RELATIVE IMPORTANCE OF CONSERVATION RESERVE PROGRAMS TO MAYFLY, STONEFLY, AND CADDISFLY SPECIES RICHNESS IN THE KASKASKIA RIVER BASIN OF ILLINOIS

BY

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THESIS

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Abstract

The Conservation Reserve (CRP) and Conservation Reserve Enhancement Programs (CREP), funded by federal and state government, offer farmers financial incentives to take erosive agricultural lands out of production. Within these program landscapes, several best management practices, including riparian zone easements and restoration, are used along streams and wetlands to improve habitat for riparian and in-stream species (State of Illinois 2013). This thesis investigates the efficacy of CRP and CREP lands to support assemblages of three environmentally sensitive orders, Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) in the Kaskaskia River basin, a heavily impacted, predominantly agricultural watershed in central and southern Illinois. A total of 10,522 EPT specimens were examined from 84 sites across the basin during May and June of 2013-2015. Seventy-six variables from geographic information system (GIS) and in-situ generated variables were used in an Akaike information criterion analysis (AICc) to construct a set of 13 best regression models accounting for variance in EPT basin richness. AICc importance values and hierarchical partitioning revealed five important variables associated with EPT richness: Link (number of first order tributaries), WT_Perm (soil permeability at the total catchment level), WT_Urban (urban land use at the total catchment level), Silt, and DO (dissolved oxygen). AICc showed that Link and WT_Perm have the highest importance value (1.00), followed by WT_Urban (0.99), and Silt (0.83). Individual percent contribution (*% I*) as determined by hierarchical partitioning placed DO third among these five variables. The amount of CRP/CREP land in the drainage ranked low in relative importance and % *I* contribution, suggesting that this mosaic of conservation practices may not contribute significantly to supporting highly diverse EPT assemblages.

Acknowledgements

I wish to thank the members of my thesis committee: my adviser R. Edward DeWalt for guidance throughout the project, Yong Cao for direction on statistical analysis, and Brian Allan for suggestions on exploratory research. I extend additional gratitude to Brian Metzke for supplying GIS data, Leon Hinz for suggestions on potential analyses, Allie Gardner for initial statistical considerations, and Jim Woolbright for information technology support. This project was funded by grant RC13CREP01 from the Illinois Department of Natural Resources.

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Introduction and Background

Stream species richness, a measure frequently associated with habitat integrity (Bunn and Arthington 2002, Dudgeon et al. 2006), is influenced by multiple environmental variables and their complex interactions (Minshall et al. 1985a, Richards et al. 1996, Ward 1998, Malmqvist and Rundle 2002). These variables are encompassed by several broad categories, including stream/watershed size, water quality, hydrology, channel morphology, substrata, geology, topography, climate, land cover, and land use. The widespread and collective importance of these variable categories to species richness of lotic systems is acknowledged. However, the relative importance of individual variables within these categories for any given stream system is often obscure (Palmer et al. 2009).

Land use, which includes many anthropogenic types known to potentially lower stream habitat quality and diversity, can vary significantly in relative importance among lotic systems. Agricultural land use is a primary cause of stream degradation in Illinois (Heatherly et al. 2007). The farming practices of land clearing, stream channelization and subsurface tiling increase field drainage efficiency and crop yield. However, these agricultural techniques can drastically alter stream flow regimes which reduce water quality and wildlife habitat due to streambed scouring, bank erosion, lowered water table, flooding, nutrient loading, and sediment loading. Stream alteration and habitat loss has resulted in the extirpation of Illinois species, especially environmentally sensitive stoneflies (DeWalt et al. 2005).

Two government programs have been established to improve stream habitat, the Conservation Reserve Program (CRP), established in 1985, a USDA program which offers farmers financial incentives to take erosive agricultural lands out of production (Stubbs 2014), and the Conservation Reserve Enhancement Program (CREP), established in 1998, an extension of CRP supported by federal and state government (State of Illinois 2013). Two major watersheds have been included in Illinois CREP, the Illinois River basin, beginning in 1998, and the Kaskaskia River basin, beginning in 2010.

The stated objective of CREP is the removal of lands that are susceptible to erosion or flooding from agricultural production to reduce landscape nutrient and sediment loss and consequently increase wildlife, reduce sediment and nutrient loading, and improve populations of threatened and endangered species (State of Illinois 2013). The CREP uses several practices to achieve this objective, many of which improve Illinois stream habitat through riparian zone easements and restoration. Riparian cover has been linked to habitat quality in Illinois watersheds within lands of predominantly agricultural use (Stone et al. 2005). Removal of riparian land from production permits the return of streamside vegetation, benefitting stream systems by stabilizing water temperature through canopy cover and introducing organic allochthonous matter (riparian leaf and wood fall) as a source of energy and habitat structure. Additionally, broad vegetated riparian zones reduce sediment and nutrient loading by allowing water percolation and soil deposition prior to entry into the stream channels (Allan 1995).

The Illinois Department of Natural Resources (IDNR) recently funded the Illinois Natural History Survey to monitor and assess the status of aquatic life in the Kaskaskia River basin in relation to CRP/CREP lands. This study assesses fish, mussel, and aquatic insect assemblages in wadeable streams draining private lands where CRP/CREP practices have been instituted. As a part of the aquatic insect component, insects collected for this thesis include specimens exclusively from three environmentally sensitive orders, the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT), traditionally used for biomonitoring due to their sensitivity to water and habitat quality (Lenat and Resh 2001). Unlike many other macroinvertebrates, EPT specimens can be easily collected and sorted alive at streamside without magnification (Lenat 1988). Furthermore, quick and accurate species level identification is facilitated by extensive taxonomic guides available for Illinois and Midwest EPT fauna (Frison 1935, Ross 1944, Burks 1953, Hitchcock 1974, Poulton & Stewart 1991).

Recent investigations involving insect communities in Kaskaskia basin streams differ from this thesis study in either number of sites sampled, basin area coverage, taxonomic resolution, or a combination of these parameters. The Critical Trends Assessment Program (CTAP), the first extensive statewide investigation of the status of Illinois biota, assessed EPT taxa from 1997 to 2007, with a limit of 17 sampled streams throughout the basin. Sangunett (2005) examined multiple streams in the Grand Prairie Natural Division, but sampled only six Kaskaskia basin sites, all in the upper basin. Stone et al. (2005) examined macroinvertebrates collected in 15 headwater streams and subwatersheds restricted to the Sugar Creek watershed of the lower Kaskaskia. Heatherly et al. (2007) examined macroinvertebrates across the state, sampling five Kaskaskia basin sites and identifying insects to genus. In contrast, this thesis attempts both a broad and yet focused approach by investigating 84 sites across the basin, using 76 continuous variables as predictors, and identifying larval EPT to the lowest possible taxonomic level.

Objectives. The objectives of this thesis are to identify and rank the most influential environmental factors associated with EPT species richness in the Kaskaskia River basin and evaluate the relative importance of CRP/CREP lands among this set of variables. Three primary questions are addressed:

1. What environmental variables explain variation in EPT species richness in the Kaskaskia River basin?

2. What is the relative importance of each of these variables?
3. Where does the importance of CRP/CREP fall in the spectrum of these environmental variables?

These questions are investigated by evaluating multiple continuous environmental variables represented in several broad categories that describe both in-stream and watershed characteristics. Stream variable categories include size, channel morphology, water quality, and in-stream substrates. Topography, land use, land management, soil hydrology, and geology comprise the watershed variable categories which include two catchment levels: local catchment, an area that drains directly into a reach, and total catchment, the entire watershed above and including a local catchment. This study approach may inform future policy decisions regarding conservation strategies for the Kaskaskia River watershed.

Important Kaskaskia basin variable categories were predicted to mimic those found important in previous studies in the basin, including channel morphology (DeWalt 2002, Sangunett 2005), stream size (Sangunett 2005), water quality (Heatherly et al.2007), land use (Heatherly et al. 2007), substrata (Stone et al. 2005), and soil hydrology (Cao et al. 2015). The importance of these categories was expected to be further supported by numerous stream macroinvertebrate studies conducted in other river basins in Illinois and throughout North America. EPT richness was hypothesized to be highest in minimally impacted heterogeneous habitats with complex, coarse textured substrates and high water quality. Conversely, it was hypothesized to be lowest in highly impacted homogeneous habitats with simple, fine textured substrates and low water quality. It was predicted that EPT richness would be enhanced in areas with higher percentage of CRP/CREP lands.

Study Area

The Kaskaskia is the second largest river system in Illinois, comprising four major basins with a combined watershed area of 14,950 km^2 (IDNR 2001) (Fig.1). The Kaskaskia River has a course of approximately 523 km which flows southwest from its farm ditch origin in Champaign County in east central Illinois to the Mississippi River in Randolph County (IDNR 2001). The river and its tributaries constitute a low gradient, warm water system characterized by runs, pools, and a substrate mixture of gravel, sand, silt, and claypan. Two large impoundments, Lake Shelbyville and Carlyle Reservoir, are located in the upper and middle river reaches, respectively.

The Kaskaskia River basin transects the Grand Prairie and the Southern Till Plain, two of the fourteen Illinois Natural Divisions, geographic regions defined by similar topography, soils, glacial history, bedrock and biota (Schwegman 1973) (Fig. 2). The Southern Till Plain was glaciated by the Illinoisan ice event, whereas the Grand Prairie was glaciated by both the Illinoisan (125,000 to 300,000 years ago) and Wisconsinan (10,000 to 75,000 years ago) glaciations (Wiggers 1997). The Grand Prairie, the largest natural division, is delineated by five geographic subdivisions: Grand Prairie, Springfield, Western, Green River Lowland, and Kankakee Sand. The principal natural features of the first three of these sections are level to rolling upland with floodplain, ravines, and wet to dry prairie (Schwegman 1973). The second largest natural division, the Southern Till Plain, is subdivided into the Effingham Plain and Mt. Vernon Hill Country sections, both described as outwash plains and dunes with wet to dry sand prairies (Schwegman 1973). Agriculture occupies 78 percent of the land in the Kaskaskia River watershed (IEPA 2012). As a result of this predominant land use, sediment and nutrient loading are identified as prime contributors to habitat and water quality degradation of the basin streams (State of Illinois 2015).

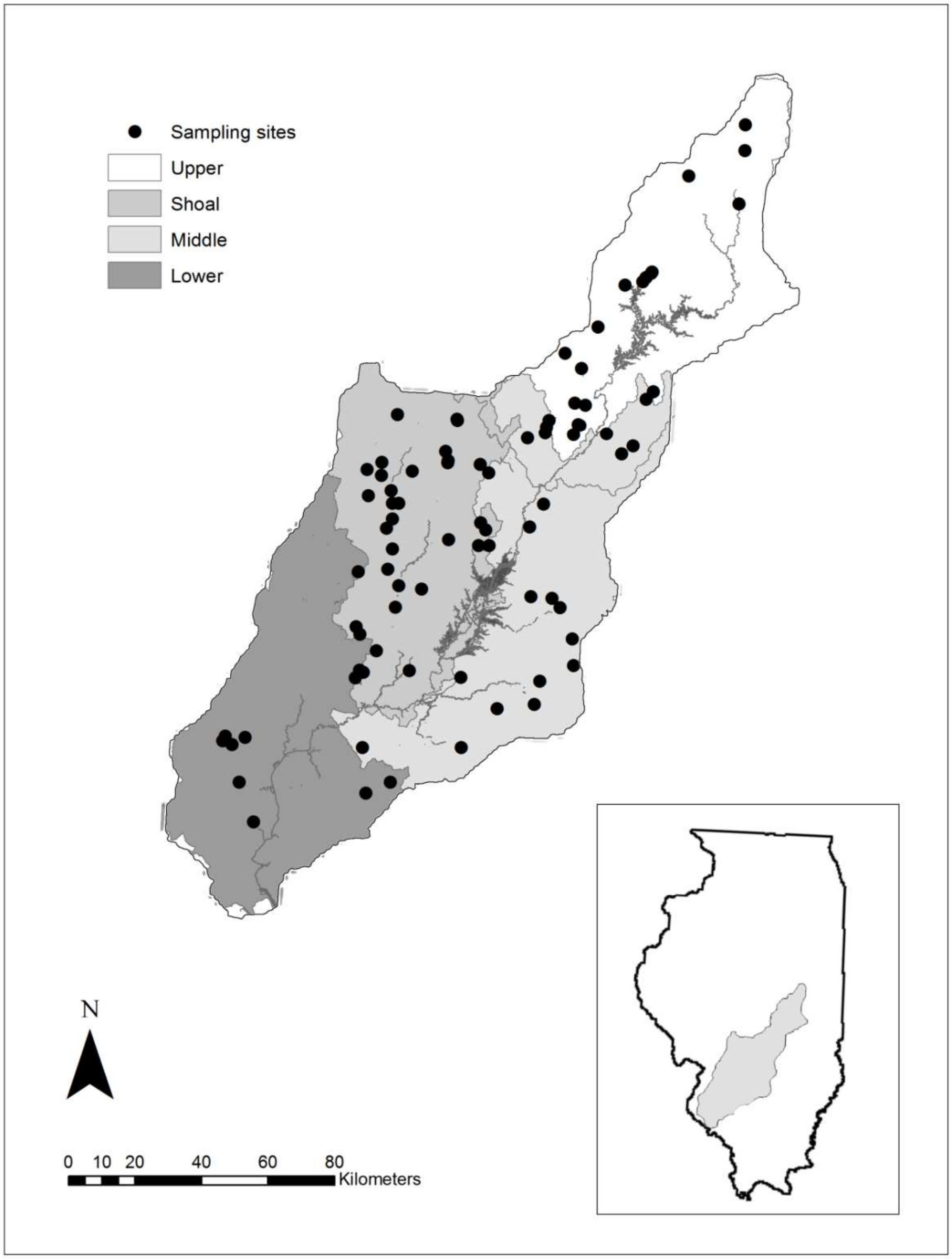

Figure 1. Locations of 84 sites sampled in wadeable streams within four major sub basins of the Kaskaskia River basin, Illinois, 2013-2015.

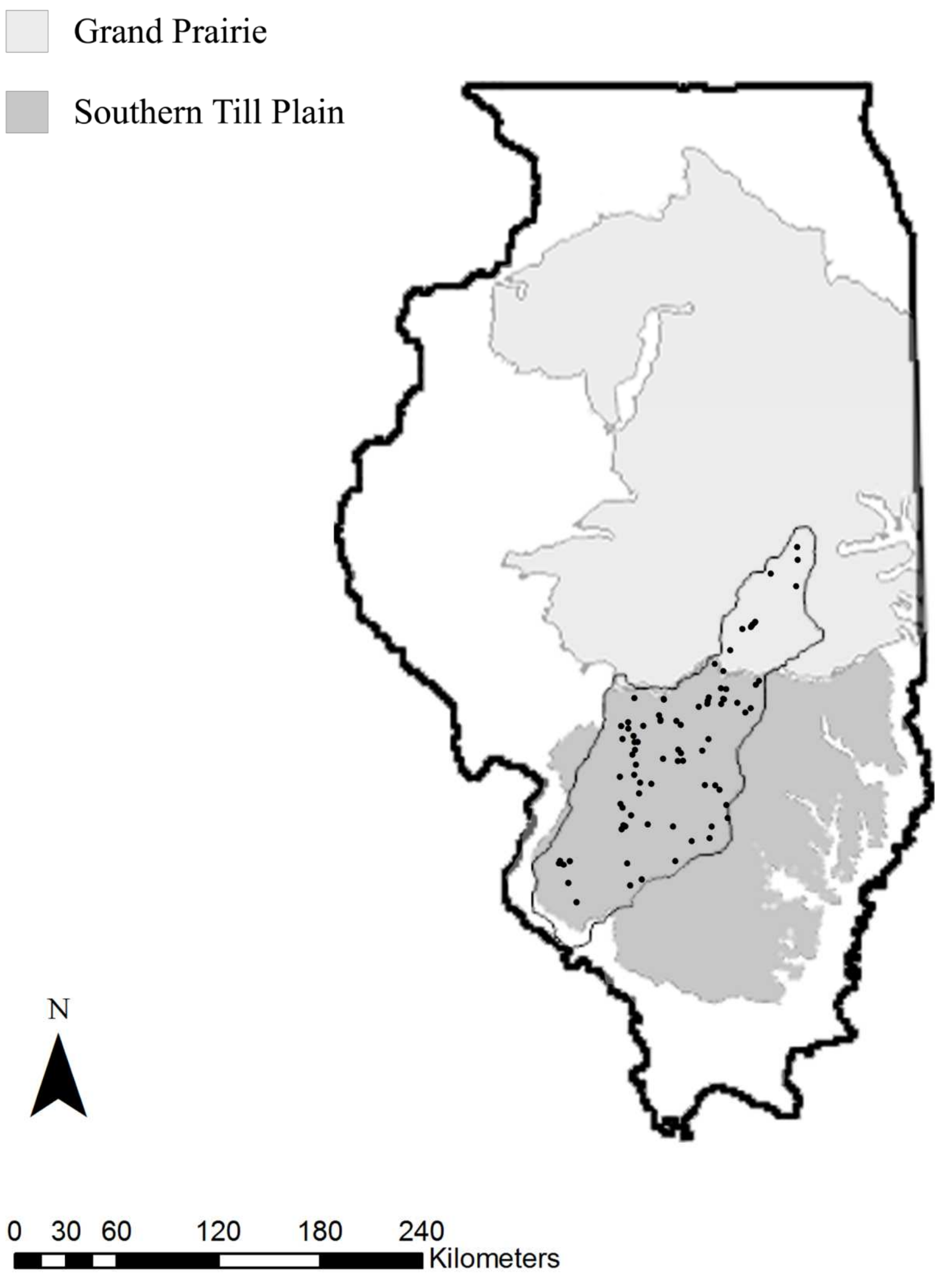

Figure 2. Grand Prairie and Southern Till Plain Natural Divisions transected by the Kaskaskia River basin, Illinois.

Methods

A list of sampling sites was generated from a stratified random sampling procedure using sub-basin Hydrologic Unit Code 8 (HUC 8), stream size, and amount of CRP/CREP land in the watershed as criteria for site selection (State of Illinois 2013), resulting in 84 sites within 53 wadeable streams that were scattered among 17 counties (Appendix A). Sites were sampled during May and early June of 2013-2015 to match the highest available summer diversity for EPT taxa in Illinois. Most sites were sampled once during the study period, exceptions being that 16 sites were sampled twice to provide information about annual variation. Annual variation is not addressed in the primary analysis of this study.

The sampling procedure followed that of CTAP (DeWalt 2002, Sangunett 2005). A 28 cm by 41 cm rectangular dip net was used to take four samples along a 100 meter stream reach. Samples included two habitat types stratified over two energy levels according to relative current. The habitats in the Kaskaskia drainage almost always included high energy gravel riffles or woody debris snags where current speed was highest. Streams also contained low energy habitats consisting of overhanging banks with tree and other plant roots providing structure for EPT. Division of samples into these two habitat types allowed a broad scope of EPT species to be recovered within a sampled stream reach. The low energy bank habitats were sampled by using the net to disturb the bottom substrate below the bank, and raking the net up through the overhanging plant roots. The high energy habitats were sampled by holding the dip net against the stream bottom while disturbing substrates in front of the dip net equal to the area of the dip net bag. Large structures, such as cobbles or limbs, within the sample area were inspected for clinging EPT, and then discarded. EPT specimens from each sample were sorted alive at streamside and placed in vials of 95% EtOH before returning them to the laboratory for identification.

Water and habitat quality were recorded for each site. A Hydrolab Quanta was used to measure water temperature, pH, DO_2, DO_2 percent saturation, and conductivity. The Quanta was calibrated each day as per the manufacturer's guidelines. Twelve habitat parameters were scored according to the CTAP scoring system. Some parameters included channel sinuosity, canopy cover, bank vegetation composition, and predominant land use. Additionally, proportions of various substrate sizes for each sampled reach were estimated through visual assessment. Geographic coordinates were recorded on-site using GPS or subsequently in the laboratory using ACME Mapper 2.1 (http://mapper.acme.com/) (datum WGS-84).

In the laboratory, each specimen was identified to the lowest possible taxonomic level. Generic assignment followed that of Merritt et al. (2008). Species level assignment followed that of the comprehensive works of Burks (1953), Ross (1944), Hitchcock (1974), and Poulton & Stewart (1991). Nomenclature was checked against current usage by consulting Mayfly Central (2015), Plecoptera Species File (DeWalt et al. 2015), and the Trichoptera World Checklist (Morse 2015). All identifications were verified by R. E. DeWalt.

After identification, specimens were placed in 2 ml vials with 95% EtOH, labeled with locality and collection information, and accessioned into the Illinois Natural History Survey Insect Collection (INHS-IC). All specimen data are available from the INHS-IC web portal (http://inhsinsectcollection.speciesfile.org/InsectCollection.aspx).

Statistical analysis. A base data set of 76 continuous independent variables was assembled from existing data at the arc watershed level (Holtrop et al. 2005) and data collected at each site (Appendix B). Multicollinearity associated with contiguous sampled reaches was avoided by averaging recorded values for three sites, K1229-F4, K1229-F5, and K1229-F6. This yielded a consolidated sample size of 82 for all statistical analyses. Because exploratory analysis showed no significant difference between average EPT richness of sampling years for the 16 replicated sites (two-tailed t- test, $p = 0.288$), year two data for these sites were excluded. Additionally, climate data were excluded from the data set since the geographical area of study was small and variation slight. CRP/CREP at the total catchment level was expected to be ineffective because it comprises a very low proportion of the basin land. Therefore, data for CRP/CREP at the local catchment level, which describes a higher proportion of the basin, were used exclusively in the analysis. Lastly, nutrient data were not available at the time of data analysis.

Reduction of the 76 base variable set was guided by statistical software and governed by decisions based on existing knowledge of stream ecology and EPT biology. All statistical packages were executed within the R software environment (R Core Team 2015). Variable reduction began by examining Pearson product-moment correlation coefficients between the 76 variables, 31 of which were consequently removed because they correlated highly ($r \geq 0.7$) with other variables. The remaining 45 were examined for variance inflation factor (VIF). Those variables with a VIF greater than 10 were considered to be highly multicollinear and were evaluated for removal from the regressor set (Quinn and Keough 2002). This resulted in a set of 18 variables distributed within each of the original variable categories. These were tested using relative weight and dominance analysis (Budescu 1993) with the statistical package *yhat* (Nimon et al. 2013), ultimately resulting in a global model of 11 regressors (Appendix C). A global model is comprised of all important variables from which candidate models can be assembled (Burnham and Anderson 2004). The global model was fit as a generalized linear model with a Poisson distribution and a c-hat value (overdispersion parameter) of 1.4 (R Core Team 2015).

The global model provided a selection pool of variables for the assembly and evaluation of all possible candidate models using the *dredge* function in the package *MuMIn* (Barton 2015). All candidate models were ranked with Akaike information criterion corrected for small sample size (AICc). AIC is based on the Kullback-Leibler (1951) theoretic criterion, with loss of information in the candidate regression models as the basis for scoring. AICc score differences between the top ranked model (i.e. model with the lowest AICc score) and each of the other models allowed selection of top models with Δ AICc ≤ 2. Models with Δ AICc ≤ 2 are designated as substantially supported for plausibility (Burnham and Anderson 2004). Akaike weights were computed to assess strength of evidence for each model as the best approximating model in the model set. Model averaging (Burnham and Anderson 2002) of the 2 Δ AICc top model set was computed with *modavg* in the package *AICcmodavg* (Mazerolle 2015) to yield average coefficient estimates and 95% confidence intervals. Variable coefficients were standardized to facilitate comparison between regressors with different units of measure (Schielzeth 2010). The R base function *importance* was used to assign relative importance values for each of the regressors in the 2 Δ AICc model set. Relative importance values calculations are based on the number of models containing the given variable and the collective weight of each of those individual models. A value of 1.00 indicates that a given variable was present in all top models.

Initial exploratory analysis showed that the sample size for this study was too small to split the data into a retained model set and test set for the purpose of cross validation. Therefore, support for variable relative importance according to AICc was sought through hierarchical partitioning with the statistical package *hier.part* (Walsh and Mac Nally 2013). Because *hier.part* does not compute for 13 or more variables and produces a rounding error for 10 to 12 variables (Olea et al. 2010), only the top nine variables according to AICc importance values were analyzed. Hierarchical partitioning evaluates the average independent and joint contribution of each regressor to the variability of the response variable by comparing all possible models in a multiple regression context (Chevan and Sutherland 1991). The independent component, *I,* is a measure of the effect of each regressor on the variance explained by the model. Similarly, the joint component, *J*, relates contribution of individual independent variables in combination with each of the other predictors. Using the function *rand.hp* in the package *hier.part*, the data matrix for the top nine AICc importance variables was randomized 1,000 times to generate distributions of *I* for each independent variable. These distributions were compared to the observed individual percent contributions (*% I)* to determine regressor significance according to upper 95% confidence levels for computed signed number of standard deviations from the mean, known as Z-scores (Mac Nally 2000).

Results

A total of 10,522 EPT specimens, comprising at least 46 species across 17 families, were collected from 84 sites in the Kaskaskia basin (Appendix D). Mayflies were the most species rich order, with 28 species across eight families. Among these, the Baetidae (small minnow mayflies) was the richest family with 13 species. Stoneflies were represented by only seven species across four families. Caddisflies were represented by 11 species across five families.

EPT species richness varied greatly throughout the basin, averaging 6.2 ± 0.40 SE. Richness was significantly higher in Grand Prairie Natural Division sites (7.9 ± 0.92 SE) than in Southern Till Plain sites (5.9 ± 0.44 SE) (one-tailed t-test, $p = 0.0316$) (Fig. 3A, B). The site that had the highest richness (16 species) was K2168-F3, West Fork Shoal Creek in Bond County in the middle basin (Fig. 3B). Three sites within the Southern Till Plain, K3496, tributary of Beaver Creek in Clinton County, K3380 tributary of Brubaker Creek in Marion County, and K3671, Lake Branch in Clinton County, produced zero EPT (Fig. 3B). Stoneflies, the most sensitive of the three insect orders, were found at a much higher proportion of Grand Prairie sites (0.69) than in Southern Till Plain sites (0.20). The Grand Prairie also provided the site with the greatest stonefly richness (K299, West Okaw River in Moultrie County, 4 species). Southern Till Plain sites, K2168-F3, West Fork Shoal Creek in Bond County, and K4479, West Fork Richmond Creek in St. Clair County had the greatest mayfly richness (both at 12 species). Caddisfly richness was evenly distributed throughout the basin.

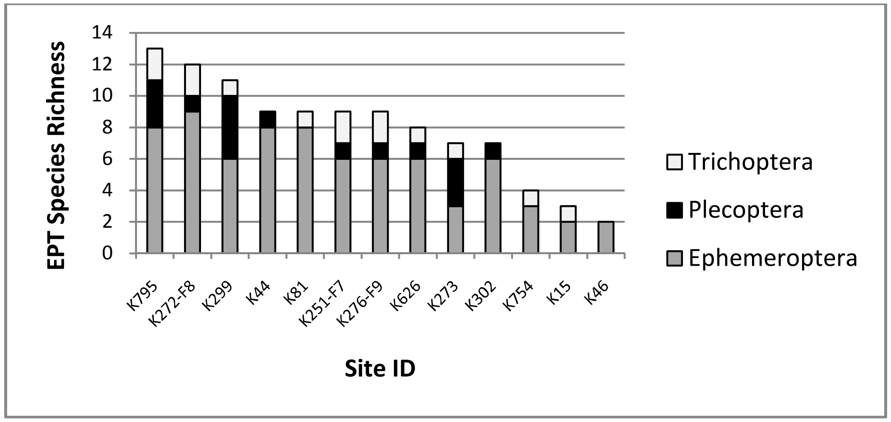

Figure 3A. EPT species richness for 13 sites sampled in Kaskaskia River basin streams in the Grand Prairie Natural Division, 2013-2015. Site ID codes correspond to those in Appendix A.

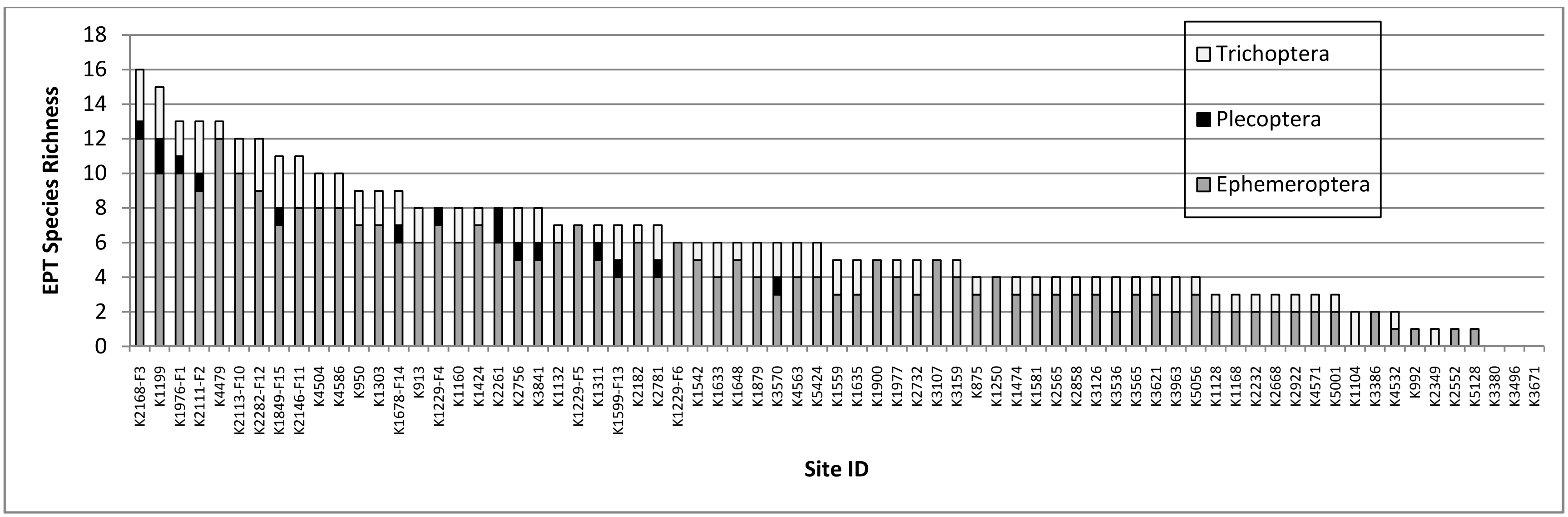

Figure 3B. EPT species richness for 71 sites sampled in Kaskaskia River basin streams in the Southern Till Plain Natural Division, 2013-2015. Sites without bars supported no EPT species. Site ID codes correspond to those in Appendix A.

The base set of 76 continuous variables (Appendix C) was reduced to a global model of 11 variables with representatives in 9 categories: stream size, soil hydrology, water quality, channel morphology, land use, substrate, geology, topography, and management (Table 1 and Table 2). Coefficients of variation ranged from 0.224 for Sinuosity, meaning most streams were channelized, to 1.465 for Link, suggesting a large range of drainage area.

Table 1. Global model variables, description of measures, variable category, and measures of central tendency and dispersion.

Variable	Measure	Category	Mean	S.E.	Median	SD	Min.	Max.	CV
Link	# 1st order reaches	Stream Size	23.561	3.8124	11.000	34.523	2.000	171.000	1.465
WT_Urban	proportion	Land Use	0.020	0.0029	0.010	0.026	0.000	0.151	1.321
Silt	proportion	Substrate	0.082	0.0120	0.050	0.109	0.000	0.700	1.321
CRP/CREP	proportion	Management	0.078	0.0100	0.049	0.091	0.000	0.532	1.172
Gradient	ft/ft units	Topography	0.002	0.0002	0.001	0.002	0.000	0.008	0.964
WT_Forest	proportion	Land Use	0.086	0.0087	0.059	0.079	0.000	0.374	0.920
W_Fines	proportion	Geology	0.546	0.0379	0.581	0.343	0.000	1.000	0.628
WT_Perm	proportion	Soil Hydrology	61.802	3.4373	51.438	31.126	22.000	158.819	0.504
W_Agri	proportion	Land Use	0.475	0.0239	0.429	0.217	0.077	0.942	0.457
DO	mg/L	Water Quality	7.515	0.2832	7.850	2.564	1.400	17.500	0.341
Sinuosity	channel/valley	Channel Morphology	1.224	0.0303	1.135	0.275	1.002	2.277	0.224

Table 2. Global model variable key. W = local catchment, WT = total catchment (see descriptions for complete list of variables in Appendix B).

Variable	Description	Type
Link	Shreve stream order	GIS
WT_Urban	urbanized	GIS
Silt	visible instream silt	on-site
CRP/CREP	Conservation Reserve/Enhancement Programs at the local catchment level	GIS
Gradient	slope of stream channel	GIS
WT_Forest	forested	GIS
W_Fines	surficial geology identified as having fine texture	GIS
WT_Perm	soil permeability	GIS
W_Agri	agricultural	GIS
DO	dissolved oxygen	on-site
Sinuosity	channel sinuosity	GIS

Note: GIS data obtained from Holtrop et al. 2005.

Model selection by AICc yielded 13 top models with Δ AICc $\leq$ 2 (Table 3). All top models had low Akaike weights for the categories of all possible models (mean = 0.023558 ± 0.002525 SE; Table 3, penultimate column) and models within the 2 Δ AICc group (mean = 0.0768 ± 0.0082 SE; Table 3, ultimate column). Therefore, no model was designated as the single best model. Additionally, pseudo R^2 values were similar among all models (mean = 0.41883 ± 0.002923 SE), with model 7 having the highest value (pseudo R^2 = 0.43664).

Table 3. Top 13 regression models ranked by AICc (● = variable presence in model).

Models	Link	WT_Perm	WT_Urban	Silt	DO	W_Agri	CRP/CREP	W_Fines	WT_Forest	Gradient	Sinuosity	K	logLik	Pseudo R^2	AICc	delta	weight (all possible models)	weight (top 13 models)
Global Model	●	●	●	●	●	●	●	●	●	●	●	12	-192.92	0.44945	414.37	9.460	0.00035	NA
Top Model 01	●	●	●	●								5	-197.06	0.40567	404.911	0.000	0.03930	0.128
02	●	●	●	●	●	●						7	-194.75	0.43018	405.003	0.092	0.03749	0.122
03	●	●	●	●		●						6	-195.96	0.41732	405.037	0.126	0.03686	0.12
04	●	●	●	●			●					6	-196.16	0.41520	405.440	0.529	0.03014	0.098
05	●	●	●	●	●							6	-196.43	0.41229	405.985	1.075	0.02294	0.075
06	●	●	●	●		●	●					7	-195.33	0.42399	406.175	1.264	0.02087	0.068
07	●	●	●	●	●	●	●					8	-194.13	0.43664	406.239	1.329	0.02020	0.066
08	●	●	●	●	●		●					7	-195.48	0.42245	406.466	1.555	0.01804	0.059
09	●	●	●	●	●	●		●				8	-194.27	0.43521	406.508	1.598	0.01766	0.058
10	●	●	●	●			●	●				7	-195.58	0.42134	406.676	1.766	0.01624	0.053
11	●	●	●	●				●				6	-196.81	0.40827	406.746	1.835	0.01568	0.051
12	●	●	●	●						●		6	-196.83	0.40816	406.773	1.863	0.01547	0.051
13	●	●	●	●					●			6	-196.83	0.40806	406.786	1.875	0.01537	0.05

According to AICc, Link, WT_Perm (soil permeability at the total catchment level), WT_Urban (urban land use at the total catchment level), and Silt were identified as the four most important variables explaining variability of EPT richness. With the exception of Sinuosity, all global model variables were contained in the 2 Δ AICc group, each model consisting of 4 to 7 variables (Table 3). However, only Link, WT_Perm, WT_Urban, and Silt were present in all models of the 2 Δ AICc group. Additionally, these four did not enclose zero in their 95% confidence intervals for standardized model average coefficients (β) (Fig. 4). Variable effect direction, as indicated by the Beta coefficients, showed that Link (β = 0.224, CI = 0.150 to 0.297) and WT_Perm (β = 0.222, CI = 0.116 to 0.328) were associated with increase in EPT richness, whereas WT_Urban (β = -0.199, CI = -0.314 to -0.084) and Silt (β = 0.158, CI = -0.288 to -0.028) were associated with decrease in EPT richness.

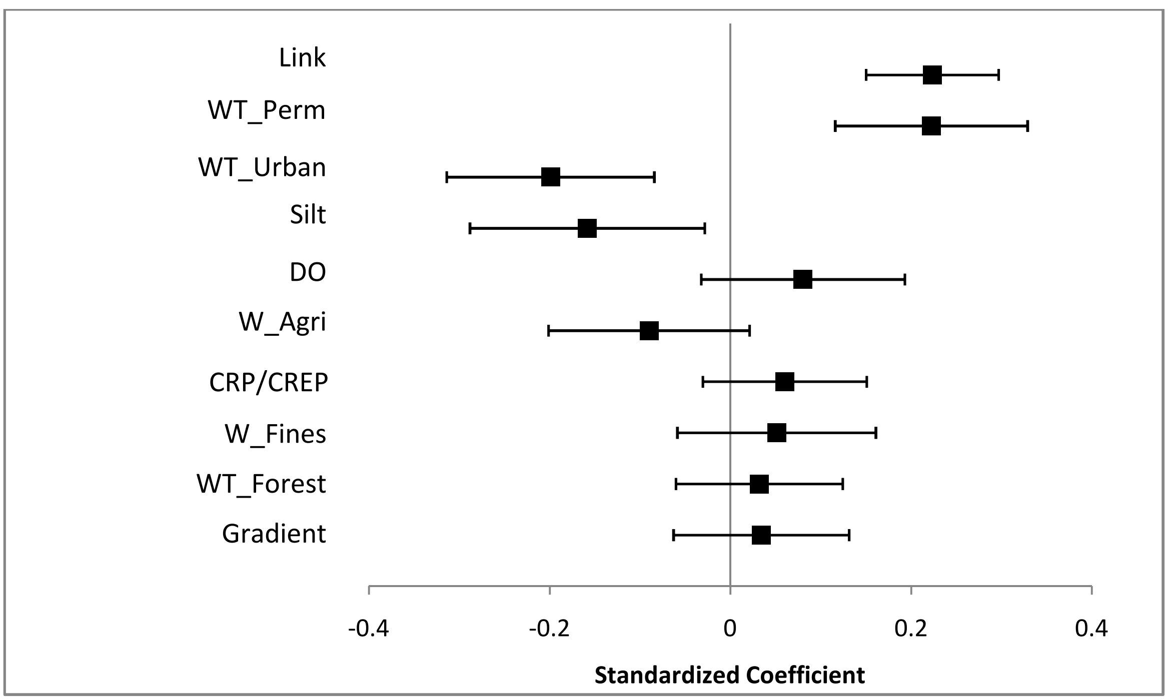

Figure 4. Standardized model average coefficients (β) with 95% confidence intervals of top 13 generalized linear regression models for independent environmental variables explaining variability of EPT species richness in Kaskaskia River basin streams sampled 2013-2015.

AICc importance values for top model variables ranged from 0.23 for Sinuosity to 1.00 for Link and WT_Perm (Fig. 5). The highest importance values were for Link, WT_Perm, WT_Urban, and Silt - all above 0.8. The remainder, including CRP/CREP, had AICc importance values less than 0.6.

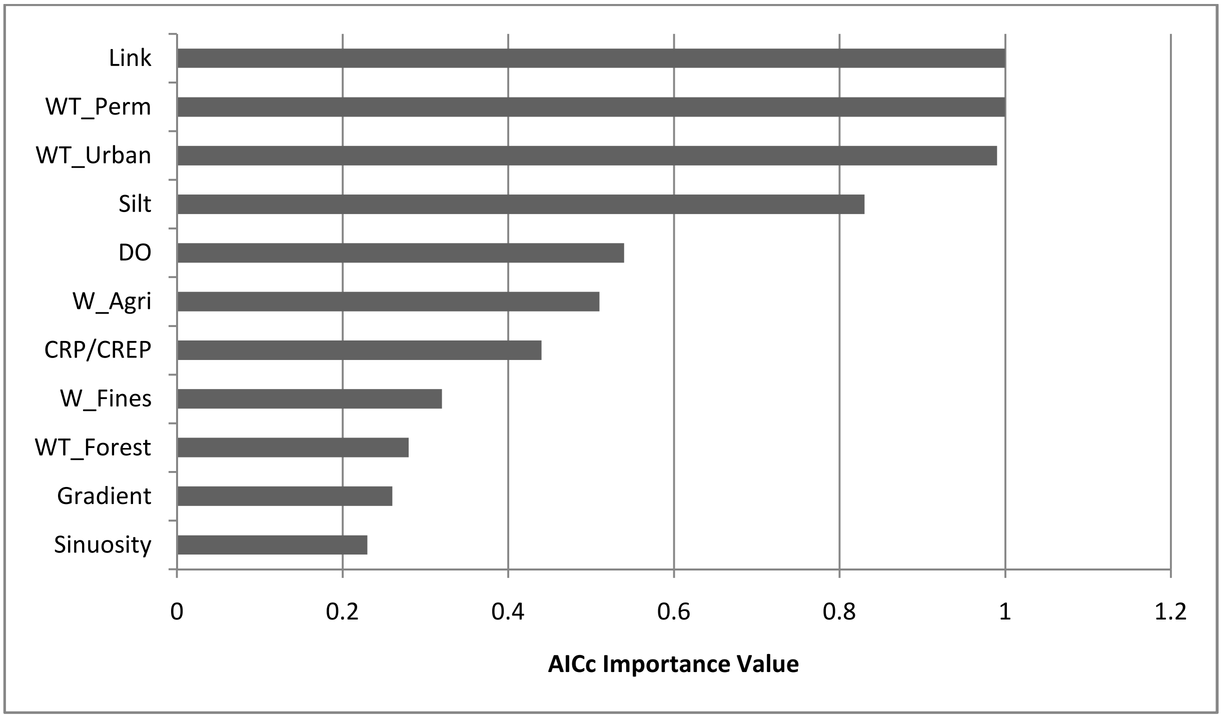

Figure 5. AICc importance values for 11 independent variables in top 13 models explaining variability of EPT species richness in Kaskaskia River basin streams.

Among the data for WT_Urban, site K46, Kaskaskia Ditch in Champaign County, is of particular interest for two reasons. First, K46 has an extreme high value for proportion of urban land use. Additionally, this was one of the 16 sites visited twice, showing a range of EPT richness from two (2013) to nine taxa (2015). A review of field notes from both visits to this site showed no considerable difference in stream conditions that could have biased samples. A severe drought in 2012 could have easily depressed EPT richness, even in 2013 (IDNR 2015).

Interannual comparison of EPT means for all sites showed an increase from 2013 (5.0 ± 0.46 SE) to 2014 (7.9 ± 0.65 SE) and a return to the initial mean in 2015 (5.3 ± 0.91), suggesting the drought may not have significantly affected the stream communities. Analysis performed without K46 retained the relative importance of WT_Urban as third within the top AICc variables but lowered the importance value from 0.99 to 0.77.

The nine variables with top AICc importance values showed slightly different ranking by *% I* (independent) contribution in hierarchical partitioning (Fig. 6). DO was moved from a fifth place rank in AICc importance to third place position in *% I* contribution. Conversely, CRP/CREP was moved from a seventh position rank in AICc importance to the last position in hierarchical partitioning. Link remained in the top ranked position, with a *% I* contribution of 40.60. A marked difference of *% I* was shown between Link and all other variables. The amount of CRP/CREP land above the site had the lowest *% I* of all variables (1.71).

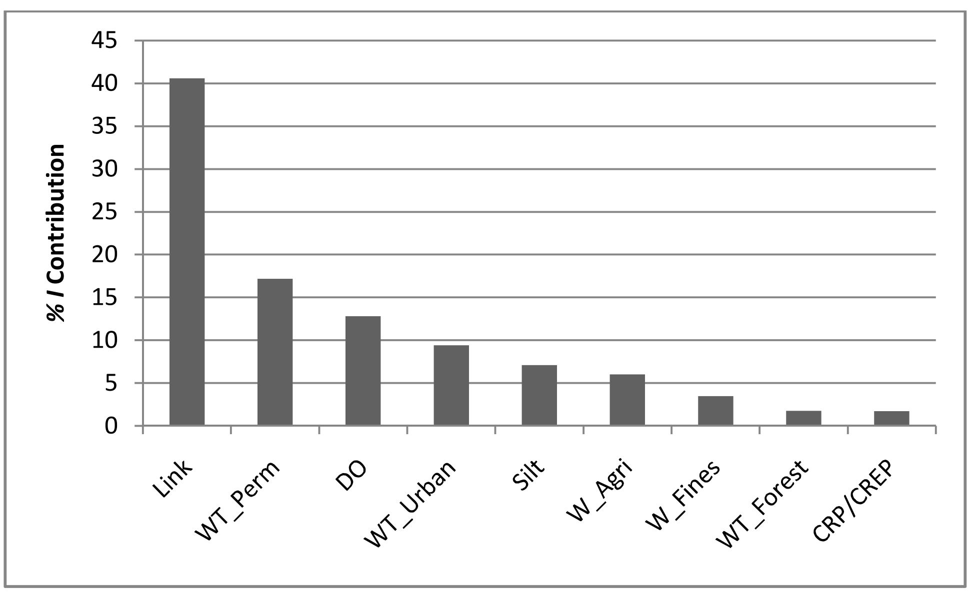

Figure 6. Comparison of percent independent contribution (*% I*) of nine independent variables to explaining variability of EPT species richness in Kaskaskia River basin streams. The *% I* values were determined through hierarchical partitioning.

Further investigation with hierarchical partitioning indicated that four variables explained a significant proportion of variance (Fig. 7). Variables above the 95% confidence limit with significant Z scores included Link, followed distantly by WT_Perm, DO, and WT_Urban.

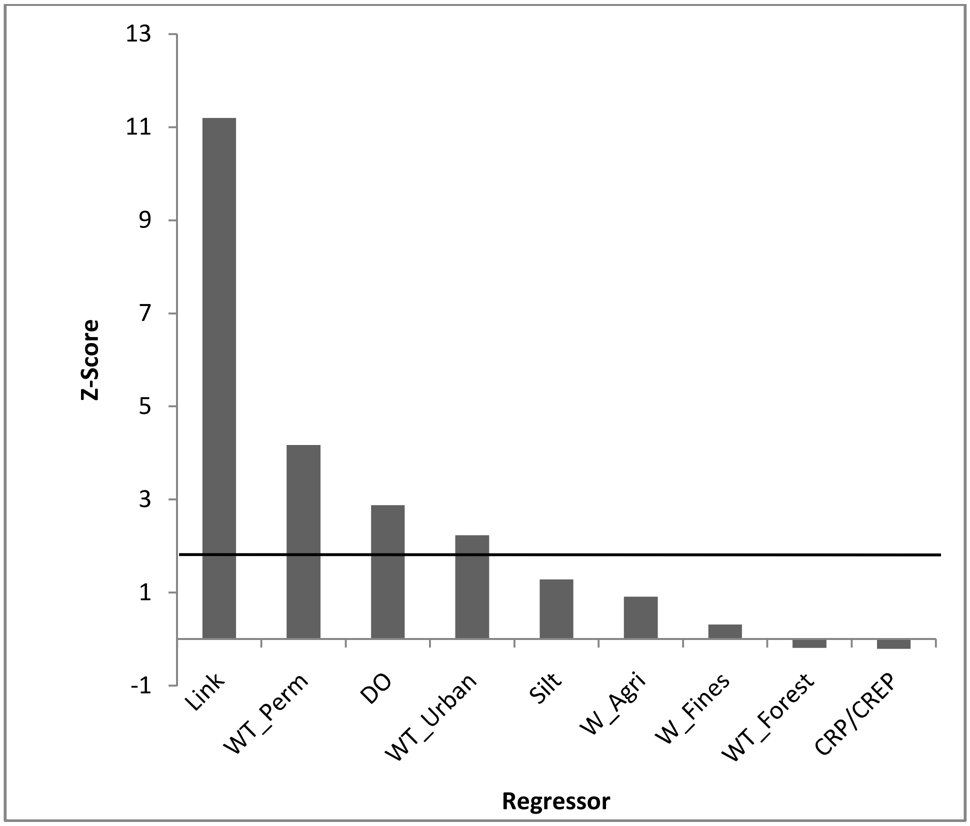

Figure 7. Z scores based on comparison of observed *% I* values to the distribution of generated *% I* values from 1,000 randomizations of the data matrix for nine variables explaining variance of EPT species richness in Kaskaskia River basin streams. The horizontal line is the upper 95% confidence limit set at the significance level of 1.65. The *% I* value is individual contribution of each variable as determined by hierarchical partitioning.

Discussion

Nationwide, the CRP has contributed significantly to environmental benefits, including reduced sediment delivery and improved runoff water quality, both of which can protect stream habitats (Stubbs 2014). CRP has reduced more than 8 billion tons of soil erosion, with a yearly reduction of 325 million tons from levels prior to the program's inception in 1986 (USDA, FSA 2011). CRP has improved runoff water quality by reducing field loss of nitrogen and phosphorus by about 607 and 122 million pounds, respectively (USDA, FSA 2011). Many studies support improved stream habitat as a result of practices defined by the USDA National Resources Conservation Service, the CRP technical supporting agency (Knight and Boyer 2007). These practices include filter strips (Krutz et al. 2005), riparian forest buffers (Boyer et al. 2003), managed grazing (Sanders and Fausch 2007), and stream bank protection (Shields et al. 2000). Direct evidence of effective stream restoration from CREP riparian buffers is provided in recent studies which show reduced nitrate levels (Messer et al. 2012) and improved overall stream condition (Teels et al. 2006).

National scale environmental benefits of CRP are associated with variable categories investigated in this thesis, including water quality and in-stream substrate, both of which showed association with EPT species richness in the Kaskaskia River basin. However, most environmental variables investigated in this thesis showed low association with EPT richness, perhaps partly due to low habitat variability found within the homogeneous, anthropogenically impacted basin system. Regardless, AICc modeling and hierarchical partitioning support expected and unexpected importance of a few variables and their represented categories. Expectedly, variables within the categories of stream size, land use, soil hydrology, and water quality were found to be important. However, channel morphology was excluded from the top categories by analysis. Four of the top five variables identified by AICc and/or hierarchical partitioning (Link, WT_Perm, Silt, and DO) were expected to show importance. Unexpectedly, WT_Urban supplanted W_Agr, and Sinuosity, Gradient and CRP/CREP were excluded from the top variable set.

EPT richness has been shown to increase with stream size (Paller et al. 2006, Sangunett 2005). The outcome of increased taxon richness along a downstream progression of increased habitat complexity is proposed in the River Continuum Concept (RCC) by Vannote et al. (1980). Lotic systems in temperate zones have been observed to harbor their greatest species richness in mid- sized streams, areas of greater spatial and temporal heterogeneity compared to the more homogeneous environments frequently found in headwaters or large streams (Minshall et al. 1985b, Grubaugh et al. 1996). Higher species richness in mid-order streams has been attributed to greater diversity of substrate composition, stream morphology, food resources, and flow and temperature regimes (Minshall et al. 1985b).

The strong positive effect of Link, a surrogate for stream size, on EPT richness may coincide with some factors discussed in the RCC and similar studies. Link range is large enough to incorporate small to medium sized streams, providing the size continuum for a positive linear relationship. Additionally, higher species richness found in mid-sized streams could be related to increase in habitat heterogeneity in those reaches. Conversely, the mechanisms for increased heterogeneity may not follow those described in the RCC due to the level of disturbance in the basin. For example, an undisturbed temperate forest stream may exhibit increase temperature variability as the stream flows from a shaded headwater to a more open canopied stream. Streams in the Kaskaskia basin from headwater to moderate sizes were often devoid of canopy cover, exhibiting uniform temperatures throughout.

Soil hydrology was expected to be identified as an important regressor category. Prevalent low permeable soils in the Kaskaskia basin, such as clay and silt, reduce rain infiltration and contribute to surface runoff which in turn augments sediment and nutrient loading. Low soil permeability can also reduce ground water recharge, resulting in lower base flows (Santhi et al. 2008). Low base flows can reduce EPT richness by restricting community composition to only those taxa with diapause life stages or short life cycles (DeWalt et al. 2005).

Although land use was expected to be identified as an important category, the inclusion of urban land use as an important variable was not predicted. Urban land encompasses a small percentage (3.5) of total watershed land in the basin's predominantly agricultural landscape (IEPA 2012). Even though a small fraction of a watershed may be occupied by urban land, it can have a disproportionately large impact (Paul and Meyer 2001). Runoff from impervious surfaces and discharge of treated municipal effluents can dramatically reduce invertebrate diversity from the introduction of toxins, change of temperature regimes, increased siltation, and input of organic nutrients (Resh and Grodhaus 1983). Benthic macroinvertebrate assemblages disturbed by urban land use have been widely studied and found to be dominated by a few tolerant taxa and devoid of sensitive species (Walsh et al.2005).

The importance of substrate, as shown by Silt, was predicted. Research has shown that sediment particle size may impact stream insect richness (Erman and Erman 1984). Large particles such as gravel and cobble provide ample cover, attachment surfaces, and varied hydrologic nuances conducive to producing multiple niches (Williams and Mundie 1978). Additionally, large sediment particles, the preferred habitat of many EPT taxa, are often present in areas of faster flow. Conversely, small sediment particles such as silt and clay are usually associated with lower EPT diversity. Silt is detrimental to benthic invertebrate habitat because it fills interstices of coarser habitable substrates and can impair respiratory function of sensitive taxa (Relyea et al. 2000, Lemly 1982).

DO was expected to be important. Well oxygenated waters generally support more macroinvertebrate species (Jacobsen 2008). The relationship between dissolved oxygen and species richness was most noticeable at the hypoxic sites that supported zero EPT.

Variability of DO_2 values was large and certainly due to diel cycles of photosynthesis. In open canopied stream reaches, supersaturation of DO_2 was recorded for some late afternoon measurements whereas hypoxic values were recorded for a few morning samples. Many reaches were observed to have copious growths of *Chladophora* sp., a filamentous alga that may drive high variation in O_2 saturation in Illinois streams (Morgan et al. 2006). The variability of percent saturation of DO_2 between AM and PM measurements could reflect the shift from predominant photosynthetic activity during the day to exclusive respiration at night (Walling and Webb 1992). Despite this potential influence on variability, DO data were still considered valid for regression analysis.

Contrary to prediction, channel morphology variables showed low effect on EPT richness variability. Previous studies found sinuosity to be a primary determinant of EPT richness in Illinois streams (DeWalt 2002, Sangunett 2005). Streams with little sinuosity, indicative of prior channelization, have scoured and homogenized stream beds (Beisel et al. 2000). The relatively low importance of sinuosity in the Kaskaskia basin may be a result of its low variability (CV = 0.224), as most of the sampled streams had been channelized.

Gradient ranked unexpectedly low in importance. Stream gradient directly affects flow velocity, which in turn influences macroinvertebrate assemblages (Allan 1995, Hynes 1970). All streams sampled in the Kaskaskia basin were of low gradient, with flow velocities that may be too low to significantly influence EPT species richness.

Three explanations and solutions are proposed for the unexpectedly low importance of CRP/CREP land to the variability of EPT basin richness. First, there is a very low proportion (0.0369) of CRP/CREP land in the basin (State of Illinois 2015). A greater percentage of CRP/CREP land may be needed to effectively counteract any negative impacts from disturbed non-conservation land. Second, habitat fragmentation is prevalent throughout the basin. Studies show the importance of non-fragmented corridors and overland dispersal routes for aquatic insect assemblages (Smith et al. 2015). Adult aquatic insects use uninterrupted riparian zones and overland straight-line pathways for travel routes to sites of reproduction. An increase in more extensive contiguous CRP/CREP riparian lands could potentially increase EPT richness by providing viable dispersal corridors for reproducing adults within and between Kaskaskia basin catchments. Third, more time may be needed for recovery of community assemblages to follow improvement in habitat quality. The inception of conservation land management is relatively recent, especially the CREP which was not introduced to the Kaskaskia basin until 2010. DeWalt et al. (2005) found that several stonefly species were extirpated from Illinois. Continued sampling has demonstrated that two of these species have recolonized the state after a 50 year absence, but only along its borders (DeWalt & Grubbs 2011). Other species whose range was greatly diminished have also slowly moved back into the state (DeWalt unpub. data). Continued management of conservation lands may be necessary for improvement in EPT assemblages to take place.

This study was limited to continuous data recorded at the reach, local catchment, and individual upstream sub catchment levels, excluding examination of some factors that may potentially influence EPT richness at broader spatial scales. One such exclusion is discrete binary GIS data for glacial history of the Grand Prairie and Southern Till Plain natural divisions. Glacial events can affect species distributions through historical distribution of refugia (Hewitt 1996, Pielou 1991). Furthermore, present species community compositions are influenced by historic glacial movements that altered geologic landscapes and the distribution of presettlement forest and prairie biomes (Vinson and Hawkins 2003). A notable outcome of glacial episodes in Illinois is the outwash from the Wisconsinan glaciation which deposited more fine sediment in the Southern Till Plain than in the Grand Prairie (Grimley and Webb 2010). This distribution of sediment resulted in more erodible soils and fine stream substrates in the Southern Till Plain, a probable reason for lower historic stonefly species richness in this natural division (Cao et al. 2013).

In summary, this thesis addressed three basic questions regarding multiple environmental variables and their association with EPT species richness in the Kaskaskia River basin.

1. What environmental variables are the most important to EPT species richness in the Kaskaskia River basin?

   Five variables were identified as most important for supporting basin EPT communities. These include Link, WT_Perm, WT_Urban, Silt, and DO.

2. What is the relative importance of each of these variables?

   According to AICc, Link was the most important, followed by WT_Perm, WT_Urban, and Silt. DO was shown to be ranked third in percent individual contribution by hierarchical partitioning.

3. Where does the importance of CRP/CREP fall in the spectrum of these environmental variables?

The amount of CRP/CREP land in the drainage ranked low in relative importance and % *I* contribution, suggesting that this mosaic of conservation practices may not contribute significantly to supporting diverse EPT assemblages. Greater area of conservation practice, connectivity of conservation lands, and time may be necessary to enrich EPT and other macroinvertebrate communities in the drainage.

Management Implications

A potential application of this thesis is guidance for decisions regarding future conservation land management policies and practices in the Kaskaskia River basin. The relative importance of certain variables to EPT richness may help to prioritize conservation. For example, focusing conservation efforts on watersheds with low soil permeability is not likely to improve conditions sufficiently to enhance EPT communities, as these areas typically have claypan stream beds with naturally low habitat suitability and EPT richness. However, efforts directed at increasing the area and continuity of conservation lands in areas with more highly permeable soils may more rapidly promote rich EPT assemblages. Establishment of conservation lands below urban areas may not improve macroinvertebrate communities, or may only provide intermittent improvement until occurrence of the next spill or flood related discharge of untreated sewage.

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Appendix A. Localities of sampling sites in wadeable Kaskaskia basin streams, 2013-2015.

Site ID	County	Stream	Locality	Latitude	Longitude	Width(m)
K15	Champaign	Kaskaskia Ditch	4.1 km SSE Bondville at 1400N	40.08007	-88.34995	6.5
K46	Champaign	Kaskaskia Ditch	4.9km N Sadorus at 600E	40.01112	-88.34871	10
K44	Piatt	Trib. Lake Fork	3.0 km NE Bement at 1000N	39.93822	-88.54365	3.5
K81	Douglas	Kaskaskia River	10.3 km NW Tuscola at 1450N	39.86631	-88.36513	14
K251-F7	Moultrie	West Okaw River	7.3 km ENE Bethany at 1850N	39.67636	-88.66329	16
K272-F8	Moultrie	West Okaw River	6.9 km ENE Bethany at 1850N	39.67315	-88.66637	15
K276-F9	Moultrie	West Okaw River	5.0 km ENE Bethany at 1750N	39.66099	-88.68367	17
K273	Moultrie	West Okaw River	6.2 km ENE Bethany, 100 m upstr. 1750N	39.65996	-88.68392	18
K299	Moultrie	West Okaw River	3.8 km E Bethany, 200 m S 1700N	39.64975	-88.69464	18
K302	Moultrie	Marrowbone Creek	1.7 km WSW Bethany at 3.00E	39.63876	-88.75623	2.5
K626	Shelby	Tributary Robinson Creek	13.9 km NNW Shelbyville at 1600N	39.52321	-88.84652	3
K754	Shelby	Angel Branch	6.9 km N Tower Hill at 1600N	39.44958	-88.95811	2
K795	Shelby	Mud Creek	5.8 km ENE Tower Hill at 1300E	39.40991	-88.89952	4
K875	Shelby	Richland Creek	10.7 km SSW Windsor at 950N	39.35306	-88.64658	2
K913	Shelby	Richland Creek	13.2 km SE Shelbyville at 800N (Clarksburg Rd.)	39.33252	-88.67075	4
K950	Shelby	Mitchell Creek	8.8 km SSE Tower Hill at 1200E	39.31612	-88.91815	4.5
K992	Shelby	Mitchell Creek	7.2 km NNW Cowden at 650N	39.31132	-88.88154	2
K1104	Montgomery	Blue Grass Creek	12.5 km NNW Hillsboro at 1850N (MacKay Ln.)	39.26891	-89.53411	2.5
K1229-F4	Shelby	Becks Creek	14.0 km SSW Tower Hill at 375N	39.26704	-89.00607	12
K1128	Montgomery	East Fork Shoal Creek	2.0 km ENE Witt, N 1800N	39.26218	-89.32631	5
K1168	Montgomery	East Fork Shoal Creek	2.0 km E Witt, S 1800N	39.25945	-89.32531	5.1
K1132	Shelby	Mitchell Creek	3.8 km WNW Cowden, S 300N	39.25882	-88.90417	6.5
K1160	Shelby	Mitchell Creek	3.3 km WNW Cowden at 1300E	39.25612	-88.89892	5
K1229-F5	Shelby	Becks Creek	9.0 km ESE Oconee at 225N	39.24891	-89.01459	15
K1199	Shelby	Richland Creek	5.1 km ESE Cowden at 1800E	39.23616	-88.80489	9
K1229-F6	Shelby	Becks Creek	9.6 km SE Oconee at 100N	39.23304	-89.01866	17
K1250	Shelby	Polecat Creek	5.3 km WSW Cowden at 100N	39.23119	-88.91961	4
K1303	Shelby	Little Creek	7.9 km SSE Oconee at 3300N	39.21786	-89.07861	1.75
K1311	Effingham	Wolf Creek	6.7 km ENE Beecher City at 500E	39.20443	-88.71194	4

Appendix A. (continued)

Site ID	County	Stream	Locality	Latitude	Longitude	Width(m)
K1424	Effingham	Wolf Creek	3.1 km E Beecher City, W 300th St.	39.18262	-88.75112	6.5
K1474	Montgomery	East Fork Shoal Creek	9.3 km S Witt at 1200N (7 Sisters Ave.)	39.17352	-89.36142	8
K1542	Montgomery	East Fork Shoal Creek	12.3 km E Hillsboro at 1025N (Fillmore Trail)	39.14887	-89.35163	10
K1581	Montgomery	East Fork Shoal Creek	8.3 km SSE Irving, 600 m S 1025N (Fillmore Tr.)	39.14298	-89.35374	10
K1559	Fayette	Hurricane Creek	11.3 km W Ramsey, E 75E	39.14146	-89.23949	10
K1599-F13	Montgomery	West Fork Shoal Creek	8.0 km WSW Hillsboro at Old Litchfield Trail	39.13692	-89.58072	17
K1633	Fayette	Hurricane Creek	9.2 km WSW Ramsey at 2600N	39.11978	-89.21008	8
K1648	Montgomery	East Branch Lake Fork	6.8 km SSE Litchfield at 800N (8^{th} Ave.)	39.11686	-89.63176	3
K1635	Montgomery	Miller Creek	5.3 km SSE Hillsboro at 1200E (Buckeye Trail)	39.11608	-89.47446	2.5
K1678-F14	Montgomery	West Fork Shoal Creek	10.0 km SW Hillsboro at Walshville Trail	39.10186	-89.58132	10
K1849-F15	Montgomery	West Fork Shoal Creek	7.4 km NNE Sorento at 475N (Shoal Cr. Trail)	39.06181	-89.54495	17
K1879	Montgomery	Grove Branch	6.7 km Sorento at 400E (Elevator Rd.)	39.04552	-89.62346	8
K1900	Fayette	Trib. Of Linn Creek	8.3 km E Vera at 1275E	39.03952	-89.01681	3
K1977	Bond	Bearcat Creek	5.9 km NE Sorento at Donnelson Ave.	39.02891	-89.51796	5
K1976-F1	Montgomery	West Fork Shoal Creek	4.4 km NE Sorento at 1600N (Panama Ave.)	39.02801	-89.53928	22
K2111-F2	Bond	West Fork Shoal Creek	3.5 km ESE Sorento at 1650N (Sorento Ave.)	38.98549	-89.53765	12
K2113-F10	Fayette	Hurricane Creek	12.3 km WNW Vandalia at 1700N	38.98459	-89.23206	10
K2182	Fayette	Vandalia Ditch	3.3 km ENE Vandalia at 1050E	38.97686	-89.06161	4
K2146-F11	Fayette	Hurricane Creek	10.4 km W Vandalia at 1550N	38.96502	-89.21315	10
K2168-F3	Bond	West Fork Shoal Creek	4.5 km SSE Sorento at Ripson Bridge Ave.	38.96032	-89.55677	15
K2232	Bond	Headwater Gov. Bond Lake	8.0 km NE Greenville at 1550E (Newport Rd.)	38.93551	-89.34005	1
K2261	Fayette	Raccoon Creek	10.1 km WSW Vandalia at 140	38.92369	-89.20036	4
K2282-F12	Fayette	Hurricane Creek	13.0 km WSW Vandalia at Hwy 140	38.92286	-89.23558	12
K2349	Bond	Dorris Creek	10.5 km W Greenville at 1130N (Mt. Nebo Ave.)	38.90523	-89.53351	5
K2552	Bond	Trib. Shoal Creek	2.6 km NNW Pocahontas at 470E (Pokey Rd.)	38.85014	-89.54664	2.5
K2565	Madison	East Fork Silver Creek	11.4 km N Highland at Ludwig Rd.	38.84018	-89.64908	5
K2668	Bond	Shoal Creek	12.1 km SW Greenville at 450N (Dolls Orchard Ave.)	38.80671	-89.5074	2.5

Appendix A. (continued)

Site ID	County	Stream	Locality	Latitude	Longitude	Width(m)
K2732	Bond	Beaver Creek	10.4 km S Greenville at Lake Lola Ave.	38.79981	-89.42702	4
K2781	Marion	North Fork Kaskaskia	5.4 km NE Patoka at 500E (Seven Hills Rd.)	38.78861	-89.04985	5
K2756	Marion	North Fork Kaskaskia River	11.4 km W Kinmundy at 900E (Jones Rd.)	38.78694	-88.97711	8
K2858	Marion	East Fork Kaskaskia River	8.9 km W Kinmundy at 2000N (Kinoka Rd.)	38.76218	-88.94841	10.5
K2922	Bond	Locust Fork	13.5 km E Highland at 600E (Jamestown Rd.)	38.74812	-89.51611	2.5
K3126	Madison	Sugar Creek	10.0 km NNE Trenton at 250N (Buckeye Rd.)	38.69154	-89.64869	14
K3107	Marion	Crooked Creek	6.9 km NNE Salem at 1400N (Basom Rd.)	38.67911	-88.90274	3.5
K3159	Madison	Sugar Creek	8.3 km SSE Highland at 100N (Rinderer Rd.)	38.67084	-89.63426	5
K3386	Clinton	Lake Branch	4.6 km WNW Breese at 1420N (Old State Rd.)	38.62847	-89.57501	3
K3380	Marion	Trib. of Brubaker Creek	4.9 km ESE Salem, 50 m N 900N (Cross Rd.)	38.60731	-88.89476	2
K3496	Clinton	Trib. Of Beaver Creek	6.9 km ESE Breese, 100 m NW north bridge 1350E	38.57861	-89.45931	2
K3536	Clinton	Sugar Creek	5.6 km SE Trenton, 50 m W 400E (Wellen Rd.)	38.57401	-89.63127	10
K3671	Clinton	Lake Branch	6.9 km SE Trenton at 1000N (Wesclin Rd.)	38.56876	-89.61821	10
K3565	Clinton	Lost Creek	9.3 km ESE Carlyle, S 4 (Huey Rd.)	38.56566	-89.28239	10
K3570	Marion	Trib. Of Crooked Creek	9.1 km SW Salem at Ruble Rd.	38.56233	-89.01046	3
K3621	Clinton	Sugar Creek	6.7 km SSE Trenton at 900N (Court Rd.)	38.55367	-89.64402	12
K3841	Marion	Raccoon Creek	9.8 km ESE Centralia at 625E (Burge Rd.)	38.49877	-89.02647	5
K3963	Washington	Webster Creek	2.9 km SSW Wamac at Irvington Rd.	38.48457	-89.15375	3
K4504	St. Clair	Prairie du Long Creek	8.8 km S Millstadt at Vogel School Rd.	38.38227	-90.08219	3
K4479	St. Clair	West Fork Richmond Creek	10.1 km WSW Freeburg at Knab Rd.	38.38109	-90.01373	4
K4532	Washington	Middle Creek	10.2 km ENE Nashville at CR11 (Pleasant Grove Rd.)	38.37626	-89.27173	1
K4563	St. Clair	Gerhardt Creek	10.3 km S Millstadt at Floraville Rd.	38.36879	-90.09027	3.5
K4571	Washington	Elkhorn Creek	9.2 km SW Okawville at Dove Rd.	38.36664	-89.61089	9
K4586	St. Clair	Prairie du Long Creek	11.7 km SSE Millstadt at Buss Branch Rd.	38.35994	-90.05818	3
K5001	Washington	Trib. Elkhorn Creek	1.8 km NNW Oakdale at Branch Rd.	38.27588	-89.51096	1.5
K5056	Monroe	Rocky Branch	6.1 NNW Red Bud at L Rd.	38.25963	-90.02845	2.5
K5128	Washington	Mud Creek	6.5 km N Coulterville at Roosevelt Rd.	38.24376	-89.59374	4.5
K5424	Randolph	Horse Creek	6.6 km SSE Red Bud at 1st Rd.	38.15455	-89.97341	4

Appendix B. Variable categories, descriptions, and data collection types for base set of 76 independent variables for Kaskaskia River basin streams.

All measurements are proportions except where indicated with ( ). Variables listed in bold are included in the global model. W = local catchment, WT = total catchment, R = local riparian, RT = total riparian.

Variable Category	**Variable**	**Variable Description**	**Data Collection Type**
Stream Size	Width	stream wetted width (meters)	on-site
	Link	Shreve stream order (number of first order reaches)	GIS
Watershed Size	W_WshedAcres	watershed area (acres)	GIS
	WT_WshedAcres	watershed area (acres)	GIS
Topography	**Gradient**	slope of stream channel (ft/ft units)	GIS
Stream Morphology	**Sinuosity**	channel sinuosity (channel length/straight-line valley length)	GIS
Stream Connectivity	Pondupst_length	distance from closest upstream lake/impoundment with area ≥ 5 acres (meters)	GIS
	Pondarea	lake/impoundment area that segment flows through (acres)	GIS
	Damupst_length	distance to closest upstream dam (meters)	GIS
Land Management	**CRP/CREP**	Conservation Reserve/Enhancement Programs at local catchment level	GIS
Land Use	**WT_Urban**	urbanized	GIS
	WT_Agri	agricultural	GIS
	WT_Forest	forested	GIS
	WT_Undisturb	undisturbed	GIS
	WT_Disturb	disturbed	GIS
	W_Urban	urbanized	GIS
	W_Agri	agricultural	GIS
	W_Forest	forested	GIS
	W_Undisturb	undisturbed	GIS
	W_Disturb	disturbed	GIS
	RT_Urban	riparian urbanized	GIS
	RT_Agri	riparian agricultural	GIS
	RT_Forest	riparian forested	GIS
	RT_Undisturb	riparian undisturbed	GIS
	RT_Disturb	riparian disturbed	GIS
	R_Urban	riparian urbanized	GIS
	R_Agri	riparian agricultural	GIS
	R_Forest	riparian forested	GIS
	R_Undisturb	riparian undisturbed	GIS
	R_Disturb	riparian disturbed	GIS
Stream Water Quality	WaterTemp	temperature(degrees celsius)	GIS
	DO	dissolved oxygen (mg/L)	hydrolab
	%Sat.DO	percent saturation oxygen	hydrolab
	Cond	conductivity(microS/cm)	hydrolab
	pH	pH	hydrolab

Appendix B. (continued)

Variable Category	Variable	Variable Description	Data Collection Type
Stream Substrate	Boulder	visible instream boulder	on-site
	Bedrock	visible instream bedrock	on-site
	Cobble	visible instream cobble	on-site
	Gravel	visible instream gravel	on-site
	Sand	visible instream sand	on-site
	Silt	visible instream silt	on-site
	Clay	visible instream clay	on-site
Soil Hydrology	**WT_Perm**	mean soil permeability (inches/hour x 100)	GIS
	W_Perm	mean soil permeability (inches/hour x 100)	GIS
Geology	W_Alluvium/fluvial	fluvial deposit of clay, silt, sand, and gravel	GIS
	W_Bedrock	bedrock in watershed	GIS
	W_Coarse	surficial geology identified as having coarse texture	GIS
	W_Fine-moraine	fine textured morainal deposit	GIS
	W_Fines	surficial geology identified as having fine texture	GIS
	W_Ice-contact	unsorted mixture of sediment deposit at a long standing glacial terminus	GIS
	W_Medium	surficial geology identified as having medium texture	GIS
	W_Medium-moraine	medium textured morainal deposit	GIS
	W_Outwash	glacial meltwater deposit	GIS
	W_Outwash ice contact	all categories classified as outwash or ice contact	GIS
	W_Rocky	bedrock and colluvium	GIS
	WT_Alluvium-fluvial	fluvial deposit of clay, silt, sand, and gravel	GIS
	WT_Bedrock	bedrock in watershed	GIS
	WT_Coarse	surficial geology identified as having coarse texture	GIS
	WT_Fine-moraine	fine textured morainal deposit	GIS
	WT_Fines	surficial geology identified as having fine texture	GIS
	WT_Ice contact	unsorted mixture of sediment deposit at a long standing glacial terminus	GIS
	WT_Loess	windblown sediment	GIS
	WT_Medium	surficial geology identified as having medium texture	GIS
	WT_Medium-moraine	medium textured morainal deposit	GIS
	WT_Outwash	glacial meltwater deposit	GIS
	WT_Outwash ice contact	all categories classified as outwash or ice contact	GIS
	WT_Rocky	bedrock and colluvium	GIS
	W_Bd201	bedrock depths from 1 to 50 ft.	GIS
	W_Bd202	bedrock depths from 50 to 100 ft.	GIS
	W_Bd203	bedrock depths from 100 to 200 ft.	GIS
	W_Bd204	bedrock depths from 200 to 400 ft.	GIS
	WT_Bd201	bedrock depths from 1 to 50 ft.	GIS
	WT_Bd202	bedrock depths from 50 to 100 ft.	GIS
	WT-Bd203	bedrock depths from 100 to 200 ft.	GIS
	WT_Bd204	bedrock depths from 200 to 400 ft.	GIS

Appendix C. Global model variable data for 84 Kaskaskia River basin sites, 2013-2015.
Link is number of first order tributaries. Sinuosity is channel length / straight-line valley length. All other measurements are proportions except where noted.

Site ID	Link	WT_Perm	WT_Urban	Silt	DO (mg/L)	W_Agri	CRP/CREP	W_Fines	WT_Forest	Gradient (ft./ft.units)	Sinuosity
K15	6	158.8186	0.0264	0.045	17.5	0.9374	0.0039	0	0.0044	0.00057	1.092
K46	10	141.967	0.1507	0.08	13.4	0.9065	0.0097	0	0.0095	0.00020	1.112
K44	4	115.0546	0.0006	0.05	16.5	0.9417	0.0132	0	0.0003	0.00052	1.027
K81	21	135.5331	0.0935	0.04	8.8	0.9077	0.0169	0.2324	0.0079	0.00067	1.164
K251-F7	37	115.8438	0.0099	0.05	8.4	0.5673	0.0139	0	0.0105	0.00102	1.380
K272-F8	38	116.3219	0.0098	0.18	8.2	0.5918	0.0456	0	0.0116	0.00008	2.048
K276-F9	41	116.851	0.0094	0.05	8.9	0.3134	0.0485	0	0.0119	0.00000	1.044
K273	40	116.7277	0.0095	0.10	9.4	0.7317	0.2589	0	0.0119	0.00000	1.068
K299	43	117.2603	0.0093	0.10	8.9	0.3488	0.1844	0	0.0131	0.00000	2.277
K302	17	114.9614	0.0168	0.30	10.0	0.5340	0.0019	0	0.0074	0.00030	1.200
K626	2	116.3284	0.0000	0.12	9.6	0.6976	0.1289	0	0.0037	0.00363	1.049
K754	2	59.5485	0.0005	0.045	8.7	0.8095	0.0116	0.9951	0.0240	0.00377	1.149
K795	13	69.1986	0.0001	0.00	8.3	0.6815	0.0529	0.2598	0.0625	0.00019	1.043
K875	4	86.2672	0.0402	0.08	7.1	0.6298	0.0533	1	0.0145	0.00159	1.166
K913	11	97.9146	0.0120	0.14	7.2	0.1738	0.0082	1	0.0357	0.00216	1.138
K950	4	50.5761	0.0071	0.25	7.7	0.6332	0.0846	0.3703	0.0605	0.00169	1.225
K992	2	52.272	0.0004	0.15	4.5	0.7096	0.1031	0.9975	0.0132	0.00227	1.059
K1104	10	51.7186	0.0010	0.00	9.0	0.7992	0.0040	0.9391	0.0022	0.00138	1.211
K1229-F4	28	46.0254	0.0293	0.05	10.3	0.4156	0.0711	0.6639	0.1550	0.00047	1.011
K1128	12	50.075	0.0863	0.01	7.8	0.5571	0.0008	1	0.0130	0.00096	1.064
K1168	15	51.1929	0.0933	0.25	7.6	0.6921	0.0013	0.902	0.0131	0.00101	1.088
K1132	10	54.0332	0.0073	0.02	8.4	0.3233	0.2450	0.0385	0.0570	0.00321	1.042

Appendix C. (continued)

Site ID	Link	WT_Perm	WT_Urban	Silt	DO (mg/L)	W_Agri	CRP/CREP	W_Fines	WT_Forest	Gradient (ft./ft.units)	Sinuosity
K1160	11	53.9491	0.0070	0.10	8.9	0.4113	0.1972	0.3582	0.0576	0.00180	1.124
K1229-F5	28	46.0254	0.0293	0.05	10.8	0.4156	0.0711	0.6639	0.1550	0.00047	1.011
K1199	29	61.7158	0.0057	0.15	9.5	0.3221	0.1017	0.6131	0.1525	0.00181	1.194
K1229-F6	28	46.0254	0.0293	0.03	10.5	0.4156	0.0711	0.6639	0.1550	0.00047	1.011
K1250	6	39.5485	0.0000	0.05	7.8	0.4273	0.5322	0.0344	0.1024	0.00000	1.027
K1303	2	39.13	0.0004	0.00	6.7	0.3626	0.0676	0.6453	0.1850	0.00492	1.077
K1311	11	27.7187	0.0223	0.03	8.4	0.3928	0.0280	1	0.0260	0.00084	1.093
K1424	14	30.2941	0.0164	0.02	7.7	0.2925	0.2057	0.4409	0.0533	0.00202	1.391
K1474	24	49.9843	0.0542	0.01	8.1	0.3761	0.0493	0.5224	0.0360	0.00142	1.119
K1542	28	50.561	0.0444	0.01	8.3	0.1810	0.0733	0.6246	0.0550	0.00166	1.159
K1581	29	51.4221	0.0425	0.01	8.0	0.2788	0.1835	0.6246	0.0639	0.00083	1.390
K1559	15	38.594	0.0005	0.00	8.2	0.0956	0.0269	0	0.0764	0.00301	1.080
K1599-F13	63	56.7136	0.0223	0.06	11.0	0.4468	0.0269	0.3878	0.0948	0.00114	1.002
K1633	22	39.1772	0.0010	0.02	7.9	0.3567	0.0649	0.2579	0.0886	0.00116	1.058
K1648	2	38.9213	0.0000	0.05	8.6	0.4077	0.0342	1	0.0469	0.00420	1.109
K1635	2	32.9294	0.0426	0.03	8.8	0.6999	0.2058	1	0.0477	0.00632	1.135
K1678-F14	69	56.9786	0.0249	0.04	10.3	0.6168	0.0008	0.3882	0.1095	0.00176	1.278
K1849-F15	126	55.7988	0.0295	0.00	8.6	0.5252	0.0423	0.5155	0.1138	0.00008	1.307
K1879	6	46.7757	0.0013	0.01	8.8	0.2469	0.0106	1	0.0798	0.00000	1.020
K1900	2	47.8836	0.0009	0.02	5.2	0.2907	0.0821	1	0.0279	0.00277	1.043
K1977	11	43.9444	0.0084	0.03	7.2	0.1981	0.0723	0.5225	0.2103	0.00172	1.207
K1976-F1	151	54.7598	0.0256	0.02	7.4	0.2407	0.0294	0.4082	0.1191	0.00011	1.225
K2111-F2	170	54.3957	0.0242	0.05	8.1	0.1697	0.0337	0.6042	0.1310	0.00005	2.252
K2113-F10	58	46.7586	0.0032	0.04	8.8	0.3063	0.0463	0.6292	0.1500	0.00036	1.152

Appendix C. (continued)

Site ID	Link	WT_Perm	WT_Urban	Silt	DO (mg/L)	W_Agri	CRP/CREP	W_Fines	WT_Forest	Gradient (ft./ft.units)	Sinuosity
K2182	10	56.1264	0.0167	0.005	6.9	0.7138	0.0017	0.1953	0.0762	0.00015	1.004
K2146-F11	2	45.751	0.0000	0.12	8.1	0.4286	0.1938	0.6843	0.0600	0.00260	1.091
K2168-F3	171	54.5289	0.0239	0.05	9.1	0.3135	0.0372	0.5055	0.1327	0.00057	2.145
K2232	2	27.229	0.0009	0.01	6.2	0.3406	0.3287	1	0.0222	0.00092	1.078
K2261	4	37.3328	0.0268	0.018	8.1	0.2163	0.1660	1	0.0335	0.00082	1.013
K2282-F12	74	45.605	0.0059	0.05	8.4	0.2990	0.0797	0.7401	0.1290	0.00042	1.135
K2349	7	46.6047	0.0022	0.01	8.3	0.3069	0.1283	0.4572	0.1947	0.00148	1.166
K2552	2	43.1876	0.0000	0.05	8.6	0.2803	0.0148	0.5847	0.1693	0.00259	1.293
K2565	11	43.1012	0.0020	0.10	6.7	0.7356	0.0114	0.4652	0.0083	0.00021	1.037
K2668	2	59.6551	0.0729	0.03	7.9	0.7453	0.0823	0.0165	0.2004	0.00070	1.071
K2732	15	35.1996	0.0627	0.09	6.0	0.4295	0.0769	0.4433	0.0632	0.00125	1.185
K2781	13	40.4012	0.0047	0.10	5.6	0.4961	0.0083	0.6875	0.1119	0.00141	1.204
K2756	6	40.5638	0.0006	0.02	6.2	0.3430	0.1422	0.7709	0.1094	0.00085	1.494
K2858	31	35.441	0.0234	0.05	6.8	0.2494	0.1067	0.4519	0.1055	0.00030	1.371
K2922	6	38.905	0.0028	0.10	5.6	0.5073	0.0062	0.5098	0.0579	0.00110	1.544
K3126	22	83.6145	0.0554	0.03	5.2	0.6227	0.0050	0.642	0.0548	0.00072	1.290
K3107	4	28.1244	0.0060	0.025	5.2	0.4255	0.2507	0.6117	0.0810	0.00142	1.102
K3159	23	83.693	0.0516	0.08	5.4	0.5953	0.0054	0.6235	0.0528	0.00011	1.094
K3386	5	32.7357	0.0036	0.20	2.4	0.7533	0.0002	1	0.0035	0.00167	1.053
K3380	3	22	0.0000	0.50	1.4	0.7425	0.0612	1	0.0169	0.00280	1.222
K3496	2	47.955	0.0046	0.70	1.4	0.1563	0.1091	0.9719	0.0365	0.00257	1.049
K3536	48	71.7867	0.0357	0.05	4.9	0.5050	0.1025	0.4366	0.0531	0.00016	2.062
K3671	7	41.4915	0.0252	0.20	1.9	0.5388	0.0268	0.5932	0.0248	0.00053	1.203
K3565	17	25.5356	0.0099	0.05	7.2	0.5616	0.0570	0.5624	0.0375	0.00057	1.158
K3570	4	52.186	0.0000	0.005	6.1	0.1271	0.0064	0.9888	0.2479	0.00789	1.210

Appendix C. (continued)

Site ID	Link	WT_Perm	WT_Urban	Silt	DO (mg/L)	W_Agri	CRP/CREP	W_Fines	WT_Forest	Gradient (ft./ft.units)	Sinuosity
K3621	50	71.9152	0.0346	0.05	5.2	0.4897	0.1004	0.2557	0.0554	0.00285	1.093
K3841	14	51.4538	0.0019	0.05	7.5	0.0769	0.2919	0.5641	0.1982	0.00372	1.528
K3963	8	52.4135	0.0412	0.01	4.7	0.2967	0.0167	0.6459	0.3001	0.00269	1.187
K4504	7	105.3085	0.0127	0.20	5.0	0.5510	0.0630	1	0.1870	0.00219	1.469
K4479	12	115.124	0.0141	0.02	5.4	0.3766	0.0984	0.5779	0.1953	0.00183	1.110
K4532	3	22	0.0005	0.10	6.3	0.7510	0.0366	1	0.0153	0.00375	1.040
K4563	9	90.1412	0.0291	0.02	8.5	0.6289	0.0267	1	0.1582	0.00352	1.094
K4571	41	48.7893	0.0037	0.20	4.4	0.2993	0.0643	0.5529	0.1703	0.00047	1.450
K4586	11	100.9854	0.0131	0.25	7.9	0.7854	0.1085	0.6023	0.1765	0.00455	1.097
K5001	2	30.805	0.0363	0.03	6.5	0.3556	0.0016	0.6286	0.0843	0.00218	1.118
K5056	3	62.2276	0.0190	0.05	7.1	0.6102	0.0387	0.8005	0.1938	0.00479	1.141
K5128	12	44.4825	0.0007	0.23	4.2	0.1441	0.0000	0.1171	0.3737	0.00000	1.122
K5424	48	80.8895	0.0087	0.05	5.2	0.5954	0.0387	0.1367	0.2914	0.00149	1.580

Appendix D. Species of Ephemeroptera, Plecoptera, and Trichoptera collected from Kaskaskia River basin streams, 2013-2015.

Taxon ↓ Site →	**K15**	**K46**	**K44**	**K81**	**K251-F7**	**K272-F8**	**K276-F9**	**K273**	**K299**	**K302**	**K626**	**K754**	**K795**	**K875**	**K913**	**K950**	**K992**	**K1104**	**K1229-F4**	**K1128**	**K1168**
Ephemeroptera																					
Baetidae (13)																					
Acentrella parvula (McDunnough, 1932)	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acentrella sp.	0	0	0	151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acerpenna macdunnoughi (Ide, 1937)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Acerpenna pygmaea (Hagen, 1861)	0	0	312	3	1	4	4	0	0	0	0	0	0	0	11	0	0	0	0	0	4
Anafroptilum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Baetis brunneicolor McDunnough, 1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Baetis flavistriga McDunnough, 1921	0	0	0	1	0	0	0	0	0	0	0	0	0	24	72	19	0	0	4	0	0
Baetis intercalaris McDunnough, 1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labiobaetis dardanus (McDunnough, 1923)	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labiobaetis propinquus (Walsh, 1863)	0	0	0	0	11	40	29	0	0	114	51	0	0	0	0	0	0	0	1	0	0
Labiobaetis sp.	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plauditus dubius (Walsh, 1862)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plauditus sp.	0	1	18	3	19	11	31	23	128	19	107	7	137	55	17	14	0	0	0	0	0
Procloeon rubropictum(McDunnough, 1923)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Procloeon viridoculare (Berner, 1940)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenidae (3)																					
Caenis amica Hagen, 1861	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Caenis diminuta diminuta Walker, 1853	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis latipennis Banks, 1907	5	21	8	73	9	35	13	6	21	0	0	0	24	0	1	102	0	0	6	0	0
Caenis sp.	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ephemerellidae (1)																					
Dannella lita (Burks, 1949)	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Ephemeridae (1)																					
Hexagenia limbata (Serville, 1829)	0	0	17	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexagenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D. (continued)

Taxon ↓ Site →	**K1132**	**K1160**	**K1229-F5**	**K1199**	**K1229-F6**	**K1250**	**K1303**	**K1311**	**K1424**	**K1474**	**K1542**	**K1581**	**K1559**	**K1599-F13**	**K1633**	**K1648**	**K1635**	**K1678-F14**	**K1849-F15**	**K1879**	**K1900**
Ephemeroptera																					
Baetidae (13)																					
Acentrella parvula (McDunnough, 1932)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acentrella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acerpenna macdunnoughi (Ide, 1937)	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acerpenna pygmaea (Hagen, 1861)	76	0	6	26	5	0	183	0	3	6	7	4	14	0	25	3	1	0	4	2	0
Anafroptilum sp.	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis brunneicolor McDunnough, 1925	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis flavistriga McDunnough, 1921	8	9	4	1	4	0	112	0	0	0	1	0	24	0	12	1	0	0	0	3	1
Baetis intercalaris McDunnough, 1921	1	3	2	0	10	0	10	0	0	1	2	3	2	0	4	3	0	0	0	18	0
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labiobaetis dardanus (McDunnough, 1923)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0
Labiobaetis propinquus (Walsh, 1863)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labiobaetis sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Plauditus dubius (Walsh, 1862)	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plauditus sp.	0	180	0	38	0	152	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4
Procloeon rubropictum(McDunnough, 1923)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procloeon viridoculare (Berner, 1940)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenidae (3)																					
Caenis amica Hagen, 1861	0	0	0	0	0	0	0	7	6	0	0	0	0	2	0	0	14	0	1	0	0
Caenis diminuta diminuta Walker, 1853	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Caenis latipennis Banks, 1907	2	4	18	36	7	56	0	8	7	28	14	13	0	17	0	2	0	41	3	0	4
Caenis sp.	1	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0	39	5	14	0	8
Ephemerellidae (1)																					
Dannella lita (Burks, 1949)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeridae (1)																					
Hexagenia limbata (Serville, 1829)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hexagenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Appendix D. (continued)

Taxon ↓ Site →	**K1977**	**K1976-F1**	**K2111-F2**	**K2113-F10**	**K2182**	**K2146-F11**	**K2168-F3**	**K2232**	**K2261**	**K2282-F12**	**K2349**	**K2552**	**K2565**	**K2668**	**K2732**	**K2781**	**K2756**	**K2858**	**K2922**	**K3126**	**K3107**
Ephemeroptera																					
Baetidae (13)																					
Acentrella parvula (McDunnough, 1932)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acentrella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acerpenna macdunnoughi (Ide, 1937)	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acerpenna pygmaea (Hagen, 1861)	2	6	14	25	1	31	7	0	1	8	0	0	32	0	58	83	3	0	13	0	1
Anafroptilum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis brunneicolor McDunnough, 1925	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Baetis flavistriga McDunnough, 1921	0	0	8	4	2	1	0	0	12	0	0	29	0	0	0	0	0	0	1	0	0
Baetis intercalaris McDunnough, 1921	0	3	59	39	0	41	12	0	2	54	0	0	0	0	11	2	0	0	0	15	0
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Labiobaetis dardanus (McDunnough, 1923)	0	2	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labiobaetis propinquus (Walsh, 1863)	0	2	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labiobaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plauditus dubius (Walsh, 1862)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plauditus sp.	0	0	28	3	28	2	2	0	50	8	0	0	0	0	0	0	1	0	0	0	13
Procloeon rubropictum(McDunnough, 1923)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procloeon viridoculare (Berner, 1940)	0	1	0	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Caenidae (3)																					
Caenis amica Hagen, 1861	2	7	0	1	0	0	0	4	0	2	0	0	12	1	0	3	12	40	0	0	3
Caenis diminuta diminuta Walker, 1853	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis latipennis Banks, 1907	1	35	10	8	6	21	9	0	4	3	0	0	1	0	15	8	21	125	0	214	4
Caenis sp.	1	4	6	16	28	0	0	0	0	1	0	0	5	0	0	0	0	0	0	1	4
Ephemerellidae (1)																					
Dannella lita (Burks, 1949)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeridae (1)																					
Hexagenia limbata (Serville, 1829)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexagenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D. (continued)

Taxon ↓ Site →	K3159	K3386	K3380	K3496	K3536	K3671	K3565	K3570	K3621	K3841	K3963	K4504	K4479	K4532	K4563	K4571	K4586	K5001	K5056	K5128	K5424	Σ
Ephemeroptera																						
Baetidae (13)																						
Acentrella parvula (McDunnough, 1932)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Acentrella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	151
Acerpenna macdunnoughi (Ide, 1937)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Acerpenna pygmaea (Hagen, 1861)	2	0	0	0	0	0	0	0	0	174	0	12	38	2	2	3	65	20	55	0	10	1372
Anafroptilum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	7
Baetis brunneicolor McDunnough, 1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Baetis flavistriga McDunnough, 1921	0	0	0	0	0	0	0	0	0	0	0	44	75	0	147	0	27	0	66	0	0	716
Baetis intercalaris McDunnough, 1921	3	0	0	0	0	0	0	1	3	0	0	15	50	0	79	0	14	0	3	0	77	543
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
Labiobaetis dardanus (McDunnough, 1923)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Labiobaetis propinquus (Walsh, 1863)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	253
Labiobaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
Plauditus dubius (Walsh, 1862)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Plauditus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1100
Procloeon rubropictum (McDunnough, 1923)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Procloeon viridoculare (Berner, 1940)	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	7
Caenidae (3)																						
Caenis amica Hagen, 1861	0	1	0	0	0	0	9	0	0	3	0	2	1	0	0	0	1	0	0	0	0	138
Caenis diminuta diminuta Walker, 1853	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Caenis latipennis Banks, 1907	1	4	0	0	302	0	110	3	411	6	7	18	15	0	0	0	35	9	0	0	0	1990
Caenis sp.	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	144
Ephemerellidae (1)																						
Dannella lita (Burks, 1949)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Ephemeridae (1)																						
Hexagenia limbata (Serville, 1829)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	23
Hexagenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix D. (continued)

Taxon ↓ Site →	**K15**	**K46**	**K44**	**K81**	**K251-F7**	**K272-F8**	**K276-F9**	**K273**	**K299**	**K302**	**K626**	**K754**	**K795**	**K875**	**K913**	**K950**	**K992**	**K1104**	**K1229-F4**	**K1128**	**K1168**
Heptageniidae (7)																					
Heptagenia elegantula (Eaton, 1885)	0	0	0	0	30	71	88	2	2	81	0	0	5	0	0	0	0	0	0	0	0
Leucrocuta aphrodite (McDunnough, 1926)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucrocuta sp.	1	0	0	0	0	1	15	0	3	0	0	13	2	0	0	0	0	0	0	0	0
Maccaffertium exiguum(Traver, 1933)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maccaffertium terminatum terminatum (Walsh,	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nixe perfida (McDunnough, 1926)	0	0	0	0	0	1	0	0	0	7	63	0	5	1	1	0	0	0	0	0	0
Nixe sp.	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Stenacron interpunctatum(Say,1839)	0	0	7	1	0	1	0	0	0	0	0	0	0	0	1	24	0	0	5	0	0
Stenonema femoratum (Say,1823)	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	4	0	0
Leptohyphidae (1)																					
Tricorythodes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
Leptophlebiidae (1)																					
Paraleptophlebia praepedita (Eaton, 1884)	0	0	0	0	0	0	0	0	0	140	13	0	0	0	0	0	0	0	1	1	0
Paraleptophlebia sp.	0	0	5	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0
Siphlonuridae (1)																					
Siphlonurus marshalli Traver, 1934	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0	0
Siphlonurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plecoptera (4)																					
Capniidae (1)																					
Allocapnia sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemouridae(1)																					
Amphinemura sp.	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0
Perlidae (3)																					
Neoperla clymene Zwick, 1983	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Perlesta lagoi Stark, 1989	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlesta ephelida Grubbs & DeWalt, 2012	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Perlesta sp.	0	0	0	0	122	117	107	55	68	18	0	0	19	0	0	0	0	0	1	0	0
Perlodidae (2)																					
Isoperla decepta Frison, 1935	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Isoperla nana (Walsh,1862)	0	0	40	0	0	0	0	3	8	0	9	0	0	0	0	0	0	0	0	0	0

Appendix D. (continued)

Taxon ↓ Site →	**K1132**	**K1160**	**K1229-F5**	**K1199**	**K1229-F6**	**K1250**	**K1303**	**K1311**	**K1424**	**K1474**	**K1542**	**K1581**	**K1559**	**F13**	**K1633**	**K1648**	**K1635**	**F14**	**F15**	**K1879**	**K1900**
Heptageniidae (7)																					
Heptagenia elegantula (Eaton, 1885)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Leucrocuta aphrodite (McDunnough, 1926)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucrocuta sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Maccaffertium exiguum(Traver, 1933)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maccaffertium terminatum terminatum (Walsh, 1862)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nixe perfida (McDunnough, 1926)	0	0	0	65	0	1	0	3	6	0	2	0	0	0	0	14	7	0	4	0	0
Nixe sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stenacron interpunctatum(Say,1839)	3	1	6	52	5	0	1	0	3	0	0	0	0	0	3	0	0	2	0	1	0
Stenonema femoratum (Say,1823)	0	0	0	4	0	0	21	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Leptohyphidae (1)																					
Tricorythodes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0
Leptophlebiidae (1)																					
Paraleptophlebia praepedita (Eaton, 1884)	0	0	0	0	1	0	0	3	5	0	0	0	0	0	0	0	0	0	0	0	0
Paraleptophlebia sp.	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Siphlonuridae (1)																					
Siphlonurus marshalli Traver, 1934	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siphlonurus sp.	0	0	1	24	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Plecoptera (4)																					
Capniidae (1)																					
Allocapnia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemouridae(1)																					
Amphinemura sp.	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlidae (3)																					
Neoperla clymene Zwick, 1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlesta lagoi Stark, 1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlesta ephelida Grubbs & DeWalt, 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlesta sp.	0	0	0	2	0	0	0	1	0	0	0	0	0	1	0	0	0	9	1	0	0
Perlodidae (2)																					
Isoperla decepta Frison, 1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoperla nana (Walsh,1862)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D. (continued)

Taxon ↓ / Site →	**K1977**	**K1976-F1**	**K2111-F2**	**K2113-F10**	**K2182**	**K2146-F11**	**K2168-F3**	**K2232**	**K2261**	**K2282-F12**	**K2349**	**K2552**	**K2565**	**K2668**	**K2732**	**K2781**	**K2756**	**K2858**	**K2922**	**K3126**	**K3107**
Heptageniidae (7)																					
Heptagenia elegantula (Eaton, 1885)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucrocuta aphrodite (McDunnough, 1926)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Leucrocuta sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	1
Maccaffertium exiguum(Traver, 1933)	0	2	0	3	0	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Maccaffertium terminatum terminatum (Walsh, 1862)	0	0	8	2	0	13	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nixe perfida (McDunnough, 1926)	1	0	9	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
Nixe sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stenacron interpunctatum(Say,1839)	0	3	1	21	4	15	7	0	0	5	0	0	0	0	0	0	0	4	0	3	0
Stenonema femoratum (Say,1823)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptohyphidae (1)																					
Tricorythodes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptophlebiidae (1)																					
Paraleptophlebia praepedita (Eaton, 1884)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraleptophlebia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siphlonuridae (1)																					
Siphlonurus marshalli Traver, 1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siphlonurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plecoptera (4)																					
Capniidae (1)																					
Allocapnia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemouridae(1)																					
Amphinemura sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlidae (3)																					
Neoperla clymene Zwick, 1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlesta lagoi Stark, 1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlesta ephelida Grubbs & DeWalt, 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perlesta sp.	0	3	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Perlodidae (2)																					
Isoperla decepta Frison, 1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoperla nana (Walsh,1862)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D. (continued)

Taxon ↓ **Site →**	**K3159**	**K3386**	**K3380**	**K3496**	**K3536**	**K3671**	**K3565**	**K3570**	**K3621**	**K3841**	**K3963**	**K4504**	**K4479**	**K4532**	**K4563**	**K4571**	**K4586**	**K5001**	**K5056**	**K5128**	**K5424**	**Σ**
Heptageniidae (7)																						
Heptagenia elegantula (Eaton, 1885)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	284
Leucrocuta aphrodite (McDunnough, 1926)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Leucrocuta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42
Maccaffertium exiguum(Traver, 1933)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Maccaffertium terminatum terminatum (Walsh, 1862)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
Nixe perfida (McDunnough, 1926)	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	198
Nixe sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5
Stenacron interpunctatum(Say,1839)	3	0	0	0	55	0	3	4	99	13	0	6	1	0	1	1	6	0	0	0	16	387
Stenonema femoratum (Say,1823)	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	5	0	0	0	0	47
Leptohyphidae (1)																						
Tricorythodes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Leptophlebiidae (1)																						
Paraleptophlebia praepedita (Eaton, 1884)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	165
Paraleptophlebia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Siphlonuridae (1)																						
Siphlonurus marshalli Traver, 1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Siphlonurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
Plecoptera (4)																						
Capniidae (1)																						
Allocapnia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Nemouridae(1)																						
Amphinemura sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Perlidae (3)																						
Neoperla clymene Zwick, 1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Perlesta lagoi Stark, 1989	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Perlesta ephelida Grubbs & DeWalt, 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Perlesta sp.	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	530
Perlodidae (2)																						
Isoperla decepta Frison, 1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Isoperla nana (Walsh,1862)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60

Appendix D. (continued)

Taxon ↓ **Site →**	**K15**	**K46**	**K44**	**K81**	**K251-F7**	**K272-F8**	**K276-F9**	**K273**	**K299**	**K302**	**K626**	**K754**	**K795**	**K875**	**K913**	**K950**	**K992**	**K1104**	**K1229-F4**	**K1128**	**K1168**
Hydropsychidae (3)																					
Cheumatopsyche sp.	0	0	0	11	1	1	0	0	0	0	0	0	1	1	3	1	0	1	0	7	56
Hydropsyche betteni Ross, 1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche simulans Ross, 1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroptilidae (1)																					
Hydroptila sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Leptoceridae (5)																					
Ceraclea maculata (Banks, 1899)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche candida (Hagen, 1861)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche diarina(Ross, 1944)	0	0	0	0	8	7	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche sp.	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oecetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Triaenodes melacus(Ross, 1947)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilidae (1)																					
Pycnopsyche sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhyacophilidae (1)																					
Rhacophila lobifera Betten, 1934	1	0	0	0	0	0	0	5	4	0	13	20	3	0	2	0	0	1	0	0	0
total	7	22	440	261	204	294	320	95	240	380	261	42	210	81	108	165	4	2	23	9	61

Appendix D. (continued)

Taxon ↓ Site →	K1132	K1160	K1229-F5	K1199	K1229-F6	K1250	K1303	K1311	K1424	K1474	K1542	K1581	K1559	K1599-F13	K1633	K1648	K1635	K1678-F14	K1849-F15	K1879	K1900
Hydropsychidae (3)																					
Cheumatopsyche sp.	35	40	0	26	0	0	31	4	1	24	30	16	26	12	60	21	12	57	5	94	0
Hydropsyche betteni Ross, 1938	0	8	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0
*Hydropsyche simulans*Ross, 1938	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Hydroptilidae (1)																					
Hydroptila sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoceridae (5)																					
Ceraclea maculata (Banks, 1899)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche candida (Hagen, 1861)	0	0	0	1	0	0	0	0	0	0	0	0	0	28	0	0	0	72	46	0	0
Nectopsyche diarina(Ross, 1944)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Oecetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triaenodes melacus Ross, 1947	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilidae (1)																					
Pycnopsyche sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rhyacophilidae (1)																					
Rhacophila lobifera Betten, 1934	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
total	127	247	39	296	32	210	372	27	32	59	59	36	67	64	105	44	75	199	85	120	21

Appendix D. (continued)

Taxon ↓ Site →	**K1977**	**K1976-F1**	**K2111-F2**	**K2113-F10**	**K2182**	**K2146-F11**	**K2168-F3**	**K2232**	**K2261**	**K2282-F12**	**K2349**	**K2552**	**K2565**	**K2668**	**K2732**	**K2781**	**K2756**	**K2858**	**K2922**	**K3126**	**K3107**
Hydropsychidae (3)																					
Cheumatopsyche sp.	19	43	8	0	27	1	5	25	18	2	11	0	25	15	130	14	27	3	19	34	0
Hydropsyche betteni Ross, 1938	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
*Hydropsyche simulans*Ross, 1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroptilidae (1)																					
Hydroptila sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoceridae (5)																					
Ceraclea maculata (Banks, 1899)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche candida (Hagen, 1861)	0	102	55	1	0	9	23	0	0	1	0	0	0	0	2	0	0	0	0	0	0
Nectopsyche diarina(Ross, 1944)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nectopsyche sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oecetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triaenodes melacus Ross, 1947	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilidae (1)																					
Pycnopsyche sp.	0	0	3	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Rhyacophilidae (1)																					
Rhacophila lobifera Betten, 1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0
total	26	214	220	126	96	140	77	30	90	93	11	29	75	17	216	114	71	172	33	267	27

Appendix D. (continued)

Taxon ↓ Site →	K3159	K3386	K3380	K3496	K3536	K3671	K3565	K3570	K3621	K3841	K3963	K4504	K4479	K4532	K4563	K4571	K4586	K5001	K5056	K5128	K5424	Σ
Hydropsychidae (3)																						
Cheumatopsyche sp.	40	0	0	0	60	0	0	21	31	76	82	61	53	5	23	3	108	22	0	0	37	1625
Hydropsyche betteni Ross, 1938	0	0	0	0	0	0	0	0	0	0	0	20	0	0	7	0	0	0	0	0	0	40
*Hydropsyche simulans*Ross, 1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Hydroptilidae (1)																						
Hydroptila sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Leptoceridae (5)																						
Ceraclea maculata (Banks, 1899)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Nectopsyche candida (Hagen, 1861)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	340
Nectopsyche diarina(Ross, 1944)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47
Nectopsyche sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Oecetis sp.	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Triaenodes melacus Ross, 1947	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Limnephilidae (1)																						
Pycnopsyche sp.	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	1	12
Rhyacophilidae (1)																						
Rhacophila lobifera Betten, 1934	0	0	0	0	0	0	0	4	0	2	4	0	0	0	0	0	0	0	0	0	0	69
total	49	5	0	0	420	0	125	38	544	276	96	184	241	7	259	7	263	51	124	2	142	10522