A Survey of Fishes from Snake Creek in the Upper James River Watershed

By:

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Introduction

Management of threatened and endangered species under Section 7 of the Endangered Species Act (ESA) is largely conducted by modifying the design, timing, and scope of federal projects to minimize the cumulative impacts on species populations. In essence the management goal of Section 7 is to prevent federal actions from reducing populations of species below current levels (Easley et al. 2001). Effective management requires knowledge of the distribution and population status of threatened and endangered species as well as the expected impact of different disturbances on those species.

A Programmatic Biological Opinion (Opinion) issued by the United State Fish and Wildlife Service (USFWS) mandates that the Federal Highway Administration (FHWA) and South Dakota Department of Transportation (SDDOT) implement Terms and Conditions (TCs) during the design and construction of bridges and culverts over streams inhabited by or potentially inhabited by *Notropis topeka* (USFWS 2004). The Opinion includes TCs that are intended to minimize impact to stream habitat, reduce or eliminate pollutant discharge during construction, provide fish passage during construction, provide fish passage for the duration of the structures life, and minimize *N. topeka* mortality during construction. Terms and Conditions of the Opinion are nondiscretionary measures that are implemented at all stream crossing projects that are likely to result in “take” of individuals or habitat suitable to this species. Fish community data is incomplete for many streams in South Dakota. Because robust fish community data are often not available, the likelihood of a stream crossing project resulting in the “take” of *N. topeka* is sometimes inferred based solely on a GIS habitat model (Wall et al. 2001). Watersheds with habitat predicted to be suitable for *N. topeka* are typically assumed to harbor the species in cases when fish community data is absent or limited. Most tributaries of James River have segments of habitat that are predicted to be suitable for this species. By using Wall et al. (2001) as the primary decision tool for inferring *N. topeka* presence robust protection is given against the possibility of failing to implement TCs at stream crossing projects inhabited by the Topeka shiner. Conversely, it is likely the TCs are sometimes implemented at stream crossing projects in watersheds that are not inhabited by the *N. topeka* when presence is inferred only by habitat conditions. Fish community data from Snake Creek are limited to a single reach surveyed in 2001 (Blausey 2001). The purpose of this study is to quantify the fish community of Snake Creek to improve decision making tools available to assess impacts of stream crossing construction on *N. topeka*.

Study Area

Snake Creek drains approximately 812,000 acres and is located in McPherson, Brown, Edmunds, Spink, and Faulk Counties in northeastern South Dakota. Snake Creek is located primarily in the Lake Dakota Basin and surrounding Drift Plains (Omernik 1995). Quantitative data regarding channel conditions at the reach scale (i.e., several hundred meters) are not available; however, quantitative habitat data are available at the valley segment scale (i.e., several to tens of kilometers). Most valley segments in Snake Creek and its tributaries are not suitable for the *N. topeka*; however, a considerable portion of the lower watershed has physical habitat predicted to be suitable for the *N. topeka* (Wall et al. 2001; Figure 1).

Methods

Fish were collected at ten reaches in the Snake Creek Watershed. Sampled reaches were located in habitat predicted to be suitable for the Topeka shiner or at locations in close proximity to habitat predicted to be suitable (Figure 1; Table 1). Sample reaches were 500 m long and were separated into ten 50 m sub-reaches. Fish were collected with a bag seine at all locations. Seining was conducted in a downstream direction and fish relative abundance was recorded for each 50 m sub-reach. If a sub-reach contained simple habitat features (i.e., run habitat) it was seined with one 50 m seine haul. Sub-reaches with complex habitat or multiple habitat types were seined with several short seine hauls that totaled 50 m.

An Index of Biotic Integrity (IBI) was used to evaluate the relative quality of the fish community. Metrics used in the IBI and the scoring range for those metrics were those suggested by Shearer (2001) for tributaries of the James River in South Dakota (Table 2). Pooled metrics were scored on a continuous scale ranging from 0 to 100 (Hughes et al. 1998). Metric values outside the scoring ranges reported by Shearer (2001) were given either the highest or lowest possible score depending on which end of the scale was exceeded. For example if the metric value was below the lowest value in the scoring range for a metric positively correlated with biotic integrity a score of zero was given for that metric. It is assumed that the likelihood of Topeka shiner presence would increase with biotic integrity. A review of *N. topeka* collections from James River tributaries indicates that the species is generally collected from stream reaches with moderate to high IBI scores (Figure 2). Similarly species richness at reaches were the *N. topeka* has been collected is higher than at reaches where it has not been collected (Figure 3). High IBI scores would indicate that the fish community is diverse with many species intolerant to habitat degradation, while low IBI scores would indicate a fish community with low diversity and abundant tolerant species.

Sample-based rarefaction (Colwell et al. 2004) and a capture-recapture model (Chao 1987) were used to describe the fish community of Snake Creek and other watersheds in eastern South Dakota. The Snake Creek analysis included data collected in this study and by Blausey (2001). Data used to analyze the fish communities of other watersheds were obtained from various sources (Dieterman and Berry 1995; Blausey et al. 2001; Wall et al. 2001; G. Cunningham, unpublished data; C. Milewski unpublished data; S. Wall, unpublished data; SDDOT, unpublished data). Comparisons were made between the Snake Creek fish community and other fish communities in eastern South Dakota. The slope of rarefaction curves were compared among all sites assuming ten reaches were sampled. Similarly estimated species richness was compared assuming ten reaches were sampled in all watersheds. Comparisons were made using ten samples to simulate effort expended in this survey and to standardize among watersheds.

Rarefaction curves are generally used to estimate expected species richness from a sub-sample of a known population and for comparing species density between populations. Although rarefaction curves do not estimate true species richness it is assumed that as the slope of the rarefaction curve approaches zero the number of species present but not sampled decreases. Sample-based rarefaction curves were calculated with 95% confidence intervals (Colwell et al. 2004).

Species richness was estimated with a capture-recapture model (i.e., Chao1 species richness estimator) and asymmetrical 95% confidence intervals were calculated. The Chao1 estimator assumes unequal capture probability between species and has been found to be a robust model that performs well when many species are captured at only one location (Chao 1987). Species richness estimators are useful for estimating the true number of species present including those not sampled. All rarefaction curves and richness estimators were generated using the software program EstimateS 7.5 (Colwell 2005). Collections of species characteristic of large rivers (Simon and Emery 1995) were removed from all datasets before calculating rarefaction curves or estimating species richness. Large river species are occasionally collected in the lower reaches of tributaries to large rivers; however, they are not typical of small stream fish communities.

Results and Discussion

A total of 29,720 fish were collected representing five families and fifteen species (Table 3). Few species were collected at most sample reaches. *Pimephales promelas, Lepomis humilis,* and *Cyprinella lutrensis* accounted for 89 % of fish collected. Index of Biotic Integrity scores by reach were low and ranged from 9 to 38 (Figure 2). Low species richness and an abundance of tolerant species primarily accounted for low IBI scores. Six species were found only at one sample reach. Of the species collected only once, two were classified as large river species (*Notropis atherinoides; Carpoides carpio*) and three (*Semotius atromaculatus; Noturus gyrinus; Ethostoma exile*) are species common to most prairie streams in eastern South Dakota. *N. atherinoides* and *C. carpio* are common in the James River mainstem; however, collections from James River tributaries are generally limited to lower tributary reaches. *Notemigonus crysoleucas* was collected at one location and is characteristic of sluggish streams, lakes, and wetlands with abundant aquatic vegetation (Pflieger 1997). *N. crysoleucas* has a patchy distribution in South Dakota and is often associated with intentional introductions (Bailey and Allum 1962).

On average 5.77 (95 % C.I. = 2.88) species are captured per sample reach in Snake Creek (Figure 3). Total observed species richness and species density was less at Snake Creek than in other streams (Figure 5). Mean species richness was estimated to be 19 species (N = 11; upper 95 % C.I. = 51 species; lower 95 % C.I. = 14 species; Figure 4). Estimated species richness for Snake Creek was less that all other watersheds; however, confidence limits for the Snake Creek richness estimate were large compared to other watersheds. For other watersheds within the range of N. topeka species richness estimates calculated with datasets consisting of ten stream reaches closely estimated observed species richness when all samples were analyzed (Figure 6). For most watersheds few additional species were collected when additional sampling effort was considered. For example on average 25 species would be observed from Medary Creek after ten reaches were sampled. Similarly estimated species richness for Medary Creek was 28.6 species after ten reaches had been sampled, indicating that three or four species were present but not sampled. Sampling an additional nine reaches on Medary Creek documented three new species. Thirteen species (excluding large river species) have been observed from Snake Creek and 19 species are estimated to be present. Based on the performance of the Chao1 estimator for other watersheds it is reasonable to assume that the species richness estimate for Snake Creek is accurate.

The fish community of Snake creek appears to be limited to mainly tolerant species. Most tributaries of the James, Big Sioux and Vermillion Rivers that have documented fish communities composed of 20 to 30 fish species, while only 13 species were observed from Snake Creek. Many fishes commonly found in the tributaries of the James River were not collected during this survey. Notable fishes not collected were, *Notropis topeka, Notropis dorsalis, Luxilus cornutus, and Campostoma anomalum*. Extremely low IBI scores reported in this survey suggest that habitat conditions in Snake Creek may not be suitable for many species common to prairie streams. Rarefaction curves and species richness estimates suggest that some species were present but not sampled during this survey; however, it is unlikely that any species not collected would constitute a significant component of the Snake Creek fish community. Species not collected in this survey will likely have a patched distribution within Snake Creek.

Management Recommendations

Collections of *N. topeka* from other watersheds in SD indicate that the species is widely distributed and relatively easy to capture when present within a watershed (S. Wall, unpublished data). It is unlikely that *N. topeka* is a component of the Snake Creek fish community. Although data reported by Wall et al. (2001) suggest that habitat in the lower section of Snake Creek is suitable for *N. topeka*, fish community data reported in this survey suggest otherwise. Low species richness and density along with an abundance of tolerant fishes suggest that habitat conditions in Snake Creek are degraded to the point that many common stream fishes have been excluded. Any "take" caused by stream crossing construction in Snake Creek would likely result from impacts to stream habitat that may have been formerly occupied by *N. topeka* or habitat that may be occupied by *N. topeka* in the future (i.e., due to reintroduction or habitat restoration). I recommend that future stream crossing projects over perennial or intermittent segments of Snake Creek be classified as "Not Likely to Adversely Affect" with regards to the Programmatic Opinion. Furthermore, I feel it is not reasonable or prudent to mandate TCs that are implemented solely for the purpose of minimizing fish mortality during construction. I recommend that TC's implemented on stream crossing projects within the Snake Creek Watershed be limited to those intended to minimize or eliminate impacts to stream habitat.

Table 1. The locations of sample reaches in the Snake Creek Watershed.

Site #	County	Township Name	Township (N)	Range (W)	Section	Quarter	Stream Section
1	Brown	New Hope	121	65	31	NE	Main Stem
2	Edmunds	Clear Lake	121	66	1	NE	Main Stem
3	Brown	Highland	122	65	18	NE	Main Stem
4	Spink	Athol	118	65	34	NE	South Fork
5	Spink	Three Rivers	117	64	11	W	Main Stem
6	Faulk	Devoe	119	67	29	NE	South Fork
7	Faulk	Pioneer	118	66	12	W	South Fork
8	Faulk	Lafoon	118	68	18	NW	South Fork
9	Faulk	Devoe	119	67	18	NW	North Fork
10	Spink	Athol	118	64	17	S	Main Stem

Table 2. Metrics used to calculate Index of Biotic Integrity scores by sample reach. Scoring range used is that reported by Shearer (2001) for James River tributaries in South Dakota.

Metric Description	Response	Scoring Range
Number of Species	+	0-16
Number of Cyprinids and Catostomids	+	0-11
Percent Insectivorous Cyprinids	+	0-61
Percent Dominant Two Taxa	-	95-0
Percent Benthic Insectivores	+	0-53
Percent Omnivores	-	93-0
Number of Intolerant Species	+	0-4
Percent Tolerant Species	-	95-0

Table 3. Relative abundance of fishes collected by sample reach in Snake Creek with classifications for tolerance, trophic guild, and river guild. Tolerance and trophic classifications were obtained from Shearer (2001) and Pflieger (1997). Locations of sample reaches are given in table 1.

Species	**Tolerance**[a]	**Trophic Guild**[b]	**River Guild**[c]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cyprinidae													
Cyprinus carpio	T	O		4	1	2	7	0	11	4	1	0	43
Semotilus atromaculatus		GE		0	0	0	0	0	0	0	1	0	0
Notropis atherinoides		I	L	0	0	0	0	5	0	0	0	0	0
Pimephales promelas	T	O		179	11577	1212	106	956	71	747	70	0	1898
Notemigonus crysoleucas		O		0	0	0	0	0	0	0	17	0	0
Cyprinella lutrensis	T	O		0	0	0	958	1990	0	3	0	0	370
Notropis stramineus	I	BI		0	0	0	445	75	0	0	0	0	76
Catostomidae													
Carpoides carpio		O	L	0	0	0	1	0	0	0	0	0	0
Catostomus commersoni		O		0	3	0	4	0	0	11	0	0	0
Ictaluridae													
Ameiurus melas	T	O		57	186	238	338	140	567	71	110	0	0
Noturus gyrinus		BI		0	0	0	9	0	0	0	0	0	0
Centrarchidae													
Lepomis cyanellus	T	GE		305	201	34	127	84	1	52	58	8	51
Lepomis humilis		I		157	751	833	2121	2123	116	99	16	0	13
Percidae													
Etheostoma exile		BI		0	0	1	0	0	0	0	0	0	0
Etheostoma nigrum		BI		0	2	2	0	0	0	0	1	0	0

[a]Tolerance: T = tolerant, I = intolerant.
[b]Trophic classifications: O = omnivore, GE = generalist, I = insectivore, BI = benthic insectivore.
[c]L indicates large river species normally found in watersheds > 2,000 mi^2 (Simon and Emery 1995).

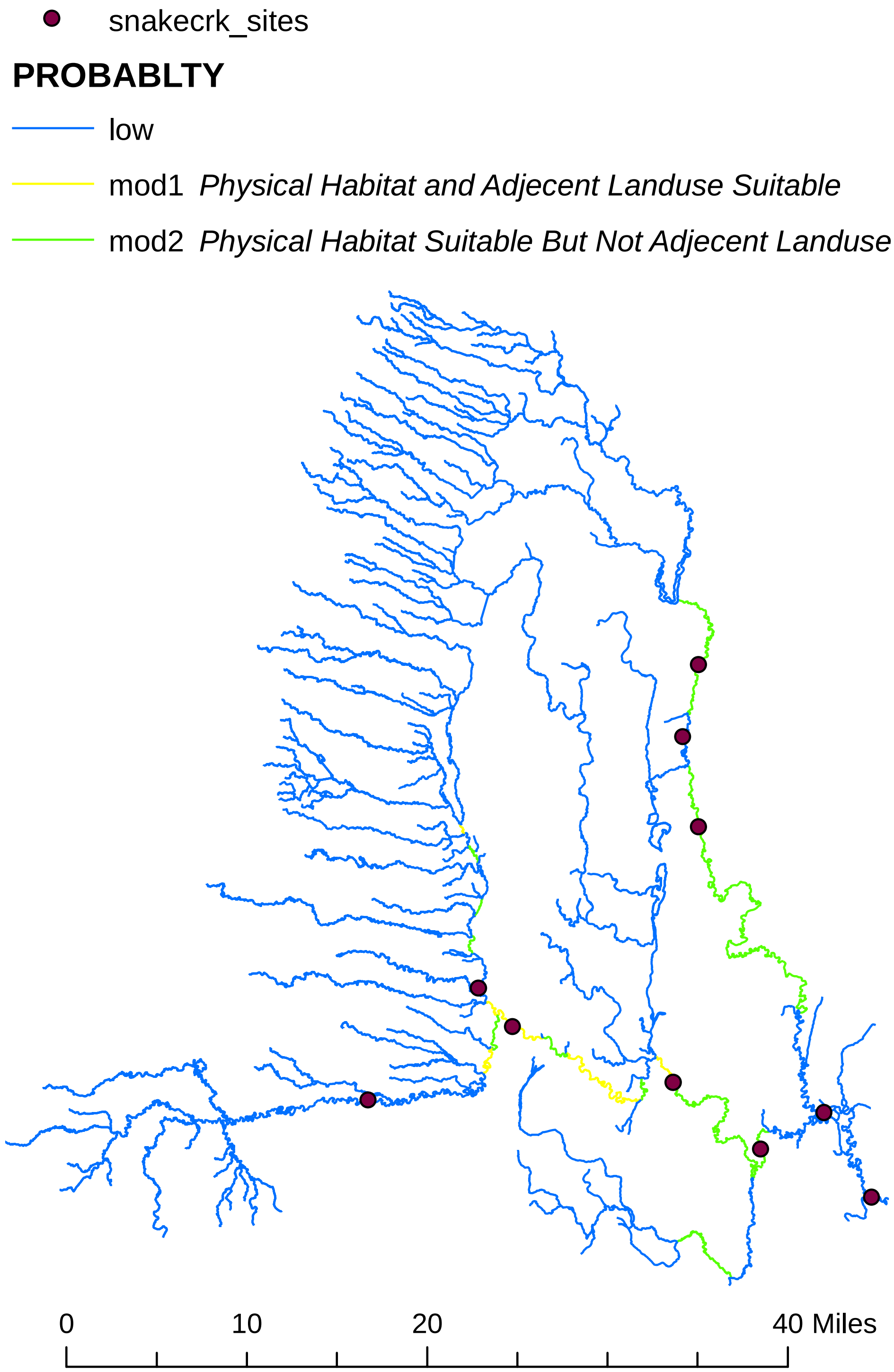

Figure 1. Map of Snake Creek displaying location of reaches sampled during the summer of 2006. Distribution of habitat predicted to be suitable for *N. topeka* is also shown (Wall et al. 2001).

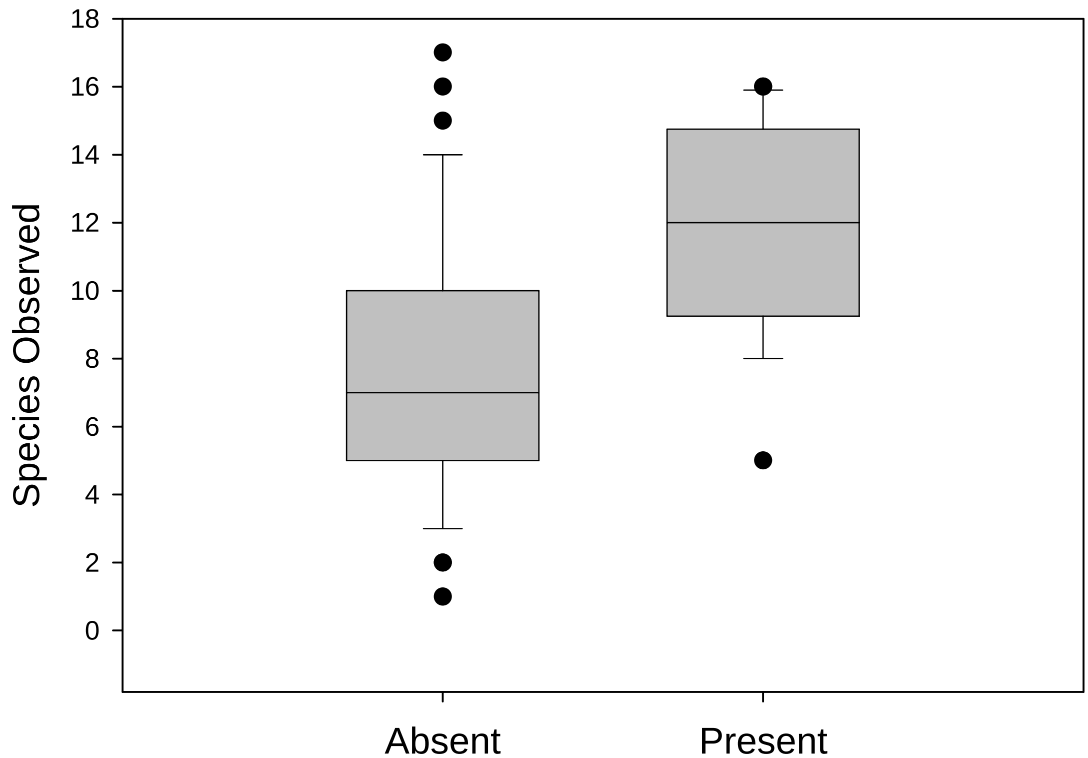

Figure. 2. Box plot comparing observed species richness at sample reaches with *N. topeka* (N = 20) and reaches where *N. topeka* was not observed (N = 49). All reaches represented are from tributaries to the James River (Blausey 2001; Shearer 2001; SDDOT unpublished data; SDSU unpublished data). Boxes represent 50 % of observations and error bars represent the 10th and 90th percentiles. Dots are outlying data points. Mean species observed was significantly different between reaches where N. Topeka was present and reaches in which it was absent ($P < 0.0001$).

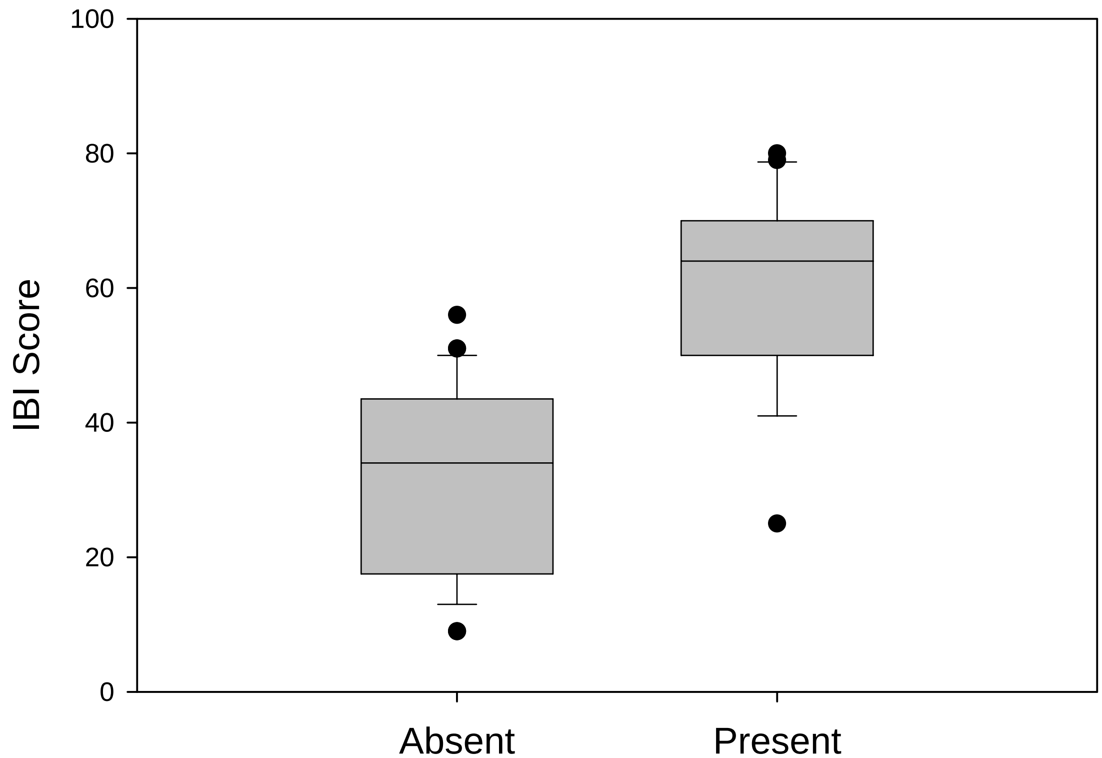

Figure 3. Box plot comparing IBI scores from sample reaches with *N. topeka* (N =20) and sample reaches where *N. topeka* was not observed (N = 49). All reaches represented are from tributaries to the James River (Blausey 2001; Shearer 2001; SDDOT unpublished data; SDSU unpublished data). Boxes represent 50 % of observations and error bars represent the 10th and 90th percentiles. Dots are outlying data points. Mean IBI score was significantly different between reaches where N. *topeka* was present and reaches in which it was absent ($P < .0001$).

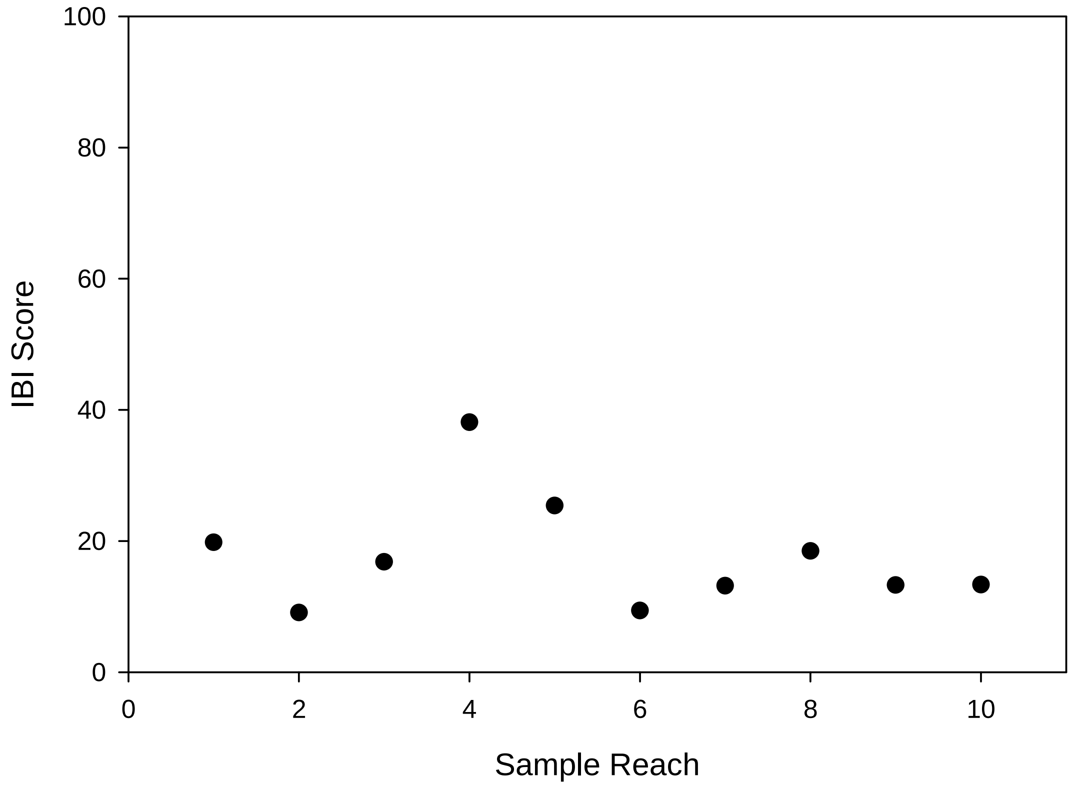

Figure 4. IBI scores by reach for Snake Creek. Reach identification corresponds with locations provided in Table 1.

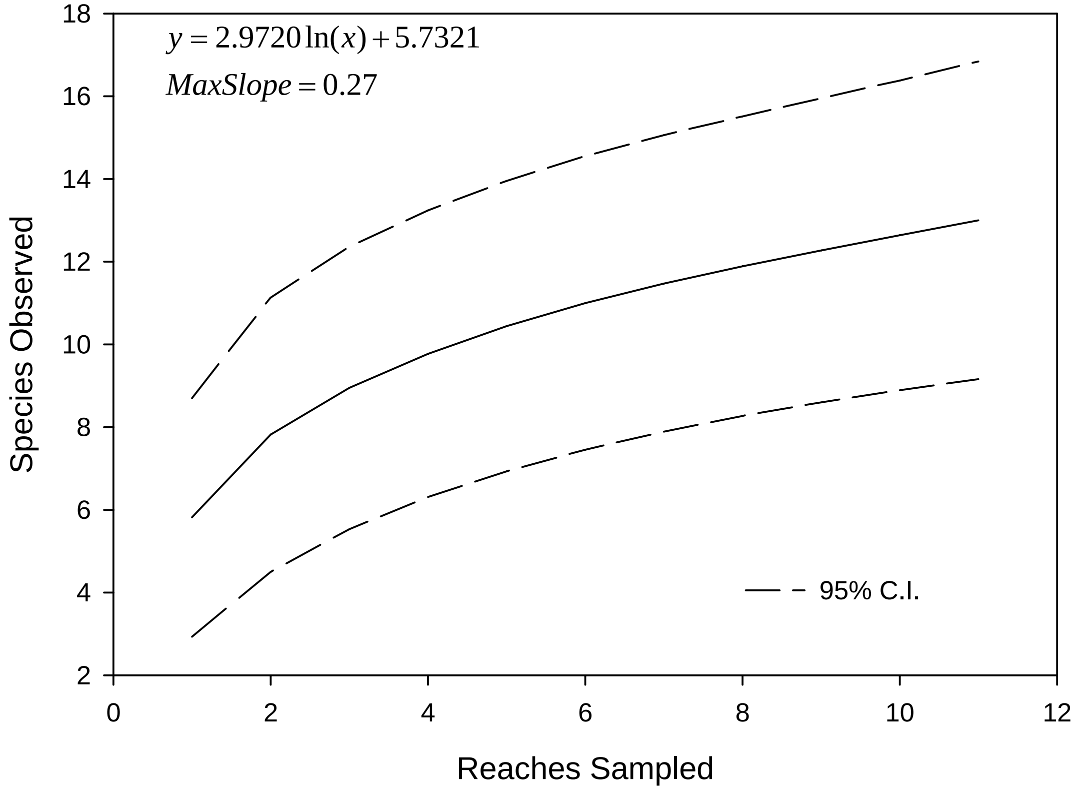

Figure 5. Sample-based rarefaction curve calculated from data collected in this survey and by Blausey (2001). Slope at eleven samples is given.

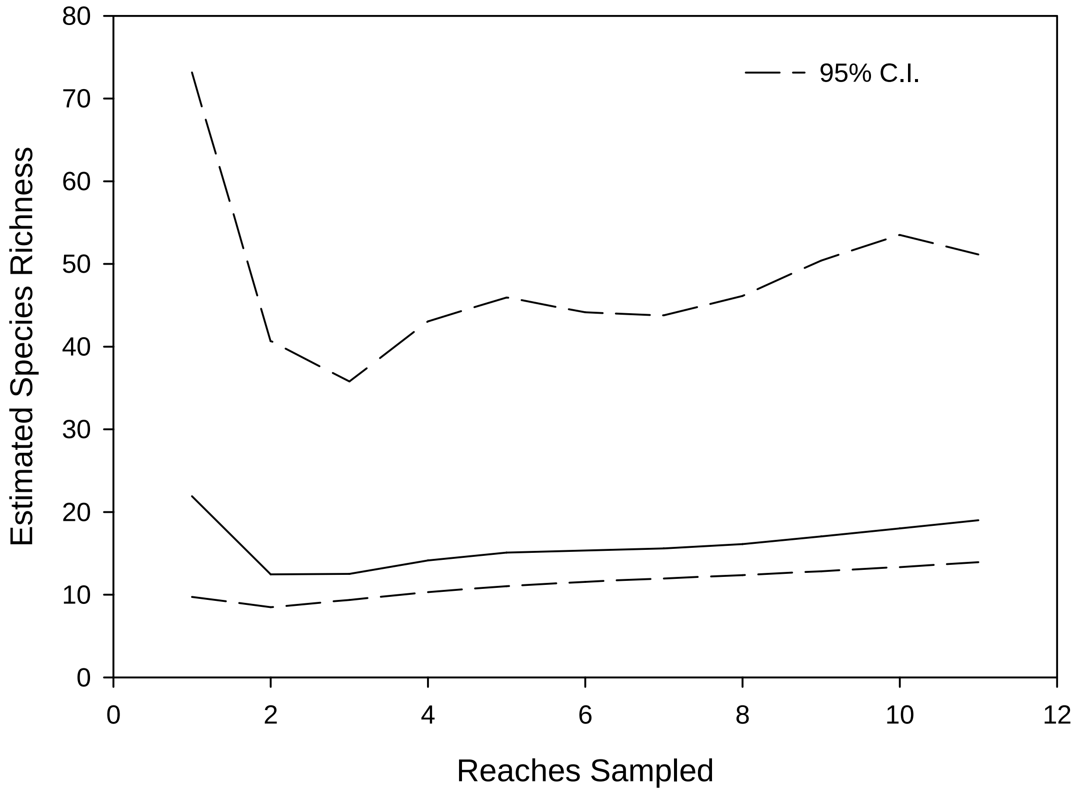

Figure 6. Chao1 species richness estimator with 95 % confidence intervals. Richness was estimated from data collected in this study and by Blausey (2001).

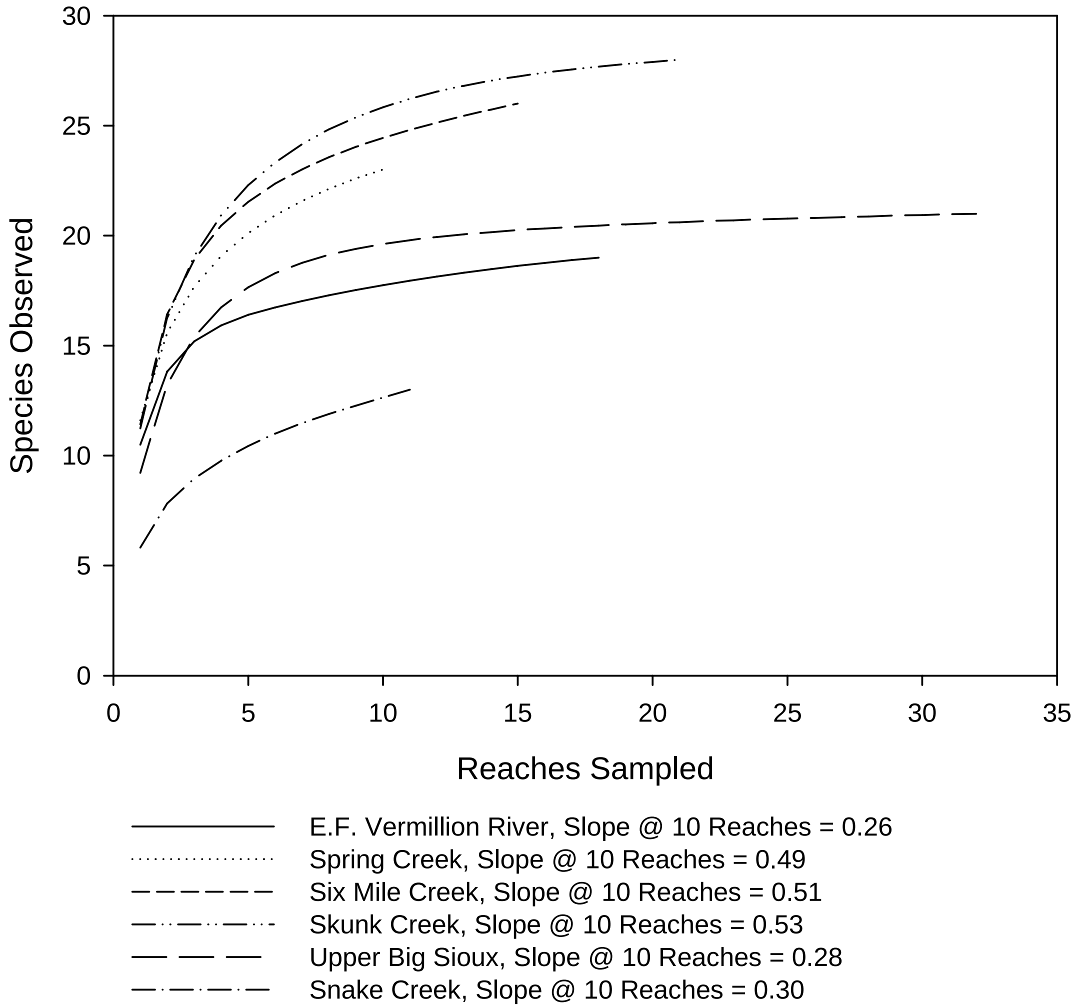

Figure 7. Sample-based rarefaction curves (Colwell et al. 2004) for several watersheds within the range of the Topeka shiner. The Topeka shiner has been documented from Six Mile Creek and Spring Creek.

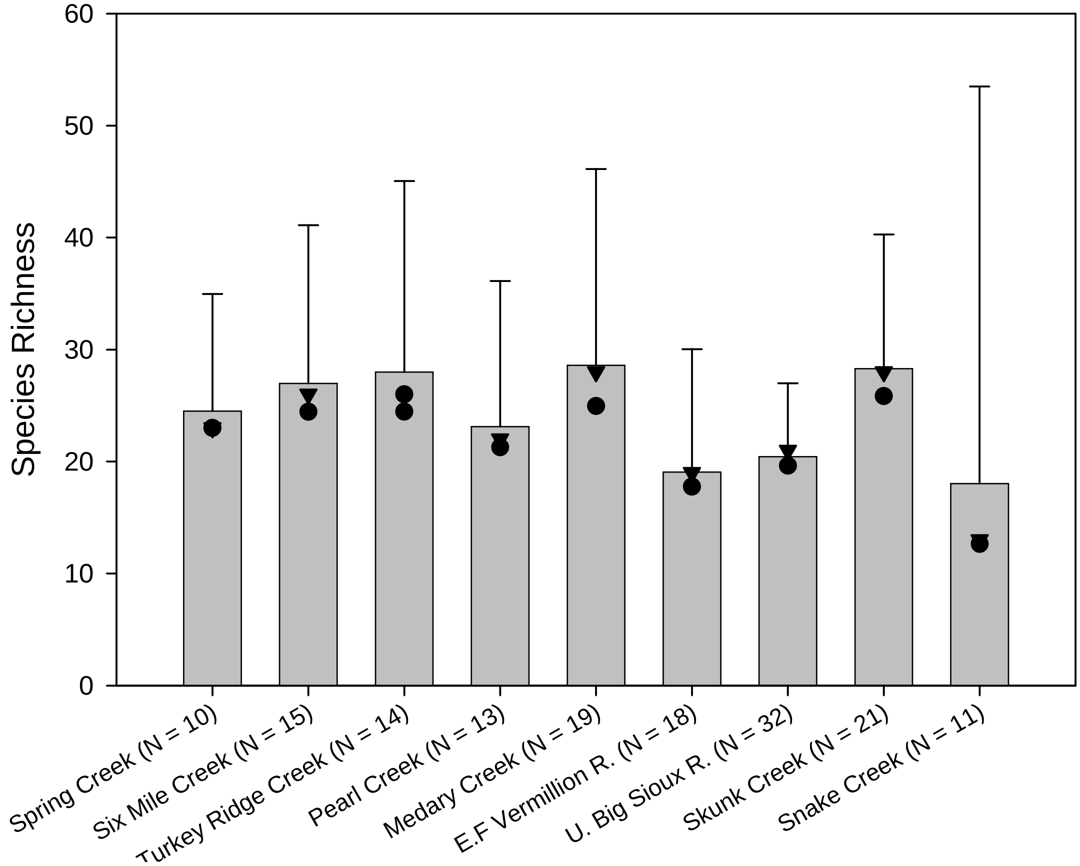

Figure 8. Estimated species richness (vertical bar) for watersheds within the range of *N. topeka*. Species richness is estimated with the Chao1 estimator and is calculated for ten reach samples for all watersheds. The upper 95 % confidence interval for the richness estimates are represented by error bars. Observed species richness at ten samples is shown with dots. Triangles represent observed species richness measured with all samples. Sample effort by watershed is denoted on the X axis. *N. topeka* has been collected from Spring Creek, Six-mile Creek, Turkey Ridge Creek, Pearl Creek.

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