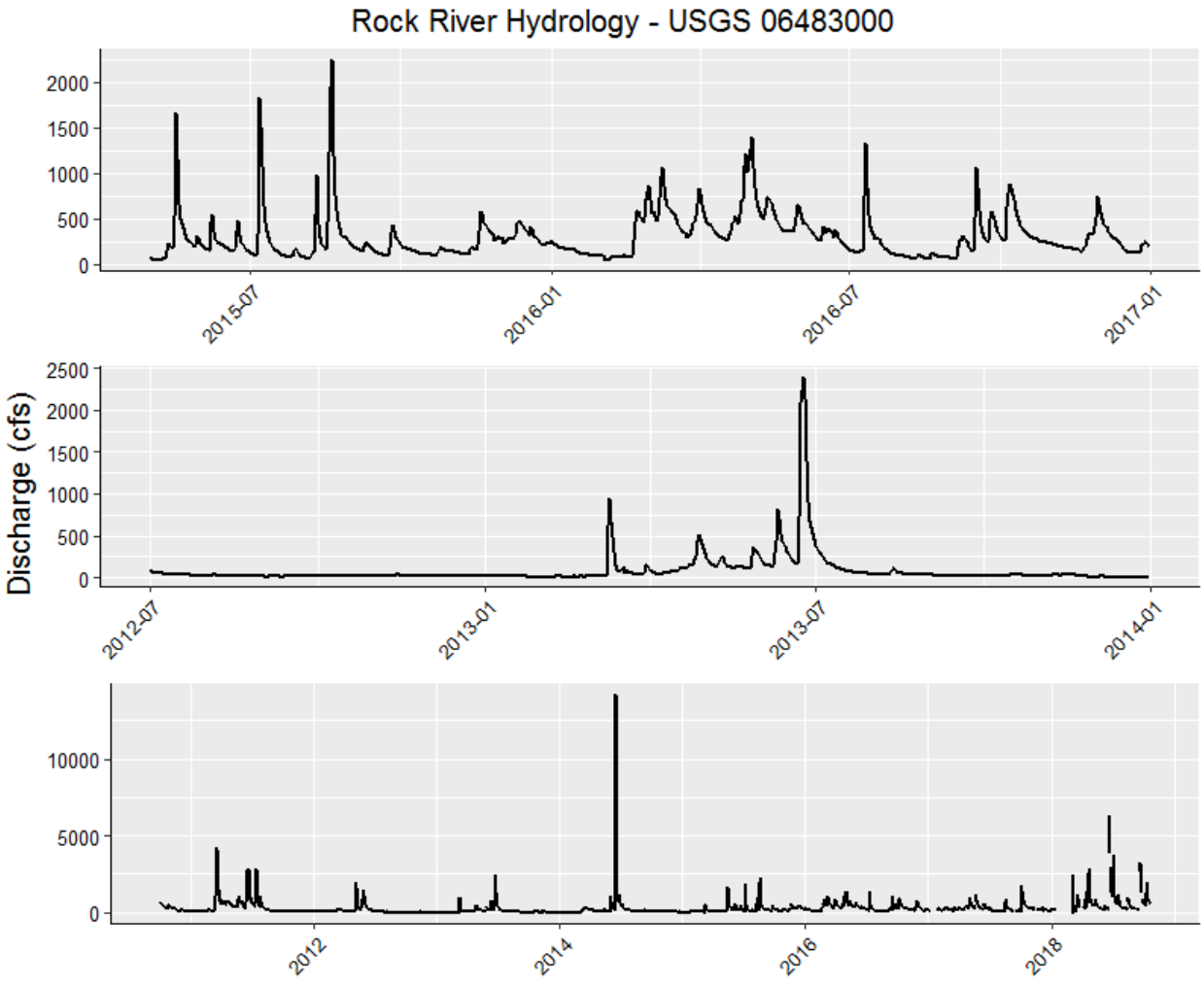


Figure 3. Rock River hydrologic patterns at Luverne, Minnesota, 2010-2018.



APPENDIX A: Maps of Stream Segments

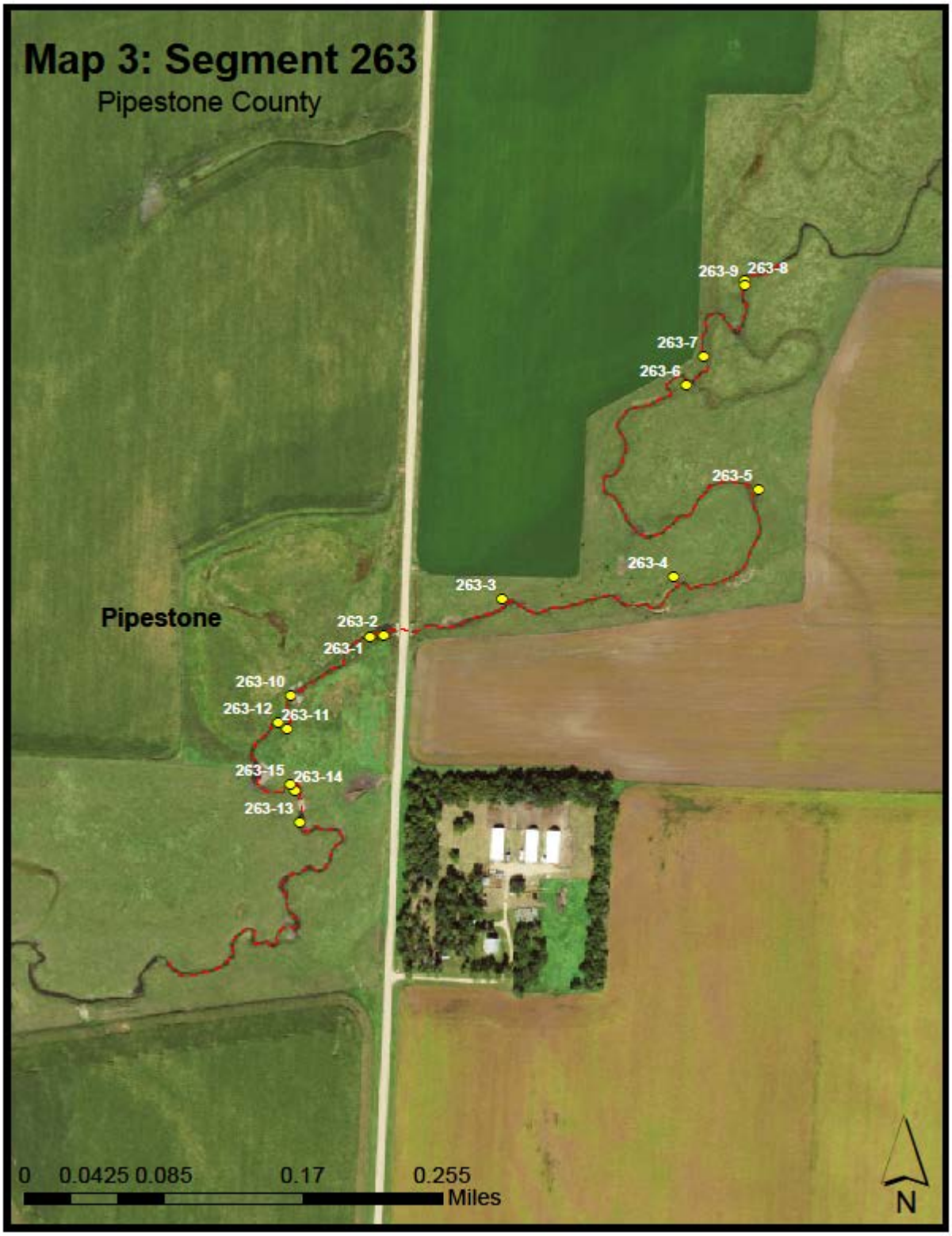
Map 1-20. Aerial views of the 20 sample segments that were sampled in 2018.

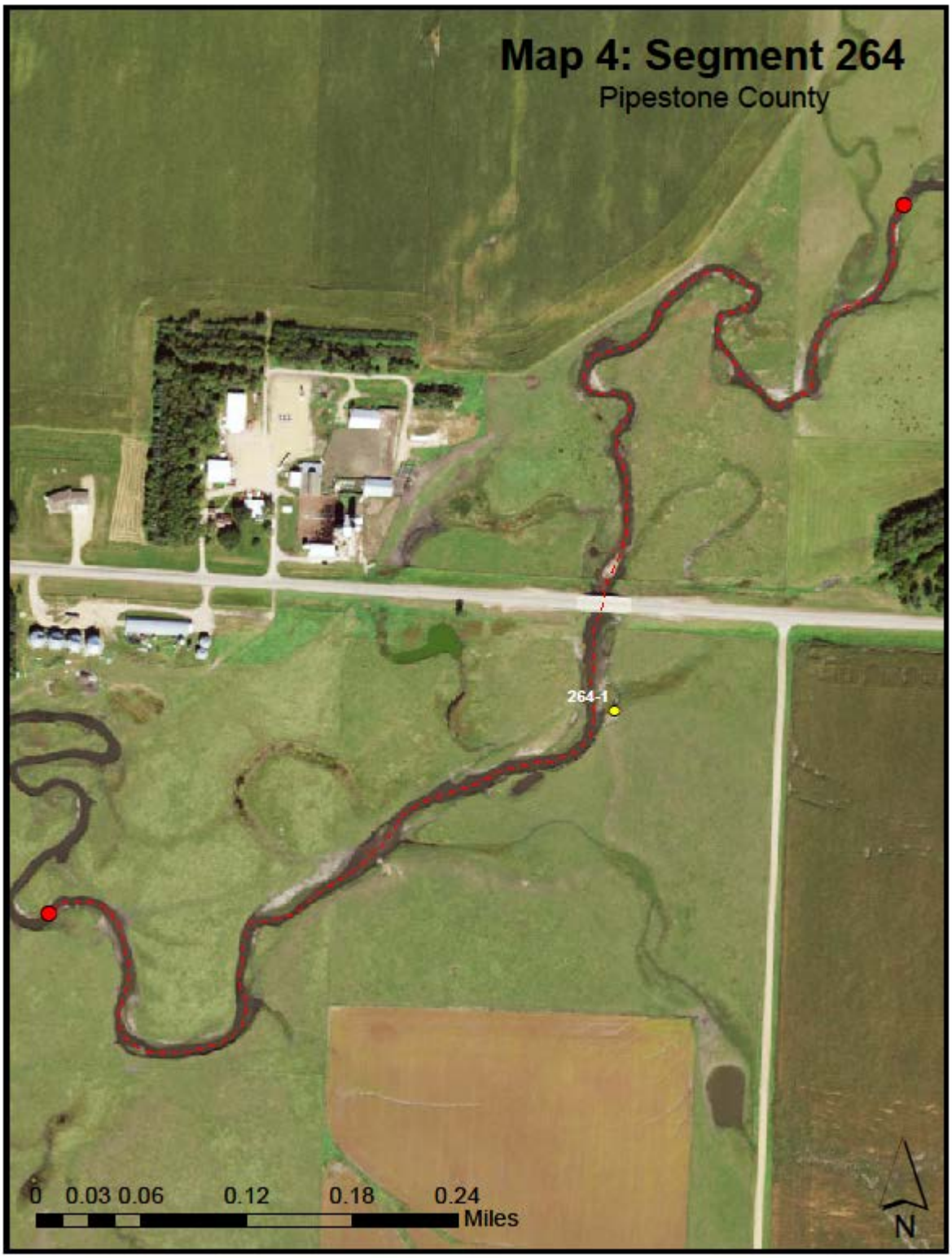
Map 21. Overview of 20 one-mile stream segments sampled during 2018.

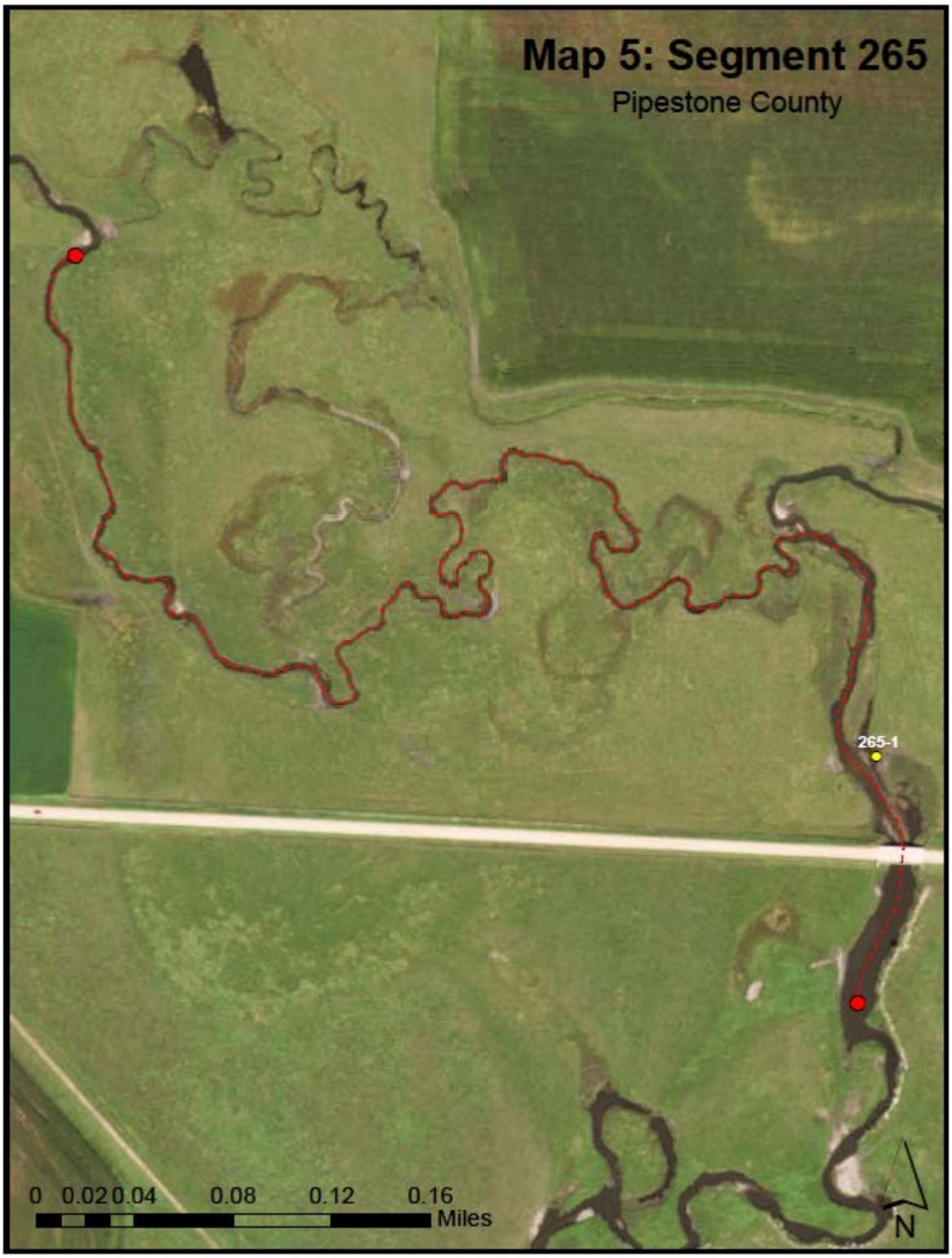
Map 22. Presence/absence of Topeka Shiners at 280 segments sampled during 2004-2018.

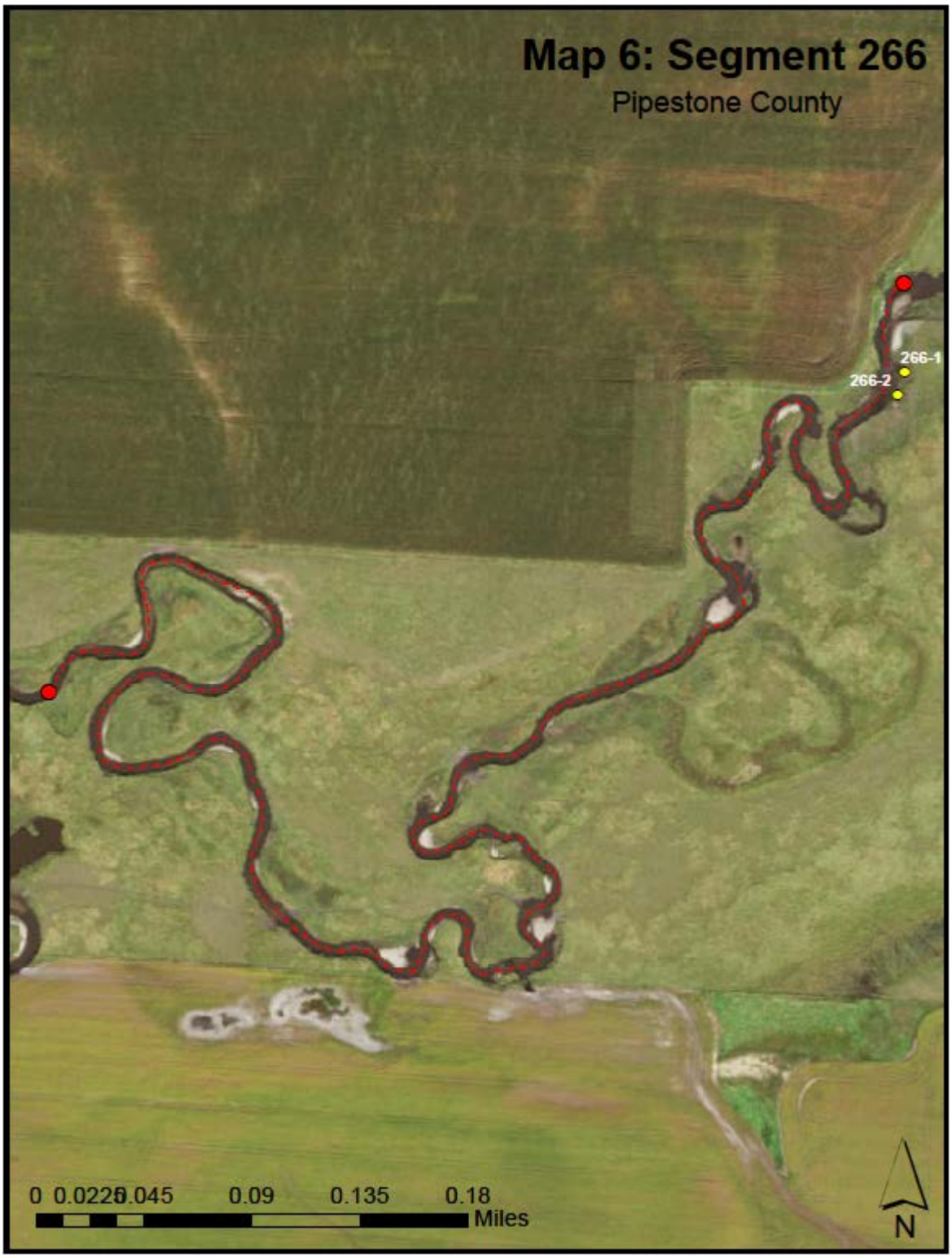

Map 1: Segment 261
Pipestone County
261-1
261-2
261-4
261-3
261-5
0 0.025 0.05 0.1 0.15 0.2
Miles
N


Map 2: Segment 262
Pipestone County
262-1
262-2
262-3
262-4
262-5
262-6
262-7
262-8
262-9
262-10
262-11
262-12
262-13
0 0.0325 0.065 0.13 0.195 0.26
Miles
N


Map 3: Segment 263
Pipestone County
Pipestone
263-9
263-8
263-7
263-6
263-5
263-4
263-3
263-2
263-1
263-10
263-12
263-11
263-15
263-14
263-13
0 0.0425 0.085 0.17 0.255
Miles
N


Map 4: Segment 264
Pipestone County
264-1
0 0.03 0.06 0.12 0.18 0.24
Miles
N

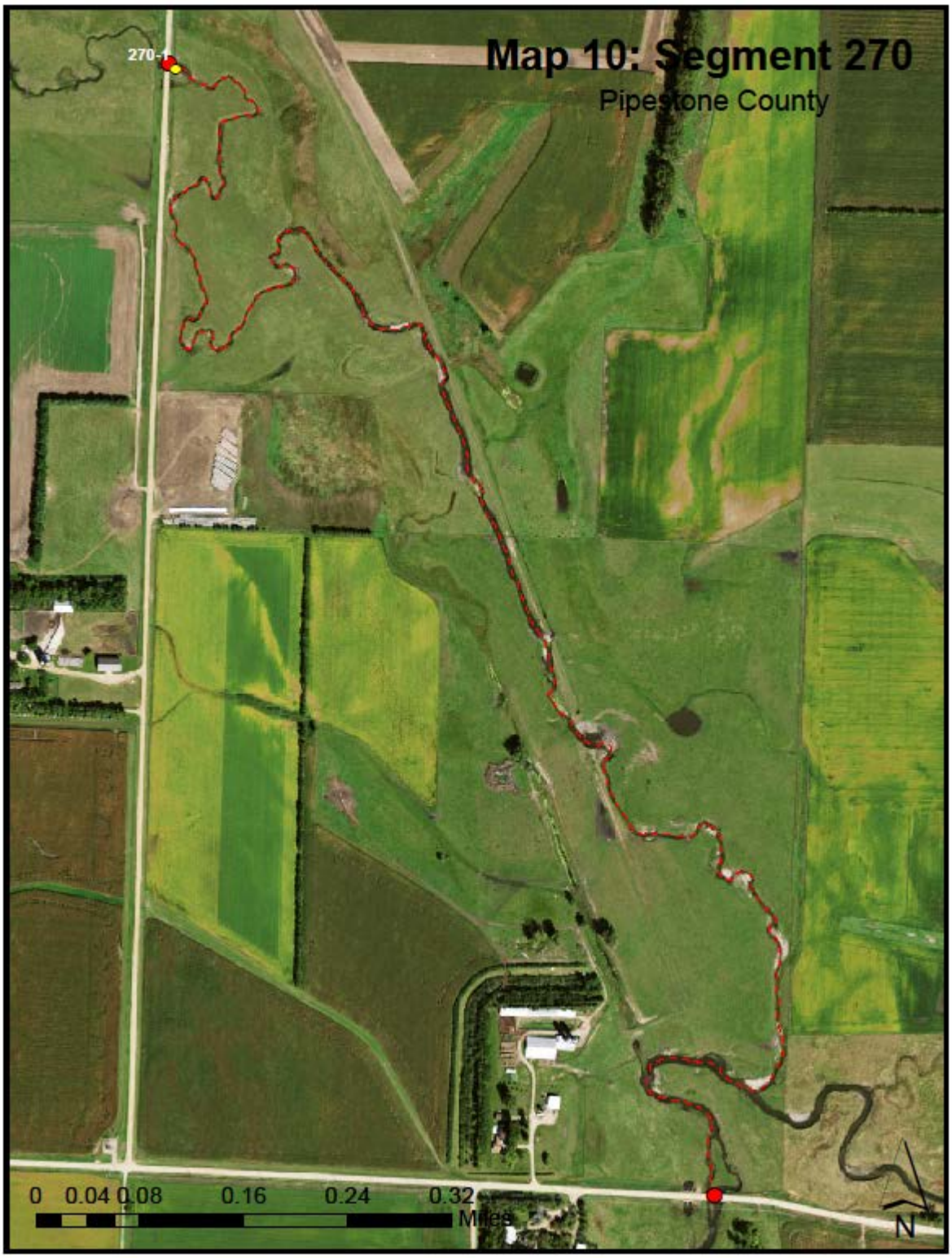

Map 5: Segment 265
Pipestone County
265-1
0 0.02 0.04 0.08 0.12 0.16
Miles
N


Map 6: Segment 266
Pipestone County
266-1
266-2
0 0.0225 0.045 0.09 0.135 0.18
Miles
N


Map 7: Segment 267
Pipestone County
267-1
0 0.0420.085 0.17 0.255 0.34
Miles
N


Map 8: Segment 268
Pipestone County
268-1
268-2
268-3
268-4
268-5
0 0.0225 0.045 0.09 0.135 0.18
Miles
N


Map 9: Segment 269
Pipestone County
269-10
269-9
269-8
269-7
269-6
269-5
269-4
269-2
269-1
269-3
0 0.0275 0.055 0.11 0.165 0.22
Miles
N


Map 10: Segment 270
Pipestone County
270-1
0 0.04 0.08 0.16 0.24 0.32
Miles
N


Map 11: Segment 271
Pipestone County
271-1
0 0.0325 0.065 0.13 0.195 0.26
Miles
N

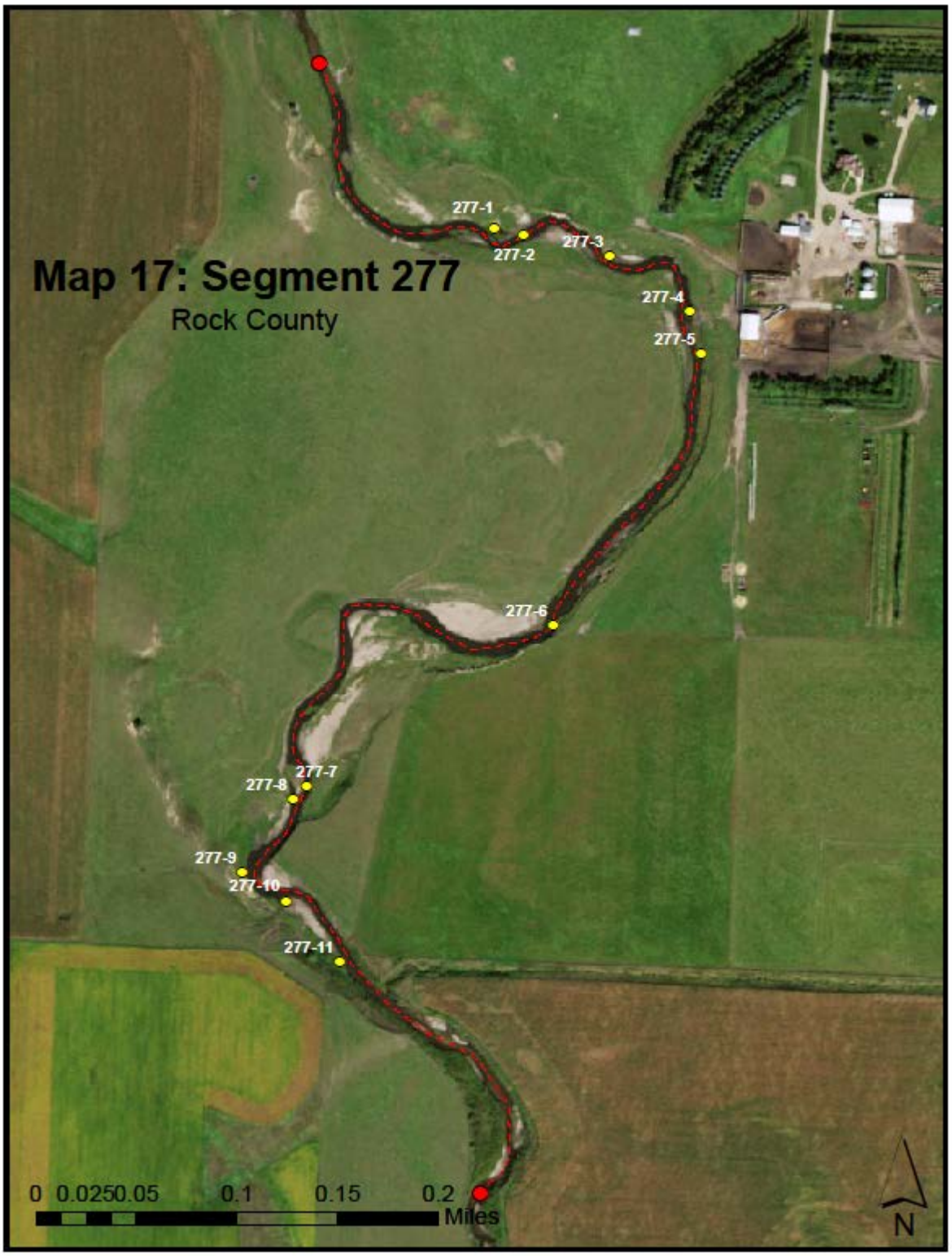

Map 12: Segment 272
Pipestone County
272-13
272-12
272-11
272-10
272-9
272-8
272-1
272-3
272-2
272-5
272-7
272-6
272-4
0 0.0250.05 0.1 0.15 0.2
Miles
N

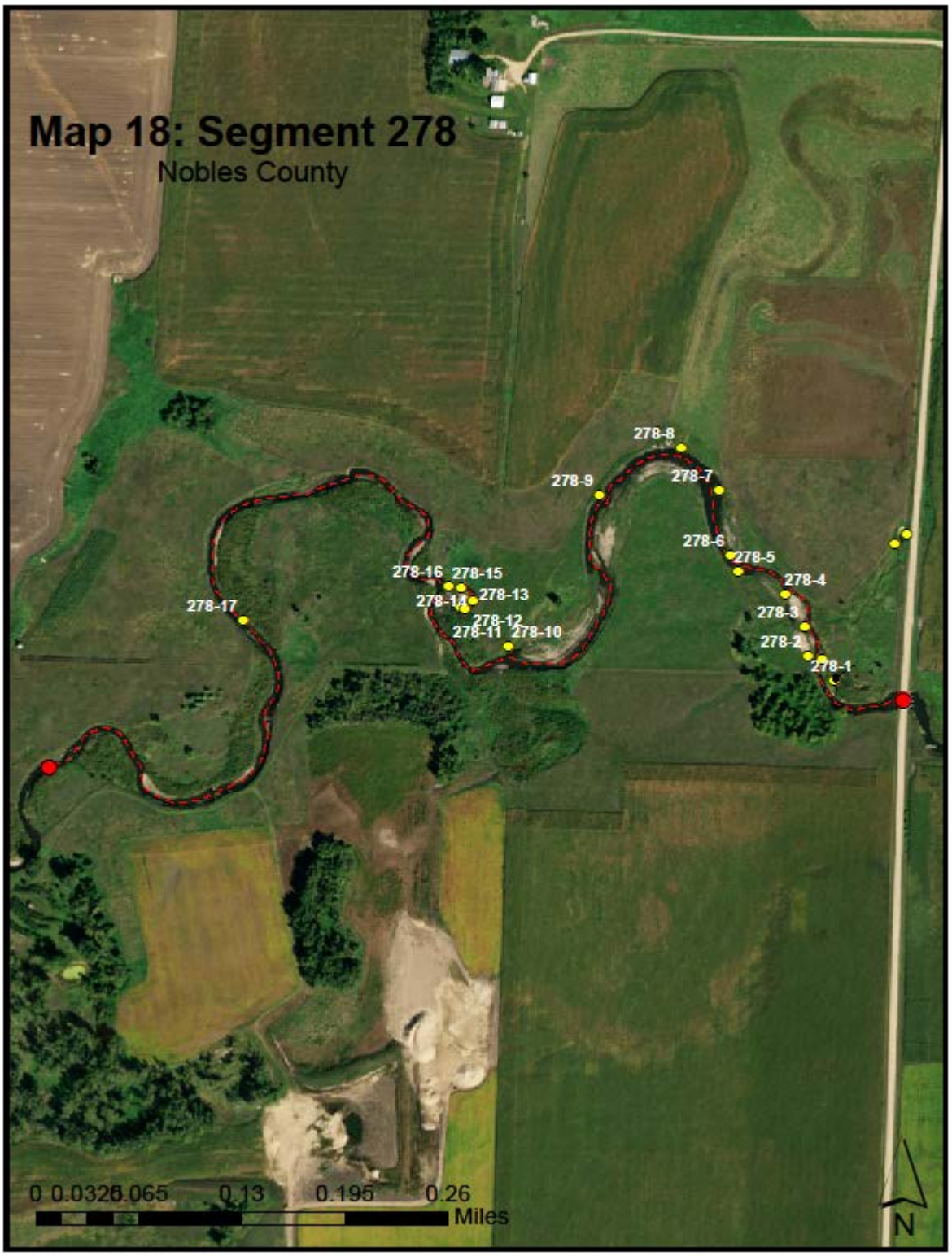

Map 13: Segment 273
Pipestone County
273-1
0 0.0220.045 0.09 0.135 0.18
Miles
N


Map 14: Segment 274
Rock County
274-1
0 0.0250.05 0.1 0.15 0.2
Miles
N


Map 15: Segment 275
Pipestone County
275-1
0 0.0375 0.075 0.15 0.225 0.3
Miles
N


Map 16: Segment 276
Nobles County
276-13
276-12
276-11
276-10
276-9
276-8
276-7
276-6
276-5
276-4
276-3
276-2
276-1
0 0.0425 0.085 0.17 0.255 0.34
Miles
N

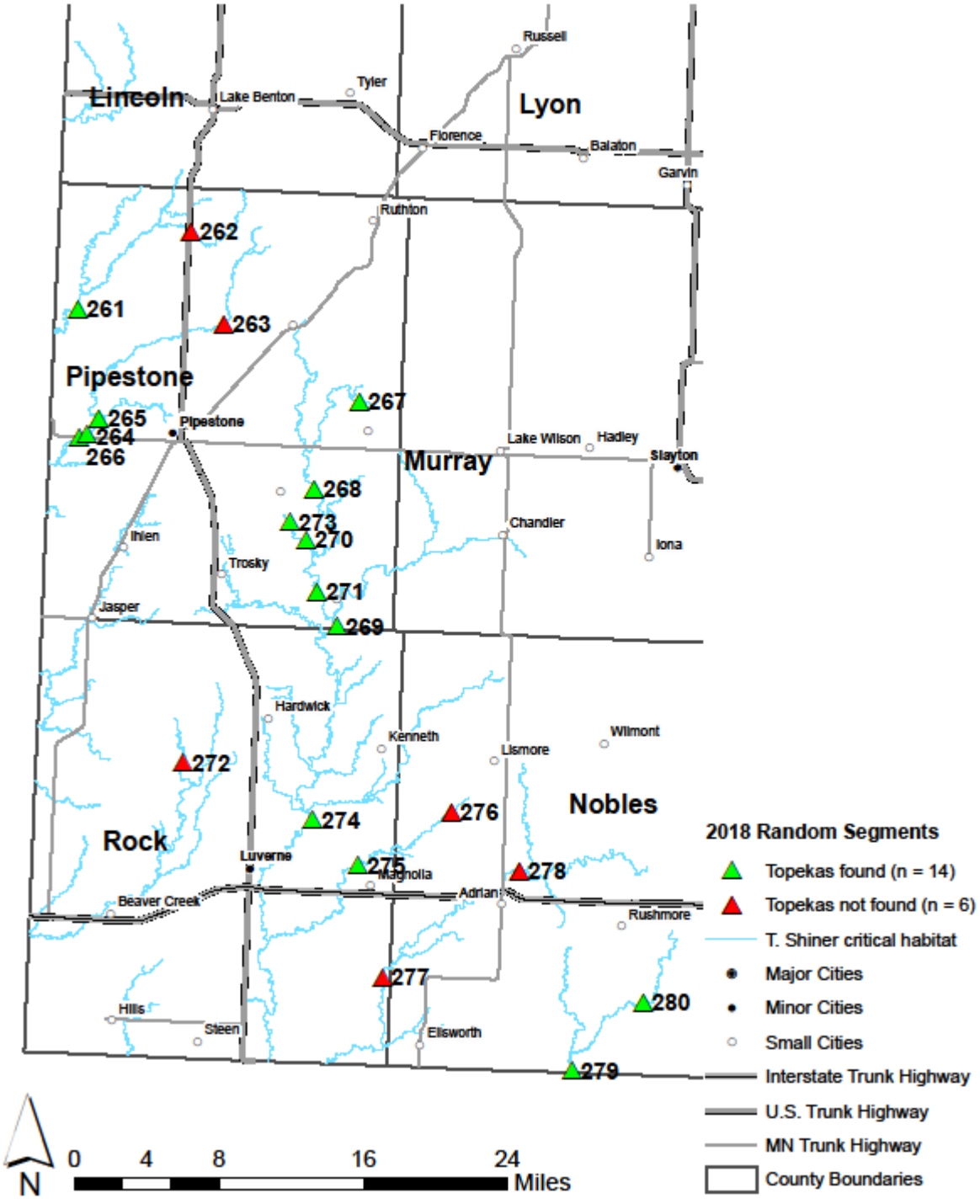

Map 17: Segment 277
Rock County
277-1
277-2
277-3
277-4
277-5
277-6
277-7
277-8
277-9
277-10
277-11
0 0.0250.05 0.1 0.15 0.2
Miles
N


Map 18: Segment 278
Nobles County
278-8
278-9
278-7
278-6
278-5
278-4
278-3
278-2
278-1
278-16
278-15
278-14
278-13
278-12
278-11
278-10
278-17
0 0.0326.065 0.13 0.195 0.26
Miles
N

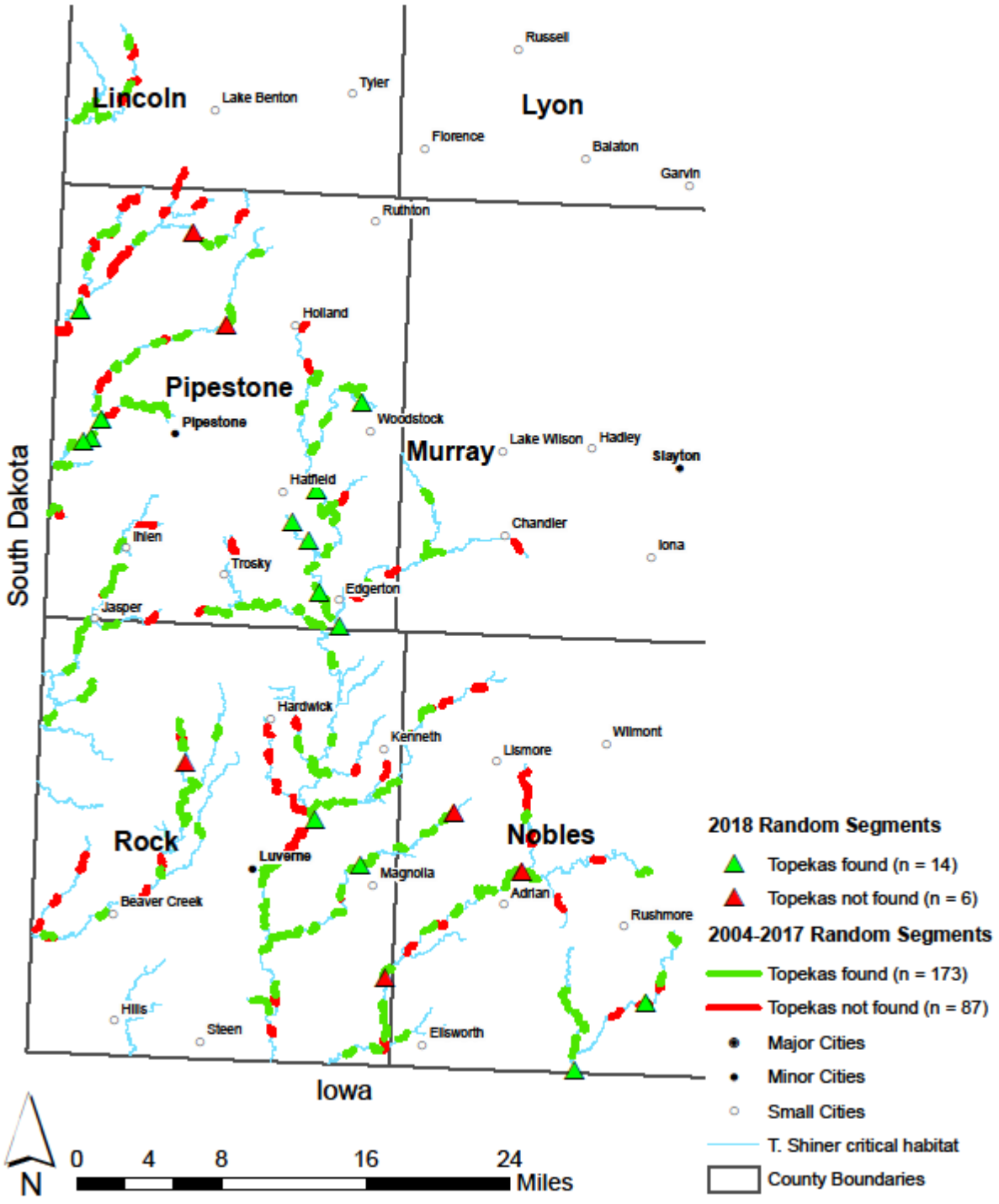

Map 19: Segment 279
Nobles County
279-3
279-2
279-1
0 0.0220.045 0.09 0.135 0.18
Miles
N


Map 20: Segment 280
Nobles County
280-1
280-2
0 0.03 0.06 0.12 0.18 0.24
Miles
N

Map 21: Overview of random segments 2018



Map 22: Overview of segments where Topeka Shiners were found 2004-2018



APPENDIX B: Tables 1 & 2.

Table 1. 2018 Segments, sample sites, and Topeka shiner presence/absence.

Table 2. List of fish species collected at segments 261-280, 2018.

Table 1. 2018 Segments, sample sites, and Topeka Shiner presence/absence.

Segment	Stream	County	Township	Range	Section	Habitat Type	Site Number	Latitude	Longitude	Date	Comment
261	Flandreau Creek	Pipestone	107	46,47	6,7,1,12	main channel border	261-1	44.098751	-96.428002	2018-05-21	
						main channel border	261-2	44.09785	-96.427423		
						main channel border	261-3	44.09761	-96.427155		
						main channel border	261-4	44.097633	-96.426904		
						off channel pool	261-5	44.096544	-96.428087		TS location
Coarse substrate abundant in areas of riffles and runs. Severe bank erosion throughout the segment, pasture road runs directly through the main stream channel. *N. topeka* captured in the first seine haul in off channel pool. Off channel pool deeply silted, some submergent aquatic macrophytes present. Mean stream width approximately 4-5m, depth <1.5m. *N topeka* present (n = 6, common).											
262	East Branch Flandreau Creek	Pipestone	108	45	18	main channel border	262-1	44.162383	-96.306085	2018-05-21	
						main channel border	262-2	44.1618	-96.305436		
						main channel border	262-3	44.161672	-96.305619		
						main channel border	262-4	44.161114	-96.306243		
						main channel border	262-5	44.15989	-96.305025		
						main channel border	262-6	44.158685	-96.304709		
						main channel border	262-7	44.158023	-96.304529		
						main channel border	262-8	44.157445	-96.304067		
						main channel border	262-9	44.157203	-96.303071		

						off channel pool	262-10	44.1561455	-96.301777	
						main channel border	262-11	44.157343	-96.300839	
						main channel border	262-12	44.156302	-96.298206	
						main channel border	262-13	44.156412	-96.298089	

Free flowing headwater stream. Mean stream width approximately 2m, depth <2m. Small coarse substrate in the main channel, heavily silted off-channel. Some small pools in the stream bends, overall minimal off-channel/no flow habitat present. Sampled the excavated gravel pond and pool upstream of the access road. *N. topeka* not present.

263	North Branch Pipestone Creek	Pipestone	107	45	8,9	pool	263-1	44.089503	-96.265264	2018-05-22
						pool	263-2	44.089523	-96.265093	
						main channel border	263-3	44.089891	-96.263664	
						main channel border	263-4	44.090149	-96.261569	
						pool	263-5	44.090949	-96.260575	
						main channel border	263-6	44.091839	-96.261509	
						main channel border	263-7	44.092102	-96.26131	
						main channel border	263-8	44.092742	-96.26084	
						main channel border	263-9	44.09278	-96.260835	
						main channel border	263-10	44.088969	-96.266203	
						main channel border	263-11	44.08867	-96.266233	
						main channel border	263-12	44.088715	-96.266346	

						pool	263-13	44.08784	-96.266035		
						pool	263-14	44.088128	-96.266107		
						pool	263-15	44.088182	-96.266167		

Incised headwater stream. Mean stream width approximately 3-5m, depth <2m. Swift/moderate flows over small coarse gravel/sand substrate, silted in the pools. Overall minimal off-channel/no flow habitat present. All available pools in bends/low flow areas were sampled. *N. topeka* not present.

264	Pipestone Creek	Pipestone	106	46	7,8,18	channel border pool	264-1	43.993708	-96.4410025	2018-05-21	TS location

Water was turbid; sampled site was a pooled backwater on the main channel border. Heavily degraded banks. Mean stream width approximately 4-5m, depth <1.5m, substrate was a sand/silt mixture. Topeka shiners were captured in the first seine haul. *N. topeka* present (n = approximately 75, abundant).

265	North Branch Pipestone Creek	Pipestone	106	46	5	side channel pool	265-1	44.009652	-96.399779	2018-05-21	TS location

Less than 5 *N. topeka* captured in the 1st seine haul in a deeply silted dead-end side channel pool, 3m in width, <1m deep. Main channel incised, mean stream width approximately 5-7m, depth <2m, substrate was sand/small gravel. Stream flows through pasture, heavily degraded banks. *N. topeka* present (n = 8, present).

266	Pipestone Creek	Rock	106	46	18	main channel border	266-1	43.991166	-96.419115	2018-05-21	
						main channel border	266-2	43.99102	-96.419171		TS location

Water was turbid; sampled site was a pooled bend on the main channel border. Heavily degraded banks. Mean stream width approximately 4-5m, depth <2m, substrate was a sand/silt mixture. Just downstream of segment 264. *N. topeka* present (n = 1, present).

267	East Branch Rock River	Pipestone	107	44	34	off channel pool	267-1	44.03161	-96.111284	2018-05-22	TS location

Off channel pool deeply silted, both submergent and emergent macrophytes present, >10m in width, benthic algae present. Off channel pool connected to main channel via small (<1m width) flowing inlet/outlet. *N. topeka* was the most abundant species in both seine hauls. *N. topeka* present (n > 100, abundant).

268	Rock River	Pipestone	106	44	29	off channel pool	268-1	43.960167	-96.157775	2018-05-22	

						main channel border	268-2	43.959766	-96.157381		
						main channel border	268-3	43.959437	-96.157059		
						main channel border	268-4	43.959302	-96.157013		
						main channel border	268-5	43.957465	-96.158237		TS location
Sampled off channel pool, only *F. sciaticus* present. *N. topeka* present in main channel border site along wide channelized reach. Moderately turbid water, swift flows, and moderately degraded bank. Substrate was sand/gravel mixture, mean stream width approximately 8-10m. *N. topeka* present (n = 1, present).											
269	Rock River	Pipestone	105	44	4,33	off channel pool	269-1	43.848418	-96.126461	2018-05-23	
						off channel pool	269-2	43.848352	-96.126635		
						off channel pool	269-3	43.847699	-96.126764		
						main channel	269-4	43.848412	-96.128853		
						main channel	269-5	43.84843	-96.12901		
						main channel border	269-6	43.848682	-96.129908		
						main channel border/pool	269-7	43.848666	-96.128499		
						main channel border	269-8	43.84885	-96.126549		
						main channel border	269-9	43.850385	-96.126606		
						main channel border/pool	269-10	43.850752	-96.126844		TS location

Stream flows through pasture land and has heavily degraded steep banks. Mean stream width 7m, depth <2.5m, strong flows, moderately turbid water, substrate was sand/silt. Surveyed the off channel pools which appear to have minimal connectivity even during high flows, no *N. topeka* present. *N. topeka* found in pooled area along the main channel border over a sand/silt substrate. *N. topeka* present (n = 3, present).

270	Tributary to the Rock River	Pipestone	105	44	8	main channel pool	270-1	43.918937	-96.164548	2018-05-22	TS location

N. topeka found in first seine haul in main channel scour pool just downstream of box culvert. Approximately 10m in width, minimal flow, and substrate was silt. Just downstream, mean stream width was <2m, depth <1m, and highly eroded banks. Stream flows through pasture. *N. topeka* present (n = 8, common).

271	Rock River	Pipestone	105	44	20,29	main channel border/pool	271-1	43.877926	-96.150454	2018-05-22	TS location

N. topeka found in first seine haul in pool along main channel boundary, most released to avoid potential mortality, *N. topeka* likely abundant. Pool was very shallow (<0.25m), substrate was silt/sand/muck, no macrophytes present. Main channel stream width approximately 8-12m, sand/silt substrate, moderate flows, heavily degraded banks. *N. topeka* present (n = 6, abundant).

272	Beaver Creek	Nobles	103	45	7	main channel border	272-1	43.736914	-96.291552	2018-05-24	
						main channel border	272-2	43.736819	-96.291398		
						main channel	272-3	43.736785	-96.291267		
						main channel border	272-4	43.736859	-96.289687		
						main channel border	272-5	43.73689	-96.289425		
						main channel border	272-6	43.736862	-96.289215		
						main channel	272-7	43.736827	-96.288527		
						main channel	272-8	43.73817	-96.291032		
						main channel border	272-9	43.739167	-96.28889		
						main channel border	272-10	43.73957	-96.288036		

						main channel border	272-11	43.739795	-96.287927		
						main channel border	272-12	43.740018	-96.287793		
						main channel border	272-13	43.740558	-96.288549		

Deeply incised stream, very little off channel habitat. Severe erosion and siltation in areas. Mean stream width 2-4m, depth <2m, substrate was gravel/sand in areas with more flow. *N. topeka* not present.

273	Tributary of the Rock River	Pipestone	105	44	6	main channel pool	273-1	43.932807	-96.183315	2018-05-22	TS location

N. topeka found in large in-channel pool (approximately 10-15m in width by 100m in length) down stream of culvert. Substrate was silt/muck over gravel, minimal flows, and abundant submergent macrophytes and algae, depth <0.5m. Stream bank/prairie restoration work has been conducted surrounding this segment. *N. topeka* present (n = 19, abundant).

274	Rock River	Rock	103	44	30	off channel pool	274-1	43.694912	-96.145713	2018-05-24	TS location

N. topeka found in first seine haul in off channel pool (approximately 15m in width by 20m in length) with abundant emergent and submergent macrophytes. Pool was surrounded by pasture land, depth <1m, substrate was silt/muck. Pool appears to have good connectivity to the main channel in high water. Main channel has highly degraded steep banks, swift flows, depth >2m, substrate was silt over gravel. *N. topeka* present (n = 4, present).

275	Elk Creek	Pipestone	102	44	10	main channel pool	275-1	43.659772	-96.093397	2018-05-24	TS location

N. topeka found in first seine haul in main channel scour pool just downstream of culvert. Approximately 5-7m in width, depth <3m, minimal flow, substrate was silt/sand. *N. topeka* also found just upstream of the culvert in a shallow pool on the main channel border. Deep silt, depth <.25m, some emergent macrophytes present. *N. topeka* present (n = 3, present).

276	Elk Creek	Nobles	103	43	22	main channel	276-1	43.705263	-95.992836	2018-05-24	
						main channel	276-2	43.705199	-95.992795		
						main channel	276-3	43.705201	-95.992711		
						main channel border	276-4	43.705224	-95.992618		
						main channel border	276-5	43.705237	-95.992433		

						main channel	276-6	43.705406	-95.992259	
						main channel	276-7	43.705628	-95.992224	
						main channel	276-8	43.705854	-95.99215	
						main channel	276-9	43.706422	-95.992115	
						main channel border	276-10	43.706905	-95.992056	
						main channel	276-11	43.707	-95.992024	
						main channel	276-12	43.707067	-95.992051	
						main channel border	276-13	43.708146	-95.990638	

Small headwater stream, partially channelized, mean stream width <2m, average depth <1m. Very few small pools and off channel habitat available, predominantly riffles/runs. Substrate was gravel/sand. *N. topeka* not present.

277	Kanaranzi Creek	Rock	101	44	12	main channel border/pool	277-1	43.570888	-96.061976	2018-05-23
						main channel border	277-2	43.570848	-96.061686	
						main channel border	277-3	43.570715	-96.060827	
						main channel border	277-4	43.570341	-96.060014	
						main channel border/pool	277-5	43.570038	-96.059884	
						main channel border	277-6	43.568048	-96.061251	

						main channel border	277-7	43.566821	-96.063633	
						side channel	277-8	43.566728	-96.063762	
						main channel border	277-9	43.566184	-96.064237	
						main channel border	277-10	43.565996	-96.063794	
						main channel border	277-11	43.565573	-96.063244	

Heavily channelized fast flowing stream with steeply eroded banks. Mean stream width approximately 10m, depth <3m, substrate was sand/gravel. Little off channel habitat was available, but may be more present during lower flows. *N. topeka* not present.

278	Kanaranzi Creek	Nobles	102	42	6	main channel border	278-1	43.659771	-95.915225	2018-05-23
						main channel border	278-2	43.659983	-95.915566	
						side channel	278-3	43.660245	-95.915617	
						side channel	278-4	43.660534	-95.915875	
						main channel border	278-5	43.660729	-95.916474	
						main channel border	278-6	43.660877	-95.916581	
						main channel border	278-7	43.661469	-95.916751	
						main channel border	278-8	43.661838	-95.91725	
						main channel border	278-9	43.661386	-95.918256	
						main channel border	278-10	43.659974	95.919333	

						main channel border	278-11	43.659973	-95.919335		
						off channel pool	278-12	43.66031	-95.919952		
						off channel pool	278-13	43.660309	-95.919889		
						off channel pool	278-14	43.660374	-95.919796		
						off channel pool	278-15	43.660492	-95.919947		
						off channel pool	278-16	43.660504	-95.920107		
						main channel border	278-17	43.66013	-95.922673		
High and fast moving water; very steep eroded banks with willow and other shrub species along much of the segment. Mean stream width 3-6m, depth <2, coarse gravel/sand substrate. Off channel habitat present with both emergent and submergent macrophytes present, but fish species present appeared recently deposited. *N. topeka* not present.											
279	Little Rock River	Nobles	101	42	35	main channel border/pool	279-1	43.500286	-95.849383	2018-05-23	
						main channel border/pool	279-2	43.500323	-95.849369		
						off channel pool	279-3	43.501563	-95.849763		TS location
Turbid and deep in main channel, >6 m wide and > 1.5m deep, substrate was a mixture of sand/silt, stream banks eroded. *N. topeka* captured in a disconnected oxbow pool with deep silt/muck substrate, aquatic macrophytes present. Oxbow appears to have good connectivity at higher flows. *N. topeka* present (n = 7, present).											
280	unnamed trib to Rock River	Rock	103	44	6	main channel border/pool	280-1	43.756983	-96.168301	2018-05-22	
						main channel border/pool	280-2	43.501563	-95.849763		TS location

N. topeka found in small pool at the base of the downstream side of the culvert, heavy silt deposit, almost no flow and nearly disconnected from the main channel. Main channel approximately 3-5m in width, depth <1.5m, moderate flows, sand/silt substrate. *N. topeka* present (n = 1, present).

Table 2. List of fish species collected at segments 261-280, 2018.

Species	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
Cyprinus carpio																			X	
Campostoma anomalum	X	X	X		X							X				X	X	X		
Chrosomus erythrogaster																	X	X		
Cyprinella lutrensis						X		X	X								X		X	
Hybognathus hankinsoni	X	X																		
Luxilus cornutus	X	X				X				X					X	X				
Notropis dorsalis	X	X	X	X	X			X	X		X	X	X		X	X	X	X		X
Notropis stramineus	X			X	X	X		X	X		X	X	X		X		X	X	X	X
Notropis topeka*	**X**			**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**				**X**	**X**
Pimephales notatus	X	X	X			X			X	X	X				X		X	X	X	X
Pimephales promelas		X	X	X	X		X		X		X	X	X	X	X	X	X	X	X	X
Rhinichthys obstusus	X	X	X					X	X						X	X	X	X		
Semotilus atromaculatus	X	X	X		X	X	X		X	X		X			X	X	X	X	X	
Catostomus commersoni			X			X			X	X		X				X	X	X		
Carpiodes cyprinusarpio						X														
Moxostoma erythrurum	X					X				X										
Moxostoma macrolepidotum	X					X			X	X										
Ameiurus melas			X		X								X	X		X				
Noturus gyrinus		X					X													
Fundulus sciadicus							**X**	**X**	**X**						**X**					
Culaea inconstans	X	X	X						X			X		X		X	X	X		
Lepomis cyanellus	X	X			X		X	X	X								X			
Lepomis humilis	X	X			X		X		X								X			
Pomoxis nigromaculatus																		X		
Lepisosteus platostomus																			X	
Etheostoma exile		X	X				X									X				
Etheostoma nigrum	X	X	X		X	X				X		X	X			X				

APPENDIX C: Habitat and Voucher Photographs

Habitat photographs for segments in which no Topeka shiners were captured are representative of the habitat along the one-mile reach of stream. Habitat photographs from segments where Topeka shiners were present represent the specific site where they were collected. Voucher photographs are presented for each of the sites were Topeka shiners were collected.

Site 261-5, Flandreau Creek: habitat photo.

Site 261-5, Flandreau Creek: voucher photo.

Site 262, East Branch Flandreau Creek: no Topeka Shiners captured.

Site 263, East Branch Flandreau Creek: no Topeka Shiners captured.

Site 264-1, Pipestone Creek: habitat photo.

Site 264-1, Pipestone Creek: voucher photo.

Site 265-4, North Branch Pipestone Creek: habitat photo.

Site 265-4, North Branch Pipestone Creek: voucher photo.

Site 266-1, Pipestone Creek: habitat photo.

Site 266-1, Pipestone Creek: voucher photo.

Site 267-1, East Branch Rock River: habitat photo.

Site 267-1, East Branch Rock River: voucher photo.

Site 268-5, Rock River: habitat photo.

Site 268-5, Rock River: voucher photo.

Site 269-10, Rock River: habitat photo.

Site 269-10, Rock River: voucher photo.

Site 270-1, Unnamed Tributary to the Rock River: habitat photo.

Site 270-1, Unnamed Tributary to the Rock River: voucher photo.

Site 271-1, Rock River: habitat photo.

Site 271-1, Rock River: voucher photo.

Site 272, Beaver Creek: no Topeka Shiners captured.

Site 273-1, Unnamed Tributary of the Rock River: habitat photo.

Site 273-1, Unnamed Tributary of the Rock River: voucher photo.

Site 274-1, Rock River: habitat photo.

Site 274-1, Rock River: voucher photo.

Site 275-2, Elk Creek: habitat photo.

Site 275-2, Elk Creek: voucher photo.

Site 276, Elk Creek: no Topeka Shiners captured.

Site 277, Kanaranzi Creek: no Topeka Shiners captured.

Site 278, Kanaranzi Creek: no Topeka Shiners captured.

Site 279-3, Little Rock River: habitat photo.

Site 279-3, Little Rock River: voucher photo.

Site 280-2, Little Rock River: habitat photo.

Site 280-2, Little Rock River: voucher photo.