Missouri Department of Natural Resources

Draft Analysis of Hinkson Creek Biological Metrics

Fall 2001 - Spring 2014

Boone County, Missouri

Prepared for:

Hinkson Creek Science Team

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1.0 Introduction

At the request of the Hinkson Creek Science Team, an in-depth analysis of primary and other biological macroinvertebrate community metrics was conducted. This analysis was to determine whether changes in metrics occur longitudinally along the Missouri Department of Natural Resources (**MDNR**) Hinkson Creek survey reach in Boone County, Missouri. Possible longitudinal effects within the survey reach mainly include urban versus rural land use, instream habitat, and the possible influence of tributaries along the survey reach.

Primary biological metrics include those that are used by MDNR to calculate Macroinvertebrate Stream Condition Index (**MSCI**) scores, which determine whether a given sample reach is supporting of the beneficial use designation (protection of warm water aquatic life) as defined in Missouri's Water Quality Standards (MDNR 2014). Primary metrics include Taxa Richness, EPT Taxa, Shannon Diversity Index, and Biotic Index. Secondary metrics included Functional Feeding Groups, Functional Habit Groups, percent sensitive taxa, and dominant macroinvertebrate taxa analysis. Dominant macroinvertebrate taxa analysis was subdivided into genus/species, family level, and percentage of EPT taxa making up Hinkson Creek samples.

A narrative to accompany the analysis of each metric is included in the text of this document, with the supporting figures and tables included as appendices at the end.

2.0 Sampling Effort

Macroinvertebrate samples were collected from Hinkson Creek at various times between the fall 2001 and fall 2014 field seasons. A total of 49 samples were collected in spring, and 35 samples were collected in fall (Table 1). Of these samples, several were noted as possibly being affected either by habitat quantity/quality limitations and/or drought. Of the 49 spring samples, only two were noted with this caveat, but drought affected as many as 14 of the 35 fall samples. Metrics likely to have differences between drought and non-drought years were analyzed using both data sets to observe the degree to which the inclusion of these affected samples changed the overall results.

Table 1. Sample Size by Hinkson Creek Station: Fall 2001 - Fall 2014

	Spring				Fall	
Station	All	Edited*		Station	All	Edited*
1	3	3		1	3	2
2	4	4		2	3	2
3	4	4		3	3	2
3.5	4	4		3.5	3	2
4	4	4		4	4	1
5	4	3		5	3	1
5.5	5	5		5.5	4	2
6	6	5		6	5	4
6.5	5	5		6.5	1	1
7	6	6		7	4	3
8	4	4		8	2	1
Total	49	47		Total	35	21

*Sites in which samples have been removed due to habitat or drought effects.

3.0 Primary Biological Metrics

An explanation of the primary biological metrics used by the MDNR is presented below.

- Taxa Richness (**TR**)
  This metric reflects the health of the community through a measurement of the number of taxa present. In general, the total number of taxa increases with improving water quality, habitat diversity, and/or habitat suitability. Taxa richness is calculated by counting all taxa from the subsampling effort.

- Total Number of Taxa in the Orders Ephemeroptera, Plecoptera, and Trichoptera (**EPT Taxa**)
  This value summarized taxa richness within the insect orders that are generally considered to be pollution sensitive. The EPT taxa index generally increases with increasing water quality.

- Biotic Index (**BI**)
  This value is a means of detecting organic pollution tolerance of individual taxa within the macroinvertebrate communities expressed as a single value between 0 and 10, with 0 being the most sensitive and 10 the most tolerant.

- Shannon Diversity Index (**SDI**)
  This index is a measure of community composition which takes into account both richness and evenness. It is assumed that a more diverse community is a more healthy community. Diversity increases as the number of taxa increase and as the distribution of individuals among those taxa is more evenly distributed.

A score of 1, 3, or 5 is calculated for each of the metrics listed above based on how they compare to numeric criteria for the study area (Tables 2 and 3). Using the values calculated from the TR, EPT Taxa, BI, and SDI data, a Macroinvertebrate Stream Condition Index (M**SCI**) score was assigned to the data for each sample station. The MSCI scores were divided into three categories. Study reaches that scored from 16-20 were considered fully supporting, scores from 10-14 were considered partially supporting, and scores of 4-8 were considered non-supporting of the warm water aquatic life beneficial use designation.

Table 2. Biological Criteria for Warm Water Reference Streams in the Ozark/Moreau/Loutre EDU, Spring

	Score = 5	Score = 3	Score = 1
TR	>71	35-71	<35
EPTT	>17	9-17	<9
BI	<6.4	6.4-8.2	>8.2
SDI	>2.8	1.4-2.8	<1.4

Table 3. Biological Criteria for Warm Water Reference Streams in the Ozark/Moreau/Loutre EDU, Fall

	Score = 5	Score = 3	Score = 1
TR	>73	73-37	<37
EPTT	>15	15-7	<7
BI	<6.8	8.4-6.8	>8.4
SDI	>3.18	3.18-1.59	<1.59

3.1 Spring Primary Biological Metrics

Graphical representations that support the following narrative are found in Appendix I.

<u>Taxa Richness</u>

TR was variable from year to year at each station, but Stations 1, 2, and 3 had the lowest percentage of fully supporting TR scores. Generally, stations upstream of the Flat Branch confluence (Station 3.5 - Station 8) had at least slightly higher percentages of samples with TR scores of 5. Only two stations had spring samples that were considered potentially affected by drought or (more likely) habitat limitations--Stations 5 and 6. When removing these samples from consideration, the percentage of fully supporting TR scores increased for both stations. Station 5 increased from 50 percent to 67 percent, and Station 6 increased from 50 percent to 60 percent.

<u>EPT Taxa</u>

Not a single spring sample has had a fully supporting EPT taxa metric score; however, three samples had EPT values that equaled the spring threshold value of 17. These samples included Station 5.5 in 2014, Station 6.5 in 2004, and Station 7 in 2002.

Station 1 has had two of three spring samples with non-supporting EPT taxa scores, all four Station 2 EPT taxa scores were non-supporting, and three of four Station 3 EPT scores were non-supporting. Stations 3.5 and 4 each had only one of four samples with non-supporting EPT scores, but half (two of four) of Station 5 scores were non-supporting. Samples collected from the remaining stations upstream of Station 5 all had partially supporting EPT taxa scores, with the exception of a non-supporting score at Station 6 in 2002, which appears to have been habitat limited.

<u>Biotic Index</u>

When viewing the charts in Appendix I, it is important to note that Biotic Index metric values increase with stream impairment; therefore, higher BI values are given lower scores. Only three samples had spring BI values with fully supporting scores: Station 6 and 7 in 2005 and Station 8 in 2012. Station 3.5 had a value that was equal to the threshold value in 2014, which nevertheless resulted in a partially supporting metric score. Generally, there was little variation among years within individual stations. Given the relatively narrow width between the red and green bars in the charts, this phenomenon also appears to exist among biological criteria reference (**BIOREF**) streams.

Shannon Diversity Index
Of the four primary metrics, this metric tended to score the best among all Hinkson Creek stations. Six of the 11 stations had 100 percent of the SDI values with fully supporting scores, and the remaining five stations had $\geq$ 65 percent of their respective SDI values that were fully supporting. There were no patterns relative to upstream/downstream with this metric. When factoring for habitat limitations at Stations 5 and 6, Station 5 went from 75 to 100 percent fully supporting and Station 6 changed from 67 to 80 percent fully supporting.

Macroinvertebrate Stream Condition Index
Station 5.5 had 100 percent (five of five) of its samples with fully supporting scores due to consistently high TR and SDI scores. The lowest percent of fully supporting scores occurred among stations downstream of the Flat Branch confluence. Of these three sites (Stations 1, 2, and 3), only Station 3 had a single fully supporting score. By comparison, the three control stations (Stations 6.5 - 8) had between 67 and 100 percent of samples with fully supporting scores.

3.2 Fall Primary Biological Metrics

Station 6.5 is not represented among the fall primary biological metrics in Appendix I due to there presently being only a single fall sample for this site.

Taxa Richness
TR varied not only from station-to-station, but also among years within the same station. Samples collected during drought years tended to have lower TR, and excluding those samples often increased the percentage of fully supporting scores for a given site considerably. Each of the sites that had 100 percent fully supporting scores after drought/habitat affected samples were removed, however, were based on a single sample (Stations 4, 5, and 8). Considerably more fall samples are considered to have been affected by drought/habitat limitations than spring. Of the 35 fall samples, 14 are considered drought/habitat affected, including all eight samples collected in fall 2012. Unlike the spring samples, the TR metric did not display a pattern relative to the Flat Branch confluence with respect to the percentage of samples with fully supporting TR scores. This percentage is highly variable, however, especially when removing drought/habitat affected samples. No definite patterns were apparent according to relative position in the survey reach with fall TR values.

EPT Taxa
Although Station 4 had an EPT taxa value equal to the threshold in fall 2014, fully supporting EPT scores were observed only among Stations 5 - 8, but only rarely. Stations 1 - 3.5 consistently had EPT taxa values that were in the partially-supporting scoring range.

Biotic Index
Although half or fewer samples collected downstream of the Flat Branch confluence had fully supporting BI metric scores, there were many that were either at or within a few tenths of the fully supporting threshold value. Far more samples attained fully supporting BI scores in the fall than spring. Whereas only three stations had *any* samples with fully supporting BI scores in spring, nine of the 11 sites had fully supporting BI scores at least some of the time in fall. No longitudinal pattern was evident with BI values or scores in fall.

Shannon Diversity Index

SDI was not as consistently robust in the fall compared to spring. After removing drought/habitat affected samples, four of the sites had 100 percent of SDI values with fully supporting scores. Of these four sites, however, Stations 4 and 5 had only a single sample, and Station 5.5 was represented by two. In general, stations higher in the watershed (upstream of and not including Station 3.5) had a higher percentage of SDI values with fully supporting scores.

Macroinvertebrate Stream Condition Index

Of the stations downstream of the Flat Branch confluence, Stations 2 and 3 had fully supporting MSCI scores, but each of those had only a single fully supporting score. Upstream of Flat Branch MSCI scores were variable, but even stations with low scores (prior to eliminating drought/habitat affected samples) had as high or higher fully supporting MSCI percentages than the stations downstream of Flat Branch with one exception. Station 3.5, which was upstream of the Flat Branch confluence, had no fully supporting fall MSCI scores.

4.0 Secondary Biological Metrics

4.1 Functional Feeding Groups and Functional Habit Groups

The following explanation of Functional Feeding Groups (**FFG**) and Functional Habit Groups (**FHG**) attributes were gleaned from Merrit et al. (2008) and Rabeni et al. (2005). Much of the following language is theirs.

Graphics associated with FFG and FHG analysis are in Appendix II.

Functional Feeding Groups (FFGs) categorize macroinvertebrates based on their primary feeding guilds. FFGs can be useful in biological assessments by inferences that can be drawn regarding abundance and quality of various habitat types. For example, scrapers, which feed by scraping rocks and other hard surfaces for food, would tend to be more abundant and account for a larger percentage of the macroinvertebrate community in a reach dominated by gravel/cobble/bedrock than one with mostly shifting sediment or hardpan clay. Water depth and clarity also may play a factor with FFGs, especially for those that feed on algae and periphyton.

Functional Habit Groups (FHGs) also can be used to judge habitat types and quality [(see Table 6B in Merrit et al. (2008)]. FHGs are the means of locomotion, attachment, or concealment for an individual macroinvertebrate taxon. The FHG of a given taxon can determine the likelihood and frequency with which an individual insect will move within any given habitat, especially via drift. Drift propensity is related to FHG, which is reflected in body shape. In cases of both FFG and FHG, when these metrics are used for purposes of monitoring and assessment, the utility of these metrics comes from determining how their relative abundances deviate from an expected value. In this case, noting any deviation from BIOREF conditions and also observing how relative abundances change longitudinally among upstream versus downstream stations.

In assessing habitat type among Hinkson Creek stations FFGs and FHGs would occur in similar percentages if habitat and water quality attributes were equal. Deviations from BIOREF percentages and differences among stations may be indicative of changes in habitat availability, water quality, or both.

Rabeni et al. (2005) rated FFGs and FHGs according to their response to deposited sediment. Among their findings, they noted that FFGs were more responsive to sediment than FHGs, and densities of all feeding groups decreased significantly in the presence of increased sediment. The relative densities of gatherers, however, increased significantly. Increasing sediment tends to result in fewer total individuals, but a higher proportion of gatherers and a lower proportion of filterers and scrapers.

Rabeni et al. (2005) rated the following FFGs relative to their tolerance to sediment, starting with the most tolerant:

shredders > gatherers > predators > scrapers > filterers

With respect to FHGs Rabeni et al. (2005) found that increasing sediment resulted in a significant decline in clingers and sprawlers, but not for the remaining habit groups. High sediment conditions result in fewer total individuals, but with a greater proportion of burrowers and climbers and a lower proportion of clingers.

Rabeni et al. (2005) also rated the following FHGs relative to their tolerance to sediment, starting with the most tolerant:

burrowers > climbers > sprawlers > swimmers > clingers

4.1.1 Functional Feeding Groups

Spring Samples

Although all Hinkson Creek stations tended to have at least somewhat more shredders than average BIOREF values, the urban reach (Stations 1 - 6) tended to have more shredders than the upstream control stations (Table 4). Stations 1 and 2 had the lowest percentage of scrapers, which is likely due to these stations having more of a glide/pool (i.e. more like northern Missouri prairie streams) condition than the remaining upstream stations. Stations 1 and 2 are characterized by having fewer riffles, more turbid water, little shallow water riffle habitat, and little gravel/cobble substrate compared to upstream stations. The remaining FFGs (predators, gatherer-collectors, filterer-collectors, and “other”) did not appear to have any notable longitudinal patterns among stations.

Fall Samples

Two of the three rural stations had a lower percentage of shredders than most of the urban stations in fall, but there was no clear separation between urban and rural (Table 5). A wider variety of FFG percentages existed among the urban stations in fall than spring. All samples had a lower percentage of shredders in the fall than in the spring, which may be due to natural cycles of leaf loading in the fall (fall sample collection season generally occurs prior to leaf fall) and invertebrate processing of this material during the winter and early spring months. As with spring, scrapers were rare at Station 1, but they were much more abundant at Station 2 in fall compared to spring. Most stations had much higher percentages of scrapers in fall compared to BIOREF streams.

Table 4. Hinkson Creek Average Functional Feeding Group by Station Compared to Ozark/Moreau/Loutre Reference Streams--Spring Season

			Sample Stations										
	Biorefs Spring	ALL Hinkson Spring Samples	1	2	3	3.5	4	5	5.5	6	6.5	7	8
Shredders	11.78	26.96	42.38	34.79	28.20	22.39	26.94	33.77	28.95	31.27	14.05	20.33	15.75
Scrapers	18.16	16.93	8.96	9.15	15.24	13.82	14.56	15.63	15.69	17.84	26.74	20.48	26.09
Predators	15.82	9.92	10.05	10.95	10.32	9.03	9.17	11.29	10.07	9.54	9.19	10.37	11.86
Gatherer Collectors	46.30	36.32	28.45	33.95	37.82	45.49	35.58	29.16	37.07	31.71	41.99	41.06	37.56
Filterer Collectors	6.52	9.05	9.34	10.31	7.79	8.35	12.36	9.36	7.02	9.07	7.08	7.14	8.28
Other*	1.41	0.83	0.82	0.85	0.63	0.93	1.39	0.79	1.20	0.57	0.94	0.62	0.45

*Other includes parasites, macrophyte piercers, and taxa with no identified FFG.

Table 5. Hinkson Creek Average Functional Feeding Group by Station Compared to Ozark/Moreau/Loutre Reference Streams--Fall Season

			Sample Stations										
	Biorefs Fall	ALL Hinkson Fall Samples	1	2	3	3.5	4	5	5.5	6	6.5	7	8
Shredders	10.75	8.25	10.02	5.83	11.20	4.90	6.98	12.02	9.69	9.76	10.87	5.76	3.88
Scrapers	16.09	22.73	7.27	23.70	14.86	23.13	27.54	24.64	23.08	22.93	35.89	28.85	29.53
Predators	15.23	12.45	14.68	13.02	13.18	9.41	9.88	11.12	12.69	12.33	12.77	12.94	14.89
Gatherer Collectors	38.99	42.52	43.07	42.54	45.72	51.22	43.17	37.84	41.03	39.78	27.01	43.27	44.19
Filterer Collectors	16.96	13.07	24.32	14.05	14.09	10.65	11.34	13.93	11.49	14.08	12.34	8.14	7.00
Other*	1.98	0.98	0.63	0.51	0.47	0.48	0.54	0.45	1.01	0.70	0.56	0.69	0.26

*Other includes parasites, macrophyte piercers, and taxa with no identified FFG.

Although scrapers were relatively rare at Station 1, filterer-collectors were much more abundant than at the remaining stations.

In summary, depending on season (spring vs. fall), differences in FFG exist between urban and rural stations. Station 1 consistently had a lower percentage of scrapers than the remaining stations downstream. Scrapers also were rare at Station 2, but only in the spring.

4.1.2 Functional Habit Groups

Spring Samples

Sprawlers were generally similar in spring samples among Hinkson Creek stations, with the exception that Station 2 had a slightly lower percentage of sprawlers than the remaining stations (Table 6). As a whole, Hinkson Creek stations had a lower percentage of sprawlers compared to BIOREF streams. Burrowers were consistently more abundant among Hinkson Creek stations than BIOREFs in spring. Surprisingly, the two most upstream stations had the highest percentage of burrowers. Climbers were most abundant at Stations 1 - 3 and then declined notably at Station 3.5. Stations 3.5 - 7 had similar percentages of climbers, but they were much lower in abundance at Station 8. Rabeni et al. (2005) observed that the relative density of climbers increases in response to increasing levels of benthic sediment.

Fall Samples

FHG relative abundance was variable among habit groups and among Hinkson Creek stations in fall. Unlike the spring data, there do not appear to be any consistent patterns with respect to urban versus rural or to the lowermost portion of the sample reach (i.e. Stations 1 - 2 or 3 vs. stations farther upstream). Compared with BIOREF streams, the average of all Hinkson Creek FHGs were roughly similar, and no obvious patterns or notable deviations were observed with the fall FHG data (Table 7).

4.2 Macroinvertebrate Taxa Sensitivity

In this section the range of BI values has been averaged for each Hinkson Creek station over time. With the exception of only a few Missouri taxa, a biotic index value from 0 to 10 has been assigned. Lower biotic index values are indicative of taxa that are intolerant of organic-type pollutants (e.g. those associated with poorly-treated wastewater), and taxa tolerance increases as the BI value approaches 10. For this analysis, taxa sensitivity has been grouped into three general categories: sensitive (BI = 0 - 4.9); midrange (BI = 5.0 - 7.4); and tolerant (BI = 7.5 - 10).

Spring Samples

Although sensitive taxa tended to make up an increasing percentage of samples from downstream to upstream, none of the Hinkson Creek stations had a similar percentage of sensitive taxa when compared to BIOREF samples (Table 8). The three stations downstream of the Flat Branch confluence (Stations 1 - 3) had the lowest percentage of sensitive taxa present, and the uppermost stations (Stations 7 and 8) had the highest. Of the three tolerance ranges, midrange taxa had the highest relative abundance at all Hinkson and BIOREF stations, but Hinkson Creek stations had a higher proportion of midrange than the BIOREFs. Although sensitive taxa were particularly

Table 6. Hinkson Creek Average Functional Habit Group by Station Compared to Ozark/Moreau/Loutre Reference Streams--Spring Season

			Sample Stations										
	Biorefs Spring	ALL Hinkson Spring Samples	1	2	3	3.5	4	5	5.5	6	6.5	7	8
Other*	14.65	16.18	11.71	19.58	20.27	23.56	13.39	13.85	15.60	12.07	18.27	15.25	15.86
Swimmers	6.07	1.32	0.47	0.64	0.56	0.85	1.46	0.68	1.51	1.68	2.23	2.00	2.04
Sprawlers	30.20	24.18	21.99	19.42	22.21	23.78	26.67	24.52	24.00	26.50	25.16	28.86	24.52
Climbers	5.91	12.27	33.56	28.60	20.23	8.86	10.13	10.05	9.10	8.30	6.71	6.50	2.53
Clingers	38.57	37.37	24.24	23.69	28.88	34.35	41.09	44.03	40.80	45.86	37.94	35.78	43.98
Burrowers	4.61	8.69	8.04	8.07	7.86	8.60	7.27	6.88	8.99	5.59	9.70	11.61	11.08

*Other includes divers, skaters, planktonic and taxa with no identified FHG.

Table 7. Hinkson Creek Average Functional Habit Group by Station Compared to Ozark/Moreau/Loutre Reference Streams--Fall Season

			Sample Stations										
	Biorefs Fall	ALLHinkson Fall Samples	1	2	3	3.5	4	5	5.5	6	6.5	7	8
Other*	14.06	22.43	25.40	19.68	20.31	30.02	15.55	21.27	32.62	20.32	12.86	21.67	16.31
Swimmers	5.67	3.81	7.10	4.99	6.14	2.23	3.26	3.54	3.99	3.05	3.19	2.40	2.37
Sprawlers	17.35	22.30	16.78	24.68	25.40	24.30	24.44	17.08	15.96	26.32	8.89	25.65	26.74
Climbers	19.55	13.53	15.81	11.62	16.89	9.89	10.14	18.10	13.12	14.01	18.90	12.38	10.97
Clingers	35.69	31.55	28.22	33.11	26.19	29.04	38.34	33.86	28.16	30.91	49.18	31.02	34.03
Burrowers	7.69	6.38	6.69	5.93	5.08	4.53	8.27	6.15	6.15	5.40	6.99	6.88	9.58

*Other includes divers, skaters, planktonic and taxa with no identified FHG.

rare among Stations 1 - 3, the percentage of tolerant taxa was similar to or only somewhat higher than the BIOREF average.

Table 8. Percentage of Biotic Index Values in Range--Average Spring Values

	Sensitive	Midrange	Tolerant	
	0-4.9	5.0 - 7.4	7.5-10	N
Biorefs Spring	22.58	39.02	38.40	13
Hinkson 1	5.12	56.21	38.78	3
Hinkson 2	4.53	51.76	43.71	4
Hinkson 3	3.63	52.04	44.42	4
Hinkson 3.5	9.08	48.02	42.92	4
Hinkson 4	10.83	49.47	40.07	4
Hinkson 5	8.13	57.35	34.53	4
Hinkson 5.5	9.49	50.28	40.23	5
Hinkson 6	13.18	45.92	40.90	6
Hinkson 6.5	11.53	46.60	41.87	5
Hinkson 7	16.26	44.91	38.83	6
Hinkson 8	17.27	45.09	37.65	3

Two samples (of 49) that were deemed drought/habitat limited were removed to observe any effects on the makeup of taxa sensitivity (Table 9). Although the relative abundance of sensitive taxa increased slightly when these samples were removed, the difference was minimal, especially when considering the final percentage of sensitive taxa compared to the BIOREFs. The degree of change for the midrange and tolerant groups also was slight.

Table 9. Percentage of Biotic Index Values in Range--Average Spring Values

	Sensitive	Midrange	Tolerant	
	0-4.9	5.0-7.4	7.5-10	N
Biorefs Spring	22.58	39.02	38.40	13
Hinkson 5	8.13	57.35	34.53	4
Hinkson 5*	9.74	54.71	35.55	3
Hinkson 6	13.18	45.92	40.90	6
Hinkson 6*	14.44	43.92	41.63	5

*samples potentially affected by drought or habitat limitations removed

<u>Fall Samples</u>
Among BIOREFs, taxa sensitivity tends to skew toward the midrange portion of the spectrum in fall (Table 10). Whereas taxa in the sensitive range make up 22.58 percent of spring BIOREF samples, they only account for 9.68 percent in fall. Of the 11 Hinkson Creek stations, nine had a reduction in the percentage of sensitive taxa from spring to fall. Only Stations 1 and 3 exhibited

increases in the relative abundance of sensitive taxa. Station 1 tolerance ranges were similar to the BIOREFs in fall with the exception of the slightly lower sensitive grouping. In fall only four of the 11 Hinkson Creek stations were dominated by taxa with midrange sensitivity; the remaining seven sites had at least slightly more tolerant taxa than midrange. Stations 7 and 8, which had the highest percentage of sensitive taxa in spring, had notably lower relative abundance of sensitive taxa in fall.

Table 10. Percentage of Biotic Index Values in Range--Average Fall Values

	Sensitive	Midrange	Tolerant	
Station	0 - 4.9	5.0 - 7.4	7.5 - 10	N
Biorefs Fall	9.68	51.58	38.74	10
Hinkson 1	7.61	51.00	41.40	3
Hinkson 2	3.80	50.62	45.58	3
Hinkson 3	4.23	48.73	47.04	3
Hinkson 3.5	2.74	43.40	53.87	3
Hinkson 4	6.29	52.13	41.59	4
Hinkson 5	5.56	54.97	39.47	3
Hinkson 5.5	3.86	41.36	54.78	4
Hinkson 6	4.00	47.15	48.85	5
Hinkson 6.5	8.72	63.76	27.53	1
Hinkson 7	6.90	41.32	51.79	4
Hinkson 8	5.50	46.34	48.16	2

Drought/habitat limitations affected 14 of the 35 Hinkson Creek samples collected in fall. The removal of samples affected by drought/habitat had more of an effect on the range of sensitivity in the fall compared to spring. The removal of these samples did not, however, yield consistent results. Four of the 11 stations actually had a lower relative abundance of sensitive taxa after drought/habitat affected samples were removed (Table 11). With the exception of Stations 1 and 7, which were unchanged, each of the stations had an increase in the midrange percentage in response to habitat/drought affected sample removal. The largest difference occurred with midrange taxa at Station 8; however, this station was represented by only a single sample after drought/habitat affected samples were removed.

Table 11. Percentage of Biotic Index Values in Range--Average Fall Values

	Sensitive	Midrange	Tolerant	
Station	0 - 4.9	5.0 - 7.4	7.5 - 10	N
EDU Fall	9.68	51.58	38.74	10
Hinkson 1	7.61	51.00	41.40	3
Hinkson 1*	6.88	51.04	42.09	2
Hinkson 2	3.80	50.62	45.58	3
Hinkson 2*	3.37	57.34	39.29	2
Hinkson 3	4.23	48.73	47.04	3
Hinkson 3*	5.63	59.12	35.25	2
Hinkson 3.5	2.74	43.40	53.87	3
Hinkson 3.5*	3.64	44.01	52.36	2
Hinkson 4	6.29	52.13	41.59	4
Hinkson 4*	5.58	65.52	28.90	1
Hinkson 5	5.56	54.97	39.47	3
Hinkson 5*	8.60	63.30	28.10	1
Hinkson 5.5	3.86	41.36	54.78	4
Hinkson 5.5*	6.18	48.64	45.20	2
Hinkson 6	4.00	47.15	48.85	5
Hinkson 6*	6.22	51.39	42.39	4
Hinkson 7	6.90	41.32	51.79	4
Hinkson 7*	5.17	41.17	53.66	3
Hinkson 8	5.50	46.34	48.16	2
Hinkson 8*	7.99	63.84	28.17	1

*samples potentially affected by drought or habitat limitations removed

4.3 Dominant Macroinvertebrate Taxa Analysis

Percent dominant taxa were analyzed at three levels: genus/species; taxonomic family level; and percent EPT taxa for each Hinkson Creek station for both sample seasons. Tables in Appendix III - V present dominant macroinvertebrate taxa data for the following sections.

4.3.1 Genus/Species Taxonomic Level Analysis

Spring Samples

The genus/species level analysis showed that the family Chironomidae (midges) accounted for nearly all of the top 10 taxa in spring, followed by riffle beetles and caenid mayflies (specifically, only one species, *Caenis latipennis*). Aquatic worms were common, but they were not consistently among the top 10 taxa at each site. Toward the upper portion of the survey reach (Stations 6 and 6.5), the heptageniid mayfly *Stenonema femoratum* occurred in sufficient abundance to be among the top 10 taxa along with *C. latipennis*. Stoneflies were not abundant in samples until Stations 7 and 8. The stonefly *Perlesta* was among the top taxa at each of these sites.

4.3.1 Genus/Species Taxonomic Level Analysis

Fall Samples

Although several taxa were consistently among the top 10 dominant taxa in fall, there tended to be more diversity of taxa among stations than in spring. Taxa in the family Chironomidae were not as overwhelmingly dominant in fall samples compared to spring. This family was represented by no more than four taxa (Station 1) among the top 10 in the fall, and the majority of stations had only one or two taxa. In contrast, spring samples had between three (Station 8) and eight (Stations 1 and 6) chironomid taxa among the top 10.

More EPT taxa were present among the top 10 taxa in fall, with *C. latipennis* being in the top three at all stations except Station 6.5. Whereas only one or two EPT taxa were among the dominant taxa in spring samples, three or four were present in fall. By comparison, BIOREF stations had five EPT taxa ranking in the top 10 in spring and six in fall. One genus of caddisfly, *Cheumatopsyche*, was present among the top taxa at each Hinkson Creek station in fall. Although *Cheumatopsyche* is a relatively tolerant genus (BI = 6.6), another caddisfly, *Helicopsyche* (BI = 0.0) has been found at all but Hinkson Creek Stations 1 and 2 at some point during the 2001-2014 study period. Between 2001 and 2012 *Helicopsyche* was encountered intermittently and in relatively low numbers between Stations 5.5 and 8. In 2014, however, it was found at every station between Stations 3 and 8, and was actually in the top 10 abundant taxa at Stations 6.5, 7, and 8. *Helicopsyche* has not been found in any BIOREF samples, spring or fall.

Relative to BIOREF samples, aquatic worms in the family Tubificidae tended to be much more abundant at all Hinkson Creek station except Station 8. Tubificids were among the top three dominant taxa at eight of the 11 stations, and it was the dominant taxa group at Stations 1 and 5.5.

In General

Hinkson Creek samples have tended to be dominated by one or two taxa during both spring and fall seasons. Abundance of subsequent taxa generally declines rapidly. This observation contrasts with BIOREF samples, in which taxa abundance is more homogeneous. It is unknown at this point whether each individual BIOREF stream exhibits similar patterns of taxa dominance. Additional analysis would be necessary to determine whether this gradual attenuation in taxa dominance among BIOREF samples is merely due to diversity of streams and averaging the data set.

From a Hinkson Creek longitudinal perspective, genus/species level taxonomic resolution offers few patterns relative to tributaries or rural versus urban watershed dominance.

4.3.2 Family Level Analysis

Spring Samples

Stations downstream of the Flat Branch confluence were dominated by Chironomidae, with Tubificidae being a distant second. These two families accounted for between 69.7 and 85.7 percent of the Station 1 - 3 samples. Chironomids tended to make up a much higher percentage of samples collected in the urban reach (Stations 1- 6). Although they were the top family at stations 6.5 - 8, chironomids were not as overwhelmingly dominant as they were in the urban reach. Tubificids also were generally not as abundant in the rural reach, with abundance being closer to the BIOREF average percentage than in the urban reach. Urban exceptions of tubificid abundance occurred at Stations 4 and 5, where they made up a similar percentage of samples compared to BIOREFs. Two mayfly families, Caenidae and Heptageniidae, were among the top dominant families at many Hinkson Creek stations. Caenid mayflies were present among the dominant taxa at each Hinkson Creek station in spring. Most members of this mayfly family found in Missouri have BI values of 7.6, which places them in the tolerant end of the sensitivity spectrum. Caenid mayflies also tend to be more tolerant of fine sediments, as evidenced by the structures covering their gills that protect them from abrasion and siltation. The other common mayfly family, Heptageniidae, was made up mostly of the species *Stenonema femoratum*. This species is also relatively tolerant, with a BI value of 7.5.

Riffle beetles in the family Elmidae also were among the top families at each Hinkson Creek station. This family has a BI value of 4.0, but the genus *Stenelmis*, which accounted for nearly all individuals of this family in Hinkson Creek samples, has a BI value of 5.4, which is toward the sensitive end of midrange.

<u>Fall Samples</u>

Although chironomids were the most abundant taxon at most Hinkson Creek stations in the fall, caenid mayflies and riffle beetles each were the primary taxon at one station each. In addition, chironomids were not the overwhelmingly dominant taxon in fall that they were in spring samples. In fall additional EPT taxa were present among the top taxa (hydropsychid caddisflies and baetid mayflies) that either were not as abundant or were absent in spring samples. Unlike the spring samples, chironomids were similarly abundant throughout the survey reach and were present in roughly similar relative abundance as in BIOREF samples. Tubificid worms made up a larger percentage of Station 1, 3.5, and 5.5 samples than the remaining sites. As was the case with chironomids, tubificid abundance did not appear to exhibit any obvious trends in the survey reach. Netspinner caddisflies in the family Hydropsychidae were present among the top taxa at all but four stations in the fall. This family of caddisflies has a BI value of 4.0, which is within the sensitive category of BI value ranges.

4.3.3 EPT Taxa Level Analysis

<u>Spring Samples</u>

Among EPT taxa, mayflies tended to be the most abundant of the three taxonomic orders at all Hinkson Creek stations. Whereas mayflies made up an average of 38.5 percent of BIOREF samples, the highest mayfly abundance among Hinkson Creek samples was 18.0 percent at Station 6.5. Although mayfly abundance was variable among stations, the two downstream sites had the lowest percentages in spring samples.

Stoneflies made up an average of 9.1 percent of BIOREF samples, but the highest percentage among Hinkson Creek samples (4.9 percent) occurred at the uppermost Station 8. The two downstream stations had no stoneflies, and Station 3 averaged < 0.1 percent of stoneflies among four samples. The percentage of stoneflies in samples tended to increase from downstream to upstream, but this generally-sensitive taxa group was relatively rare throughout the survey reach.

Caddisflies were less abundant in spring BIOREF samples than stoneflies, but they were present at each of the Hinkson Creek stations in roughly similar percentages. Although caddisfly percentages were lowest among stations downstream of the Flat Branch confluence, other upstream stations had similar values.

Fall Samples

Mayflies were the most abundant order among EPT taxa in fall Hinkson Creek samples. Unlike spring samples, however, mayflies were near or exceeded the percent composition of BIOREF sites at seven of the 11 stations. Mayflies made up the lowest percentage of Station 1, 5.5, and 6.5 samples (it should be noted, however, that Station 6.5 was represented by a single fall sample).

Compared to spring, stoneflies are very rare in BIOREF samples, averaging only 0.l percent of sample composition. Stoneflies likewise were rare in Hinkson Creek, with a single individual found in the Station 6.5 sample and a single individual in one of the two Station 8 samples.

The highest fall relative abundance of caddisflies occurred at Station 1 and 6.5. With the exception of these two stations and Station 3.5, which had the lowest caddisfly abundance, the remaining Hinkson Creek stations had similar percentages of caddisflies with no discernible pattern.

5.0 Conclusions

1. Spring data tended to exhibit more trends relative to longitudinal positioning of Hinkson Creek sampling stations than fall.
    - More taxa richness fully supporting scores occurred upstream of the Flat Branch confluence.
    - All but one EPT Taxa score among Stations 1, 2, and 3 (downstream of Flat Branch) were *non* supporting.
    - The lowest percentage of fully supporting MSCI scores occurred downstream of the Flat Branch confluence.
    - Scrapers were relatively rare at Stations 1 and 2. This observation was not related to Flat Branch, bur rather it was probably a function of the glide/pool tendencies of these stations.
    - More shredders were present in the urban (Stations 1 - 6) than the rural reach (Stations 6.5 - 8), which is suggestive of a more sediment tolerant community.
    - More climbers (which tend to increase with fine sediment) were present at Stations 1 - 3. Burrowers, however, were most abundant at Stations 7 and 8.
2. Fall data tend to be more variable, with few notable longitudinal patterns.
3. The fall sample season for Hinkson Creek tends to show more variability in response to drought than spring samples.
4. In spring the macroinvertebrate community tended to be more pollution tolerant among downstream stations and more sensitive in the upstream reaches. Stations 1 - 3 had the lowest percentage of sensitive taxa and Stations 7 and 8 had the highest.
5. In fall, Station 1 sensitivity was similar to BIOREF percentages. BIOREFs as a whole, however, tended to have a lower percentage of sensitive taxa in fall compared to spring. Station 1 did, however, have a higher percentage of sensitive taxa in fall than spring.

Stations 7 and 8 had a much lower percentage of sensitive macroinvertebrates in fall than they did in spring.

6. Genus/species level taxonomic analysis showed that true flies in the family Chironomidae (non-biting midges) accounted for nearly all of the top 10 taxa in spring. Fall samples tended to show more taxonomic diversity. Only Stations 7 and 8 had a stonefly taxon present in sufficient numbers to rank in the top 10.
7. Hinkson Creek tends to have a higher percentage of aquatic worms (Tubificidae) compared to BIOREF streams. Tubificids are generally tolerant of organic pollutants and fine sediments.
8. Unlike BIOREF streams, which have several taxa of roughly similar abundance in the top 10 taxa, Hinkson Creek samples tend to be dominated by one or two taxa.
9. Mayfly taxa commonly found in Hinkson Creek samples (*C. latipennis* and *S. femoratum*) fall within the "tolerant" range of the sensitivity spectrum.
10. Chironomids were not the overwhelmingly dominant taxa group in fall. Several stations had chironomid abundance similar to BIOREF percentages.
11. Among EPT taxa, mayflies were the most abundant of the three orders in spring samples. Mayflies were present in no more than half the abundance as BIOREFs in spring. In fall, however, mayflies were present in percentages comparable to BIOREF streams in seven of the 11 stations.

6.0 References Cited

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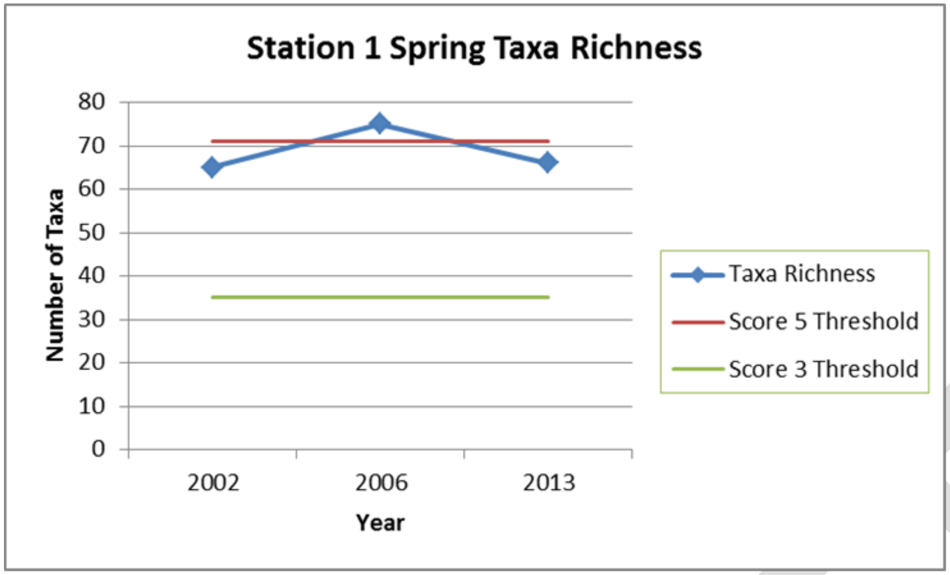
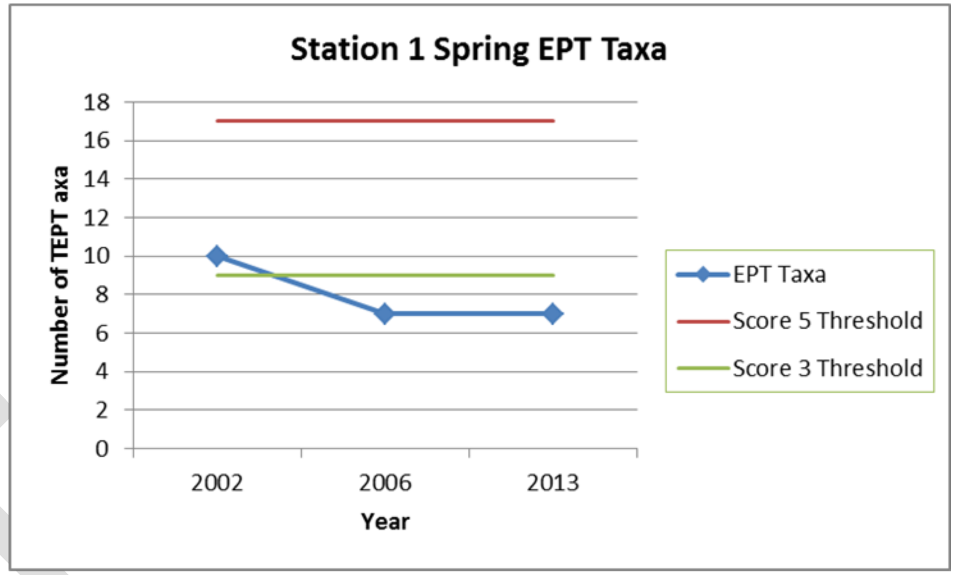
Rabeni, C.F., K.E. Doisy, and L.D. Zweig. 2005. Stream invertebrate community functional responses to deposited sediment. Aquatic Sciences 67: 395-402.

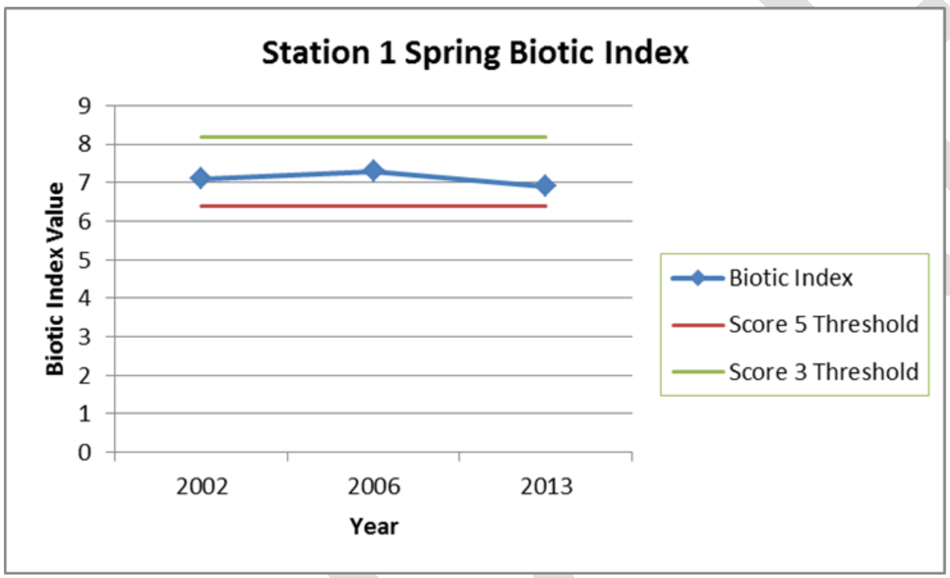
Appendix I

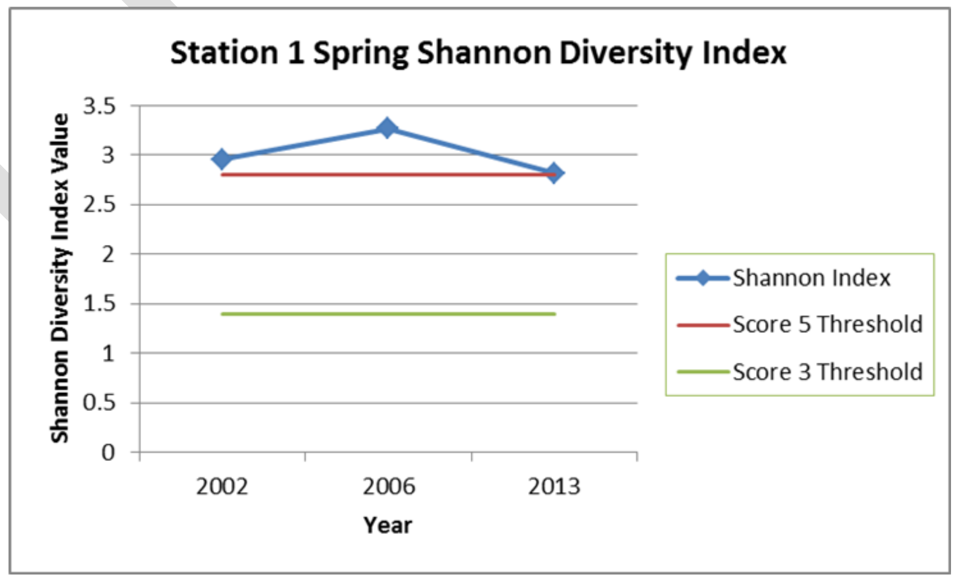
Graphical Representations of Taxa Richness, EPT Taxa, Biotic Index, and Shannon Diversity Index: Hinkson Creek Spring and Fall Data

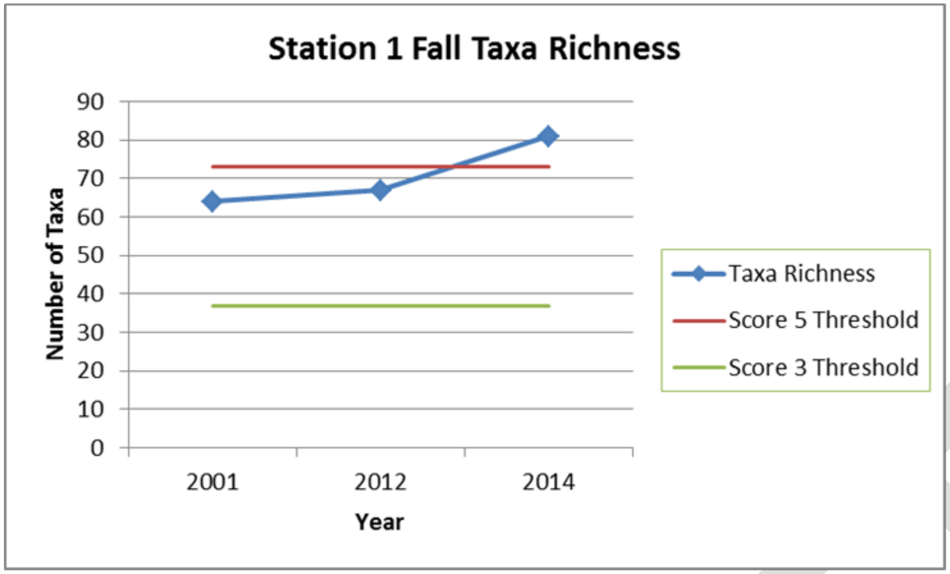
Appendix I
Primary Biological Metrics Charts
page 1







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60
50
40
30
20
10
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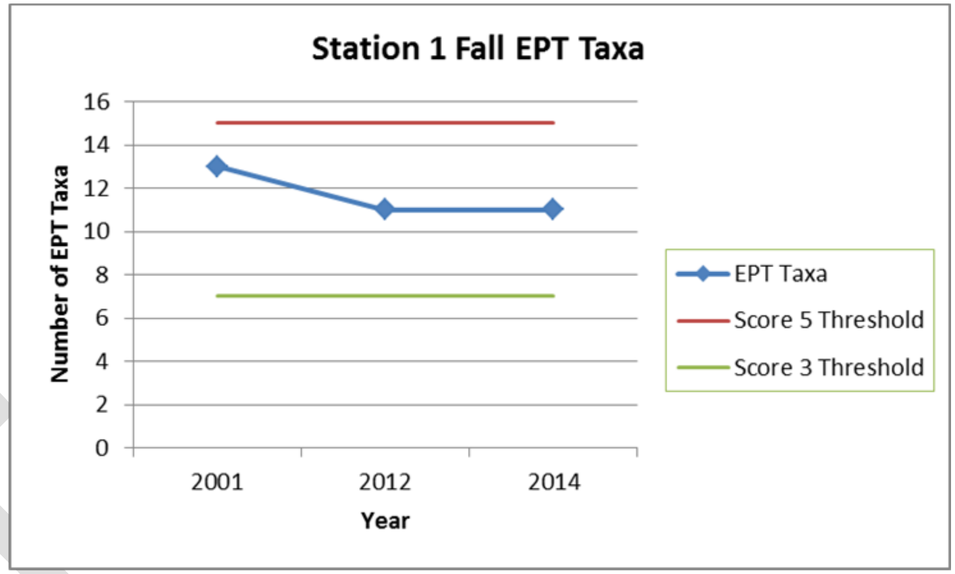
2001
2012
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold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Number of EPT Taxa
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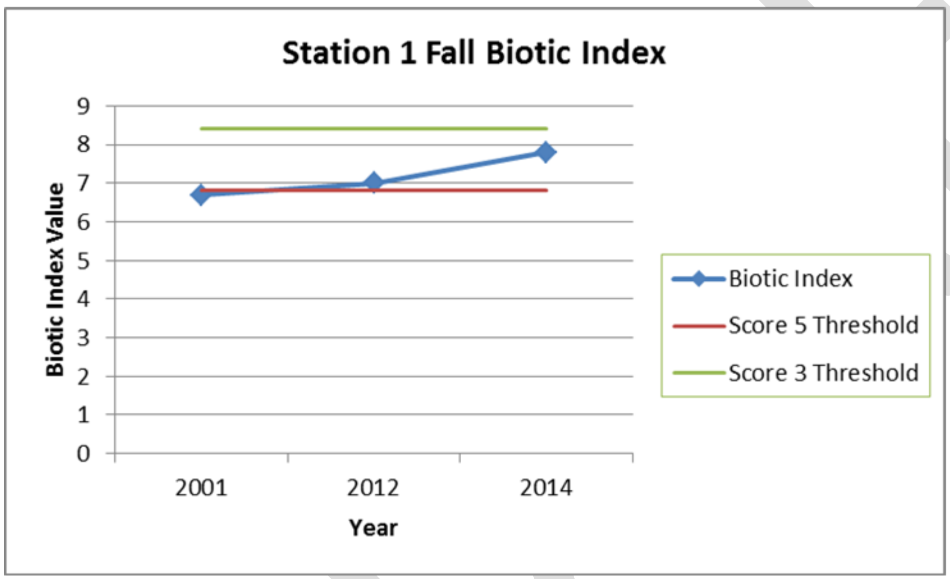
2001
2012
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold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2001
2012
2014
Year
Biotic Index
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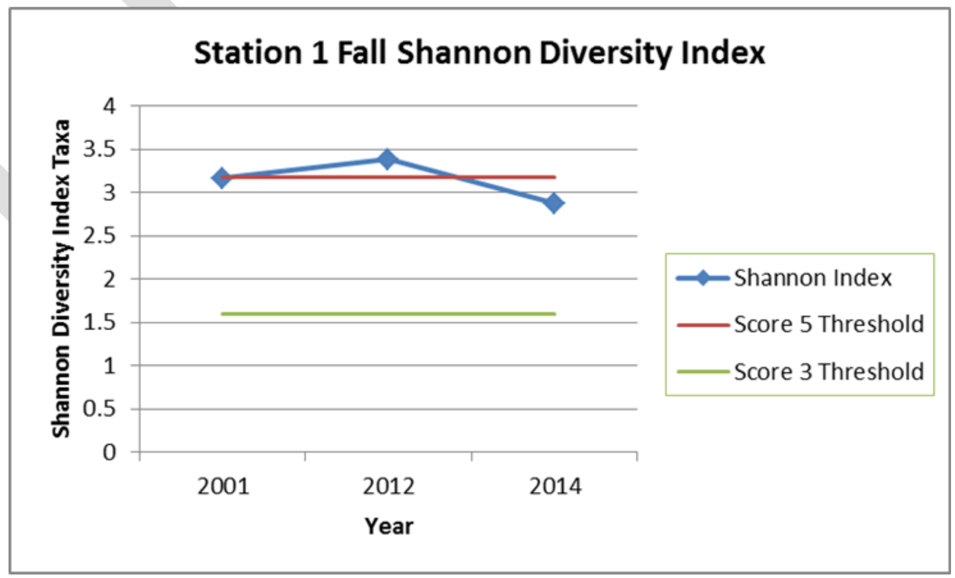
Score 3 Threshold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Shannon Diversity Index Taxa
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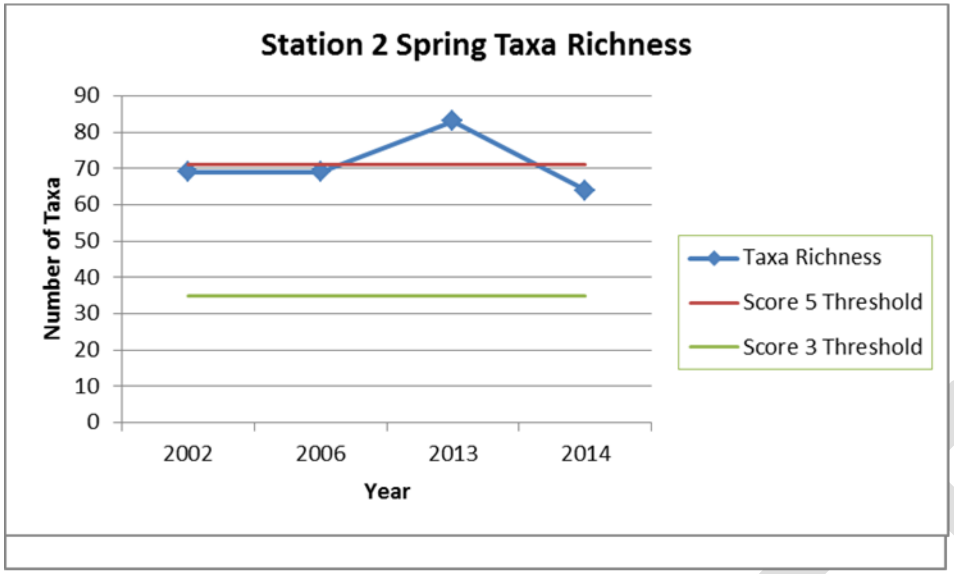
2012
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold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Year
Taxa Richness
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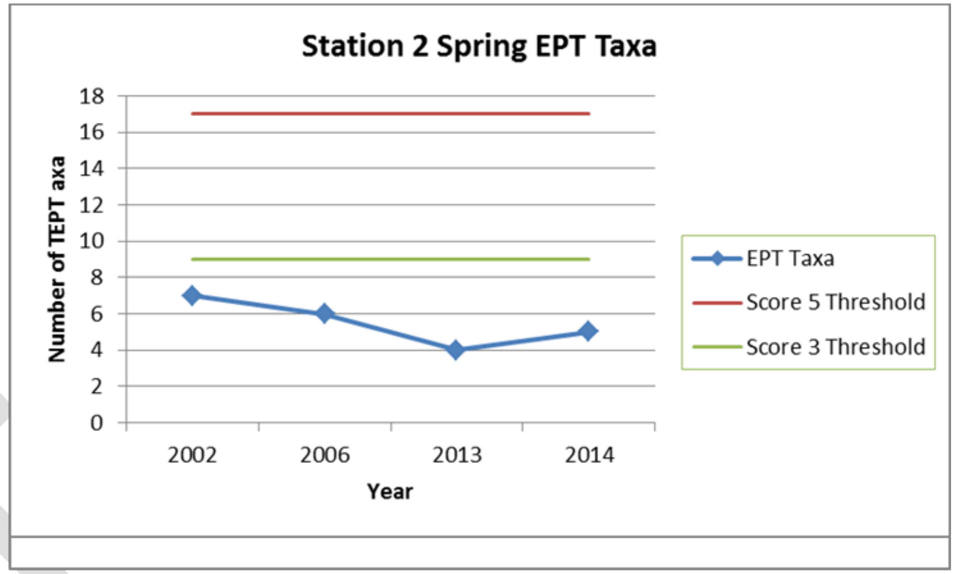
Score 3 Threshold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Number of TEPT axa
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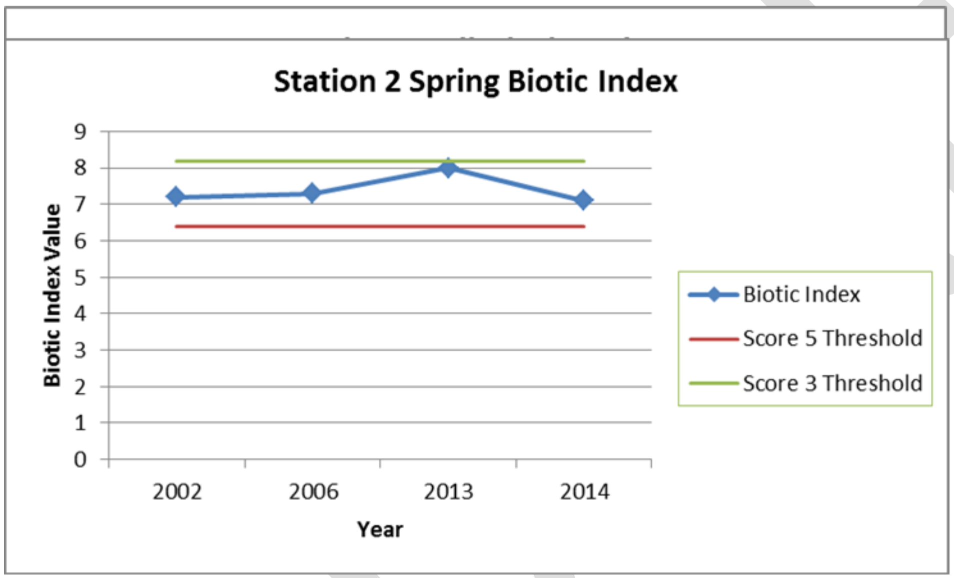
2002
2006
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 2 Spring Biotic Index
Biotic Index Value
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4
3
2
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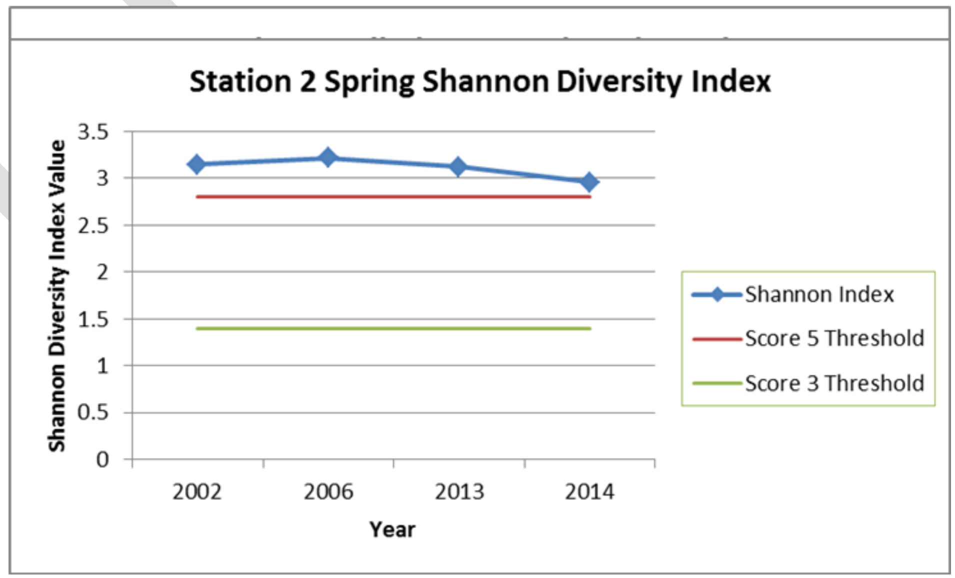
2002
2006
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold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Shannon Diversity Index Value
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2
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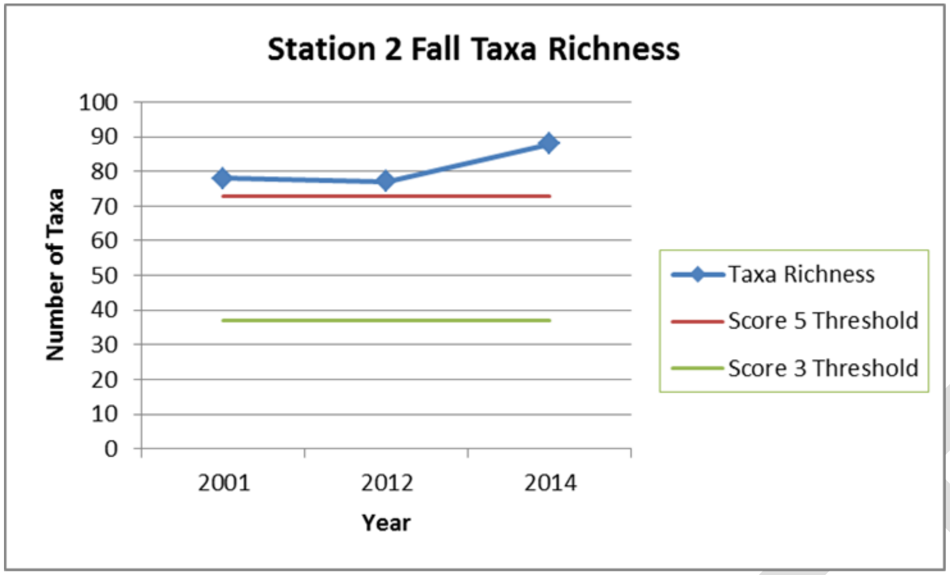
0
2002
2006
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold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Number of Taxa
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2012
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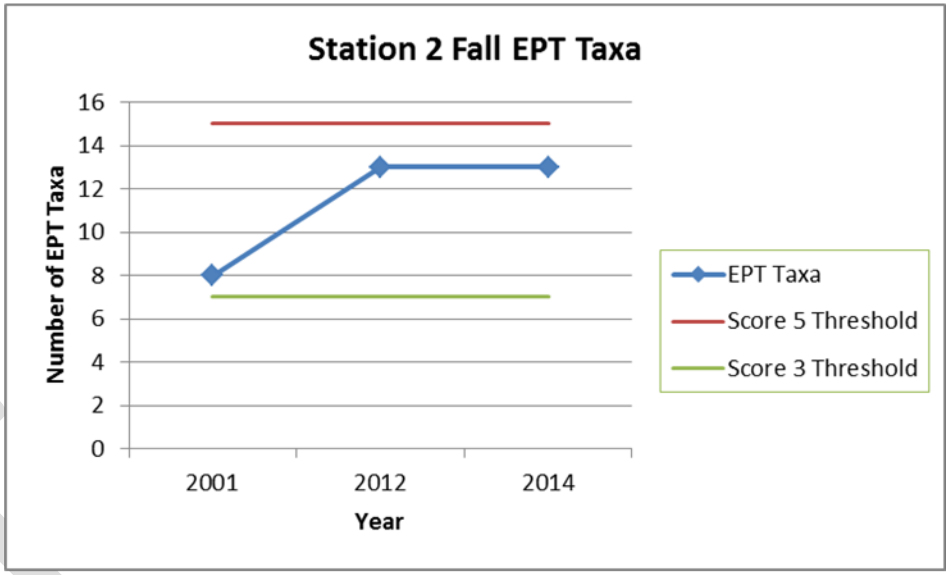
Taxa Richness
Score 5 Threshold
Score 3 Threshold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Number of EPT Taxa
2001
2012
2014
Year
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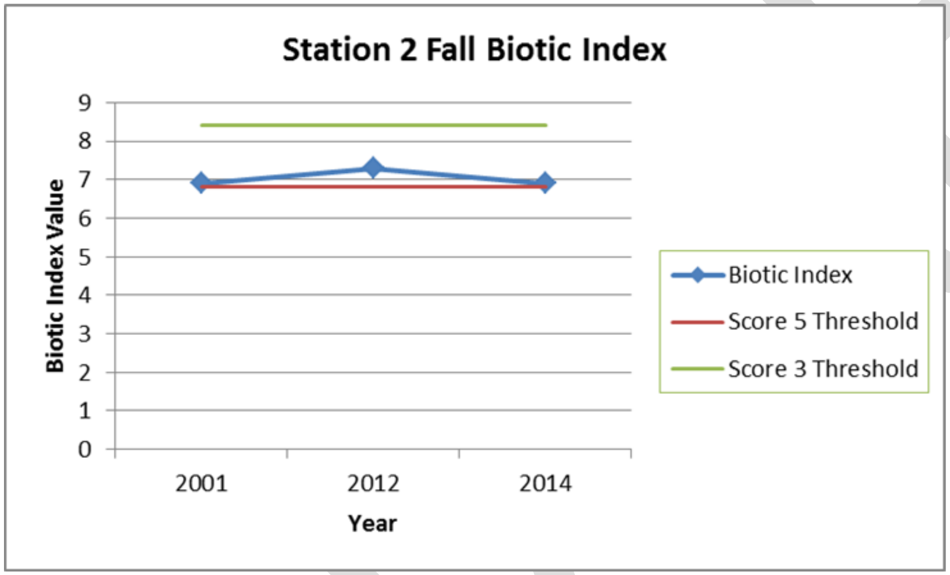
Score 5 Threshold
Score 3 Threshold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Biotic Index Value
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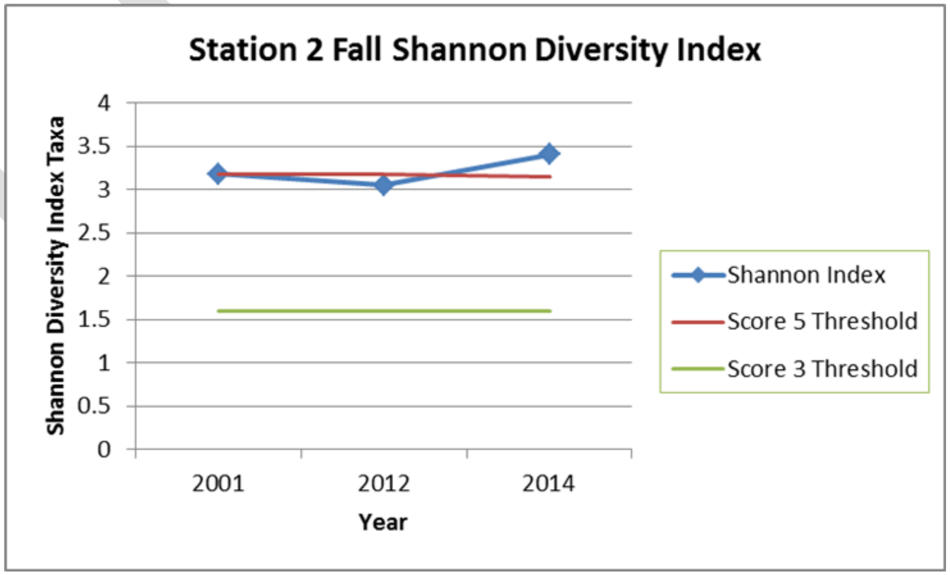
2012
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold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3.5
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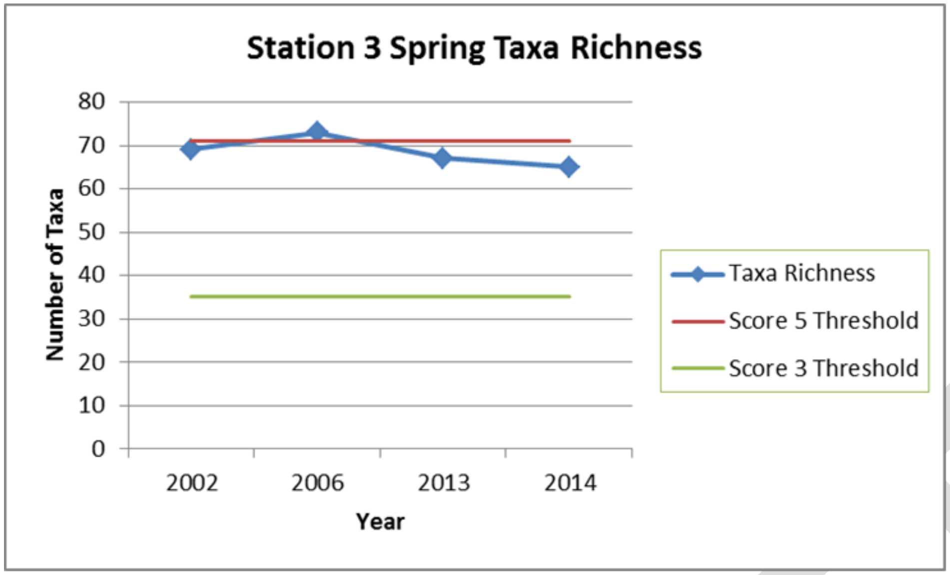
2012
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold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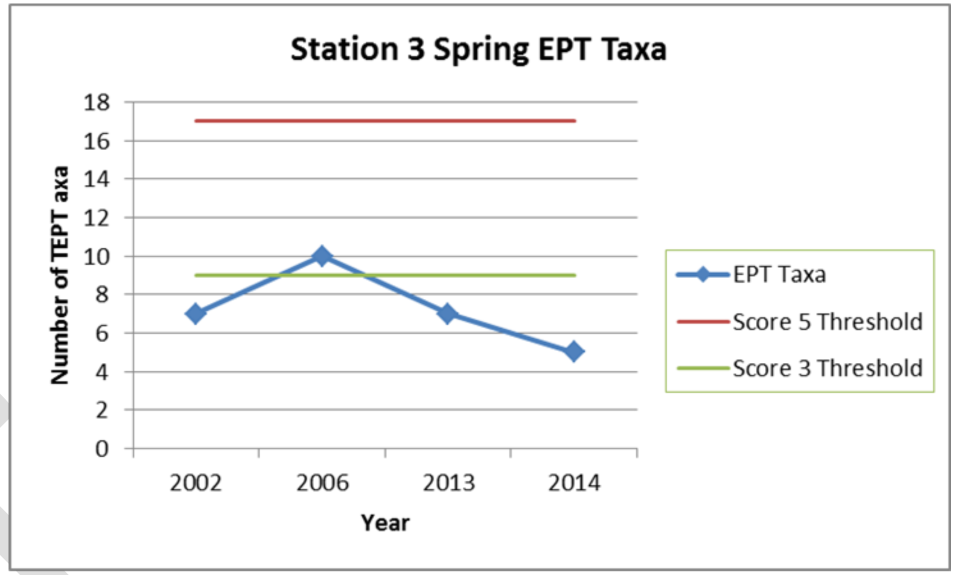
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Year
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Score 5 Threshold
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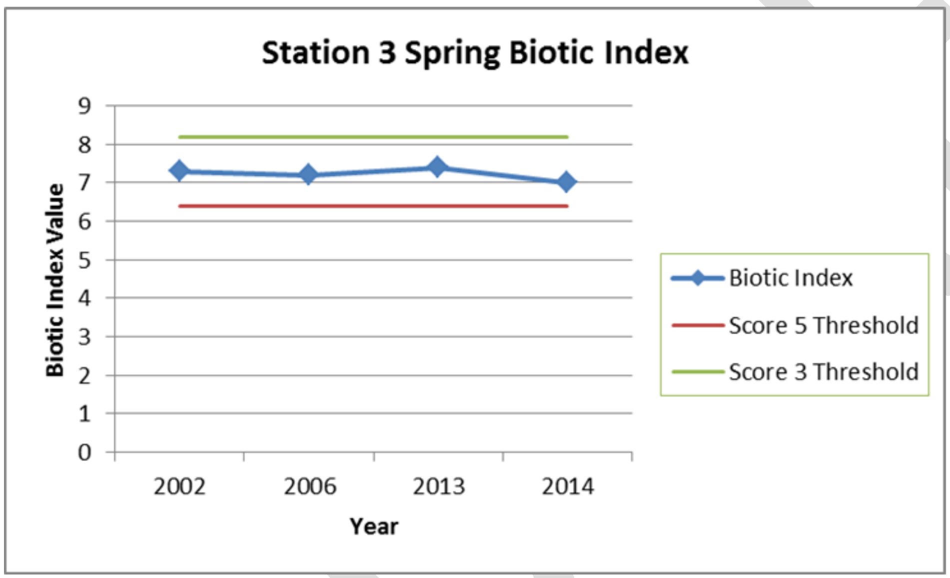
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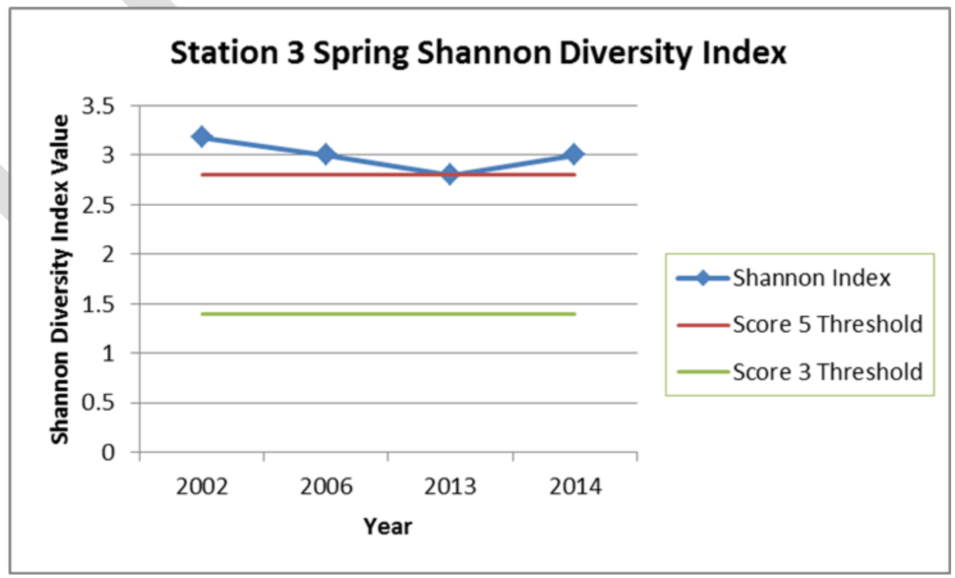
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Year
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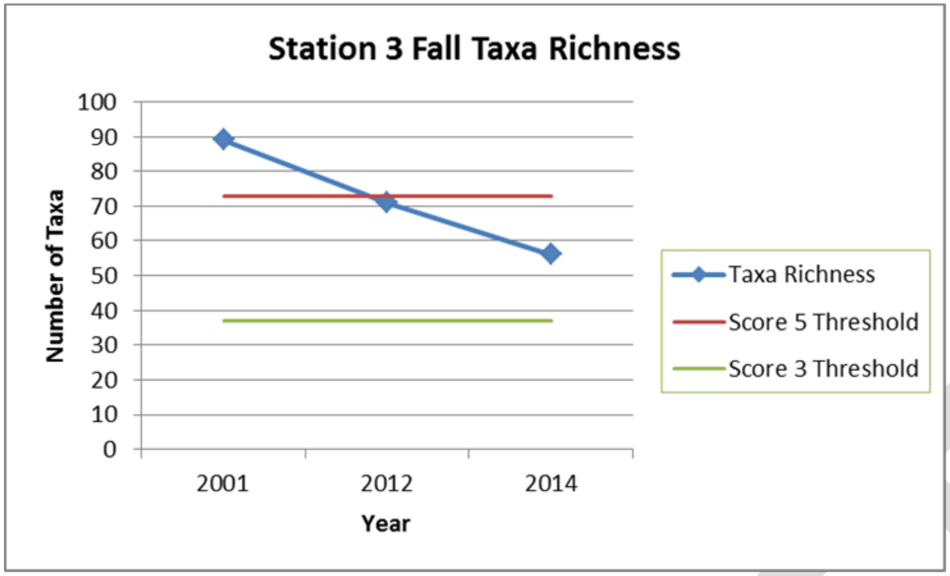
Score 3 Threshold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Number of Taxa
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Taxa Richness
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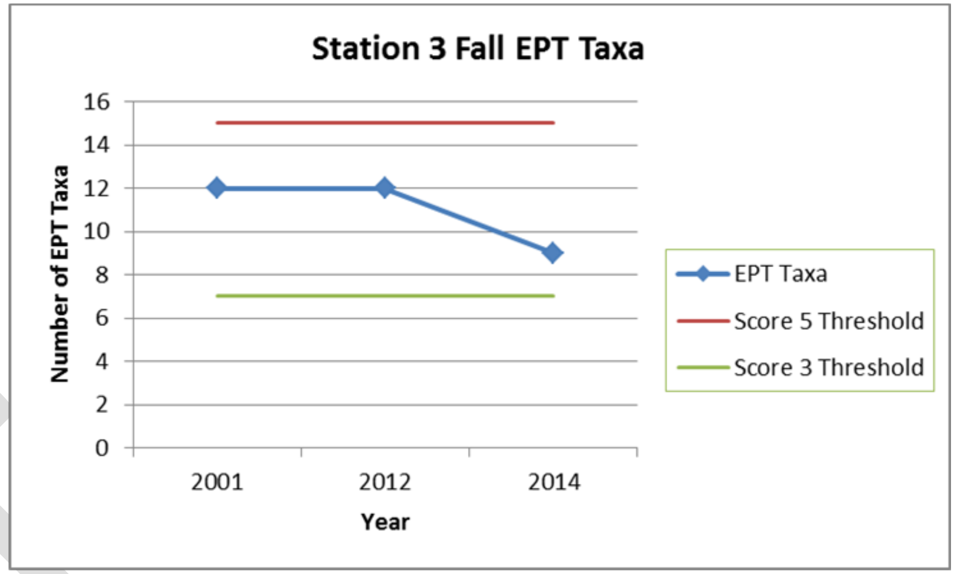
Score 3 Threshold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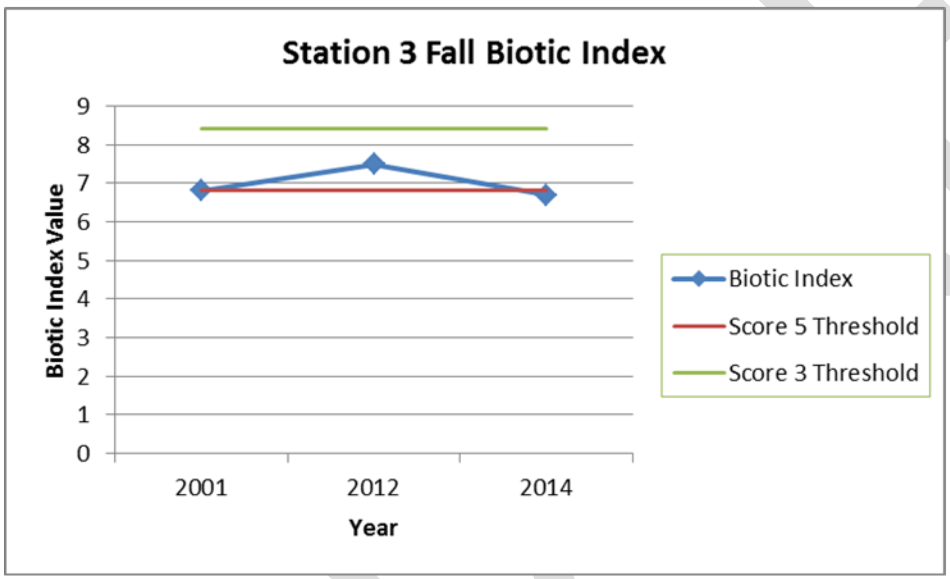
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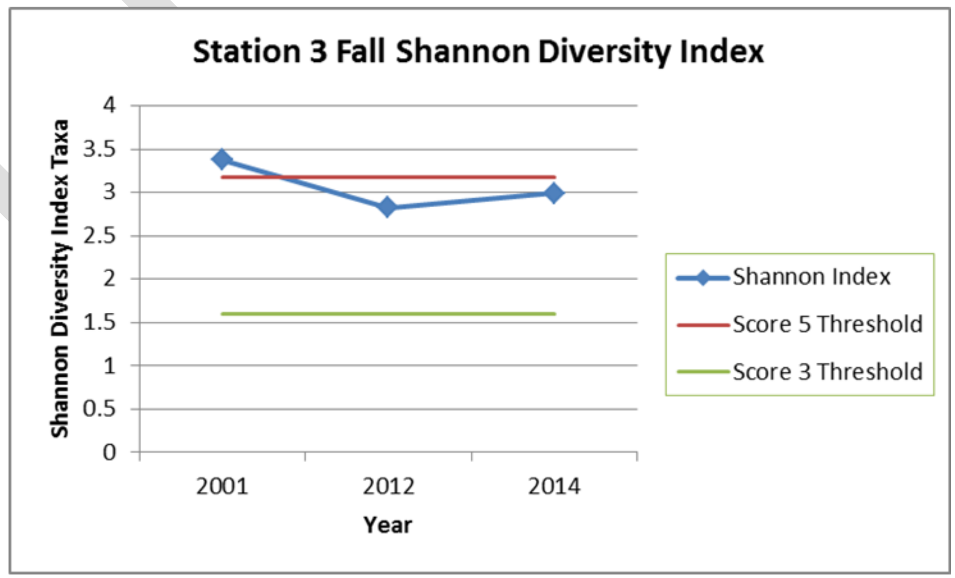
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2014
Year
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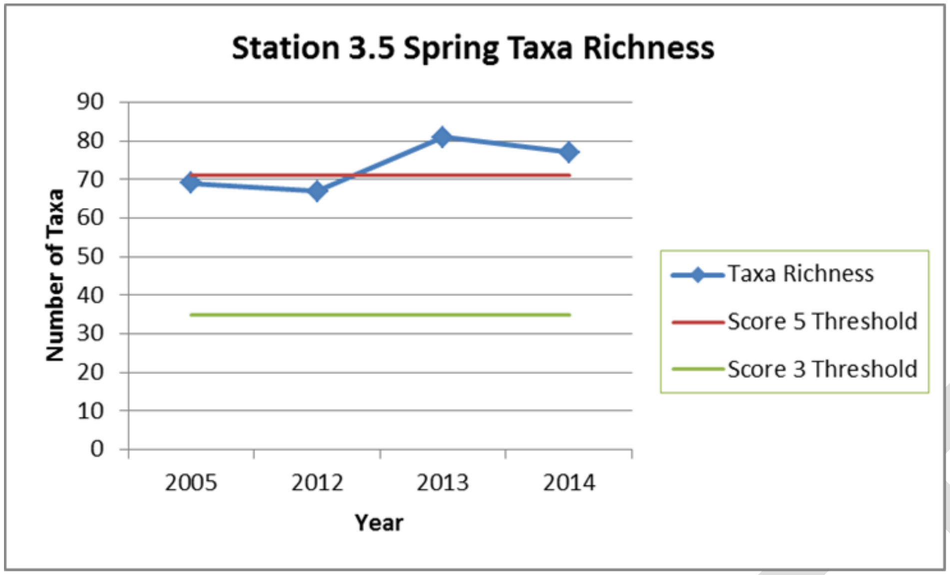
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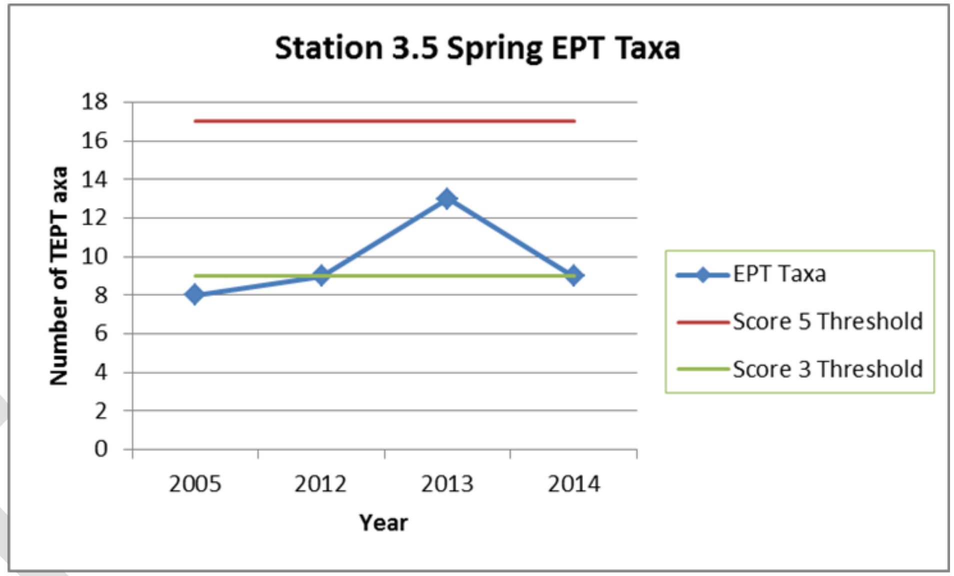
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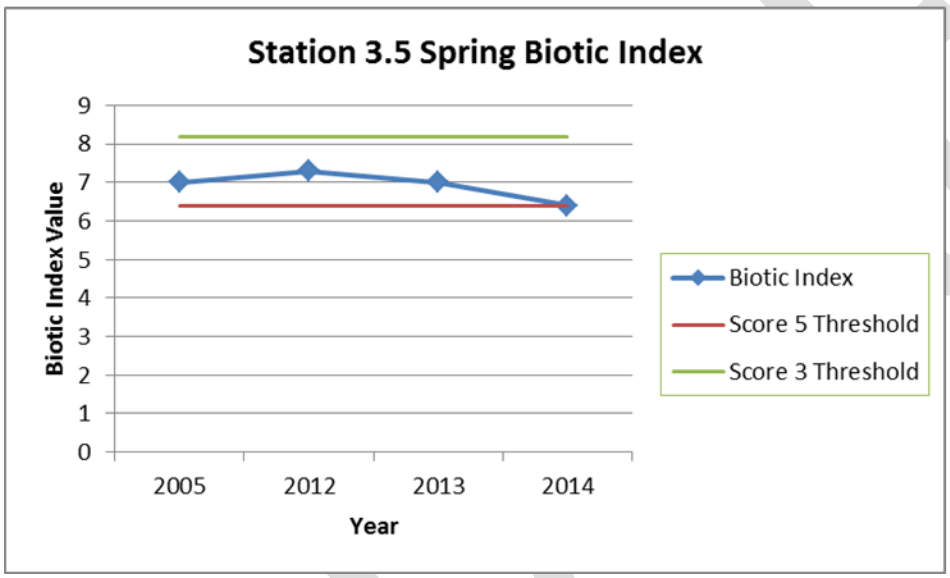
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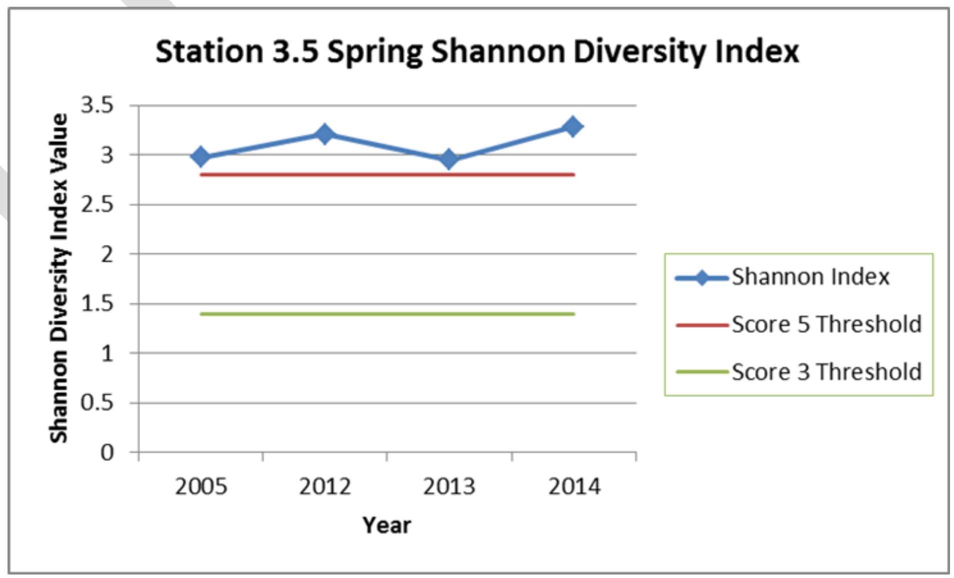
Score 3 Threshold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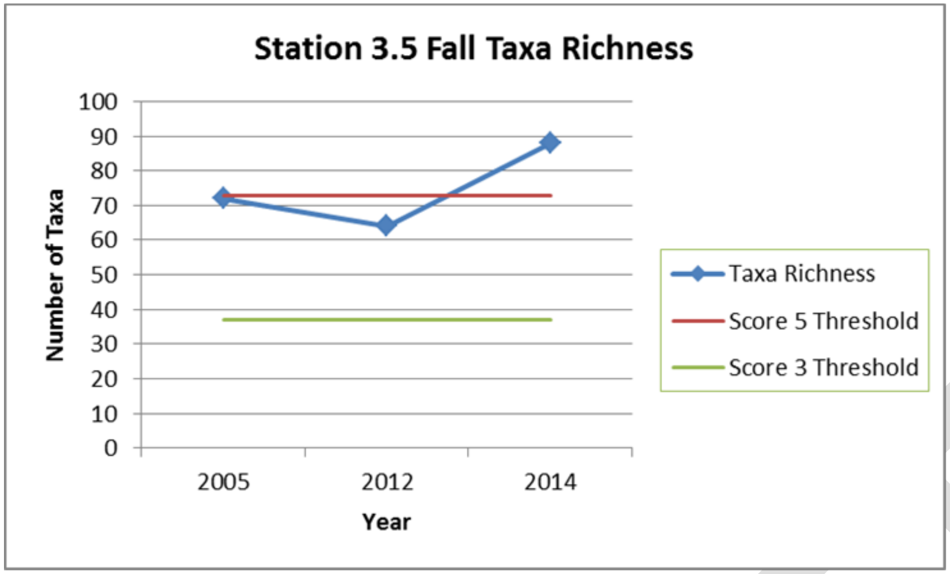
Score 3 Threshold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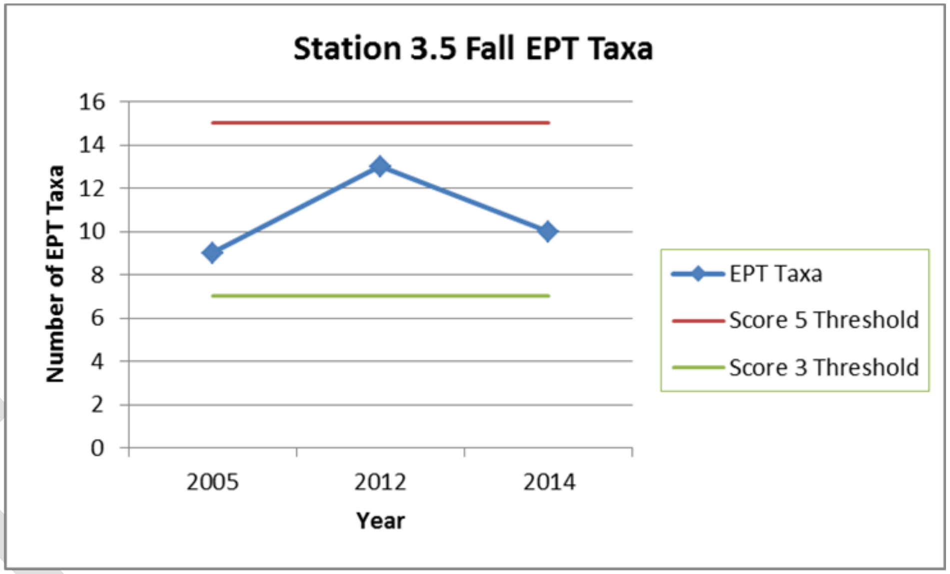
Number of Taxa
2005
2012
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold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6
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2
0
Number of EPT Taxa
2005
2012
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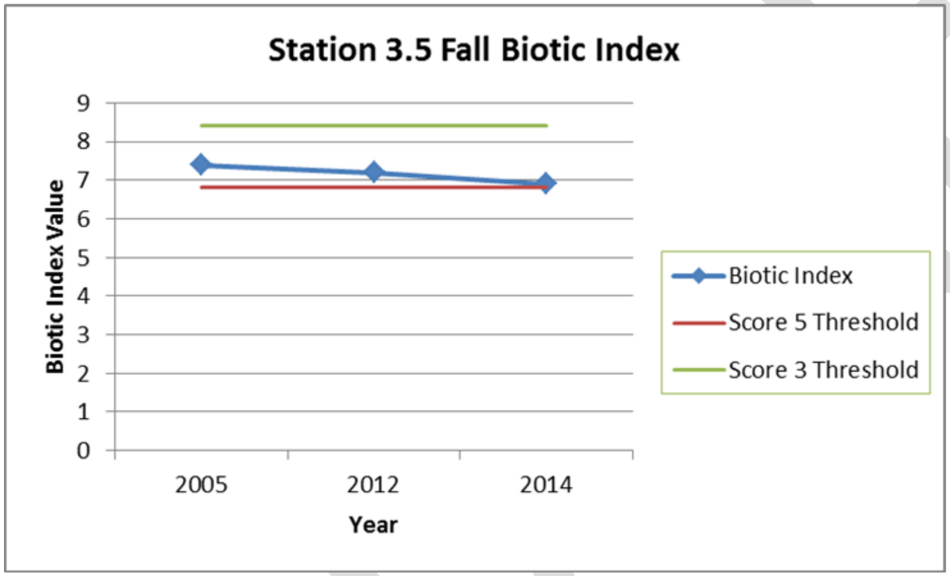
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold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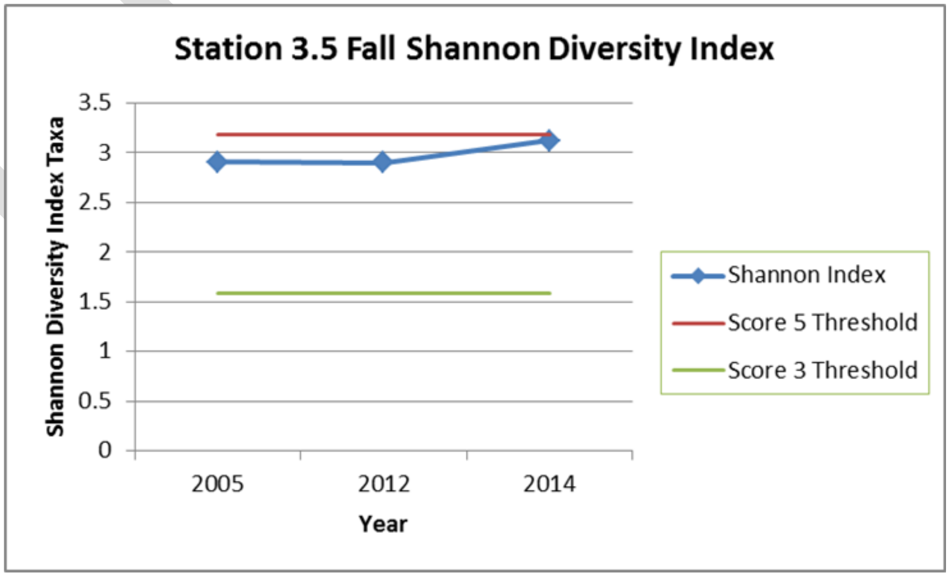
1
0
Biotic Index Value
2005
2012
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 3.5 Fall Shannon Diversity Index
3.5
3
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1.5
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0.5
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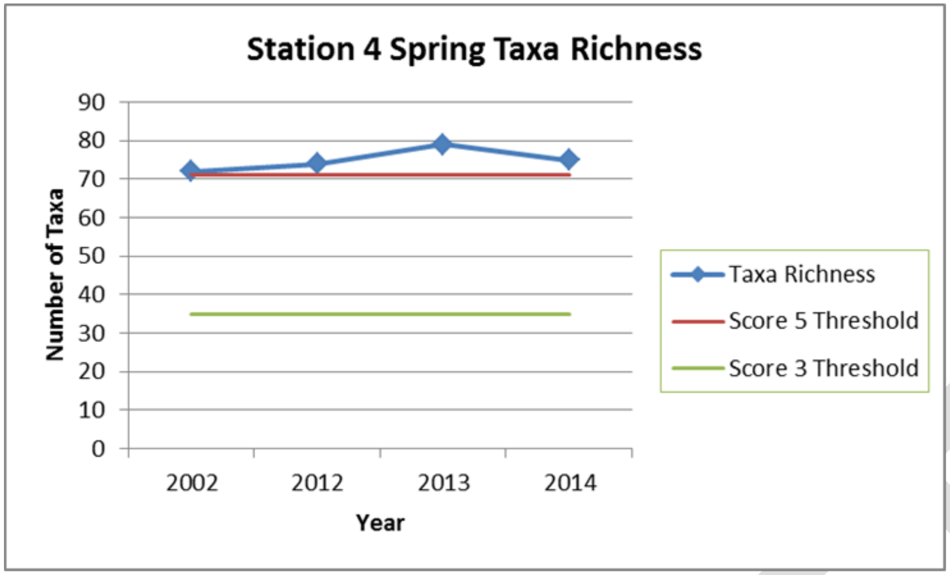
Shannon Diversity Index Taxa
2005
2012
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 4 Spring Taxa Richness
Number of Taxa
0
10
20
30
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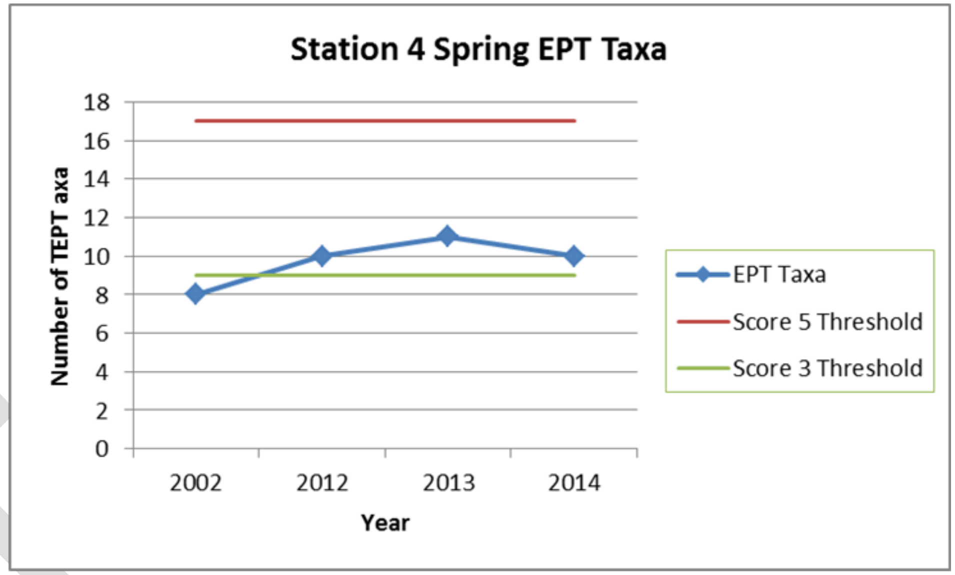
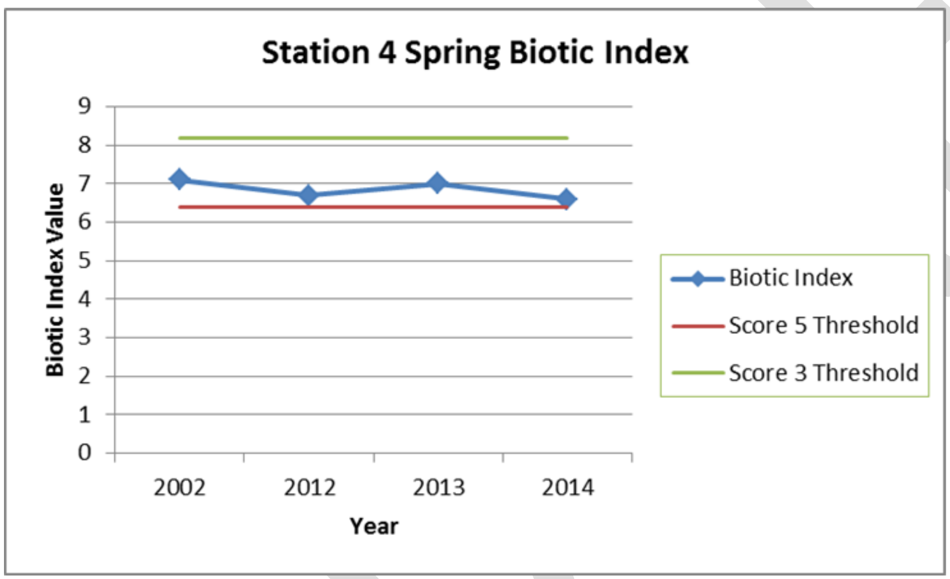
50
60
70
80
90
2002
2012
2013
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 4 Spring EPT Taxa
Number of TEPT axa
0
2
4
6
8
10
12
14
16
18
2002
2012
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 4 Spring Biotic Index
Biotic Index Value
0
1
2
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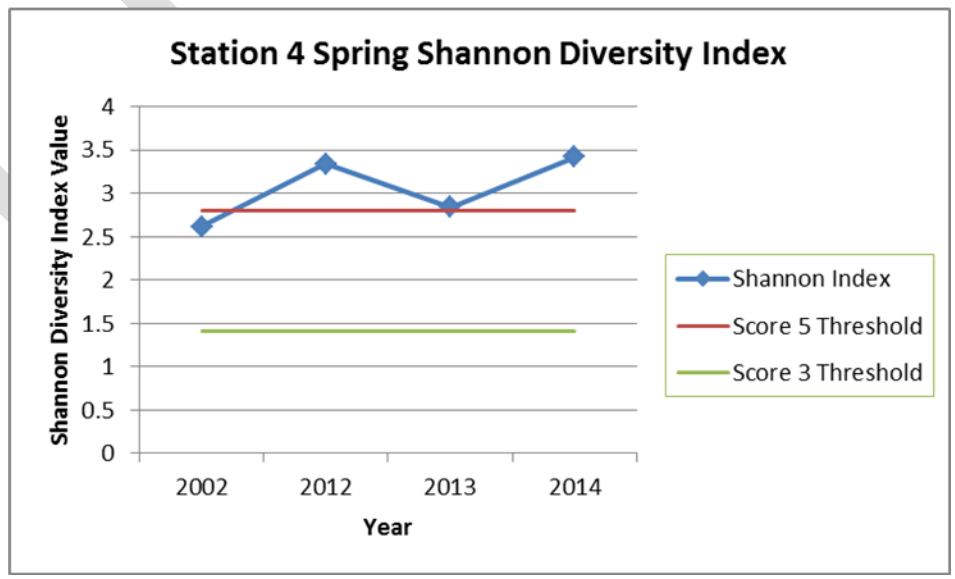
6
7
8
9
2002
2012
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 4 Spring Shannon Diversity Index
Shannon Diversity Index Value
0
0.5
1
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2.5
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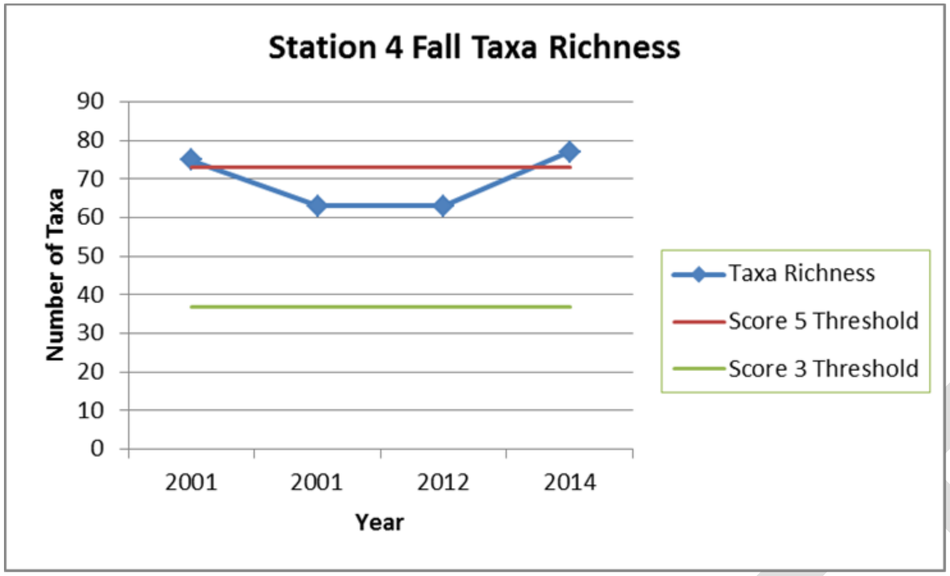
3.5
4
2002
2012
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 4 Fall Taxa Richness
Number of Taxa
90
80
70
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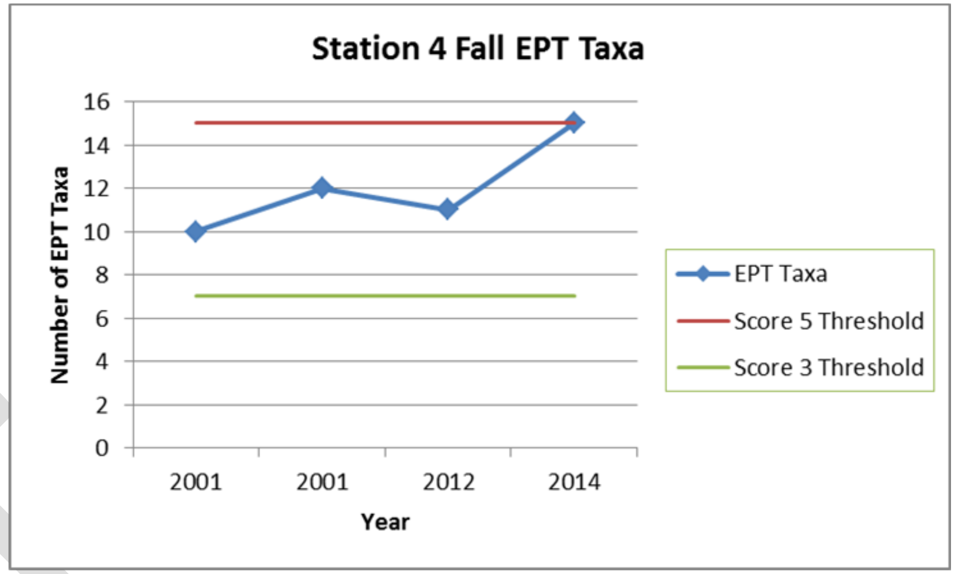
20
10
0
2001
2001
2012
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 4 Fall EPT Taxa
Number of EPT Taxa
16
14
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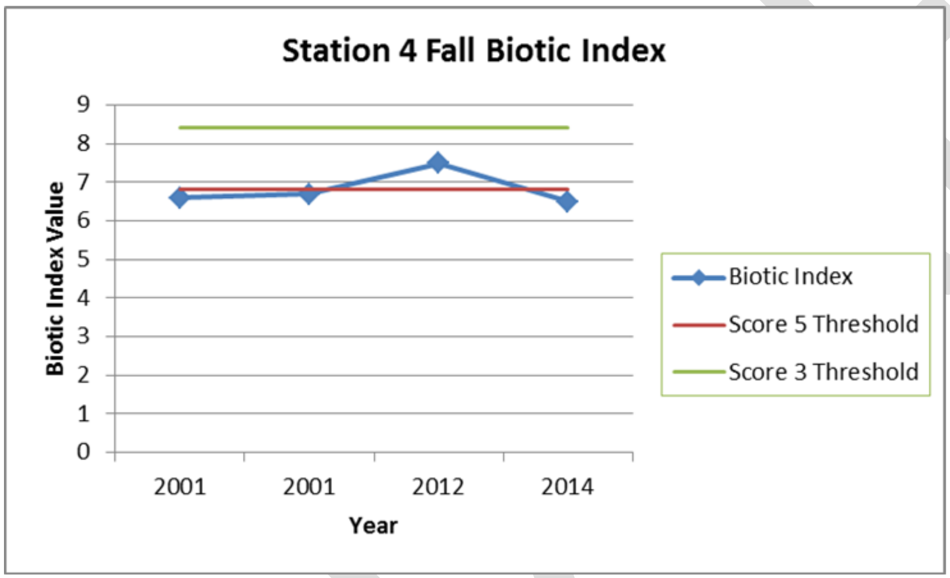
8
6
4
2
0
2001
2001
2012
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 4 Fall Biotic Index
Biotic Index Value
9
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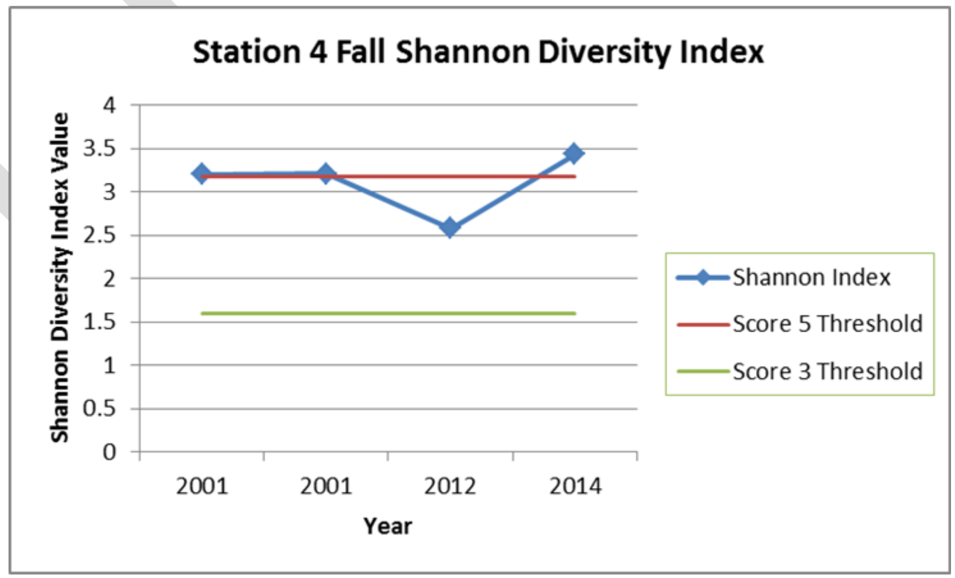
4
3
2
1
0
2001
2001
2012
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 4 Fall Shannon Diversity Index
Shannon Diversity Index Value
4
3.5
3
2.5
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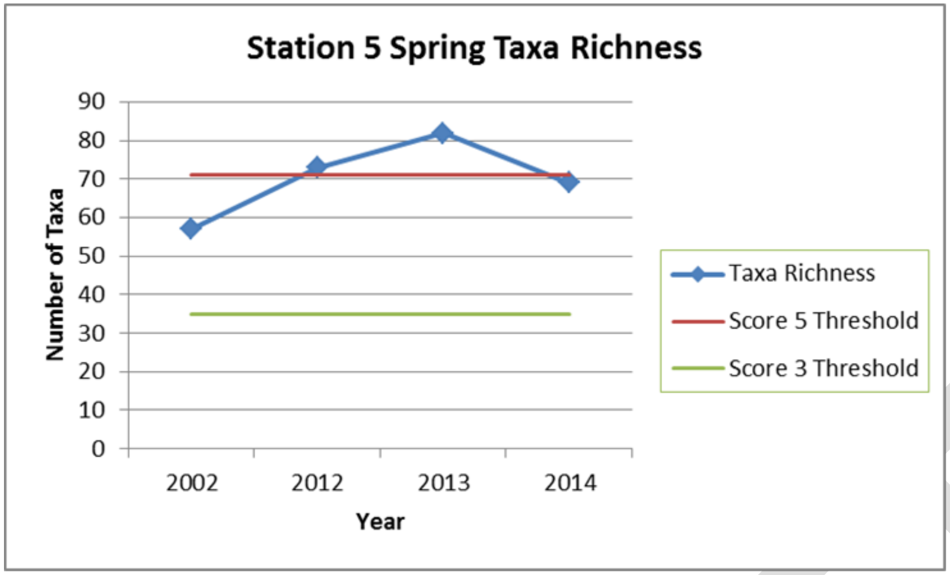
1.5
1
0.5
0
2001
2001
2012
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 5 Spring Taxa Richness
Number of Taxa
90
80
70
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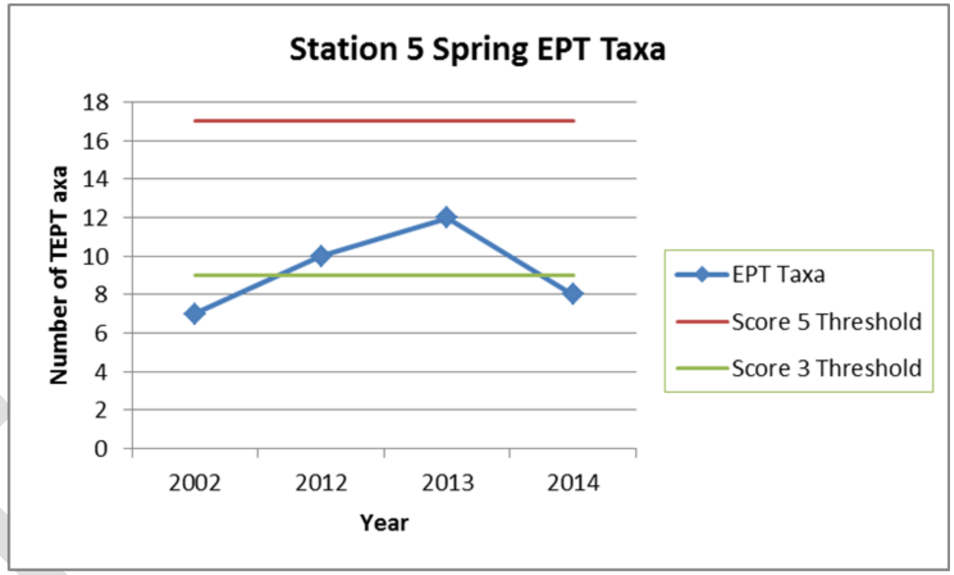
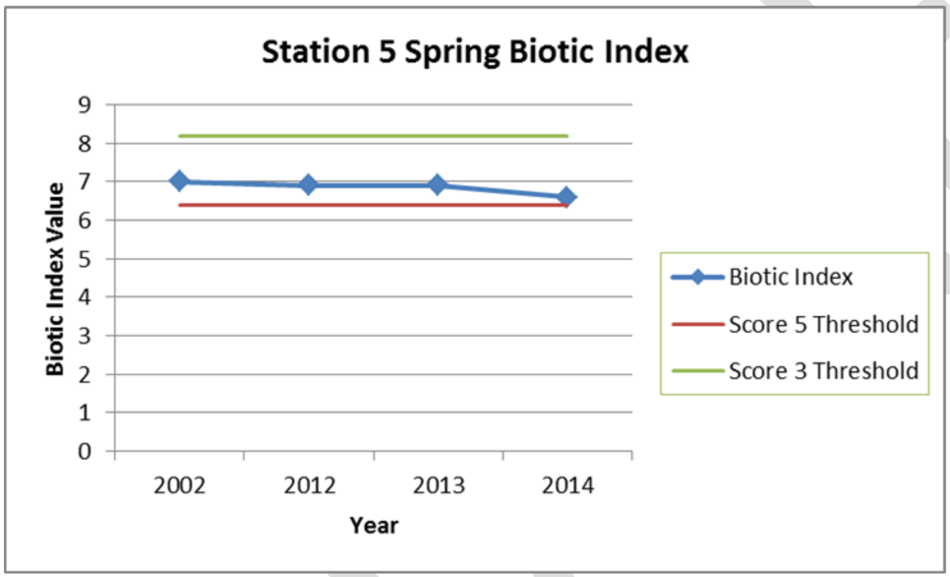
40
30
20
10
0
2002
2012
2013
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 5 Spring EPT Taxa
Number of TEPT axa
18
16
14
12
10
8
6
4
2
0
2002
2012
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 5 Spring Biotic Index
Biotic Index Value
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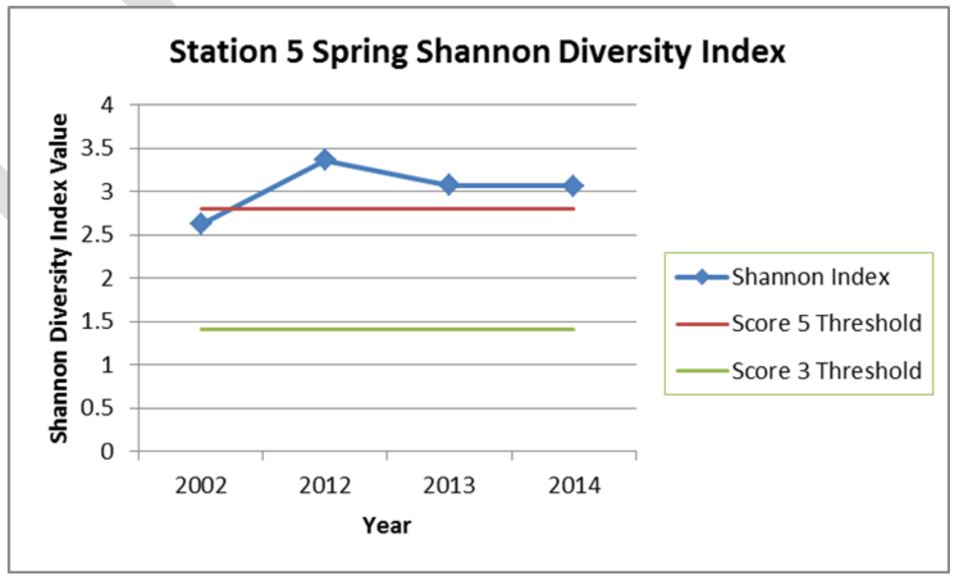
4
3
2
1
0
2002
2012
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 5 Spring Shannon Diversity Index
Shannon Diversity Index Value
4
3.5
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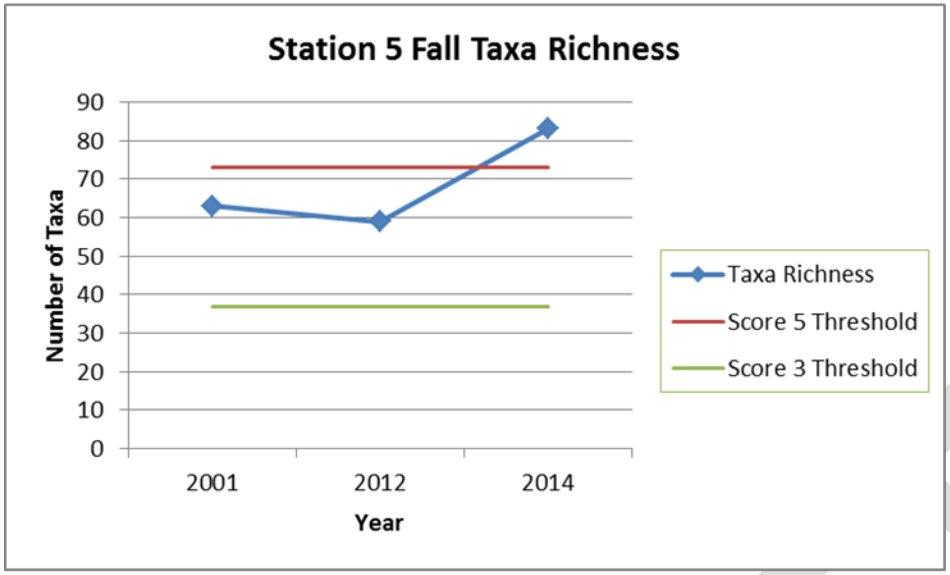
2.5
2
1.5
1
0.5
0
2002
2012
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 5 Fall Taxa Richness
Number of Taxa
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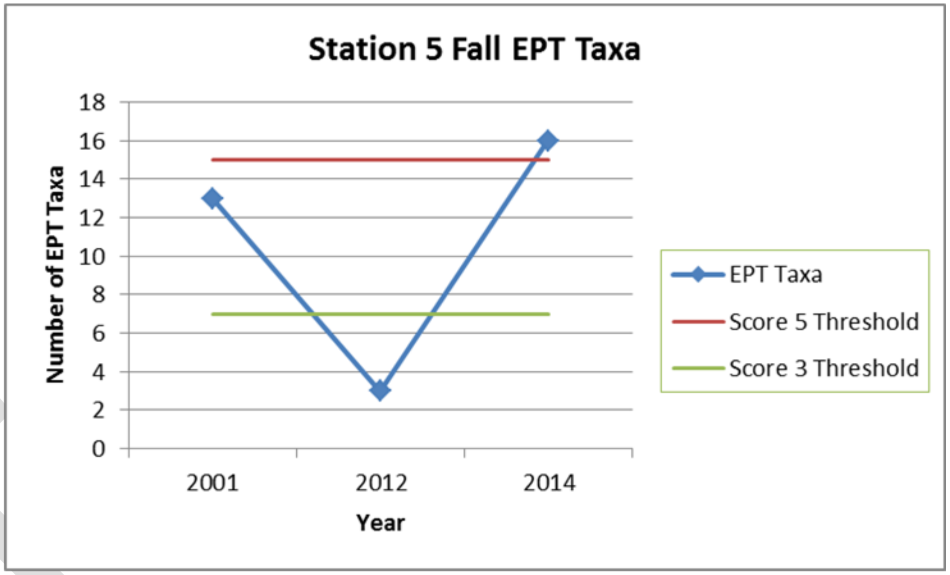
50
40
30
20
10
0
2001
2012
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 5 Fall EPT Taxa
Number of EPT Taxa
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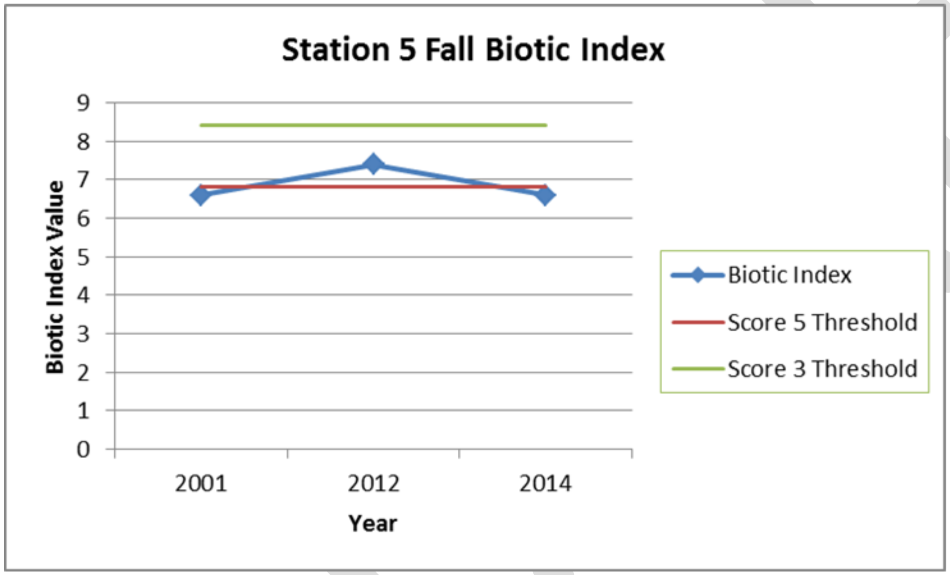
16
14
12
10
8
6
4
2
0
2001
2012
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 5 Fall Biotic Index
Biotic Index Value
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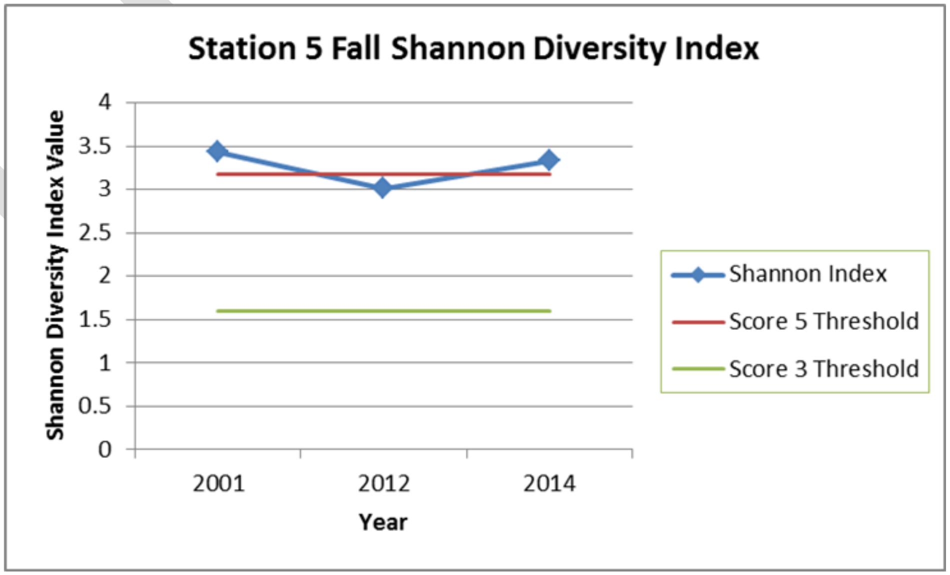
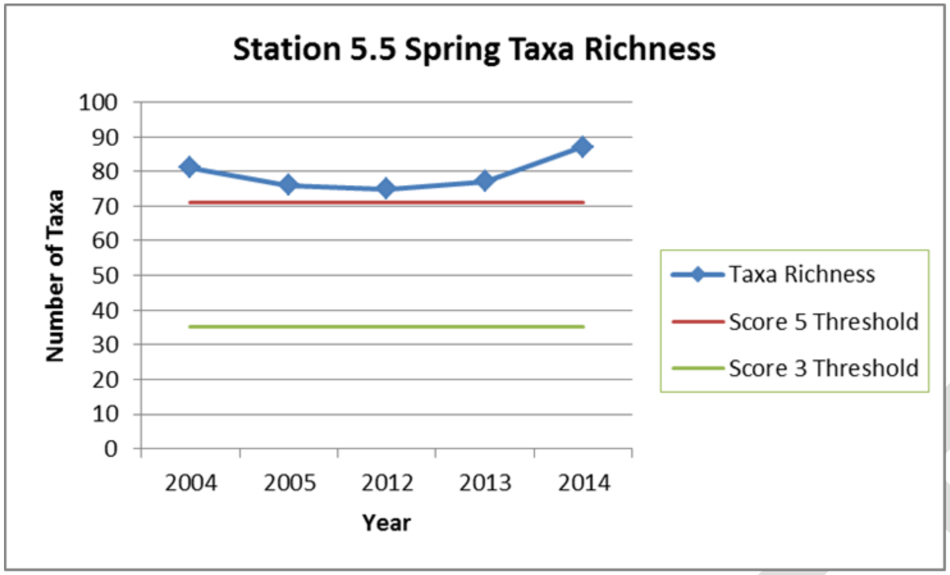
8
7
6
5
4
3
2
1
0
2001
2012
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 5 Fall Shannon Diversity Index
Shannon Diversity Index Value
4
3.5
3
2.5
2
1.5
1
0.5
0
2001
2012
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 5.5 Spring Taxa Richness
Number of Taxa
100
90
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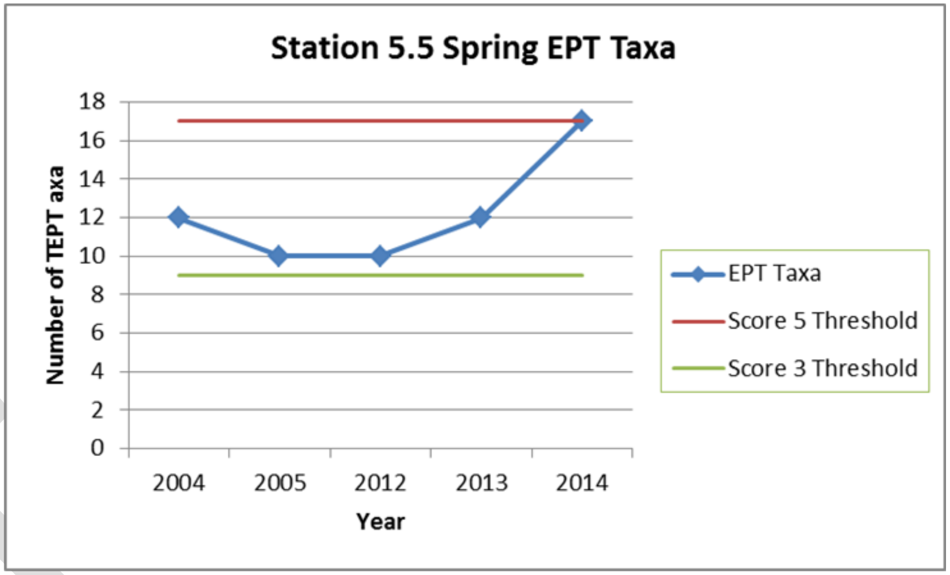
30
20
10
0
2004
2005
2012
2013
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 5.5 Spring EPT Taxa
Number of TEPT axa
18
16
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10
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6
4
2
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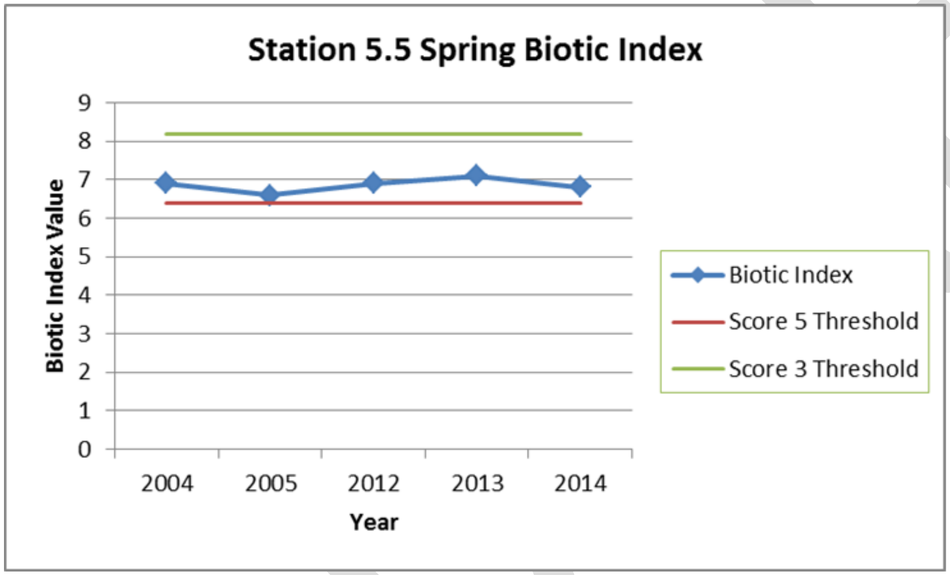
2004
2005
2012
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 5.5 Spring Biotic Index
Biotic Index Value
9
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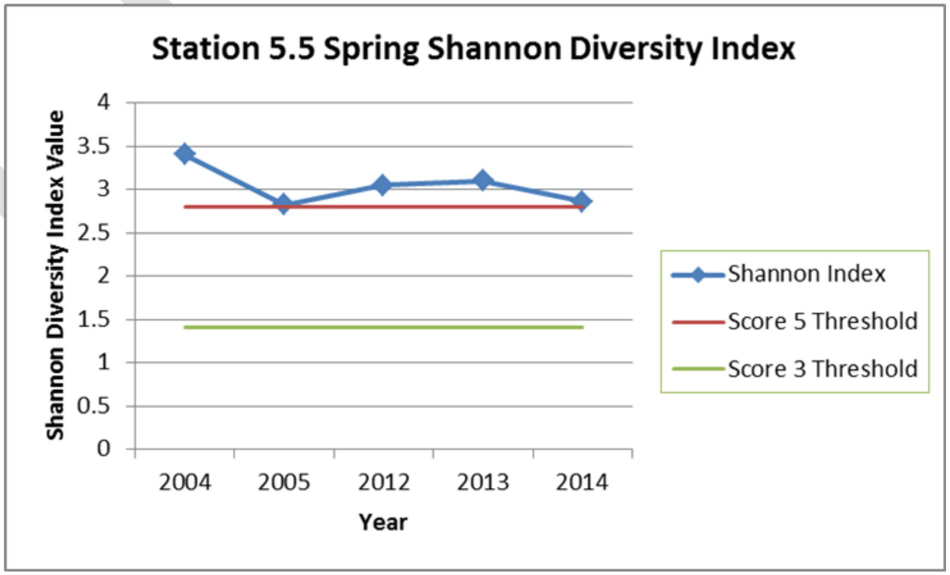
0
2004
2005
2012
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 5.5 Spring Shannon Diversity Index
Shannon Diversity Index Value
4
3.5
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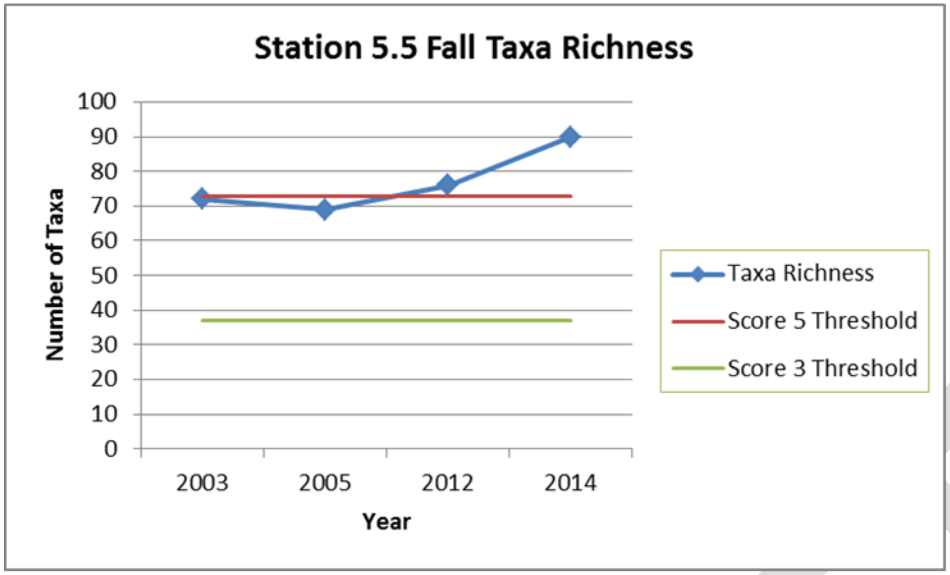
2.5
2
1.5
1
0.5
0
2004
2005
2012
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 5.5 Fall Taxa Richness
Number of Taxa
100
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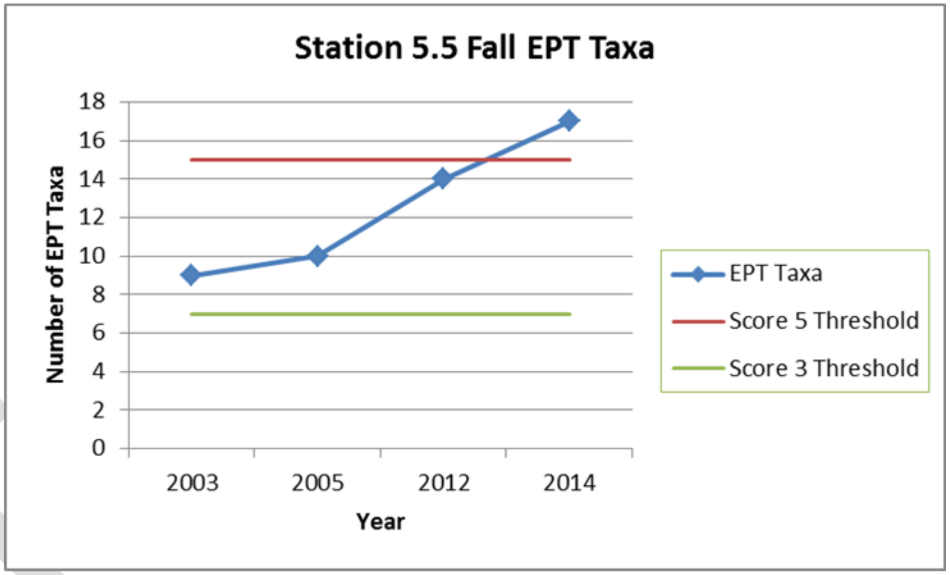
2012
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 5.5 Fall EPT Taxa
Number of EPT Taxa
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6
4
2
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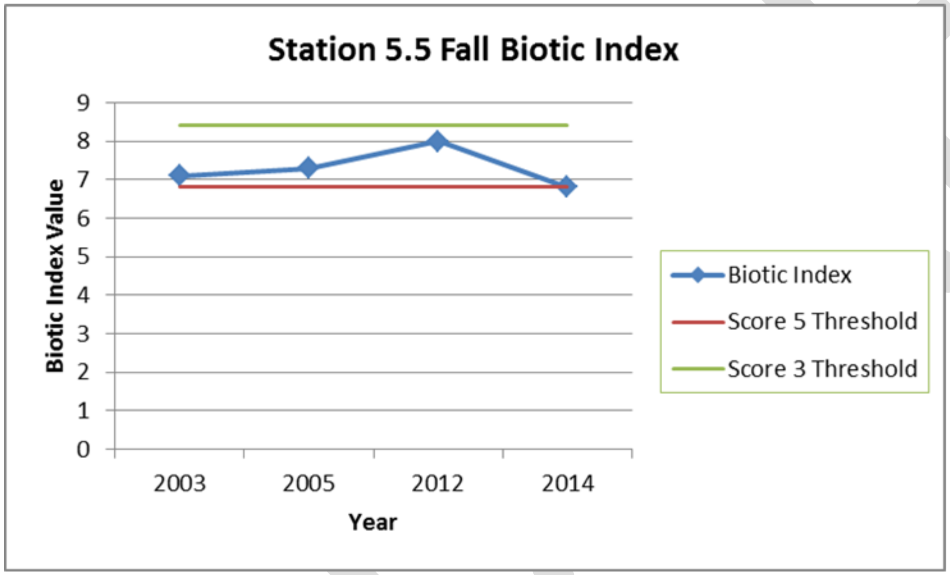
2003
2005
2012
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 5.5 Fall Biotic Index
Biotic Index Value
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2
1
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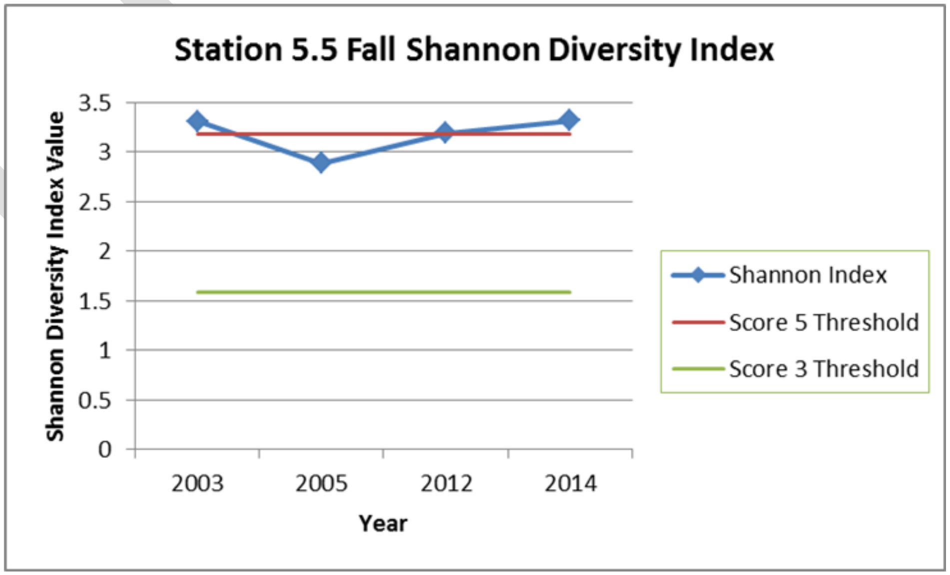
2005
2012
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 5.5 Fall Shannon Diversity Index
Shannon Diversity Index Value
3.5
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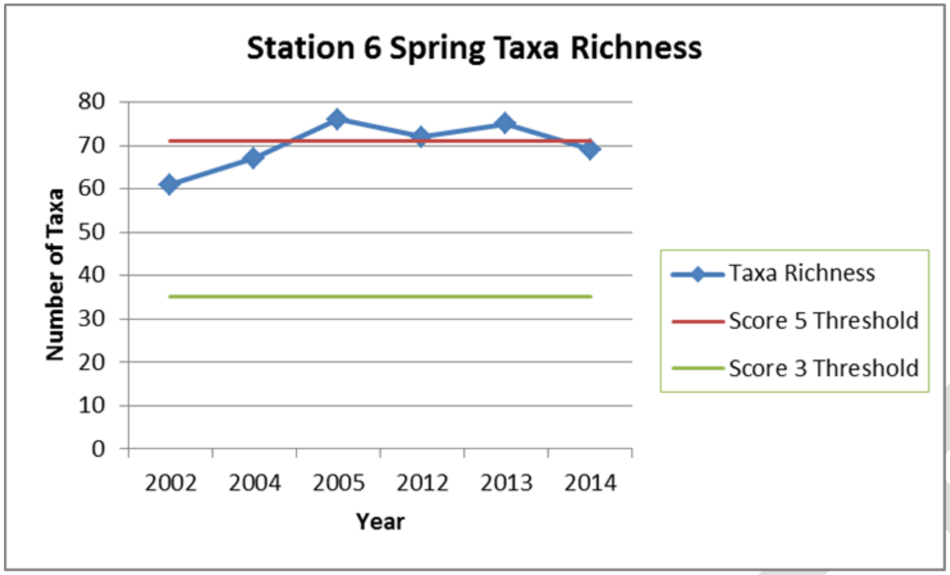
2.5
2
1.5
1
0.5
0
2003
2005
2012
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 6 Spring Taxa Richness
Number of Taxa
80
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40
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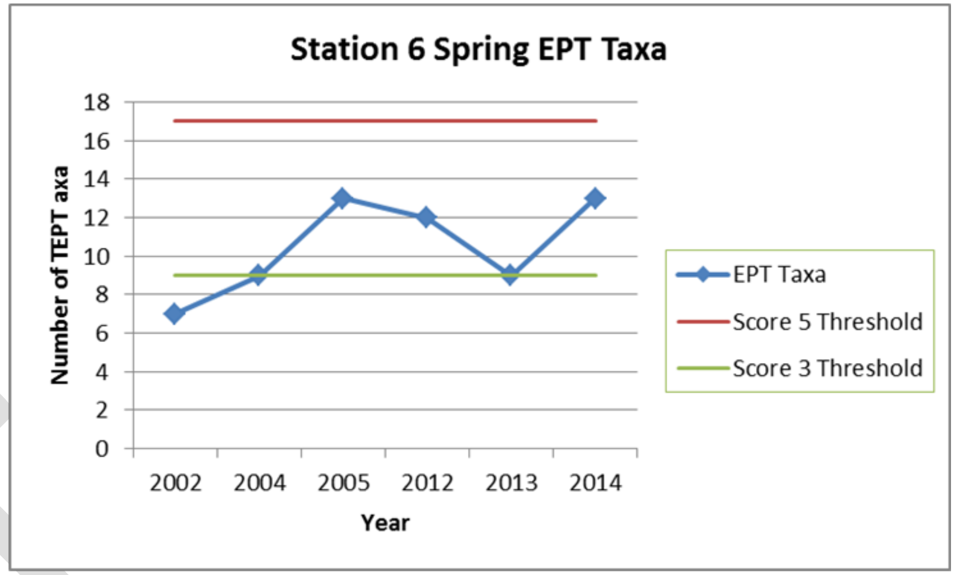
20
10
0
2002
2004
2005
2012
2013
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 6 Spring EPT Taxa
Number of TEPT axa
18
16
14
12
10
8
6
4
2
0
2002
2004
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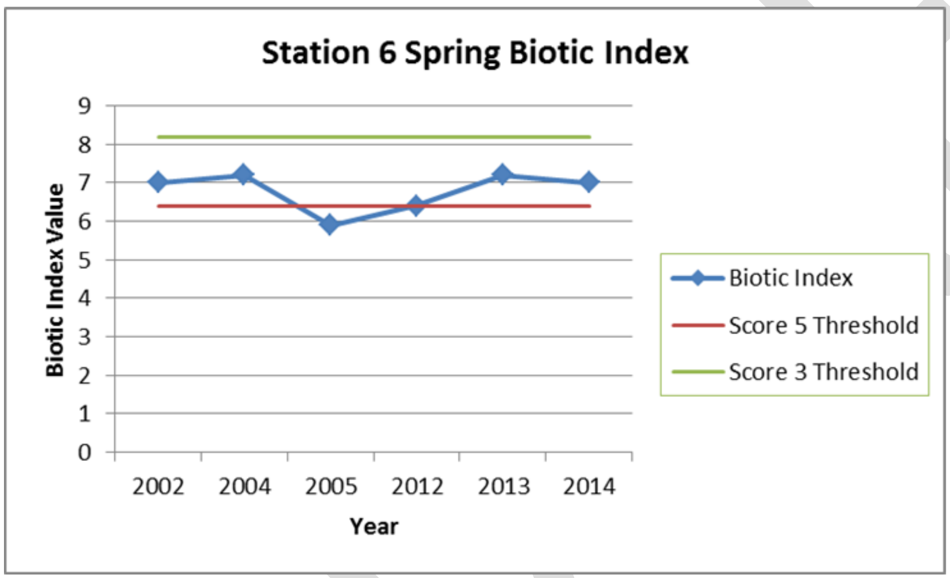
2012
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 6 Spring Biotic Index
Biotic Index Value
9
8
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2005
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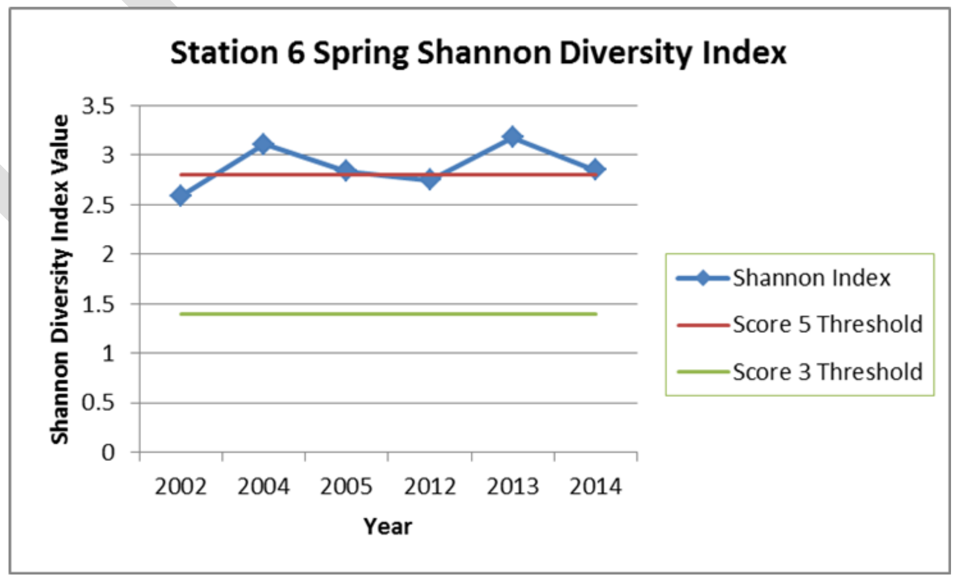
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 6 Spring Shannon Diversity Index
Shannon Diversity Index Value
3.5
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2
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0.5
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2005
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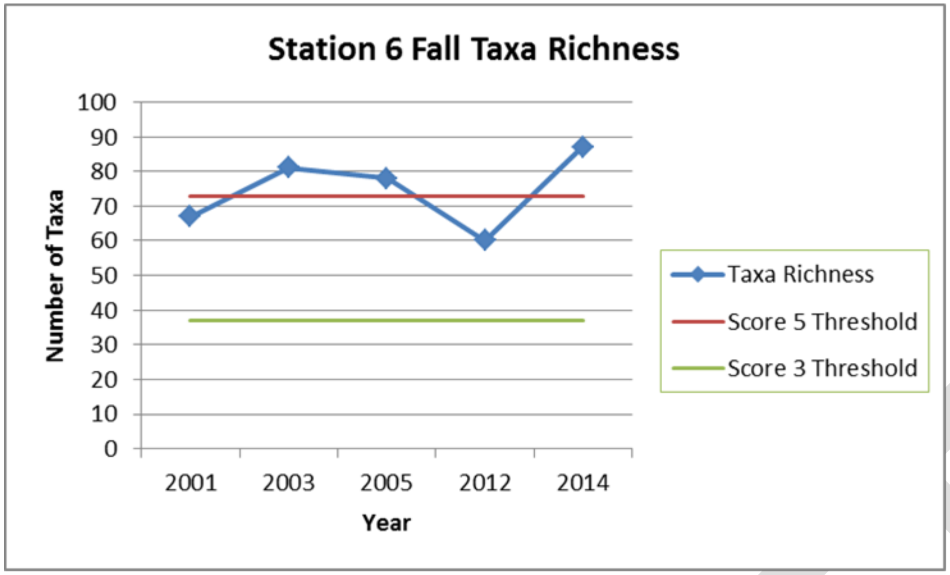
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 6 Fall Taxa Richness
Number of Taxa
100
90
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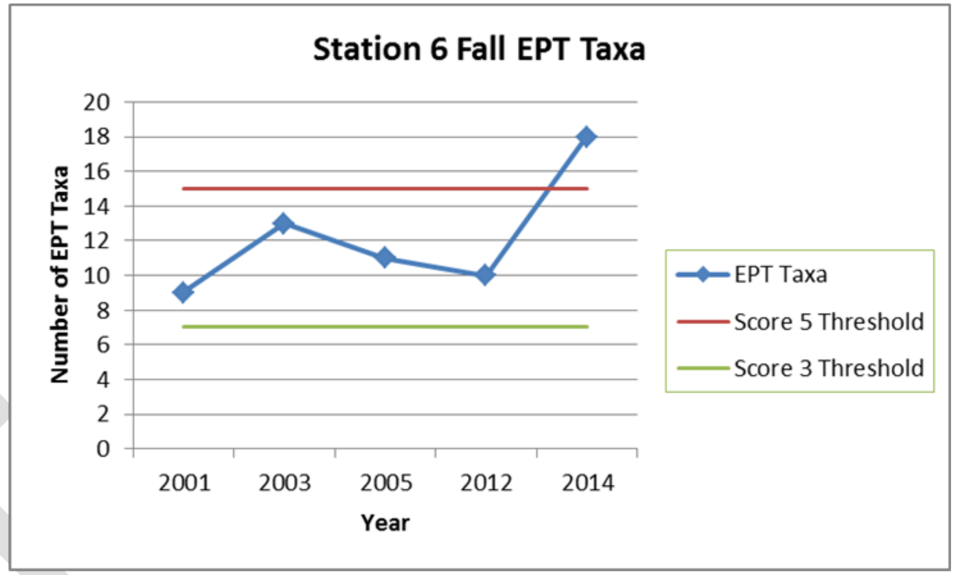
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 6 Fall EPT Taxa
Number of EPT Taxa
20
18
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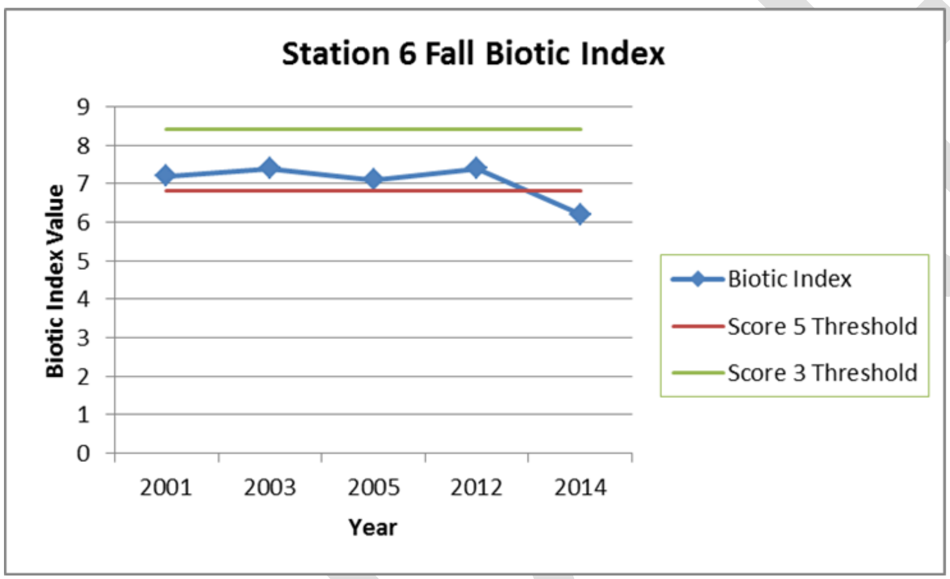
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 6 Fall Biotic Index
Biotic Index Value
9
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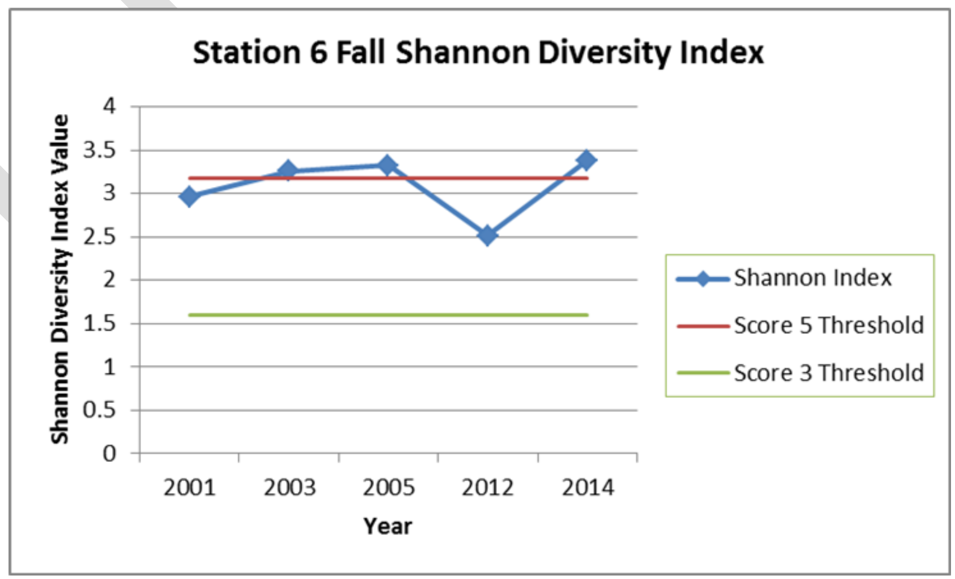
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 6 Fall Shannon Diversity Index
Shannon Diversity Index Value
4
3.5
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1.5
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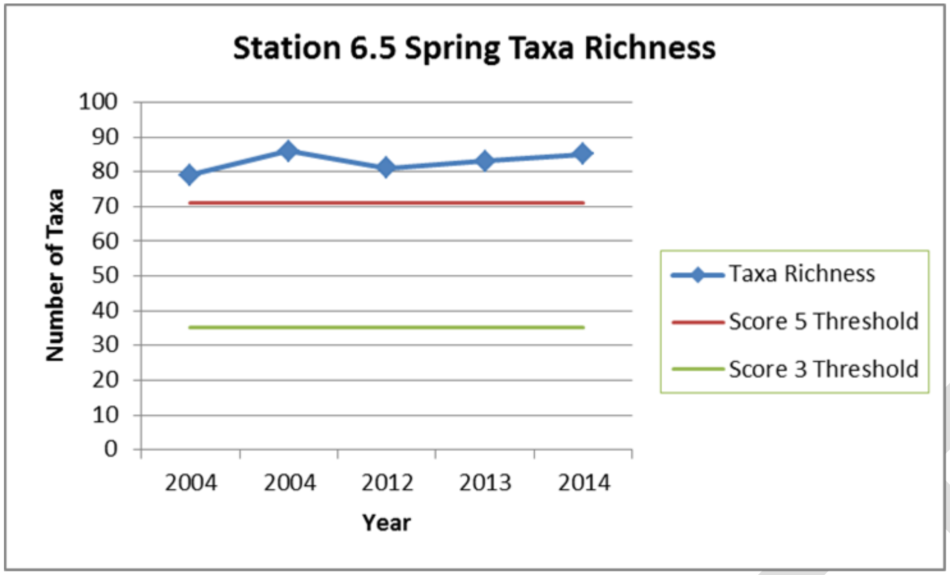
0.5
0
2001
2003
2005
2012
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 6.5 Spring Taxa Richness
Number of Taxa
100
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2012
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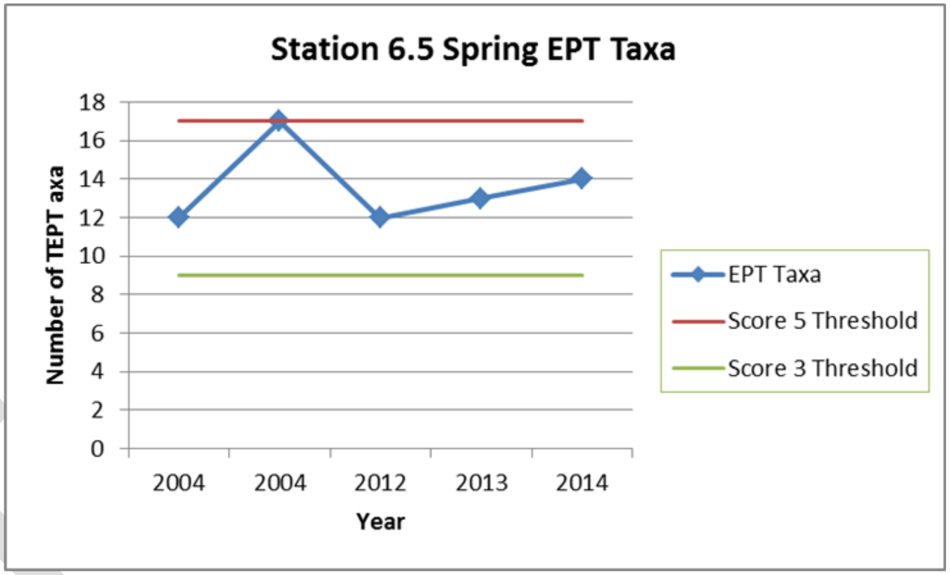
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 6.5 Spring EPT Taxa
Number of TEPT axa
18
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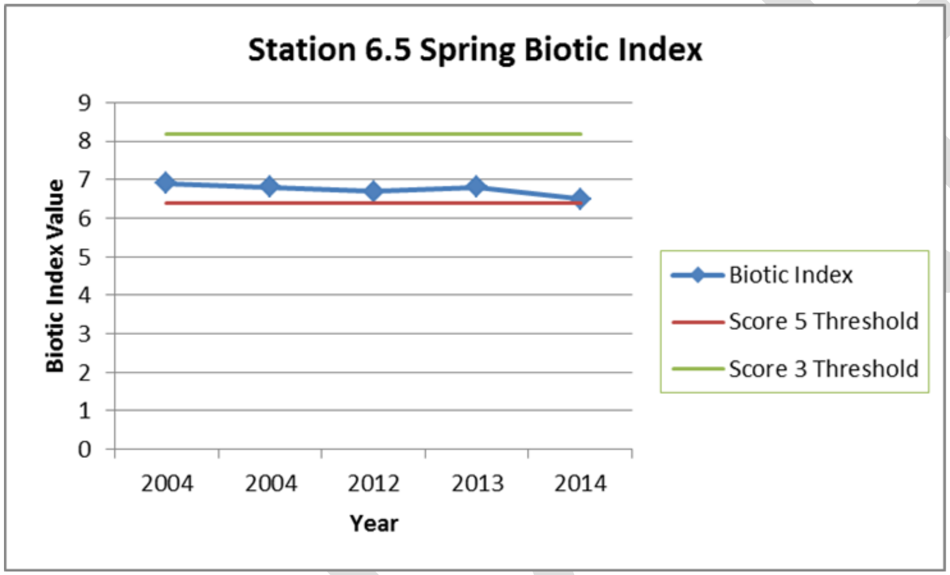
2004
2004
2012
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 6.5 Spring Biotic Index
Biotic Index Value
9
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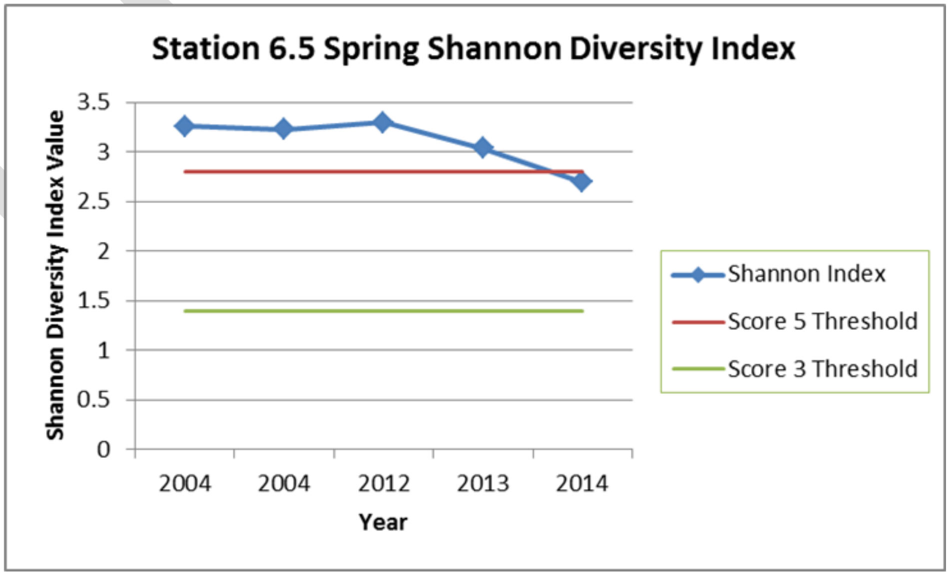
2
1
0
2004
2004
2012
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 6.5 Spring Shannon Diversity Index
Shannon Diversity Index Value
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0.5
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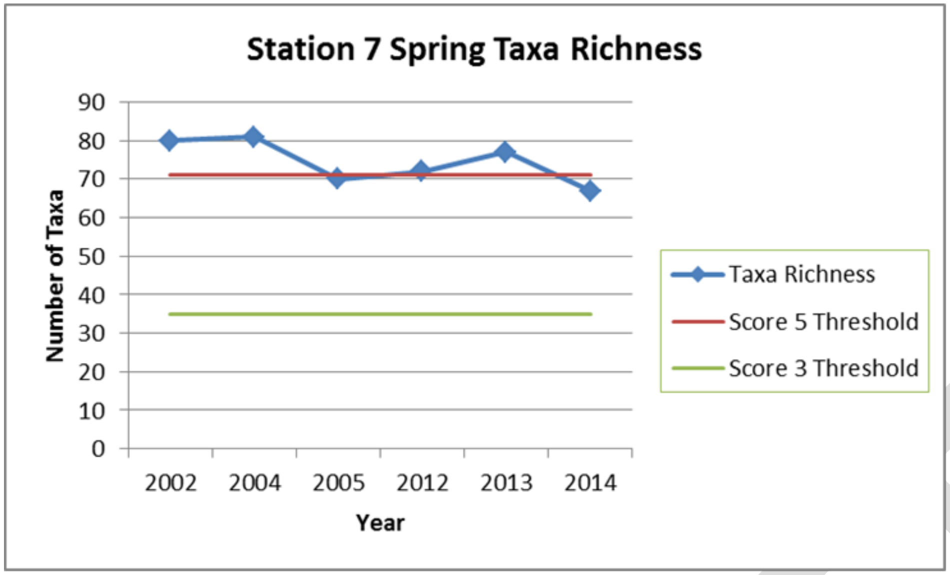
2004
2004
2012
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 7 Spring Taxa Richness
Number of Taxa
0
10
20
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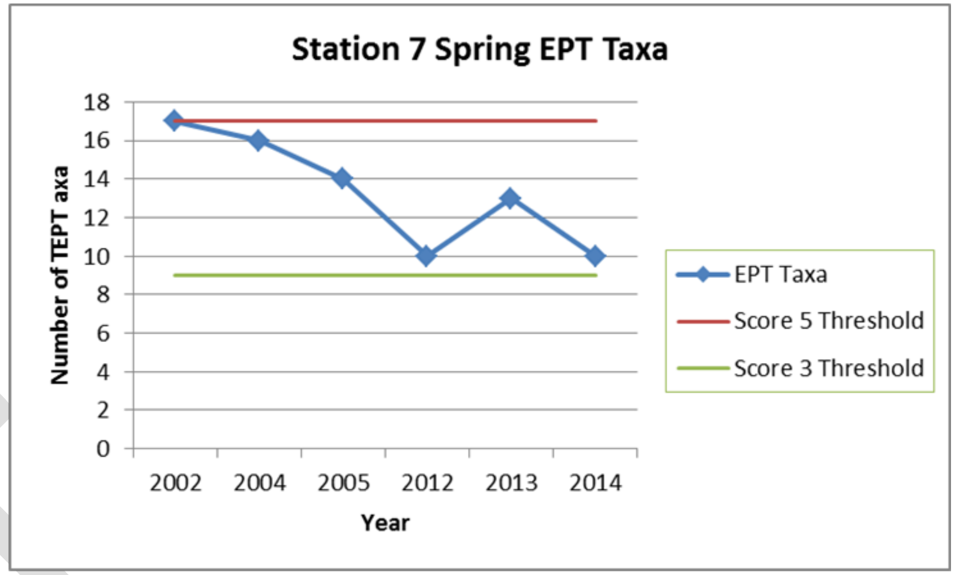
70
80
90
2002
2004
2005
2012
2013
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 7 Spring EPT Taxa
Number of TEPT axa
0
2
4
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2002
2004
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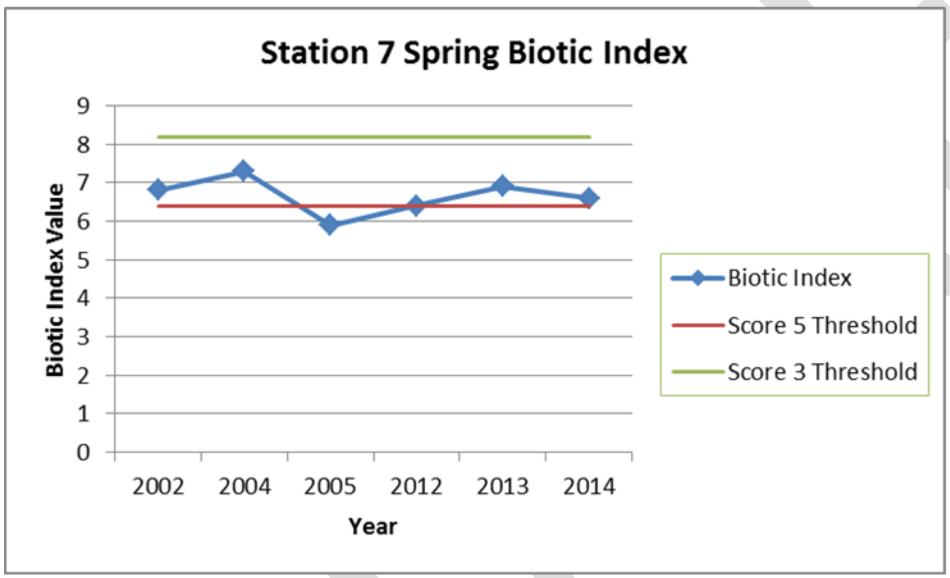
2012
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 7 Spring Biotic Index
Biotic Index Value
0
1
2
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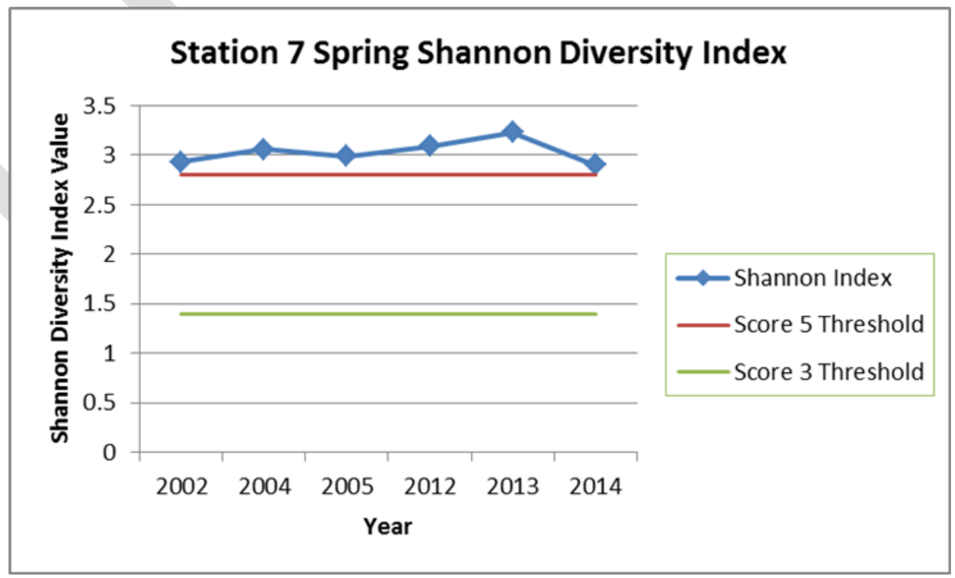
8
9
2002
2004
2005
2012
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold


Station 7 Spring Shannon Diversity Index
Shannon Diversity Index Value
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0.5
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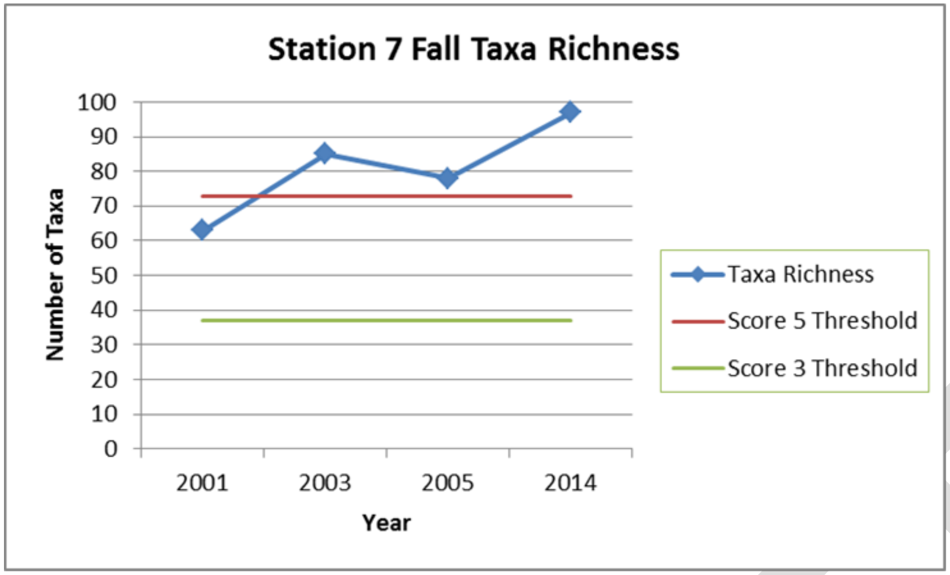
2.5
3
3.5
2002
2004
2005
2012
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold


Station 7 Fall Taxa Richness
Number of Taxa
100
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30
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10
0
2001
2003
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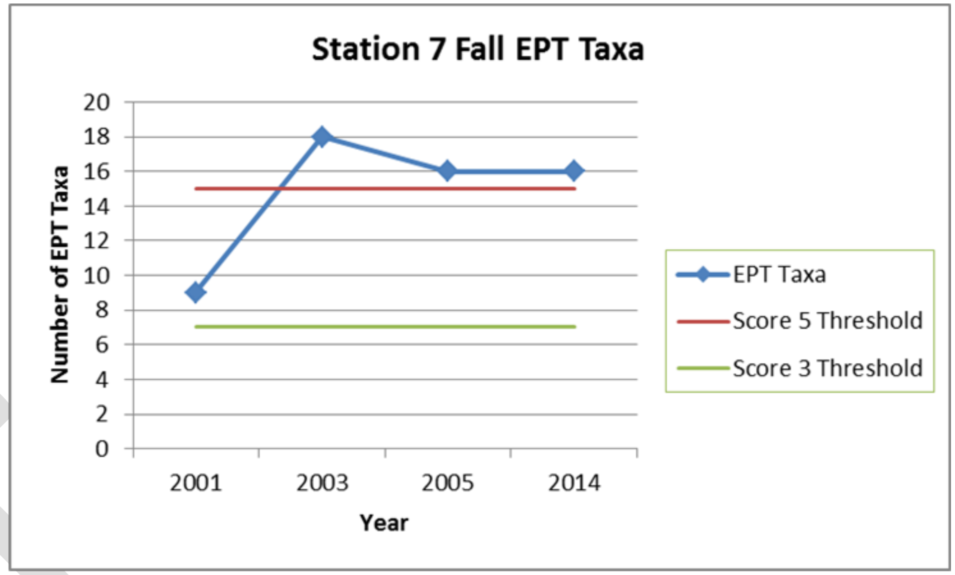
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold


Station 7 Fall EPT Taxa
Number of EPT Taxa
20
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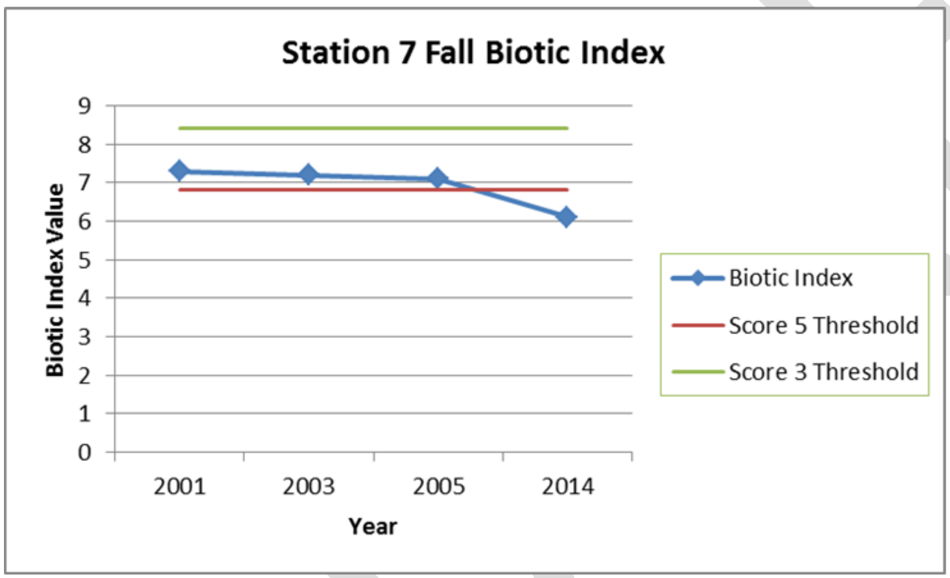
4
2
0
2001
2003
2005
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold


Station 7 Fall Biotic Index
Biotic Index Value
9
8
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5
4
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2
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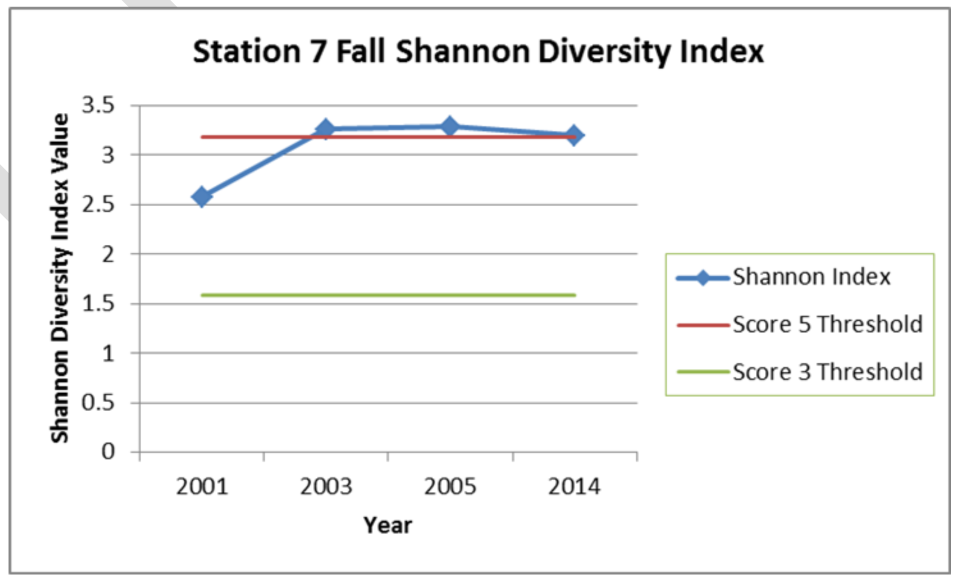
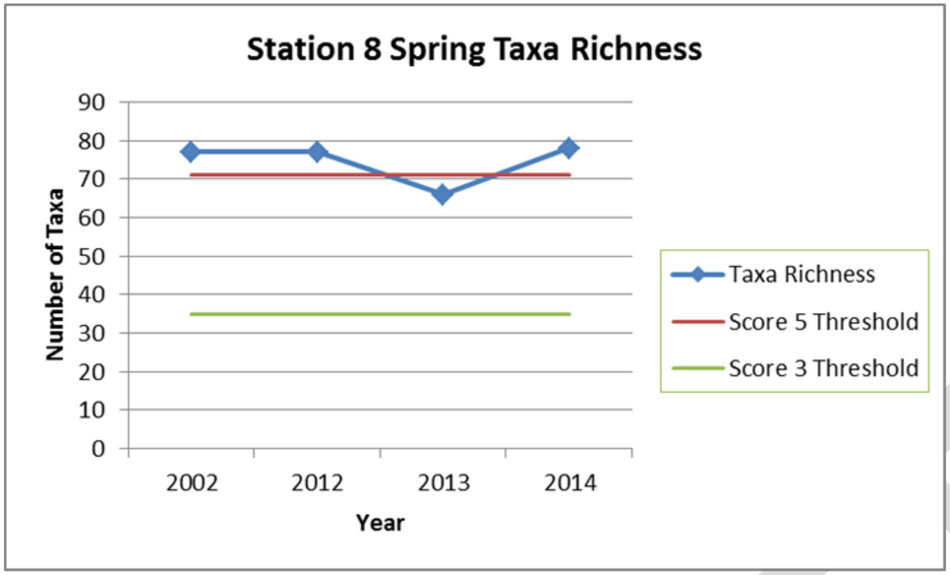
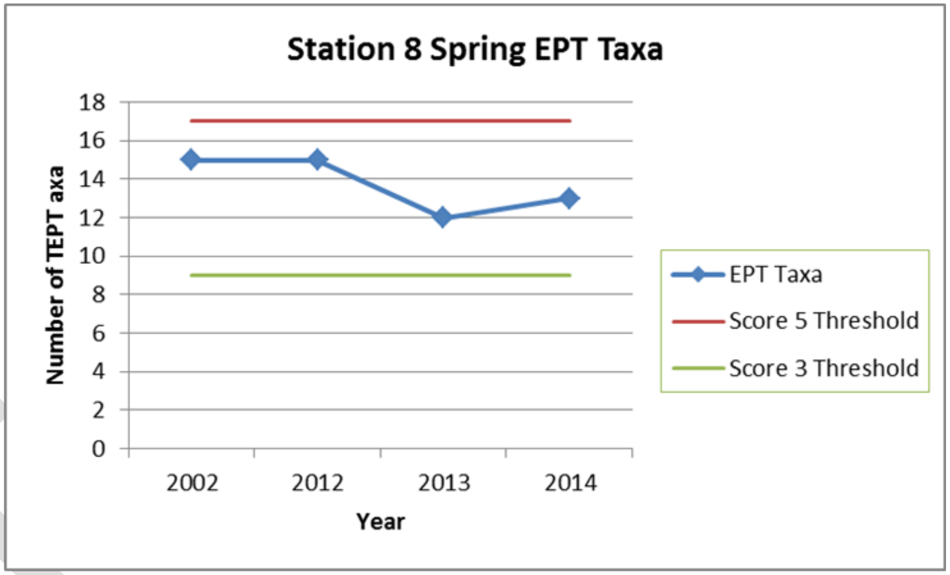
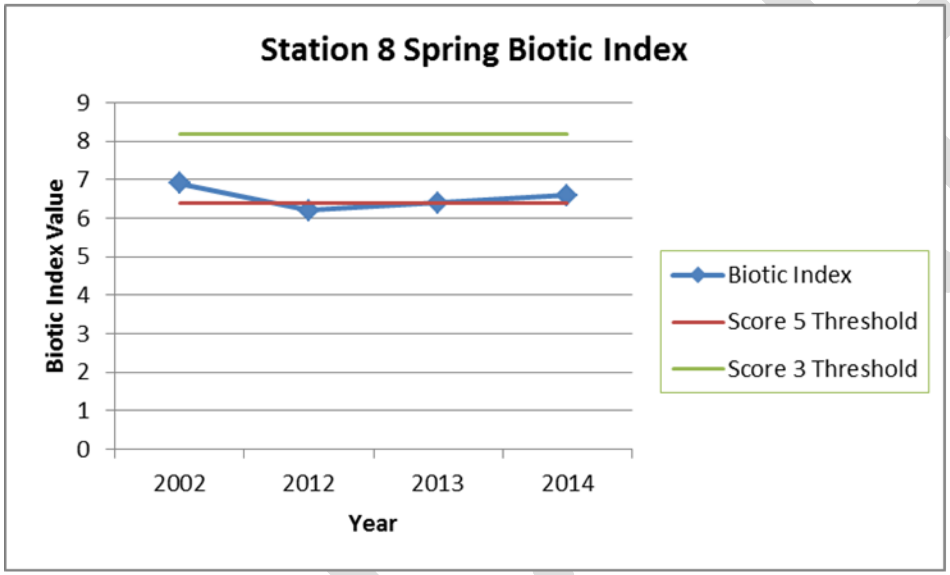
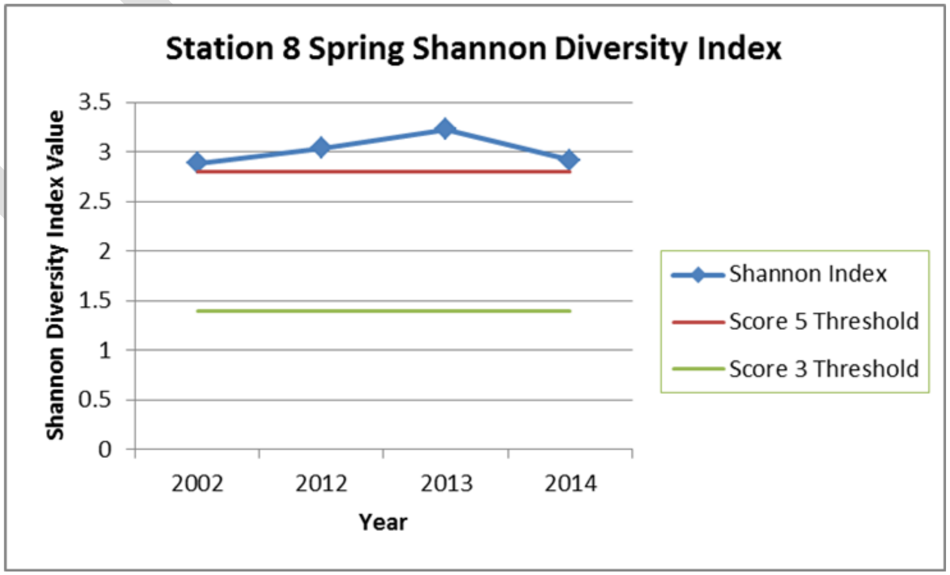
2003
2005
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold

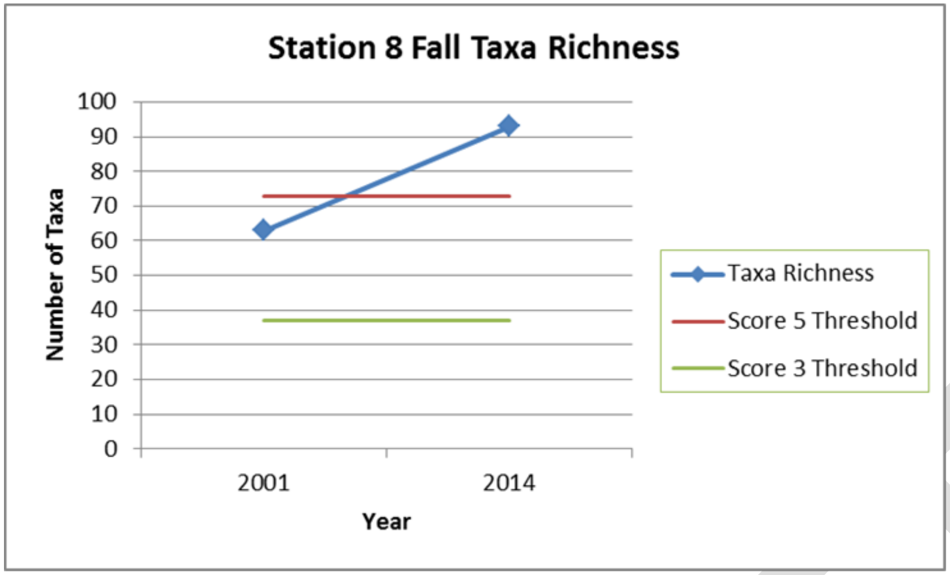

Station 7 Fall Shannon Diversity Index
Shannon Diversity Index Value
3.5
3
2.5
2
1.5
1
0.5
0
2001
2003
2005
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold

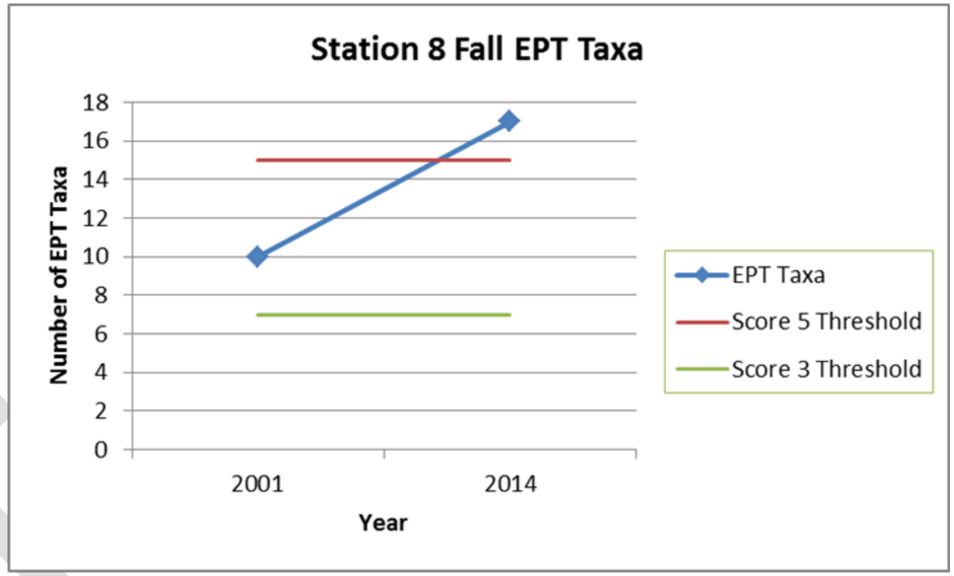

Station 8 Spring Taxa Richness
Number of Taxa
90
80
70
60
50
40
30
20
10
0
2002
2012
2013
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold

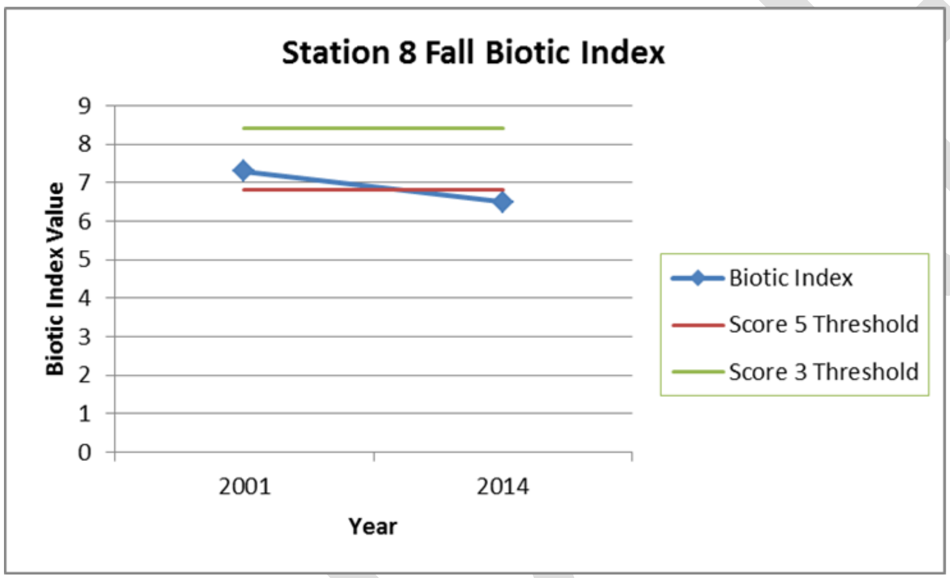

Station 8 Spring EPT Taxa
Number of TEPT axa
18
16
14
12
10
8
6
4
2
0
2002
2012
2013
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold

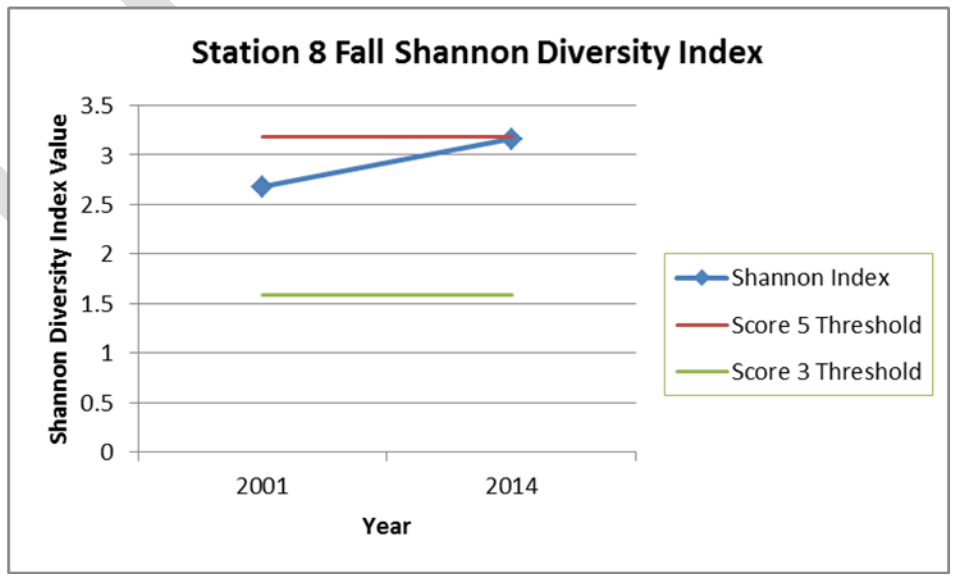

Station 8 Spring Biotic Index
Biotic Index Value
9
8
7
6
5
4
3
2
1
0
2002
2012
2013
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold

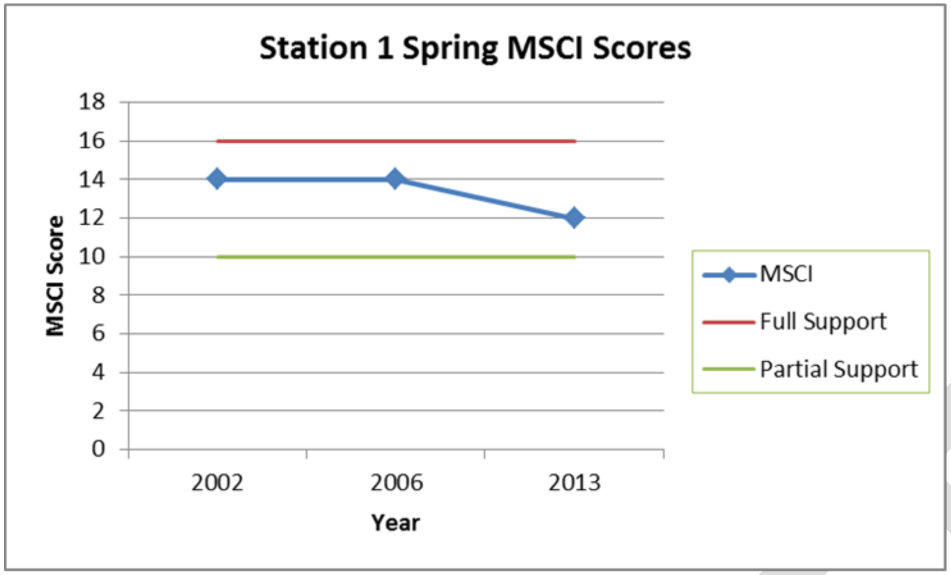

Station 8 Spring Shannon Diversity Index
Shannon Diversity Index Value
3.5
3
2.5
2
1.5
1
0.5
0
2002
2012
2013
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold

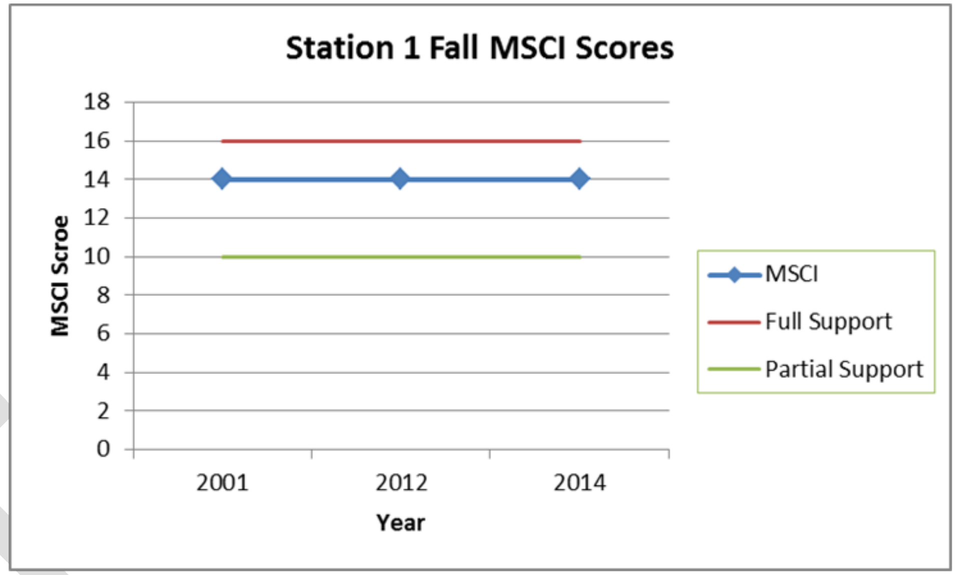

Station 8 Fall Taxa Richness
Number of Taxa
100
90
80
70
60
50
40
30
20
10
0
2001
2014
Year
Taxa Richness
Score 5 Threshold
Score 3 Threshold

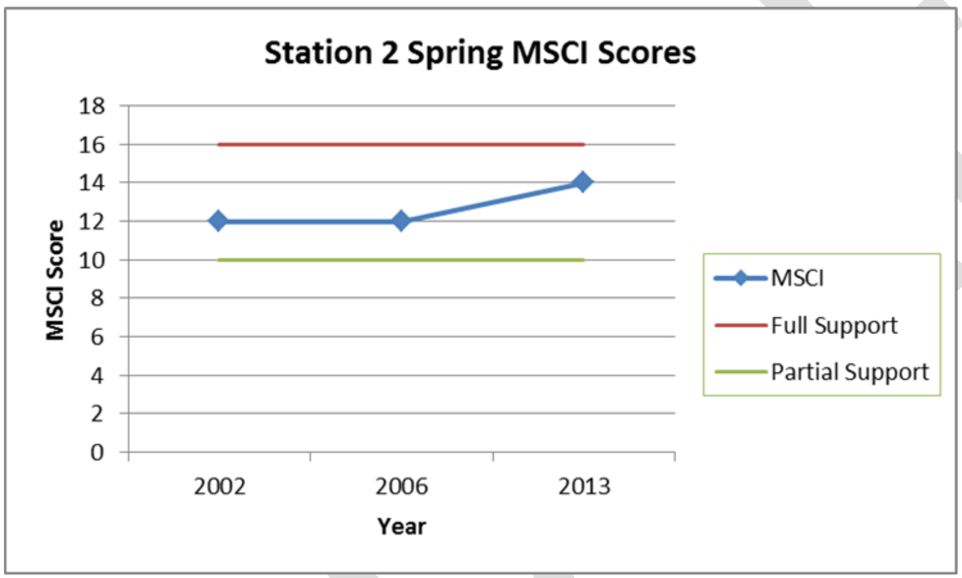

Station 8 Fall EPT Taxa
Number of EPT Taxa
18
16
14
12
10
8
6
4
2
0
2001
2014
Year
EPT Taxa
Score 5 Threshold
Score 3 Threshold

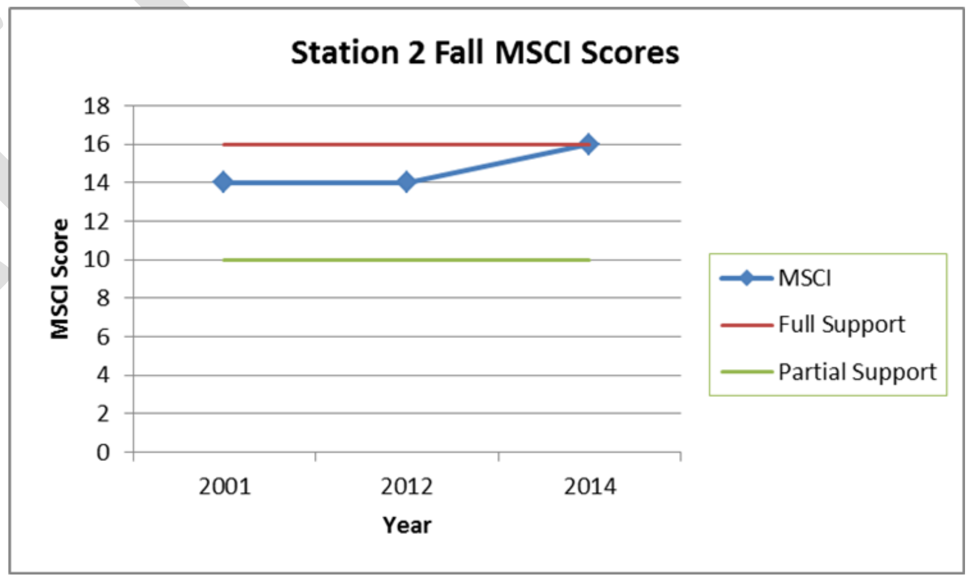

Station 8 Fall Biotic Index
Biotic Index Value
9
8
7
6
5
4
3
2
1
0
2001
2014
Year
Biotic Index
Score 5 Threshold
Score 3 Threshold

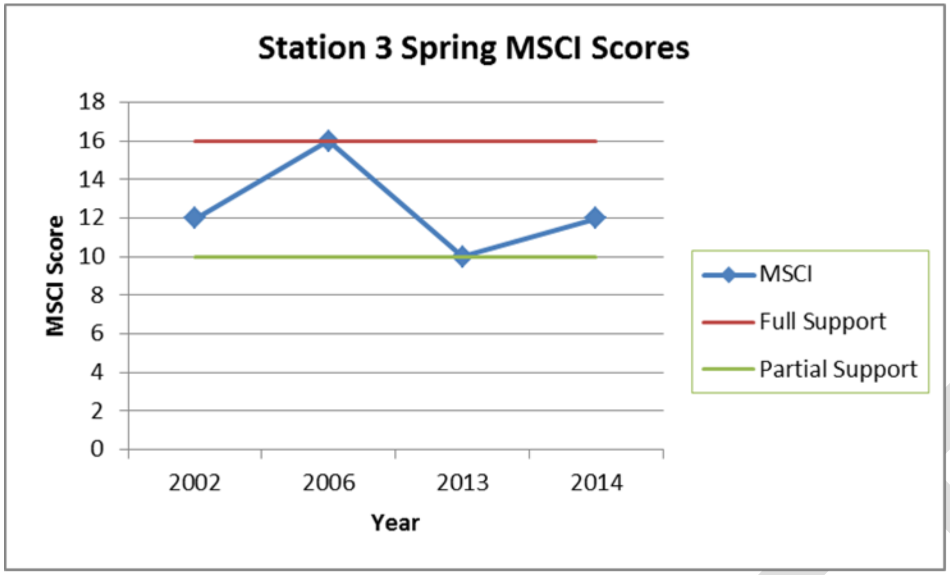

Station 8 Fall Shannon Diversity Index
Shannon Diversity Index Value
3.5
3
2.5
2
1.5
1
0.5
0
2001
2014
Year
Shannon Index
Score 5 Threshold
Score 3 Threshold

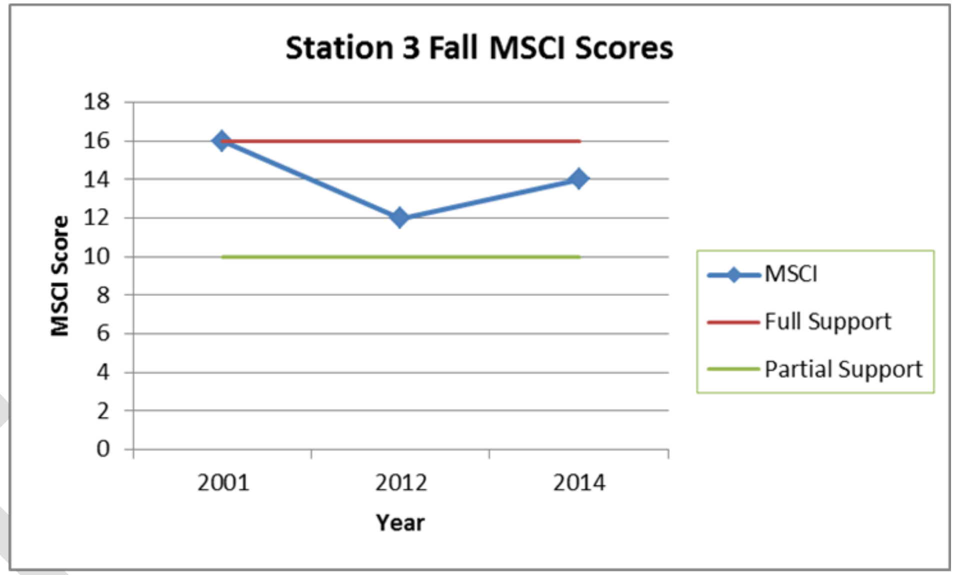

Station 1 Spring MSCI Scores
MSCI Score
18
16
14
12
10
8
6
4
2
0
2002
2006
2013
Year
MSCI
Full Support
Partial Support

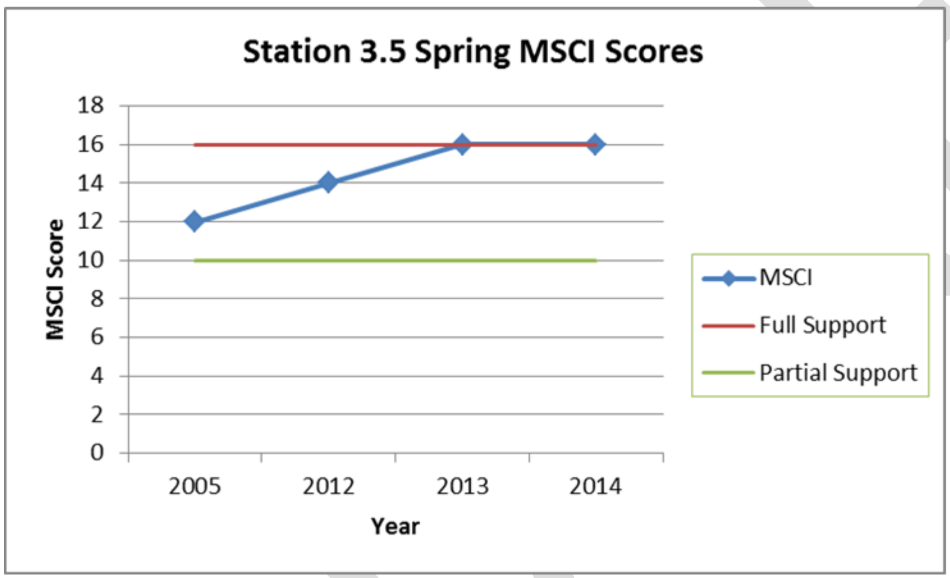

Station 1 Fall MSCI Scores
MSCI Scroe
18
16
14
12
10
8
6
4
2
0
2001
2012
2014
Year
MSCI
Full Support
Partial Support

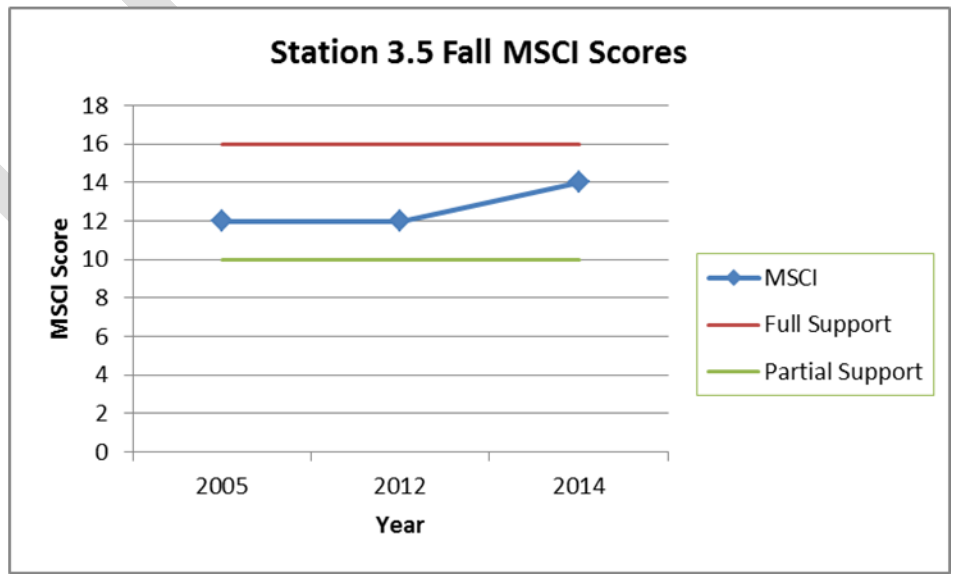

Station 2 Spring MSCI Scores
MSCI Score
18
16
14
12
10
8
6
4
2
0
2002
2006
2013
Year
MSCI
Full Support
Partial Support

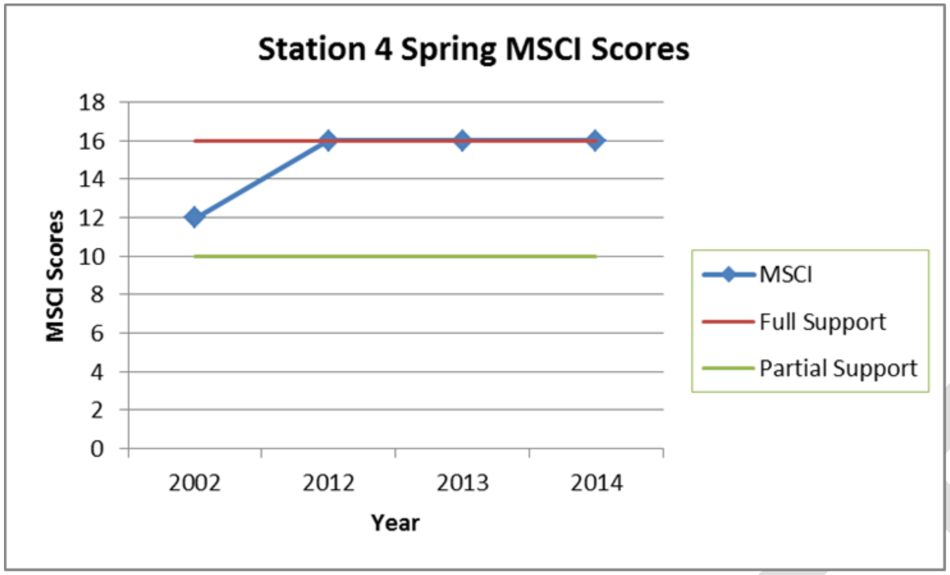

Station 2 Fall MSCI Scores
MSCI Score
18
16
14
12
10
8
6
4
2
0
2001
2012
2014
Year
MSCI
Full Support
Partial Support

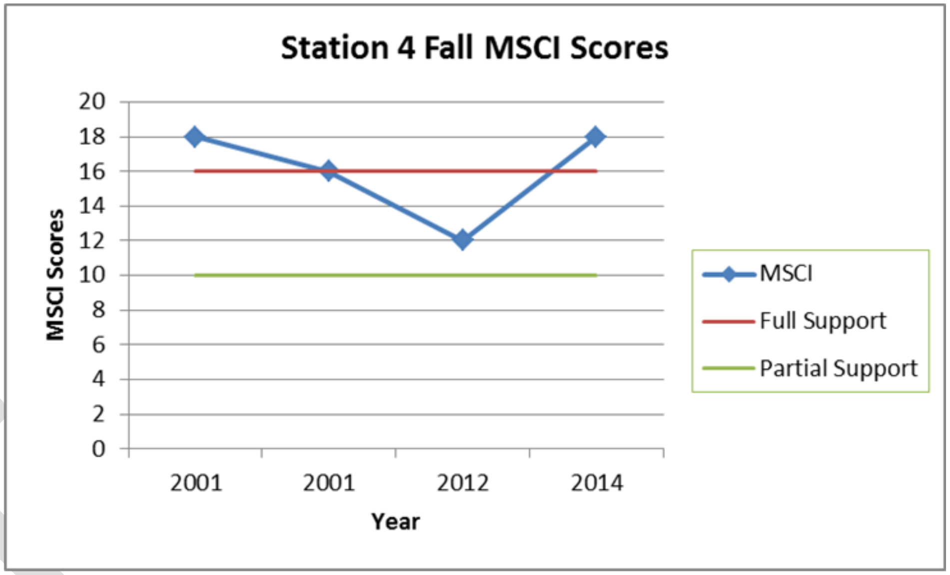

Station 3 Spring MSCI Scores
MSCI Score
Year
2002
2006
2013
2014
0
2
4
6
8
10
12
14
16
18
MSCI
Full Support
Partial Support

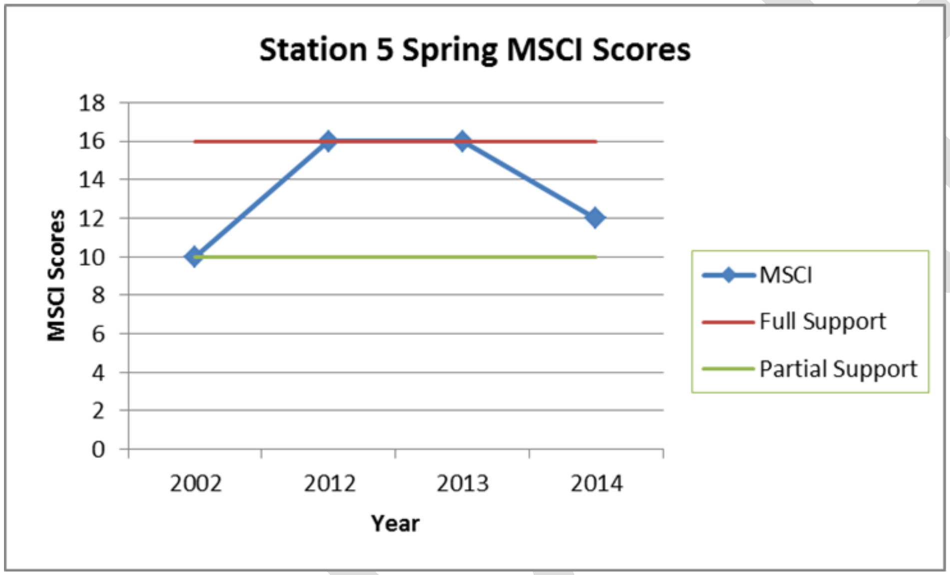

Station 3 Fall MSCI Scores
MSCI Score
Year
2001
2012
2014
0
2
4
6
8
10
12
14
16
18
MSCI
Full Support
Partial Support

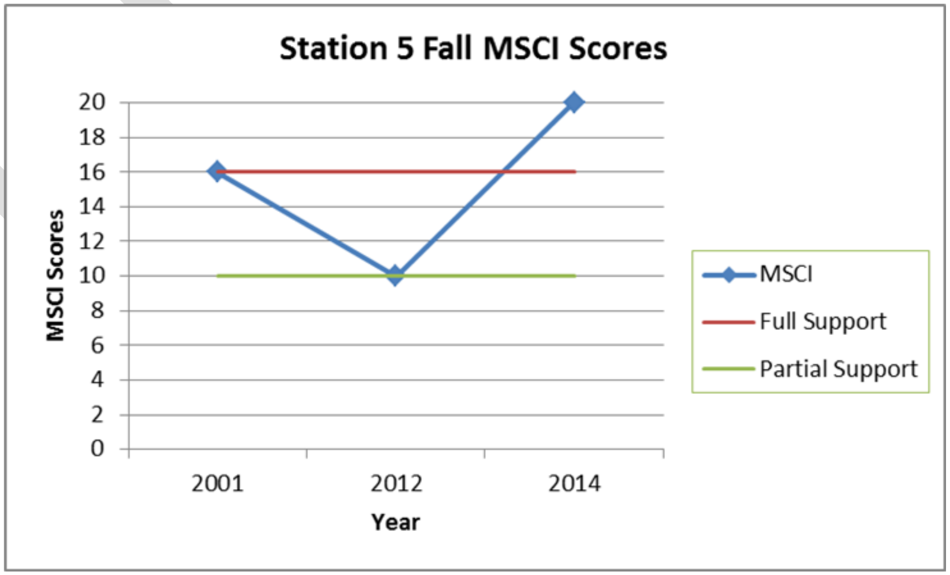

Station 3.5 Spring MSCI Scores
MSCI Score
Year
2005
2012
2013
2014
0
2
4
6
8
10
12
14
16
18
MSCI
Full Support
Partial Support

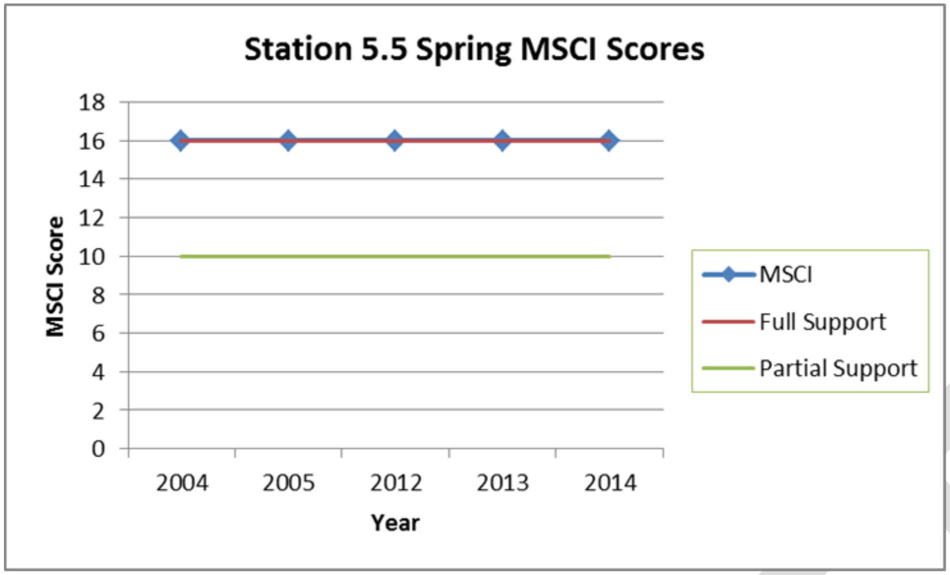

Station 3.5 Fall MSCI Scores
MSCI Score
Year
2005
2012
2014
0
2
4
6
8
10
12
14
16
18
MSCI
Full Support
Partial Support

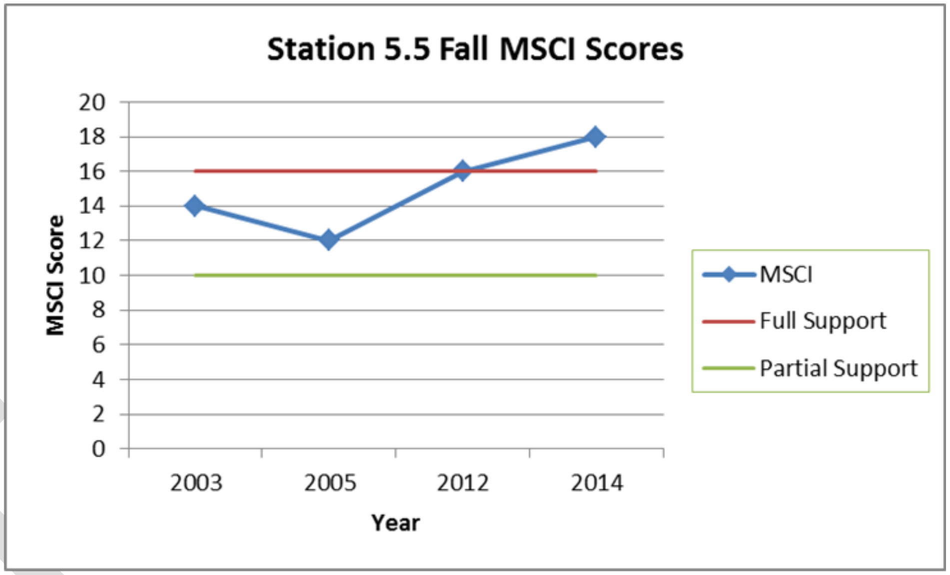

Station 4 Spring MSCI Scores
MSCI Scores
18
16
14
12
10
8
6
4
2
0
2002
2012
2013
2014
Year
MSCI
Full Support
Partial Support

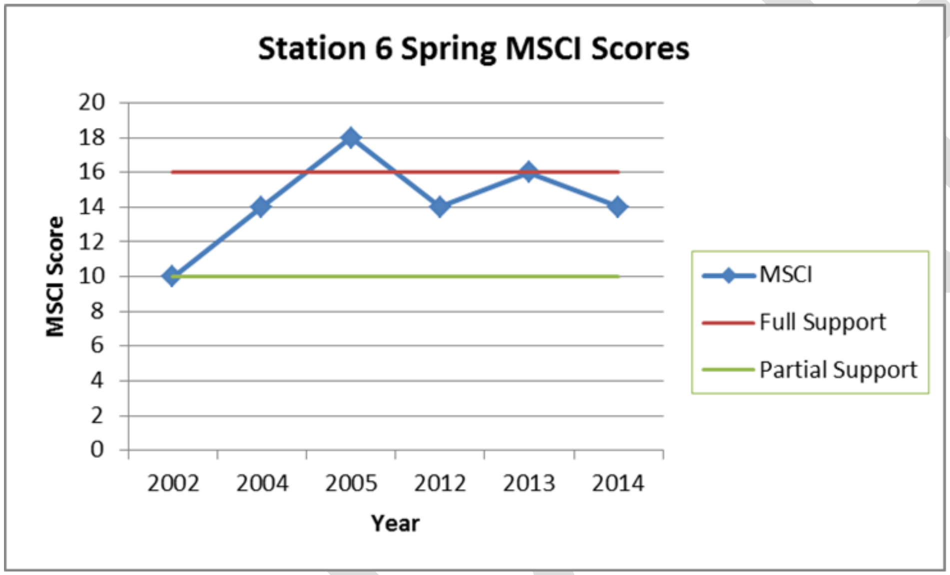

Station 4 Fall MSCI Scores
MSCI Scores
20
18
16
14
12
10
8
6
4
2
0
2001
2001
2012
2014
Year
MSCI
Full Support
Partial Support

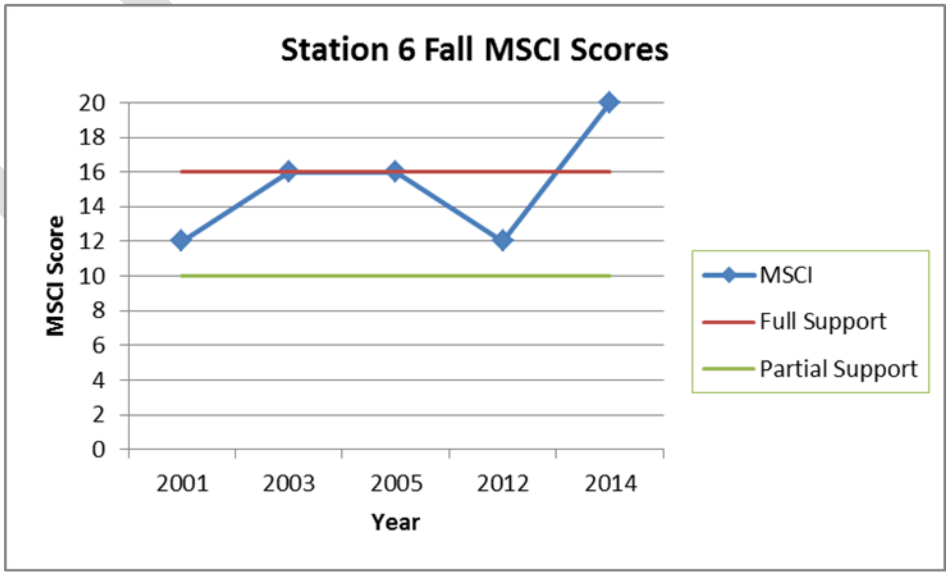

Station 5 Spring MSCI Scores
MSCI Scores
18
16
14
12
10
8
6
4
2
0
2002
2012
2013
2014
Year
MSCI
Full Support
Partial Support

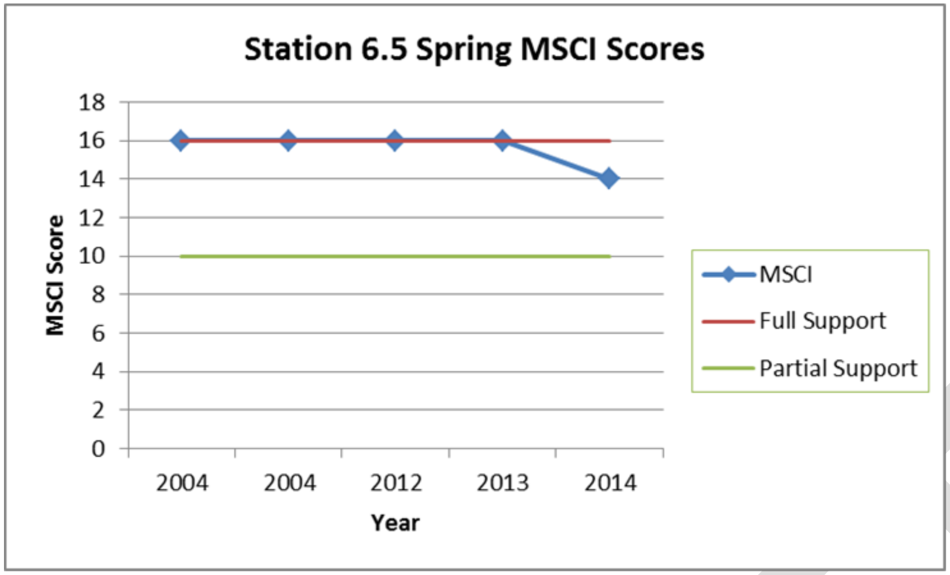

Station 5 Fall MSCI Scores
MSCI Scores
20
18
16
14
12
10
8
6
4
2
0
2001
2012
2014
Year
MSCI
Full Support
Partial Support

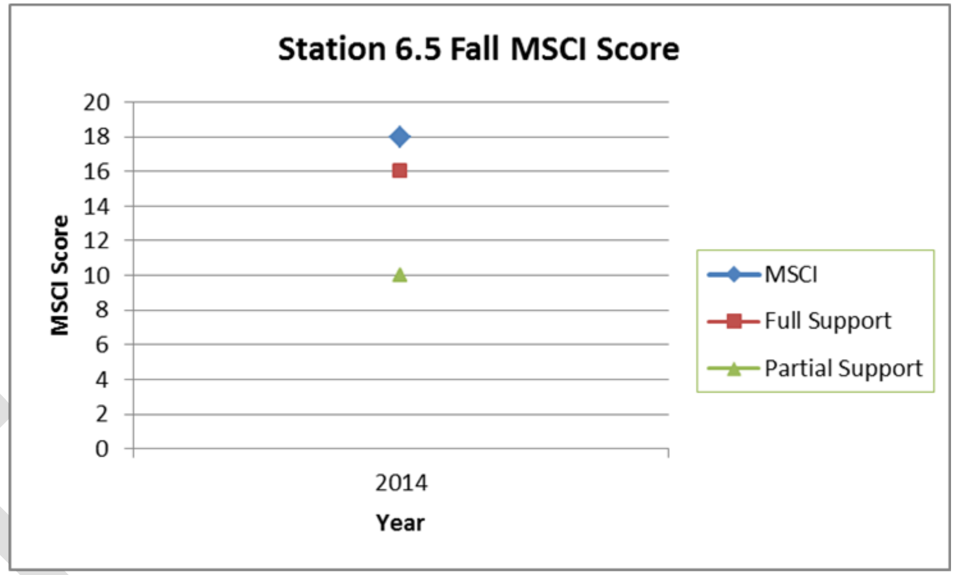

Station 5.5 Spring MSCI Scores
18
16
14
12
10
8
6
4
2
0
MSCI Score
2004
2005
2012
2013
2014
Year
MSCI
Full Support
Partial Support

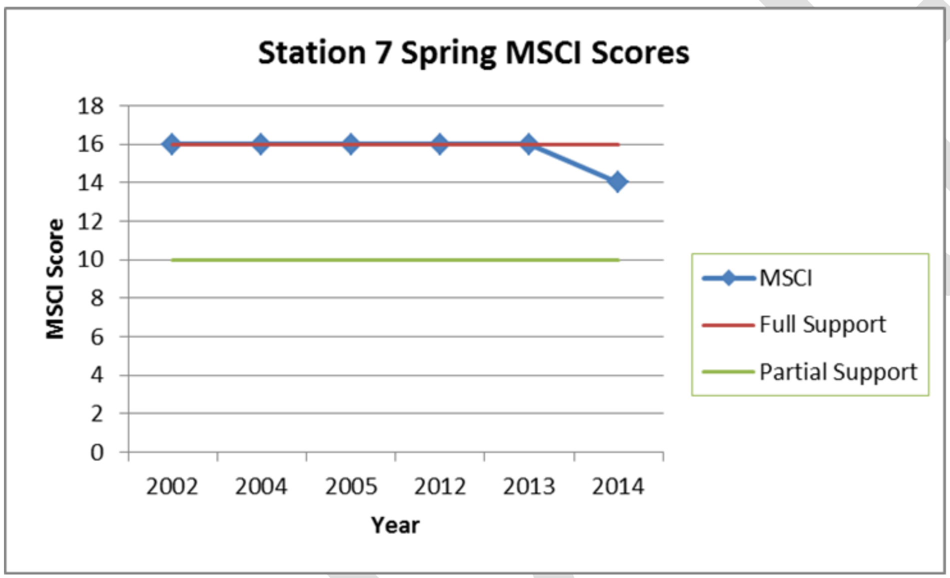

Station 5.5 Fall MSCI Scores
20
18
16
14
12
10
8
6
4
2
0
MSCI Score
2003
2005
2012
2014
Year
MSCI
Full Support
Partial Support

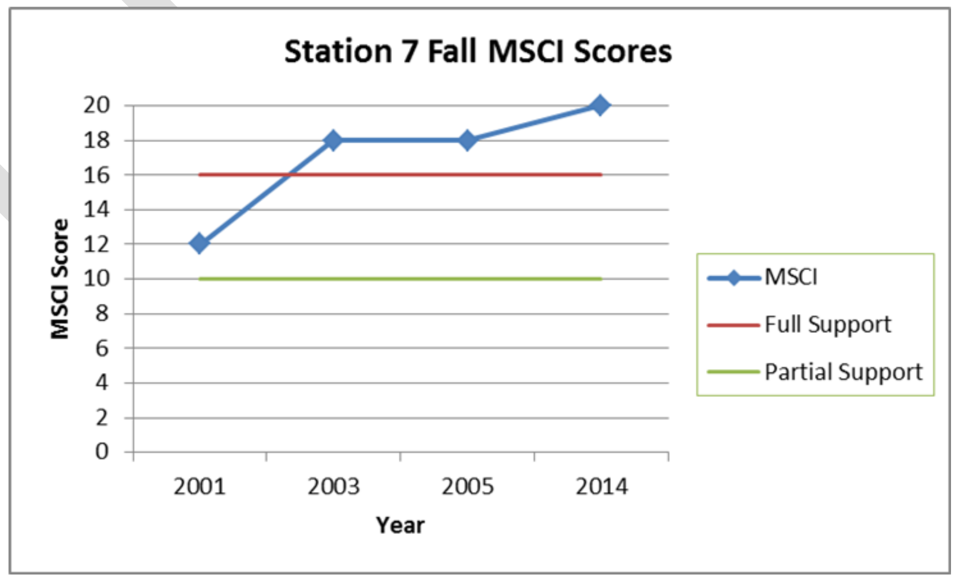

Station 6 Spring MSCI Scores
20
18
16
14
12
10
8
6
4
2
0
MSCI Score
2002
2004
2005
2012
2013
2014
Year
MSCI
Full Support
Partial Support

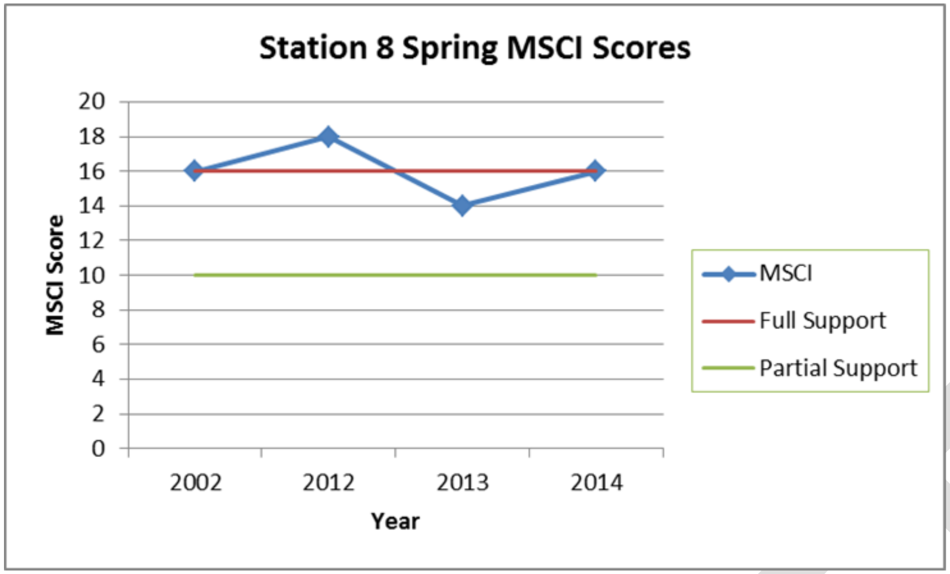

Station 6 Fall MSCI Scores
20
18
16
14
12
10
8
6
4
2
0
MSCI Score
2001
2003
2005
2012
2014
Year
MSCI
Full Support
Partial Support

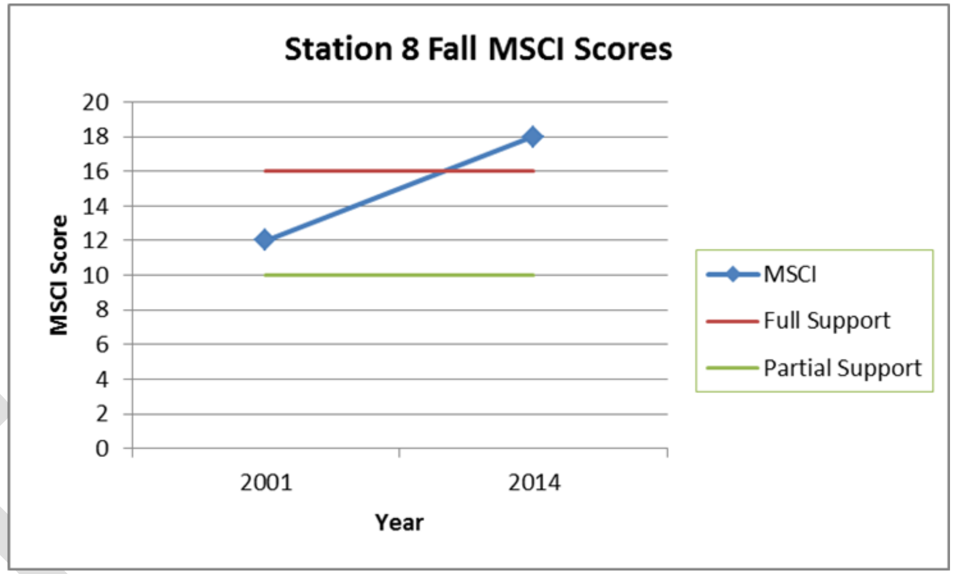

Station 6.5 Spring MSCI Scores
MSCI Score
18
16
14
12
10
8
6
4
2
0
2004
2004
2012
2013
2014
Year
MSCI
Full Support
Partial Support

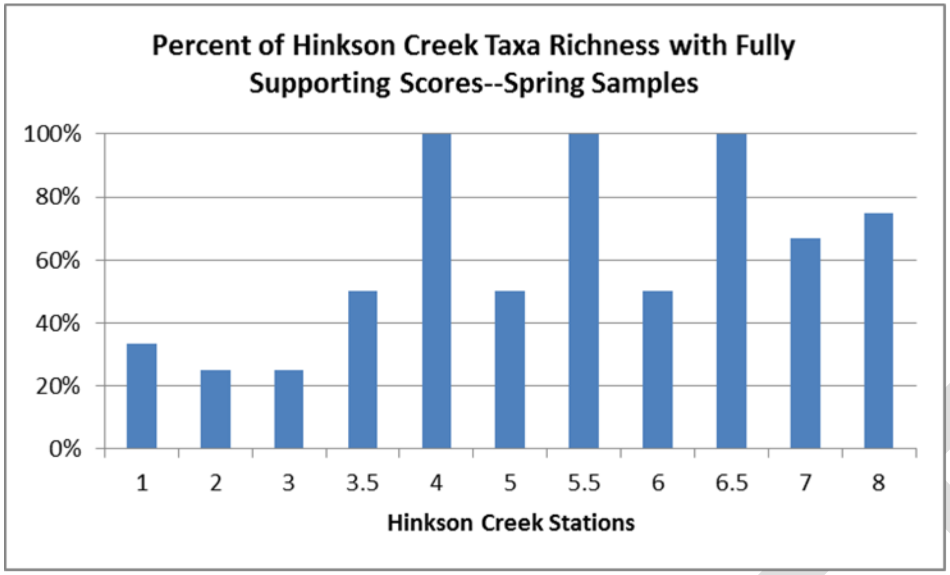

Station 6.5 Fall MSCI Score
MSCI Score
20
18
16
14
12
10
8
6
4
2
0
2014
Year
MSCI
Full Support
Partial Support

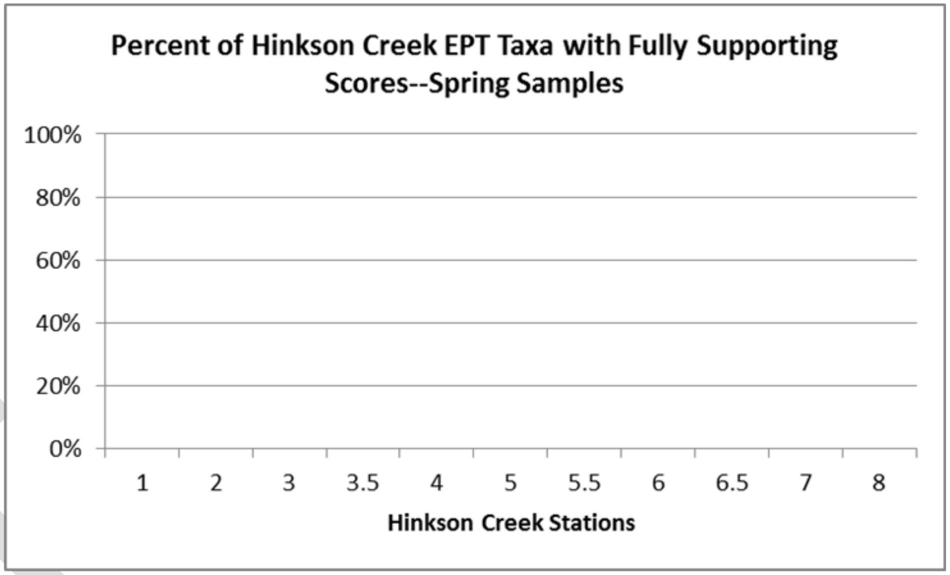

Station 7 Spring MSCI Scores
MSCI Score
18
16
14
12
10
8
6
4
2
0
2002
2004
2005
2012
2013
2014
Year
MSCI
Full Support
Partial Support

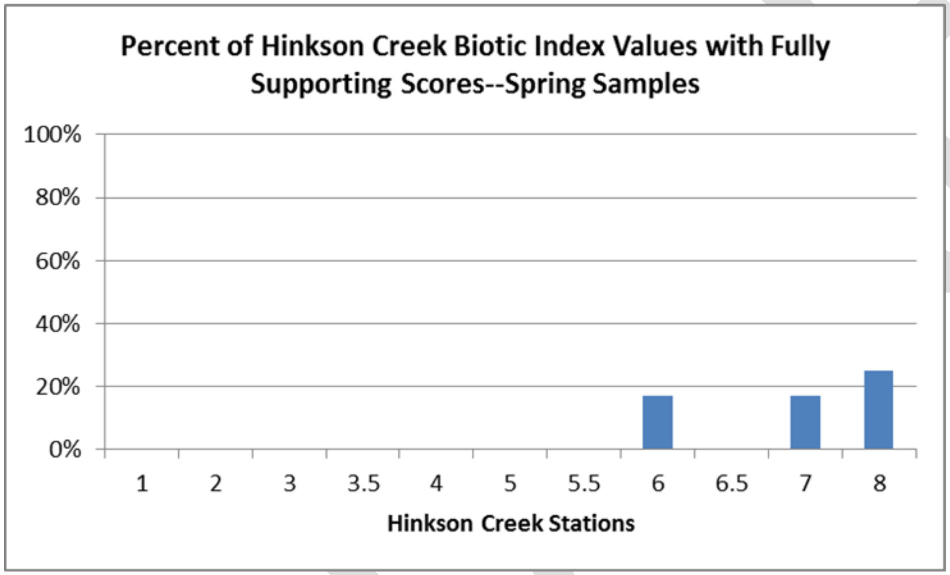

Station 7 Fall MSCI Scores
MSCI Score
20
18
16
14
12
10
8
6
4
2
0
2001
2003
2005
2014
Year
MSCI
Full Support
Partial Support

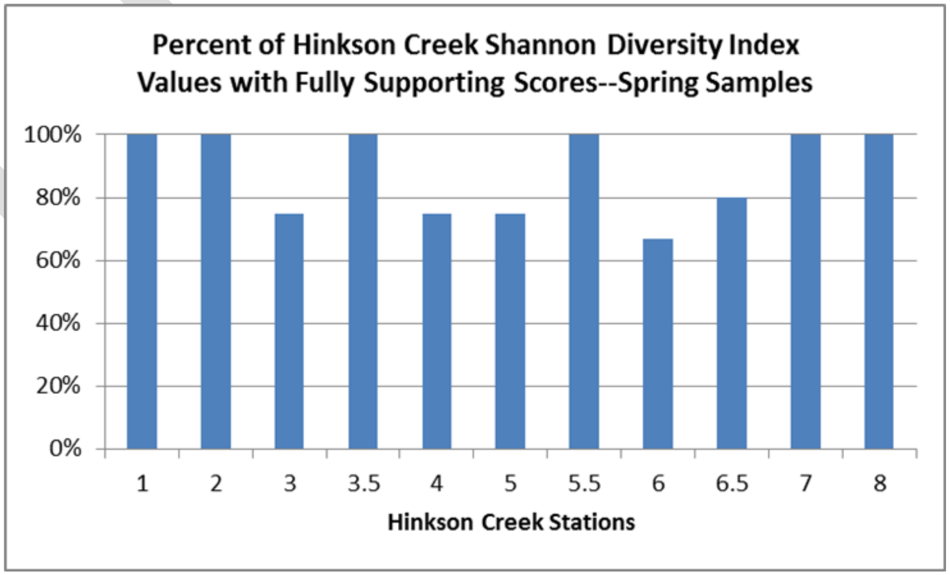

Station 8 Spring MSCI Scores
MSCI Score
20
18
16
14
12
10
8
6
4
2
0
2002
2012
2013
2014
Year
MSCI
Full Support
Partial Support

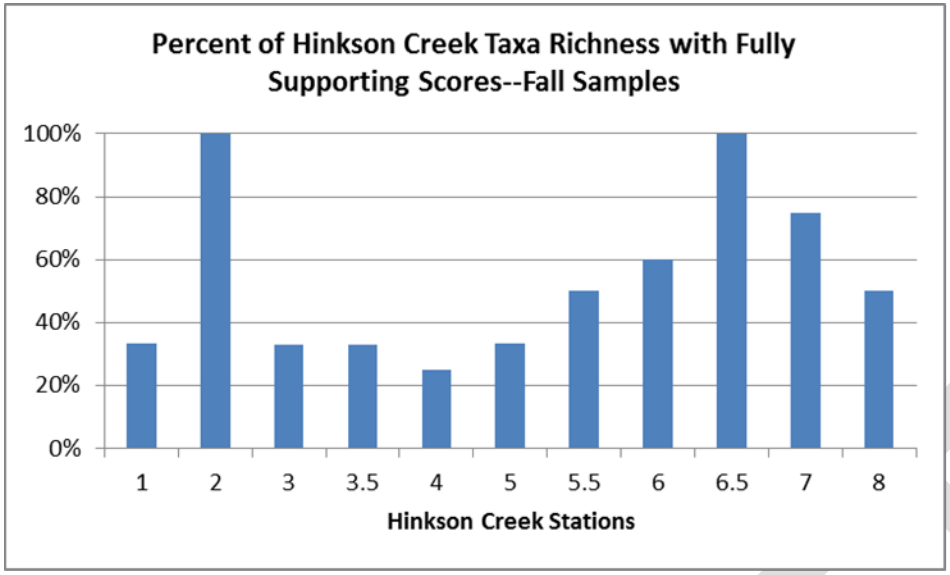

Station 8 Fall MSCI Scores
MSCI Score
20
18
16
14
12
10
8
6
4
2
0
2001
2014
Year
MSCI
Full Support
Partial Support

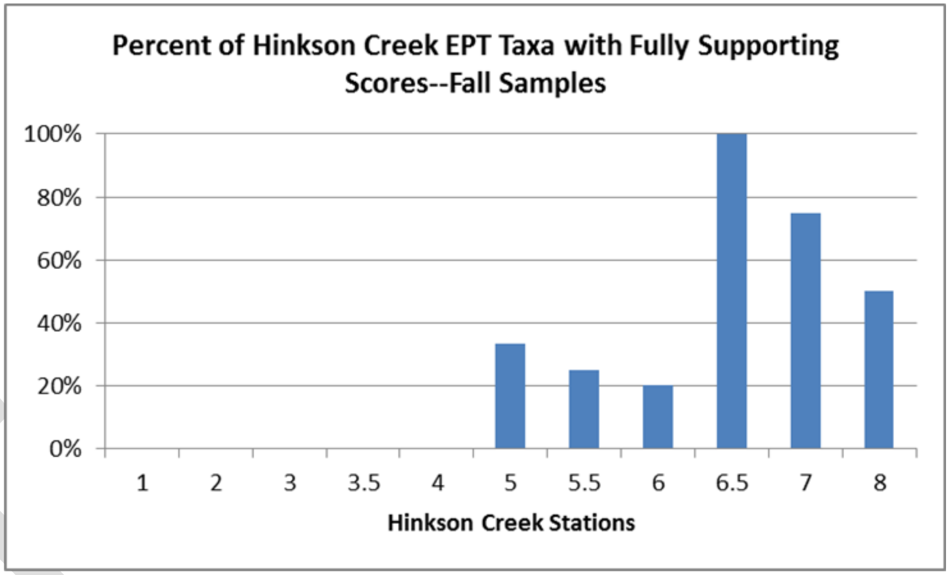

Percent of Hinkson Creek Taxa Richness with Fully Supporting Scores--Spring Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations

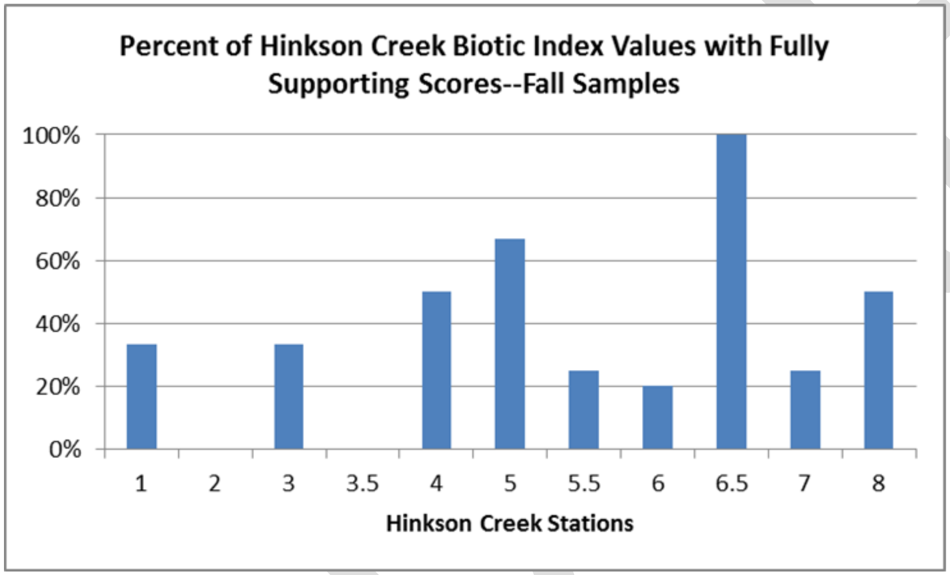

Percent of Hinkson Creek EPT Taxa with Fully Supporting Scores--Spring Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations

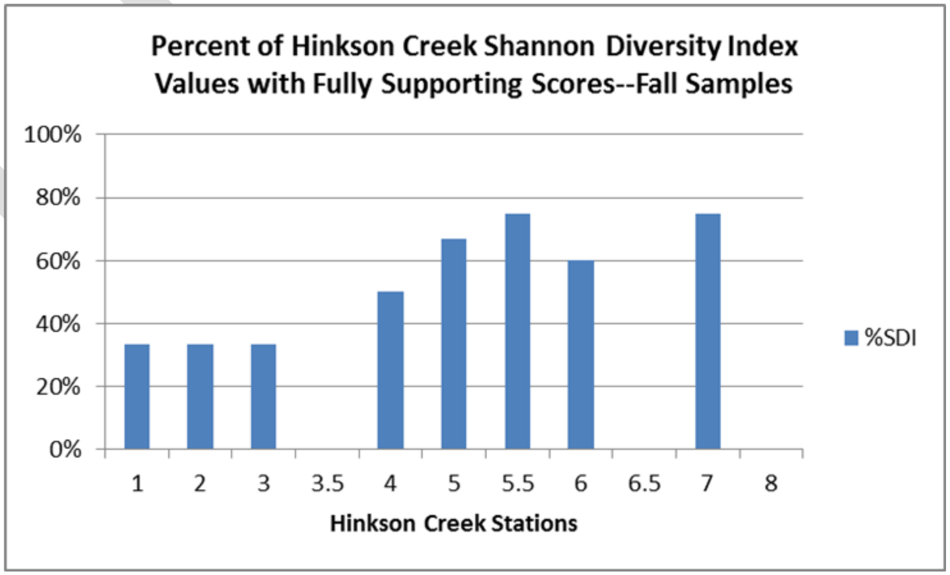

Percent of Hinkson Creek Biotic Index Values with Fully Supporting Scores--Spring Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations

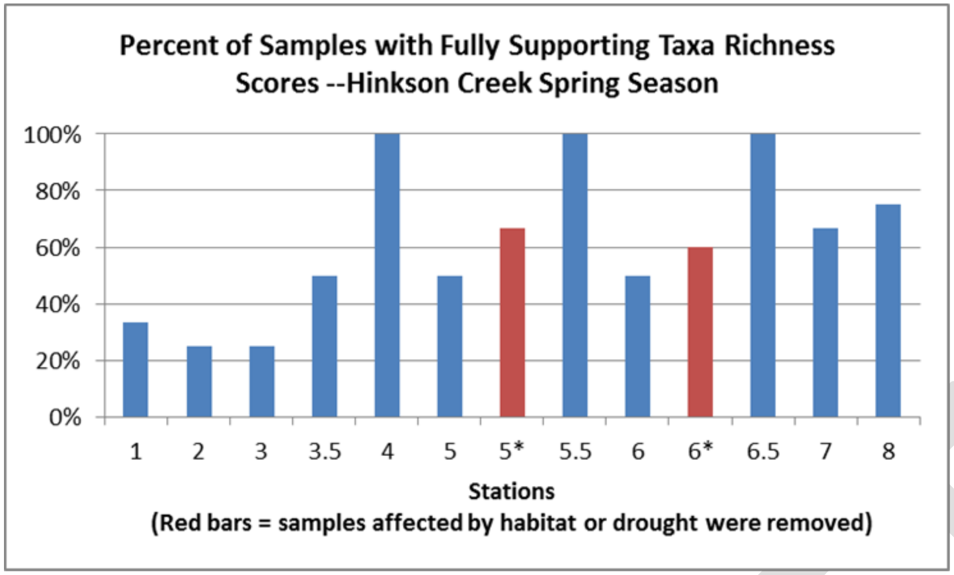

Percent of Hinkson Creek Shannon Diversity Index Values with Fully Supporting Scores--Spring Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations

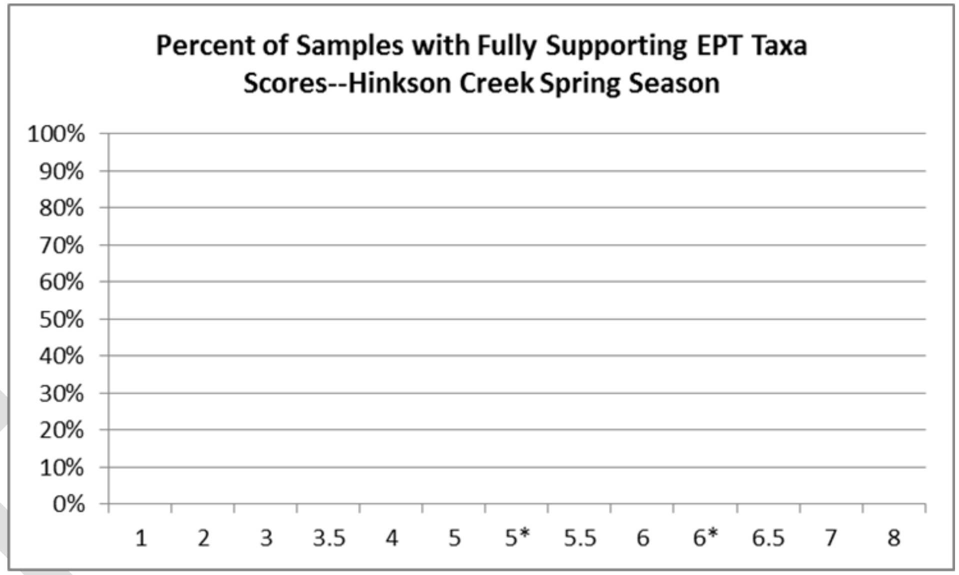

Percent of Hinkson Creek Taxa Richness with Fully Supporting Scores--Fall Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations

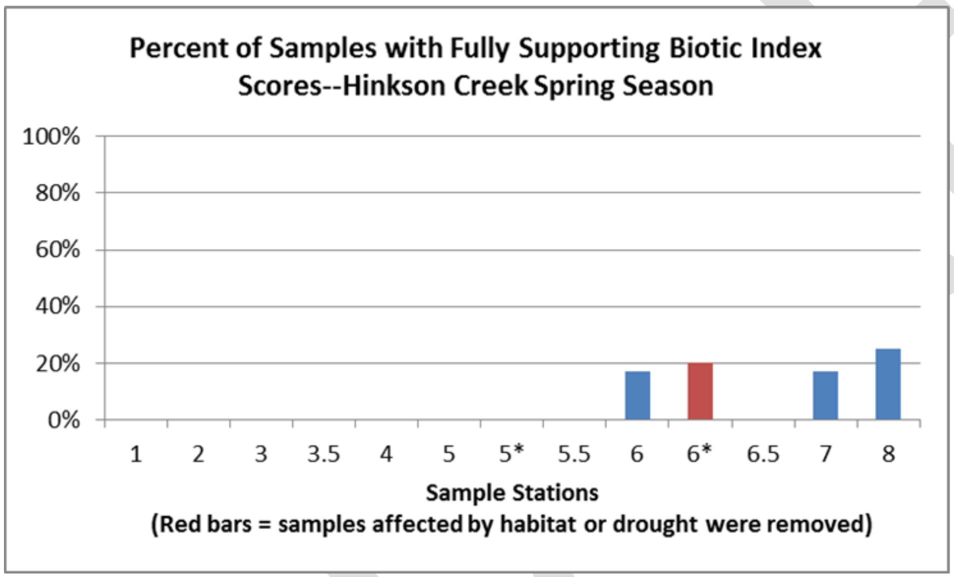

Percent of Hinkson Creek EPT Taxa with Fully Supporting Scores--Fall Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations

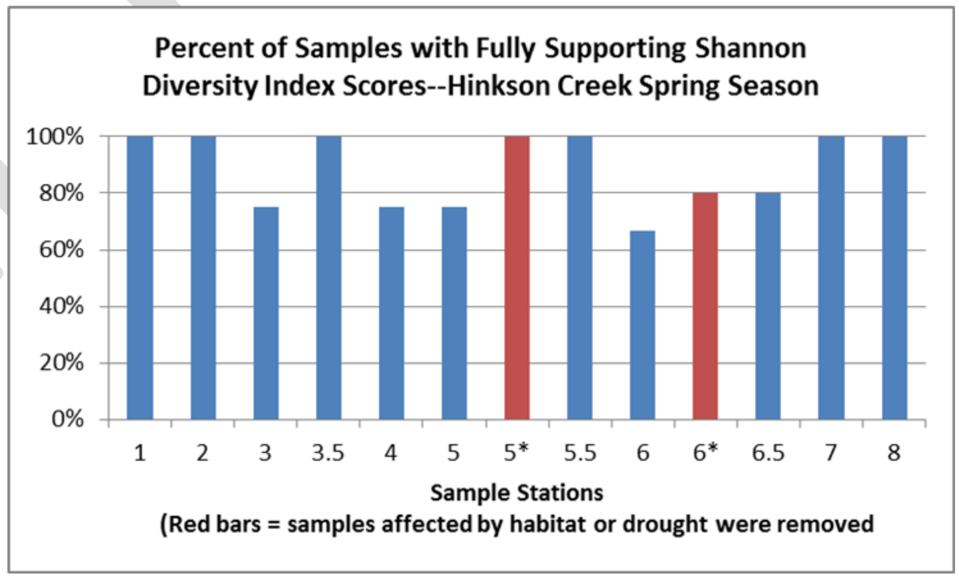

Percent of Hinkson Creek Biotic Index Values with Fully Supporting Scores--Fall Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations

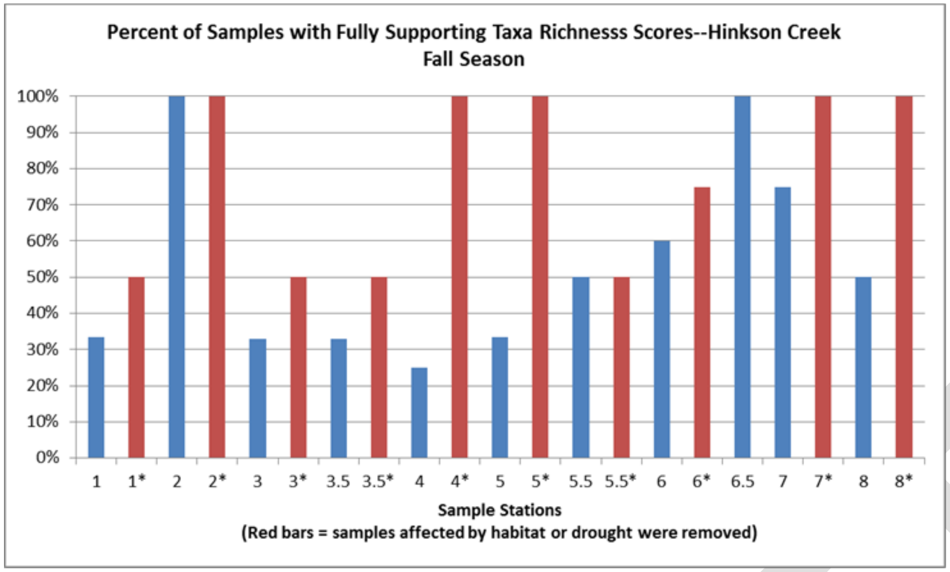

Percent of Hinkson Creek Shannon Diversity Index Values with Fully Supporting Scores--Fall Samples
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5.5
6
6.5
7
8
Hinkson Creek Stations
%SDI

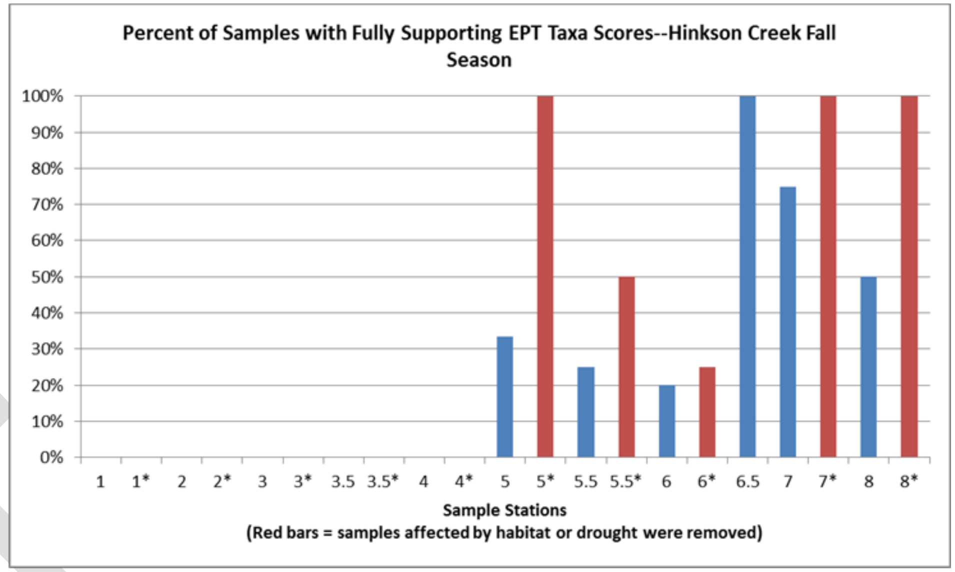

Percent of Samples with Fully Supporting Taxa Richness Scores --Hinkson Creek Spring Season
100%
80%
60%
40%
20%
0%
1 2 3 3.5 4 5 5* 5.5 6 6* 6.5 7 8
Stations
(Red bars = samples affected by habitat or drought were removed)

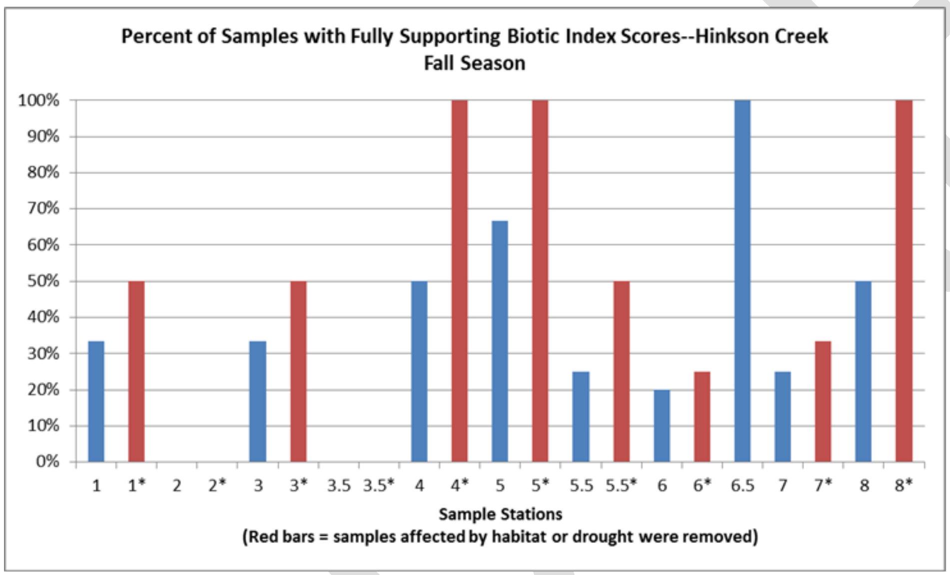

Percent of Samples with Fully Supporting EPT Taxa Scores--Hinkson Creek Spring Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 3.5 4 5 5* 5.5 6 6* 6.5 7 8

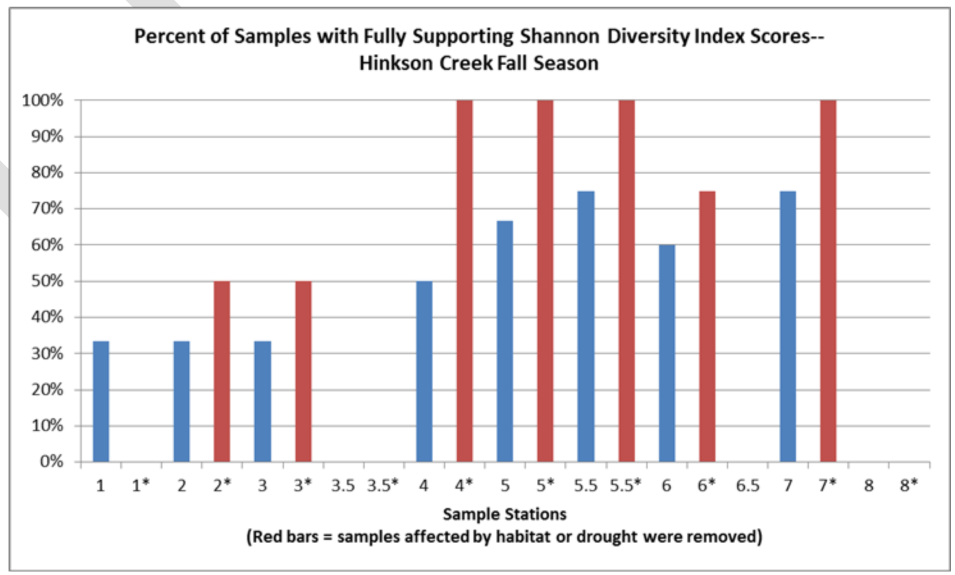

Percent of Samples with Fully Supporting Biotic Index Scores--Hinkson Creek Spring Season
100%
80%
60%
40%
20%
0%
1 2 3 3.5 4 5 5* 5.5 6 6* 6.5 7 8
Sample Stations
(Red bars = samples affected by habitat or drought were removed)

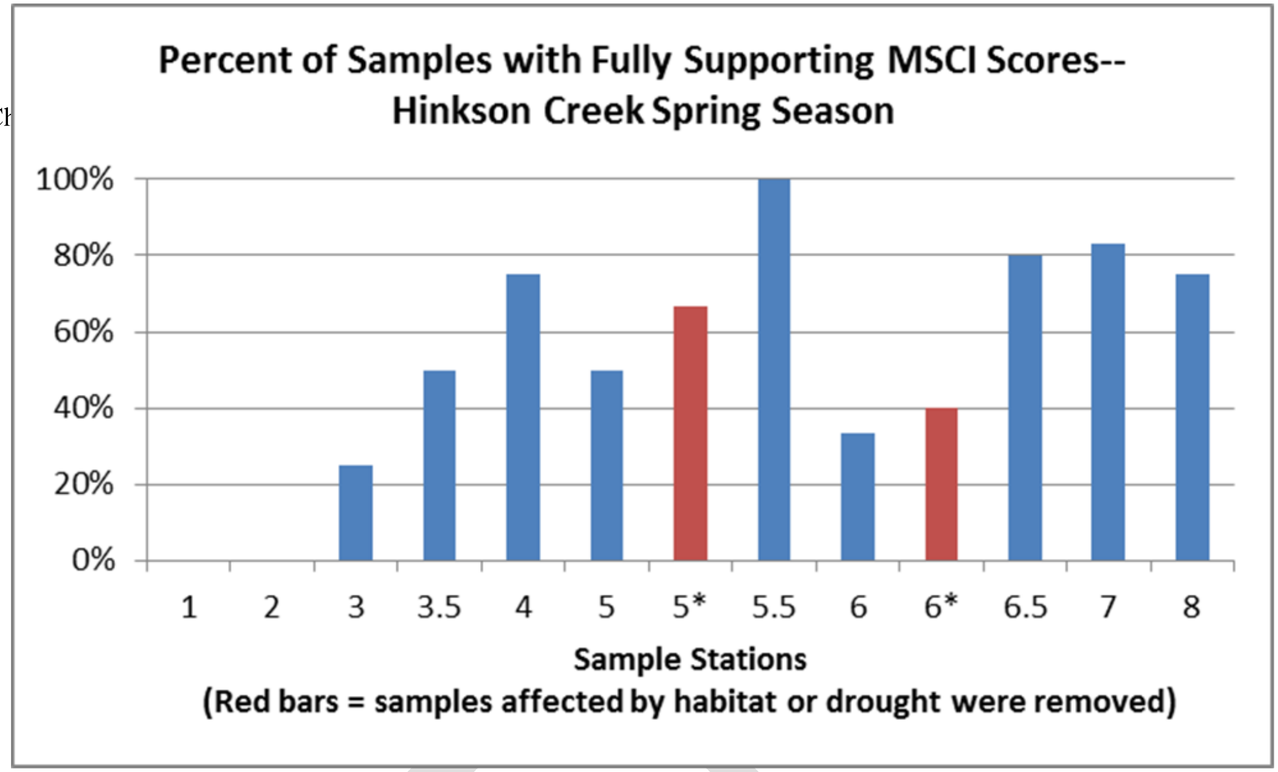

Percent of Samples with Fully Supporting Shannon Diversity Index Scores--Hinkson Creek Spring Season
100%
80%
60%
40%
20%
0%
1 2 3 3.5 4 5 5* 5.5 6 6* 6.5 7 8
Sample Stations
(Red bars = samples affected by habitat or drought were removed

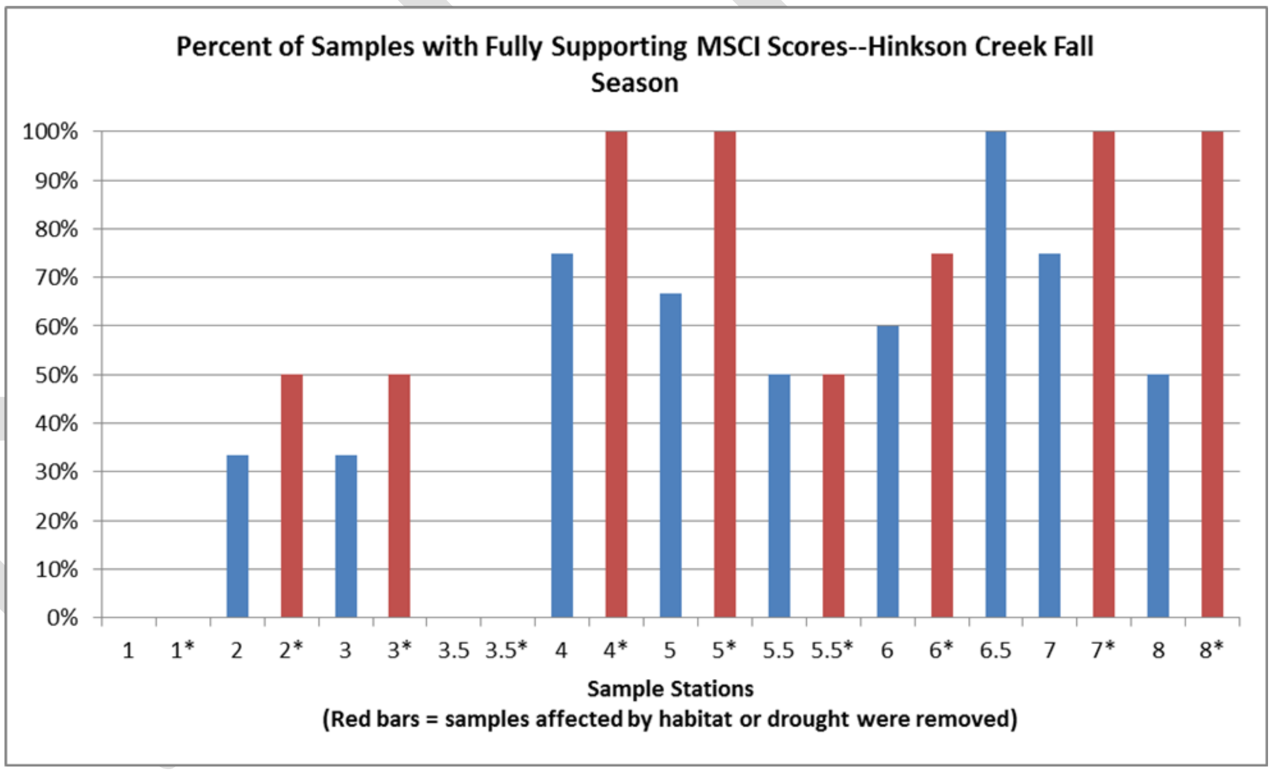

Percent of Samples with Fully Supporting Taxa Richnesss Scores--Hinkson Creek Fall Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 1* 2 2* 3 3* 3.5 3.5* 4 4* 5 5* 5.5 5.5* 6 6* 6.5 7 7* 8 8*
Sample Stations
(Red bars = samples affected by habitat or drought were removed)


Percent of Samples with Fully Supporting EPT Taxa Scores--Hinkson Creek Fall Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 1* 2 2* 3 3* 3.5 3.5* 4 4* 5 5* 5.5 5.5* 6 6* 6.5 7 7* 8 8*
Sample Stations
(Red bars = samples affected by habitat or drought were removed)


Percent of Samples with Fully Supporting Biotic Index Scores--Hinkson Creek Fall Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 1* 2 2* 3 3* 3.5 3.5* 4 4* 5 5* 5.5 5.5* 6 6* 6.5 7 7* 8 8*
Sample Stations
(Red bars = samples affected by habitat or drought were removed)

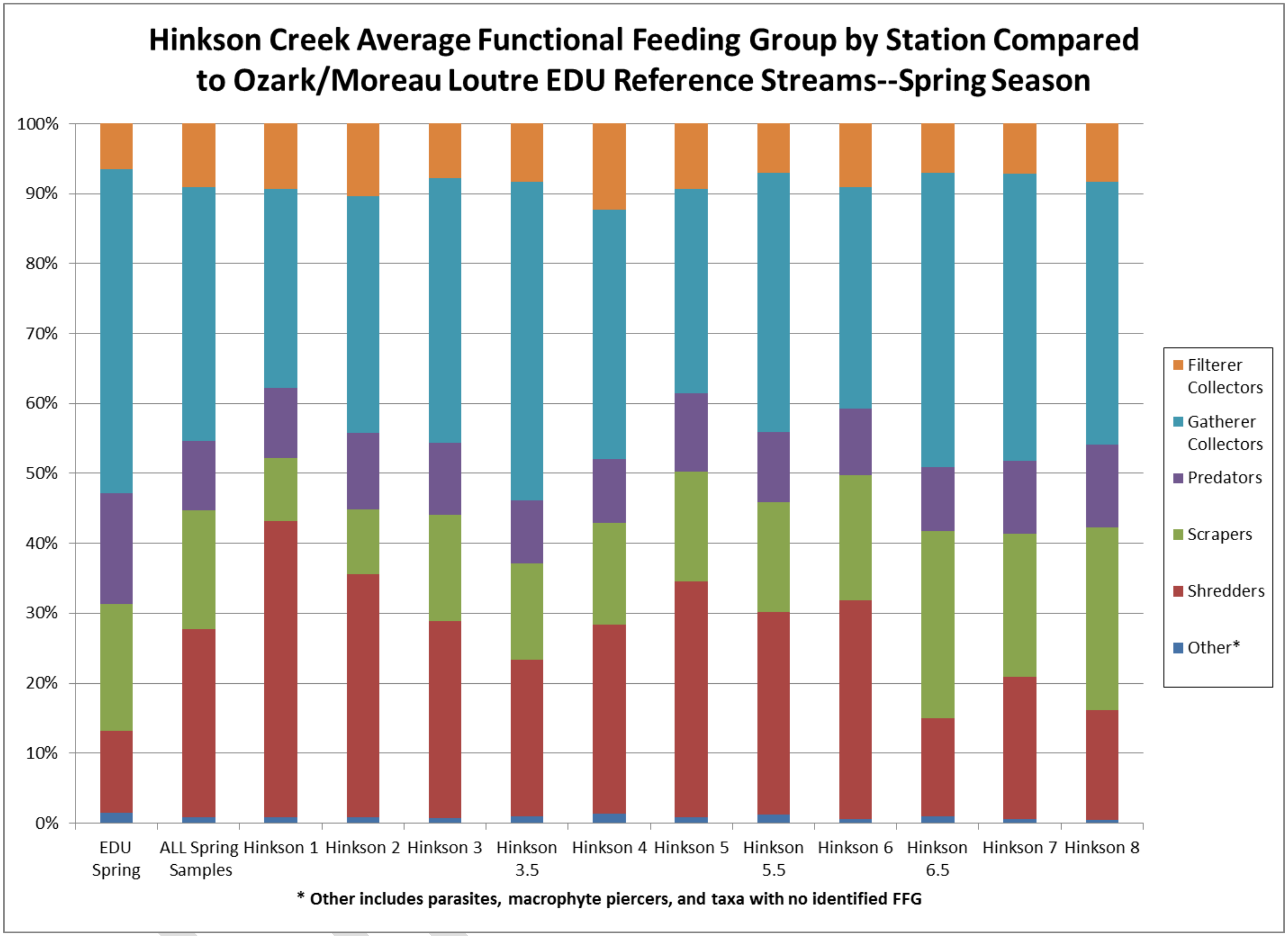

Percent of Samples with Fully Supporting Shannon Diversity Index Scores--Hinkson Creek Fall Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 1* 2 2* 3 3* 3.5 3.5* 4 4* 5 5* 5.5 5.5* 6 6* 6.5 7 7* 8 8*
Sample Stations
(Red bars = samples affected by habitat or drought were removed)

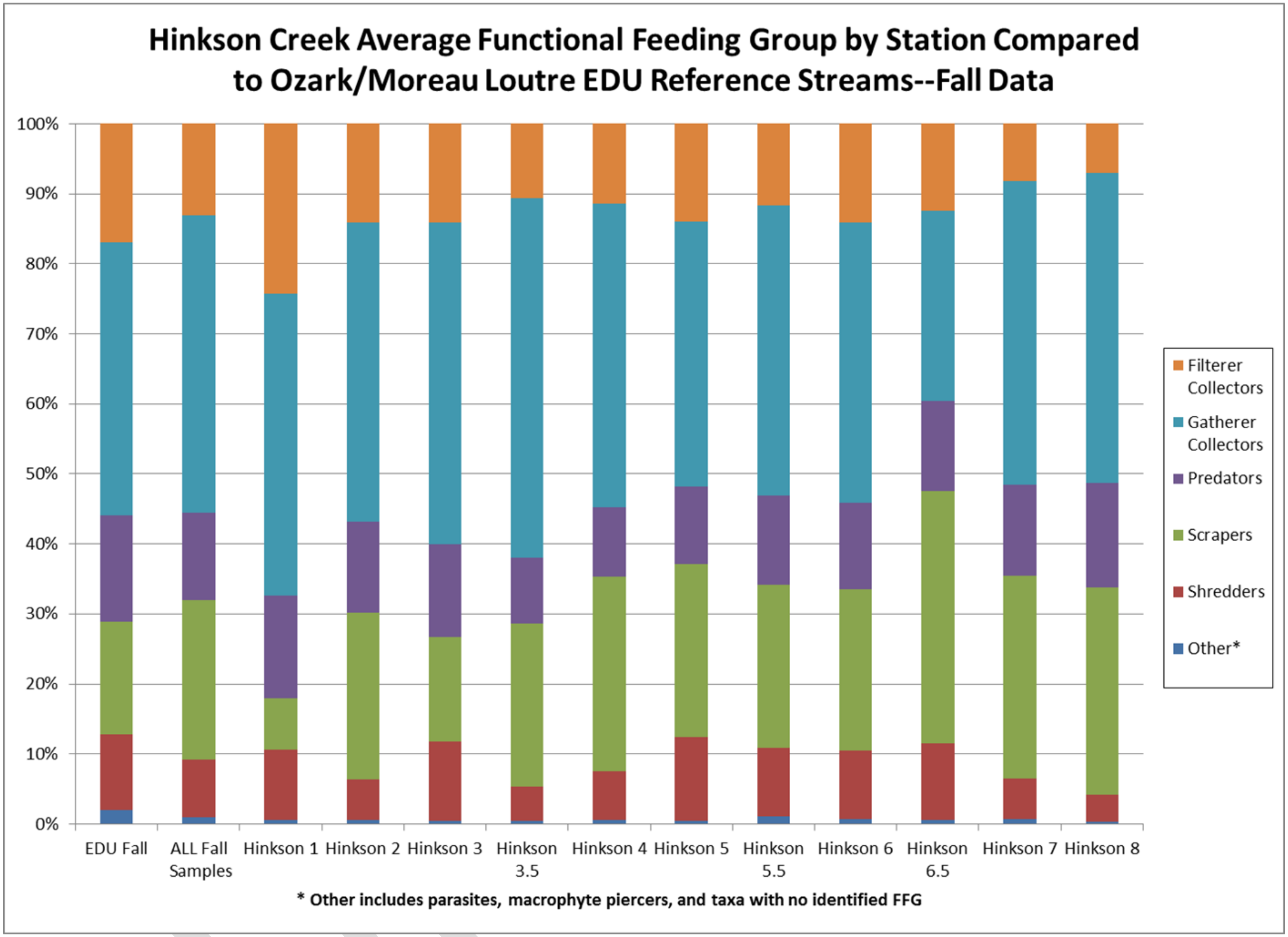

Percent of Samples with Fully Supporting MSCI Scores--
Hinkson Creek Spring Season
100%
80%
60%
40%
20%
0%
1
2
3
3.5
4
5
5*
5.5
6
6*
6.5
7
8
Sample Stations
(Red bars = samples affected by habitat or drought were removed)

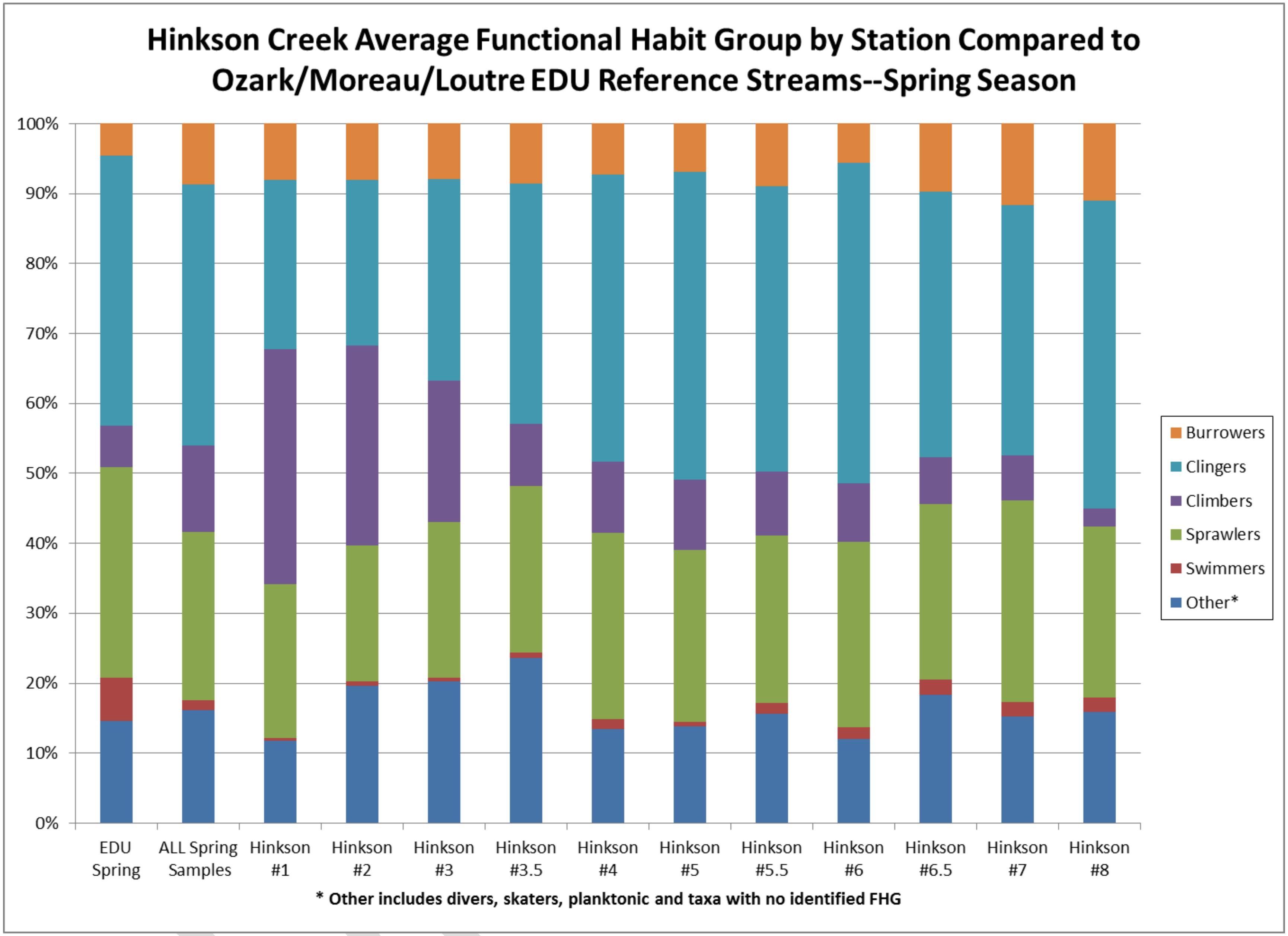

Percent of Samples with Fully Supporting MSCI Scores--Hinkson Creek Fall
Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
1*
2
2*
3
3*
3.5
3.5*
4
4*
5
5*
5.5
5.5*
6
6*
6.5
7
7*
8
8*
Sample Stations
(Red bars = samples affected by habitat or drought were removed)

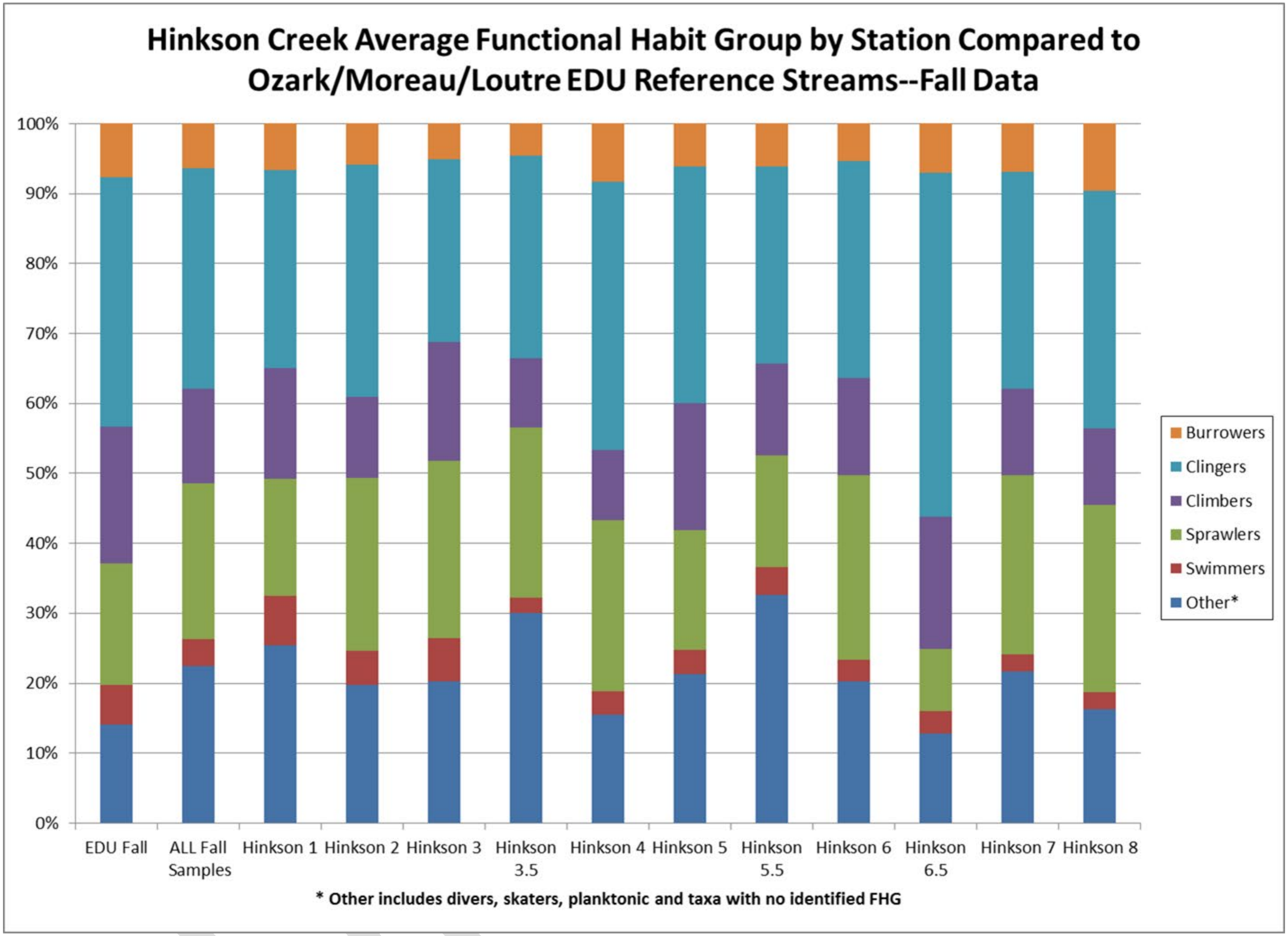
Appendix II

Graphical Representations of Functional Feeding Group and Functional Habit Group Data


Hinkson Creek Average Functional Feeding Group by Station Compared to Ozark/Moreau Loutre EDU Reference Streams--Spring Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
EDU Spring
ALL Spring Samples
Hinkson 1
Hinkson 2
Hinkson 3
Hinkson 3.5
Hinkson 4
Hinkson 5
Hinkson 5.5
Hinkson 6
Hinkson 6.5
Hinkson 7
Hinkson 8
Filterer Collectors
Gatherer Collectors
Predators
Scrapers
Shredders
Other*
* Other includes parasites, macrophyte piercers, and taxa with no identified FFG


Hinkson Creek Average Functional Feeding Group by Station Compared to Ozark/Moreau Loutre EDU Reference Streams--Fall Data
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
EDU Fall
ALL Fall Samples
Hinkson 1
Hinkson 2
Hinkson 3
Hinkson 3.5
Hinkson 4
Hinkson 5
Hinkson 5.5
Hinkson 6
Hinkson 6.5
Hinkson 7
Hinkson 8
Filterer Collectors
Gatherer Collectors
Predators
Scrapers
Shredders
Other*
* Other includes parasites, macrophyte piercers, and taxa with no identified FFG


Hinkson Creek Average Functional Habit Group by Station Compared to Ozark/Moreau/Loutre EDU Reference Streams--Spring Season
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
EDU Spring
ALL Spring Samples
Hinkson #1
Hinkson #2
Hinkson #3
Hinkson #3.5
Hinkson #4
Hinkson #5
Hinkson #5.5
Hinkson #6
Hinkson #6.5
Hinkson #7
Hinkson #8
Burrowers
Clingers
Climbers
Sprawlers
Swimmers
Other*
* Other includes divers, skaters, planktonic and taxa with no identified FHG


Hinkson Creek Average Functional Habit Group by Station Compared to Ozark/Moreau/Loutre EDU Reference Streams--Fall Data
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
EDU Fall
ALL Fall Samples
Hinkson 1
Hinkson 2
Hinkson 3
Hinkson 3.5
Hinkson 4
Hinkson 5
Hinkson 5.5
Hinkson 6
Hinkson 6.5
Hinkson 7
Hinkson 8
Burrowers
Clingers
Climbers
Sprawlers
Swimmers
Other*
* Other includes divers, skaters, planktonic and taxa with no identified FHG

Appendix III

Percent Dominant Taxa--Genus/Species Taxa Analysis

Appendix III
Percent Dominant Taxa--Genus/Species Analysis
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Hinkson #1 Spring Top Taxa--Avg. Values	Hinkson #1 Avg. %	Hinkson #1 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	15.53	1	7.59	3
Polypedilum flavum	11.09	2	1.38	17
Tanytarsus	7.92	3	2.09	12
Polypedilum illinoense grp.	6.86	4	0.16	68
Hydrobaenus	4.77	5	1.77	16
Dicrotendipes	4.68	6	0.46	43
Tubificidae	4.09	7	2.16	10
Caenis latipennis[E]	3.81	8	10.22	2
Thienemannimyia grp.	3.60	9	0.92	24
Polypedilum scalaenum grp.	3.38	10	0.19	60

Hinkson #2 Spring Top Taxa--Avg. Values	Hinkson #2 Avg. %	Hinkson #2 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	12.41	1	7.59	3
Tanytarsus	7.83	2	2.09	12
Polypedilum illinoense grp.	6.15	3	0.16	68
Tubificidae	6.00	4	2.16	10
Stenelmis	5.62	5	12.62	1
Polypedilum halterale grp.	4.85	6	0.12	75
Caenis latipennis[E]	4.48	7	10.22	2
Enchytraeidae	4.15	8	0.63	34
Polypedilum scalaenum grp.	3.83	9	0.19	60
Thienemannimyia grp.	3.36	10	0.92	24

Hinkson #3 Spring Top Taxa--Avg. Values	Hinkson #3 Avg. %	Hinkson #3 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	12.03	1	7.59	3
Stenelmis	10.79	2	12.62	1
Tubificidae	9.43	3	2.16	10
Caenis latipennis[E]	8.23	4	10.22	2
Polypedilum flavum	5.79	5	1.38	17
Tanytarsus	5.20	6	2.09	12
Limnodrilus hoffmeisteri	3.44	7	0.67	30
Thienemannimyia grp.	3.24	8	0.92	24
Dicrotendipes	3.15	9	0.46	43
Polypedilum scalaenum grp.	2.72	10	0.19	60

Hinkson #3.5 Spring Top Taxa--Avg. Values	Hinkson #3.5 Avg. %	Hinkson #3.5 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	13.53	1	7.59	3
Caenis latipennis[E]	10.29	2	10.22	2
Stenelmis	10.00	3	12.62	1
Tubificidae	6.18	4	2.16	10
Cladotanytarsus	5.21	5	0.78	27
Paratanytarsus	4.61	6	0.60	35
Chironomus	2.71	7	0.66	32
Limnodrilus hoffmeisteri	2.59	8	0.67	30
Tanytarsus	2.45	9	2.09	12
Corbicula	2.07	10	0.05	104

Appendix III
Percent Dominant Taxa--Genus/Species Analysis
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Hinkson #4 Spring Top Taxa--Avg. Values	Hinkson #4 Avg. %	Hinkson #4 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	16.40	1	7.59	3
Caenis latipennis[E]	12.00	2	10.22	2
Stenelmis	6.67	3	12.62	1
Tanytarsus	4.00	4	2.09	12
Simulium	3.65	5	2.61	8
Cricotopus bicinctus	3.60	6	0.19	57
Hydrobaenus	3.03	7	1.77	16
Thienemannimyia grp.	2.95	8	0.92	24
Tubificidae	2.85	9	2.16	10
Cladotanytarsus	2.49	10	0.78	27

Hinkson #5 Spring Top Taxa--Avg. Values	Hinkson #5 Avg. %	Hinkson #5 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	21.41	1	7.59	3
Caenis latipennis[E]	7.84	2	10.22	2
Stenelmis	7.03	3	12.62	1
Cricotopus bicinctus	5.22	4	0.19	57
Tanytarsus	4.20	5	2.09	12
Hydrobaenus	3.81	6	1.77	16
Cricotopus trifascia	2.61	7	0.33	47
Cladotanytarsus	2.48	8	0.78	27
Thienemannimyia grp.	2.47	9	0.92	24
Polypedilum flavum	2.16	10	1.38	17

Hinkson #5.5 Spring Top Taxa--Avg. Values	Hinkson #5.5 Avg. %	Hinkson #5.5 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	19.29	1	7.59	3
Caenis latipennis[E]	11.40	2	10.22	2
Stenelmis	8.81	3	12.62	1
Stictochironomus	3.26	4	1.30	18
Simulium	3.14	6	2.61	8
Tubificidae	2.80	7	2.16	10
Hydrobaenus	2.75	8	1.77	16
Cricotopus bicinctus	2.72	9	0.19	57
Polypedilum flavum	2.66	10	1.38	17

Hinkson #6 Spring Top Taxa--Avg. Values	Hinkson #6 Avg. %	Hinkson #6 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	19.85	1	7.59	3
Caenis latipennis[E]	11.48	2	10.22	2
Stenelmis	7.04	3	12.62	1
Hydrobaenus	5.87	4	1.77	16
Simulium	5.37	5	2.61	8
Cricotopus bicinctus	4.89	6	0.19	57
Stenonema femoratum[E]	3.06	7	1.22	21
Tubificidae	2.94	8	2.16	10
Polypedilum flavum	2.55	9	1.38	17
Tanytarsus	2.52	10	2.09	12

Appendix III
Percent Dominant Taxa--Genus/Species Analysis

Hinkson #6.5 Spring Top Taxa--Avg. Values	Hinkson #6.5 Avg. %	Hinkson #6.5 Rank	EDU BIOREF %	BiorefRank
Stenelmis	17.44	1	12.62	1
Caenis latipennis[E]	13.83	2	10.22	2
Cricotopus/Orthocladius	7.73	3	7.59	3
Tubificidae	4.88	4	2.16	10
Hydrobaenus	4.73	5	1.77	16
Tanytarsus	3.40	6	2.09	12
Hyalella azteca	3.00	7	2.19	9
Stictochironomus	2.73	8	1.30	18
Cricotopus trifascia	2.50	9	0.33	47
Stenonema femoratum[E]	2.42	10	1.22	21

Hinkson #7 Spring Top Taxa--Avg. Value	Hinkson #7 Avg. %	Hinkson #7 Rank	EDU BIOREF %	BiorefRank
Cricotopus/Orthocladius	14.23	1	7.59	3
Caenis latipennis[E]	11.66	2	10.22	2
Stenelmis	9.46	3	12.62	1
Hydrobaenus	7.90	4	1.77	16
Stictochironomus	5.45	5	1.30	18
Simulium	4.44	6	2.61	8
Cladotanytarsus	3.66	7	0.78	27
Hyalella azteca	2.83	8	2.19	9
Tubificidae	2.54	9	2.16	10
Perlesta[P]	2.14	10	2.65	7

Hinkson #8 Spring Top Taxa--Avg. Values	Hinkson #8 Avg. %	Hinkson #8 Rank	EDU BIOREF %	BiorefRank
Stenelmis	14.79	1	12.62	1
Cricotopus/Orthocladius	12.21	2	7.59	3
Caenis latipennis[E]	11.90	3	10.22	2
Hydrobaenus	6.10	4	1.77	16
Simulium	5.82	5	2.61	8
Stictochironomus	5.17	6	1.30	18
Perlesta[P]	3.29	7	2.65	7
Hyalella azteca	2.84	8	2.19	9
Tubificidae	2.80	9	2.16	10
Physella	2.36	10	0.54	40

Ozark/Moreau/Loutre Biocriteria Reference Stream Dominant Taxa--Spring Season		
Taxa	BiorefRank	Percentage
Stenelmis	1	12.62
Caenis latipennis[E]	2	10.22
Cricotopus/Orthocladius	3	7.59
Caenis[E]	4	7.32
Acentrella[E]	5	4.62
Isoperla[P]	6	3.39
Perlesta[P]	7	2.65
Simulium	8	2.61
Hyalella azteca	9	2.19
Tubificidae	10	2.16

Note: There are a total of 219 taxa among the Ozark/Moreau/Loutre biological criteria reference stream spring samples. The number of Hinkson Creek taxa range from 55 to 85 among all sites between 2002 and 2014.

Appendix III
Percent Dominant Taxa--Genus/Species Analysis
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Hinkson #1 Fall Top Taxa--Avg. Values	Hinkson #1 Avg. %	Hinkson #1 Rank	EDU BIOREF %	BiorefRank
Tubificidae	14.92	1	2.88	11
Cheumatopsyche[T]	11.17	2	3.49	9
Caenis latipennis[E]	5.75	3	4.33	5
Tanytarsus	4.64	4	4.81	3
Rheotanytarsus	4.02	5	4.03	6
Baetis[E]	3.68	6	1.66	18
Dubiraphia	2.92	7	1.61	19
Polypedilum flavum	2.90	8	4.71	4
Dicrotendipes	2.43	9	1.89	15
Stenelmis	2.38	10	6.83	2

Hinkson #2 Fall Top Taxa--Avg. Values	Hinkson #2 Avg. %	Hinkson #2 Rank	EDU BIOREF %	BiorefRank
Caenis latipennis[E]	15.77	1	4.33	5
Stenelmis	14.00	2	6.83	2
Tubificidae	8.39	3	2.88	11
Cheumatopsyche[T]	6.74	4	3.49	9
Stenonema femoratum[E]	4.66	5	3.77	8
Tanytarsus	3.37	6	4.81	3
Enallagma	2.54	7	2.85	12
Tricorythodes[E]	2.13	8	8.74	1
Menetus	1.97	9	1.33	24
Dubiraphia	1.80	10	1.61	19

Hinkson #3 Fall Top Taxa--Avg. Values	Hinkson #3 Avg. %	Hinkson #3 Rank	EDU BIOREF %	BiorefRank
Caenis latipennis[E]	16.91	1	4.33	5
Stenelmis	7.37	2	6.83	2
Tubificidae	7.03	3	2.88	11
Cheumatopsyche[T]	6.27	4	3.49	9
Polypedilum flavum	4.62	5	4.71	4
Baetis[E]	3.73	6	1.66	18
Enallagma	3.60	7	2.85	12
Dubiraphia	3.55	8	1.61	19
Stenonema femoratum[E]	2.70	9	3.77	8
Tanytarsus	2.54	10	4.81	3

Hinkson #3.5 Fall Top Taxa--Avg. Values	Hinkson #3.5 Avg. %	Hinkson #3.5 Rank	EDU BIOREF %	BiorefRank
Caenis latipennis[E]	18.68	1	4.33	5
Stenelmis	14.07	2	6.83	2
Tubificidae	13.49	3	2.88	11
Corbicula	4.17	4	n/a	n/a
Tricorythodes[E]	3.96	5	8.74	1
Stenonema femoratum[E]	3.27	6	3.77	8
Menetus	2.93	7	1.33	24
Cheumatopsyche[T]	2.27	8	3.49	9
Tanytarsus	2.19	9	4.81	3
Enallagma	2.08	10	2.85	12

Hinkson #4 Fall Top Taxa--Avg. Values	Hinkson #4 Avg. %	Hinkson #4 Rank	EDU BIOREF %	BiorefRank
Caenis latipennis[E]	17.46	1	4.33	5
Stenelmis	16.12	2	6.83	2
Tubificidae	5.48	3	2.88	11
Stenonema femoratum[E]	4.27	4	3.77	8
Cheumatopsyche[T]	4.26	5	3.49	9
Ormosia	3.20	6	0.01	159
Stenacron[E]	2.93	7	0.54	41
Dubiraphia	2.89	8	1.61	19
Polypedilum flavum	2.67	9	4.71	4
Rheotanytarsus	1.91	10	4.03	6

Hinkson #5 Fall Top Taxa--Avg. Values	Hinkson #5 Avg. %	Hinkson #5 Rank	EDU BIOREF %	BiorefRank
Stenelmis	13.43	1	6.83	2
Caenis latipennis[E]	9.87	2	4.33	5
Polypedilum flavum	6.50	3	4.71	4
Tubificidae	6.29	4	2.88	11
Cheumatopsyche[T]	3.78	5	3.49	9
Enallagma	3.75	6	2.85	12
Physella	3.74	7	1.68	17
Stenonema femoratum[E]	3.37	8	3.77	8
Tanytarsus	3.29	9	4.81	3
Dubiraphia	2.70	10	1.61	19

Hinkson #5.5 Fall Top Taxa--Avg. Values	Hinkson #5.5 Avg. %	Hinkson #5.5 Rank	EDU BIOREF %	BiorefRank
Tubificidae	13.57	1	2.88	11
Stenelmis	12.25	2	6.83	2
Caenis latipennis[E]	9.12	3	4.33	5
Hyalella azteca	4.46	4	1.94	14
Polypedilum flavum	4.43	5	4.71	4
Stenonema femoratum[E]	3.91	6	3.77	8
Cheumatopsyche[T]	3.06	7	3.49	9
Menetus	2.74	8	1.33	24
Chironomus	2.67	9	1.47	22
Tanytarsus	2.23	10	4.81	3

Hinkson #6 Fall Top Taxa--Avg. Values	Hinkson #6 Avg. %	Hinkson #6 Rank	EDU BIOREF %	BiorefRank
Caenis latipennis[E]	18.62	1	4.33	5
Stenelmis	12.22	2	6.83	2
Tubificidae	5.48	3	2.88	11
Stenonema femoratum[E]	4.75	4	3.77	8
Tanytarsus	4.56	5	4.81	3
Cheumatopsyche[T]	4.39	6	3.49	9
Physella	3.62	7	1.68	17
Polypedilum flavum	3.50	8	4.71	4
Dubiraphia	2.34	9	1.61	19
Cricotopus/Orthocladius	2.26	10	0.66	31

Hinkson #6.5 Fall 2014--Avg. Values	Hinkson #6.5 Avg. %	Hinkson #6.5 Rank	EDU BIOREF %	BiorefRank
Stenelmis	27.78	1	6.83	2
Tubificidae	6.47	2	2.88	11
Polypedilum flavum	5.87	3	4.71	4
Cheumatopsyche[T]	5.78	4	3.49	9
Enallagma	4.83	5	2.85	12
Dubiraphia	4.75	6	1.61	19
Caenis latipennis[E]	4.23	7	4.33	5
Stictochironomus	3.36	8	0.21	63
Helicopsyche[T]	3.02	9	n/a	n/a
Polypedilum halterale grp.	2.59	10	1.00	30

Hinkson #7 Fall Top Taxa--Avg. Values	Hinkson #7 Avg. %	Hinkson #7 Rank	EDU BIOREF %	BiorefRank
Caenis latipennis[E]	17.81	1	4.33	5
Stenelmis	10.77	2	2.88	11
Stenonema femoratum[E]	6.21	3	3.77	8
Dubiraphia	5.18	4	1.61	19
Tubificidae	4.95	5	2.88	11
Hyalella azteca	4.61	6	1.94	14
Physella	3.75	7	1.68	17
Enallagma	3.18	8	2.85	12
Cheumatopsyche[T]	2.91	9	3.49	9
Tanytarsus	2.65	10	4.81	3

Hinkson #8 Fall Top Taxa--Avg. Values	Hinkson #8 Avg. %	Hinkson #8 Rank	EDU BIOREF %	BiorefRank
Caenis latipennis[E]	19.53	1	4.33	5
Stenelmis	13.89	2	2.88	11
Stenonema femoratum[E]	6.86	3	3.77	8
Hyalella azteca	4.91	4	1.94	14
Enallagma	4.67	5	2.85	12
Stictochironomus	4.47	6	0.21	63
Dubiraphia	4.04	7	1.61	19
Cheumatopsyche[T]	4.04	8	3.49	9
Tubificidae	3.53	9	2.88	11
Stenacron[E]	2.58	10	0.54	41

Ozark/Moreau/Loutre Biocriteria Reference Stream Dominant Taxa--Fall Season		
Taxa	BiorefRank	Percentage
Tricorythodes[E]	1	8.74
Stenelmis	2	6.83
Tanytarsus	3	4.81
Polypedilum flavum	4	4.71
Caenis latipennis[E]	5	4.33
Rheotanytarsus	6	4.03
Caenis hilaris[E]	7	3.92
Stenonema femoratum[E]	8	3.77
Cheumatopsyche[T]	9	3.49
Chimarra[T]	10	3.47

Note: There are a total of 174 taxa among the Ozark/Moreau/Loutre reference stream fall samples. The number of Hinkson Creek taxa range from 56 to 87 among all sites between 2002 and 2014.

Appendix IV

Percent Dominant Taxa--Family Level Taxa Analysis

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Percent Dominant Taxa--Family Level Analysis
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Hinkson #1 Top Families--Spring	Hinkson #1 Avg. %*	EDU Bioref %
Chironomidae	78.8	26.9
Tubificidae	6.9	3.2
Elmidae	3.8	13.0
Caenidae[E]	3.8	18.8
Coenagrionidae	0.6	1.5
Heptageniidae[E]	0.4	2.7

*average of 3 samples

Hinkson #2 Top Families--Spring	Hinkson #2 Avg. %*	EDU Bioref %
Chironomidae	66.5	26.9
Tubificidae	9.6	3.2
Elmidae	6.1	13.0
Caenidae[E]	4.5	18.8
Enchytraeidae	4.1	0.6
Coenagrionidae	1.4	1.5

*average of 4 samples

Hinkson #3 Top Families--Spring	Hinkson #3 Avg. %*	EDU Bioref %
Chironomidae	56.0	26.9
Tubificidae	13.7	3.2
Elmidae	11.2	13.0
Caenidae[E]	8.2	18.8
Coenagrionidae	1.2	1.5
Heptageniidae[E]	1.0	2.7

*average of 4 samples

Hinkson #3.5 Top Families--Spring	Hinkson #3.5 Avg. %*	EDU Bioref %
Chironomidae	51.8	26.9
Elmidae	11.0	13.0
Tubificidae	10.3	3.2
Caenidae[E]	10.2	18.8
Corbiculidae	1.7	0.1
Coenagrionidae	1.5	1.5

*average of 4 samples

Hinkson #4 Top Families--Spring	Hinkson #4 Avg. %*	EDU Bioref %
Chironomidae	56.1	26.9
Caenidae[E]	12.0	18.8
Elmidae	8.1	13.0
Tubificidae	4.2	3.2
Simuliidae	3.6	2.7
Heptageniidae[E]	1.9	2.7

*average of 4 samples

Hinkson #5 Top Families--Spring	Hinkson #5 Avg. %*	EDU Bioref %
Chironomidae	64.5	26.9
Elmidae	7.9	13.0
Caenidae[E]	7.9	18.8
Tubificidae	3.1	3.2
Simuliidae	1.8	2.7
Arachnida	1.8	1.8

*average of 4 samples

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Percent Dominant Taxa--Family Level Analysis
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Hinkson #5.5 Top Families--Spring	Hinkson #5.5 Avg. %*	EDU Bioref %
Chironomidae	53.3	26.9
Caenidae[E]	11.4	18.8
Elmidae	9.4	13.0
Tubificidae	4.2	3.2
Simuliidae	2.7	2.7
Hyalellidae	2.3	2.2

*average of 5 samples

Hinkson #6 Top Families--Spring	Hinkson #6 Avg. %*	EDU Bioref %
Chironomidae	54.8	26.9
Caenidae[E]	11.5	18.8
Elmidae	7.7	13.0
Simuliidae	5.3	2.7
Tubificidae	3.9	3.2
Heptageniidae[E]	3.0	2.7

*average of 6 samples

Hinkson 6.5 Top Families--Spring	Hinkson #6.5 Avg. %*	EDU Bioref %
Chironomidae	35.5	26.9
Elmidae	19.2	13.0
Caenidae[E]	13.8	18.8
Tubificidae	6.6	3.2
Hyalellidae	3.0	2.2
Heptageniidae[E]	2.3	2.7

Hinkson #7 Top Families--Spring	Hinkson #7 Avg. %*	EDU Bioref %
Chironomidae	49.9	26.9
Caendiae[E]	11.7	18.8
Elmidae	10.6	13.0
Simuliidae	4.1	2.7
Tubificidae	3.3	3.2
Hyalellidae	2.8	2.2

*average of 6 samples

Hinkson #8 Top Families--Spring	Hinkson #8 Avg. %*	EDU Bioref %
Chironomidae	35.7	26.9
Elmidae	15.5	13.0
Caenidae[E]	11.9	18.8
Simuliidae	5.7	2.7
Tubificidae	4.1	3.2
Perlidae[P]	3.2	3.2

*average of 4 samples

Appendix IV
Percent Dominant Taxa--Family Level Analysis
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Hinkson #1 Top Families--Fall	Hinkson #1 Avg. %*	EDU Bioref %
Chironomidae	37.4	32.7
Tubificidae	16.2	3.8
Hydropsychidae[T]	11.6	3.5
Baetidae[E]	6.6	3.7
Caenidae[E]	5.7	9.5
Elmidae	5.3	8.7

*average of 3 samples

Hinkson #2 Top Families--Fall	Hinkson #2 Avg. %*	EDU Bioref %
Chironomidae	23.8	32.7
Elmidae	16.1	8.7
Caenidae[E]	15.8	9.5
Tubificidae	9.3	3.8
Hydropsychidae[T]	6.7	3.5
Heptageniidae[E]	5.6	4.5

*average of 3 samples

Hinkson #3 Top Families--Fall	Hinkson #3 Avg. %*	EDU Bioref %
Chironomidae	29.3	32.7
Caenidae[E]	14.4	9.5
Tubificidae	9.9	3.8
Elmidae	7.5	8.7
Hydropsychidae[T]	6.3	3.5
Baetidae[E]	5.0	3.7

*average of 3 samples

Hinkson #3.5 Top Families--Fall	Hinkson #3.5 Avg. %*	EDU Bioref %
Caenidae[E]	18.7	9.5
Chironomidae	17.6	32.7
Tubificidae	17.3	3.8
Elmidae	16.2	8.7
Heptageniidae[E]	3.9	4.5
Corbiculidae	3.9	< 0.1

*average of 3 samples

Hinkson #4 Top Families--Fall	Hinkson #4 Avg. %*	EDU Bioref %
Chironomidae	21.6	32.7
Elmidae	19.1	8.7
Caenidae[E]	17.5	9.5
Tubificidae	7.4	3.8
Heptageniidae[E]	7.2	4.5
Hydropsychidae[T]	4.3	3.5

*average of 4 samples

Hinkson #5 Top Families--Fall	Hinkson #5 Avg. %*	EDU Bioref %
Chironomidae	30.2	32.7
Elmidae	16.1	8.7
Caenidae[E]	9.9	9.5
Tubificidae	7.0	3.8
Heptageniidae[E]	5.3	4.5
Coenagrionidae	4.9	5.0

*average of 3 samples

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Percent Dominant Taxa--Family Level Analysis
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Hinkson #5.5 Top Families--Fall	Hinkson #5.5 Avg. %*	EDU Bioref %
Chironomidae	22.9	32.7
Tubificidae	15.3	3.8
Elmidae	14.0	8.7
Caenidae^{E}	9.1	9.5
Heptageniidae^{E}	4.7	4.5
Coenagrionidae	3.5	5.0

*average of 4 samples

Hinkson #6 Top Families--Fall	Hinkson #6 Avg. %*	EDU Bioref %
Chironomidae	26.3	32.7
Caenidae^{E}	18.6	9.5
Elmidae	14.6	8.7
Tubificidae	7.5	3.8
Heptageniidae^{E}	5.7	4.5
Hydropsychidae^{T}	4.6	3.5

*average based on 5 samples

Hinkson #6.5 Top Families--Fall	% Present in Sample #14979	EDU Bioref %
Elmidae	32.5	8.7
Chironomidae	23.0	32.7
Tubificidae	6.8	3.8
Coenagrionidae	6.2	5.0
Hydropsychidae^{T}	5.8	3.5
Caenidae^{E}	4.2	9.5

Hinkson #7 Top Families--Fall	Hinkson #7 Avg. %*	EDU Bioref %
Chironomidae	20.8	32.7
Caenidae^{E}	17.7	9.5
Elmidae	15.3	8.7
Heptageniidae^{E}	6.8	4.5
Tubificidae	5.4	3.8
Coenagrionidae	4.7	5.0

*average of 4 samples

Hinkson #8 Top Families--Fall	Hinkson #8 Avg. %*	EDU Bioref %
Caenidae^{E}	18.9	9.5
Elmidae	18.0	8.7
Chironomidae	17.5	32.7
Heptageniidae^{E}	9.4	4.5
Coenagrionidae	5.0	5.0
Hydropsychidae^{T}`	4.1	3.5

*average of 2 samples

Appendix V

Percent Dominant Taxa--EPT Level Taxa Analysis

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Percent Dominant Taxa--EPT Taxa Analysis
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Hinkson Creek Average EPT Contribution by Station--Spring Season												
		Station										
EPT Order	EDU Biorefs	1	2	3	3.5	4	5	5.5	6	6.5	7	8
Ephemeroptera	28.5	4.7	5.1	9.5	11.7	15.2	10.0	14.1	16.1	18.0	14.4	15.4
Plecoptera	9.1	0.0	0.0	<0.1	0.3	0.2	0.2	1.0	1.8	1.5	2.8	4.9
Trichoptera	1.9	0.8	0.4	0.6	1.1	2.1	0.9	1.1	0.6	1.0	1.0	1.4

Hinkson Creek Average EPT Contribution by Station--Fall Season												
		Station										
EPT Order	EDU Biorefs	1	2	3	3.5	4	5	5.5	6	6.5*	7	8
Ephemeroptera	27.3	15.1	27.4	24.3	28.1	28.9	19.8	16.0	26.2	9.3	27.4	30.8
Plecoptera	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	<0.1
Trichoptera	8.5	12.1	7.0	7.1	2.7	5.6	4.5	3.9	5.8	11.3	6.7	7.1

*based on a single sample