Topeka Shiner Monitoring in Minnesota: 2016

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INTRODUCTION

The material presented in this report is the result of a stream monitoring survey for *Notropis topeka* (Topeka Shiner) in southwest Minnesota as per a contractual agreement between me, George R. Cunningham, and the Minnesota Department of Natural Resources (DNR) under **PO# 3000092542**.

Notropis topeka (Topeka Shiner) was historically widespread in smaller stream systems (1st through 3rd order) throughout the central portion of the tallgrass prairie biome of the United States. Since the 1970's, the species has exhibited widespread range contraction and is estimated to occur in only 10 to 15 percent of its historic geographic distribution (Tabor 2002, USFWS 2009). The decline of this species is the result of habitat loss resulting from the near complete conversion of the tallgrass prairie biome for agricultural purposes (Cross 1967; Eddy and Underhill 1974; Gelwicks and Bruenderman 1996; Pflieger 1997; Berg et al. 2004). Specifically, the conversion of the tallgrass prairie ecoregions from a perennial grassland system with meandering, sinuous stream channels connected to their floodplains to a row crop agriculture landscape created stream conditions of ditched and straightened channels as well as down cut and degraded stream channels, resulting in widespread alteration of stream channels disconnected from their floodplains. Moreover, the construction of thousands of small flood control dams throughout the range of *N. topeka*, (combined with the conversion of the grassland ecoregions), has created pronounced functional changes to riverine ecosystem dynamics including: alterations to natural hydrographs, disruption of sediment dynamics and floodplain connectivity, increased turbidity, higher water temperatures, loss of aquatic vegetation, and introduced species (particularly sight feeding predators). In response to the rapid and dramatic decline in distribution and potential abundance of this species, the U.S. Fish and Wildlife Service (USFWS) designated the species as endangered under the Endangered Species Act of 1973 (Tabor 1998).

In 2004, the DNR began a presence/absence survey effort to monitor *N. topeka* populations in Minnesota at randomly selected sites within the federally designated critical habitat for the species in southwestern Minnesota. A protocol was established (Ceas and Anderson 2004) to conduct a presence/absence survey for this species at twenty (20) randomly selected 1-mile long stream segments from within the Big Sioux and Rock River drainages of southwestern Minnesota. Surveys were conducted annually from 2004 to 2010 by Ceas and continued in 2012 to 2014 with Nagle and Larson. I conducted monitoring efforts in 2015, and continued in 2016 with the assistance of Konrad Schmidt.

Analysis of data from the annual surveys conducted from 2004 to 2010 found *N. topeka* at an average of 76.4% of the stream segments over this period (Nagle and Larson 2014). However, this percentage dropped to 60% starting in 2010 and declined further in 2012 and 2013 (40% and 30% respectively), with a slight improvement observed in 2014 (Nagle and Larson 2014). In 2015, Cunningham 2015 found *N. topeka* at 65% of the stream segments. Although the monitoring protocol used for this species is not designed to systematically evaluate population trends, a simple criteria to evaluate relative abundance indicates a decline of this species (Ceas and Larson 2010; Nagle and Larson 2014) with a slight increase found in 2015. Results from the monitoring surveys conducted in 2016 are detailed in this report with a discussion regarding previous survey efforts and results.

METHODS

Sampling methods for 2016 monitoring generally followed the previous methods by Ceas and Nagle, but deviated from previous sampling efforts by using a fixed distance sampling measure at stream segments not occupied by *N. topeka* or where professional judgment indicated additional effort was required to detect this species. At thirteen (13) stream segments (discussed below in segment discussion section) we used a 50 meter sampling distance at each site within the stream segment. At seven (7) stream segments, Topeka shiners were found in the first short seine haul where stream conditions presented pool habitat, small off-channel habitat adjacent to a bridge crossing, and at a known *N. topeka* site. These locations are noted in the segment discussion section below.

Selection of Stream Segments

For each year of *N. topeka* monitoring, 20 one-mile stream segments were selected at random from the federally designated *N. topeka* critical habitat within Minnesota, employing an ArcView extension program developed by the DNR. Final map files for the 2016 survey were provided to me by the DNR and overlaid on aerial imagery (**Appendix A**). The location of the 2016 stream segments are depicted in **Map 1**.

As was explained to me and described in the contract for this work, the entire stream segment needed to be available for sampling. We choose to follow the prescription provided us that Minnesota state law allows free access to streams and rivers if one enters the waterbody via a public access point (bridge crossing) ***and*** stays within the stream and on the stream bed. We followed this process at several stream segments. Also, we sampled one location via canoe since land access was denied.

Landowner Contact

Once I received the locations of the 20 one-mile stream segments, I began a land records search using the online landowner parcel databases maintained by each County office in southwest Minnesota. Once the landowner was determined, an Internet search of the person's name and address was conducted to find their phone numbers. Landowners were contacted via phone and asked permission to access their land. Those landowners that did not answer repeated calls were later asked in person to access their land by visiting their place of residence (most of the time this was near the stream segment). Nearly all the landowners agreed, however one (1) of the original stream segments needed to be replaced with a backup segment due to landowner objections (Segment 233). Of the 5 randomly-generated backup segments, this particular backup segment was chosen because it was a stream of similar size to the one we were denied access.

Selection of Sampling Sites

Based on habitat preferences characterized in the literature and the experience of the surveyors, sampling sites were identified within each randomly selected 1-mile stream segment using aerial imagery. At each segment, a brief reconnaissance was conducted to prioritize sampling of *N. topeka* habitat. Basic habitat descriptions and locality information for each of the 20 one-mile stream segments sampled are presented in **Table 1 of Appendix B**. The stream segments with sampled sites are depicted in aerial maps in **Appendix A**. Each sampling site is depicted on the aerial maps with a site number. The point mark on the aerial maps represents the center point distance for those sites sampled using a 50 meter sampling distance, except for Site 228-2 which is the end of the 50 meter sampling distance and the location of *N. topeka* capture. For those seven (7) sites where the 50 meter sampling distance was not used, the point represents the capture location of *N. topeka*.

Fish Sampling

Presence/absence surveys were conducted for *N. topeka* shiners using 12' x 4' wall seines with 1/4" mesh during 15 June to 18 June and again on 27 June and 28 June 2016. Sampling efforts were focused on low-flow areas along the main channel boundary (MCB), in-channel pools, bend pools, deep undercut banks, backwaters, and off-channel ponds and oxbows. An attempt was made to standardize sampling during this survey effort using a 50 meter standard sampling distance. However, in seven (7) of the stream segments *N. topeka* was captured during short seine hauls conducted as an immediate first collection effort in habitat types judged by us to be the best area to collected the target species. Given the protocol established by MNDNR that states once *N. topeka* has been collected at a site, no further sampling is required, we did not sample further using the 50 meter standard sampling distance. For all other stream segments,

sampling occurred until *N. topeka* was collected using the 50 meter sampling distance, or in the case of Segments 221 and 233, 10 sites each of 50 meters in length were sampled at locations deemed the most suitable to harbor *N. topeka* based on our professional judgment. Although no systematic population size estimate methodology was used in this presence/absence survey, a qualitative assessment of relative abundance of all fishes observed was made based on the professional judgment of the surveyor. The abundance categories are listed below and are based on those used in prior annual monitoring efforts by Ceas and Nagle.

- *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
- *Present* = <5 individuals captured after substantial sampling effort

RESULTS

N. topeka was observed in 18 of the 20 one-mile stream segments sampled for this 2016 monitoring effort. Stream segments where this species was observed are listed in **Table 2 of Appendix B**. This species was not found in Segment 221 or 233; thus, 90% of the randomly selected stream segments were found to be occupied by *N. topeka*. This represents an increase in occupancy from data collected from 2012 – 2015 and is similar to the percentage observed from 2005 - 2009 (**Figure 1**). Averaged over those first six (6) years of monitoring, *N. topeka* was present at just over 79% of randomly selected stream segments. Monitoring surveys conducted from 2010, 2012 and 2013 found the percentage of selected stream segments occupied by *N. topeka* had fallen rapidly, with a slight increase in 2014, then a larger increase in 2015. During the last 3 years of sampling, the percentage of stream segments occupied by *N. topeka* has increased dramatically from the low observed in 2013. Averaging the percent of *N. topeka* occupancy from randomly selected stream segments across all years of monitoring (2005-2016) reveals a rate of 67%.

As for the abundance of *N. topeka* at occupied stream segments, we observed only three (3) segments with rankings of *Common* based on the abundance definition criteria listed above. This finding is the same as the result of the 2015 monitoring. Any comparison with previous surveys is difficult since standardized collection methodology has not been employed to determine abundance based on a standard unit of effort. Different investigators with slightly different methods of sampling conducted without a using a standard unit of distance sampled at each site within a stream segment makes comparisons difficult among the years of sampling data. **Figure 2** depicts the number of stream segments considered to be *Common* or *Abundant* for *N. topeka*

from 2006 - 2016. Again, making absolute statements about a decline in abundance of this species solely based on empirical data is difficult given the reasons stated above, but conversations with previous investigators (Konrad Schmidt, Jay Hatch at UMN) strongly indicate that the abundance of *N. topeka* has declined markedly. Statements by these two investigators based on their data collection experience and data indicate that in the early to mid- 2000s, finding large numbers of *N. topeka* in off-channel habitats and slow moving deep pools on the margin of the stream channel was a common occurrence. They would easily find 30 to 50 individuals and sometimes more than a hundred in certain habitats. Since 2010 the abundance of *N. topeka* has declined dramatically and the sampling efforts during 2016 in such habitats as a restored oxbow (Segment 228) and a nearly cut-off channel meander (Segment 223) found very few individuals of this species.

A total of 32 fish species were collected during the 2016 surveys. *Fundulus sciadicus* (Plains Topminnow), a threatened species in Minnesota, was collected in two (2) stream segments (223 and 230). A list of fish species collected within each sample Segment is presented in **Table 2 of Appendix B**. Photographs of each stream segment, along with location sites of observed *N. topeka* and the respective fish, are in **Appendix C**.

Comments on Each Segment

Segment 221 – Very heterogeneous instream habitat composed of submerged sand/silt bars, deep run pools, deep undercut banks, areas of riffles composed of boulders, and patches of cobble in runs. Instream aquatic macrophytes were abundant and at the time of sampling the water level was high and the temperature was cold to cool. The fish species diversity was the second highest of the stream segments sampled. This is also one of two streams where 10 sites each of 50 meters in length were sampled. *N. topeka* was not collected in this stream segment.

Segment 222 – This stream segment was very different than the other sampled segments. This was a clear, cool headwater stream with abundant flow. A large deep hole was at the culvert crossing. The substrate was composed of cobble and gravel; *Ranunculus* spp. abundant throughout the stream. *N. topeka* were commonly collected but not in large numbers. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was caught immediate in a 15 meter seine haul along the shallower margin of the pool.

Segment 223 – The stream segment flows through native grassland, very high ridge (moraine) west of the stream; water was very turbid; collapsed stream banks evident and undercut banks. The sampling site was a nearly cut-off meander with deep muck with some gravel. We expected to collect a large number of *N. topeka* given the habitat, but only a few were observed; abundance was categorized as “present”.

Segment 224 – This stream flows through extensive row crop upstream. Substrate was muck with gravel and sand. The water was turbid and of high flow. The sampled site was a pool margin of a large culvert pool by road crossing. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was caught immediately in a 15 meter seine haul along the shallower margin of the pool. This species' abundance was categorized as "present".

Segment 225 – This segment had high water and fast current conditions at the time of sampling. The stream flows through pasture though the site collection was just downstream of the Interstate culvert crossing. The habitat was a main channel border pool with an undercut bank and instream vegetation. The substrate was silty muck. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was caught immediately in a 15 meter seine haul along the shallower margin of the pool. This species' abundance was considered "present".

Segment 226 – The stream flows through pasture where grazing pressure is moderately high. Erosion is evident along the sampled sites and the banks are undercut. Stream habitat is mostly long runs and straights with a few bend pools. This is a result of an entrenched system where the top of the bank is very high from the water line. As the time of sampling the water was turbid and of high flow. The substrate was a combination of gravel, sand, and silt. The site with *N. topeka* was a shallow vegetated channel border pool. This species' abundance was considered "present".

Segment 227 – At this segment the water was warm and turbid with slow moving current, and a very wide channel with undercut banks. The stream flows through pasture but row crop is on the hilltops. The substrate was mostly silt. *N. topeka* was collected and was common in abundance. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was caught immediately in a 15 meter seine haul along a channel margin pool and adjacent undercut bank.

Segment 228 – The two (2) sampled sites were in a recently restored oxbow, a restoration project developed by the USFWS. This oxbow was sampled in 2015 (prior to restoration) and yielded more *N. topeka* than this year. The abundance of this species for 2016 was categorized as "present" and was only found in Site 228-2. Prior to sampling, heavy rain occurred the day and night before resulting in very high water in the stream system outside the oxbow, which allowed flow back into the restored site. The substrate was silt and sand with some gravel.

Segment 229 – This stream segment was wide with fast moving current and turbid. Four (4) sites were sampled within the segment, with *N. topeka* being collected at Site 229-4. The abundance of the species was categorized as "present". High banks are eroded along the tight bends of the

stream, and stream banks are undercut; the substrate is silt along the margins but gravel and sand in the mid-channel.

Segment 230 – This segment is a semi-entrenched system with undercut eroded banks. The stream flows through a narrow band of pasture with row crop close to the stream on either side. The segment has a heterogeneous configuration of riffle, pool, and meander bends with substrate of boulder and cobble. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was caught immediately in a 10 meter seine haul along an off-channel pool with cold water temperature, and abundant *Ranunculus* spp. with substrate of silt and sand. *N. topeka* was categorized as "present" at this site.

Segment 231 – The stream segment is wide and the water was flowing fast, with large boulders making sampling difficult. The stream segment is a series of long run pools with bend pools, moderate amount of bank erosion, undercut banks in places; substrate was boulder and cobble with a layer of silt. Four (4) sites were sampled with Site 231-4 being occupied by *N. topeka*. This species' abundance was considered "present". This site was the shallow margin of large side pool adjacent to the main channel with substrate composed of muck and silt.

Segment 232 – This segment was also sampled during 2015, and as then, *N. topeka* was readily collected with little effort with this species' abundance rated as common. The stream segment flows along the base of a bluff with boulders present along the bluff that are a major part of the stream substrate. In the shallow areas the substrate is a mix of cobble and gravel with a fine layer of silt. There is abundant submerged vegetation along channel margin. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was caught immediately in a 15 meter seine haul along the channel and an adjacent margin pool.

Segment 233 – The stream segment was entrenched with vertical eroding banks immediately north and south of the highway. North of the highway, there is very little pool habitat and no undercut banks; substrate was silt and gravel with muck along the channel margin. South of the highway the stream is mostly a long series of glide pools separated by boulder riffles with large woody debris in places. Drainage pipes are common along this reach. Further upstream the substrate is rubble and boulder. The banks are undercut and deep pools are present. Row crop is very near the stream and the stream segment has little to no connection with the floodplain. Although *N. topeka* was not collected along this stream segment, the highest fish species diversity was recorded from this segment.

Segment 234 – This segment is a previously ditched channel which is now entrenched. The substrate is boulder, cobble and gravel with channel margin of sand and silt. The stream is a series of runs-riffles-pools. The site with *N. topeka* is a pool along the margin of the main channel

with undercut banks and sand and silt substrate. The abundance of this species was categorized as "present". This area also was at the confluence with a very small tributary entering Chanarambie Creek.

Segment 235 – This segment had very high and fast moving water that was also very turbid. The stream is semi-entrenched with eroding banks that flow through pasture. The floodplain was once actively farmed, but is now in a grassland restoration program. The *N. topeka* site was a deep bend pool with an undercut bank. The species' abundance was categorized as "present".

Segment 236 – The off-channel habitat was warm, turbid and had abundant submerged vegetation. The substrate was deep silt, but the water depth was shallow. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was collected in an initial 10 meter seine haul in the off-channel habitat. While very little effort was spent to find *N. Topeka* at this site, the species' abundance was categorized as "present".

Segment 237 – The stream segment flows through pasture with row crop in close proximity to the stream. The water was turbid and high. The banks were undercut and collapsed clay wedges were part of substrate in the main channel. The substrate in other areas was a mix of cobble and gravel with sand and silt along channel margin. *N. topeka* was collected along channel bend in area of collapsed banks forming small pockets of pooled slower water. The abundance of the species was considered "present".

Segment 238 – This stream segment is part of the lower portion of the Rock River so the stream is very wide with heterogeneous habitat. The segment flows through pasture and woodland with row crop on tables but occasionally near stream bank. The water was turbid and warm. Large, eroded banks exist along the segment with very high banks in places. Bend-way weirs are located along portions of the segment along with large woody debris. The segment is composed of long straights, riffles and bend pools; the substrate is mostly silt and muck with pockets of gravel. The shallow runs and riffles have sand and gravel substrate. The site with *N. topeka* is just downstream of a tributary confluence, the area had gravel bars and the channel border pool was deep with undercut banks and muck substrate. *N. topeka* was considered "present" in abundance.

Segment 239 – The segment had high water, very turbid; it is an entrenched and ditched stream system; row crop adjacent to stream banks. The substrate was deep silt. This was one of the segments where the 50 meter distance sample was not used since *N. topeka* was collected immediately in a very short seine haul at the culvert pool on the upstream side of the road crossing. This species' abundance was categorized as "present".

Segment 240 – The stream segment flows through heavily grazed pasture and the stream banks are highly impacted by cattle activity. A high moraine feature is located on the southern border of the segment. The water was turbid with no noticeable flow. The substrate was deep silt with gravel and boulders near the bridge abutments. The sampled site was a straightened section of stream downstream of the bridge. *N. topeka* was collected along the undercut bank of the channel margin; its abundance was categorized as "present".

DISCUSSION

The result of this 2016 monitoring survey indicates an increase in the detection presence on *N. topeka* in stream segments in southwest Minnesota. An apparent increase in occupancy in randomly selected stream segments is evident over the years from 2014 to 2016. In addition, the abundance of this species at sites within stream segments appears similar to what I observed in 2015.

The dichotomy between increased stream occupancy and lower abundance within a segment is difficult to deduce. The recent years of high water conditions, including 2016, may have created favorable conditions for young of the year recruitment and winter survival of all age classes, with subsequent dispersal to more available habitat. However, one would expect a corresponding increase in abundance with the recent high water years but this has not been observed. As was explained in the 2015 report, stream flow gauge data over the last 15 years seem to indicate a much lower stream discharge in the late fall and winter months. These lower discharges could create conditions of extreme low flow that would dry off-channel habitats and lower pool depths in the main channel and channel borders. Given the low winter temperatures in that region, ice could form down to the substrate creating lethal winter conditions for fish species. Altered stream hydrology may be a critical piece to understanding the decline in abundance of *N. topeka* in Minnesota.

Although sampling effort is not part of the sampling protocol for this long-term monitoring survey, the effort needed during 2016 to detect *N. topeka* was minimal at most stream segments. As the sampling protocol is currently defined, once *N. topeka* is observed, sampling at that stream segment is discontinued. Slightly more effort may have been used in the monitoring activity in 2015 by this author; that was the first time I had sampled extensively in southwest Minnesota, so curiosity may have led to more sampling effort per stream segment. Nevertheless, as was explained earlier in this report, compared to most non-standardized collection efforts 10 - 15 years ago, the abundance of *N. topeka* has declined dramatically in Minnesota. Unfortunately without a catch per unit effort metric, making definitive, empirical statements about declines is difficult. However, as was stated in the 2015 monitoring report, the landscape of southwest

Minnesota has changed significantly since 2000. These observations were born out by conversations with landowners who mentioned the vastly different landscape since the 1980s and 1990s. Still more evident was the continued conversion of grassland and tile drainage construction observed during the 2016 monitoring. Even though commodity prices are much lower than a few years ago, producers are still converting grassland and placing tile drainage in fields for row crop production. As I stated in the 2015 report, the land management changes within *N. topeka* watersheds leads to, and will continue to exacerbate over time, fundamental changes to stream dynamics (e.g. sediment, flow regimes, channel morphology, floodplain connectivity, and excess nutrient loading) that I believe has, and will continue to, negatively affect this species. As these stream systems experience flashier flow regimes in one part of the year and dry conditions in another portion of the year due to both changes on the landscape and climate change induced effects, the stream channels will lose connectivity with their floodplains and experience channel degradation, all of which will result in the loss of *N. topeka* preferred habitat.

Hybridization

An interesting aspect of this sampling effort, as was observed in 2015, was the collection of fish that appear to be a mix of *N. topeka* and *N. stramineus* genomes. These hybrid fish were found in four (4) localities: Segment 225, 229, 237, and 239. These hybrid fish represent a mix of characters between the two parental species. They do not demonstrate the typical diamond shaped scales of *N. stramineus* but the more oval shape of *N. topeka*. In addition, the scale margins above the lateral line are darkened by melanophores, creating an etched-like appearance typical of what you see in *N. topeka*. Also, the bodies of these fish are much deeper than a typical *N. stramineus*. These hybrid fish usually do not possess a chevron in the caudal peduncle, their snout is more pointed and their eyes are larger in diameter which is more typical of *N. stramineus*. Some of the *N. topeka* collected exhibited characters of a weakly developed chevron, very slightly pointed snout, and a portion of the pre-dorsal scales would be diamond-shaped. This suggests that some genetic component of *N. stramineus* to the genome of *N. topeka*. As was stated in the 2015 report, these hybrids appear to be occupying streams that no longer have off channel habitats, have become semi-entrenched, experience significant bank erosion, possess habitats more similar to the larger streams they are connected with but whose upper reaches still have, or did have until recently, *N. topeka* as part of the fish community. As a result of this degradation, prime habitat for *N. topeka* in these stream systems is very rare or nonexistent. So without appropriate spawning habitat, the two closely related species of *N. topeka* and *N. stramineus* are forced to share the same habitat and presumably the result is hybridization. Besides the research issue of altered hydrology in *N. topeka* streams, genetic

analysis of *N. topeka*, *N. stramineus*, and the hybrids that exists together in these streams should be topic of research by geneticists.

LITERATURE CITED

Ceas, P. A., and Y. C. Anderson. 2004. Results of a pilot monitoring project for Topeka shiners in southwestern Minnesota. Final report submitted to the Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources. 9+ pp.

Ceas, P. A., and K. A. Larson. 2010. Topeka shiner monitoring in Minnesota: Year seven. Final report submitted to the Division of Ecological Resources, Minnesota Department of Natural Resources. 10+ pp.

Cross, F.B. 1967. Handbook of Fishes of Kansas. Museum of Natural History, University of Kansas. Miscellaneous Publication 45.

Cunningham, G.R. 2015. Topeka Shiner Monitoring in Minnesota: 2015. Report to the Minnesota Department of Natural Resources.

Eddy, S. and J. C. Underhill. 1974. Northern fishes with special reference to the Upper Mississippi Valley. 2nd edition. University of Minnesota Press, Minneapolis.

Gelwicks, G. and S. A. Bruenderman. 1996. Status survey for the Topeka shiner in Missouri. Unpublished report. Missouri Department of Conservation.

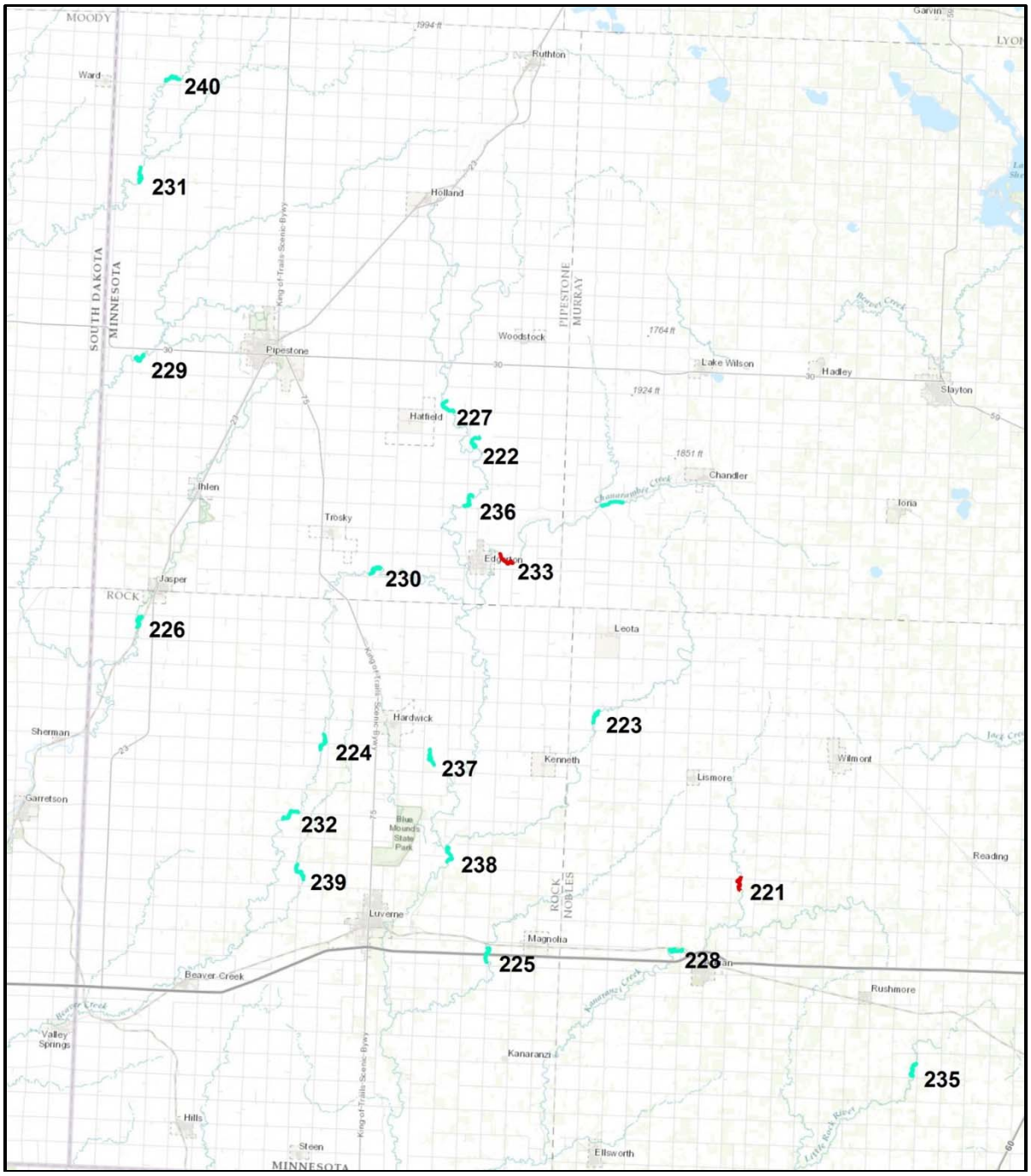
Nagle, B. C., and K. A. Larson. 2014. Topeka shiner monitoring in Minnesota: 2014. Final report, Division of Ecological and Water Resources, Minnesota Department of Natural Resources. 70 pp.

Pflieger, W. L. 1997. The fishes of Missouri. Missouri Department of Conservation.

Tabor, V. M. 1998. Final rule to list the Topeka shiner as endangered. Federal Register. 63: 69008-69021.

Tabor, V. M. 2002. Endangered and threatened wildlife and plants; designation of critical habitat for the Topeka shiner. Federal Register. 67: 54261-54306.

USFWS. 2009. Topeka Shiner (*Notropis topeka*) 5-year review: summary and evaluation. Kansas Ecological Field Office, Manhattan, KS.



Map 1. Overview of 2016 stream segments sampled for *N. topeka* monitoring.

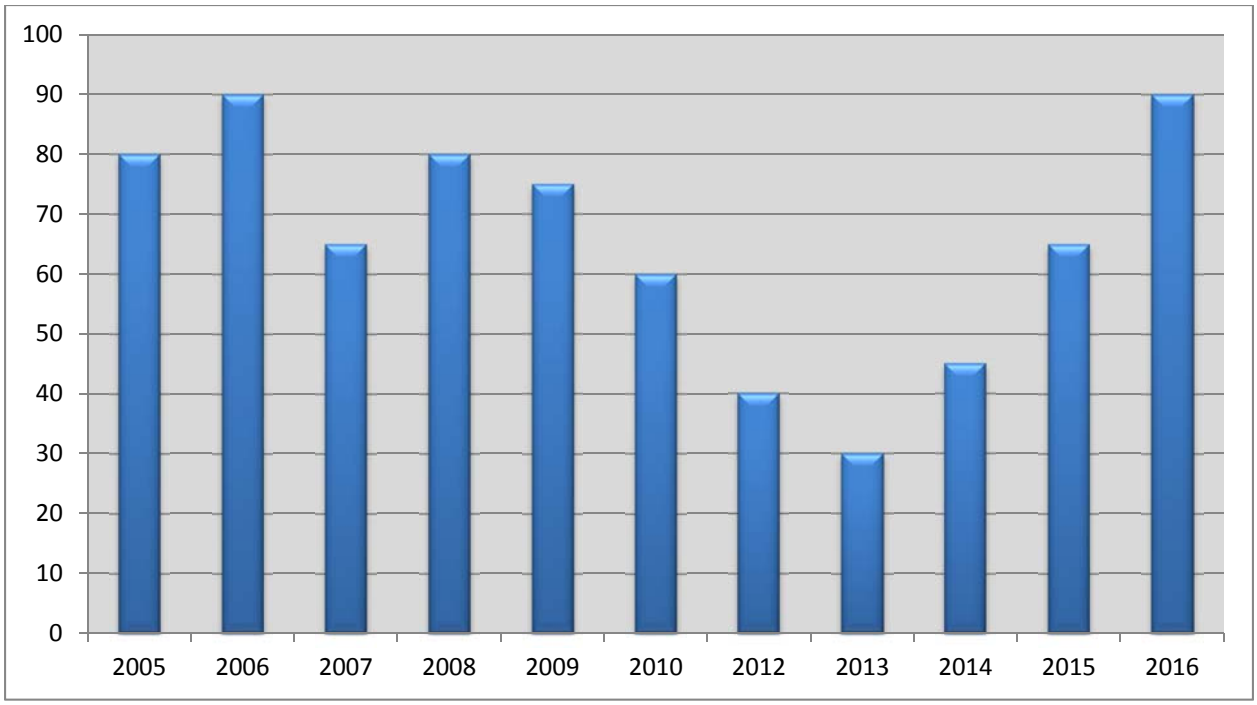


Figure 1. Percentage of randomly selected stream segments with *N. topeka*, 2004-2016.

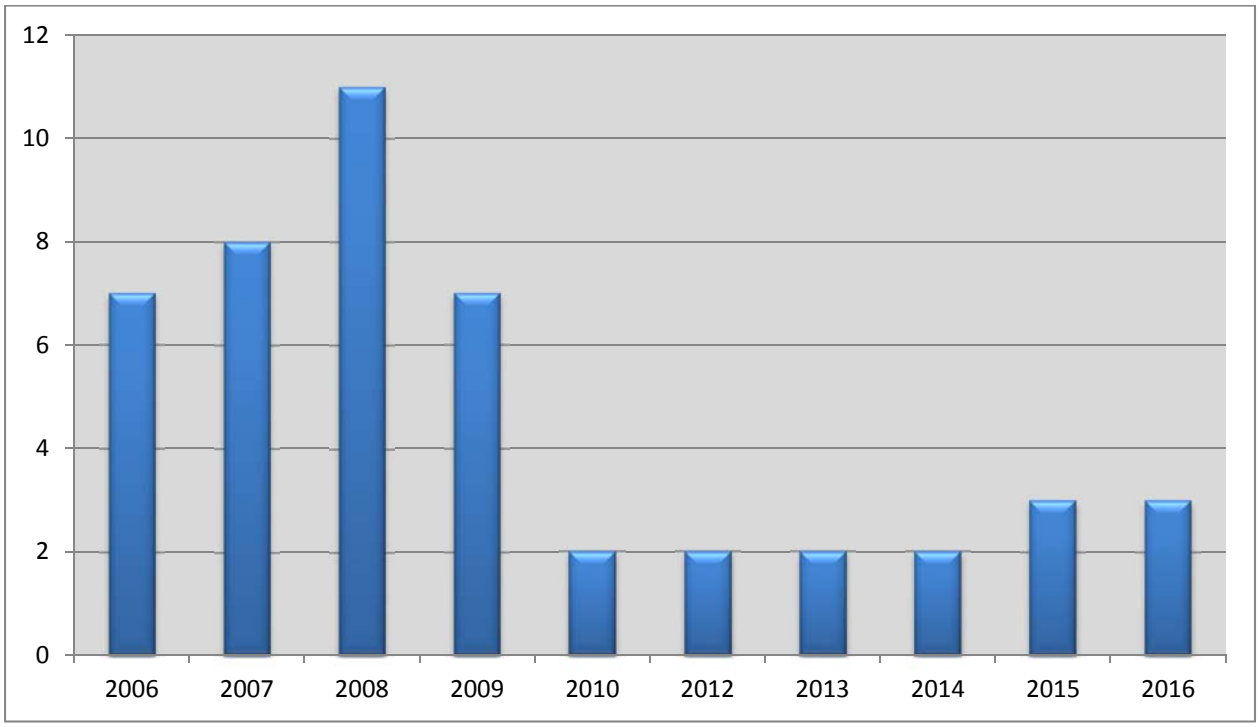
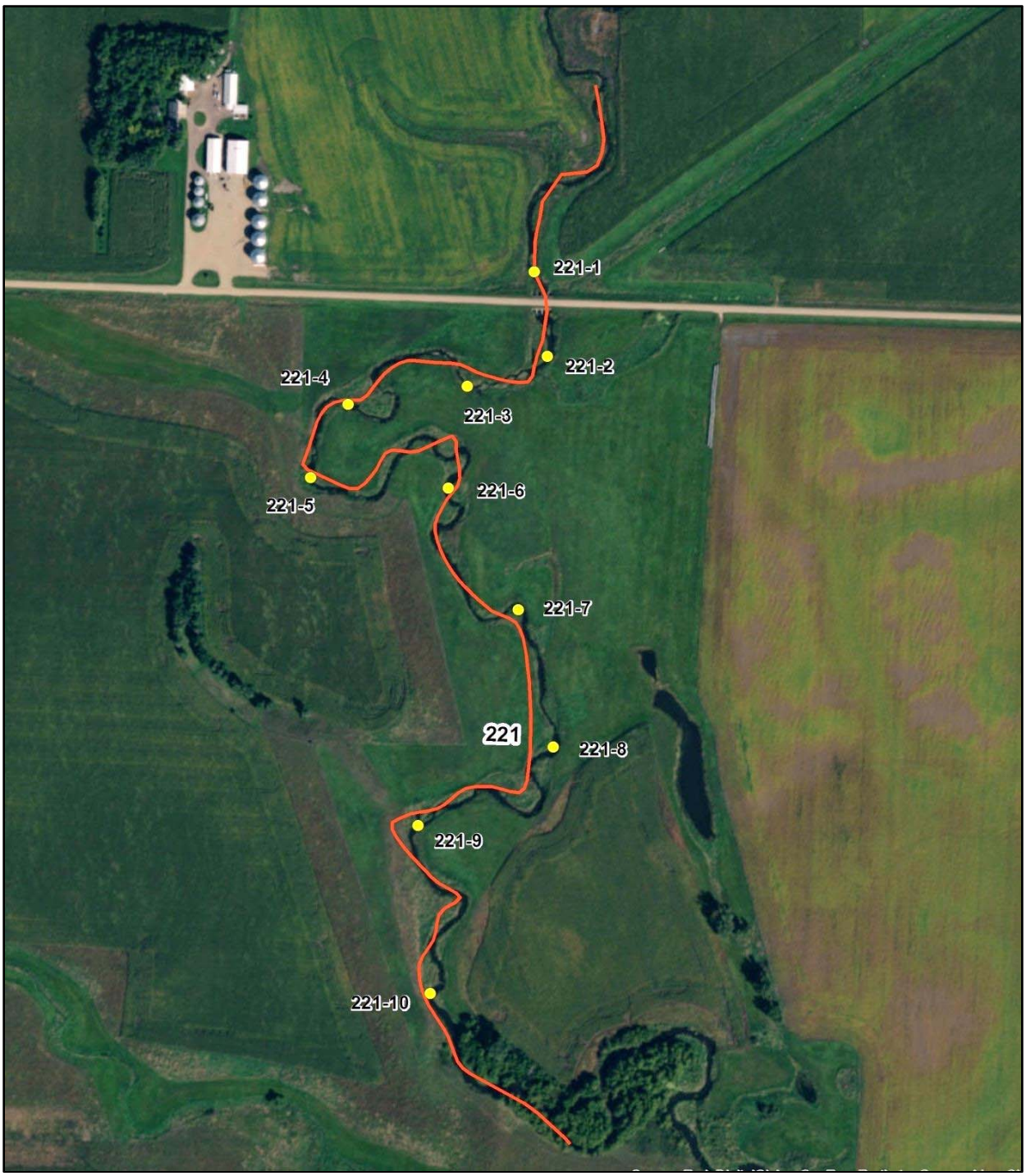


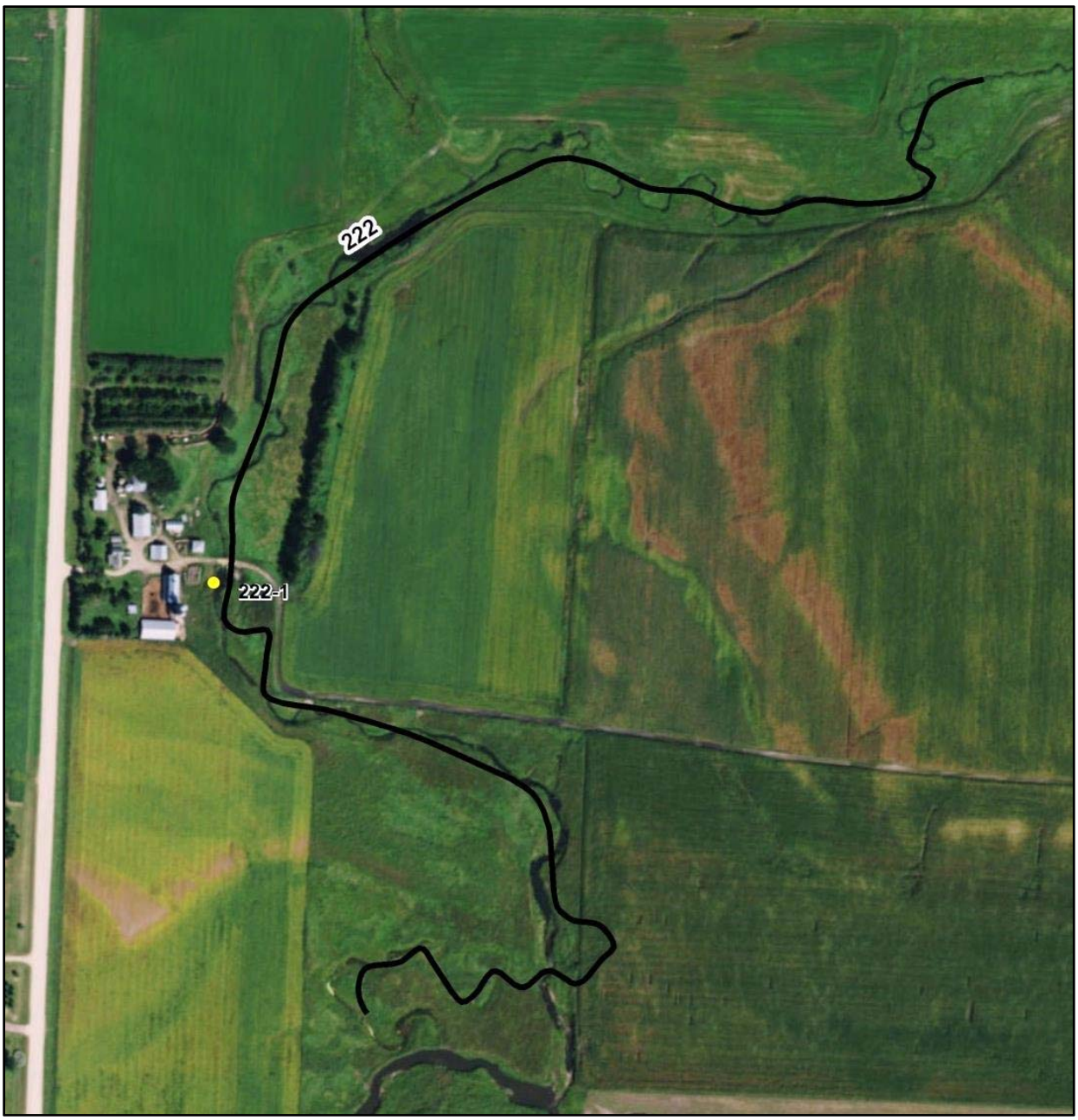
Figure 2. Number of sites where *N. topeka* was considered Abundant or Common, 2006-2016. The abundance measure is based on Ceas' and Nagle's definitions.

Appendix A

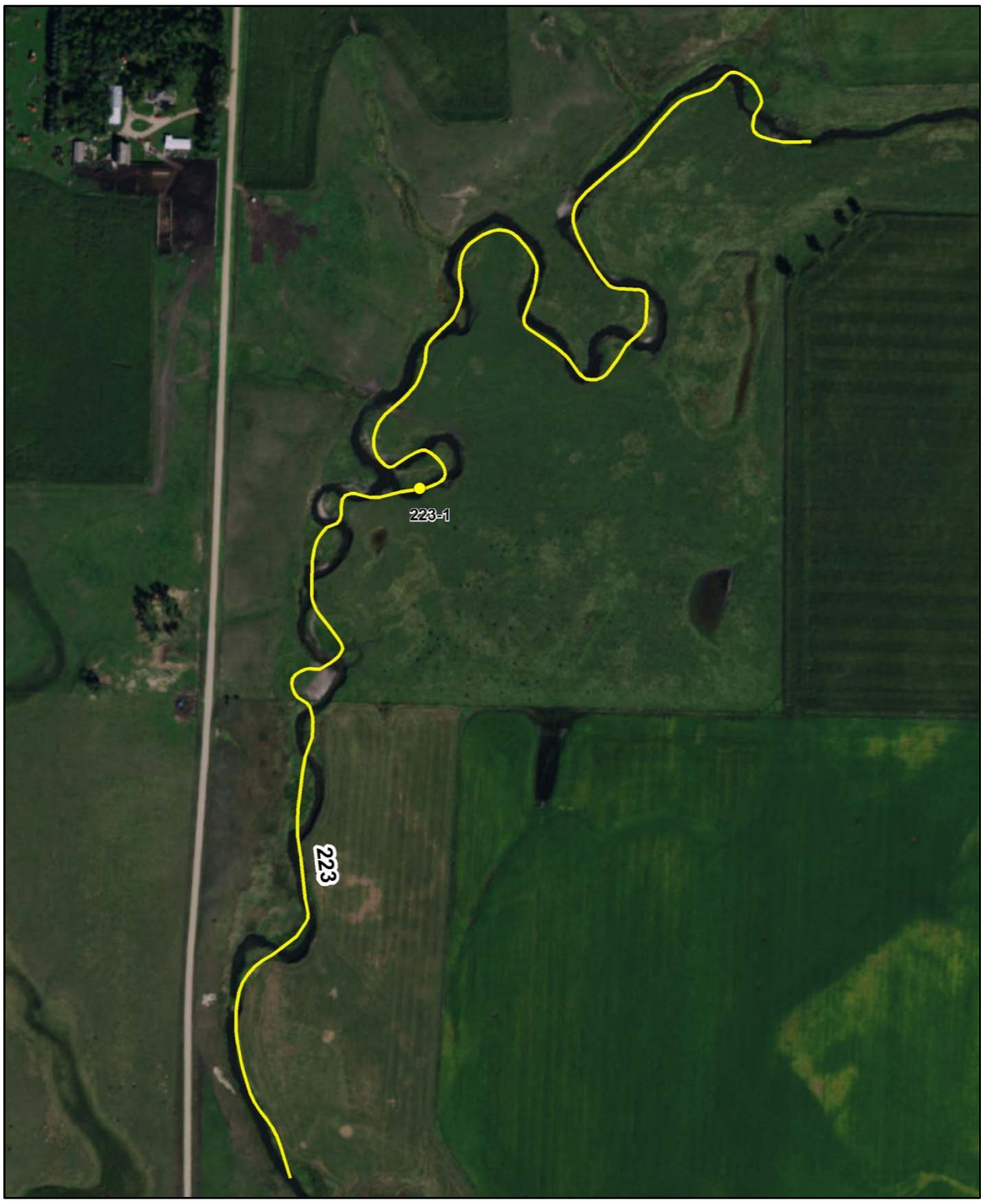
Maps 2-21. Aerial images of each randomly selected 1-mile stream segment sampled in 2016.



Map 2: Segment 221 (Sites 1-10)



Map 3: Segment 222 (Site 1)



Map 4: Segment 223 (Site 1)

Map 5: Segment 224 (Site 1)

Map 6: Segment 225 (Site 1)

Map 7: Segment 226 (Sites 1-3)

Map 8: Segment 227 (Site 1)

Map 9: Segment 228 (Sites 1&2)

Map 10: Segment 229 (Sites 1-4)

Map 11: Segment 230 (Site 1)

Map 12: Segment 231 (Sites 1-4)

Map 13: Segment 232 (Site 1)

Map 14: Segment 233 (Sites 1-10)

Map 15: Segment 234 (Sites 1&2)

Map 16: Segment 235 (Site 1)

Map 17: Segment 236 (Site 1)

Map 18: Segment 237 (Site 1)

Map 19: Segment 238 (Site 1)

Map 20: Segment 239 (Site 1)

Map 21: Segment 240 (Site 1)

Appendix B

Table 1. Stream segment descriptions and sampling site location data for 2016.

Table 2. List of fish species collected at all stream segments in 2016.

Table 1. Locations of the 20 stream Segments sampled in 2016, corresponding sampling sites within each segment, and a brief habitat description for each segment.

Segment	Stream	County	Township	Range	Section	Habitat Type	Site Number	Latitude	Longitude	Date
221	Kanaranzi Creek	Nobles	103	42	32	in-channel/MCB	221-1	43.68896353	-95.90587457	2016-06-28
						in-channel/MCB	221-2	43.68827792	-95.90569813	
						pool	221-3	43.68801464	-95.9065808	
						pool	221-4	43.68783228	-95.90791196	
						pool	221-5	43.68722442	-95.9083007	
						pool	221-6	43.68717927	-95.9067563	
						pool	221-7	43.68620797	-95.90592242	
						pool	221-8	43.68510309	-95.90547562	
						in-channel/MCB	221-9	43.6844205	-95.90696	
						pool	221-10	43.68306162	-95.90676027	
Very heterogeneous instream habitat composed of submerged sand/silt bars, deep run pools, deep undercut banks, areas of riffles composed of boulders, patches of cobble in runs; aquatic macrophytes abundant; substrate composed of sand/silt and with area of cobble and boulders; high water, water temperature cold to cool; pasture south of the road but north of the road row crops nearly to stream. Width approx. 4m, depth 0.75 to >1.5m. No *N. topeka* captured.										
222	unnamed trib to Rock River	Pipestone	106	44	33	channel border pool	222-1	43.946228	-96.142858	2016-06-17
Clear, cool water, deep hole at culvert crossing, substrate composed of cobble and gravel; width of 3-3.5m, 0.5m deep. *N. topeka* common in this habitat. *Ranunculus* sp. abundant throughout stream; landuse is pasture but degraded, wintering area for cattle slopes down to stream.										
223	Champepadan Creek	Nobles	104	43	29	off channel pool	223-1	43.784374	-96.031293	2016-06-16
Stream flows through native grassland, very high ridge (moranine) west of the stream; water was very turbid, collapsed stream banks evident, undercut banks; sampling site was a cut off meander with deep muck with some gravel. *N. topeka* present.										
224	Beaver Creek	Rock	104	45	5	glide pool/run	224-1	43.761389	-96.255381	2016-06-15
Water was turbid, high water; sampled site was pool margin of a large culvert pool by road crossing; >5 m wide, 1-1.5 m deep, substrate was muck with gravel and sand. *N. topeka* present. Southside the stream flowed through pasture but on the north side row crop was close to the stream.										
225	Elk Creek	Rock	102	44	16	channel border pool	225-1	43.638197	-96.114619	2016-06-15
High water; stream flows through pasture; site collection was a main channel border pool with an undercut bank and instream vegetation; substrate was silty muck; site was 1 m deep and 3 m wide. *N. topeka* present.										

Table 1. Continued

226	Split Rock Creek	Rock	104	47	12	bend pool	226-1	43.83189412	-96.41476926	2016-06-18
						bend pool	226-2	43.83129351	-96.41428552	
						channel border pool	226-3	43.832136	-96.412991	TS location
Stream flows through pasture, grazing pressure moderately high, erosion evident along the sampled sites, banks undercut; habitat is mostly long runs and straights with a few bend pools, this is a result of an entrenched system where the top of the bank is very high from the water line; water was turbid and high flow; substrate was a combination of gravel sand and silt; site with *N. topeka* was a shallow vegetated channel border pool with mostly a silt substrate. *N. topeka* present.										
227	Rock River	Pipestone	106	44	29	main channel border	227-1	43.96459	-96.158721	2016-06-17
Water was warm and turbid, slow moving current; 1 m deep, 4-5 m wide, substrate was mostly silt; *N. topeka* was common. Stream flows through pasture but row crop on the hilltops.										
228	Kanaranzi Creek	Nobles	102	43	14	off channel pool	228-1	43.644789	-95.959818	2016-06-15
						off channel pool	228-2	43.644186	-95.960261	TS location
Sampled sites were in a recently restored oxbow, substrate was silt and sand with some gravel. *N. topeka* present only in 228-2. Recent heavy rain fall event resulted in very high water in the stream system outside the oxbow.										
229	Pipestone Creek	Pipestone	106	46	18	channel border pool	229-1	43.98928875	-96.42582161	2016-06-16
						channel margin	229-2	43.98940297	-96.42428507	
						riffle	229-3	43.98859934	-96.42559482	
						main channel pool	229-4	43.988417	-96.424283	TS location
Fast moving flow, turbid conditions; high banks are eroded along the tight bends of the stream, banks undercut; stream flows through pasture; substrate is silt along the margins but gravel and sand in the mid-channel; 1 - 1.5 m deep, 5 - 8 m wide. Site with *N. topeka* was the margin of the main channel, undercut banks with sand and gravel, slower current but deep. *N. topeka* present.										
230	Poplar Creek	Pipestone	105	45	26	off channel pool	230-1	43.864933	-96.222953	2016-06-18
Semi-entrenched system, undercut eroded banks, stream had riffle, pool, bend configuration with substrate of boulder and cobble; 3 -4 m wide, 0.75 m deep; stream flows through a narrow band of pasture with row crop close to the stream on either side. The site of *N. topeka* capture was an off-channel pool with cold water temperature, abundant *Ranunculus* sp. with substrate of silt and sand. *N. topeka* present.										
231	Flandreau Creek	Pipestone	107	47	1	main channel	231-1	44.09939963	-96.42891166	2016-06-17
		Pipestone	107	46	6	riffle	231-2	44.09918147	-96.42807635	
						main channel border	231-3	44.09867964	-96.42801346	
						main channel border	231-4	44.097796	-96.427444	TS location
Stream flows through pasture, water was turbid and fast; stream is a series of long run pools with bend pools, moderate amount of bank erosion, undercut banks in places, substrate was boulder and cobble with a layer of silt. The *N. topeka* collection site was the shallow margin of large side pool adjacent to the main channel; substrate was muck and silt. *N. topeka* present.										

Table 1. Continued

232	Beaver Creek	Rock	103	45	18	main channel border	232-1	43.719318	-96.2782	2016-06-15
Stream flows along the base of a bluff, boulders present along bluff and major part of stream substrate, in shallow areas the substrate is a mix of cobble and gravel with a fine layer of silt; abundant submerged vegetation along channel margin; 1.5 - 2 m wide and 0.5 - 0.75m deep; valley is grazing land with row crop on top of bluff; *N. topeka* commonly collected in all habitat described herein.										
233	Chanarambie Creek	Pipestone	105	44	22	glide run/pool	233-1	43.87738416	-96.11427777	2016-06-27
						riffle	233-2	43.87809771	-96.11457638	
						bend pool	233-3	43.87912379	-96.11511224	
						channel border pool	233-4	43.87986091	-96.11532086	
						bend pool	233-5	43.87638815	-96.11256287	
						bend pool	233-6	43.87564334	-96.11143343	
						bend pool	233-7	43.87399915	-96.10854249	
						bend pool	233-8	43.87494707	-96.10678175	
						bend pool	233-9	43.87552525	-96.10696762	
						channel border pool	233-10	43.87559953	-96.10610089	
Entrenched stream segment, vertical eroding banks immediately north and south of the highway; north of the highway very little pool habitat and no undercut banks; substrate was silt and gravel with muck along the channel margin. South of the highway the stream is mostly a long series of glide pools separated by boulder riffles, large woody debris in places, drainage pipes common along this reach; substrate is rubble and boulder; undercut banks and deep pools; row crop very near the stream, little to no connection with the floodplain. *N. topeka* was not collected in this segment.										
234	Chanarambie Creek	Murray	105	43	8	main channel	234-1	43.91111827	-96.03200374	2016-06-17
						main channel border	234-2	43.910915	-96.031351	TS location
Previously ditched channel, now entrenched, substrate is boulder, cobble and gravel with channel margin sand and silt; stream a series of runs-riffles-pools; The *N. topeka* site was the main channel pool margin of undercut banks and sand and silt substrate, this area also was at confluence with a very small tributary entering Chanarambie Creek. *N. topeka* present.										
235	Little Rock River	Nobles	101	41	4	off channel pool	235-1	43.575725	-95.758173	2016-06-16
Very high and fast moving water; turbid; stream is semi-entrenched with eroding banks; flows through pasture however the floodplain was once actively farmed now is a restoration program; 1.2 -1.75 m deep, 4 m wide; substrate gravel and sand. *N. topeka* collected at the margin of a large bend pool, undercut bank with much slower moving water, substrate was sand and silt. *N. topeka* present.										
236	Rock River	Pipestone	105	44	9	main channel border	236-1	43.908397	-96.144514	2016-06-17
Turbid and deep in main channel, >6 m wide and > 1.5 deep, substrate was deep silt; stream banks well vegetated with some undercut banks. *N. topeka* present.										

Table 1. Continued

237	unnamed trib to Rock River	Rock	103	44	6	main channel border	237-1	43.756983	-96.168301	2016-06-15
Stream flows through pasture with row crop in close proximity to the stream; turbid high water; undercut banks, collapsed clay wedges in main channel; substrate a mix of cobble and gravel with sand and silt along channel margin; 0.75 -1 m deep, 3 - 3.5 m wide. *N. topeka* was collected along channel bend in area with collapsed banks forming little pockets of pooled slower water. *N. topeka* present.										
238	Rock River	Rock	103	44	29	channel border pool	238-1	43.701549	-96.150251	2016-06-27
Stream flows through pasture and woodland with row crop on tables but occasionally near stream bank; turbid, warm water conditions, the stream segment is wide and large, eroded banks along segment, very high banks in places, bendway weirs along portions, large woody debris; stream composed on long straights, riffles and bend pools, substrate mostly silt and muck with pockets of gravel, shallow runs and riffles have sand and gravel; Site of *N. topeka* collection was just downstream of tributary confluence along a channel border pool that was deep with undercut banks and muck substrate. *N. topeka* present.										
239	Little Beaver Creek	Rock	103	45	31	main channel	239-1	43.683175	-96.272501	2016-06-15
High water, turbid, entrenched and ditched stream system; row crop adjacent to stream banks; substrate deep silt. The *N. topeka* collection site was a pool formed by the road culvert. The substrate was concrete, sand and silt with vegetated banks. *N. topeka* present.										
240	Willow Creek	Pipestone	108	46	17	channel border	240-1	44.157708	-96.39888	2016-06-16
Straighten section of stream, flows through heavily grazed pasture, banks highly impacted by cattle activity; water turbid, no noticeable flow; deep silt is substrate with gravel and boulders near bridge abutments. The *N. topeka* collection site was the margin of a long straight pool with undercut banks and silt substrate. *N. topeka* present.										

Table 2. Complete List of Fish Species Captured at Segments 221-240 for Sampling Year 2016.

Species	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Cyprinus carpio					X (r)	X (f)							X (f)		X (r)					
Campostoma anomalum	X (c)	X (c)	X (f)		X (c)	X (r)				X (f)		X (c)	X (r)	X (f)			X (a)	X (r)	X (c)	X (f)
Chrosomus erythrogaster	X (va)	X (c)																		
Cyprinella lutrensis					X (r)	X (f)	X (r)		X (a)	X (r)	X (r)	X (r)	X (c)					X (r)		X (f)
Hybognathus hankinsoni					X (r)					X (r)	X (c)		X (f)	X (f)	X (f)		X (r)	X (f)		X (a)
Luxilus cornutus	X (a)	X (c)	X (f)	X (c)		X (f)	X (f)			X (c)	X (va)	X (c)	X (a)	X (a)		X (c)	X (c)	X (c)	X (f)	X (c)
Notropis dorsalis	X (r)	X (r)	X (f)	X (r)		X (c)	X (r)			X (f)	X (r)		X (a)	X (r)	X (c)			X (c)	X (f)	X (f)
Notropis stramineus	X (r)	X (c)	X (c)	X (r)	X (f)	X (c)	X (c)		X (a)	X (c)	X (f)		X (a)	X (f)	X (a)	X (f)	X (f)	X (c)	X (r)	
Notropis topeka*		**X (c)**	**X (p)**	**X (p)**	**X (p)**	**X (p)**	**X (c)**	**X (p)**	**X (p)**	**X (p)**	**X (p)**	**X (c)**		**X (p)**	**X (p)**	**X (p)**	**X (p)**	**X (p)**	**X (p)**	**X (p)**
Pimephales notatus	X (c)	X (a)	X (c)		X (f)	X (a)	X (f)	X (a)	X (f)	X (f)	X (a)		X (f)	X (va)	X (c)		X (c)	X (c)		X (f)
Pimephales promelas	X (va)	X (c)	X (a)	X (va)	X (a)	X (a)	X (c)	X (c)	X (c)	X (a)		X (a)			X (c)	X (c)	X (c)	X (a)	X (a)	X (c)
Rhinichthys obstusus	X (f)	X (c)								X (f)	X (r)		X (r)	X (r)			X (c)	X (r)	X (r)	
Semotilus atromaculatus	X (va)	X (c)	X (a)		X (a)	X (a)		X (a)	X (c)	X (c)	X (a)			X (va)	X (a)	X (c)	X (a)	X (a)	X (a)	X (c)
Catostomus commersoni	X (a)	X (c)	X (c)		X (f)	X (c)	X (c)	X (r)	X (f)	X (a)	X (c)	X (r)	X (c)	X (a)	X (c)		X (r)	X (c)	X (r)	X (f)
Carpiodes carpio																		X (f)		
Moxostoma erythrurum													X (r)							
Ameiurus melas	X (r)			X (r)	X (f)			X (r)		X (r)	X (r)	X (r)	X (r)						X (r)	
Noturus gyrinus	X (r)		X (r)			X (r)					X (f)	X (r)	X (r)							X (r)
Noturus flavus													X (f)							
Esox lucius							X (r)								X (r)					
Percopsis omiscomaycus													X (r)							
Fundulus sciadicus			**X (r)**							**X (r)**										
Culaea inconstans	X (f)	X (r)						X (r)			X (f)				X (r)					
Micropterus salmoides	X (r)																	X (r)		
Lepomis cyanellus	X (r)		X (f)		X (r)	X (f)	X (r)	X (c)		X (f)	X (c)	X (c)	X (r)	X (f)			X (r)			X (f)
Lepomis macrochirus	X (r)			X (f)									X (r)		X (r)	X (f)				
Lepomis humilis	X (f)		X (f)			X (c)		X (f)	X (f)		X (f)	X (c)	X (f)	X (f)		X (f)		X (f)		
Pomoxis nigromaculatus													X (r)							
Etheostoma exile	X (f)							X (r)	X (r)				X (r)							X (r)
Etheostoma nigrum	X (c)	X (r)			X (f)	X (f)				X (r)	X (f)				X (f)		X (r)		X (f)	X (f)
Perca flavescens														X (r)						
Percina maculata												X (r)	X (r)							

** Abundance based on Ceas and Nagle definition*

Abundance Categories:

va Very Abundant > 35 individuals

a Abundant > 20 individuals

c Common > 10 individuals

f Few > 5 individuals

r Rare < 5 individuals

APPENDIX C: PHOTOGRAPHS OF HABITAT & FISH

Stream photographs for Segments with no *N. topeka* collected are representative stream habitat for the 1-mile stream segments. Stream photographs for those Segments with *N. topeka* are the actual stream sites inhabited by *N. topeka*. The yellow outlined areas on these photographs represent the exact location where the species was captured. Voucher photographs of *N. topeka* from the actual site of capture are included.

Segment 221, Kanaranzi Creek, general habitat photo.

No *N. topeka* collected.

Segment 222-1, unnamed tributary to the Rock River, *N. topeka* collection site and voucher photo.

Segment 223, Champepadan Creek, general habitat photo.

Yellow square is the image on the next page as a close up.

Segment 223-1, Champepadan Creek, *N. topeka* collection site and voucher photo.

Segment 224-1, Beaver Creek, *N. topeka* collection site and voucher photo.

Segment 225-1, Elk Creek, *N. topeka* collection site and voucher photo.

Segment 226-3, Split Rock Creek, *N. topeka* collection site and voucher photo.

Segment 227-1, Rock River, *N. topeka* collection site and voucher photo.

Segment 228-1, Kanaranzi Creek, *N. topeka* collection site and voucher photo.

Segment 229-4, Pipestone Creek, *N. topeka* collection site and voucher photo.

Segment 230-1, Poplar Creek, *N. topeka* collection site and voucher photo.

Segment 231-4, Flandreau Creek, *N. topeka* collection site and voucher photo.

Segment 232-1, Beaver Creek, *N. topeka* collection site and voucher photo.

Segment 233, Chanarambie Creek, general habitat photos.

No *N. topeka* collected.

Segment 234-2, Chanarambie Creek, *N. topeka* collection site and voucher photo.

Segment 235-1, Little Rock River, *N. topeka* collection site and voucher photo.

Segment 236-1, Rock River, *N. topeka* collection site and voucher photo.

Segment 237-1, unnamed tributary to the Rock River, *N. topeka* collection site and voucher photo.

Segment 238-1, Rock River, *N. topeka* collection site and voucher photo.

Segment 239-1, Little Beaver Creek, *N. topeka* collection site and voucher photo.

Segment 240-1, Willow Creek**,** *N. topeka* collection site and voucher photo.