Topeka Shiner Monitoring in Minnesota: 2017

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Contents

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**.

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 yearly 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 (2014). I conducted monitoring efforts in 2015, and under a 2 year contract with DNR, myself and Konrad Schmidt have completed monitoring for the years 2016 and 2017.

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, I collected *N. topeka* at 65% of the stream segments, but in 2016 this species was observed in 90% of the assigned stream segments (Cunningham 2016). 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 and 2016. Results from the monitoring surveys conducted in 2017 are detailed in this report with a discussion regarding previous survey efforts and results.

METHODS

Sampling methods for the 2017 monitoring generally followed the previous methods by Ceas and Nagle, but deviated from previous sampling efforts by using a fixed distance sampling measure at ***all*** stream segments. Using a fixed distance measure will allow for further statistical analysis of sampling over time using a catch per unit effort metric, a standard analysis measure in fish sampling research. We used a 50 meter sampling distance at each assigned stream segment with a maximum of 10 sites sampled per segment following the protocol establish by Ceas and Anderson (2004). For clarification, the term “segment” refers to one of the 20 one-mile randomly

assigned streams, whereas the term "site" is the 50 meter sampling distance and is delimited by a number from 1 – 10 (ex. 241-1).

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 2017 survey were provided to me by the DNR and overlaid on aerial imagery (**Appendix A**). The location of the 2017 stream segments are depicted in **Figure 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. Also, we sampled several locations via canoe. Since land access denial and/or skepticism of our intent was challenged by landowners in 2015 and 2016 (mostly the result of MN establishing buffer strip requirements on public waters, but originally proposed on all waterways) we choose to traverse several streams that were floatable rather than potentially be denied access.

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). In 2017, the use of backup segments was not necessary since we were granted access or floated the waterbody to the assigned segment.

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 of the 50 meter sampling site.

Fish Sampling

Presence/absence surveys were conducted for *N. topeka* using 12' x 4' or 8' X 4' wall seines with 1/4" mesh during 21 – 27 June 2017. Sampling efforts were focused on low-flow areas along the main channel border, in-channel pools, bend pools, deep undercut banks, backwaters, and off-channel ponds and oxbows. Again, a 50 meter standardize sampling distance was used during this survey effort. We followed the protocol established by MNDNR that states once *N. topeka* has been collected at a site, no further sampling is required in that segment. If we did not encounter *N. topeka* we continued sampling a stream segment until 10 sites had been sampled. Thus, for each stream segment, sampling occurred until *N. topeka* was collected or 10 sites (each of 50 meters) were sampled at locations deemed the most suitable for *N. topeka* based on our professional judgment. These sites were distributed throughout the 1-mile segment rather than lumped in close proximity to each other in a short stretch of the segment. Although no systematic population size estimate methodology is used in this presence/absence survey protocol, 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 12 of the 20 one-mile stream segments sampled (60%). Stream segments where this species was observed are listed in **Table 2 of Appendix B**. The percent occupancy is similar to sampling years of 2015 and 2007 (**Figure 2**). Average percent occupancy for randomly selected stream segments across all years of monitoring (2004-2017) is 66%. This is down from a 79% occupancy during the first six (6) years of monitoring.

As for the abundance of *N. topeka* at occupied stream segments, we observed an increase in those segments where the number of *N. topeka* collected was considered common or abundant based on the definitions by Ceas and Nagle. **Figure 3** depicts the number of stream segments considered to be *Common* or *Abundant* for *N. topeka* from 2006 - 2017. Any comparison of

abundance with previous surveys is difficult because different investigators use slightly different methods of sampling without using a standard unit of distance sampled at each site within a stream segment, which leads to high variability. 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 indicates 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 channels was a common occurrence. They would easily find 30 to 50 individuals and sometimes more than a 100 in certain habitats. Only in Segment 246 did we observe large numbers of *N. topeka*.

A total of 27 fish species were collected during the 2017 surveys, however one (1) species, *Umbra limi* (Central Mud Minnow) was found outside the assigned segment boundary of Segment 259 and is not included in **Table 2 of Appendix B**. *Fundulus sciadicus* (Plains Topminnow), a threatened species in Minnesota, was collected in four (4) stream segments. 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 241 – The stream segment is contiguous to Segment 242, however the upper reach of this stream (above Site 241-8) has much less water and very homogeneous habitat. The pasture adjacent to the stream is severely grazed and the stream banks are collapsed in a number of places. The water was turbid from silt, and the substrate was silt and sand and gravel. The lower portion of the stream has an appearance much like Segment 242 but a steeper gradient; the pasture is in better condition. The stream habitat was composed of bend pools, riffles, and undercut banks. It is very odd that *N. topeka* was not found in this segment given its adjacency to Segment 242. I suspect ground water from the ridge to the west and the ridge to the southeast is providing the flows for this headwater stream.

Segment 242 – Stream was cold with blackish tannic water and very little velocity. The substrate was a sand gravel mix with a mud/silt layer above. Emergent and submergent vegetation was present and well undercut meandering stream banks. The stream flows through pasture on the west side of road crossing, and the east side has pasture with row crop along east side. *N. topeka* was easy to find in this site with abundance categorized as “common”.

Segment 243 – Extreme headwaters of the stream, this segment has been dredged in the past, evidenced by dredge piles parallel to stream course. Very dense stands of Narrow-leaf Cattail and *Phragmites*, also dense stands of other submergent and emergent vegetation. This is not *N. topeka* habitat and suspect this area was a large wetland system prior to dredging. Most likely little to no water in hot, dry years. Stream is only 1 m wide and on average 0.5 m deep with some pool areas 1 m deep. Very few individual fish of any species found in this segment.

Segment 244 – Stream flows through pasture but row crop is nearby; substrate was silt with sand and gravel. Both emergent and submergent vegetation present. The pool is actually an old dugout area evidenced by dredge spoil in the south side of the stream. *N. topeka* easily collected in this site and categorized as "abundant".

Segment 245 – Meander stream flowing through grassland with high moraine features. Stream habitat composed of undercut banks and complex habitat of bend pools, runs, and pools with some vertical bank erosion; substrate compacted gravel with silt along the border, deeper bend pools with gravel and silt substrate. *N. topeka* easily collected at this site and categorized as "abundant".

Segment 246 – Headwaters of the stream, flows through pasture bordered by moraines; lower end of the segment is a deep (>2 m deep) and long pool, the remainder of stream is 0.5 - 1 m deep and 0.5 - 1 m wide. Substrate was packed gravel with areas of sand and silt, some areas of muck. Cool water temperature and slightly turbid. Site 246-5 is a dugout pond 1 m higher in elevation than the stream bank, the substrate was compacted silt and sand. A large number of *N. topeka* in this habitat, thus it is categorized as "abundant".

Segment 247 – Headwaters of the stream, flows through pasture but row crop very near on both sides; upper 1/3 of stream has exposed bedrock as the substrate with silt pools in the lower reach. Abundant submergent vegetation with dense stands of Reed Canary Grass throughout the margin of the stream banks. The water was clear with temperature varying from cool to warm. Habitat consisted of many long pools with silt and muck substrate. These long pools where inhabited by large numbers of *F. sciadicus*.

Segment 248 – The stream was slightly turbid with a substrate mixture of boulders, silt and sand. A diversity of habitat types existed with pools, undercut banks, long straights, and beaver dams. Reed Canary Grass dominated the stream banks and submergent vegetation present throughout. *N. topeka* easily found and is classified as "common".

Segment 249 – Stream flow through pasture but row crop very close by in places; moderate gradiant with relatively fast moving flow and slightly turbid. Multiple habitat types were present but fairly long areas of glide runs which are the result of previous ditching. The substrate was

gravel and sand with a layer of silt. Dugout pond (Site 249-8) with abundant *P. promelas*, an indication the pond may freeze completely in winter.

Segment 250 – Headwaters of the stream system. Densely vegetated with Narrow-leaf Cattail and very little water, shallow and narrow in the lower reach but further upstream large, long pools present. Overall very little habitat diversity throughout the segment. The pasture is heavily grazed with Reed Canary Grass as dominate vegetation along the stream margin. This segment is not typical *N. topeka* habitat, plus this segment of stream is located above the dams in Blue Mounds State Park and historically *N. topeka* has not been collected upstream of these dams.

Segment 251 – The surrounding upland habitat is pasture, the water was turbid with moderate to fast flow. Lots of bank erosion throughout, many vertical eroded banks, but undercut bank habitat common throughout. The substrate is muck with some sand. The *N. topeka* collection site was at the confluence of a grassed waterway inlet, most likely tile drainage enters further up in the grassed waterway since the water temperature was cool. *N. topeka* present and the species' abundance was considered "present".

Segment 252 – Stream flows through heavily grazed pasture, with substrate composed mostly of silty muck with only a few areas with gravel. The water was very turbid. The stream is mostly shallow, particularly along the cattle crossing points and only about 1 m in width. There was very little habitat diversity throughout the segment. The segment does not represent typical *N. topeka* habitat.

Segment 253 – Stream flows through pasture with a moraine on the north and west side of the stream. Diverse habitat types composed of straights, pools and undercut banks but the stream is entrenched 4 - 5 m below historic floodplain. Low number of fishes collected in most seine hauls, this may be due to spring and early summer aerial spraying for thistles (per conversation with renter). Substrate mostly sand with gravel and silt, the water was warm and turbid. I was surprised *N. topeka* was not collected in this segment since it was collected a short distance further downstream in 2016.

Segment 254 – The stream is entrenched with sand dominated substrate including some areas of gravel and silt. The stream banks were eroded, vertical walls in places and concrete as stabilization material in areas. The water was turbid and evidence that the water level recently receded from high flows. This segment of stream has a highly altered morphology upstream with a landscape dominated by row crop with numerous tile drainage outlets. The *N. topeka* site was a small pocket pool with an undercut bank and flooded terrestrial vegetation. The abundance of this species was categorized as "present".

Segment 255 – The stream's water velocity was fast and the temperature was cool, mostly likely from title drainage inputs. A grass border exists on the north side of stream west of the road crossing with corn along the south border. The stream was slightly turbid with muck substrate near the culvert. On the east side of the road crossing the stream is bordered by trees, many exposed roots and highly eroded banks; the substrate was muck with some sand and gravel patches as well as clay hard pan in places. *N. topeka* collected in the pool immediately adjacent to the culvert. The species' abundance was categorized as "present".

Segment 256 – This segment is the main stem of the Rock River but also a disconnected side channel/pool. The main channel was wide, turbid, with substrate composed of gravel and sand. The upland condition is a treed border along the main channel with some row crop to bank edge. The *N. topeka* collection site is an off channel pool of the main stem of the Rock River. This area is a remnant of the abandon main channel. The habitat consisted of no flow, warm water, turbid with muck substrate with deep muck in places. Willow brush surrounded the off channel habitat and flooded willow was present. *N. topeka* present in large numbers and is categorized as "abundant".

Segment 257 – Surrounding land use is pasture with row crop on the more level ground. The substrate was muck, the water was turbid and fast. The stream had numerous undercut banks, bank erosion was abundant with areas of vertical walls. *N. topeka* was collected along a channel bend pool that was connected to an off channel pool fed by a title drainage outlet. The abundance of the species was considered "present".

Segment 258 – Stream velocity was fast and the water was turbid. Site 258-1 had hard packed gravel and cobble substrate, the other two sites had muck as the substrate. Only a very thin grass strip along the field border separated the stream from row crop. In many areas along the stream bank the corn was planted right on top of the bank; vertical eroded banks in many places. The stream was fairly wide at 4 -5 m. The *F. sciadicus* location was a side channel backwater with abundant emergent and submergent vegetation. The *N. topeka* location was a deep bend pool with an undercut bank. *N. topeka* was considered "present" in abundance.

Segment 259 – Very wide (+ 10 m) stream with a heavy bed load of sand but with areas of muck and patches of gravel. Surrounding landscape is pasture but row crop close to the stream bank in places. A number of tile drainage outlets present. Very few undercut banks or pool habitat, mostly shallow channel habitat and noticeable stream bed degraded throughout. *N. topeka* and *F. sciadicus* were collected at the same site which was along the channel border in a shallow, well vegetated area fed by a tile drainage outlet. *N. topeka* abundance was categorized as "common".

Segment 260 – Stream flows through pasture and restored grassland, the water was slightly turbid and the flow was fast. The substrate was gravel and sand with layer of silt, boulder riffles in places. Also, long straight areas within this segment but overall it was fairly shallow. The number of individual fish was noticeably low, even in the gravel and boulder riffle. The larger bodied fish were found in shallow areas - a likely effect of *E. lucius* presence that probably is forcing fish to use shallow areas. The source of *E. lucius* is probably the sand and gravel lakes scattered throughout the watershed.

DISCUSSION

The result of this 2017 monitoring survey indicates a slight decrease in the percent of occupied stream segments from 2016, however the number of segments with greater *N. topeka* abundance increased. Although the percent occupancy decreased, the 2017 results are still higher than the years of 2010 to 2014. The majority of the change in occupancy from 2016 to 2017 is most likely related to the kinds of stream segments that were sampled in 2017. Several of the segments (241, 243, headwaters of Medary and Flandreau Creek, respectively) simply are not *N. topeka* habitat and have historically low observation records. This same headwater phenomenon could explain the lack of observations in Segments 247 and 249, as well as Segment 250 which has not had a recent record in many decades mostly likely because of the influence of the dams in Blue Mounds State Park.

The high abundance recorded in 2017 could be from two factors, an increase in sampling intensity and the hydrological pattern in southwest MN over the last several years. Since a new sampling design was fully implemented and a number of streams were traversed by canoe, the intensity of our sampling may have increased. A lot of work went into the 2017 survey and this may have translated into greater sampling intensity resulting in high abundance findings. However, my working hypothesis is that the high water event of 2014 coupled with the sustained high flows from late 2015 to summer of 2016 have been advantageous for successful recruitment of *N. topeka* in MN. The recent years of high water conditions (from a review of stream flow gauge data) 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. That same review of stream flow gauge data depicts much less water than in the last half of 2012 and through 2013. The low flow regimes during these years, potentially linked to the monumental land use changes that took place from 2007 to 2014 because of high commodity prices may be responsible for the low occupancy and abundance that was observed from 2012 - 2014. As further extensive changes in the landscape have somewhat abated due to lower commodity prices and high stream flows,

N. topeka may be increasing in its numbers and occupancy through southwest MN. But only additional monitoring over the next few years can determine if this supposition is true.

However, observations during the 2017 monitoring season noted continued conversion of grassland and tile drainage construction, albeit not at the scale conducted during 2007 - 2014. As I stated in both the 2015 and 2016 reports, the land management changes within *N. topeka* watersheds have led to, and will continue to exacerbate 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 (historic and current) plus climate change induced effects, the stream channels will continue to degrade and the streams will lose connectivity with their floodplains, all of which will result in the loss of *N. topeka* preferred habitat.

Hybridization

I have mentioned the issue of potential hybridization between *N. topeka* and *N. stramineus* in previousreports. In 2017, hybridization was observed in several stream segments. These hybrid fish were found in four (4) localities: Segment 245, 254, 255 and 259. Segment 259 was interesting because of the wide range of phenotypic characteristics observed among a number fish types. A range of phenotypes were expressed from "pure" *N. topeka* to individuals that exhibited a 50-50 set of parental characters to individuals that were more *N. topeka* or *N. stramineus* but did not represent full parental phenotypes. See my 2015 and 2016 reports for further explanation on hybridization characteristics. As was stated in the 2015 and 2016 report and observed in 2017, 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 further downstream 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. The research issue of hybridization between *N. topeka* x *N. stramineus* may be answered by work being conducted at Iowa State University through a joint program of *N. topeka* research involving streams in Iowa and Minnesota. My conversations with these researchers indicate they have observed hybridization and are planning to conduct genetic analysis of these specimens.

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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.

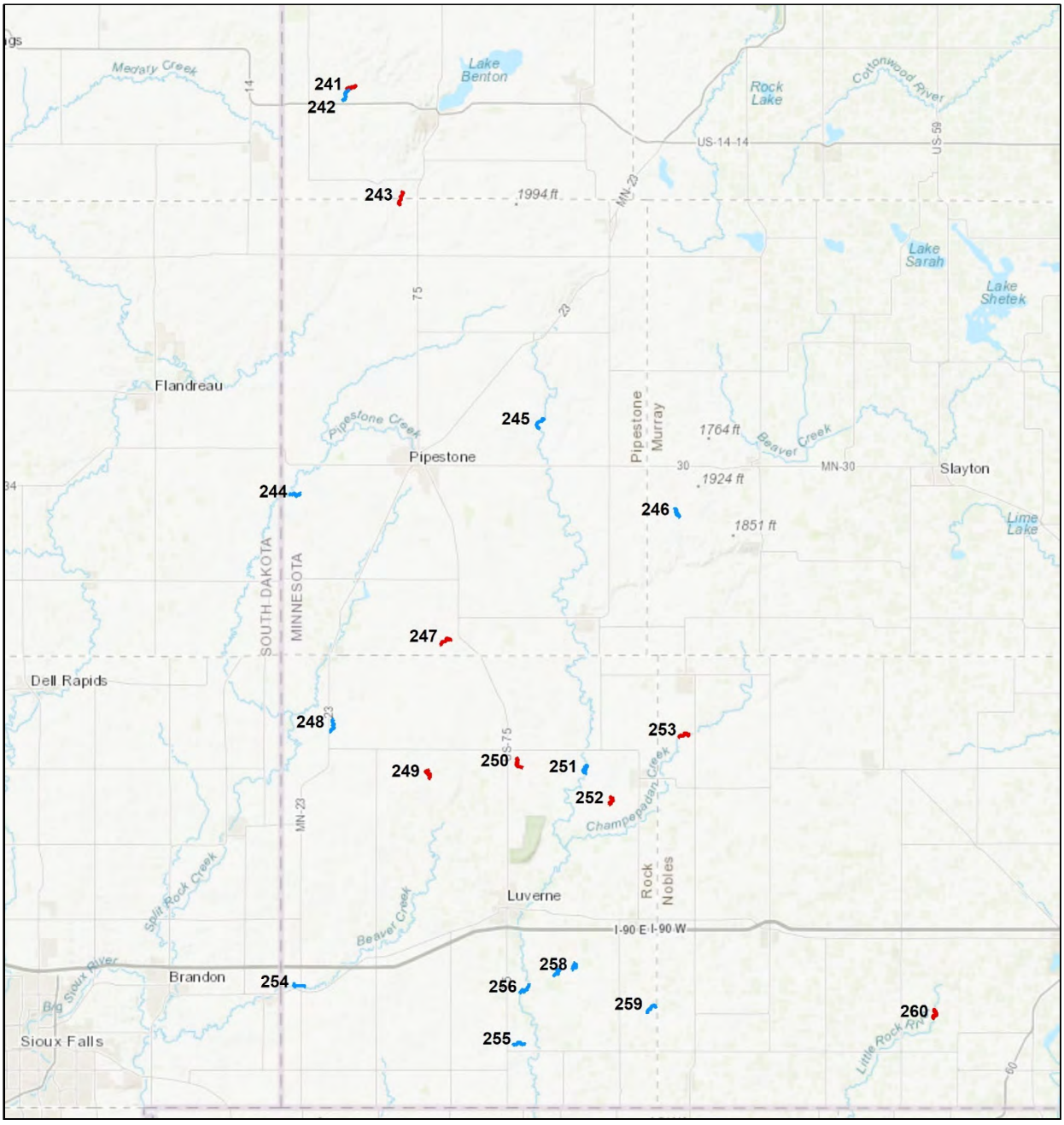


Figure 1. Overview of 2017 stream segments sampled for *N. topeka* monitoring.

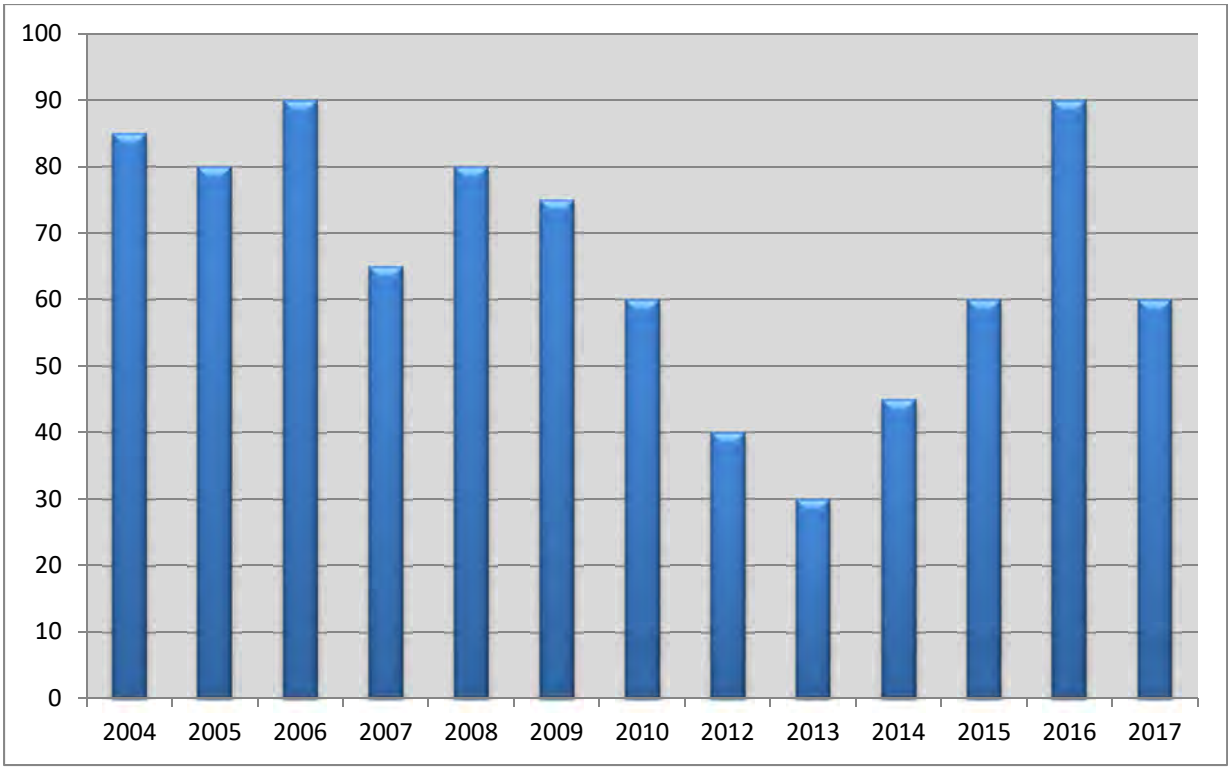


Figure 2. Percentage of randomly selected stream segments with *N. topeka*, 2004-2017.

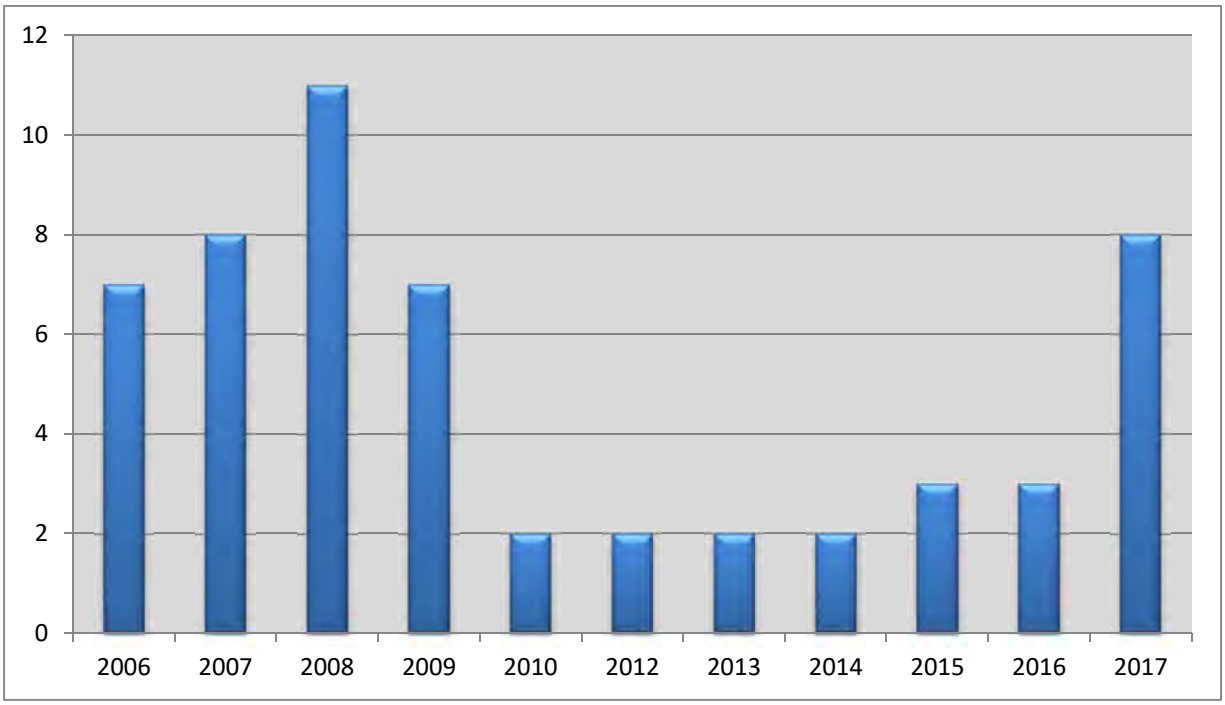
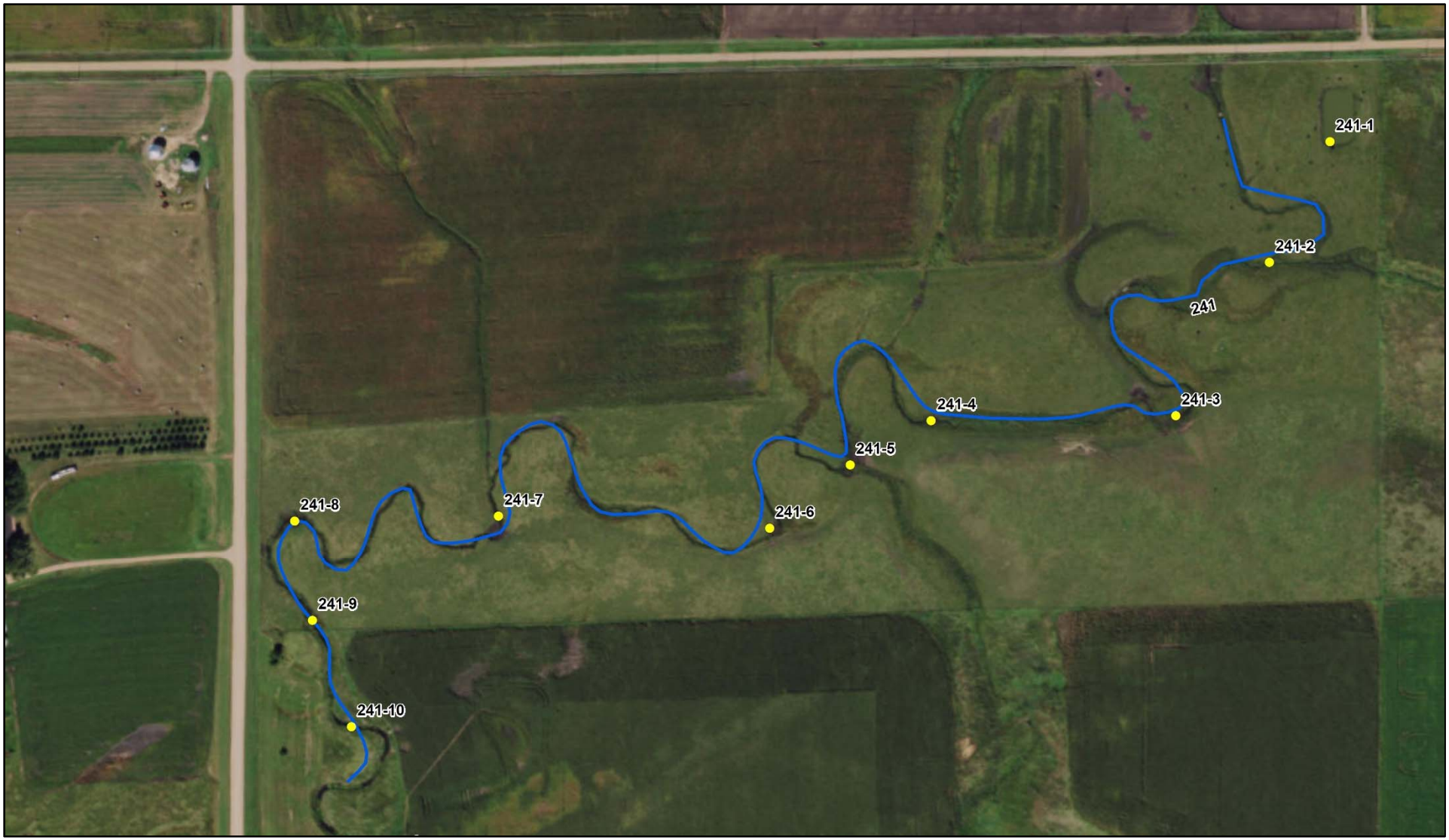


Figure 3. Number of sites where *N. topeka* was considered Abundant or Common, 2006-2017. The abundance measure is based on Ceas' and Nagle's definitions.

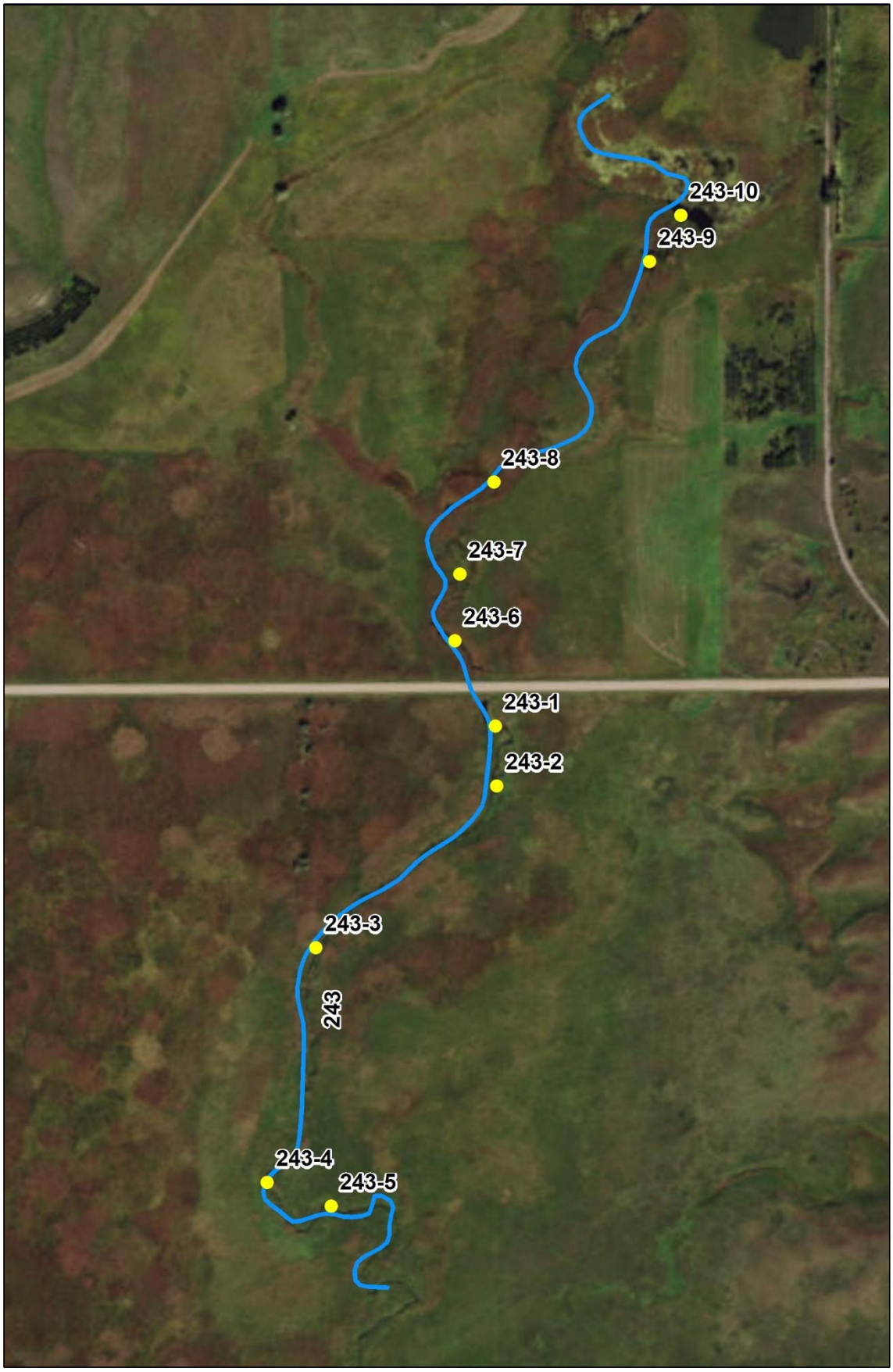
Appendix A

Maps 1-20. Aerial images of each randomly selected 1-mile stream segment sampled in 2017.



Map 1 Segment 241 (Sites 1-10)

Map 2: Segment 242 (Site 1)

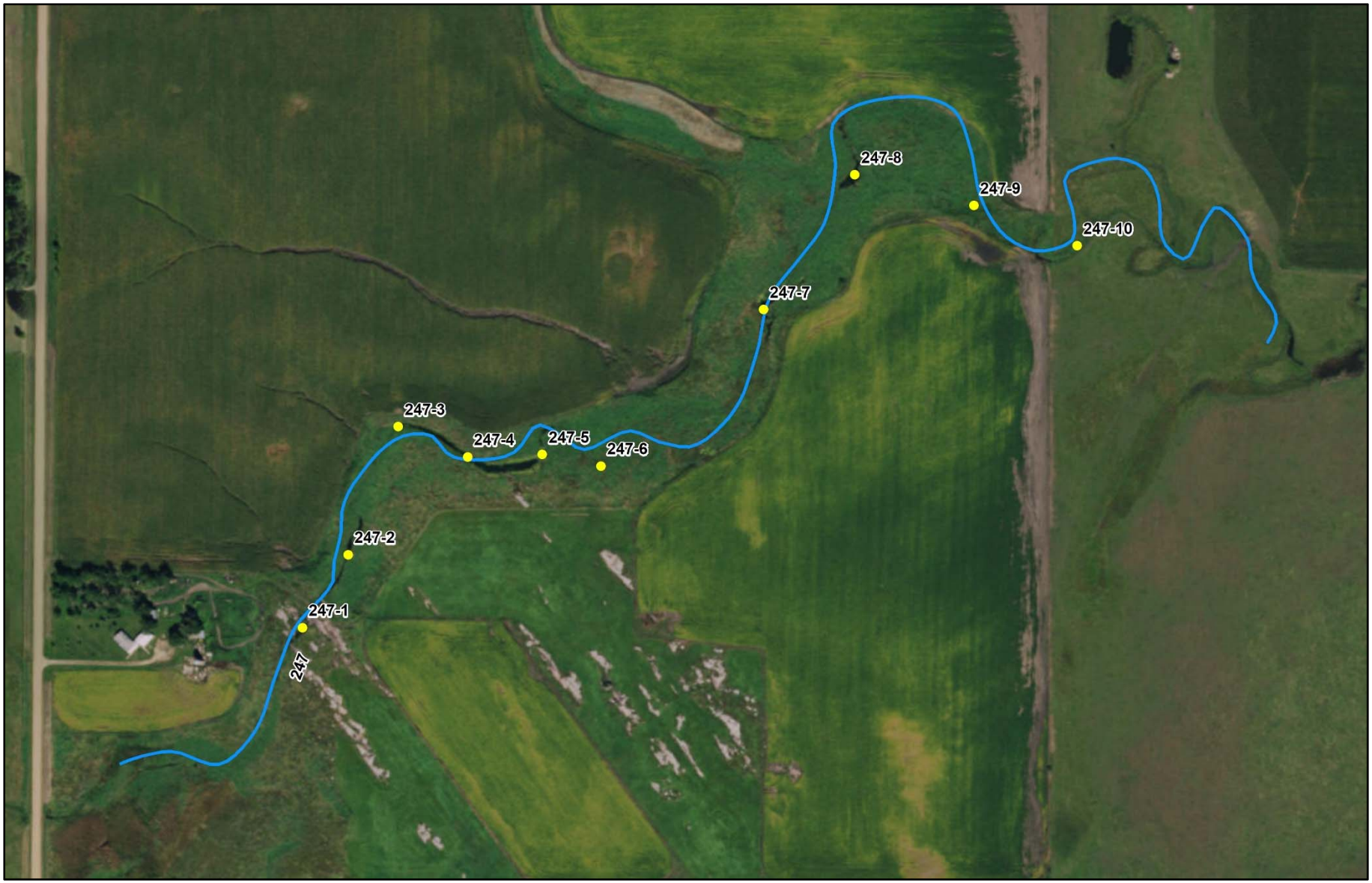


Map 3: Segment 243 (Sites 1-10)

Map 4: Segment 244 (Site 1)

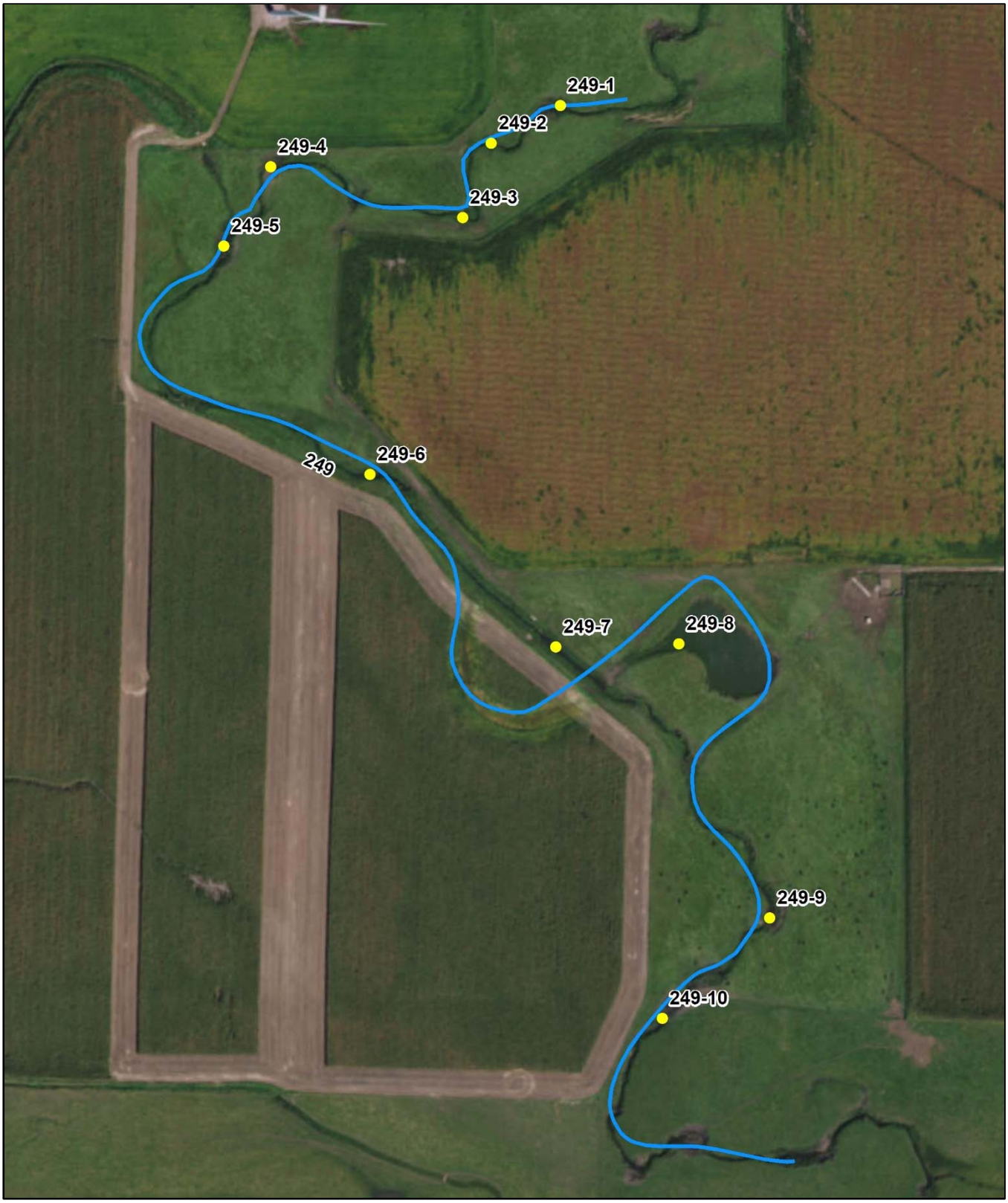
Map 5: Segment 245 (Site 1)

Map 6: Segment 246 (Sites 1-5)



Map 7: Segment 247 (Sites 1-10)

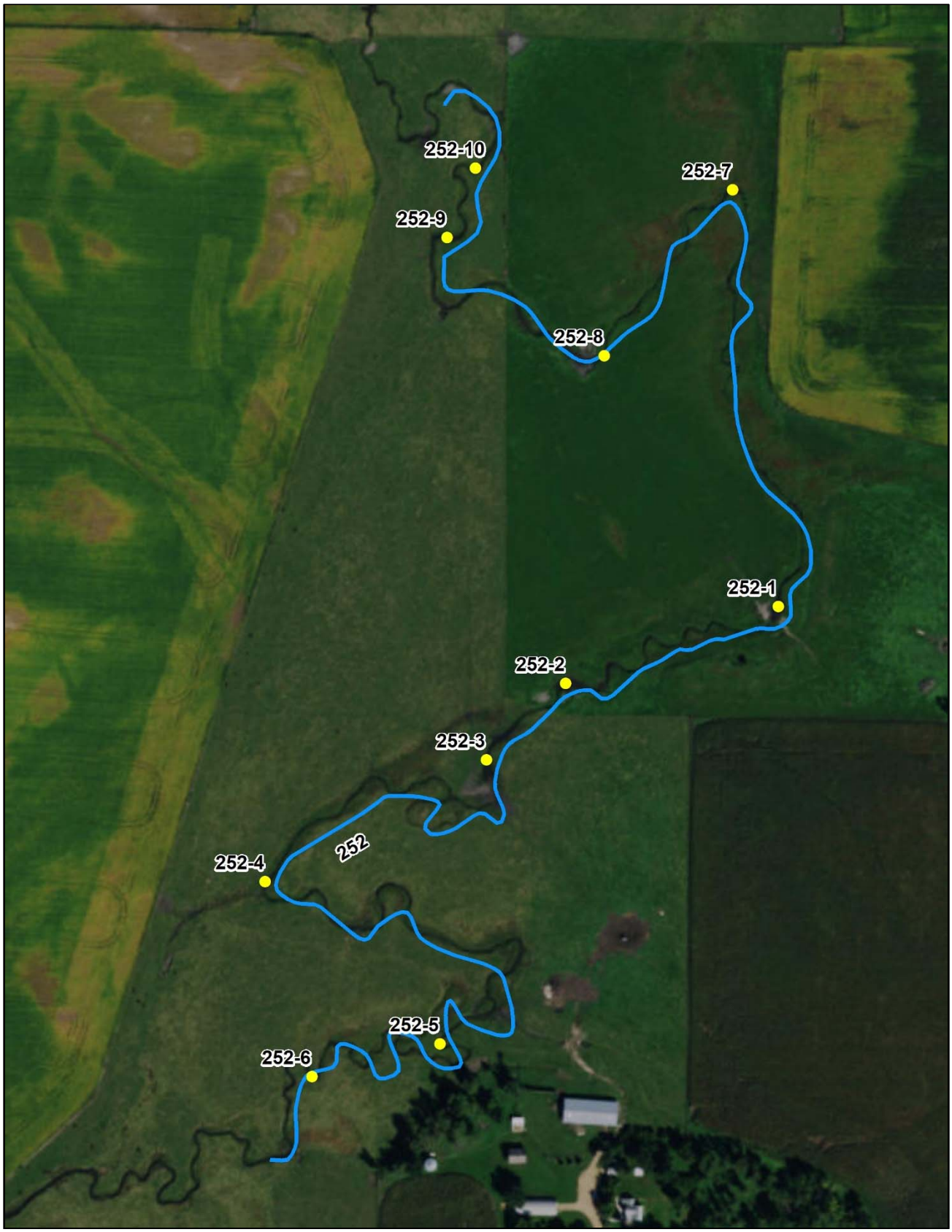
Map 8: Segment 248 (Site 1)



Map 9: Segment 249 (Sites 1-10)

Map 10: Segment 250 (Sites 1-10)

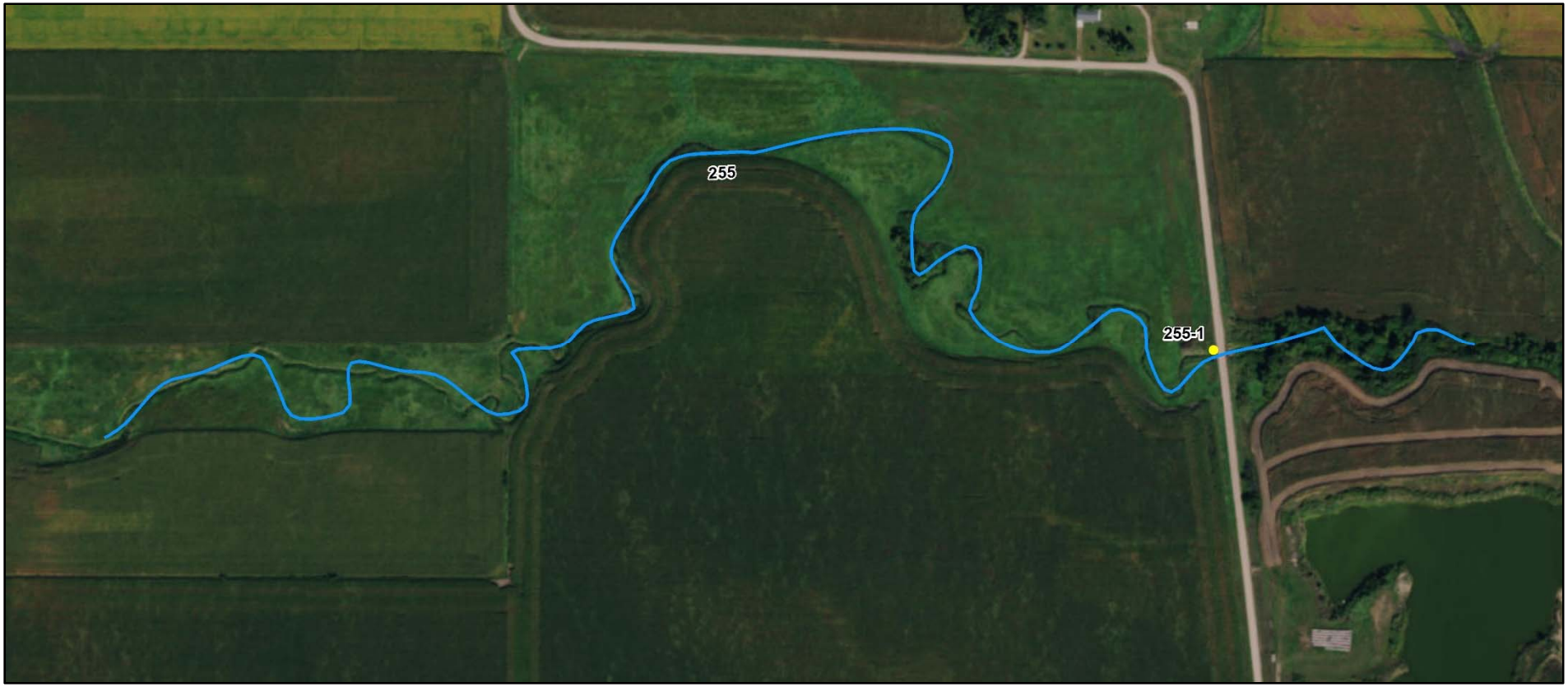
Map 11: Segment 251 (Site 1)



Map 12: Segment 252 (Sites 1-10)

Map 13: Segment 253 (Sites 1-10)

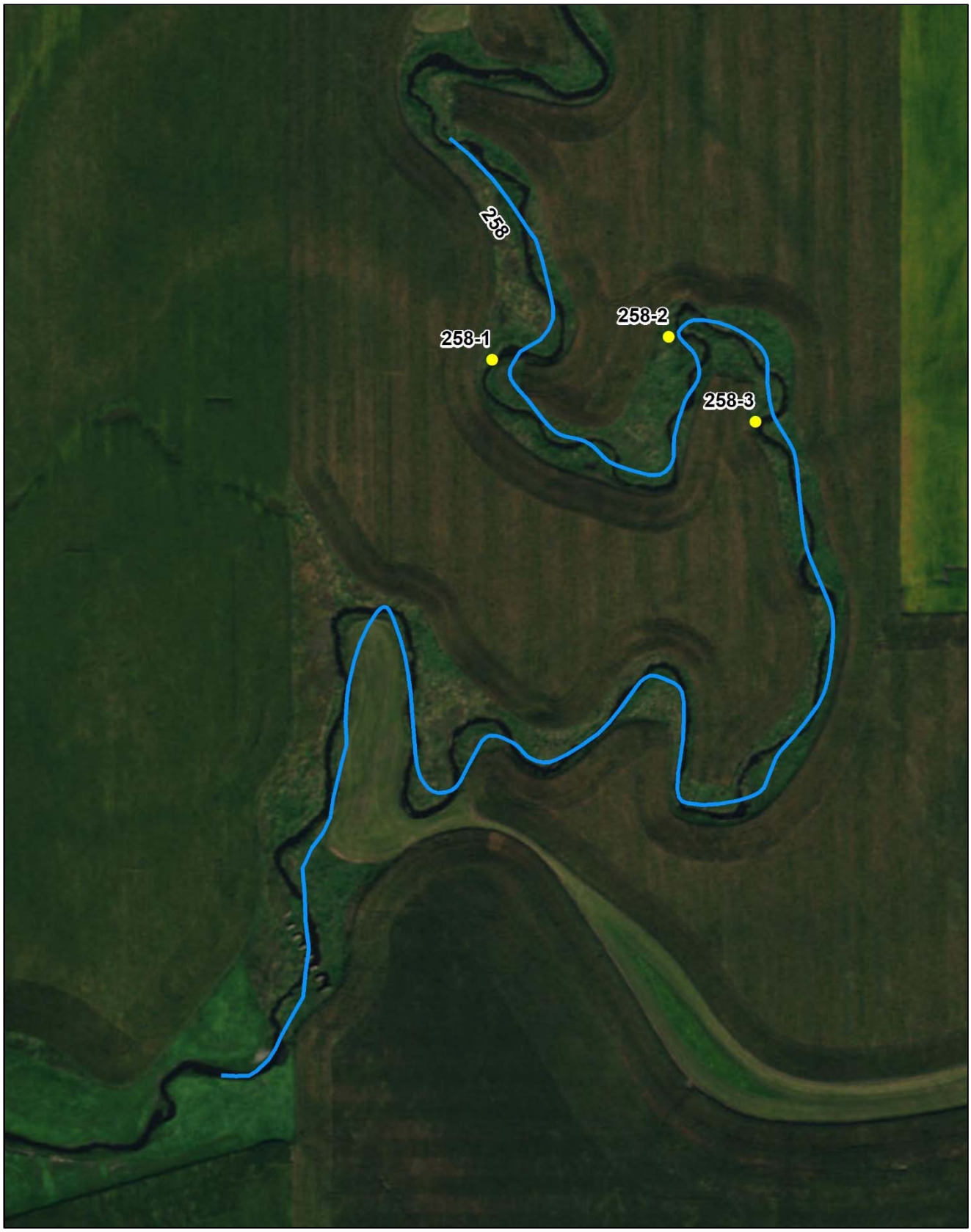
Map 14: Segment 254 (Sites 1-4)



Map 15: Segment 255 (Site 1)

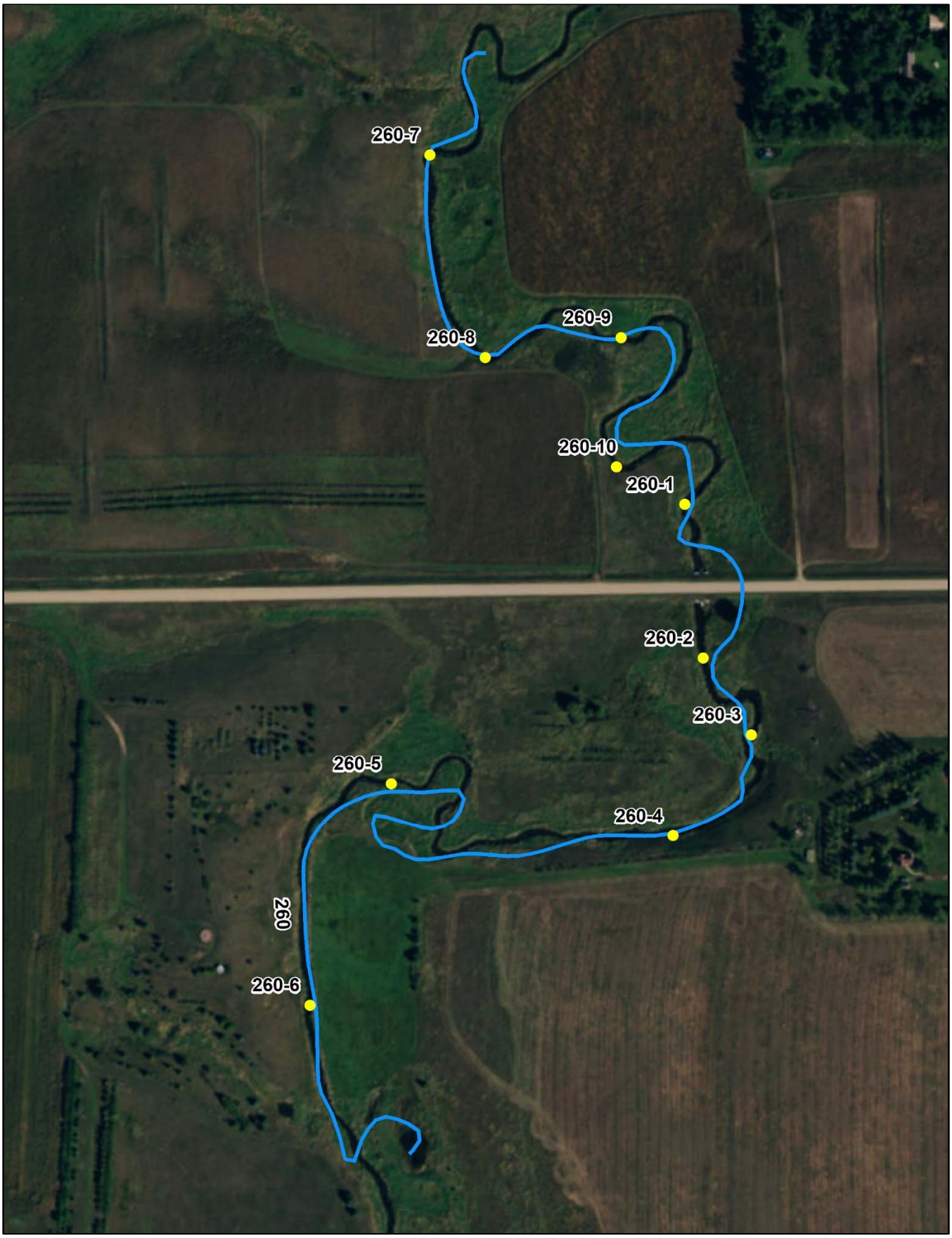
Map 16: Segment 256 (Site 1)

Map 17: Segment 257 (Site 1)



Map 18: Segment 258 (Sites 1-3)

Map 19: Segment 259 (Site 1)



Map 20: Segment 260 (Sites 1-10)

Appendix B

Table 1. Stream segment descriptions and sampling site location data for 2017.

Table 2. List of fish species collected at all stream segments in 2017.

Table 1. Locations of the 20 stream Segments sampled in 2017, 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
241	Medary Creek	Lincoln	109	46	3	dugout pond	241-1	44.283376	-96.37413	2017-06-24
						main channel	241-2	44.282604	-96.374669	
						bend pool	241-3	44.281623	-96.375506	
						main channel	241-4	44.281591	-96.377688	
						bend pool	241-5	44.281308	-96.378412	
						bend pool	241-6	44.280903	-96.37913	
						bend pool	241-7	44.280979	-96.381551	
						bend pool	241-8	44.280948	-96.383371	
						main channel	241-9	44.280311	-96.383213	
						main channel	241-10	44.279631	-96.382863	
Upper end of stream (above 241-8) much less water, very homgeneous habitat; pasture is severely grazed, lots of collasped stream banks. Turbid from silt, substrate silt and sand and gravel; narrow width, 0.5 - 0.7 m deep. The lower portion appearence much like Seg. 242 but a steeper gradient; pasture in better condition. Habitat composed of bend pools, riffles, and undercut banks. Very odd no *N. topeka* found in this segment given it adjacency to Seg. 242. Suspect ground water from the ridge to the west and the ridge to the southeast (area with corn) provides the flows for this headwater stream.										
242	Medary Creek	Lincoln	109	46	4	pool	242-1	44.278604	-96.383668	2017-06-24
Cold, black tannic water, very little velocity; 2m wide and up to 0.75 m deep; substrate was sand gravel mix with a mud/silt layer above, emergent and submergent vegetation present. Well undercut meandering banks. Stream flows through pasture on the west side of road crossing, east side has pasture with row crop along east side. *N. topeka* was easy to find in this site. *N. topeka* present.										
243	Flandreau Creek	Pipestone	108	46	1	bend pool	243-1	44.197079	-96.325604	2017-06-24
						main channel	243-2	44.196581	-96.325587	
						main channel	243-3	44.195234	-96.327678	
						pool	243-4	44.193289	-96.328241	
						bend pool	243-5	44.193091	-96.327504	
		Lincoln	109	45	36	pool	243-6	44.197788	-96.326072	
						pool	243-7	44.198342	-96.326015	
						pool	243-8	44.199111	-96.32562	
						bend pool	243-9	44.200942	-96.323817	
						marsh pool	243-10	44.201327	-96.323457	
Extreme headwaters of the stream, this Segment has been dredged in the past, evidenced by dredge piles parallel to stream course. Very dense stands of Narrow-leaf Cattail and Phragmites, also dense stands of other submergent and emergent vegetation. This is not *N. topeka* habitat and suspect this area was a large wetland system prior to dredging. Most likely little to no water in hot, dry years. Stream is only 1 m wide and on average 0.5 m deep with some pool areas 1 m deep. Very few individual fish found in this segment.										

Table 1. Continued

Segment	Stream	County	Township	Range	Section	Habitat Type	Site Number	Latitude	Longitude	Date
244	unnamed trib to Pipestone Creek	Pipestone	106	47	24	pool	244-1	43.972348	-96.432424	2017-06-25
Stream flows through pasture but row crop nearby; substrate was silt with sand and gravel. Both emergent and submergent vegetation present; depth 0.5 - .07 m, the pool is actually an old dugout area evidenced by dredge spoil in the south side of the stream. *N. topeka* easily collected in this spot. *N. topeka* present.										
245	Rock River	Pipestone	107	44	31	channel border pool	245-1	44.029194	-96.174348	2017-06-24
Meander stream flowing through grassland with high moraine features. Stream 3 m wide, 0.5 - 1 m deep; undercut banks, complex habitat of bend pools, runs, pools; some vertical bank erosion; substrate compacted gravel with silt along the border, deeper bend pools with gravel and silt substrate. Very nice habitat,*N. topeka* easilty collected. *N. topeka* present.										
246	NB Chanarambie Creek	Murray	106	43	29	pool	246-1	43.954263	-96.030512	2017-06-25
						bend pool	246-2	43.955041	-96.030012	
						bend pool	246-3	43.95665	-96.03249	
						bend pool	246-4	43.95752	-96.032348	
						dugout pond	246-5	43.95755	-96.03163	TS location
Headwaters of stream, flows through pasture bordered by moraines; lower end of segment is a deep (>2 m deep) and long pool, remainder of stream is 0.5 - 1 m deep and 0.5 - 1 m wide. Substrate was packed gravel with areas of sand and silt, some areas of muck. Cool water temperature and slightly turbid. Site 246-5 is a dugout pond 1 m higher in elevation from stream bank, substrate was compacted silt and sand, lots of *N. topeka* in this habitat. *N. topeka* present.										
247	unnamed trib to Poplar Creek	Pipestone	105	45	32	main channel border	247-1	43.857869	-96.282816	2017-06-25
							247-2	43.858392	-96.282361	
							247-3	43.859312	-96.28186	
							247-4	43.859095	-96.281168	*F. sciadicus* location
							247-5	43.859113	-96.280423	*F. sciadicus* location
							247-6	43.85903	-96.279837	
							247-7	43.860154	-96.278215	*F. sciadicus* location
							247-8	43.861122	-96.277304	*F. sciadicus* location
							247-9	43.860901	-96.276115	
							247-10	43.860612	-96.275085	
Headwaters of the stream, flows through pasture but row crop very near on both sides; upper 1/3 of stream has exposed bedrock as substrate with silt pools in lower reach. Abundant submergent vegetation with dense stands of Reed Canary Grass throughout margin of stream banks; clear water with temperature varying from cool to warm; 0.5 - 1 m wide and 0.5 m deep; many long pools with silt and muck substrate throughout the Segment with widths >5 m but depth less than 1 m. The long pools were inhabited by large numbers of*F. sciadicus* .										

Table 1. Continued

Segment	Stream	County	Township	Range	Section	Habitat Type	Site Number	Latitude	Longitude	Date
248	unnamed trib to Pipestone Creek	Rock	104	46	19	bend pool	248-1	43.791537	-96.40012	2017-06-25
Stream was slightly turbid; substrate was a mix of boulders, silt and sand; depth was 0.75 - 1 m and 3.5 m wide; diversity of habitat types with pools, undercut banks, long straights, and beaver dams. Reed Canary Grass dominated the stream banks and submergent vegetation present throughout. *N. topeka* easily found. *N. topeka* present.										
249	Mound	Rock	103	46	1	bend pool	249-1	43.760021	-96.296182	2017-06-26
						bend pool	249-2	43.75979	-96.296767	
						bend pool	249-3	43.759336	-96.29701	
						pool	249-4	43.759648	-96.298634	
						glide run/pool	249-5	43.759162	-96.299033	
						glide run/pool	249-6	43.757765	-96.297793	
						glide run	249-7	43.756711	-96.296219	
						dugout pond	249-8	43.756731	-96.295177	
						bend pool	249-9	43.755049	-96.294407	
						glide run/pool	249-10	43.754435	-96.295319	
Stream flow through pasture but row crop very close by in places; moderate gradiant with relatively fast moving flow; slightly turbid conditions; multiple habitat types but fairly long areas of glide runs which are previously ditched areas; gravel and sand substrate with a layer of silt; depth 0.5 - 1.2 m and width 2 - 3 m. Dugout pond with abundant*P. promelas* , an indication the pond may freeze completely in winter.										
250	Mound Creek	Rock	104	45	35	pool	250-1	43.761909	-96.196723	2017-06-26
						glide pool	250-2	43.762728	-96.200013	
						glide pool	250-3	43.762806	-96.200871	
						off channel pool	250-4	43.763000	-96.201245	
						pool	250-5	43.763239	-96.202733	
						bend pool	250-6	43.765787	-96.201799	
						pool	250-7	43.766501	-96.202399	
						bend pool	250-8	43.768251	-96.201792	
						bend pool	250-9	43.768006	-96.202578	
						bend pool	250-10	43.768774	-96.20274	
Headwaters of stream system; densely vegetated with Narrow-leaf Cattail and very little water, shallow and narrow in the lower reach; further upstream large, long pools 0.75 - 1 m deep; the upper reach is shallow and narrow, very little habitat diversity throughout; heavily grazed pasture with Reed Canary Grass as dominate vegetation along stream margin; Segment is not typical*N. topeka* habitat, and this segment of stream is located above the dams in Blue Mounds SP. Historically, *N. topeka* has not been collected upstream of these dams.										

Table 1. Continued

Segment	Stream	County	Township	Range	Section	Habitat Type	Site Number	Latitude	Longitude	Date
251	Rock River	Rock	104	44	33	main channel border	251-1	43.763305	-96.127347	2017-06-22
Upland habitat was pasture, water turbid, moderate to fast flow; lots of bank erosion throughout, many vertical eroded banks, undercut bank habitat common throughout; substrate is muck with some sand. The *N. topeka* collection site was at the confluence of a grassed waterway inlet, most likely tile drainage enters further up in the grassed waterway since the water temperature was cool. *N. topeka* present.										
252	unnamed trib to Rock River	Rock	103	44	10	pool	252-1	43.736515	-96.100443	2017-06-27
						pool	252-2	43.736104	-96.102016	
						pool	252-3	43.735696	-96.102604	
						bend pool	252-4	43.735045	-96.10424	
						bend pool	252-5	43.734176	-96.102947	
						bend pool	252-6	43.734002	-96.103895	
						bend pool	252-7	43.738742	-96.10078	
						main channel	252-8	43.737856	-96.10173	
						main channel	252-9	43.738487	-96.102895	
						bend pool	252-10	43.738858	-96.102685	
Stream flows through heavily grazed pasture; substrate is mostly silty muck, very few areas with gravel; very turbid; mostly a shallow stream, particularly along cattle crossing points; width only 1 m; very little habitat diversity throughout.										
253	Champepadan Creek	Pipestone	104	43	29	bend pool	253-1	43.788839	-96.023162	2017-06-26
						bend pool	253-2	43.788523	-96.023855	
						bend pool	253-3	43.788003	-96.024683	
						pool	253-4	43.787584	-96.025271	
						bend pool	253-5	43.787054	-96.025163	
						bend pool	253-6	43.787359	-96.028512	
						glide run	253-7	43.788267	-96.022317	
						bend pool	253-8	43.788093	-96.020918	
						bend pool	253-9	43.787071	-96.020207	
						bend pool	253-10	43.788424	-96.019892	
Stream flows through pasture with a moraine on the north and west side of the stream; lots of diversity in terms of habitat with straights, pools undercut banks but the stream is entrenched 4 - 5 m below historic floodplain. Low number of fishes collected in most seine hauls, this may be due to spring and early summer aerial spraying for thistles (per conversation with renter). Substrate mostly sand with gravel and silt; depth 0.7 - 1 m and 4 - 6 m wide; turbid warm water. Surprised no *N. topeka* were collected since they were collected further downstream in 2016.										

Table 1. Continued

Segment	Stream	County	Township	Range	Section	Habitat Type	Site Number	Latitude	Longitude	Date
254	Beaver Creek	Rock	102	47	35	off channel pool	254-1	43.593898	-96.43943	2017-06-26
						bend pool	254-2	43.594656	-96.439704	
						main channel border	254-3	43.595265	-96.439471	
						bend pool	254-4	43.595453	-96.440075	TS location
Entrenched stream with sand dominated substrate including areas of gravel and silt; eroded banks, vertical walls in places and concrete as stabilization material in areas; turbid condition and water level recently receded from high flows; highly altered morphology upstream with much more row crop with tile drainage outlets. The*N. topeka* site was a small pocket pool with an undercut bank and flooded terrestrial vegetation. *N. topeka* present.										
255	Ash Creek	Rock	101	45	14	pool	255-1	43.549098	-96.196378	2017-06-21
Fast moving water and cool temperature, mostly likely from title drainage inputs; grass border on the north side of stream west of the road crossing with corn along the south border; slightly turbid; muck substrate near culvert; east of road crossing the stream is bordered by trees, many exposed roots and highly eroded banks; substrate muck with some sand and gravel patches as well as clay hard pan in places; 0.5 - 0.75 m deep, 2 -3 m wide. *N. topeka* collected in pool immediately adjacent to the culvert pool. *N. topeka* present.										
256	Rock River	Rock	102	45	36	off channel pool	256-1	43.594808	-96.189698	2017-06-23
The segment include the main stem of the Rock River and a disconnected side channel/pool. The main channel was wide, turbid, with substrate of gravel and sand. The upland condition is a treed border along the main channel with some row crop to bank edge. This is an off channel pool of the main stem of the Rock River. This area is the remnant of the abandon main channel. The habitat consisted of no flow, warm water and turbid with muck substrate with deep muck in places. Willow brush surrounded the off channel habitat and flooded willow was present. N. topeka present in large numbers.										
257	Elk Creek	Rock	102	44	30	bend pool	257-1	43.606657	-96.157282	2017-06-23
Surrounding landuse is pasture with row crop on the more level ground. Substrate was muck, water was turbid and fast; lots of undercut banks, bank erosion abundant with areas of vertical walls; 0.75 -1 m deep, 5 - 8 m wide. *N. topeka* was collected along channel bend pool that was connected to a off channel pool fed by tile drainage outlet. *N. topeka* present.										
258	Elk Creek	Rock	102	44	29	bend pool	258-1	43.610463	-96.141826	2017-06-23
						side channel backwater	258-2	43.610596	-96.140396	*F. sciadicus* location
						bend pool	258-3	43.610098	-96.139693	TS location
Stream flows was fast, water was turbid; hard packed gravel and cobble subtrate at Site 258-1, but other 2 sites were muck substrate. Only a very thin grass strip along field border of row crop; many areas the corn was planted right on top of stream bank, vertical eroded banks in many places. Stream was 4 -5 m wide. *F. sciadicus* location was a side channel backwater well vegetated. The *N. topeka* location was a deep bend pool with undercut bank. *N. topeka* present. *F. sciadicus* present.										
259	Kanaranzi Creek	Rock	101	44	1	main channel border	259-1	43.579426	-96.057522	2017-06-22
Very wide (+ 10 m) stream with a heavy bed load of sand but with areas of muck and patches of gravel. Surrounding landscape is pasture with row crop, tile drainage outlets present. Very few undercut banks or pool habitat; depth 0.5 - 0.75 m. The *N. topeka* and *F. sciadicus* collected at the same site which was along the channel border in a shallow, well vegetated area fed by tile drainage outlet. *N. topeka* present.										

Table 1. Continued

Segment	Stream	County	Township	Range	Section	Habitat Type	Site Number	Latitude	Longitude	Date
260	Little Rock River	Nobles	101	41	4	main channel	260-1	43.573126	-95.756708	2017-06-27
			101	41	9	main channel	260-2	43.572177	-95.756552	
						bend pool	260-3	43.571702	-95.75614	
						channel border	260-4	43.571078	-95.75681	
						channel border pool	260-5	43.571401	-95.759214	
						main channel	260-6	43.570029	-95.75991	
			101	41	4	bend pool	260-7	43.575285	-95.758884	
						bend pool	260-8	43.574035	-95.758411	
						main channel	260-9	43.574156	-95.757251	
						bend pool	260-10	43.573359	-95.75729	

Stream flows through pasture and restored grassland; water slightly turbid with fast flow; substrate was gravel and sand with layer of silt, boulder riffle in places. Long straight areas within this segment but fairly shallow 0.5 - 0.75 m; width 6 - 8 m; individual number of fish noticeable low with larger bodied fish found in shallow areas - a likely effect of *E. lucius* presence that probably is forcing fish to use shallow areas. The source of *E. lucius* is probably the sand and gravel lakes within the watershed.

Table 2. Complete List of Fish Species Captured at Segments 241-260 for Sampling Year 2017.

Species	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
Campostoma anomalum						X (r)	X (r)		X (r)	X (r)		X (a)	X (r)		X (c)	X (f)	X (f)	X (f)	X (c)	X (f)
Chrosomus erythrogaster						X (c)													X (r)	
Cyprinella lutrensis				X (r)	X (r)				X (r)		X (f)			X (a)		X (f)	X (f)	X (f)	X (f)	X (f)
Hybognathus hankinsoni	X (r)		X (r)		X (r)		X (r)					X (r)							X (a)	
Luxilus cornutus	X (f)			X (r)	X (f)	X (c)	X (f)	X (c)	X (f)	X (f)		X (a)	X (c)		X (a)	X (f)	X (f)	X (c)	X (c)	X (r)
Notropis dorsalis	X (r)				X (f)	X (r)			X (a)	X (f)	X (a)	X (c)	X (f)	X (c)	X (a)	X (f)			X (a)	X (f)
Notropis stramineus	X (f)			X (f)	X (c)				X (r)		X (a)		X (r)	X (a)	X (a)	X (f)	X (a)	X (a)	X (a)	X (f)
Notropis topeka*		**X (c)**		**X (a)**	**X (a)**	**X (a)**		**X (c)**			**X (p)**			**X (p)**	**X (p)**	**X (a)**	**X (c)**	**X (p)**	**X (c)**	
Pimephales notatus	X (a)	X (c)		X (f)	X (a)	X (c)		X (f)			X (a)	X (c)	X (a)		X (a)	X (c)	X (a)	X (a)	X (c)	X (c)
Pimephales promelas	X (va)	X (va)		X (c)	X (f)	X (c)	X (va)	X (c)	X (va)	X (va)	X (a)			X (a)	X (c)	X (c)	X (c)	X (c)	X (a)	X (va)
Rhinichthys obstusus	X (f)					X (f)				X (r)		X (c)	X (c)		X (c)	X (r)	X (f)	X (r)	X (c)	
Semotilus atromaculatus	X (c)	X (f)	X (f)	X (c)	X (f)	X (c)	X (c)	X (c)	X (a)	X (c)	X (c)	X (a)	X (a)	X (r)	X (c)	X (r)	X (c)	X (c)	X (c)	X (c)
Catostomus commersoni	X (a)	X (r)		X (f)	X (r)	X (c)	X (f)	X (c)	X (va)	X (c)	X (c)	X (c)	X (c)	X (r)	X (r)	X (c)			X (f)	X (c)
Moxostoma erythrurum														X (c)					X (r)	
Ameiurus melas	X (f)				X (r)		X (f)							X (c)		X (f)				
Ameiurus natalis	X (r)															X (r)				
Noturus gyrinus	X (r)																	X (r)		X (r)
Noturus flavus					X (r)								X (r)						X (r)	
Esox lucius				X (r)																X (f)
Fundulus sciadicus							**X (va)**				**X (r)**							**X (r)**	**X (r)**	
Culaea inconstans	X (r)	X (f)	X (va)			X (r)	X (va)			X (f)	X (r)	X (r)	X (r)		X (r)					
Lepomis cyanellus	X (r)	X (r)	X (r)	X (c)	X (r)	X (a)		X (f)	X (f)	X (c)	X (c)		X (r)	X (f)		X (r)	X (r)	X (r)	X (f)	X (f)
Lepomis humilis		X (r)		X (f)							X (c)					X (c)	X (r)	X (f)	X (r)	X (f)
Etheostoma exile	X (f)	X (r)		X (a)			X (r)													
Etheostoma nigrum	X (c)	X (f)			X (f)	X (f)	X (f)		X (va)	X (c)		X (f)	X (f)		X (f)			X (r)	X (f)	
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 all 1-mile stream segments surveyed in 2017. Those segments with *N. topeka* depict the actually collection site. The yellow outlined areas on those photographs represent the exact location where the species was captured. Voucher photographs of *N. topeka* are from the actual site of capture. Stream photographs for segments without *N. topeka* observations depict representative stream habitat for that 1-mile stream segment.

Segment 241, Medary Creek, upper reach general habitat photo.

N. topeka not collected.

Segment 241, Medary Creek, lower reach general habitat photo.

N. topeka not collected.

Segment 242-1 Medary Creek, general habitat and *N. topeka* collection site plus voucher photos.

Segment 243, Flandreau Creek, general habitat photo.

N. topeka not collected.

Segment 244-1, unnamed tributary to Pipestone Creek, *N. topeka* collection site and voucher photos.

Segment 245, Rock River, general habitat photo.

Segment 245-1, Rock River, *N. topeka* collection site and voucher photos.

Segment 246, Chanarambie Creek, general habitat photo.

Segment 246-5, Chanarambie Creek, *N. topeka* collection site (dugout) and voucher photos.

Segment 247, unnamed tributary to Poplar Creek, general habitat photos.

N. topeka not collected.

Segment 248, unnamed tributary to Pipestone Creek general habitat photo.

Segment 248-1, unnamed tributary to Pipestone Creek, *N. topeka* collection site and voucher photos.

Segment 249, unnamed tributary to Beaver Creek, general habitat photo.

N. topeka not collected.

Segment 250, Mound Creek, general habitat photo.

N. topeka not collected.

Segment 251, Rock River, general habitat photo.

Segment 251-1, Rock River *N. topeka* collection site and voucher photos.

Segment 252, unnamed tributary to the Rock River, general habitat photo.

N. topeka not collected.

Segment 253, Champepadan Creek, general habitat photo.

N. topeka not collected.

Segment 254, Beaver Creek, general habitat photo.

Segment 254-4, Beaver Creek, *N. topeka* collection site and voucher photos.

Segment 255, Ash Creek, general habitat photo.

Segment 255-1, Ash Creek, *N. topeka* collection site and voucher photos.

Segment 256, Rock River, general habitat photo.

Segment 256-1, Rock River, *N. topeka* collection site and voucher photos.

Segment 257, Elk Creek, general habitat photo.

Segment 257-1, Elk Creek, *N. topeka* collection site and voucher photos.

Segment 258, Elk Creek, general habitat photo.

Segment 258-3, Elk Creek, *N. topeka* collection site and voucher photos.

Segment 259-1, Kanaranzi Creek, *N. topeka* collection site and general habitat plus voucher photos.

Segment 260, Little Rock River, general habitat photo.

N. topeka not collected.